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Plant diversity

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Introduction

Prior to human habitation New Zealand was largely covered with conifer–broadleaf, beech or mixed forests. Above the tree line, tussock grasslands and short alpine vegetation dominated. Since the arrival of humans, much of the forest has been removed and replaced with native and exotic grasslands.

The make-up of the flora is a puzzle, with an assemblage ranging from seemingly ancient species to obvious recent arrivals, but with the bulk of the flora somewhere in between. There are strong floristic links to Tasmania, south-eastern Australia and Chile. A number of plants from tropical plant groups have their southern-most occurrence in New Zealand. There is a great deal of controversy over the origins of the flora, and recent research is revealing some interesting insights. Across the different groups of flowering plants endemism is often high at the species level, but much less so at generic or family level. Many genera are represented by one or a few species only, while others have speciated extensively. Bryophytes are particularly diverse in New Zealand.

an **assemblage** is a collection of species

endemism or **endemic** is where species occur naturally in a given location, and nowhere else

Description of the flora

Bryophytes

The term 'bryophyte' refers to three distinct, relatively unspecialised, groups of plants: the mosses, the liverworts and the hornworts. All three groups have the gametophyte (gamete-producing) generation as the dominant phase of the life cycle, with the sporophyte (spore-bearing) generation dependent on the gametophyte for life.

Mosses

New Zealand has a diverse moss flora, with 523 species and 23 varieties in 208 genera, approximately 5% of the *circa* 10,000 species known worldwide. Of the New

Zealand mosses, 108 species and 11 genera are endemic, around 20% of the species recorded for the country. There are no endemic families.

The vast majority of mosses conform to a general pattern, with spore-bearing capsules on long stalks or setae which release spores by flexing minute peristome teeth after the lid (operculum) is lost. There are also several unusual moss genera in the New Zealand flora. For instance, species of *Sphagnum* differ from other mosses in lacking peristome teeth, instead firing off the operculum explosively to release the spores as

the capsule dries. In place of a long seta, a short stalk supports the capsule. Species of *Andreaea* also differ markedly from the other mosses because the capsules do not shed an operculum, instead splitting into four equal valves.

peristome teeth are teeth-like structures found inside the opening of the capsule in mosses

setae (*sing.* seta), are the stalks of a moss or liverwort sporophyte



Figure 2.1 (A) Milk moss. **(B)** Umbrella moss.
Photos: J. Braggins.

Habitats

In New Zealand, mosses are found in a wide range of habitats:

- tree trunks, branches and root mounds in conifer/ broadleaved and beech forests
- tree fern trunks in moist areas
- soil
- dung or carcasses
- flowing streams, bogs and swamps, and
- exposed sites such as alpine and subalpine areas.

Epiphytic and forest-floor: Many mosses are epiphytes of forest trees and shrubs, absorbing moisture from rain or mist, or directly from stem-flow down the trunk during rain showers. Mosses often colonise humus and tree roots, where the largest moss in the world, *Dawsonia*

superba, can be found reaching 50 cm in height in forests throughout the country. Bryophytes can cover up to two-thirds of the forest floor, and are important contributors to carbon cycling. Other conspicuous and attractive mosses include the umbrella mosses, species of either *Hypnodendron* or *Hypopterygium*. In darker, wetter sites, tree ferns can support a wide variety of moss species, some specific to different tree fern species. One such moss is the endemic *Cryptopodium bartramiioides*, with its attractive chestnut-coloured shoots and long, fine leaves.

epiphytes are plants that nourish themselves but grow on the surface of another plant for support

Soil: Disturbance of soil provides habitats for a range of moss species, the most conspicuous of which are species of *Fissidens*, known as the 'split-tooth mosses',

and members of the family Polytrichaceae. These mosses are primary colonisers, stabilising soil and allowing ferns and flowering plant seedlings to establish. Prior to the arrival of humans, soil mosses would have originally relied on natural erosion and fallen trees for habitat, but now happily grow on freshly cut tracks and roadsides. Another conspicuous moss of this habitat is the apple moss (*Breutelia*), with its spherical green capsules resembling tiny Granny Smith apples.

Dung and carcasses: Another group of mosses likely to have gained more habitat since the arrival of humans are mosses in the family Splachnaceae, which grow on animal dung and rotting carcasses. The walls of their capsules emit volatile substances which are attractive to flies, and their spores are sticky. The odour from ripe capsules can be detected by flies (and by humans with very sensitive noses), and the spores stick to the bodies of the flies, to be transported to another smelly substrate where the moss can establish.

