

The fern *Polypodium vulgare* as a weed in New Zealand

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The fern *Polypodium vulgare* has been naturalised in New Zealand for several decades. It has increased markedly in abundance. This article outlines the relationships of *Polypodium vulgare*, its distribution in New Zealand, and the threats that it poses to conservation values.

Relationships of *Polypodium vulgare*

Polypodium vulgare was described by Linnaeus in 1753. Its indigenous distribution is wide-ranging, encompassing Europe, Turkey, Russia, China, Mediterranean Africa, southern Africa, and the Kerguelen Islands in the Indian Ocean (Page 1997; Roux 2009; Crouch et al. 2011; Lu and Haufler 2013).

There are a number of similar species in the northern hemisphere that have been segregated from what used to be a broadly circumscribed *Polypodium vulgare*, such as *P. cambricum* (= *P. australe*) and *P. interjectum* of Europe, western Asia, and northern Africa (Page 1997), and several North American species including *P. virginianum* (Haufler et al. 1993). The plants naturalised in New Zealand have been identified as *P. vulgare sensu stricto* (hereafter, *P. vulgare*) based on chromosome number and micro-morphological characters (Lovis 1980; Shepherd & Perrie 2006; Brownsey & Perrie 2014). However, Lovis (1980) considered plants from the Port Hills to have “atypical macro-morphology” for *P. vulgare*, and noted that “it remains possible that our plants have not originated from Europe”. Southern Africa, for instance, is an alternative source.

There are no indigenous species of *Polypodium* in New Zealand, but its family, Polypodiaceae, has native representatives in *Loxogramme*, *Microsorium*, and *Pyrrosia* (Brownsey and Perrie 2014). In New Zealand, *Polypodium vulgare* is most likely to be confused with *Microsorium pustulatum* (Lovis 1980; Wilson 2013; Brownsey and Perrie 2014). They can be distinguished by the frond lamina of *P. vulgare* being dissected right to the rachis to form distinct pinnae, even in the basal third of the lamina, whereas the lamina of *M. pustulatum* is only pinnatifid (i.e., there is always a wing of lamina alongside the rachis) (Figs. 1 and 2, p. 76). Additionally, the frond margins are serrate in *P. vulgare* (sometimes only minutely so) but entire in *M. pustulatum*. *Blechnum deltooides* (previously known in Australasia as *B. vulcanicum*)

is also superficially similar to *P. vulgare*, but easily distinguished by reproductive features; the sori of *B. deltooides* are linear on dimorphic and much-narrowed fertile fronds, while they are circular in *P. vulgare* (Figs. 1 and 2).

