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Cover image: *Deparia petersenii* subsp. *congrua*. Mature deeply 1-pinnate-pinnatifid frond.

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Contents

Introduction

Athyriaceae is a large family, which reaches its greatest diversity in tropical and north temperate zones. It is represented in New Zealand by the genera *Athyrium*, *Deparia*, and *Diplazium*, with a total of six species. *Diplazium australe* occurs in lowland districts throughout much of the North Island, and in Marlborough, Nelson, and Westland as far south as Hokitika; it is also found in the eastern states of Australia. Two naturalised species, *D. esculentum* and *D. nipponicum*, occur in a few places in the northern half of the North Island and are recorded here for the first time.

Deparia petersenii subsp. *congrua* has a similar distribution to *Diplazium australe*, but its biostatus is uncertain. It is treated here as including *D. tenuifolia*, a species that was previously regarded as distinct. *D. petersenii* subsp. *congrua* was not recorded until the late 19th century and appears to have spread widely since then. *D. petersenii* subsp. *petersenii* is known to have naturalised in several other parts of the world but is recorded here in New Zealand for the first time. *Athyrium filix-femina* and *A. otophorum* are both naturalised species; *A. filix-femina* occurs in urban areas from Auckland to Dunedin, but *A. otophorum* is a casual recorded only from the Far North.

All members of the family in New Zealand are terrestrial ferns bearing scales, and sometimes hairs. They are recognised by their elongated sori, which are arranged singly or back-to-back along the veins, or bent across the vein at one end.

Athyriaceae Alston, *Taxon* 5: 25 (1956)

Type taxon: *Athyrium* Roth

Terrestrial or rupestral ferns (NZ) or sometimes rheophytic (not NZ). Rhizomes short- to long-creeping or erect, scaly (NZ) and sometimes also hairy (not NZ). Fronds monomorphic, not articulated to rhizome. Laminae entire to 4-pinnate, anadromous or catadromous, herbaceous to coriaceous, scaly and sometimes hairy. Veins free or rarely anastomosing. Sori elongated along veins and either single or paired back-to-back or bent across the vein at one end or horseshoe-shaped (NZ) or rarely round (not NZ), borne on abaxial surface away from margins; receptacles flat; paraphyses absent; indusia present, same shape as the sori, opening away from the vein; sporangial maturation mixed. Sporangia with vertical annulus, usually 64 spores per sporangium. Homosporous; spores monolete, lacking chlorophyll; perispores nearly plain to coarsely tuberculate, echinate or folded.

Taxonomy: A family of 3 genera and about 650 species (PPG 1 2016).

Rothfels et al. (2012) undertook a family-level classification for the eupolypod II clade of leptosporangiate ferns, one of two major clades within the eupolypod ferns that, together with Lindsaeaceae, Saccolomataceae, Dennstaedtiaceae, and Pteridaceae, make up the Polypodiales. Rothfels et al. (2012) argued that the eupolypod II clade was one of the few that was still poorly understood at the time of the classification proposed by Smith et al. (2006), and they therefore presented a new classification derived largely from published molecular studies.

Athyriaceae was previously included by Kramer (1990) within the subfamily Athyrioideae in a very broadly construed Dryopteridaceae. Smith et al. (2006) separated Dryopteridaceae from Woodsiaceae, the latter comprising both the woodsioid and athyrioid ferns. Pichi Sermolli (1977) and Wang et al. (2003) further sub-divided Athyriaceae, distinguishing *Woodsia* and its segregates as a much-reduced Woodsiaceae. Rothfels et al. (2012) went even further and subdivided Athyriaceae into five families, separating off four small groups from the much larger Athyriaceae. These included Cystopteridaceae, Diplaziopsidaceae, Rhachidosoraceae, and Hemidictyaceae, which were in many respects somewhat closer to Aspleniaceae.

Five genera, *Anisocampium*, *Athyrium*, *Cornopteris*, *Deparia*, and *Diplazium*, were recognised within Athyriaceae by Rothfels et al. (2012), but this was reduced to just three by PPG 1 (2016). Although Wei et al. (2018) subsequently reinstated *Anisocarpium* and *Cornopteris,* and resurrected *Pseudathyrium*, in order to recognise monophyletic taxa within the family, we prefer to accept just the three large genera of PPG 1.

The three genera, *Athyrium*, *Deparia*, and *Diplazium*, occur in New Zealand. *Deparia* is distinguished by the U-shaped groove on the adaxial surface of the rachis, which is not open and confluent with the grooves of the pinna costae. In New Zealand it is also distinguished by having both hairs and scales on the laminae. *Diplazium* is distinct from *Athyrium* in having a U-shaped rachis groove, and sori that are linear and either single or sometimes paired back-to-back, whereas *Athyrium* has a V-shaped rachis groove and sori that are J-shaped, horseshoe-shaped or linear. Athyrioid ferns are sister to the diplazioid ferns, and together they are sister to the deparioid ferns (Rothfels et al. 2012).

1 Laminae scaly and hairy; groove on adaxial surface of rachis not open and confluent with grooves of pinna costae..... *Deparia*

Laminae scaly or glabrous but not hairy; groove on adaxial surface of rachis open and confluent with grooves of pinna costae.....2

2 Groove on adaxial surface of rachis V-shaped; sori linear, single on veins, or bent across the vein at one end, not paired back-to-back; rhizomes always erect; veins always free..... ..... *Athyrium*

Groove on adaxial surface of rachis U-shaped; sori linear, either single or paired back-to-back along veins; rhizomes erect or rarely long-creeping; veins free or rarely anastomosing..... ..... *Diplazium*

Distribution: A subcosmopolitan family, but less common in south temperate regions than in the tropics and north temperate zone. Two non-endemic genera and one naturalised genus in New Zealand with six species; none endemic.

Biostatus: Indigenous (Non-endemic).

Table 1: Number of species in New Zealand within *Athyriaceae* Alston

Category	Number
Indigenous (Non-endemic)	2
Exotic: Fully Naturalised	1
Exotic: Casual	3
Total	**6**

Recognition: The family Athyriaceae comprises terrestrial ferns that are most easily recognised by their elongated sori arranged singly or back-to-back along the veins, or bent across the vein at one end (J-shaped). The fronds bear non-clathrate scales and the adaxial rachis is grooved. Athyriaceae is distinguished from Aspleniaceae by its non-clathrate scales, base chromosome number of x = 40 or 41 rather than 36, and often by its sori when they are arranged back-to-back or bent across the veins rather than confined to one side of the vein as in Aspleniaceae.

Athyrium Roth, *Tent. Fl. Germ. 3 (1.1),* 31, 58 (1799)

Type taxon: *Athyrium filix-femina* (L.) Roth

Etymology: From the Greek *a* (without) and *thyra* (door), a reference to the late opening or reflexing of the indusia to expose the sporangia.

Terrestrial ferns. Rhizomes erect (NZ) or rarely creeping (not NZ), scaly (NZ) and rarely hairy (not NZ). Rhizome scales non-clathrate, narrowly ovate. Stipes adaxially grooved, scaly. Laminae 2-pinnate to 2-pinnate-pinnatifid (NZ) or also entire and 3-pinnate-pinnatifid (not NZ), usually herbaceous, scaly (NZ) and sometimes hairy (not NZ), groove of rachis V-shaped and continuous with grooves of pinna midribs. Veins free. Sori elongated along veins and either single or bent across the vein at one end or horseshoe-shaped (NZ) or rarely round (not NZ), indusia same shape as the sori (NZ) or rarely absent (not NZ), opening away from the vein, entire or laciniate. Spores monolete, perispores nearly plain to rugose (NZ), rarely winged (not NZ).