Aquatic: A number of mosses will live in aquatic habitats, attached firmly by fine, hair-like rhizoids and absorbing nutrients from the water. Species of *Sphagnum* usually grow in swamps and bogs, in wet forest floors and anywhere there is poor drainage, and some thermal areas. *Sphagnum* is of economic use for potting plants and hanging baskets. It has great water-holding capacity, as many of the cells are large and once dead will absorb water. 'Moss peat' is the decomposed remains of *Sphagnum* bogs and is mainly found in the Hauraki Plains, the Chatham Islands and Southland.

rhizoids are root- or hair-like structures in certain bryophytes

Alpine: Cold alpine areas seem an unlikely place to find mosses, but there are a number of species characteristic of such areas. Mosses such as the red-brown species of *Andreaea* penetrate small cracks in the rock with their rhizoids, forming brittle, almost black, wind-resistant cushions.

Liverworts and hornworts

New Zealand has about 600 described species of liverworts and hornworts, more than either Europe or North America. Around half of the species are endemic and there are three endemic single-genus families. Fourteen genera are endemic, and seven others are shared with South America, New Caledonia, or are bipolar in distribution (found in both hemispheres).

Liverwort species: Of the seven orders of liverworts found worldwide, New Zealand has representatives of six. Most of New Zealand's species are part of the Jungermanniales, the leafy liverworts: plants with three rows of ornate leaves. The other order with a large number of species in New Zealand is the Metzgeriales, containing both leafy and non-leafy (thalloid) species. There are only 21 species from the Marchantiales (thalloid liverworts) in New Zealand, but they are abundant, especially in urban areas.



Figure 2.2 (A) A thalloid liverwort, *Lunularia cruciata*. **(B)** A leafy liverwort, *Bazzania adnexa*. Most New Zealand liverworts are leafy. Photos: J. Braggins.

The southern hemisphere is relatively poor in endemic thallose liverworts, but there is one that is of interest, *Neohodgsonia*, a monotypic genus from New Zealand, Tristan da Cunha and Gough Islands. One of the most unusual species in the New Zealand flora is *Monoclea forsteri*. This species, and one other species of *Monoclea* from Central and South America, are the only members of an entire order, the Monocleales. There are no New Zealand species in the Sphaerocarpaceae, and there are only three species in the Calobryales, a small order of primitive leafy liverworts. Recently, the Treubiales were recognised as a distinct order. The New Zealand flora has three species in the genus *Treubia*.

Liverwort species in New Zealand vary in size from a maximum stem length of 1.1 m and leaf length of 12+ mm in *Schistochila appendiculata*, down to leaves of just 0.2 mm length in the tiny creeping epiphyte *Diplasiolejeunea pusilla*.

Hornworts: Hornworts are traditionally placed in a single order (Anthocerotales), with one or two families and six genera. There are 13 New Zealand species in four genera (*Anthoceros*, *Dendroceros*, *Megaceros* and *Phaeoceros*), all of which are placed in the family Anthocerotaceae.

Habitats

Liverworts and hornworts form a significant element in New Zealand's wet forests. While mosses tend to dominate the forest floor of the drier forests of eastern New Zealand, forests in the western half of the country are dominated by liverworts which are much less tolerant of periods of drought. Many of the leafy 'mosses' seen in western forests are in fact leafy liverworts. They are commonest on tree bases and branches, soil banks, overhangs, rotten logs and long-lived leaves.

The mountains of Stewart Island and the South Island have a number of species with restricted distributions, and there is an archaic element in peat soils over granite on Stewart Island, the subantarctic islands, Fiordland and Nelson. There are also two species endemic to Central North Island volcanic rocks and soil. Like the mosses, liverworts and hornworts can cover extensive parts of the forest floor, stream banks and tree trunks, and are important contributors to carbon and water cycling.

2.1 Differences between bryophytes

Mosses, liverworts and hornworts are collectively known as **bryophytes**, although they are probably not closely related. It is thought that bryophytes were amongst the first land plants, evolving from a Chara-like green alga around 470 million years ago. New Zealand has a very rich flora of bryophytes, especially in the mosses and liverworts. The different bryophytes share a number of features, including similar lifecycles of alternating gamete-producing and spore-producing generations, with the gamete-producing generation (gametophyte) dominant over the spore-producing generation (sporophyte). The sporophyte generation is represented by a diploid capsule where meiosis and spore production occurs. All bryophytes lack specialised water- and food-conducting tissues, and absorb and transport water and nutrients cell to cell. There are a number of key differences between the groups.