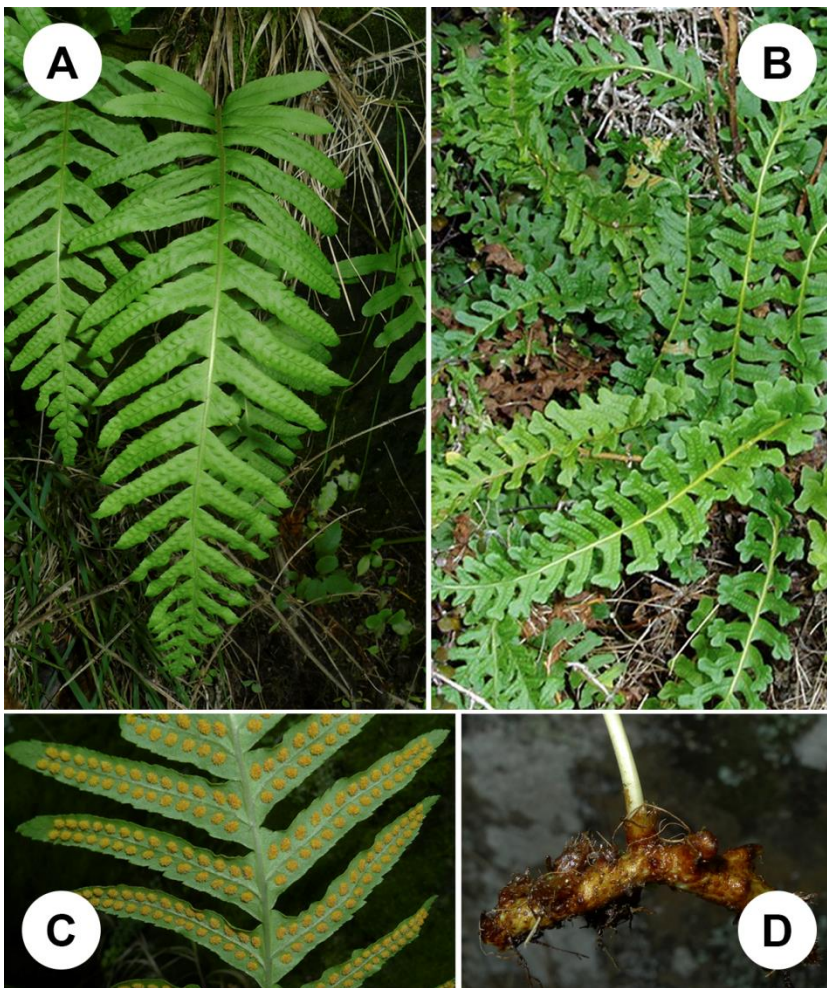


Figure 1. *Polypodium vulgare*. A: Frond, with the lamina dissected to the rachis. B: Crested forms occur rarely in the wild; this is from a northern Canterbury population. C: Underside of fertile frond, showing the unprotected orange sori (clusters of spore-producing sporangia), the lamina dissected to the rachis, and the serrate lamina margins. D: Creeping rhizome. Photos A, C, and D by Leon Perrie; B by Miles Giller.



Figure 2. Native New Zealand ferns superficially similar to *Polypodium vulgare*. A: In *Microsorium pustulatum* the lamina is not dissected right to the rachis, and the margins are entire. B: *Blechnum deltooides* (previously known as *B. vulcanicum*) has distinctive fertile fronds with narrow pinnae (at middle-right and bottom-centre in this image). Photos by Leon Perrie.

Distribution in New Zealand

The first record of *Polypodium vulgare* occurring wild in New Zealand was made by Lovis (1980), who wrote that it “was first discovered...by Yvonne Elder and John Thompson, who saw it in a wall just outside the bottom of the Lyttelton Reserve...sometime between 1966 and 1973”. Because of the much larger colonies present in 1980 at Breeze Bay, Lovis thought that this Lyttelton Reserve site may not have been the “original site of introduction, although the possibility of an ultimate origin for *Polypodium* on the Port Hills by escape from a Lyttelton garden cannot be discounted”.

Only four populations of *Polypodium vulgare* in New Zealand, all on the Port Hills, were known to Lovis (1980). Three were so limited that it was still practically possible to describe them in detail: Lyttelton Reserve with “six plants...present, but all were juvenile or submature”; Mount Cavendish with seven plants and “three tiny sporelings”; and a roadside between Jollies Bush and Evans Pass, being “of limited extent, (30 metres) but includes one patch of substantial size (100+ fronds) and several smaller clumps”. The population at Breeze Bay was the biggest but limited accessibility meant assessing its size was difficult. Lovis (1980) thought it likely that both the Jollies Bush/Evans Pass and Mount Cavendish populations were “of quite recent establishment” as it was “difficult to believe that such a distinctive fern would have gone unnoticed by earlier pteridologists, growing so close to the main station for *Pleurosorus rutaefolius* [= *Asplenium subglandulosum*] in the Christchurch district”.

The subsequent spread of *Polypodium vulgare* in New Zealand has been substantial. It is now abundant on the Port Hills, and it has spread to Banks Peninsula and northern Canterbury, ranging from near sea-level to an elevation of at least 700 m (Brownsey and Perrie 2014). It has also been found wild in the southern North Island (Shepherd and Perrie 2006). A wind-blown origin to the North Island from the eastern South Island seems more likely than human-mediated transfer, at least for the population near Cape Palliser, which is exposed to the south and has few people living nearby.

