Introduction to
plant life in New Zealand

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Plant Conservation Training Module 1

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Cover photograph: The sporangia of the primitive fern para (*Ptisana salicina*) are fused into groups called synangia. Para was once common in the north of New Zealand but it is now declining.

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1. Introduction

This introduction to plant identification in New Zealand is the first in a series of training resources to be developed by the New Zealand Plant Conservation Network. It was initially prepared after the Network was funded by the New Zealand Government's Biodiversity Condition and Advice Fund in 2005 to develop plant conservation training for iwi. The book was modelled on a range of material including NorthTec's plant courses and the Department of Conservation's training programme.

The New Zealand Plant Conservation Network is involved in a variety of programmes to implement the New Zealand Biodiversity Strategy and Global Strategy for Plant Conservation. Those programmes include education and advocacy, developing plant conservation strategies, prioritising conservation effort and gaining resources, providing technical expertise and disseminating information about native plants.

A key area of work is education to raise awareness of the plight of New Zealand's indigenous plants and fungi, and to inform people about the native plant life of New Zealand (through publications, website, meetings and training courses and workshops). To this end, the Network is developing other training resources, including covenant management—techniques for managing and restoring Nga Whenua Rahui kawenata and conservation covenants; and wetland and stream side management—techniques for restoring and protecting stream side vegetation and wetlands.

What is the New Zealand Plant Conservation Network?

The New Zealand Plant Conservation Network was established in April 2003 and now has over 600 members worldwide. The Network's mission is:

- To educate people about New Zealand's native plant life (including fungi) and promote indigenous plant conservation in New Zealand and throughout Oceania.
- To collaborate to protect and restore New Zealand's indigenous plant life, their natural habitats and associated species.
- To disseminate information about the taxonomy, biology, ecology, and status of indigenous plant species and communities in New Zealand, and
- To promote activities to protect them throughout their natural range.

The Network has a vision that "*no indigenous species of plant will become extinct nor be placed at risk of extinction as a result of human action or indifference, and that the rich, diverse and unique plant life of New Zealand will be recognised, cherished and restored.*"

To achieve that vision the Network works with many people and organisations throughout New Zealand.

The importance of plant conservation in New Zealand

Plant diversity is a key component of nature's life-support systems. The quality of our life, the quality of the water we drink, the quality of the air we breathe and the quality of the soil all depend on maintaining natural plant communities. Most of New Zealand's indigenous plants and fungi, the communities they are part of and the animal communities they support are endemic. That means they do not occur in the wild anywhere else in the world. Our responsibility is to protect these natural resources not only because of the ecosystem services that they deliver or because of the many uses to which they can be put but because of their intrinsic right to exist. New Zealand is world renowned for its flora, fauna and fungi and is regarded internationally as a global biodiversity "hot spot". The continued survival of New Zealand's native plant life is threatened.

Myrsine umbricola, a Nationally Critical shrub known from only a few locations in the Tararua Range.

The 2008 revision of threatened and uncommon plants in New Zealand, identified 180 indigenous vascular plant taxa as Nationally Threatened (91 Nationally Critical, 45 Nationally Endangered, 44 Nationally Vulnerable) and a further 651 taxa as At Risk. In addition, a further 171 plants were listed as taxonomically indeterminate and may warrant further conservation attention once their taxonomic staus is clarified. Overall, this represents a decline in the conservation staus of the New Zealand flora since the previous listing in 2004 (de Lange et al. 2009: Threatened and uncommon plants of New Zealand (2008 revision) *New Zealand Journal of Botany 47*: 61–96).

Many native plant communities in New Zealand are also threatened, such as wetlands, coastal dunes and lowland forest. Other, non-vascular, plant species and over 50 species of fungi are also known to be at risk of extinction in the wild.

Among the most significant threats are land development (such as subdivision, wetland drainage and forest clearance), invasion of exotic plant, animal and fungal species and global environmental changes (such as a changing climate). Plant conservation, in response to those threats, will halt and reverse the current decline of native plant life in New Zealand.

More information about the Network

More information about New Zealand's native plant life (including all native plants mentioned in this module) and the New Zealand Plant Conservation Network maybe obtained by visiting the Network website at www.nzpcn.org.nz. This website includes information about how to become a Network member to gain full access to the website and to receive the monthly Network newsletter.

The contact address for the Network is as follows:

New Zealand Plant Conservation Network
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Involvement of NorthTec

This book was written for the New Zealand Plant Conservation Network by Iain Reid of NorthTec and John Sawyer and Jeremy Rolfe of the Network. NorthTec has been involved in plant training programmes for many years, running a range of courses including innovative Horticulture and Sustainable Rural Development Level 2 programmes that are delivered at many marae and small rural areas throughout Northland. It also has a strong Level 4 programme which is rapidly upgrading to more advanced levels and a wide range of disciplines.

For more information about the courses run by NorthTec contact:

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2. Why New Zealand plants?

Native plants

New Zealand has a unique assemblage of **indigenous** (native) plants—some 2360 vascular plants (ferns, conifers and flowering plants) all told. Eighty percent of these native plants are not found anywhere else—these are the **endemics.**

Plants are important for New Zealand's ecosystems as the primary producers feeding a multitude of native animals (insects, birds, reptiles) and fungi directly or indirectly via a food chain—as the saying goes, "all flesh is grass". The native plants have also been important resources for the Māori—providing food, shelter and materials for everyday use.

New Zealand's geological past gives a clue to the origins of New Zealand's flora.

New Zealand was once attached to a great southern continent named **Gondwanaland.** That included Africa, South America, Madagascar, India, Australia and Antarctica. Plate tectonics, or continental drift, saw these land masses drift apart and oceans begin to separate them preventing animals and plants from directly crossing to the next land mass (see Figures 1 and 2). Once separated only plants and animals able to disperse across seas where able to reach other lands.

Evidence points to New Zealand separating from Australia some 60–80 million years ago—prior to the demise of the dinosaurs. Although closer to the South Pole at the time it retained an assemblage of **ancient rafters**—tuatara, kauri, kahikatea, rimu, beech trees, probably ratites (moa and kiwi ancestors). In isolation these plants and animals and plants evolved and were joined by "**drifters**"—plants and animals able to cross the Tasman Sea through wind or bird dispersal. These too continued to evolve in the New Zealand environment. Box 1 shows how the flora has changed since the original castaways colonised New Zealand 80 million years ago.

Over time many plant extinctions have taken place, although of our recent flora, only six species are now believed to be globally extinct. Even today we still receive new natural immigrants from Australia, such as the orchid *Pterostylis alveatua* that has established in the Nelson area in recent years. In 2006, a single plant of *P. alveata* was found growing in the Hutt Valley, north of Wellington.

Pterostylis alveata.

Box 1: Colonisation of New Zealand by plants

Original castaways (colonised NZ at least 80 million years ago: Jurassic–Cretaceous–dinosaur age):
Ferns (some)
Gymnosperms ➔ Araucarian pines including *Agathis* and podocarps, *Libocedrus, Sequoiadendron spp. (*extinct now).
Angiosperms ➔ Southern beech (*Nothofagus brassii group)*, tawa, rewarewa, fuchsias

Early colonisers (Paleocene–Eocene): 65–35 million years ago
Metrosideros; *Nothofagus fusca* group; *Dicksonia*

Early west wind drifters (Oligocene–Miocene): 35–5 million years ago
Nīkau palm, coprosmas, kōwhai
Coconut palm—now extinct
Gum trees (*Eucalyptus*)—now extinct
Wattles (*Rycosperma*)—now extinct

Later west wind drifters (Pliocene–Pleistocene): 5–0.01 million years ago
Native orchids and hebes (koromiko)

Recent west wind drifters (Holocene): 0.11 million years ago to present
Native orchids
Pomaderris apetala (tainui)

20th century arrivals
Natural dispersal: *Myrmechila trapeziformis*
Human-assisted dispersal: Exotic plants introduced deliberately or accidentally by humans include ***cultivated plants*** (some arrived with Polynesian settlers) some of which are part of the ***weed flora***—naturalised exotic (non-native) plants.
Today's New Zealand flora is a mix of indigenous and exotic species, with the number of exotic species escaping into the wild increasing each year. By 2006 there were approximately 2500 exotic plant species growing wild in New Zealand.

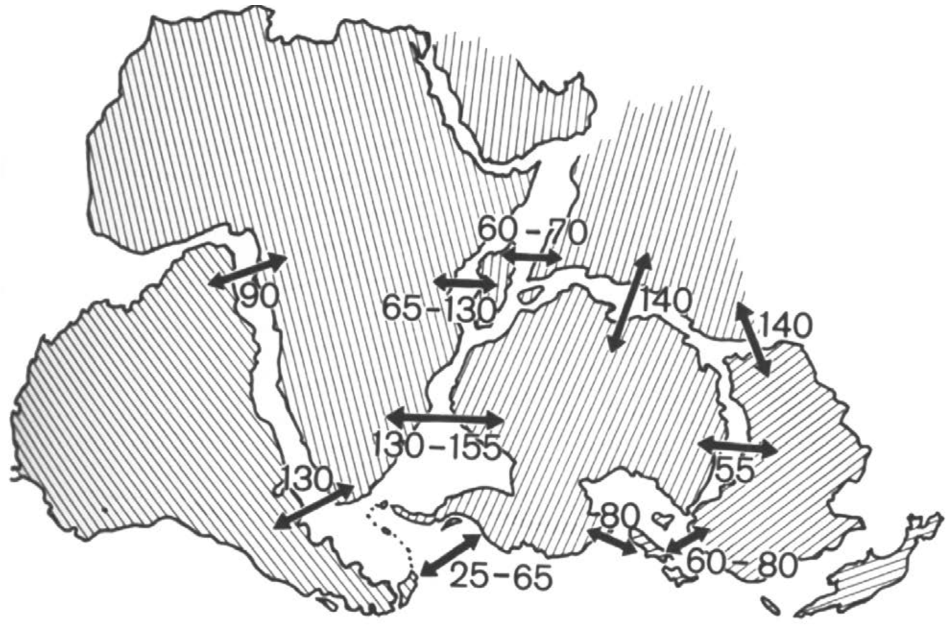


Figure 1: The rifting of Gondwanaland (source: Stevens 1980).Timing in millions of years of splitting apart of the Gondwana land masses

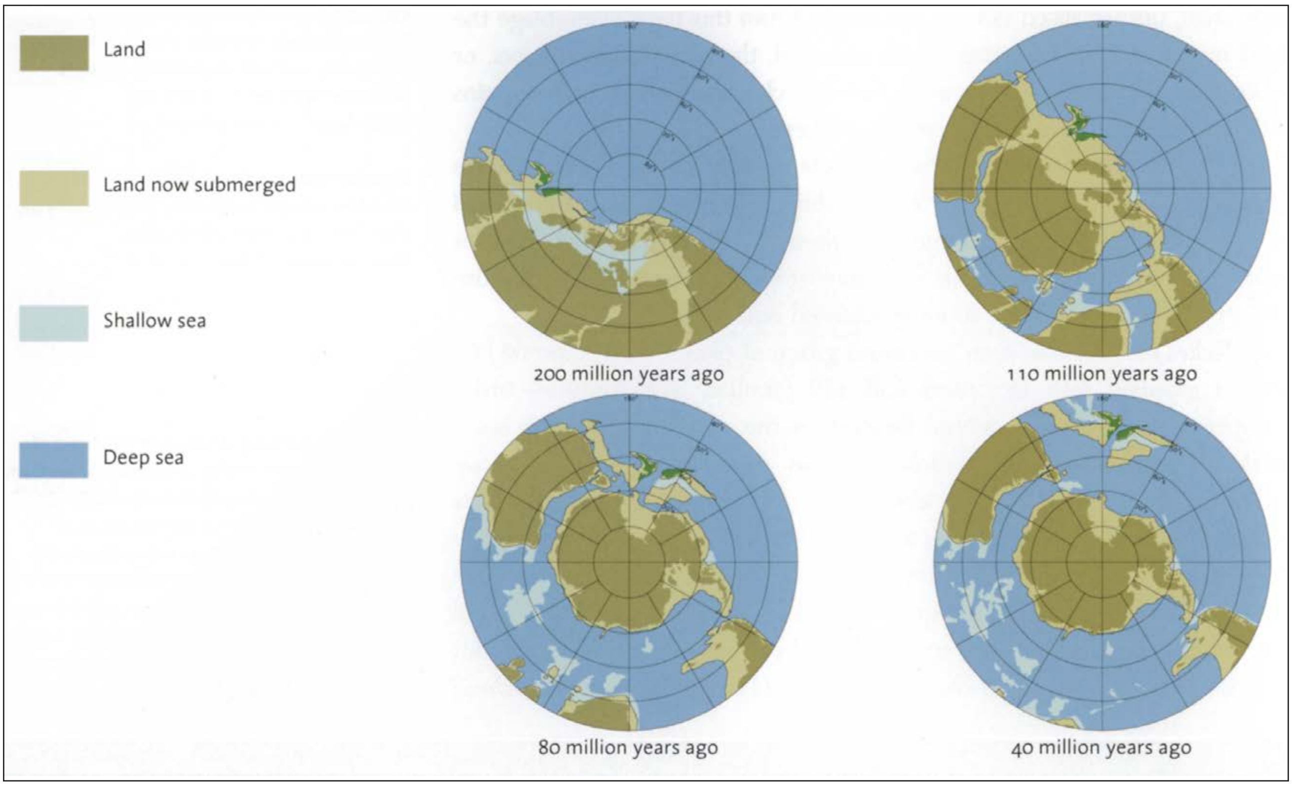


Figure 2: From: Philip Simpson's Pohutakawa and Rātā – New Zealand's iron hearted trees, Te Papa Press. Published with permission.