- Mosses are leafy and the leaves usually have a midvein or nerve. They have a persistent, coloured seta (stalk) bearing the capsule. Once the calyptra and operculum (lid) have been shed, the capsule opens by an apical pore with one or two rows of peristome teeth, which control and

aid in the release of the spores. The rhizoids are multicellular and usually reddish brown.

calyptra is a membranous hood covering the capsule of mosses

- Liverworts are leafy or thalloid, and those with leaves never have midveins. Among the chloroplasts, oil bodies (oil-containing structures) are a characteristic feature of the cells of leafy liverworts. The seta is colourless, transparent and short-lived and the capsule opens by four slits. Spring-like elaters are present, mixed with the spores to assist in their dispersal. Rhizoids are unicellular and colourless or occasionally purple.

thalloid means a plant not differentiated into roots, stems or leaves

- Hornworts are always thalloid, have no seta and have a capsule shaped like a tapering horn which opens by one or two slits. Multicellular elaters are present with the spores in the capsule. Hornworts have one or two chloroplasts per cell; liverworts and mosses have many.

Origins of the New Zealand bryophytes

The New Zealand moss flora is thought to have a Gondwanan distribution, with close relationships to the floras of Tasmania, southeastern Australia and temperate South America. Southeast Asian, Polynesian and bipolar (both hemispheres) elements characterise the remaining New Zealand flora. It is considered that the endemic liverwort and hornwort flora is likely to be a mixture of palaeoendemics and relatively new endemics post-dating the breakup of Gondwanaland. The richness of the liverwort flora is probably supported by the cool wet climate, the age of the landmass and the wide range of available habitats. Liverwort spores are easily wind-dispersed, but do not appear to tolerate drying, freezing or exposure to ultraviolet radiation, limiting the possibilities of long-distance dispersal at high altitudes, but not ruling out dispersal at lower altitudes.

paleoendemic refers to old, remnant species which were once more widespread

In New Zealand, the combined number of moss and liverwort species together make up two-thirds as many as the number of flowering plant species. This very high ratio of bryophytes is unusual in the world, and is likely to be due to the constantly wet climate of New Zealand, with cool, dark evergreen forests and constant light, temperature and humidity, the length the landmass has existed, and because bryophyte spores are much more easily dispersed than the seeds of flowering plants.

Ferns and fern allies (Pteridophytes)

Pteridophytes, or the ferns and so-called fern allies, differ from the bryophytes in a number of ways.

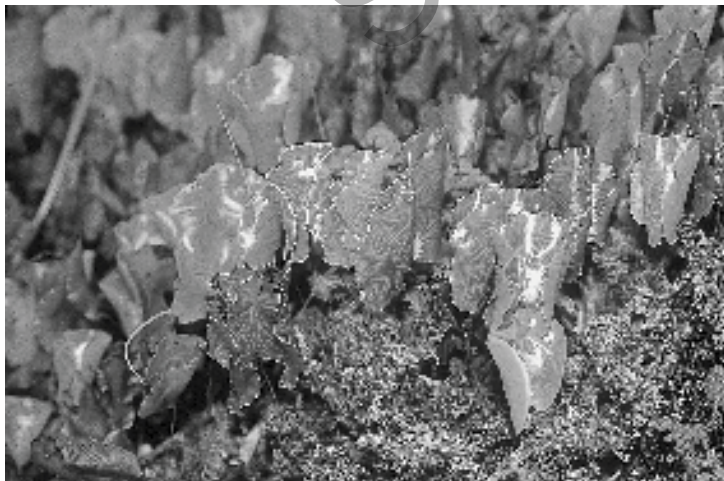


Figure 2.3 The kidney fern, *Trichomanes reniforme*.
Photo: J. Braggins.

- Pteridophytes have a sporophyte plant as the dominant generation, which arises from a separate, small gametophyte.
- Ferns and fern allies are known as vascular plants: plants with specialised water and food-conducting cells known as xylem and phloem.
- Like bryophytes, ferns and fern allies reproduce by spores; they do not produce seeds.

The New Zealand pteridophyte flora includes 226 species, of which 194 are native (six are undescribed) and 32 have been introduced since the arrival of Europeans.