This spread has been mapped (Figs. 3 and 4, p 78). The data for these maps are from herbarium specimens of Auckland Museum, Manaaki Whenua Landcare Research, and Te Papa, together with observations of the authors and from the iNaturalist citizen-science website (www.inaturalist.nz, accessed 27 August 2019). The large increase in records between 1997-2008 and 2009-2019 reflects presumably both actual increase in plant numbers and the advent of more observers (including those of iNaturalist, along with the work of Christchurch City Council rangers extending to Banks Peninsula around this time).

Even as early as 1980, Lovis noted that *Polypodium vulgare* was exhibiting “a very wide range of ecological tolerance” in New Zealand. It had already colonised Mount Cavendish with “the hottest and driest north-facing rocks on the Port Hills”, where “at least in dry summers, it very probably persists...solely through its fleshy rhizome”. This was “a dramatic contrast to the damp south-facing rocks above Breeze Bay”. We have generally found *Polypodium vulgare* on dry banks, but have seen it

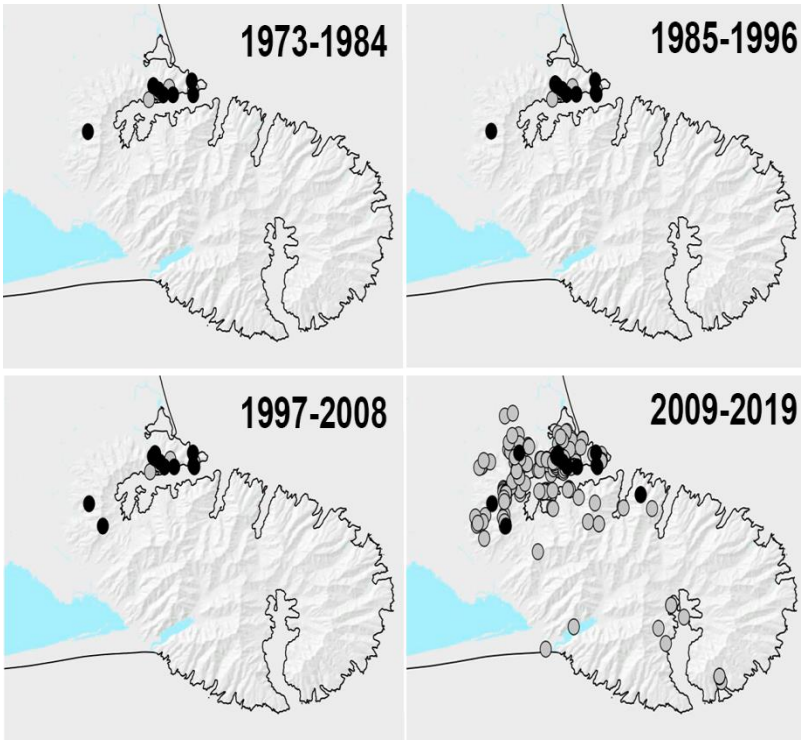


Figure 3. Distribution through time of *Polypodium vulgare* on the Port Hills and Banks Peninsula. The black circles are specimens from the herbaria of Auckland Museum, Manaaki Whenua Landcare Research, and Te Papa. The grey circles are unvouchered observations, by ourselves and from the iNaturalist citizen-science website. Maps from LINZ, CC BY.