Exotic plants

Exotic plants have been brought to New Zealand over many centuries and for many reasons. Some species were brought accidentally; some were deliberately introduced as garden ornamentals (such as *Tradescantia fluminensis* / wandering willie) or as food crops (such as *Solanum tuberosum* / potato and *Actinidia deliciosa* / kiwifruit). Other exotic plants, such as *Pinus radiata* and *Cupressus macrocarpa*, have been planted in New Zealand for use in forestry. There are now more than 35,000 exotic plant species in New Zealand but not all of these occur in the wild—the majority of exotics are still confined to gardens and urban landscapes. But of these exotic plant species, by 2007, 2440 had naturalised into the wild. That means exotic plant species now outnumber indigenous species in New Zealand and exotics are establishing in the wild at a rate of approximately 12 species per year. Whether a plant becomes a weed depends on the species and the location.

Weeds are by definition plants that are not wanted in a particular place. Weeds are exotic plants that are capable of persisting and reproducing by seeds, spores or vegetative means to form populations where they are not wanted. Some weeds only persist in cultivated lands—horticultural and agricultural weeds that compete with cultivated plants. Other weeds are capable of growing in areas of native vegetation, particularly after disturbance—these are **environmental weeds** which pose the greatest threat to native vegetation and habitats.

Some exotic plants are so thoroughly naturalised that many consider them to be native. Some weeds are closely related to native plants. For example, pampas grasses from South America and species of native toetoe belong to closely related genera—*Austroderia* and *Cortaderia*—and can be confused (see exercise page 9). Sometimes the news is not all bad: gorse for instance, can sometimes act as a nurse crop for native bush regeneration.

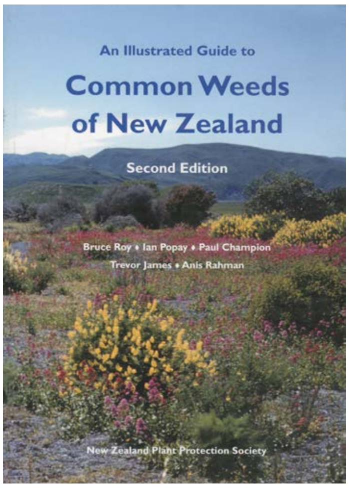
Environmental weeds can harm native plants by:

- Smothering them—particularly climbers such as old man's beard and moth plant
- Competing with native plants for living space, resources, pollinators, seed disseminators
- Preventing / suppressing natural regeneration by smothering seedlings, biochemical warfare (allelopathy)
- Increasing fire risk e.g., gorse
- Harbouring pests
- Altering successional processes

Exotic plants can also play a role in changing the character of a landscape.

More information about weeds

There are many sources of information about exotic plants and weeds in New Zealand. A very useful resource is the website of the New Zealand Plant Conservation Network—www.nzpcn.org.nz. It contains fact sheets for all environmental weeds in New Zealand including photos for most species and also has a checklist of the naturalised plants in New Zealand.



An "Illustrated Guide to common Weeds of New Zealand" Bruce Roy, Ian Popay, Paul Chapman, Trevor James, second edition by the New Zealand Plant Protection Society covers a wide range of weeds.

Some volumes of the Flora of New Zealand also include exotic species.

Many regional councils and the Department of Conservation have weed publications and offer advice on their management.

Examples of additional website resources include:
www.doc.govt.nz/conservation/threats-and-impacts/weeds/

Purple Loosestrife; Christchurch City Council: www.ccc.govt.nz/guides/PurpleLoosestrife/

Fact sheets and other information about many weed species; Environment Bay of Plenty: www.envbop.govt.nz/land/plants/pest-plants.asp

Toetoe (*Austroderia*) or pampas (*Cortaderia*)?

Tall white seed heads on a giant grass plant are a feature in New Zealand. Some are native species, collectively known as toetoe, but others are introduced species called pampas which have naturalised throughout New Zealand and are now considered weeds. Find a specimen of one of these grasses and use the following test to see whether or not it is native:

- Hold a leaf with two hands and give a sharp sideways tug. If it snaps cleanly it is pampas. Toetoe has more main veins and the leaves are tougher.

Once you have tried this test a few times, see what other differences you can find. The following key will help to identify all *Austroderia* and *Cortaderia* species in New Zealand:

1	Leaf-blade with prominent midrib and several conspicuous lateral ribs; leaf-sheath evidently glaucous, remaining entire and strict. Flowers Spring to mid-Summer. (*Austroderia*; endemic spp.)	2
	Leaf-blade with prominent midrib only; leaf-sheath not glaucous, later curling up and fracturing into short segments. Flowers Autumn. (*Cortaderia*; naturalised spp.)	6
2	Leaf-sheath with long hairs; all flowers ⚥. Chatham Island species.	7. *A. turbaria*
	Leaf-sheath glabrous; flowers on separate plants all ⚥, or all ♀.	3
3	Leaf-blade margins very slightly scabrid.	4
	Leaf-blade margins very strongly scabrid and cutting at mid-point.	5
4	Leaf-blade glabrous above ligule; ligule 1 mm; contra-ligule absent; caespitose.	1. *A. fulvida*
	Leaf-blade densely hairy above ligule; ligule 3 mm; contra-ligule present; rhizomatous. North Island species.	5. *A. splendens*
5	Leaf-sheath ivory under waxy coating; culm internodes ivory. North Island species.	6. *A. toetoe*
	Leaf-sheath green under waxy coating; culm internodes green.	3. *A. richardii*
6	Leaf-blade blue-green above, dark green below; rachis finely silky hairy; plants ♀ and ⚥; lemma hairs of ♀ floret arising throughout.	4. *C. selloana*
	Leaf-blade dark green on both surfaces; rachis minutely scabrid; all plants ♀; lemma hairs mostly arising above palea height.	2. *C. jubata*

Adapted from: http://floraseries.landcareresearch.co.nz/pages/Taxon.aspx?id=_15a3308f-cd4b-4b76-9aa3-51888203dcad&fileName=Flora%205.xml

Leaf sheaths of naturalised *Cortaderia* species (pampas) curl and fracture when old.

Long hairs on leaf-sheath of *Austroderia turbaria*.

Waxy coating on leaf-sheath of *Austroderia toetoe*.

3. Plant names – which name do you use?

There are three types of name used for most plant species in New Zealand: the Māori name, the common name and the latinised botanical name. Although, you may think it easier to use Māori or common names for plants there are several advantages of using the full latinised botanical name.

Leptospermum scoparium (top) and *Muehlenbeckia australis*.

What are the advantages of using botanical names?

1. THEY AVOID CONFUSION

Common names can cause confusion as one name may apply to several species not necessarily related. For example, in New Zealand tea tree applies to *Leptospermum scoparium* agg. and *Kunzea ericoides* agg. and the exotic plant *Camellia sinensis*. Pōhuehue is a Māori name used for a range of *Muehlenbeckia* species including *Muehlenbeckia complexa*, *Muehlenbeckia ephedroides*, *Muehlenbeckia axillaris* and *Muehlenbeckia australis*. Mingimingi is used for many small-leaved shrubs, such as *Coprosma propinqua, Leptecophylla juniperina*, and *Leucopogon fasciculatus*.

2. THEY HELP TO SHOW RELATIONSHIPS BETWEEN PLANTS

Botanical names may sound complicated but they help show how different species are related to each other. For example, the common names 'potato', 'black nightshade' and 'poroporo' do not indicate any relationship between these three species, but the botanical names (*Solanum tuberosum*, *Solanum nigrum* and *Solanum aviculare* and *Solanum laciniatum*) show that they are all related to each other and in the same genus.

The genus *Solanum* includes the indigenous porporo (*S. aviculare*) and introduced potato (*S. tuberosum*).

3. THEY FACILITATE INTERNATIONAL COMMUNICATION (UNIVERSALITY)

The binomial (two name) system is an international system for naming species. Botanists have adopted, by international agreement, a single language to be used on a world wide basis. A botanical name in India refers to the same plant as a botanical name in Iceland.

Some Māori names for plants have been adopted as part of the scientific names of plants. For example, *Corokia* for korokio, *Austroderia toetoe* for toetoe, *Manoao colensoi* for manoao or silver pine, *Phyllocladus toatoa* for toatoa, *Podocarpus tōtara* for tōtara and *Raukaua anomalus* for raukawa.

From left: Korokio (*Corokia cotoneaster*), tōtara (*Podocarpus tōtara*), raukawa (*Raukaua anomalus*).

Parsonsia capsularis var. *rosea*.

Corybas cheesemanii.

Agathis australis, kauri.

4. THEY CAN HELP DESCRIBE THE PLANT

Some botanical names describe a significant feature of the species. For example, a native jasmine is named *Parsonsia capsularis* var. *rosea*, because the seeds of this species are borne in long capsules (*capsularis*) and the flowers are pink (*rosea*). The genus name *Coprosma* translates to dung because many species in the genus have an unpleaseant smell. One species of coprosma smells so strongly that it is named *Coprosma foetidissima* (very fetid). Another coprosma has large leaves and is named *C. grandifolia* (big leaf). Please note that some apparently descriptive names can be misleading. For example, the leaves of *Helichrysum lanceolatum* (lance-shaped), are mostly rounded.

5. THEY HONOUR A PERSON

Some plants are named in honour of a particular person. For example, the orchid *Corybas cheesemanii* is named in honour of Thomas Cheeseman, an early New Zealand botanist.

How to write botanical names

1. GENUS AND SPECIES NAMES

The convention for writing the genus and species name is as follows:

Capital letter   lowercase letter (even if named after a place or person)

Agathis australis kauri — common name lowercase

Both names are underlined (when handwritten or typed) or set in italics in print.

Agathis australis kauri

4. Where plants grow and why

Plants grow in a range of environmental conditions that vary from site to site depending on the geology and the climate.

Autecology is the study of an organism and how it relates to its environment. It focuses on why a plant is distributed in a certain way and on phenological (timing of flowering and fruiting) morphological and physiological adaptations, population dynamics, genetics and evolution.

Environment	Evolution → Genetic change	Adaptation
• water availability • seasonality • altitudinal distribution • ecosystem • soil type		• morphological (structures) • phenological (timing of events) • reproductive strategies • physiological (biochemical)

Environmental adaptation

Plants become adapted to the conditions they evolve in. The more extreme the conditions the more extreme the adaptation. Environmental adaptation in plants can be described in terms of adaptation to water and seasonality (usually temperature).

Three terms describe plants' adaptation to water:

Xerophyte (arid): adapted to extremely dry conditions or physiological drought (such ice or salt).  e.g., *Myosotis albosericea*. Photo: John Barkla.	**Mesophyte**: adapted to moderate conditions of dry or moisture; most plants.  e.g., cabbage tree (*Cordyline australis*)	**Hydrophyte (aquatic)**: wholly or partly submerged in water.  e.g., mangrove (*Avicennia marina* subsp. *australasica*).

Seasonality

An interesting aspect of the New Zealand floras response to seasons is that most native plants are evergreen, meaning they bear foliage throughout the year. Deciduous plants have leaves that fall off or are shed seasonally to avoid adverse weather conditions such as cold or drought. Some examples of deciduous trees in New Zealand include tree fuchsia, shrubby tororaro, and lowland ribbonwood.

Altitudinal distribution

Different plants are found in different altitudinal zones. This **altitudinal zonation** can be very distinct (e.g., the tree line on mountains) and is usually an indication of changing temperatures. Altitudinal distribution of plants is usually described as five zones:

<table>
<tr>
<td>Coastal: On or near the sea coast, e.g., pīngao, karo.
</td>
<td colspan="2">Lowland: Altitude of less than 500 m, e.g., maire, kohuhu, black beech.
</td>
</tr>
<tr>
<td>Montane: Between approx 500 m and the tree line, e.g., mountain beech.
</td>
<td>Subalpine: Above the tree line to the snow zone, e.g., leatherwood, tussock grasses.
</td>
<td>Alpine: The snow zone, e.g., lichens, algae and herbaceous plants; no tussock grasses.

Photo: Les Molloy.</td>
</tr>
</table>

Zones change with latitude. For example, in the sub-antarctic islands, subalpine type plants may grow on the coast.

Some books specialise in plants of particular zones (e.g., Andrew Crowe's "Which Coastal Plant") or have separate sections on zones (e.g., Salmon's "New Zealand Flowering Plants in Colour"). For the purposes of plant identification you can narrow down your search by knowing which zone/habitat you are in.

Ecosystem distribution

An ecosystem is a living community which interacts with its environment. Ecosystems are often less clear cut and 'tidy' than altitudinal zonations and ecosystems can exist within other ecosystems e.g., freshwater streams within a forest. Ecosystems were originally thought of as closed systems, but they are now regarded as continuous interacting mosaics up to landscape scale. Examples of ecosystem descriptions are shown below:

Some plant identification books specialise in ecosystem types, such as *Wetland Plants in New Zealand* by Peter Johnson & Pat Brooke and *Flowering Plants of New Zealand* by John Salmon which is organised by habitat/ ecosystem.