True ferns (Filicopsida) can be characterised by having large leaves, or fronds with branching veins. Spore-bearing sporangia are produced on the undersides or margins of the fronds. Most ferns have sporangia which open by the movement of a row of annulus cells. Three more primitive families lack catapult-like annulus cells, having sporangia which simply split along a line of weakness and release larger numbers of spores.

sporangia are the capsules in fungi and plants in which meiosis occurs and haploid spores develop

The fern allies include three very different groups of plants which are each given equal status to the true ferns: the Psilotopsida (fork ferns), Lycopsidea (club mosses, spike mosses and quillworts) and Equisetopsida (horsetails). These three groups appear to be very primitive in structure, and can be distinguished from true ferns by their small leaves with single unbranched veins by their sporangia, often on the upper surface of the leaf and often in cones, and the way the sporangia open along a line of weakness at maturity. Recent DNA evidence indicates that the Psilotopsida and Equisetopsida should be placed within the ferns, with only the Lycopsidea separate. The New Zealand flora has native members of the Psilotopsida and Lycopsidea, and introduced members of the spike mosses and horsetails.

Ferns

Just under half of the native species are endemic, although there are no endemic families and only three endemic monospecific genera.

Primitive species

New Zealand has members of three very primitive fern families – the Ophioglossaceae, the Marattiaceae and the Osmundaceae.

The Ophioglossaceae are unusual in that they are very unfern-like, with sterile simple or dissected fronds, and fertile spikes which bear the sporangia.

There are two genera in the flora – *Botrychium* (the parsley fern or moonwort) and *Ophioglossum* (the adder’s tongue ferns). Both genera have common and widespread species, but some species are rare.

The Marattiaceae are large ferns with sporangia fused into groups on the underside of the fronds. There is one species in New Zealand, *Marattia salicina*: the king or horseshoe fern. This fern can have fronds as large as 300 × 200 cm and is popular in gardens. It was once common, but is palatable to livestock and populations are now scattered.

The Osmundaceae are an ancient family of three genera, all with representatives in New Zealand. The two species of *Leptopteris* (crepe fern or Prince of Wales feathers) look more traditionally fern-like, but have filmy fronds and scattered sporangia, not in sori. Both of these species are endemic. The royal fern (*Osmunda regalis*) has colonised and become established in the northern part of the North Island. It is an unusual plant in that the fertile fronds have the normal leaf tissue replaced in the upper part of the frond with clusters of sporangia. One species, *Todea barbara*, is found in warmer parts of the North Island, Australia and South Africa.

sori (*sing.* sorus) are groups of sporangia

Advanced species

Of the more advanced ferns, the three most diverse families are the Hymenophyllaceae, the Blechnaceae and the Aspleniaceae.

The Hymenophyllaceae have two genera in New Zealand, *Hymenophyllum* (the filmy ferns) and *Trichomanes* (bristle and kidney ferns). Both genera are conspicuous members of the fern flora, usually found in damp bush or areas of high rainfall. Their fronds are very thin and translucent, and are often seen growing in large mats on tree trunks, tree ferns, rocks and root mounds. The kidney fern (*T. reniforme*) is a particularly attractive fern, with shining translucent kidney-shaped leaves.

The Blechnaceae is another diverse family in New Zealand with two genera, *Blechnum* (the hard or water ferns) and *Doodia* (the rasp ferns). Species of *Blechnum* are usually found in moist sites, often by tracks. Species of *Doodia* tend to have harsh, hairy and scaly pink-tinged fronds and will often tolerate drier conditions than species of *Blechnum*. Most members of the family have fertile and sterile fronds quite different in appearance.

The spleenworts (*Asplenium*), blanket fern (*Pleurosorus*) and Hart’s tongue fern (*Phyllitis*) are all members of the Aspleniaceae. Spleenworts have elongated spore-