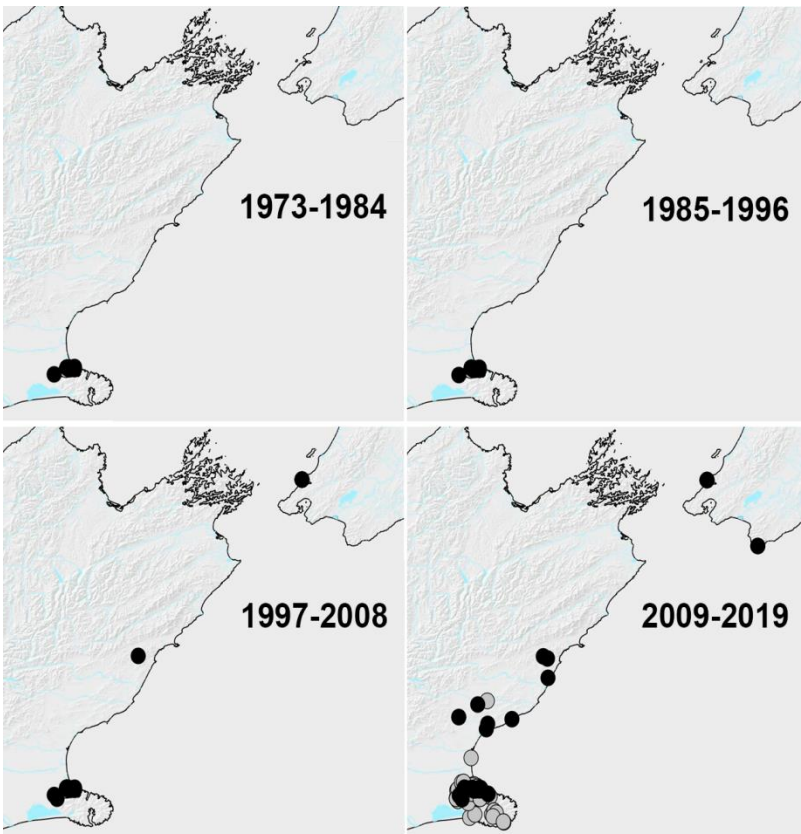


Figure 4. Distribution through time of naturalised *Polypodium vulgare* in New Zealand (north-eastern South Island and southern North Island). The black circles are specimens from the herbaria of Auckland Museum, Manaaki Whenua Landcare Research, and Te Papa. The grey circles are unvouchered observations, by ourselves and from the iNaturalist citizen-science website. Maps from LINZ, CC BY.

even in damp seepages, albeit rarely (Fig. 5). It ranges from full-light, open sites to heavy shade, and has been recorded in both very hot sites and very cold sites. Its ability to drop its fronds and survive as just a rhizome means it is probably most reliably located in spring when it is producing new fronds.



Figure 5. Some of the habitat diversity of *Polypodium vulgare*. Photos top-left and middle-right by Alice Shanks; top-right by Kate McCombs CC BY-NC; middle-left, bottom left, and bottom-right by Miles Giller.

The potential distribution of *Polypodium vulgare* in New Zealand is probably extensive. Although the number of genotypes in New Zealand is presumably very limited, and one genotype is unlikely to have the range of its species, the indigenous distribution of *P. vulgare* is massive, spanning the climates of northern to southern Europe. The current New Zealand distribution of *P. vulgare* falls within the “cool, semi-arid” and “mild, semi-arid” macroclimatic zones of Singers and Rogers (2014),

and these extend along the eastern side of the axial ranges from East Cape to southern Otago (see Figure 1 of Singers and Rogers 2014). The cliffs, banks, and outcrops that the species seems to prefer are readily available northwards to Marlborough, Wairarapa, and Hawke's Bay, westwards to the foothills of the Southern Alps, and southwards into Otago.

The problem of *Polypodium vulgare*

Polypodium vulgare in New Zealand has shown itself to be proficient at occupying a wide range of habitats. It is capable of locally dominating habitats, along with other weeds, to the detriment of indigenous species that are out-competed (including out-shaded). This affects herbs but also the seedlings of larger plants.

On Banks Peninsula and the Port Hills, *Polypodium vulgare* grows at the same sites as the Nationally Threatened species *Anogramma leptophylla* and *Myosotis lytteltonensis* and the Nationally At Risk species *Asplenium subglandulosum* and *Veronica lavaudiana*. In northern Canterbury, *P. vulgare* occurs alongside the Nationally At Risk species *Clematis petriei*, *Daucus glochidiatus*, *Discaria toumatou*, *Leptinella pusilla*, and *Linum monogynum*. As the spread of *P. vulgare* continues, it will probably move into additional rock outcrops and dry substrates in northern Canterbury that are home to other Nationally Threatened and At Risk species, such as *Anemanthele lessoniana*, *Carex inopinata*, *Chenopodium allanii*, *Coprosma intertexta*, *Leptinella serrulata*, *Pseudopanax ferox*, and *Teucrium parvifolium*.