Marine: Saltwater, offshore.

Saltwater Estuarine: Tidal, on the margin of ocean, river and coast.

Riparian/Freshwater: flowing water bodies with vegetation mainly on banks.

Duneland: Sandy, coastal margin, lightly vegetated.

Shrubland: Low canopy, small tree or shrub dominated.

Freshwater Wetland: Low lying, highly saturated, fertile areas with still waters.

Peat bog: Low lying, highly saturated with deep peat layers. Very acid and low fertility.

Photo: Barbara Mitcalfe.

Lacustrine (lake): Large, still water bodies. Can be highly nutrient enriched (eutrophic) e.g., Lake Wairarapa; medium enriched (mesotrophic) e.g., Lake Taupo; or low nutrient (oligotrophic) e.g., Lake Wakatipu.

Grassland: Tussock dominated, generally drier.

Herbfield: No canopy, herb dominated. Often wet, cold, boggy or higher altitude.

Photo: Vivienne McGlynn.

Fellfield/scree: Rocky areas. Dominated by small herbs. Usually higher altitude.

Alpine / nival: High altitude; dominated by lichen and algae.

Photo: Les Molloy.

Forest: Tall canopy of trees. Often wetter, more fertile and sheltered areas.

There are many other types of ecosystem, such as sandy desert, stony desert, volcanic, tundra, etc. However, those shown here are the most common in New Zealand.

5. Plant communities in New Zealand

Plants do not occur alone. They form communities and interact with one another and other organisms. There are a range of plant communities that occur in the New Zealand botanical region that may be observed as you travel through and across New Zealand (see box below).

Climate especially rainfall and temperature gradients are the main determinants of what grows where, but soils, relief and disturbance factors are also important.

The main plant community types in New Zealand*

Forests
- Kauri/podocarp/broad-leaf forest (northern) + hard beech in places
- Podocarp/broad-leaf forest
- Broad-leaf forest
- Kauri forest (northern)
- Podocarp forest
- Coastal forest and offshore islands (Composition changes with latitude, climate)
- Kermadec islands , Chatham islands, Subantartic islands—unique flora
- Tawhai/beech forest (cooler and drier locations)—really a type of broadleaf forest dominated by *Nothofagus* sp.
- Mixed beech/podocarp/broadleaf forest
- River/alluvial forest (kōwhai, ribbonwood, matai, tōtara feature)
- Duneland forest (well drained)
- Plantation

Scrub/shrublands (induced, natural, and seral or successional)

Coastal, montane, subalpine, zones/belts and boundary of wetlands, heathland

Tea tree /manuka/kanuka shrubland—often successional following disturbance

Fernland (Bracken-dominated community)—as above

Herbfields and fellfields (alpine subalpine and subantarctic, areas)
- Scree
- Megaherbs feature of subantarctic islands

Tussock grasslands
- Tall Tussock/Snow tussock grasslands (colder, drier but not to dry areas)
- Red tussock grassland (often boggy sites)
- Short tussock grassland (cold dry eastern sites generally)

Wetlands
- Saline(saltwater) wetlands and mangrove swamps.
- Freshwater wetlands (running/ stationary , fertile / infertle)
  - swamps
  - rivers
  - bogs
  - lakes and ponds
- Seepages

Dunelands
- Fore-dunes—spinifex, pingao and exotic marram grass
- Back-dunes—shrubs (e.g., *Ozothamnus*, coprosma) flax, herbs and grasses

* Exotic plants occur in all of these plant communities.

Kauri (*Agathis australis*).

A plant's place in the forest—is it an epiphyte, a parasite or a saprophyte?

Sometimes plants grow on each other as epiphytes (perching plants) (see box below). In other cases they take nutrients from their host. This select group of plants that depend on their host plants for **nutrition** is called parasites. Some parasitic plants also photosynthesise themselves—these are called hemi-parasites. In New Zealand several species of hemi-parasitic plant (such as the red and scarlet mistletoe—*Peraxilla tetrapetala* and *Peraxilla colensoi)* are under threat from forest clearance and browsing by possums and, as a result, are becoming increasingly rare. One species of mistletoe—Adams's mistletoe (*Trilepidea adamsii*)—that used to occur near Auckland is already extinct.

Peraxilla tetrapetala, red mistletoe.

Epiphytes, parasites and hemi-parasites

Epiphyte: a plant that perches on another plant without harming it.

e.g., *Tmesipteris lanceolata*

Parasite: an organism that derives its food from the living body of another.

e.g., *Dactylanthus taylorii.*
Photo: Avi Holzapfel.

Hemi-parasite: a plant that derives water and nutrients from a host but also photosynthesises.

e.g., green mistletoe (*Ileostylus micranthus*).
Photo: Peter de Lange.

Plants that feed off dead rotting vegetation are known as saprophytes. Examples include thismia (*Thismia rodwayi*) and the cryptic orchid, *Molloybas cryptanthus*.

Molloybas cryptanthus, a saprophytic orchid. Photo: Ian St. George.

Vegetation strata

A forest can be viewed as a layered structure. Plants when mature will occupy a distinct layer (stratum). The description of layers in a forest is generally like this:

Strata in a forest ecosystem

Emergent
e.g., rimu, rātā.

Canopy
e.g., kāmahi, tawa.

Subcanopy
e.g., putaputāwētā, coprosma.

Understorey
e.g., kawakawa, smaller tree ferns.

Floor
e.g., ferns, herbs.

Photo: Les Molloy.

Often the climbers, epiphytes, parasites and hemi-parasites occupy intermediate layers. A young canopy tree species may temporarily occupy the shrub and sub canopy layers as it grows before maturing into a canopy tree. Most vegetation types including shrublands, wetlands, grasslands are also layered. Knowing where in a forest a plant grows can be useful for identification purposes.

Guide books such as Andrew Crowe's series *Which Native Tree*, *Which Forest Plant* and *Which Native Fern* relate the plants to a particular place in the strata of a forest.

6. Life cycle and growth form

Three terms are used to describe the life cycles of plants from germination of a seed to flowering, and production of new seed:

- Annual – The entire life cycle occurs within one year, and the plant dies, e.g., *Atriplex* species.
- Biennial – A plant flowers and produces seed in the second year after it germinated, e.g., New Zealand gentians.
- Perennial – Continue from one year to the next. Includes most New Zealand species from the smallest herbs to the largest trees. Many exotic plants are also perennial.

There are a variety of different habits or growth forms for native plants. They include divaricating, erect, prostrate, scrambling, matted and rhizomatous:

Divaricating/ filiramulate: branching at a very wide angle with stiff intertwined stems.

e.g., *Corokia cotoneaster*

Prostrate / procumbent (if not rooting): stems lying flat on the ground.

e.g., *Coprosma acerosa*
Photo: Lisa Forester.

Erect: stem perpendicular to the ground.

e.g., rimu (*Dacrydium cupressinum*)

Scrambling/climbing: multiple thin stems adhering to and entwining its host.

e.g., mangemange (*Lygodium articulatum*)

Matted/cushion: cushioned, low, closely packed leaves.

e.g., *Raoulia* aff. *australis.*

Heteroblastic: different forms in juvenile and adult phases of the plant.

e.g., lancewood (*Pseudopanax crassifolius*), juvenile (left) and adult.

Fastigiate (like Lombardy poplar): branches erect and close to central axis.

e.g., young rewarewa (*Knightia excelsa)*.

Tufted
Sprouting from a single base portion.

e.g., *Poa billardierei.*

Rhizomatous
Creeping on rooted rhizomes below the surface.

e.g., *Dianella nigra.*

Floating: lying flat on open water.

e.g., duckweed (*Lemna minor*).
Duckweed (large green leaves) growing with *Wolffia australiana* (small green leaves) and *Azolla filiculoides*.

Rosette: leaves arising in a circle from the base.

e.g., *Celmisia semicordata.*
Photo: John Sawyer.

7. Flower power

Flowers are one of the most important features used to identify plants.

Kōwhai (*Sophora fulvida*) and kakabeak (*Clianthus puniceus*).

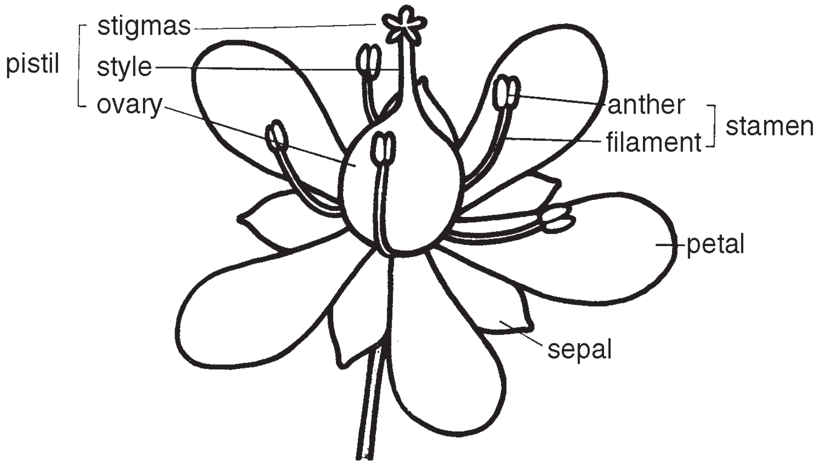
Flower types

The parts of a flower vary greatly from plant to plant. However, all tend to follow a basic pattern of:

- **Calyx**—sepals
- **Corolla**—petals
- **Stamens**—filaments and anthers
- **Pistils**—ovary, style, stigma

A **complete flower** has all the flower parts—sepals, petals, stamens, pistil.

An **incomplete** flower lacks one or more of these parts. Some flowers, e.g., *Clematis* spp. lack petals but have petal-like sepals. In these cases, the sepals are known as **tepals**.



Flower parts may be **free** (completely separate from each other) or **fused** (partly to wholly united). Fused parts may be:

- **Connate**—like parts, such as petals, fused to each other, e.g., the petals of fuchsia flowers are partly fused to form a tube
- **Adnate—**unlike parts, such as stamens fused to petals

Kōtukutuku (*Fuchsia excorticata*) petals are partly connate.

Flowers can also be described as ‘perfect’ or ‘imperfect’.

❶ **Perfect** (hermaphrodite) flowers: have both sexual parts on one flower—functional stamens (male) and pistils (female).

e.g., horokaka (*Disphyma australe*).

❷ **Imperfect** flowers: functional stamens and pistils on different flowers, either on the same plant—**monoecious,** or on different plants—**dioecious**.

Monoecious: Male flowers and female flowers on the same plant.

e.g., shrubby tororaro (*Muehlenbeckia astonii*). ♀ left, ♂ right. *M. astonii* plants may also be dioecious.

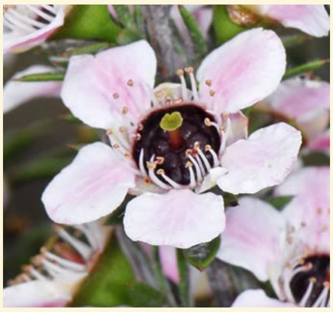
Dioecious: Separate male and female plants.

e.g., *Coprosma spathulata*, male (left) and female.

Some species, e.g., kōtukutuku/tree fuchsia (*Fuchsia excorticata*), may have perfect and imperfect flowers on the same plant.

Plants can also be split into two groups based on the symmetry of their flowers:

❸ **Regular**: actinomorphic (radially symmetrical).



e.g., mānuka (*Leptospermum scoparium*).

❹ **Irregular:** zygomorphic (bilaterally symmetrical).

e.g., bamboo orchid (*Earina mucronata*).

A male single-sex flower of dioecious *Coprosma rugosa*.

Thus, flowers can be:

❶ and ❸ Perfect and regular

❶ and ❹ Perfect and irregular

❷ and ❸ Imperfect and regular

❷ and ❹ Imperfect and irregular

A perfect, regular flower: Tararua gentian (*Gentianella montana* subsp. *ionostigma*).

Can plants count?

All flowering plants fall into one of two groups: monocotyledons or dicotyledons. When the seed of a monocotyledonous plant germinates, a single seed leaf appears, whereas dicotyledonous plants produce two seed leaves.

Monocotyledonous plants: Approximately 30 percent of New Zealand's flowering plants, including cabbage tree, orchids, nīkau, rengarenga, grasses, flax have flower parts in threes or multiples thereof e.g., six, nine.

Libertia grandifolia, a monocotyledon, has flower parts in groups of three,

Dicotyledonous plants: Approximately 70 percent of New Zealand's flowering plants. They usually have flower parts in fours or fives. For example, the **Pittosporum** family has 5 petals, 5 sepals, and 5 stamens and 1 ovary.

Kōhūhū (*Pittosporum tenuifolium*), a dicotyledon, has flower parts in groups of five.

Inflorescences

Flowers are either **solitary** (single) or have a few to many on a special flower branch called an **inflorescence.** This gives another clue to plant identity (see diagram below). Seven types of inflorescence are described here:

Composite head/capitulum: many small flowers tightly packed together, e.g., plants in the daisy family.

e.g., *Galinsoga quadriradiata.*

Corymb: modified raceme where stalks of lower flowers are elongated to same level as the upper flowers.

e.g., elderberry (*Sambucus nigra*).