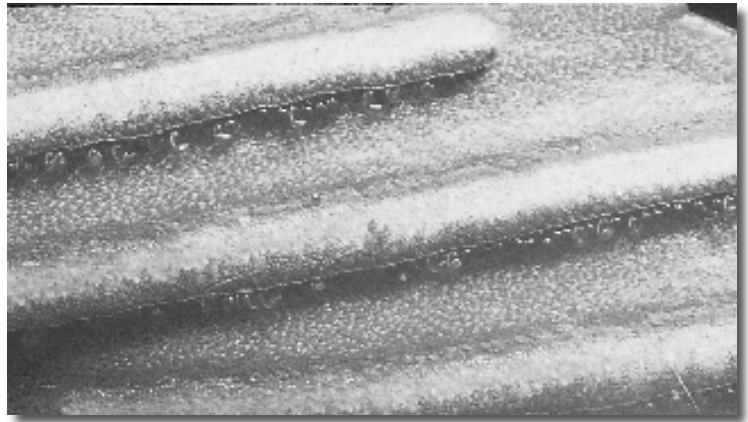


Figure 2.4 Underside of *Asplenium oblongifolium*, showing the sori, some of which have already opened to scatter the spores. Photo: J. Braggins.

bearing sori along the veins, often in a herringbone pattern. *Asplenium* is one of the larger genera in New Zealand and species are found throughout the country in a number of habitats. A well-known example is the hen and chickens fern (*A. bulbiferum*) which reproduces asexually by structures called bulbils on its fronds, and is a popular house plant. Hart’s tongue fern (*Phyllitis scolopendrium*, from Europe) has colonised wooded parts of New Zealand since the 1970s. The blanket fern (*Pleurosorus rutifolius*) is uncommon, but when found is usually confined to dry, hot rock faces.

Tree ferns

A conspicuous part of the fern flora are the tree ferns, of which two families are represented in New Zealand.

The Dicksoniaceae (genus *Dicksonia*) have woody trunks to 7 m in height, harsh fronds with hairs, and marginal sori. There are three species, which can be found anywhere from open scrub, boggy areas to montane forests.

The other family is the Cyatheaceae (genus *Cyathea*), which have tall woody trunks reaching up to 20 m, both hairs and scales on the fronds, and spherical sori positioned away from the frond margins. The seven species recognised for New Zealand live in dry or damp forests, river banks and similar habitats. The silver tree fern or ponga (*Cyathea dealbata*) is the source of the silver fern national emblem of New Zealand.

Both *Cyathea* and *Dicksonia* species provide habitat for mosses, liverworts, lichens, small epiphytic angiosperms and the fern ally *Tmesipteris*. The thick litter created by falling fronds can smother small plants, but does provide a rich habitat for invertebrates and lizards.

montane means pertaining to mountain areas



Figure 2.5 Tree fern, *Cyathea medullaris*.
Photo: J. Braggins.

Aquatic ferns

One of the more unusual ferns in the flora is the aquatic fern *Azolla*. Plants are free-floating and will form large red carpets on the surface of ponds. There are one native and one introduced species. Another introduced aquatic fern is *Salvinia molesta*, a tropical species from South America that is found in waterways north of the Waikato. This fern is a problem because of its ability to grow quickly and smother small lakes and ponds with dense mats of floating fronds, reducing bird habitat and preventing recreational use.

Fern allies

Fork-ferns

Species of the fork-fern genera *Psilotum* and *Tmesipteris* (Psilotaceae) are distinctive in that they lack true roots and have forking aerial stems, tiny vestigial leaves, and bright yellow sporangia. *Psilotum nudum* is usually found in tropical and subtropical parts of the world, and in New Zealand is largely restricted to the northern part of the North Island, often in rock crevices and in warm soil in thermal areas. There are four species of *Tmesipteris* found in New Zealand,

three of which are shared with Australia and/or New Caledonia. These plants are often found as single stems hanging from the trunks of tree ferns in forested areas.

Club mosses

The club mosses (Lycopodiaceae) have a very long fossil record. The four genera found in New Zealand are small herbaceous plants with a single sporangium on each fertile leaf. New Zealand has four species of *Lycopodium*, four species of *Lycopodiella* and three of *Huperzia*, and most of these are also found in Australia, Southeast Asia or New Caledonia.

Plants tend to grow on the ground under scrub, on banks, in bogs and thermally heated soil, or as epiphytes, often hanging from the bases of *Collospermum* or *Astelia* clumps in trees. Species of *Lycopodium*, *Lycopodiella* and *Huperzia* can be recognised by their forking stems, narrow-scale leaves and fertile leaves forming cones. Another genus in the Lycopodiaceae is *Phylloglossum*, small plants with underground tubers (swollen stems), a basal rosette of sterile leaves, and a terminal cone of fertile leaves. There is a single species found in New Zealand and Australia, *P. drummondii*. This species is now restricted to gumland areas of the far north of the North Island, but has previously been recorded as far south as Banks Peninsula. It is above ground only in winter and early spring.