Habitat occupied by weeds such as *Polypodium vulgare* curtails the potential population size of indigenous species. This is especially problematic for species with naturally small populations, such as those with very particular environmental requirements, whose long-term viability may be compromised. Thus, another weed competitor is another issue that requires active management to ensure that native species do not become extinct in the wild.

Page (1997) described *Polypodium vulgare* in Britain as a “weak calcifuge”. This may mean *P. vulgare* is unlikely to invade limestone and other calcareous outcrops, which are often home to plant species of conservation concern (Rogers et al. 2018).

Control

Christchurch City Council trialled herbicide control in 2009 and again in 2016-2017. Metsulfuron was the most effective of various options tried, but its long term effectiveness has yet to be established. The rhizome of *Polypodium vulgare* has resistance against at least some herbicides, allowing plants to regenerate their fronds. It was found that spraying in November/December before the summer die-back was more effective than spraying the new growth in March.

Manual removal (including the rhizomes) has seen *Polypodium vulgare* locally eliminated from several covenants in northern Canterbury. Where feasible, manual control seems to be the most effective control option currently available.

Greater Wellington Regional Council attempted in 2010 to manually control the Plimmerton population, but having to dig out the rhizomes from a rocky slope meant it was very disruptive. Plans were subsequently made to use herbicide, but landowner permission has not been forthcoming, and it is expected that the population is persisting. Someone (not Greater Wellington Regional Council) seemingly tried to control the Cape Palliser population, but this has not been completely successful, with an iNaturalist observation of living plants made in August 2019.

Legal status

Polypodium vulgare is listed as an “unwanted organism” by the National Pest Plant Accord, preventing its sale, propagation, and distribution. The National Pest Plant Accord is a cooperative agreement between the Nursery and Garden Industry Association, regional councils, and government departments with biosecurity responsibilities. It makes illegal, via the Biosecurity Act, the sale and distribution of a plant species where either formal or casual horticultural trade is the most significant way of that species spreading in New Zealand. It is worth noting that *P. vulgare* was being recommended for planting in New Zealand gardens as late as 1998 (Auckland Botanic Gardens 1997; Van der Mast and Hobbs 1998). In about 2005 and again in 2010, live plants of *P. vulgare* were transferred from the Port Hills to the Te Mata Road area in Hawke’s Bay, to cultivate as a source for herbal medicinal products.

Polypodium vulgare is listed as an “Organism of Interest” in the Regional Pest Management Plan 2018-2038 of Environment Canterbury. Organisms of Interest “are not accorded pest status but future control of them could arise, for example through Site-led programmes”. In the Pest Management Plan 2019-2039 of Greater Wellington Regional Council, *P. vulgare* is designated a “Harmful organism” but not a “Pest”, which means they do not have to control it, but that it is “watch-listed for ongoing surveillance or future control opportunities”. *Polypodium vulgare* is not mentioned in the Regional Pest Management Plans of Otago Regional Council, Marlborough District [Unitary] Council, or Hawke’s Bay Regional Council.

Conclusions

GWRC (2019, figure 5) describe an “invasion curve” of pest establishment. The “Lag Stage” involves initial slow establishment where “Pest numbers are low, the rate of population increase is slow and the distribution of the species [in an area] is limited. The most effective option [for pest management] during this stage may be eradication to prevent further establishment”. Next is the “Explosion Stage”, where “a pest has adapted to its environment and has reached a population base that allows rapid growth in population size and range. At this stage it is not realistic or cost-effective to eradicate the pest, but it may be possible to prevent further spread through containment”. Finally is the “Established Stage”, which occurs when “the pest fills most of its available habitat. At this stage, pests can only be suppressed to mitigate their impacts”.

Based on the observations mapped here, *Polypodium vulgare* appears to be in the Established Stage on Port Hills, and the Explosion Stage on Banks Peninsula and at least parts of northern Canterbury. It is seemingly still only in the Lag Stage in the southern North Island.