Cyme: each branch terminated by a flower, new flowering branches emerge laterally below the flower.

e.g., willowherb (*Epilobium nummularifolium*).

Panicle: highly branched (multiple raceme).

e.g., bush lawyer (*Rubus cissoides*).

Raceme: flowers attached to main stem by short stalks.

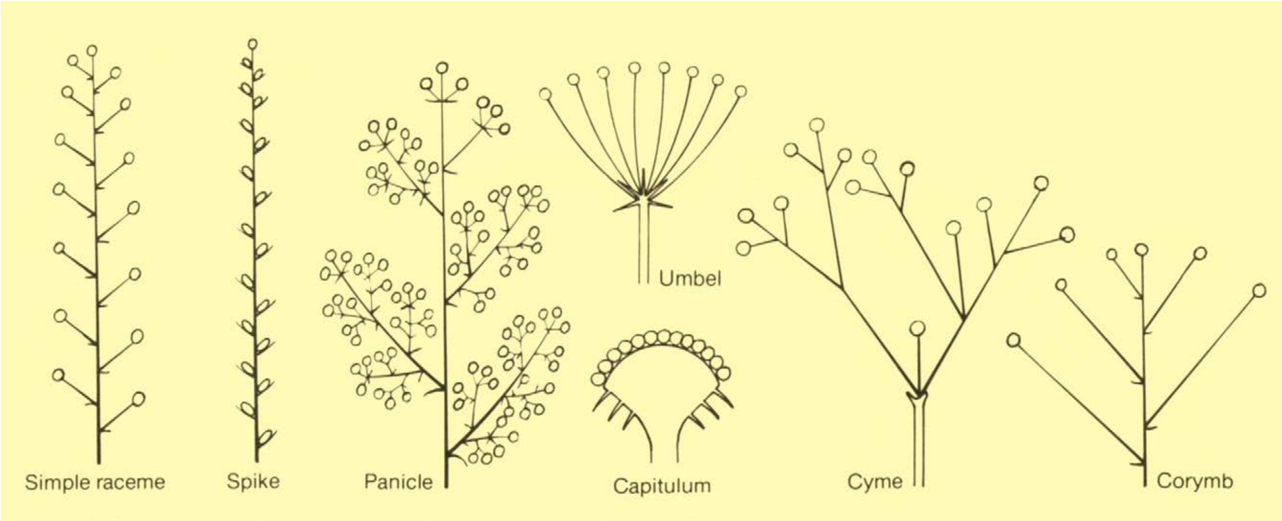
e.g., *Hebe perbella.*

Spike: flowers attached to main stem without stalks.

e.g., selfheal (*Prunella vulgaris*).

Umbel: “umbrella like”; the flower stalks arise from one point at the stem. Simple or compound.

e.g., carrot (*Daucus carota*).



Forms of inflorescences (from *The Native Trees of New Zealand* by J.T. Salmon).

From left: hinau (raceme), makomako (panicle), tarata (compound umbel).

ODD FACT

The tendril of **kohia** (*Passiflora tetrandra*) is thought to be a modified inflorescence.

Flower size and colour

The size and colour of flowers are important for plant identification. Flower size is usually measured across the petals at the longest dimension. Flower colour is the colour of the petal arrangement or inflorescence including petals and sepals.

Pollination

Pollination is the sexual reproduction process in seed-producing plants whereby pollen (male gamete, equivalent to sperm in animals) is transferred from staminate cone (male or pollen cone in conifers) or stamens (in flowers) to a stigma (in flowers) or ovulate cone (female cone in conifers). There are a number of agents used to transfer pollen, including the wind, birds and bats and other animals such as insects. If pollination is successful, fertilisation occurs and a seed develops.

Left: A tui pollinating *Peraxilla colensoi*. Photo: © University of Canterbury. Right: Short-tailed bat—a pollinator of *Dactylanthus taylorii* (Pue o te Reinga). Photo: J.L. Kendrick; © Department of Conservation.

Essentially there are two types of pollination:

Self pollination

Pollen transferred from anther to stigma on same plant. This is common in legumes and orchids.

Cross pollination

Pollen is transferred from an anther of one plant to a stigma of another. This is the most common form of pollination and occurs in several ways. Some New Zealand examples include:

- Birds—mainly red flowers
- Bees—mainly blue flowers
- Moths—small white flowers, evening scented
- Flies—white flowers
- Wind—grasses, rushes, conifers, coprosmas, beeches

8. Spores, seed and fruit

Plant reproduction

“Plants are great travellers in space and time” as David Attenborough says in the TV programme ‘The Private Life of Plants’:

They do this as **spores** and **seeds** as individual plants are of course pretty much stationary. This is how plants leave descendants and disperse to new sites. Plants can also reproduce by vegetative means (asexual reproduction). In New Zealand we have plants that sexually reproduce in the following ways:

Lycopodium fastigiatum, a clubmoss.

SPORE BEARING

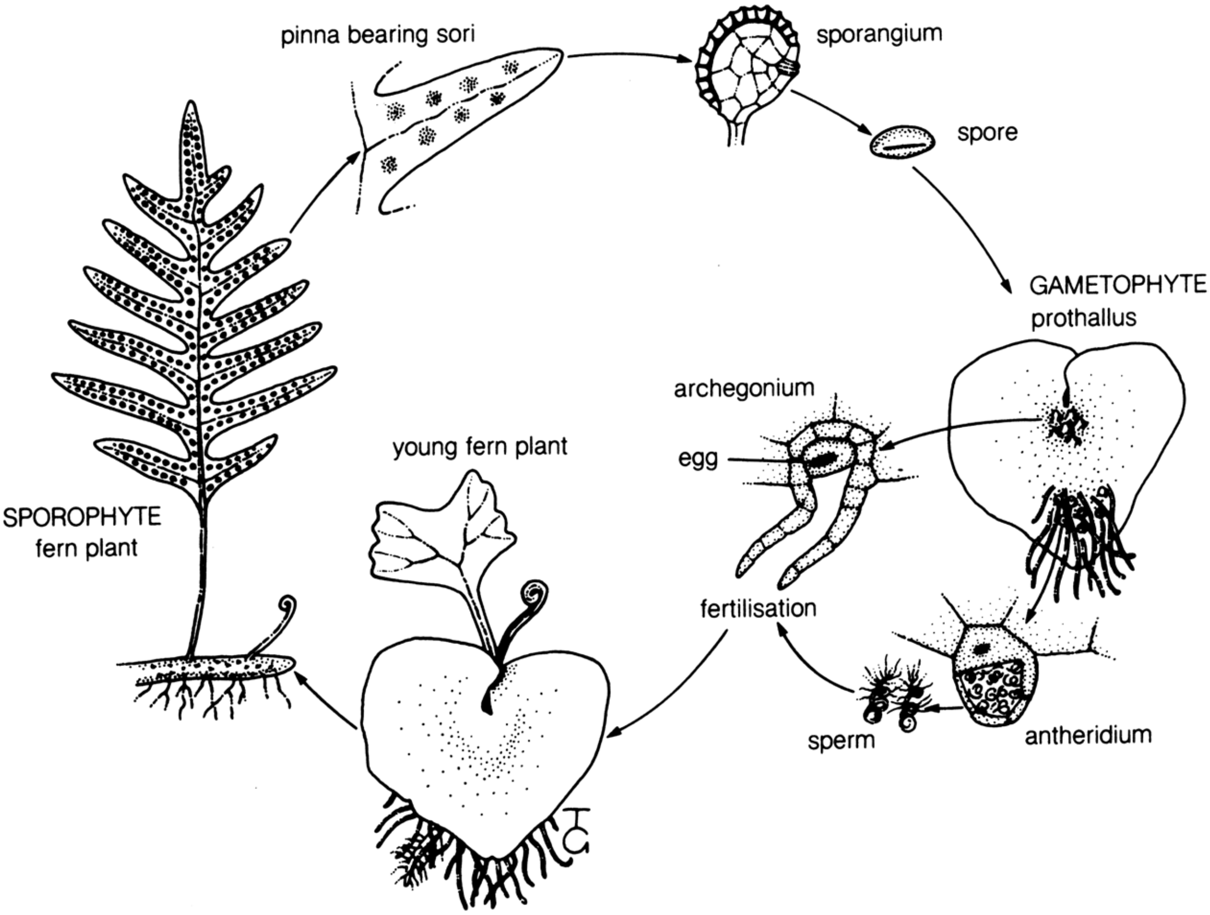
There are three groups of plant that reproduce by spores:.

1. **Bryophytes** (liverworts, mosses, hornworts)

These are non-vascular plants that bear spores and were the first land plant group to evolve. These are not covered in this module.

2. **Lycophytes** (clubmosses, quillworts)
3. **Ferns**

Lycophytes have in the past been known as fern allies, but DNA research has shown that ferns are more closely related to flowering plants than they are to lycophytes.



Life cycle of spore bearing plant. Illustration by Tim Galloway. (taken from *New Zealand Ferns and Allied Plants* by P.J. Brownsey & John Smith–Dodsworth).

SEED BEARING (SPERMATOPHYTES)

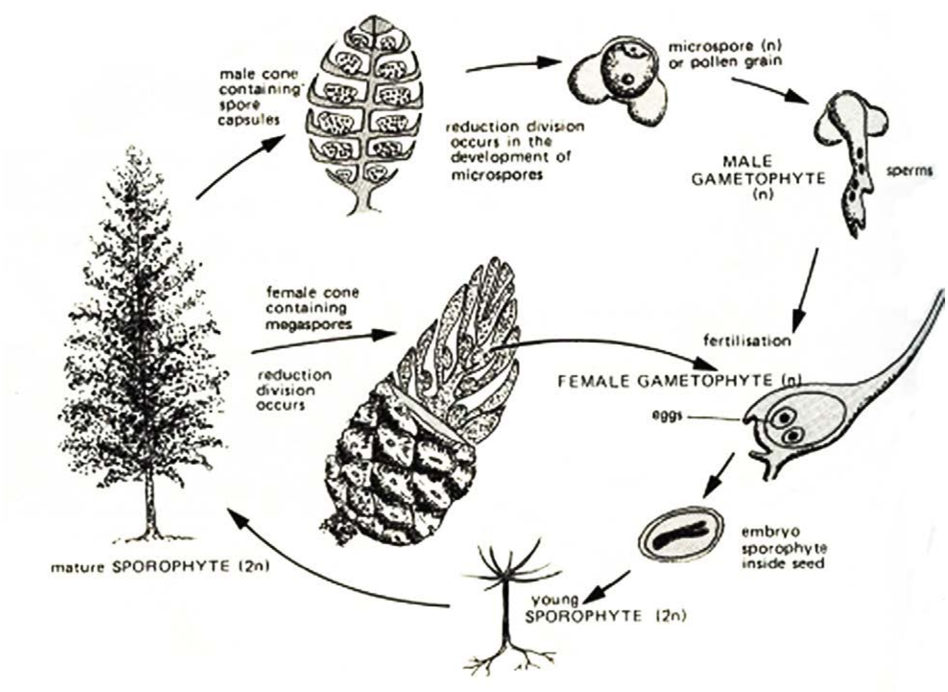
Two groups of plants reproduce with seeds: gymnosperms (conifers) and angiosperms (flowering plants).

1. **Conifers "cone bearers"** (gymnosperm) kauri, kaiwaka, podocarps, celery pines

Kauri. Photo: John Smith-Dodsworth

podocarp = "foot seed"

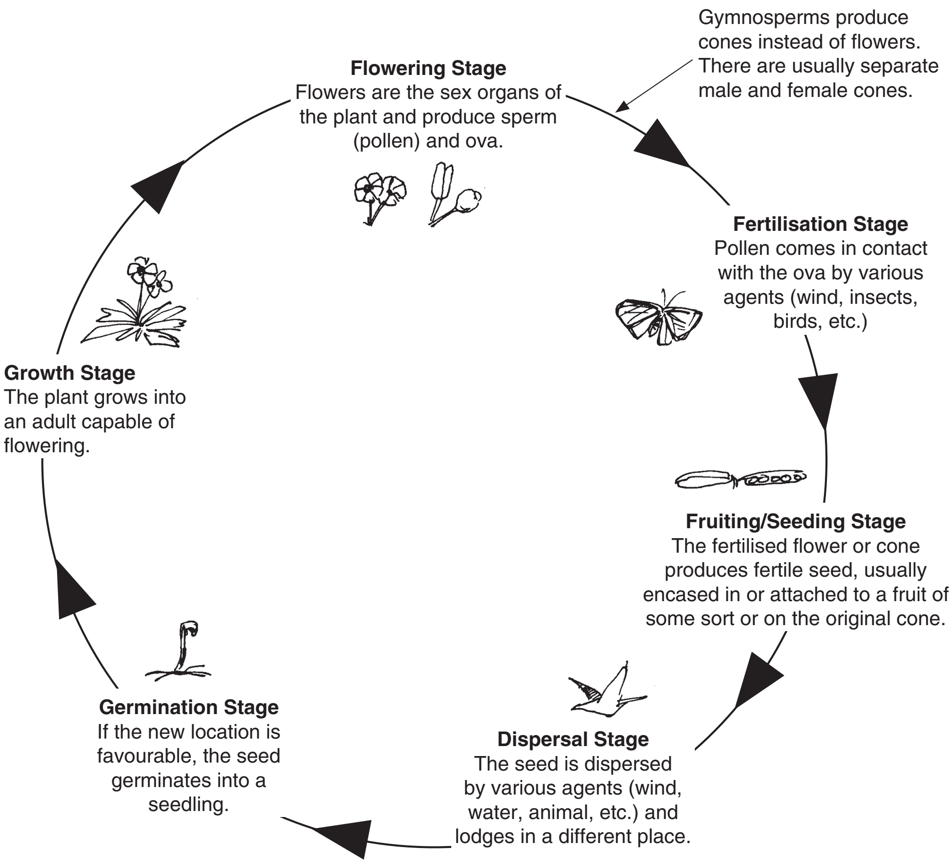
The cone is obvious in kauri and kaiwaka although small in the latter. It is reduced to a single scale in podocarps though surrounded by, or borne on, a fleshy stalk—the seed (fruit) is at foot of fruit hence the name podocarp = foot seed. The life cycle is shown below:



Life cycle of a cone bearing plants. Note the two dispersal units—pollen and seed.