Taxonomy: A genus of c. 230 species (PPG 1 2016). *Athyrium* is one of the largest genera of ferns and one of the most taxonomically difficult, complicated by a high degree of hybridisation. It was circumscribed broadly by PPG 1 (2016), but Wei et al. (2018) segregated *Anisocampium*, *Cornopteris*, and *Pseudathyrium* as separate genera and recognised 10 sections within *Athyrium*.

Two naturalised species occur in New Zealand (Brownsey in Webb et al. 1988; Heenan et al. 2004).

1 Secondary pinnae adnate to costa; basal acroscopic lobe on secondary pinnae about equal to other lobes..... *filix-femina*
Secondary pinnae short-stalked; basal acroscopic lobe on secondary pinnae longer than other lobes..... ..... *otophorum*

Distribution: A widespread genus but one largely concentrated in the northern hemisphere, especially in eastern and south-eastern Asia and the Himalayas, with few species in the southern hemisphere (Kramer 1990). None indigenous to Australia or most of the Pacific islands. Two naturalised species in New Zealand.

Biostatus: Exotic; fully naturalised.

Table 2: Number of species in New Zealand within *Athyrium* Roth

Category	Number
Exotic: Fully Naturalised	1
Exotic: Casual	1
Total	**2**

Recognition: In New Zealand, species of *Athyrium* can be recognised by their 2-pinnate to 2-pinnate-pinnatifid scaly fronds, the presence of a V-shaped groove on the abaxial surface of the rachis, which is confluent with the grooves of the pinna costae, and their sori, which are J-shaped and bent across the vein at one end.

Cytology: The base chromosome number in *Athyrium* is x = 40 (Kramer 1990).

Athyrium filix-femina (L.) Roth, *Tent. Fl. Germ. 3 (1.1),* 65 (1799)

≡ *Polypodium filix-femina* L., *Sp. Pl.* 1090 (1753)

Lectotype (selected by Jonsell & Jarvis 1994): Tab. 180, f. 4 in *Phytographia* (Plukenet 1692; see Jarvis 2007), (*n.v.*)

Etymology: From the Latin *filix* (fern) and *femina* (female), the female fern.

Vernacular name: lady fern

Rhizomes erect, sometimes forming short woody trunks; bearing scales. Rhizome scales narrowly ovate, 8–12 mm long, 3–4 mm wide, chestnut-brown to dark brown. Fronds 260–950 mm long. Stipes 45–310 mm long, pale brown or purplish-brown; bearing narrowly ovate pale to dark brown scales, 5–13 mm long, 0.5–3 mm wide. Rachises pale brown, winged distally, grooved, bearing scales up to 8 mm long and 1.5 mm wide. Laminae 2-pinnate to 2-pinnate-pinnatifid, elliptic to narrowly elliptic, tapering to a pinnatifid apex, 210–690 mm long, 90–400 mm wide, yellow-green on both surfaces, herbaceous, bearing linear scales up to 1.5 mm long. Primary pinnae in 20–35 pairs, narrowly spaced or overlapping distally, narrowly ovate, narrowly winged throughout; the longest at or below the middle, 45–200 mm long, 18–50 mm wide, apices acuminate, short-stalked. Secondary pinnae decreasing very gradually in length along each primary pinna to the distal end or more or less equal in length and decreasing only at the distal end; the longest secondary pinnae narrowly ovate, 10–27 mm long, 5–10 mm wide, apices acute, bases adnate, margins serrate to divided more than halfway to midrib; the distal secondary pinnae ovate or narrowly ovate to oblong, apices acute or obtuse, bases adnate. Tertiary segments 2–6 mm long, 1–3 mm wide, apices obtuse; the basal acroscopic lobe about the same length as the others. Sori elongated along veins, either linear or bent across the vein at one end; indusia 0.7–1 mm long, opening away from vein, free margins laciniate or deeply toothed.

Distribution: North Island: Auckland.

South Island: Canterbury, Otago.

Altitudinal range: 0–30 m.

A widespread northern temperate species naturalised in lowland urban areas of Auckland, Hamilton, Christchurch, and Dunedin, now also moving into areas surrounding Christchurch.

Biostatus: Exotic; fully naturalised.

Habitat: *Athyrium filix-femina* occurs most frequently on stream and river banks, either under shade or in the open, but also occurs in swampy peat. It is particularly well established along the banks of the Avon River and in the Travis Wetland in Christchurch, but is also found in Riccarton Bush.

First record: Molloy (1976, p. 16). Voucher CHR 172587, WELT P020885, 1966.

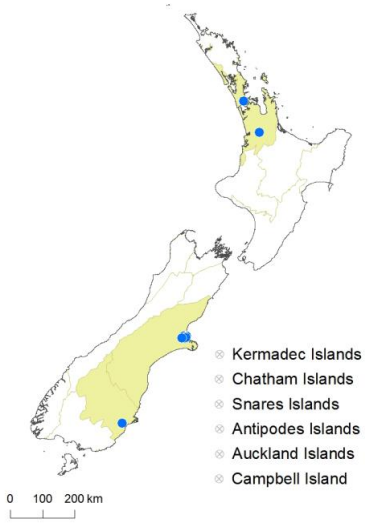

Fig. 1: *Athyrium filix-femina* distribution map based on databased records at AK, CHR & WELT.

Recognition: *Athyrium filix-femina* is a naturalised plant confined to lowland areas around urban centres. It is a terrestrial species with an erect rhizome and fronds that are more or less 2-pinnate. It is most easily recognised by its elongated sori, which are usually linear along one side of a vein, or bent across the vein at one end. The free margins of the indusia are laciniate or deeply toothed. It is distinguished from *A. otophorum* by the secondary pinnae, which are adnate to the costae rather than short-stalked, and by the basal acroscopic lobe on each secondary pinna, which is about the same size as the others, rather than being significantly longer.

The species is extremely variable worldwide and many different cultivars are recognised (Hoshizaki & Moran 2001). Plants in Auckland, Hamilton, and Dunedin are generally more finely divided than those from Christchurch, and may have resulted from different introductions to New Zealand.

Fig. 2: *Athyrium filix-femina*. Mature plant growing on open river bank.

Fig. 3: *Athyrium filix-femina*. Mature 2-pinnate-pinnatifid frond.

Fig. 4: *Athyrium filix-femina*. Adaxial surface of rachis showing V-shaped groove confluent with grooves of pinna costae.

Fig. 5: *Athyrium filix-femina*. Base of stipe showing narrowly ovate, chestnut-brown scales.

Fig. 6: *Athyrium filix-femina*. Abaxial surface of fertile frond showing mature sori extending along the veins.

Fig. 7: *Athyrium filix-femina*. Abaxial surface of fertile pinna showing sori elongated along the veins.

Athyrium otophorum (Miq.) Koidz., *Fl. Symb. Orient.-Asiat.* 40 (1930)

≡ *Asplenium otophorum* Miq., *Ann. Mus. Bot. Lugduno-Batavi 3,* 3: 175 (1867)
Syntype: Japan, *Buerger*, L 0052444 (!online)

Etymology: From the Greek *otos* (ear) and *phorus* (bearing), a reference to the shape of the pinnules.

Distribution: North Island: Northland.

Altitudinal range: 10 m.

Known from one locality in Kerikeri.

Occurs naturally in China, Korea, Japan, and Taiwan.

Biostatus: Exotic; casual.

Habitat: Recorded as sporadically self-sown along the edges of paths and among ferns in a cultivated area at Kerikeri. Self-sown sporelings have also been recorded in a shade-house at Helensville.

First record: Heenan et al. (2004, p. 802). Voucher AK 283997, 2003.