scales are small plant organs, either leaf-like or dry and membranous

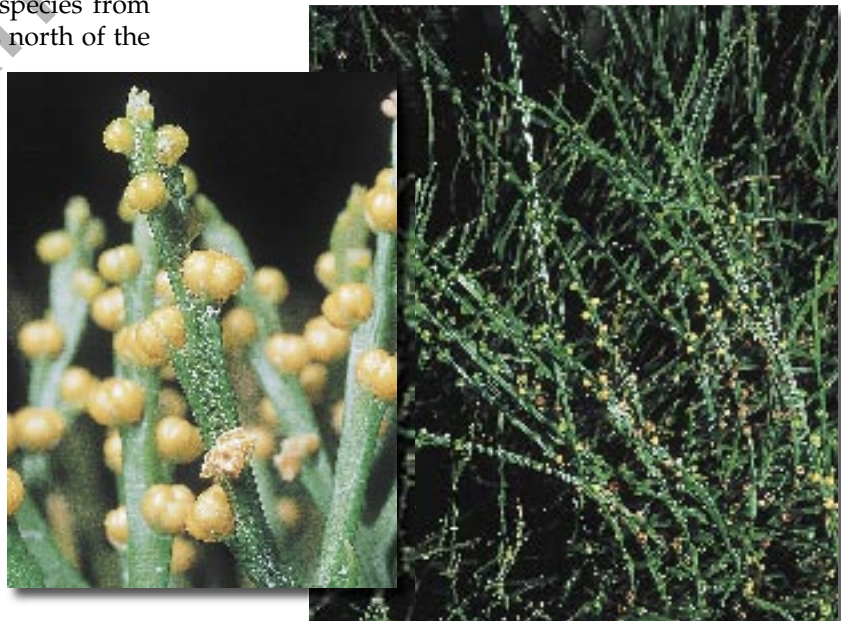


Figure 2.6 A fork fern of the *Psilotum* genus.
Photos: J. Braggins.



Figure 2.7 The club moss *Huperzia varia*.
Photo: J. Braggins.

Other fern allies

The quillworts (Isoetaceae) are represented in New Zealand by one genus, *Isoetes*, and one to two endemic species. Plants are aquatic, with swollen stems and tufts of narrow leaves with sporangia in their bases. Colonies are found in the mud of lowland and montane lakes of both islands in 50 cm or more of water.

The spike mosses (Selaginaceae) are now naturalised in New Zealand, and are represented by three species of *Selaginella*, originally from Africa and Southeast Asia. Stems are creeping or erect, with long roots, simple sterile leaves, and sporangia on fertile leaves which cluster into cones at the shoot tips. One species, *Selaginella kraussiana*, is an invasive weed in warmer areas of the North Island and in glasshouses.

The horsetails (Equisetaceae) are also invasive weeds, with three species of the genus *Equisetum* now found in New Zealand. Horsetails have hollow, jointed and grooved stems, and produce leaves in whorls. Sporangia are borne in terminal cones. The main problem species is *E. arvense*, which is difficult to eradicate because of its extensive underground rhizomes and resistance to herbicides.

Origins of the New Zealand pteridophytes

The closest affinities of the pteridophyte flora are with temperate Australia, followed by links to the tropics. Smaller numbers of species share links with southern Africa, South America and the circum-Antarctic islands. Most of the endemic ferns and fern allies have a largely southern distribution, while those with tropical or Australian affinities are in the warmer northern parts of the country. Species distributions seem to be controlled more by rainfall and temperature than geographical features.

Recent molecular studies plus fossil and pollen evidence indicate that the majority of genera arrived in New Zealand after the separation from Gondwana, and it is likely that many arrived by long-distance dispersal. Conversely, there is evidence that at least some species of *Asplenium* and *Tmesipteris* have in fact dispersed from New Zealand to Australia.

Conifers

Conifers, cycads, ginkgo and certain unusual plants in the order Ephedrales (*Gnetum*, *Ephedra* and *Welwitschia*) are known as gymnosperms, seed plants with no ovaries protecting the ovules. The New Zealand indigenous flora lacks cycads, ginkgo and members of Ephedrales, although all three groups are now present as introduced or exotic plants, and cycad, *Ephedra* and ginkgo fossils are known from New Zealand Cretaceous deposits. The Coniferophyta, or cone-bearing conifers, are the only group of living gymnosperms native to New Zealand, with four families, 10 genera and 20 endemic species.