2. **Flowering Plants** (angiosperms)

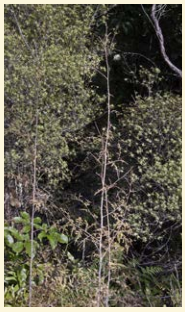
This is the largest group of plants in New Zealand. See the following life cycle:



Life cycle of a flowering plant

Life stage for seed bearing plants

Life stages are the different forms the plant takes during its life span. This can be important for identification and for such things as cultivation and translocation. There are six common life stages for canopy trees from seed to adult plant:

 **Seed** The matured ovule without accessory parts, contained in a fruit or cone. Common to all flowering and cone bearing plants.	 **Seedling** A newly germinated plant.	 **Sapling** A juvenile tree which has reached the stage of 1 or 2 main stems. Still in the shrub layer.
 **Juvenile** A plant of non-reproducing size. May be heteroblastic (having different leaf shapes from the adult).	**Pole** A subcanopy size individual, with long thin trunk and foliage tuft, of a potential canopy tree.	 **Adult** A mature plant of maximum stature and form, capable of reproducing.

Life stages of kahikatea, *Dacrycarpus dacrydioides*.

Types of fruit

Fruits are another useful identification clue. Fruit are matured ovaries and are often attractive to birds and mammals to aid seed dispersal, but essentially they form a case to transport or protect the seed. Fruits are either succulent/fleshy (i.e., juicy or watery) or dry (no flesh or juice). Seed ID is a more specialised field and is not covered in this module. Refer to *Seeds of New Zealand gymnosperms & dicotyledons* by Colin J. Webb & Margaret J.A. Simpson. Below are some different types of fleshy and dry fruit.

Berry: simple, fleshy, multi-seeded.

e.g., *Alseuosmia pusilla.*

Drupe: simple, fleshy, one-seeded

e.g., karaka (*Corynocarpus laevigatus*).

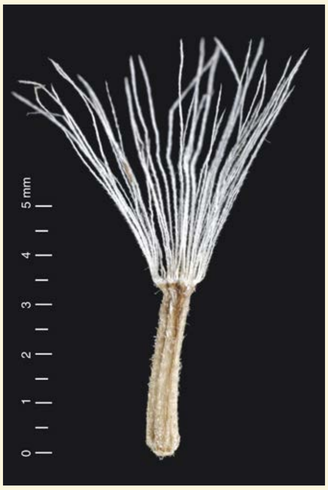
Dehiscent/pod: bursts spontaneously when opening.

e.g., willowherb (*Epilobium nummulariifolium*).

Nut: hard, one-seeded.

e.g., *Gahnia setifolia.*

Achene: small, dry, one-seeded, thin pericarp.



e.g., *Brachyglottis compacta.*

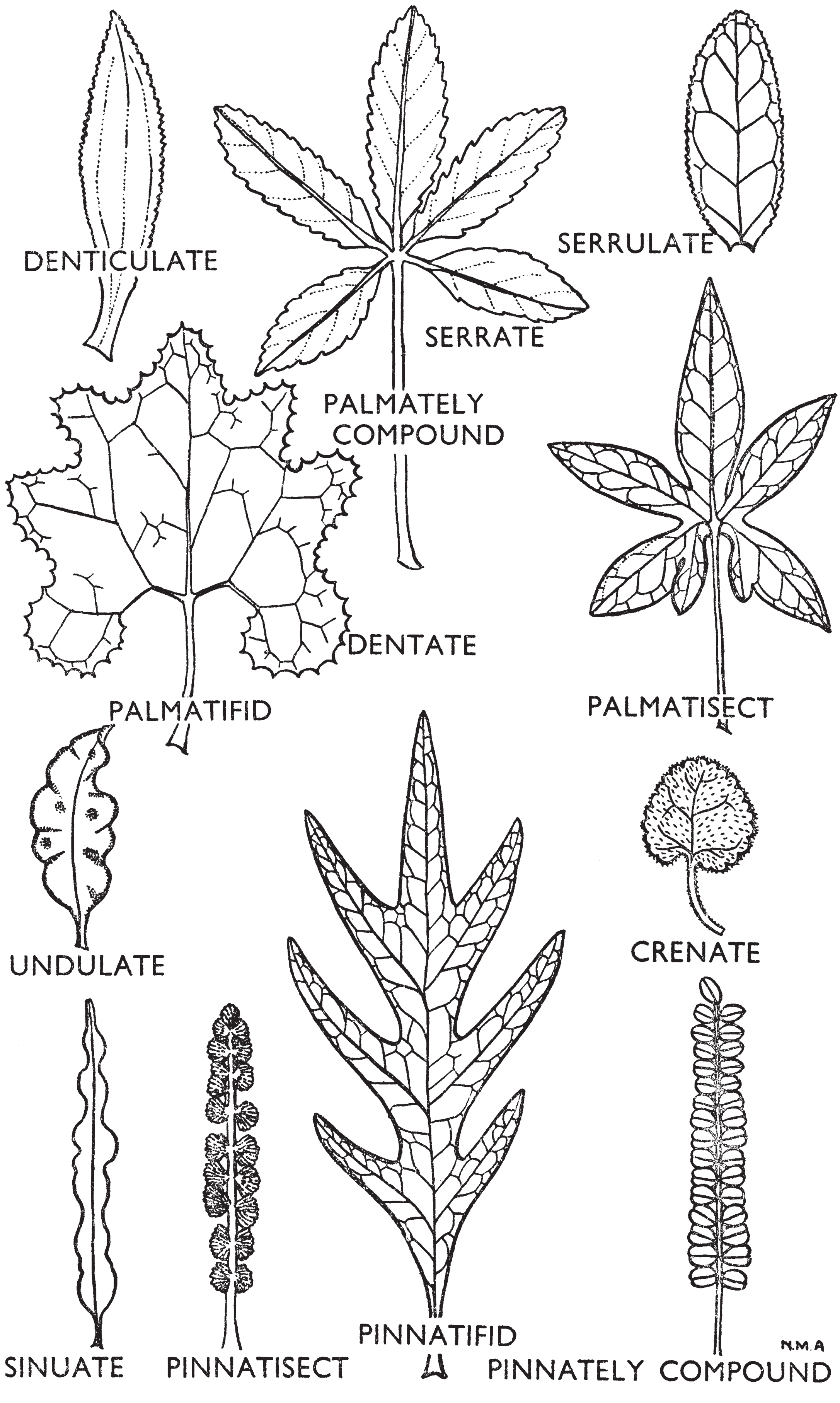
Capsule: dry, dehiscent, formed from two or more carpels.

e.g., mānuka (*Leptospermum scoparium*).

Dispersal mechanisms for plants

Dispersal is crucial to plants to ensure they spread out and form expanded or new populations. To achieve this, plants use five basic methods of dispersal:

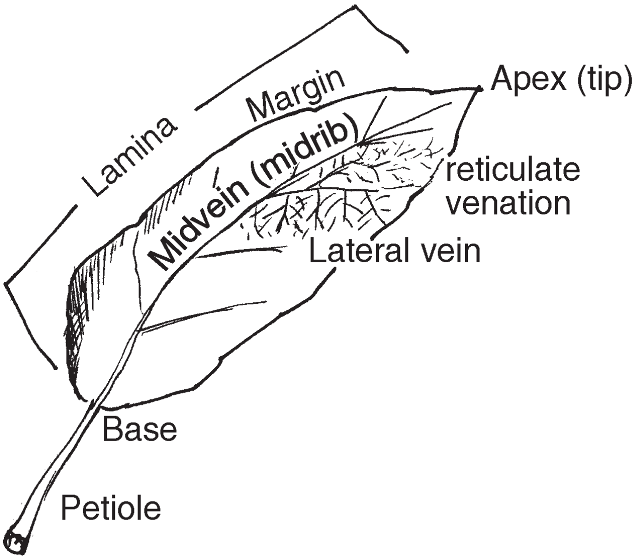
Animal: edible, catching.  e.g., bidibidi (*Acaena anserinifolia*).	**Wind:** lightness, parachutes, wings.  e.g., fireweed (*Senecio diaschides*).
Water: flotation.  e.g., mangrove (*Avicennia marina* subsp. *australasica*).	**Ballistic dehiscent:** capsule splits open explosively to expel seeds.  e.g., broom (*Carmichaelia australis*).
Gravity: seed fall.  e.g., rengarenga (*Arthropodium cirratum*).	



Leaves, simple and compound, margins and lobing. From *Flora of New Zealand* Vol. 1, by H.H. Allan (illustration by Nancy M. Adams). © Landcare Research NZ Ltd..

9. Leaf it up to me

Every plant species has its own combination of leaf characters that make it recognisable—shape, size, texture, form and arrangement.



Parts of a leaf

There are three principal parts to a leaf:

1. The **leaf blade** or **lamina.**
2. The **leaf stalk** or **petiole** (if absent, leaf is said to be **sessile**). Most monocot leaves are sessile. (Leaflet stalk = **petiolule**).
3. The **leaf base.** The **leaf tip** is the **apex.**

Leaf types

There are a number of different leaf types including the simple or compound leaf or different types of compound leaf and plants with flattened stem leaves.

1. Simple = single leaf

e.g., karamu *Coprosma lucida*

2. Compound = more than one leaf blade compose the leaf and may be either

Palmately compound: shaped like a hand.	**Digitately compound**: finger-like variation of palmately compound.	**Pinnately compound**: feather pattern.
		
e.g., fivefinger (*Pseudopanax arboreus*).	e.g., patē (*Schefflera digitata*).	e.g., kōwhai (*Sophora* species).

Each separate leaf division of a compound leaf is called a leaflet but how do you know if it is a leaflet or a leaf? In a simple leaf the **leaf stem**, or **petiole**, swells where it attaches to the twig, and the new **bud** is usually found there. The base of a leaflet on a compound leaf will neither swell nor have a bud present.

A leaf that is divided into leaflets is termed foliolate: two leaflets = bifoliolate, three leaflets = trifoliolate, etc.

3. **Cladodes /phylloclades** or "flattened stem leaves"

Some plants have flattened stem leaves instead of what are typically thought of as leaves.

e.g., tānekaha (*Phyllocladus trichomanoides*).

e.g., NZ broom (*Carmichaelia williamsii*).

Photo: Andrea Brandon.

4. **Blade or tiller**

Grasses.

e.g., red tussock (*Chionochloa rubra*).

5. Frond

Leaf of a palm or fern.

e.g., nikau (*Rhopalostylis sapida*).

e.g., *Blechnum filiforme*.

Leaf arrangement (Phyllotaxis)

Examining the leaf arrangement can be useful for distinguishing plants with similar leaves. Leaves can be alternate, opposite, whorled, imbricate or a rosette.