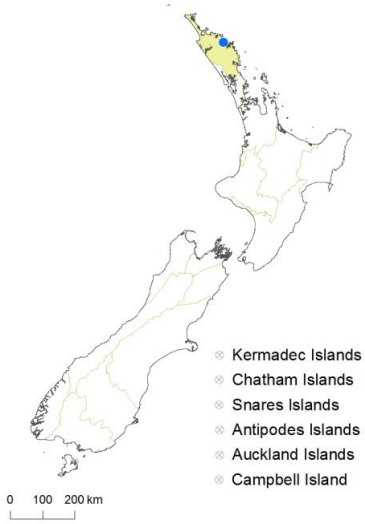

Fig. 8: *Athyrium otophorum* distribution map based on databased records at AK, CHR & WELT.

Recognition: In New Zealand *Athyrium otophorum* has a short, erect rhizome giving rise to fronds up to 550 mm long. It has yellow-brown stipes up to 220 mm long, bearing linear or narrowly ovate, blackish-brown scales proximally. The laminae are 2-pinnate to 2-pinnate-pinnatifid, ovate to broadly ovate, up to 350 mm long and 350 mm wide, and glabrous or with occasional narrow scales on the rachis. The primary pinnae are up to 200 mm long and 60 mm wide. The secondary pinnae are up to 40 mm long and 12 mm wide, shortly-stalked, lobed or deeply pinnatifid, with the basal acroscopic lobe longer than the others. The indusia are entire and elongated along the veins and up to 2 mm long.

Fig. 9: *Athyrium otophorum*. Herbarium specimen from Helensville, AK 289666, showing 2-pinnate-pinnatifid frond with expanded basal acroscopic lobe on secondary pinnae.

Fig. 10: *Athyrium otophorum*. Herbarium specimen from Kerikeri, AK 283997, showing 2-pinnate-pinnatifid frond with expanded basal acroscopic lobe on secondary pinnae.

Deparia Hook. & Grev., *Icon. Filic. 2,* t. 154 (1829)

= *Lunathyrium* Koidz., *Acta Phytotax. Geobot.* 1: 30 (1932)

= *Athyriopsis* Ching, *Acta Phytotax. Sin.* 9: 63 (1964)

Type taxon: *Deparia macraei* Hook. & Grev.

Etymology: From the Greek *depas* (dish or saucer), a reference to the minutely dish-like form of the sori in the type species.

Terrestrial ferns. Rhizomes creeping (NZ) or erect (not NZ), scaly. Rhizome scales non-clathrate, narrowly ovate or ovate. Stipes adaxially grooved, scaly and hairy. Laminae 1-pinnate-pinnatifid to 1-pinnate-bipinnatifid (NZ) or entire to 3-pinnate (not NZ), herbaceous, scaly and hairy, groove of rachis U-shaped and not continuous with grooves of pinna midribs. Veins free. Sori elongated along veins and either single or paired on a vein (NZ) or rarely round or bent across the vein at one end (not

NZ), indusia same shape as the sori, opening away from the vein, margins toothed or laciniate. Spores monolete, perispores echinate.

Taxonomy: A genus of c. 70 species (PPG 1 2016). *Deparia* and allied genera in Japan were more clearly defined by Kato (1977), and subsequently *Deparia* was revised in the Pacific region (Kato 1984). Several genera that had been recognised earlier were reduced to sections within *Deparia*, including *Lunathyrium* and *Athyriopsis*.

Allan (1961) had earlier misidentified the sole New Zealand species as *Athyrium japonicum* (Thunb.) Copel. which, as *Deparia japonica* (Thunb.) M.Kato, is now known to be confined to the Himalayas, China, Korea, and Japan (Kato 1984).

Kuo et al. (2016, 2018) investigated over 80% of the species in *Deparia* using both morphological characters and analysis of four chloroplast DNA regions. They identified seven major clades that could be characterised morphologically. New Zealand plants of *D. petersenii* fell within the AT clade, roughly approximating to the previously recognised genus *Athyriopsis*. The lineage is characterised by creeping rhizomes, toothed indusial margins, and usually by auricled basal pinnae (although not in *D. petersenii*).

Distribution: Distributed in tropical and warm-temperate parts of the Old World from tropical Africa through Asia, Australasia, and the Pacific Islands to Hawai'i and North America (Kato 1984), with the greatest diversity in Asia; four species native to Africa and Madagascar (Roux 2009), 53 species in China (Wang et al. 2013), one in Australia (Jones 1998), about five in the south Pacific (Kato 1984), four indigenous to Hawai'i (Palmer 2003), and one in North America (Smith 1993). One species in New Zealand of uncertain biostatus.

Biostatus: Indigenous; wild.

Table 3: Number of species in New Zealand within *Deparia* Hook. & Grev.

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

Recognition: In New Zealand, *Deparia* can be recognised by the 1-pinnate-pinnatifid to 1-pinnate-bipinnatifid fronds bearing both hairs and scales, the presence of a U-shaped groove on the adaxial surface of the rachis that is not continuous with the grooves of the pinna costae, sori that are linear and arranged singly or paired back-to-back, and echinate spores (Large & Braggins 1991).

Cytology: The base chromosome number in *Deparia* is x = 40 or rarely 41 (Kramer 1990).

Deparia petersenii (Kunze) M.Kato, *Bot. Mag. (Tokyo),* 90: 37 (1977)

≡ *Asplenium petersenii* Kunze, *Analecta Pteridogr.* 24 (1837)
≡ *Diplazium petersenii* (Kunze) Christ, *Bull. Acad. Int. Géogr. Bot.* 1902: 245 (1902)
≡ *Athyriopsis petersenii* (Kunze) Ching, *Acta Phytotax. Sin.* 9: 66 (1964)
≡ *Lunathyrium petersenii* (Kunze) H.Ohba, *Sci. Rep. Yokosuka City Mus.* 11: 53 (1965)
Lectotype (selected by Sledge 1977): China, Canton, *C.W. Petersen*, 1827, C 10016377 (!online)

Etymology: Named in honour of C.W. Petersen, who collected the type specimen.

Vernacular name: Japanese lady fern

Taxonomy: Kato (1984) recognised three subspecies within *Deparia petersenii*: subsp. *petersenii*, widespread from the Himalayas to south-east Asia; subsp. *deflexa*, occurring in Malaya, Sumatra, and Java; and subsp. *congrua*, distributed from Australia and the Solomon Islands to the Marquesas Islands. Subsp. *congrua* occurs throughout much of New Zealand, but subsp. *petersenii* has been collected only once as a rare escape, and subsp. *deflexa* is unknown here.

1 Lamina thick and brittle, often with blue-green iridescence on the adaxial surface; primary pinnae divided about half-way to costa.... ..... subsp. *petersenii*
Lamina thin and pliable, never with blue-green iridescence on the adaxial surface; primary pinnae divided to c. 1 mm from the costa.... ..... subsp. *congrua*

Biostatus: Indigenous (Non-endemic).

Deparia petersenii subsp. *congrua* (Brack.) M.Kato, *J. Fac. Sci. Univ. Tokyo, Sect. 3, Bot.* 13: 426 (1984)

≡ *Diplazium congruum* Brack., *U.S. Expl. Exped., Filic. 16,* 141, t. 18, f. 2 (1854)
≡ *Athyrium congruum* (Brack.) Copel., *Univ. Calif. Publ. Bot.* 14: 359 (1929)
Holotype: Samoan or Navigators' Islands [Samoa], *U.S. South Pacific Exploring Expedition*, 1838–42, US 00135221 (!online)

= *Asplenium umbrosum* var. *tenuifolium* Kirk, *Trans. & Proc. New Zealand Inst.* 23: 425 (1891)
≡ *Deparia tenuifolia* (Kirk) M.Kato, *J. Fac. Sci. Univ. Tokyo, Sect. 3, Bot.* 13: 407 (1984)
Holotype: Takaka Valley, Nelson, N.Z., *J. McKerrow Campbell*, Herb. T. Kirk, K! (photo WELT E474/5)

= *Asplenium umbrosum* var. *multifidum* Dobbie, *New Zealand Ferns ed. 3,* 316, f. 104b (1931)
Lectotype (selected by Brownsey & Perrie 2017): Fig. 104b in Dobbie, *New Zealand Ferns ed. 3*, 317 (1931)

Etymology: From the Latin *congruus* (agreeable).