Podocarpaceae

The most diverse family of conifers in New Zealand is the Podocarpaceae – the ‘foot-seed’ family. This family of evergreen shrubs and trees has distinctive female cones which are reduced to one or a few fertile leaf-like bracts, each with a single inverted ovule. This is usually enclosed in a layer called an epimatium which is equivalent to the ovule-bearing scale of members of the pine family. Mature seeds are usually supported on a fleshy, coloured stalk, or receptacle, which is attractive to birds. Male and female cones are borne on separate trees.

The family is found throughout the southern hemisphere, with a centre of diversity in southeast Asia. Many of the species are large trees and three of the largest podocarps are found in New Zealand (rimu, kahikatea and tōtara). New Zealand has representatives of five genera with species found elsewhere – *Podocarpus*, *Prumnopitys*, *Dacrycarpus*, *Dacrydium* and *Lepidothamnus*; and two endemic genera, *Halocarpus* and *Manoao*.

2.2 Fleshy 'fruits' and dispersal

Podocarp fruits are not really fruits at all, as they are not derived from the ovary wall of a flower. However, as coloured sources of food energy for birds they do fulfill a similar ecological role, and it is perhaps useful to consider them as 'fruits'. All podocarp fruits develop from parts of their very reduced cones. In most podocarps, the fertile scale, or epimatium, develops into a leathery covering for the developing seed. In *Prumnopitys*, however, the epimatium becomes fleshy and covers the seed, resulting in a plum-like 'fruit' with a hard stone, giving the translation of the genus – 'plum-pine'. In other genera, the receptacle or one or more sterile bracts swell to form the fruit, while in *Phyllocladus*, a fleshy cup or aril develops. Colours of fruit range from red, orange and yellow, to green, purple and white.

A number of species of birds disperse podocarp seeds, and in return gain an important source of food. Kererū (*Hemiphaga novaeseelandiae*), tūi (*Prosthemadera novaeseelandiae*) and bellbirds (*Anthornis melanura*) are all known to feed on podocarp fruits and disperse the seeds. These birds swallow the fleshy part and the seed but digest only the pulp, with the seed passing through the digestive tract to be released in the droppings. Kererū are particularly fond of both mataī and the turpentine-scented miro fruits. It is likely that kōkako (*Callaeas* spp.) and saddleback (*Philesturnus carunculatus*) were also significant dispersers of podocarp seed when they were more numerous.

Other animals may feed on podocarp fruits without actually dispersing the seeds. Silvereyes (*Zosterops lateralis*) tend to eat the receptacle and leave the seed, although it may then drop to the forest floor. Other introduced birds such as sparrows (*Passer domesticus*) crush the receptacles and drink the juice, without dispersing the seeds, although larger birds such as blackbirds (*Turdus merula*) may sometimes disperse some seed. Kākā (*Nestor meridionalis*) are known to destroy podocarp seeds, such as those of miro, by cracking them open and eating the seed contents. Weta will eat both the fleshy receptacles and seed contents of podocarp fruits. There is some evidence that the fruits of *Halocarpus* could be dispersed by lizards. Rats and mice also destroy podocarp seeds, and their numbers fluctuate dramatically with the availability of podocarp and other fruit sources.

Figure 2.8
Seeds of the tōtara, *Podocarpus totara*. Photo: J. Braggins.



Podocarpus: Comprised of four species including tōtara (*P. totara*) which is one of the largest forest trees in New Zealand, often reaching a height of 30–40 metres and a diameter of 3 metres in lowland and montane forest of both main islands. The prostrate subalpine snow tōtara (*P. nivalis*) is one of the smallest conifers in New Zealand, rarely reaching 1 m in height. All of the New Zealand species have one (occasionally two) seeds on top of a fleshy red receptacle, linear flattened leaves, and stringy loose bark. Other species include Hall's tōtara (*P. hallii*) and *P. acutifolia*, a small tree of the northern South Island.

Dacrydium: A largely tropical genus of perhaps 16 species from southeast Asia through New Guinea and the Western Pacific to New Zealand, Tasmania and Chile. There is one species in New Zealand, the rimu (*Dacrydium cupressinum*) – a large tree growing up to 60 m in height, with long pendulous branches and scale leaves. Female cones consist of usually a single seed attached to a swollen red receptacle which is eaten by birds. Rimu trees are emergent canopy trees found throughout New

Zealand in lowland and montane forests. Several species formerly included in *Dacrydium* were separated into the genera *Halocarpus*, *Lepidothamnus* and *Lagarostrobos*. The single New Zealand species of *Lagarostrobos* was later distinguished as *Manoao colensoi*.