<table>
<tr>
<td>Alternate: singly along the stem.

e.g., Streblus heterophyllus.</td>
<td>Opposite: in pairs along the stem.

e.g., hangehange (Geniostoma ligustrifolium).</td>
<td rowspan="2">Whorled: Arranged in a ring around the stem.

e.g., cleavers (Galium aparine).</td>
</tr>
<tr>
<td>Imbricate: overlapping.

e.g., rimu (Dacridium cupressinum).</td>
<td>Rosulate/rosette: a dense radiating cluster of leaves

e.g., Celmisia semicordata.
Photo: John Sawyer.</td>
</tr>
</table>

Leaf shape

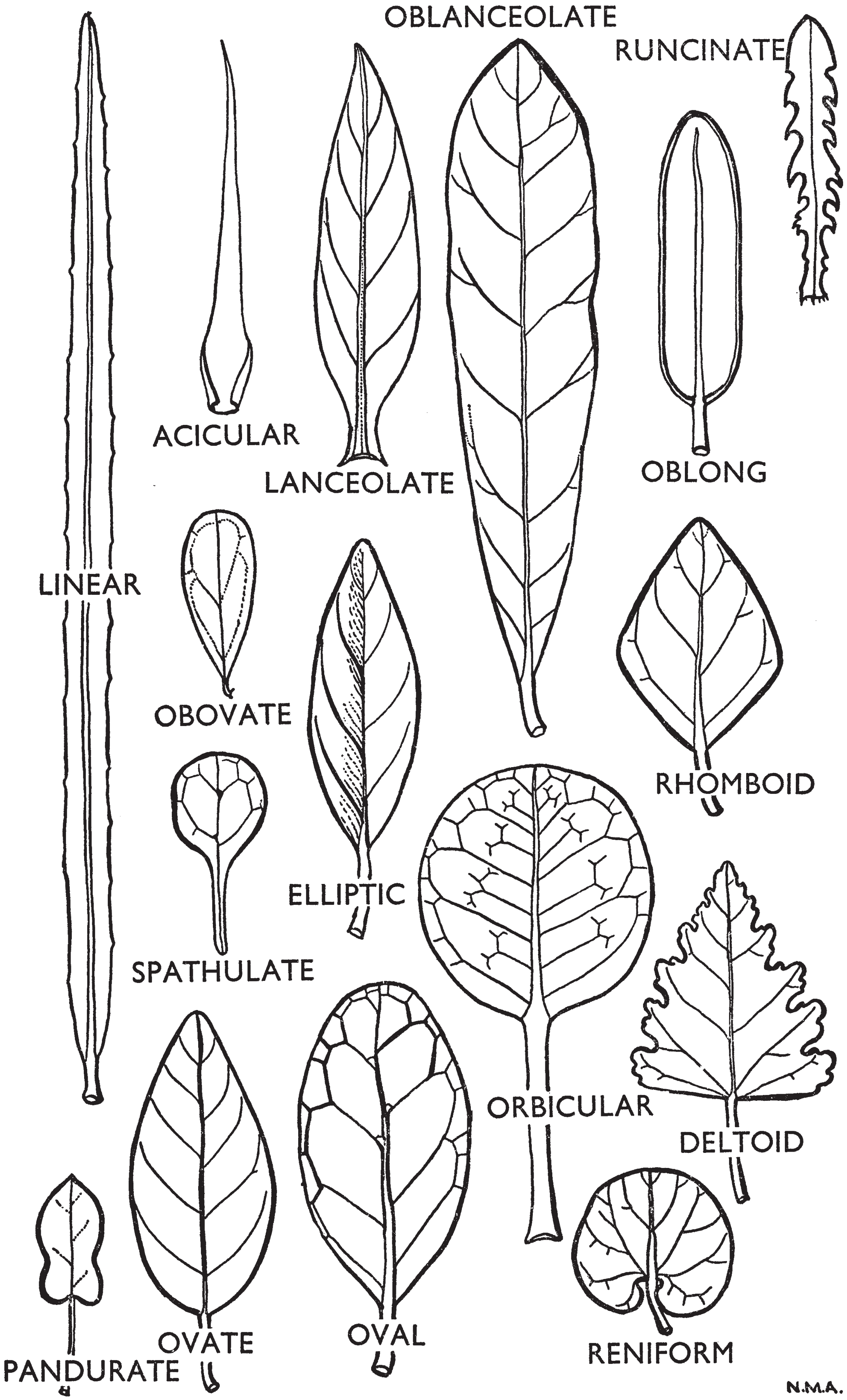
Leaves maybe described in basic **plane shapes**. Some of the terms used to describe leaf shapes are listed below with examples of plants which have these leaf shapes.

Linear: very narrow, margins ± parallel.  e.g., (*Lilium formosanum*).	**Oblong:** rectangular.  e.g., firethorn (*Pyracantha angustifolia*).	**Orbicular:** almost round.  e.g., red pondweed (*Potamogeton cheesemanii*).
Elliptic: tapering, widest at middle.  e.g., northern rātā (*Metrosideros robusta*).	**Lanceolate:** tapering, widest toward base.  e.g., tawa (*Beilschmiedia tawa*).	**Oblanceolate:** tapering, widest toward apex.  e.g., maire taike (*Mida salicifolia*).
Ovate: egg shaped, widest near base.  e.g., red beech (*Nothofagus fusca*).	**Obovate:** reverse egg shaped, widest near apex.  e.g., *Coprosma rigida.*	**Cordate:** heart shaped, notch at base.  e.g., kawakawa (*Piper excelsum*).
Obcordate: heart shaped, notch at apex.  e.g., *Myrsine umbricola.*	**Reniform:** kidney shaped.  e.g., kidney fern (*Cardiomanes reniforme*).	**Spathulate/spatulate:** spatula shaped.  e.g., *Selliera rdicans.*

Ensiform: sword shaped.  e.g., montbretia (*Crocosmia* × *crocosmiiflora*).	**Hastate:** spear like.  e.g., climbing dock (*Rumex sagittatus*).	**Flabellate:** fan shaped.  e.g., *Asplenium flabellifolium.*
Deltoid: broadly triangular.  e.g., Canadian poplar (*Populus* ×*canadensis*).	**Rhomboid:** ± diamond shaped.  e.g., *Peperomia tetraphylla.*	**Filiform:** thread like.  e.g., hook sedge (*Uncinia filiformis*).
Acicular: needle like.  e.g., *Pinus contorta.*	**Acerose:** narrow, with a sharp, stiff point.  e.g., *Leptecophylla juniperina.*	**Lyrate:** pinnatifid or pinnatisect, terminal lobe much larger than lower lobes.  e.g., tūrepo (*Streblus heterophyllus*).

Because leaves vary in shape, even on individual plants, these terms may be qualified with words such as 'narrowly' or 'broadly', or combined with other terms to fully describe the range of leaf shapes present on a plant. For example, pōhuehue (*Muehlenbeckia complexa*) is described in the book *Trees and Shrubs of New Zealand* as having leaves "oblong, obovate or orbicular".

Pōhuehue leaves vary from oblong through obovate to orbicular.



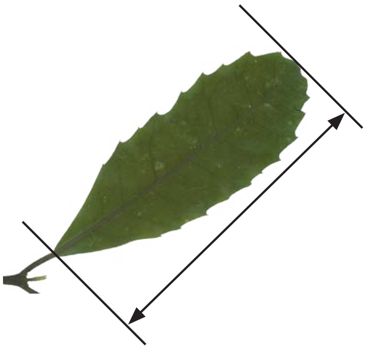
Leaf shapes From *Flora of New Zealand* Vol. 1, by H.H. Allan (illustration by Nancy M. Adams). © Landcare Research NZ Ltd..

Muehlenbeckia astonii—obcordate leaves.

Well that's about the size of it

Big/large and small/little are relative terms, so measurements are much more useful when describing a plant, for example, 5 cm long by 2.5 cm at the widest. It is important not to include the leaf stalk when taking a measurement of a leaf. A leaf is regarded as broad if its width is more than half the length:

Length:



Narrow e.g., tawa (*Beilschmiedia tawa*, left) and broad leaves, e.g., kawakawa (*Piper excelsum*).

Leaf vein pattern (venation/veination)

Leaves usually have some pattern on them in the form of a venation. This may be parallel or like a net (see below). **Venation** can also affect the surface **appearance** or **texture**—whether veins are raised or sunk for instance. The main central vein or **midrib** maybe distinct as in the koromiko *Hebe ligustrifolia* where it is orange compared to *Hebe stricta*. *Hebe acutiflora* has orange-yellow mid-ribs.

Most monocots have parallel venation, although there are exceptions such as supplejack (*Ripogonum scandens*).

Hebe ligustrifolia (top, orange mid-rib) and *Hebe stricta* var. *stricta*. Illustrations from *Eagle's Trees and Shrubs of New Zealand* (two volumes), © Audrey Eagle.

Parallel venation: most monocots.

e.g., turutu (*Dianella nigra*).

Net venation (reticulate)—pinnate: feather-like.

e.g., karamū (*Coprosma lucida*).

Net venation (reticulate)—palmate: hand-like.

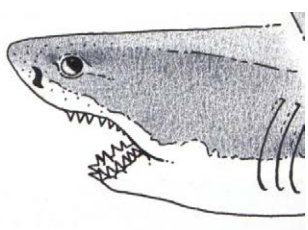
e.g., *Hibiscus diversifolius.*

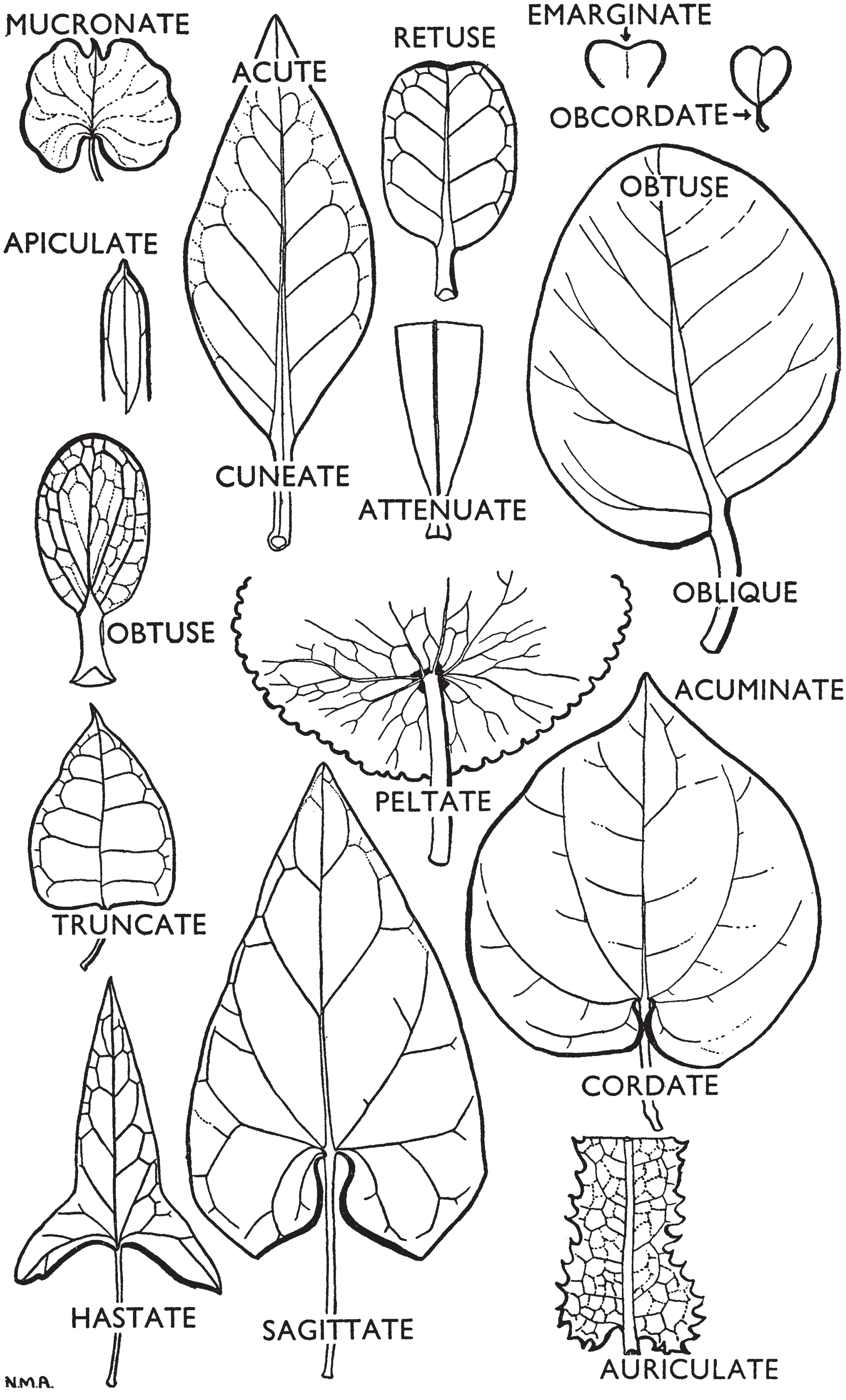
Leaf margins (edges)

Leaf margins exhibit a wide range of forms. Some of the common types of leaf margin are shown here:

Entire: smooth.  e.g., hangehange (*Geniostoma ligustrifolium*).	**Crisped:** margin tightly wavy, crinkled.  e.g., filmy fern (*Hymenophyllum flexuosum*).	**Serrate:** teeth directed toward apex.  e.g., pukatea (*Laurelia novae-zelandiae*).	**Biserrate:** doubly serrate.  e.g., blackberry (*Rubus fruticosus* agg.).
Dentate: teeth directed outward.  e.g., lacebark (*Hoheria sexstylosa*).	**Erose:** irregularly toothed.  e.g., makomako (*Aristotelia serrata*).	**Crenate**: bluntly toothed.  e.g., tūrepo (*Streblus banksii*).	**Undulate:** wavy.  e.g., māpou (*Myrsine australis*).
Pinnatifid: cleft more than halfway to midrib.  e.g., *Microsorum novae-zealandiae.*	**Pinnatisect:** deeply cleft to midrib.  e.g., poniu (*Rorippa palustris*).	**Lobed:** cut less than half way to midrib.  e.g., *Hydrocotyle elongata.*	**Cleft:** irregularly, coarsely lobed.  e.g., *Alseuosmia quercifolia.*

The irregular leaf serrations of *Aristotelia serrata* are reminiscent of shark teeth, giving rise to the Maori name 'makomako'.





Leaf tips and bases. From *Flora of New Zealand* Vol. 1, by H.H. Allan (illustration by Nancy M. Adams). © Landcare Research NZ Ltd..

Leaf tips and bases

Leaf tips and bases can be characteristic and may help to identify plants.