Sheppard et al. (2016) state that “Weed management is most cost-effective at the early stages of weed invasion...Best practice weed management is preventative, focusing on eradication of weed species with populations consisting of very small numbers of individuals, while large entrenched populations are best suited to biocontrol programmes and site-led control at high value sites”.

In 1980, *Polypodium vulgare* was so uncommon in New Zealand that the four known wild populations, all on the Port Hills, could be described in detail, even to the number of sporelings present. Nobody foresaw its massive spread and no preventative action was taken. Unfortunately, this now means that if the natural values (e.g., rare species) on the Port Hills that are harmed by *P. vulgare* are to be conserved, ongoing weed control will be forever needed (in lieu of biocontrol).

What has happened on the Port Hills provides a strong demonstration to pest managers in other parts of New Zealand: *Polypodium vulgare* should not be left unchecked. It may be possible to contain *P. vulgare* from becoming too abundant in eastern Banks Peninsula. Elsewhere, Environment Canterbury should seek to contain *P. vulgare* within northern Canterbury if it is already too late for eradication, while other pest managers should be actively excluding/eradicating it; this particularly applies to the regions that are probably most at risk of invasion by *P. vulgare*, namely Otago Regional Council, Marlborough District Council, Greater Wellington Regional Council, and Hawke’s Bay Regional Council.

Polypodium vulgare has proven its invasiveness in New Zealand. Substantive action is now needed if its spread is to be curtailed.

Acknowledgements

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References

- Auckland Botanic Gardens. 1997. Ferns for Auckland. Advisory leaflet B12.
- Brownsey PJ, Perrie LR. 2014. Polypodiaceae (excluding *Notogrammitis*). In: Breitwieser I, Heenan PB, Wilton AD, editors. Flora of New Zealand – Ferns and Lycophytes. Fascicle 1. Lincoln: Manaaki Whenua Press.
- Crouch NR, Klopper RR, Burrows JE, Burrows SM. 2011. Ferns of southern Africa. A comprehensive guide. Cape Town: Struik Nature.

- GWRC. 2019. Greater Wellington Regional Pest Management Plan 2019-2039. Wellington: Greater Wellington Regional Council.
- Haulfer CH, Windham MB, Lang FA, Whitmore SA. 1993. *Polypodium*. In: Flora of North America Editorial Committee, editor. Flora of North America. Vol. 2. Pteridophytes and Gymnosperms. New York: Oxford University Press.
- Lovis J. 1980. A puzzling *Polypodium* on the Port Hills. Canterbury Botanical Society Journal 14: 55–57.
- Lu S, Haufler C. 2013. Polypodiaceae. In: Wu Z, Raven PH, Hong D (ed). Flora of China. Vol. 2-3. Lycopodiaceae through Polypodiaceae. Science Press, Beijing.
- Page CN. 1997. The ferns of Britain and Ireland. Cambridge: Cambridge University Press.
- Rogers GM, Courtney SP, Heenan PB. 2018. The calcicolous vascular flora of New Zealand. Wellington: Department of Conservation.
- Roux JP. 2009. Synopsis of the Lycopodiophyta and Pteridophyta of Africa, Madagascar and neighbouring islands. *Strelitzia* 23. South African National Biodiversity Institute, Pretoria.
- Shepherd LD, Perrie LR. 2006. *Polypodium vulgare*: a new weed fern for Wellington. Wellington Botanical Society Newsletter September 2006: 15.
- Sheppard CS, Burns BR, Stanley MC. 2016. Future-proofing weed management for the effects of climate change: is New Zealand underestimating the risk of increased plant invasions? *New Zealand Journal of Ecology* 40: 398–405.
- Singers NJD, Rogers GM. 2014. A classification of New Zealand's terrestrial ecosystems. Department of Conservation, Wellington.
- Van der Mast S, Hobbs J. 1998. Ferns for New Zealand Gardens. Godwit Publishing Ltd., Auckland.
- Wilson HD. 2013. Plant life on Banks Peninsula. Manuka Press, Cromwell.