Halocarpus: An endemic genus with three species. *Halocarpus* is similar to *Dacrydium* in that female cones are borne on the ends of branches, but differs markedly in that the seed is inverted at maturity. The scales do not become fleshy, but the seed becomes surrounded by a white, yellow or orange fleshy collar, giving the genus its name. Juvenile and adult foliage is often markedly different, with small overlapping scale-like leaves in adult foliage, and longer flattened leaves in the juvenile material. Bog pine (*Halocarpus bidwillii*) and pink pine (*H. biformis*) are small trees or shrubs of montane forests and subalpine areas from the mid North Island to Stewart Island. Monoao (*H. kirkii*, not to be confused with *Manoao*) is a medium-sized tree (up to 24 m in height) in lowland forests of the northern part of the North Island.

Lepidothamnus: A small genus of three species, distinguished by its erect ovules and lack of resin ducts in the leaves. The two New Zealand species are the yellow silver pine (*L. intermedius*) and the pygmy pine (*L. laxifolius*). The third species, *L. fonckii*, is Chilean. The yellow silver pine forms small trees up to 15 m in height in montane forests throughout New Zealand. The pygmy pine is one of the smallest conifers known. It is found in mountainous areas from the middle of the North Island to Stewart Island.

Manoao: Silver pine is an endemic genus with a single species, *M. colensoi*. It was considered to be a species of *Lagarostrobos* until recently, when it was separated as a new monotypic genus, leaving the Tasmanian Huon pine (*Lagarostrobos franklinii*) as a single species in another monotypic genus. Silver pines are either shrubs or small trees (15–20 m) of high rainfall areas from the northern North Island to south Westland. Female cones produce erect purple-black seeds supported by a fleshy green-yellow epimatium (enclosing layer, similar to a scale). In contrast, the epimatium of the Huon pine is usually dry, and the seeds are thought to be dispersed by water.



Figure 2.9 Maturing kahikatea growing on farmland.
Photo: J. Braggins.

2.3 Pollen and pollination

Podocarps have an unusual mode of pollination, involving pollination drops and buoyant pollen. Most genera in the Podocarpaceae have inverted ovules with a channel called the micropyle pointing downwards. They also produce a droplet of liquid from the micropyle known as a pollination drop. Podocarps with this system also produce pollen with hollow, buoyant bags called sacci, which allows pollen landing on the pollination drop to float upwards into the ovule through the micropyle to reach the female tissue and begin growth of the pollen tube. There are a number of variations on this theme within the Podocarpaceae.

The Phyllocladaceae are significantly different in their mode of pollination. Ovules are erect rather than inverted, removing the need for buoyant pollen, which is reflected in the morphology of the *Phyllocladus* pollen. Sacci are tiny and not air-filled. Instead, species of *Phyllocladus* have a retractable pollination drop. Pollen grains enter the drop and fall into the micropyle and the drop is retracted as a response to the presence of pollen.

Prumnopitys: A genus of trees with species ranging from Southeast Asia, through Australia, New Caledonia and New Zealand, and extending into Central and South America. There are two species in New Zealand, mataī (*Prumnopitys taxifolia*) and miro (*Prumnopitys ferruginea*). Both are common in lowland forest throughout New Zealand. Both species have their seeds enveloped by a fleshy covering derived from the epimatium, which enables the seed to be dispersed by birds, especially the kererū (*Hemiphaga novaeseelandiae*).

- Miro forms a large tree (25–50 m), has leaves flattened into one plane, solitary pollen cones, and solitary bright red fruits which smell of turpentine.
- Mataī forms a large tree (30–50 m), has leaves in irregular rows and purple fleshy fruits, which like the pollen cones are borne in spikes. Juvenile mataī plants have a divaricating habit for many years and often appear to be brown and dead.

Dacrycarpus: A largely tropical genus, with species extending through New Guinea and New Caledonia into Southeast Asia. New Zealand has a single species, kahikatea (*Dacrycarpus dacrydioides*), which is the tallest of the trees found there, sometimes exceeding 65 m in height. It is a common tree of lowland forests and swampy areas throughout the country and will often form extensive monocultures in such areas. Mature trees