Terms used to describe the tips of leaves include:

Acuminate: tapering to a long fine point.  e.g., grass-leaved orchid (*Pterostylis graminea* agg.).	**Acute:** sharply pointed.  e.g., *Pittosporum cornifolium.*	**Apiculate:** a short slender ± flexible point.  e.g., spider orchid (*Corybas rivularis* agg.).	**Emarginate**: shallow notch at the apex.  e.g., rōhutu (*Lophomyrtus obcordata*).
Mucronate: with a short sharp tip.  e.g., *Tmesipteris tannensis.*	**Obtuse:** blunt.  e.g., pygmy orchid (*Bulbophyllum pygmaeum*).	**Retuse:** apex rounded with a small notch.  e.g., northern rātā (*Metrosideros robusta*).	**Rounded**  e.g., *Coprosma pedicellata.*

Terms used to describe the bases of leaves include:

Cordate: Heart shaped with a notch at base.  e.g., kawakawa (*Piper excelsum*).	**Cuneate:** wedge shaped, tapering to base.  e.g., hard beech (*Nothofagus truncata*).	**Hastate:** arrowhead shape, basal lobes pointed or narrow.  e.g., climbing dock (*Rumex saggitatus*).	**Oblique:** with unequal sides.  e.g., akapuka (*Griselinia lucida*).
Peltate: shield-like, with stalk attached well inside margin.  e.g., nasturtium (*Tropaeolum majus*).	**Saggitate:** arrowhead shape, basal lobes at narrow angle to stalk.  e.g., pink bindweed (*Calystegia sepium* subsp. *roseata*).	**Truncate:** cut squarely across the base.  e.g., round-leaved coprosma (*Coprosma rotundifolia*).	**Attenuate:** Tapering gradually to base.  e.g., *Plantago raoulii.*

Leaf surfaces

The upper (adaxial) and lower (abaxial) leaf surfaces also have distinctive features which help identify leaves. They also provide texture and colour. Some of the main terms used are shown below.

Glabrous: smooth, lacking hairs.

e.g., koromiko (*Hebe stricta*).

Hispid: rough with short, stiff hairs.

e.g., fireweed (*Senecio hispidulus*).

Stellate: star-shaped hairs with branches radiating from the base.

e.g., filmy fern (*Hymenophyllum frankliniae*).

Pubescent: covered in short, soft hairs.

e.g., *Hebe amplexicaulis* f. *hirta.*

Hirsute: bearing coarse hairs.

e.g., *Hydrocotyle moschata* var. *moschata.*

Strigose: hairs appressed against the surface.

e.g., *Hydrocotyle moschata* var. *parviflora.*

Pilose: bearing long, soft, straight hairs.

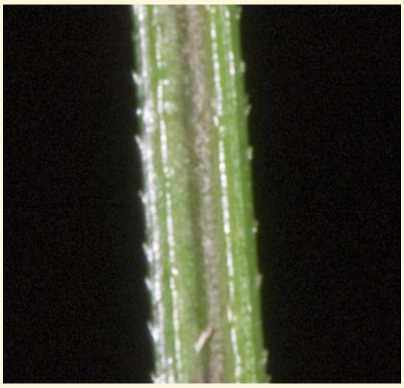
e.g., adaxial margins of toetoe (*Austroderia fulvida*).

Villous: bearing long, soft, shaggy hairs.

e.g., *Nertera villosa.*

Tomentose: “woolly”.

e.g., *Pseudognaphalium luteo-album.*

Glandular: with **glands**—hairs with secretory function.  e.g., sundew (*Drosera auriculata*).	**Stinging**  e.g., ongaonga (*Urtica ferox*).	**Domatia:** small pits in the leaf surface.  e.g., karamū (*Coprosma lucida*).
Coriaceous: rough leathery texture.  e.g., akiraho (*Olearia paniculata*).	**Scabrid (scabrous):** rough.  e.g., margin of hook sedge (*Uncinia silvestris*).	**Glaucous** – distinctly bluish grey due to waxy surface (bloom).  e.g., shore spurge (*Euphorbia glauca*). Photo: John Sawyer.

Specific leaf patterns

In addition to hairs and glands, plants may have specific patterns. This may include blotching or wrinkly appearance.

Blotching/marbleing  e.g., marbleleaf / putaputāwētā (*Carpodetus serratus*).	**Bullate**: blistered appearance.  e.g., ramarama (*Lophomyrtus bullata*).

Gland dots

e.g., ngaio (*Myoporum laetum*).

Rugose: wrinkly.

e.g., *Pomaderris apetala.*

Stipule

One of a pair of scale-like or leaf-like appendages at the base of the petiole. This is present in some plants, such as *Coprosma* species:

Stipules from (left) *Coprosma macrocarpa*, *C. microcarpa, C. rhamnoides*, *C. robusta*, *C. tenuifolia.*

The difference with ferns

Fern fronds have four basic shapes. They are:

Simple/single

e.g., *Notogrammitis billardierei.*

Simple/lobed

e.g., kōwaowao (*Microsorum pustulatum*).

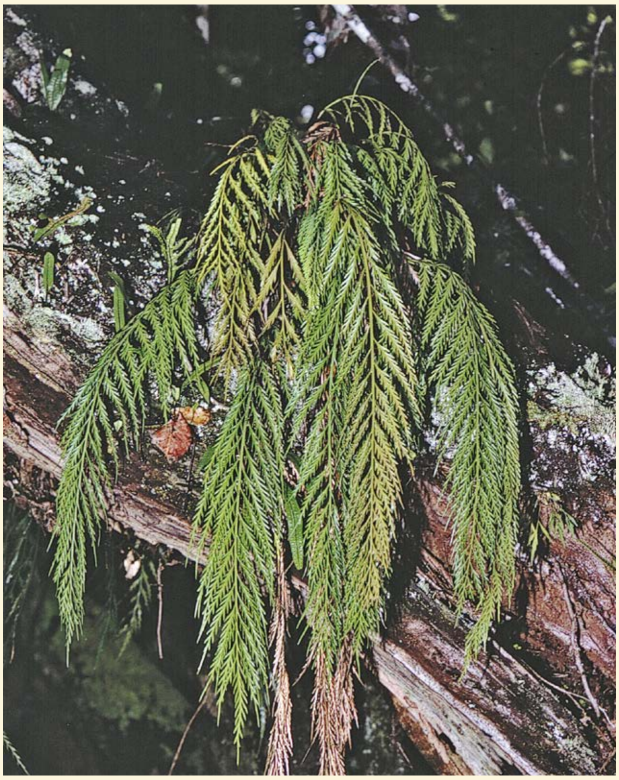
Pinnate (once divided)	Multipinnate (divided 2, 3 or 4 times)
	
e.g., button fern (*Pellaea rotundifolia*).	e.g., pig fern (*Paesia scaberula*).

The shape of the **pinnae** of fern fronds is described in three ways:

Untoothed (Entire)	Toothed	Lobed
		
e.g., jointed fern (*Arthropteris tenella*).	e.g., shining spleenwort (*Asplenium oblongifolium*).	e.g., *Lindsaea trichomanoides.*

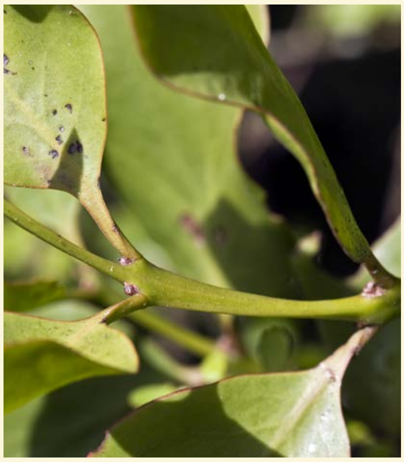
The way in which ferns grow is another way of distinguishing them:

Tufted	Creeping
	
e.g., kiwakiwa (*Blechnum fluviatile*).	e.g., kidney fern (*Cardiomanes reniforme*).

Climbing  e.g., thread fern (*Blechnum filiforme*).	**Perching**  e.g., hanging spleenwort (*Asplenium flaccidum*).
Tree  e.g., kātote (*Cyathea smithii*).	**Floating**  e.g., *Azolla filiculoides.*

10. Stem and bark

The stem or trunk of a plant can be in various forms such as square, round or hollow. The mint family and related puriri family also have square or 4-angled stems. In some species only the young shoots are square, e.g., *Neomyrtus pedunculata*. Below are some stem shapes:

Square	**Ribbed**	**Flattened**
		
e.g., *Teucridium parvifolium.*	e.g., old man's beard (*Clematis vitalba*).	e.g., mistletoe (*Ileostylus micranthus*).
Circular	**Hollow**	
		
e.g., arrow bamboo (*Pseudosasa japonica*).	e.g., Himalayan honeysuckle (*Leycesteria formosa*).	

The surfaces of stems or trunks, including the bark of woody plants, also have many forms including fibrous, hammer marked, hairy or stringy. Stem and bark surfaces are shown below:

Smooth (glabrous) Smooth exposed epidermis.  e.g., fennel (*Foeniculum vulgare*).	**Succulent** Soft, mucilaginous.  e.g., *Crassula sieberiana.*	**Rough** Coarse and scratchy to touch.  e.g., black maire (*Nestegis cunninghamii*).	**Papery** Thin, dry and flaking.  e.g., kōtukutuku (*Fuchsia excorticata*).
Prickly/thorny  e.g., matagouri (*Discaria toumatou*).	**Hairy (hirsute)** Fine or soft hairs.  e.g., fireweed (*Senecio scaberulus*).	**Grooved** Generally vertical or spiralled striations.  e.g., lancewood (*Pseudopanax crassifolius*).	**Stringy** Long, stringy serrations on the bark or stem.  e.g., old man's beard (*Clematis vitalba*).

It is interesting to compare the trunk and bark features of the "big five" podocarps: rimu, kahikatea, tōtara, mataī, miro (see the pictures below).

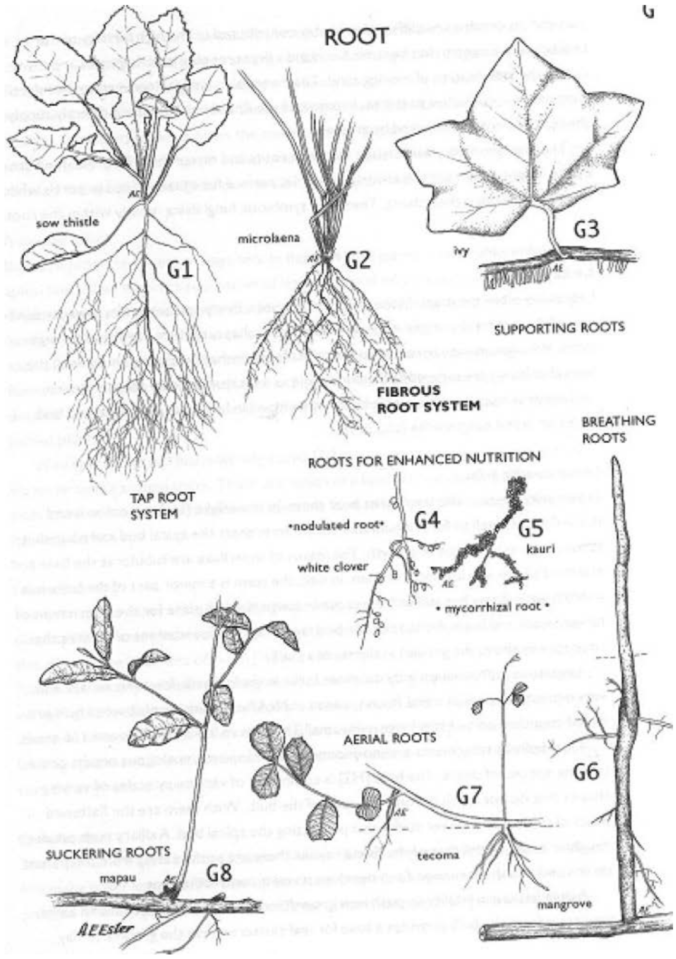
Bark of the five podocarps, from left: rimu, kahikatea, tōtara, mataī, miro.

11. Roots

While roots are very useful for the plants to draw up nutrients and water from the soil they are not much used for identification purposes. This is because you usually cannot see them. Usually only the descending roots of the tree epiphytes rātā and puka (*Griselinia lucida*) or the succulent roots of tree orchids are visible.

Aerial roots are produced by pohutakawa and pneumatophore are produced by manawa and swamp maire. The attaching roots of parasites called haustoria are another distinctive root structure. Pukatea and kahikatea produce buttress roots in swampy conditions when mature.

Some different types of plant root are shown here.



Right: Root types.