Rhizomes long-creeping, up to 260 mm long (in herbarium specimens), 2.5–7 mm in diameter, with stipes arising 5–40 mm apart; bearing scales. Rhizome scales ovate or narrowly ovate, 4–6 mm long, 0.8–2 mm wide, golden brown. Fronds 180–910 mm long. Stipes 35–480 mm, blackish-brown proximally, yellow-brown or rarely red-brown distally; bearing multicellular pale brown hairs up to 0.5 mm long, and narrowly ovate, pale to dark brown scales up to 9 mm long and 2.5 mm wide. Rachises yellow-brown or rarely red-brown, becoming green distally, winged distally, adaxially grooved, bearing multicellular hairs up to 0.5 mm long, and scales up to 1.5 mm long; hairs more abundant distally. Laminae 1-pinnate-pinnatifid to 1-pinnate-bipinnatifid, elliptic or ovate or narrowly ovate, tapering to a pinnatifid apex, 115–510 mm long, 40–270 mm wide, dark green adaxially, yellow-green abaxially, herbaceous or coriaceous, bearing multicellular colourless hairs to 1 mm long and linear pale brown scales to 1.5 mm long; hairs more abundant on adaxial surface. Primary pinnae in 7–15 pairs below pinnatifid apex, scarcely overlapping, winged throughout, narrowly elliptic or ovate; the longest at or below the middle of the lamina, 20–195 mm long, 10–75 mm wide, apices acuminate, deeply divided almost to the costae into secondary segments, short-stalked or rarely sessile. Secondary segments oblong; the longest at or below the middle of the primary pinna, 5–40 mm long, 3–10 mm wide, apices acute or obtuse, margins serrate to divided halfway to the midrib, or rarely ¾ to the midrib, bases adnate; the distal secondary segments almost entire. Sori elongated along veins, either linear or rarely paired back-to-back; indusia 1–3 mm long, opening away from vein, free margins laciniate.

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

South Island: Western Nelson, Sounds-Nelson, Westland.

Kermadec Islands.

Altitudinal range: 0–400 m.

Deparia petersenii subsp. *congrua* occurs on the Kermadec Islands, and in lowland parts of the North Island from Te Paki to Auckland, the Waikato, and Bay of Plenty, extending to East Cape and through Taranaki to Wellington. It is apparently absent from large parts of the central and eastern North Island. It reaches 400 m in Puketi Forest and on Raoul Island. In the South Island it is confined to a few lowland localities around Nelson, and on the West Coast as far south as Hokitika. There is also an unvouchered record from the Marlborough Sounds.

Also Australia (Queensland, New South Wales, Victoria), Norfolk Island, Solomon Islands, Vanuatu, New Caledonia, Fiji, Samoa, Tonga, Cook Islands, Society Islands, Marquesas Islands.

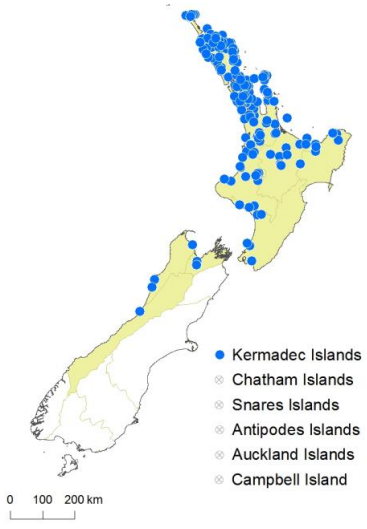

Fig. 11: *Deparia petersenii* subsp. *congrua* distribution map based on databased records at AK, CHR & WELT.

Biostatus: Indigenous (Non-endemic).

Habitat: *Deparia petersenii* subsp. *congrua* is a terrestrial fern that grows in damp soils along stream banks, near hot streams, on alluvial terraces, lakesides, swamp margins, and bush margins, and on tracksides and road banks. It grows in kauri, podocarp (especially kahikatea), and broadleaved forest, and under mānuka and kānuka, as well as under introduced *Salix* and *Pinus* species.

Recognition: In New Zealand *Deparia petersenii* subsp. *congrua* is recognised by its creeping rhizomes, and fronds, that bear both scales and hairs, the latter being more abundant distally and adaxially. The primary pinnae are divided almost to the costae into secondary pinnae, which are sometimes themselves divided more than halfway to the midrib. Neither the secondary or tertiary segments are ever completely divided to the costae. The sori are elongated along the veins and sometimes arranged back-to-back.

Subsp. *congrua* is distinguished from subsp. *petersenii* by its thinner and less brittle laminae, lacking blue-green iridescence on the adaxial surface, and its primary pinnae, which are more highly divided to within c. 1 mm of the costa.

Cytology: n = 82 (Brownlie 1961).

Notes: This species has been widely misidentified in earlier New Zealand literature as *Diplazium japonicum* (Thunb.) Beddome or *Athyrium japonicum* (Thunb.) Copel. based on *Asplenium japonicum* Thunb.

Kato (1984) recognised three subspecies within *D. petersenii*. Subsp. *congrua* was distinguished from subsp. *petersenii* by its lamina and pinnae, which narrowed gradually to an acuminate apex rather than narrowing abruptly; and from subsp. *deflexa* by its thicker rhizome (up to 5 mm diameter cf. up to 2.5 mm diameter), more widely spaced stipes, and oblique rather than patent pinna segments. Subsp. *congrua* is present in Australia, New Zealand, and the Pacific, whereas subsp. *petersenii* occurs from the Himalayas to Japan and south to Papua New Guinea, and subsp. *deflexa* in peninsular Malaysia, Sumatra, and Java. However, following work on *Deparia* (Kuo et al. 2016), Kuo noted that *D. petersenii* is not a monophyletic group and there is a lot of polyploidy (Kuo, pers. comm. 2016), suggesting that these taxa may need to be revisited, including the possibility that subsp. *deflexa* is just a small form of subsp. *congrua*.

In New Zealand, *Deparia petersenii* subsp. *congrua* is remarkable in that it was not recorded until found on the Kermadec Islands by Cheeseman (1888) and then at the Ōkura River near Kerikeri by Miss Clarke (Cheeseman 1890). In the first edition of his *Manual of the New Zealand Flora*, Cheeseman (1906) cited specimens from Kaitāia, the Bay of Islands, and the Wairoa River – all areas that were well covered by many earlier botanists in New Zealand but who apparently failed to find it. Allan (1961) and Crookes (1963) also recorded it only from the Kermadec Islands and the North Island.

If Kirk's *Asplenium umbrosum* var. *tenuifolium* is treated as an extreme form of *Deparia petersenii* subsp. *congrua* (see below), then his record (Kirk 1891) would be the first for the South Island, more or less contemporaneous with its discovery at the Bay of Islands and on the Kermadec Islands. In the North Island there appears to have been a steady southward movement of this taxon having been recorded from Te Whāiti in 1920 (AK 114934), Rotorua in 1927 (CHR 292805), Taumarunui in 1967 (CHR 165882), Whanganui River in 1967 (WELT P025053), Kapiti Island in 1962 (WELT P023617), Paraparaumu in 1967 (WELT P010589), and Mananui near Hokitika in 1940 (CHR 23790).

The biostatus of subsp. *congrua* in New Zealand is unresolved. It is unclear whether it is a relatively recent natural arrival or was introduced by human intervention. It was first detected at about the same time in three widely different locations, and appears to have spread extensively since that time to the point where it is now well integrated with native vegetation in many areas.

Kato (1984) recognised both *D. petersenii* and *D. tenuifolia* in New Zealand. He stated that *D. tenuifolia* differed in "its more deeply cut leaves with pinnatifid and well-spaced pinnules. Larger plants of *D. petersenii* with lobed pinna-segments approach *D. tenuifolia*, but in *D. tenuifolia* even smaller leaves are tripinnatifid with well-spaced pinnules". In our opinion there is a gradation from 1-pinnate-pinnatifid to 1-pinnate-bipinnatifid forms, with the latter occurring most frequently in shaded habitats rather than in the open. This also reflects the views of de Lange (1988, 1989), who observed plants in the wild and grew highly divided forms in cultivation, noting that they reverted to 1-pinnate-pinnatifid forms within 8 months. In agreement with his suggestion, *D. tenuifolia* is here reduced to synonymy with *D. petersenii*.

The name *Asplenium umbrosum* var. *leumfolia* was published by Dobbie (1931, p. 314) with a one-line description and without any accompanying illustration. Although described as a variety of *Asplenium umbrosum* (= *Diplazium australe*), the description states "root creeping", which presumably indicates a creeping rhizome. If so, that would exclude *Diplazium australe* and would relate better to *Deparia petersenii*. However, no specimens of this taxon are known, and without either a specimen or an illustration it is impossible to know what it represents.

Fig. 12: *Deparia petersenii* subsp. *congrua*. Mature deeply 1-pinnate-pinnatifid frond.

Fig. 13: *Deparia petersenii* subsp. *congrua*. Mature 1-pinnate-bipinnatifid frond, with longest secondary segments near middle of the primary pinnae.

Fig. 14: *Deparia petersenii* subsp. *congrua*. Mature 1-pinnate-pinnatifid frond, with longest secondary segments near middle of the primary pinnae.

Fig. 15: *Deparia petersenii* subsp. *congrua*. Young plants growing on forest floor.

Fig. 16: *Deparia petersenii* subsp. *congrua*. Base of stipe showing narrowly ovate brown scales and multicellular colourless hairs.

Fig. 17: *Deparia petersenii* subsp. *congrua*. Adaxial surface of rachis showing U-shaped groove not confluent with grooves of pinna costae.

Fig. 18: *Deparia petersenii* subsp. *congrua*. Abaxial surface of primary pinnae showing indusia elongated along the veins, with a few arranged back-to-back.

Fig. 19: *Deparia petersenii* subsp. *congrua*. Abaxial surface of primary pinnae showing mature sori and indusia elongated along the veins.

Deparia petersenii (Kunze) M.Kato, *Bot. Mag. (Tokyo),* 90: 37 (1977) subsp. *petersenii*

Distribution: North Island: Volcanic Plateau.

Altitudinal range: 10 m.

Deparia petersenii subsp. *petersenii* is known only from Robbins Park, near Tauranga.

Occurs naturally in Himalayas, southern India, Sri Lanka, Burma, Thailand, Vietnam, China, Japan, Taiwan, Philippines, Indonesia, and Papua New Guinea. Naturalised in the Azores (Sledge 1977), south-east Brazil (Kato 1984) and Hawai'i where Palmer (2003) noted that it was first collected in 1938 since spreading rapidly in disturbed areas and into intact native forest. It is also recorded as naturalised in Florida (Smith 1993) and sometimes in Australia (Jones 1998), but in these areas it appears to be more of an escape from cultivation than truly naturalised.

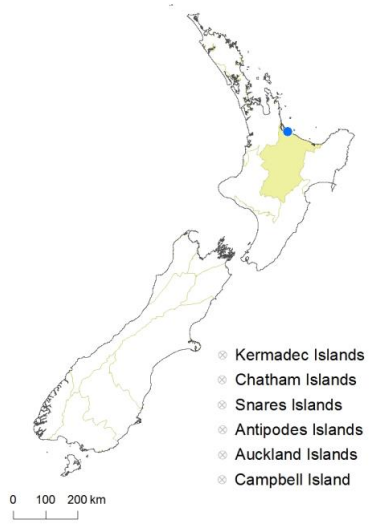

Fig. 20: *Deparia petersenii* subsp. *petersenii* distribution map based on databased records at AK, CHR & WELT.

Biostatus: Exotic; casual.

Habitat: Recorded from concrete and brick walls in a garden close to glasshouses.

First record: New record. Voucher AK 363422, 2016.

Recognition: Very similar to subsp. *congrua* but distinguished by its more thickly succulent and brittle laminar tissue, usually with some blue-green iridescence on the adaxial surface, and pinnae lobed about halfway to the costa. Subsp. *congrua* has thinner and less brittle laminar tissue, always lacking blue-green iridescence on the adaxial surface, and pinnae lobed to c. 1 mm from the costa, giving the frond a rather more open and less chunky look.

Notes: Parris (pers. comm. 2017) noted that *Deparia petersenii* subsp. *petersenii* has been in cultivation in New Zealand for some decades and used to be sold in garden centres, but that it didn't survive long outside, even in Auckland or Kerikeri. The extent of its occurrence in New Zealand and its relationship to subsp. *congrua* require further investigation.

Fig. 21: *Deparia petersenii* subsp. *petersenii*. Mature 1-pinnate-pinnatifid frond.

Fig. 22: *Deparia petersenii* subsp. *petersenii*. Mature plants with 1-pinnate-pinnatifid fronds.

Fig. 23: *Deparia petersenii* subsp. *petersenii*. Base of stipe showing narrowly ovate brown scales.

Fig. 24: *Deparia petersenii* subsp. *petersenii*. Mature 1-pinnate-pinnatifid frond.

Diplazium Sw., *J. Bot. (Schrader),* 1800(2): 61 (1801)

Type taxon: *Diplazium plantagineum* (L.) Sw. = *Diplazium plantaginifolium* (L.) Urb.

Etymology: From the Greek *diplasios* (double), a reference to the paired sori in these ferns.

Terrestrial or rupestral ferns. Rhizomes erect or creeping, scaly. Rhizome scales non-clathrate, narrowly ovate or ovate. Stipes adaxially grooved, scaly, sometimes spiny (not NZ). Laminae 2-pinnate to 3-pinnate-pinnatifid (NZ) or entire or 4-pinnate (not NZ), herbaceous (NZ) or coriaceous (not NZ), scaly, groove of rachis U-shaped and continuous with grooves of pinna midribs. Veins free or rarely anastomosing. Sori elongated along veins and either single or arranged back-to-back; indusia same shape as the sori, opening away from the vein, margins entire to laciniate. Spores monolete, perispores rugose.

Taxonomy: A genus of about 350 species (PPG 1 2016), badly in need of monographic study (Kramer 1990) and probably paraphyletic (Wang et al. 2003). *Diplazium* and allied genera in Japan were more clearly defined by Kato (1977), and some 86 species were treated by Wang et al. (2013) for the *Flora of China*.

Allan (1961) included the sole indigenous New Zealand species in *Athyrium*.

1	Veins anastomosing; secondary pinnae lobed less than halfway to midrib; roots producing young plants from vegetative buds.....	*esculentum*
	Veins free; secondary pinnae usually lobed halfway or more to midrib; roots not producing young plants from vegetative buds..... 2	
2	Rhizome erect; laminae 2-pinnate-pinnatifid to 3-pinnate-pinnatifid; tertiary segments 5–38 mm long, 2–12 mm wide, serrate or divided almost to midrib, apices acute or obtuse.....	*australe*
	Rhizome creeping; laminae 2-pinnate to 2-pinnate-pinnatifid; tertiary segments 8–11 mm long, 4–5 mm wide, entire or shallowly toothed, apices truncate or rounded.....	*nipponicum*

Distribution: Worldwide, but mainly in the tropics and subtropics, with a few species extending locally into temperate regions; two species in southern Africa (Crouch et al. 2011), 86 in China (Wang et al. 2013), 10 in Australia (Jones 1998), c. 20 in the Pacific and three indigenous to Hawai'i (Palmer 2003). One non-endemic and two naturalised species in New Zealand.

Biostatus: Indigenous (Non-endemic).

Table 4: Number of species in New Zealand within *Diplazium* Sw.

Category	**Number**
Indigenous (Non-endemic)	1
Exotic: Casual	2
Total	**3**

Recognition: In New Zealand, *Diplazium* can be recognised by its 2-pinnate to 3-pinnate-pinnatifid fronds bearing scales, the presence of a U-shaped groove on the adaxial surface of the rachis that is continuous with the grooves of the pinna costae, sori that are linear and arranged singly or back-to-back along the veins, and rugose spores (Large & Braggins 1991).

Cytology: The base chromosome number in *Diplazium* is x = 40 or 41 (Kramer 1990).

Diplazium australe (R.Br.) N.A.Wakef., *Vict. Naturalist* 58: 142, f. 3 (1942)

≡ *Allantodia australis* R.Br., *Prodr. Fl. Nov. Holland.* 149 (1810)
≡ *Athyrium australe* (R.Br.) C.Presl, *Tent. Pterid.* 98 (1836)
≡ *Asplenium brownii* J.Sm., *J. Bot. (Hooker),* 4: 174 (1841) nom. nov. pro *Allantodia australis* R.Br. 1810
≡ *Asplenium australe* (R.Br.) Brack., *U.S. Expl. Exped., Filic. 16,* 173 (1854) nom. illeg., non *Asplenium australe* Sw. 1801
≡ *Athyrium brownii* (J.Sm.) J.Sm., *Hist. Fil.* 328 (1875) nom. illeg.
≡ *Athyrium umbrosum* subsp. *australe* (R.Br.) C.Chr., *Index Filic.* 36, 147 (1905)
≡ *Athyrium umbrosum* var. *australe* (R.Br.) Domin, *Biblioth. Bot.* 20(85): 86 (1913)
Holotype: Insula Van Diemen [Tasmania], *D. Nelson s.n.*, BM! (photo WELT E464/7).

= *Allantodia tenera* R.Br., *Prodr. Fl. Nov. Holland.* 149 (1810)
Lectotype (selected by Brownsey & Perrie 2017): Paterson's River [New South Wales] , *R. Brown Iter Austral. 24*, 1802-5, K001089463!

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

Rhizomes erect, sometimes forming short woody trunks or occasionally prostrate; bearing scales. Rhizome scales narrowly ovate, up to 6 mm long and 1 mm wide, dark brown. Fronds 340–1400 mm long. Stipes 80–800 mm long, blackish-brown proximally, yellow-brown or red-brown distally; bearing narrowly ovate dark brown scales, up to 15 mm long and 2 mm wide. Rachises yellow-brown or red-brown, winged only at distal end, adaxially grooved, glabrous or with a few scattered scales in developing fronds. Laminae 2-pinnate-pinnatifid to 3-pinnate-pinnatifid, ovate to broadly ovate, tapering rapidly to a pinnatifid apex, 170–780 mm long, 110–740 mm wide, dark green on both surfaces, herbaceous, glabrous. Primary pinnae in 9–18 pairs, widely spaced to overlapping, winged at distal end or rarely winged throughout in small fronds, ovate or narrowly ovate; the longest at or near the base, 80–525 mm long, 40–270 mm wide, apices acute to acuminate, bases stalked. Secondary pinnae winged throughout, gradually decreasing in length along each primary pinna to its apex; the longest secondary pinnae narrowly ovate, 20–165 mm long, 10–70 mm wide, apices acute, margins divided nearly to the midrib in smaller fronds or divided into tertiary pinnae in largest fronds,

bases short-stalked; the distal secondary pinnae narrowly ovate to oblong, apices acute, bases adnate. Longest tertiary pinnae or pinna segments oblong, 5–38 mm long, 2–12 mm wide, apices acute or obtuse, margins serrate to divided almost to the midrib, bases adnate or short-stalked. Quaternary pinna segments up to 7 mm long and 3 mm wide. Veins free. Sori linear, elongated along one or both sides of veins; indusia 1–2 mm long, opening away from vein, free margins entire or lightly toothed.

Note: measurements given above are from measurable herbarium specimens. Larger fronds are known to occur in the wild. AK 157334 comprises parts of a frond that was said to be 2 m long. Laminae may reach 1200 mm long and 900 mm wide.

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

South Island: Western Nelson, Sounds-Nelson, Westland.

Altitudinal range: 0–800 m.

Diplazium australe occurs in lowland areas throughout much of the North Island from Te Paki to Wellington, but is absent from large parts of the east coast. It is most commonly found below 350 m but extends to 500 m in Taranaki and on Rainbow Mountain, near Rotorua, and 800 m on Mt Pirongia. In the South Island it is confined to lowland areas of the Marlborough Sounds, Nelson, and the West Coast as far south as Hokitika. It does not occur on any of the offshore islands.

Also Australia (Queensland, New South Wales, Victoria, Tasmania) and Norfolk Island.

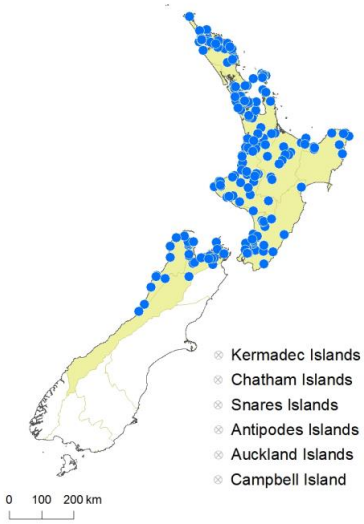

Fig. 25: *Diplazium australe* distribution map based on databased records at AK, CHR & WELT.

Biostatus: Indigenous (Non-endemic).

Habitat: *Diplazium australe* is a terrestrial fern that grows in damp soils and silt along stream banks, on alluvial terraces and swamp margins, in damp paddocks and ditches, and on forest margins and in clearings. It grows under podocarp (especially kahikatea) and broadleaved forest, under mature mānuka and kānuka, and under *Pinus* and willows. It is often found in association with *Deparia petersenii*.

Recognition: *Diplazium australe* is recognised by its erect rhizomes that sometimes form a short trunk, and fronds that are more or less 3-pinnate and are either glabrous or bear a few scales on the stipes and rachises. The sori are elongated along the veins, either singly or with at least a few arranged back-to-back. The free margins of the indusia are entire or only lightly toothed.

Cytology: n = 123 (Brownlie 1958).

Notes: The names *Asplenium umbrosum* Sm. and *Athyrium umbrosum* (Aiton) C.Presl used in earlier New Zealand Floras are misidentifications of *Diplazium australe*.

Fig. 26: *Diplazium australe*. Mature 2-pinnate-pinnnatifid frond.

Fig. 27: *Diplazium australe*. Mature plants growing on forest floor.

Fig. 28: *Diplazium australe*. Juvenile 2-pinnate-pinnatifid frond.

Fig. 29: *Diplazium australe*. Adaxial surface of rachis showing U-shaped groove confluent with groove of pinna costa.

Fig. 30: *Diplazium australe*. Base of stipe and young crozier bearing dark brown ovate scales.

Fig. 31: *Diplazium australe*. Abaxial surface of primary pinna showing immature indusia extending along the veins.

Fig. 32: *Diplazium australe*. Abaxial surface of secondary pinnae showing mature indusia extending along the veins.

Fig. 33: *Diplazium australe*. Abaxial surface of primary pinnae showing mature indusia extending along the veins.

Diplazium esculentum (Retz.) Sw., *J. Bot. (Schrader),* 1801(2): 312 (1803)

≡ *Hemionitis escultenta* Retz., *Observ. Bot. 6,* 38 (1791)
≡ *Asplenium esculentum* (Retz.) C.Presl, *Reliq. Haenk. 1,* 45 (1825)
≡ *Anisogonium esculentum* (Retz.) C.Presl, *Tent. Pterid.* 116 (1836)
≡ *Athyrium esculentum* (Retz.) Copel., *Philipp. J. Sci.* 3: 295 (1908)

Holotype: Habitat in India orientali, *J.G. König s.n.*, LD 1122195 (!online.; see Roux 2009), with fragment at K taken from holotype.

Etymology: From the Latin *esculentus* (edible), a reference to the use of this species as a food source.

Vernacular name: vegetable fern

Distribution: North Island: Northland, Auckland.

Altitudinal range: 10–40 m.

Known from one locality in Kerikeri and two in Auckland.

Occurs naturally in India, Malaysia, China, Taiwan, Indonesia, Philippines, Papua New Guinea, Solomon Islands, and Vanuatu. Naturalised in southern Africa (Roux 2009), Queensland (Jones 1998), Hawai'i (Palmer 2003), south-east USA (Smith 1993).

Biostatus: Exotic; casual.

Habitat: Recorded as a cultivation escape, initially from a garden in Kerikeri, where the species had spread rapidly and aggressively. It has also been collected from flood-deposited material washed downstream from plantings at Puhinui Creek, and from a possible past deliberate planting at Glendowie, both in Auckland.

First record: New record. Voucher AK 259023-24, WELT P022986, CHR 546537, 2002.

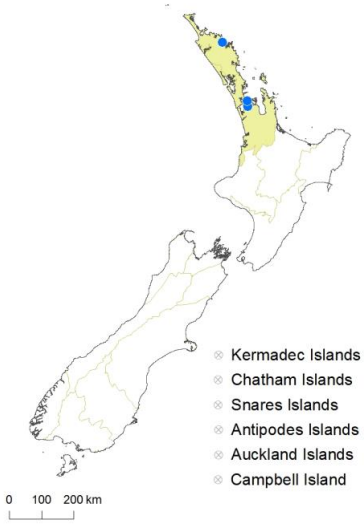

Fig. 34: *Diplazium esculentum* distribution map based on databased records at AK, CHR & WELT.

Recognition: In New Zealand *Diplazium esculentum* has a short, erect rhizome with black, wiry roots that produce young plants from vegetative buds; fronds up to 500 mm long; yellow-brown stipes up to 270 mm long, becoming blackish proximally; laminae 1-pinnate-pinnatifid in juvenile fronds becoming 2-pinnate in mature fronds, ovate or broadly ovate, up to 320 mm long and 300 mm wide; the longest primary pinnae ovate or elliptic, 160 mm long, 75 mm wide, with a long pinnatifid terminal segment tapering to a sharp acuminate apex; secondary pinnae narrowly triangular, up to 40 mm long, 13 mm wide, with sharp acuminate apices, margins serrate, lobed proximally; veins anastomosing; abaxial lamina surface bearing pale brown scales and abundant glandular and non-glandular, multicellular, colourless or brownish hairs. The species has not yet been seen fertile in New Zealand, but it spreads vegetatively via an extensive underground network of black, wiry, easily detached roots that produce numerous young plants from vegetative buds.

Notes: *Diplazium esculentum* (Retz.) Sw. is a widespread species in tropical and subtropical Asia and the western Pacific, often used for culinary and ornamental purposes. Parris noted (label data, AK 259023 and WELT P022986) that *Diplazium esculentum* was sold in New Zealand garden centres in the early 1990s as *Thelypteris* 'Mexico'. Because it was an invasive weed of open situations, she recommended that it should not be cultivated in New Zealand, noting that it was capable of colonising riverbanks at an average rate of spread of 1 m per year.

Fig. 35: *Diplazium esculentum*. Herbarium specimen from Kerikeri, WELT P022986, showing 1-pinnate sterile frond.

Diplazium nipponicum Tagawa, *Acta Phytotax. Geobot.* 2: 197 (1933)

≡ *Allantodia nipponica* (Tagawa) Ching, *Acta Phytotax. Sin.* 9: 56 (1964)

= *Athyrium nipponicolum* Ohwi, *Bull. Natl. Sci. Mus., Tokyo, n.s.* 3: 100 (1956) nom. nov. pro *Diplazium nipponicum* Tagawa 1933 (non *Athyrium nipponicum* (Mett.) Hance 1872)
Holotype: Japan, Honshu, Pref. Fukui, Prov. Echizen, Sakai-gun, Kazentani-tôge, *Z. Tashiro s.n.*, 29 May 1932, KYO (*n.v.*); isotype MICH *s.n.* (!online)

Etymology: *nipponicum* (Latin) – from Japan.

Distribution: North Island: Auckland.

Altitudinal range: c. 40 m.

Known from one locality in Hamilton.

Occurs naturally in China and Japan.

Biostatus: Exotic; casual.

Habitat: Recorded growing on waste land on a damp clay bank under *Salix* species. Also known to be cultivated in Auckland and Kerikeri, where it is capable of spreading.

First record: New record. Voucher WELT P010256, 1979.

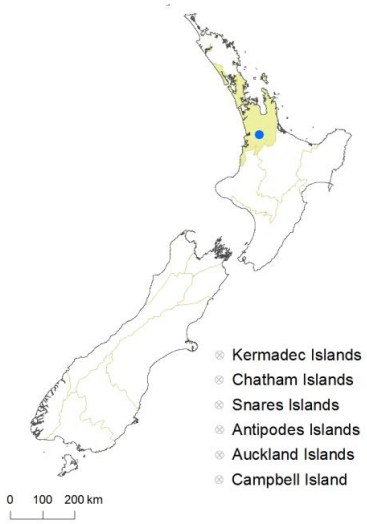

Fig. 36: *Diplazium nipponicum* distribution map based on databased records at AK, CHR & WELT.

Recognition: In New Zealand *Diplazium nipponicum* has a creeping rhizome with fertile fronds 430–1000 mm long; green or yellow-brown stipes 120–370 mm long, becoming blackish proximally; laminae 2-pinnate to deeply 2-pinnate-pinnatifid, broadly ovate, 270–650 mm long and 175–600 mm wide; the longest primary pinnae ovate,140–380 mm long, 60–140 mm wide, with a short pinnatifid terminal segment tapering to an acuminate apex; secondary pinnae up to 75 mm long, 18 mm wide; tertiary segments oblong, 8–11 mm long, 4–5 mm wide, with truncate or rounded apices, margins entire or shallowly toothed, all of similar size; veins free; abaxial lamina surface bearing scattered pale brown linear scales. Indusia elongated, margins laciniate or toothed.

Notes: *Diplazium nipponicum* was apparently sold in the horticultural trade before 1989 (B.S. Parris, pers. comm., 2016).

Fig. 37: *Diplazium nipponicum*. Herbarium specimen from Hamilton, WELT P010256, showing deeply 2-pinnate-pinnatifid frond.

Fig. 38: *Diplazium nipponicum*. Herbarium specimen from Hamilton, WELT P010256, showing oblong tertiary segments with rounded apices.

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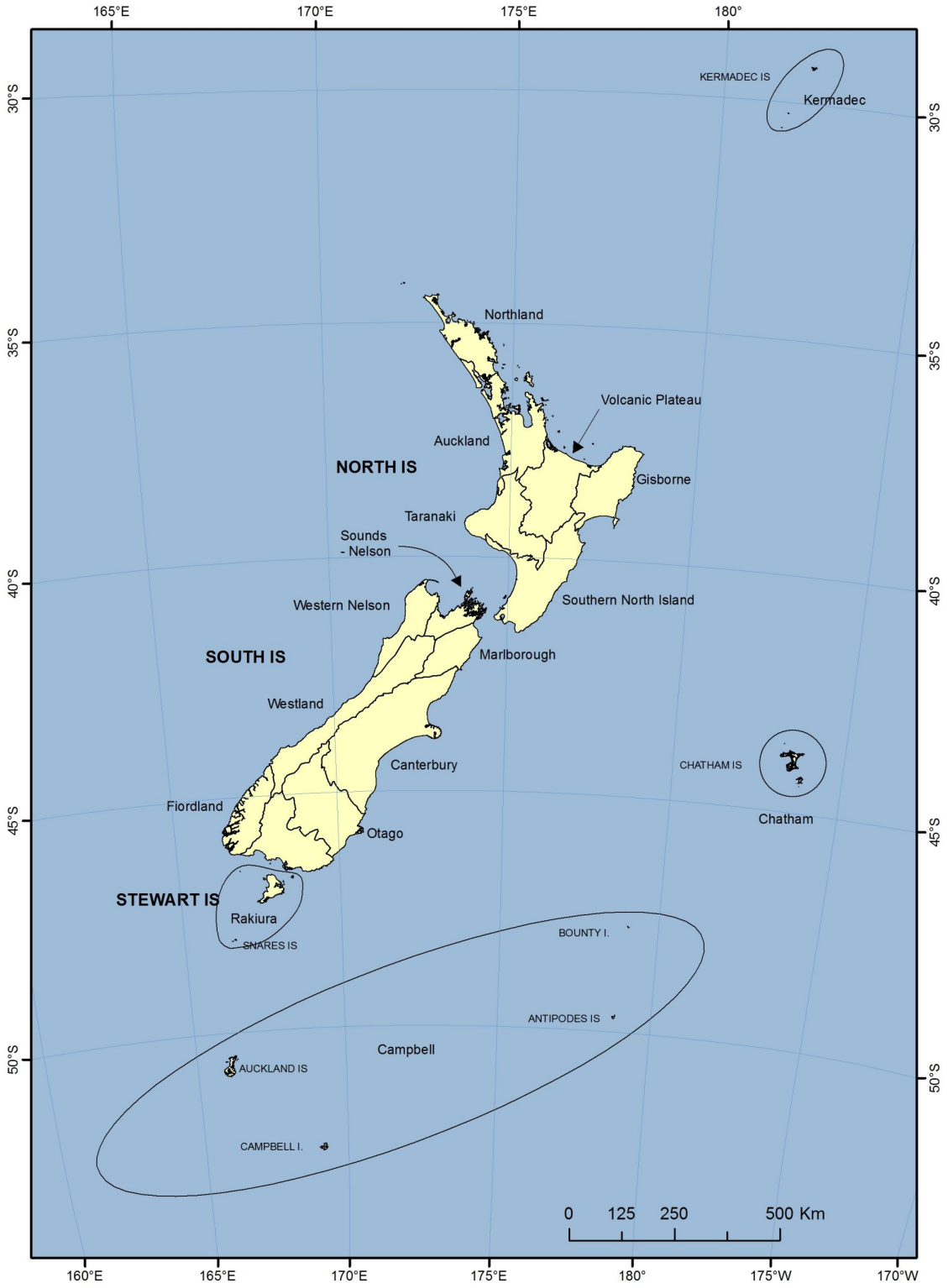
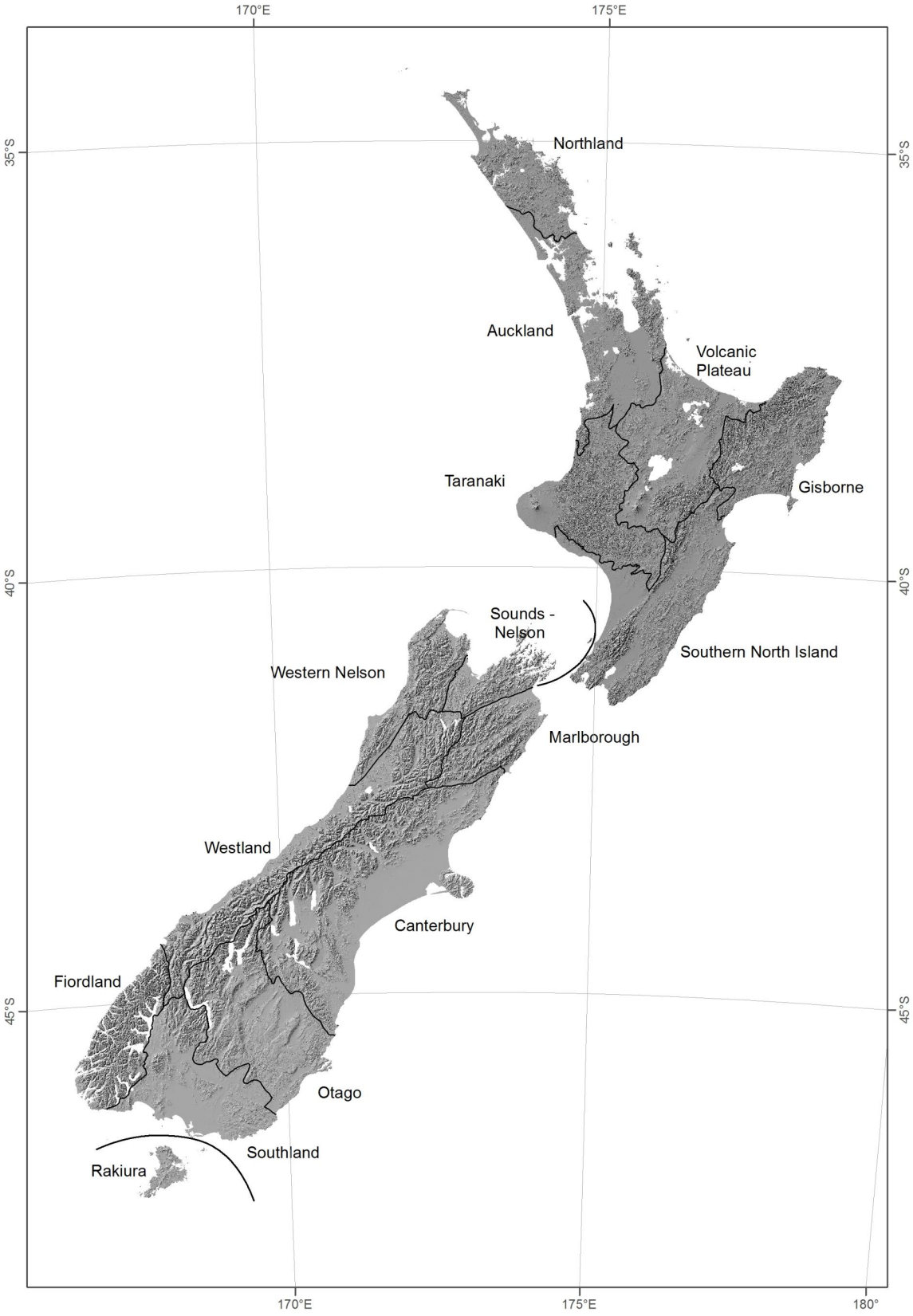


Map 1: Map of New Zealand and offshore islands showing Ecological Provinces



Map 2: Map of New Zealand showing Ecological Provinces

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