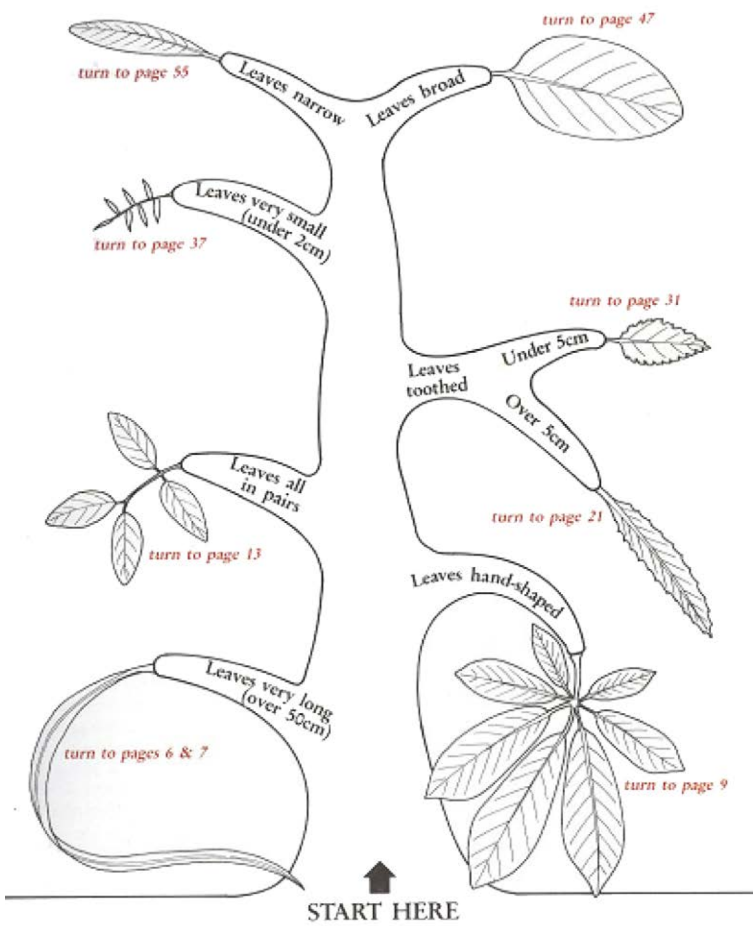
From *Wild Plants of Auckland* by Alan Esler.

Below: Pukatea (*Laurelia novae-zelandiae*), an example of buttress roots.

12. Plant identification

There are many sources of information to help identify plants:

1. **Written and pictorial descriptions** of plants, which you can compare with your unknown specimen to aid in its identification. Good descriptions direct you to crucial diagnostic features for the relevant taxon, explain the range variability found and point out botanical and ecological characteristics of importance.
   A good source of information about native plants is the website of the New Zealand Plant Conservation Network – see www.nzpcn.org.nz. This site has information (including photos) about all New Zealand's indigenous and naturalised exotic plants.
   Please note—to use an identification guide properly, you need to know enough of the vocabulary to understand the choices presented to you. All good identification guides provide a glossary and a list of abbreviations to help with this.
2. **Ask an expert**. Many people around the country, including professional botanists and members of botanical societies, may be able to assist with identification. Providing fresh samples will help accurate identification, but may not always be possible. Ensure that you have the appropriate permission before collecting specimens (see page 59). Alternatively, photographs that show significant features can be used. A desktop scanner is a useful way to make an image of the specimen if you don't have a good camera.
3. **Keys** help you find the likely description of your specimen rapidly and simply. Most keys are arranged to present you with a series of choices (decision points), usually dichotomous (dividing in two). The paired statements of each 'couplet' are framed to be contrasting and mutually exclusive. Each choice you make narrows down the possibilities for your specimen until you find the appropriate description. Terminology is precise and brief.
   Keys can vary in complexity. An easy one to use is *Which Native Tree?* by Andrew Crowe.



Advice for using keys

- Note down the route taken—to trace path in case you need to back track
- Read full description of both choices for each step
- Do not guess—consult glossary if precise meaning of term unknown. Where measurements are required, use a ruler
- If features are very small, use an appropriate lens to inspect them clearly.
- If key is multi-part one, look carefully at the descriptions for higher levels of taxa before progressing to species key.
- If both pairs of choices seem reasonable, try each route-one will usually prove to be unsuitable at a later stage.

You may like to try out the following key on a kōwhai *Sophora* sp. specimen:

A selection of *Sophora:* Clockwise from above: *S. chathamica* (photo: Geoff Walls), *S. fulvida*, *S. molloyi*, *S. prostrata*.

Sophora (FABACEAE) in New Zealand: taxonomy, distribution, and biogeography

P. B. Heenan, P.J. de Lange and A.D. Wilton

Key to the New Zealand kōwhai species (adapted from *NZ Journal Of Botany* 2001, Volume 39)
This key is only for New Zealand species of *Sophora*, and does not include hybrid material. If the key does not work, the plant material should be checked to see if it is hybrid origin.

1	Shrub, branches at or near ground level and usually slender	2
	Tree, branches well above ground level and usually thick	5
2	Branchlets not interlaced, usually grey to grey-brown, glabrous to sparsely hairy	3
	Branchlets interlaced, usually yellow-brown to orange-brown, sparsely to moderately hairy	4
3	Shrub usually wider than high; main branches spreading to decumbent, sometimes prostrate, underground branches and rhizomes absent; leaves 23-37 leaflets; Leaflets 5.0-12.0 x 2.0-6.0 mm elliptic, elliptic oblong, to broadly elliptic, sparsely hairy; Kapiti island, islands in Cook Strait, southern headlands of North Island, dry and exposed windy bluffs	***S. molloyi***
	Shrub usually of similar width and height; main branches upright to spreading, underground branches and rhizomes usually present, often with numerous branches near the base; leaves with 35-52 leaflets; leaflets 3.3-5.8 x 2.5 -3.1 mm, orbicular, obovate, to oblong obovate , usually more or less glabrous; northern Nelson, western Marlborough, marble and limestone outcrops	***S. longicarinata***
4	Branchlets interlaced on juvenile and adult; leaves <3 cm long, leaflet pairs 1-5, usually glabrous; standard petal orange; pods lacking wings; seeds dark brown; eastern South Island, dry grey scrub communities	***S. prostrata***
	Branchlets interlaced in juvenile only; leaves> 3cm,leaflet pairs>sparsely to moderately hairy; Flowers usually absent, if present standard petal yellow; pods usually absent, if present winged; seeds yellow or yellow brown; North and South Islands, terraces and hillslopes	***S. microphylla***
5.	Ovary and leaves with hairs spreading, curved and/or twisted; leaflets densely hairy	6
	Ovary and leaves with hairs appressed, straight, leaflets not densely hairy, or if densely hairy greater than 15 mm long	7
6	Leaves with 61-91 leaflets; leaflets elliptic to elliptic oblong, occasionally narrowly obovate usually sessile; leaflet hairs appressed, decumbent, or spreading, predominantly straight and sometimes twisted; northern North Island, andesitic and volcanic rock outcrops	***S. fulvida***
	Leaves with 47-75 leaflets; leaflets ovate, broadly elliptic, to sometimes more or less orbicular, with a more or less petiolule; leaflet hairs appressed, decumbent, spreading or patent, predominantly curly, curved, or twisted, central North Island, siltsone, sandstone and mudstone (papa)	***S. godleyi***
7	Leaves with less than 23 leaflets; leaflets more than 18 mm long, three times longer than wide narrowly elliptic to elliptic-oblong, densely hairy; eastern North Island, terraces and hillslopes	***S. tetraptera***
	Leaves with more than 24 leaflets; leaflets less than 16 mm long, length usually less than twice their width, elliptic, broadly elliptic, obovate, broadly obovate, ovate, broadly ovate, oblong to more or less orbicular, glabrous or moderately hairy	8
8	Juvenile growth present, leaflets 4.5-12.5 x 2.3 -5.7 mm, distal and proximal leaflets usually similar in size, distant, not crowded or overlapping , elliptic, broadly elliptic, obovate to ovate, sometimes more or less orbicular, usually moderately hairy; North and South Islands, terraces and hill country	***S. microphylla***
	Juvenile growth habit absent, leaflets 6.0-16.0 x 4.0-8.0 mm, distal leaflets usually smaller than proximal leaflets, crowded and overlapping, broadly elliptic, broadly obovate, obovate to more or less orbicular, moderately hairy; North Island and Chatham Islands, coastal and lowland hill country	***S. chathamica***
	Juvenile growth absent; leaflets 3.3-5.8 x 2.5-3.1 mm, distal and proximal leaflets similar in size, overlapping to distant, orbicular, obovate, to oblong-obovate, more or less glabrous; Northern Nelson, western Marlborough, marble and Limestone rock outcrops	***S. longicarinata***

Key to the New Zealand gymnosperms (conifers) 21 species

3 = kauri/kawaka group—dry cone group
5 = celery pine group
9 = tōtara group—needle-leaved podocarp group
10 = matai/miro—plum-fruited podocarp group
11/12 (and 2 (b)0 = rimu-like group for convenience—scale leaved podocarp group

1. (a) Trees or shrubs with part of the cone or seed fleshy. 2
   (b) Trees, with dry winged seeds, some reaching 35–(60) metres or more when mature. 3

2. (a) Trees or upright shrubs. 4
   (b) Prostrate or sprawling herb-like shrub to 30 cm. . . . . ***Lepidothamnus laxifolius*** pigmy pine (0.3 m) PODOCARPACEAE

3. (a) Large, paddle shaped leaves up to 4 cm long (juveniles larger) with parallel veins. Large spherical cones with numerous seeds. . . . . ***Agathis australis*** kauri (60 m) ARAUCARIACEAE
   (b) Small flattened scale like leaves in 4 rows in opposite pairs; juvenile foliage frond-like. Mature branchlets compressed. Small cones of 4-6 scales. . . . . ***Libocedrus plumosa*** kawaka, NZ cedar (25 m) CUPRESSACEAE
   (c) Small cones of 4-6 scales, mature branchlets compressed. Bark very thick, pyramidal growth form. . . . . ***Libocedrus bidwillii*** mountain cedar (20 m) CUPRESSACEAE

4. (a) Trees or shrubs with rhomboid leaf-like flattened stems (cladodes or phylloclades) resembling celery leaf (hence common name celery pine). No true leaves. 5
   (b) True leaves present. 6

5. (a) Leaves larger than for tanekaha, phylloclades pinnately arranged on rachis which is 10–30 cm long thick leathery, bluish green—often bronze coloured. Bark greyish & warty with short horizontal ridges running around it. Northern North Island only. . . . . ***Phyllocladus toatoa*** toatoa (20 m) PHYLLOCLADACEAE (ex PODOCARPACEAE)
   (b) Green phylloclades 1.2 – 2.5 cm long, 9–15 on rachis 2.5 – 7.5 cm long. Bark smooth & lightish grey. . . . . ***Phyllocladus trichomanoides*** tānekaha, celery pine (30 m) PHYLLOCLADACEAE (ex PODOCARPACEAE)
   (c) . . . **“*Phyllocladus* aff. *trichomanoides*”** Surville cliffs tānekaha PHYLLOCLADACEAE (ex PODOCARPACEAE)
   (d) Small tree or shrub, phylloclades smaller than for tanekaha. . . . . ***Phyllocladus alpinus*** mountain toatoa (9 m) PHYLLOCLADACEAE (ex PODOCARPACEAE)

6. (a) Mature and juvenile leaves similar. 7
   (b) Mature leaves small and scale-like, juvenile leaves larger, gradual or abrupt transition from leafy juvenile shoots bearing linear leaves to narrow adult shoots with appressed scale leaves. 12

7. (a) All leaves usually linear, at least 10 mm long 8
   (b) Small scale or awl-like leaves and exposed seeds on a fleshy base. Tall trees reaching over 35 m tall. 11

8. (a) Conifers with linear leaves and exposed seeds on a fleshy base. Leaves stiff and hard, straight, bark thick and stringy (hybrids in this group known). 9

(b) Conifers with linear leaves and seeds wrapped in a fleshy layer, stalk not fleshy. Leaves softer in texture, sometimes curved. 10

9. (a) Bark very thick and stringy. Large forest tree. Seed ovoid. . . . . ***Podocarpus totara*** tōtara (40 m) PODOCARPACEAE

(b) Bark thinner more papery and flaky. Leaves often larger than true tōtara esp. juvenile. Seed long narrow and often pointed. . . . . ***Podocarpus cunninghamii*** (formerly known as *P. hallii*), thin-barked tōtara, Hall's tōtara (20 m) PODOCARPACEAE

(c) Bark thin and stringy, mature leaves greater than 10 mm long, needle-leaved shrub or small tree. . . . . ***Podocarpus acutifolius*** prickly tōtara (9 m) PODOCARPACEAE

(d) Prostrate to low growing alpine shrub, branches wide-spreading, leaves up to 15mm long. . . . . ***Podocarpus nivalis*** snow tōtara (5 m) PODOCARPACEAE

10. (a) Seeds with black flesh (like little plum). Leaves bluish green above and whitish below. in two irregular rows on branchlets. Leaf tips are rounded with a small sharp point. Bark bluish, almost black, shiny, hammer marked; loose flakes leave red marks on trunk when shed. Juvenile has untidy interlacing slender branchlets with a mixture of scale like leaves and larger linear leaves, bronze-green. . . . . ***Prumnopitys taxifolia*** mataī, black pine (40 m) PODOCARPACEAE

(b) Seeds with red flesh (like little plum). Spirally arranged leaves are distinctly flattened into 2 rows, narrowed to a point and green underneath. Juvenile and adolescent leaves 1–3 cm long. Bark dark grey to grey brown, rough also hammer marked but not leaving red marks as in matai. . . . . ***Prumnopitys ferruginea*** miro, brown pine (25 m) PODOCARPACEAE

11. (a) Trees with black spherical seed on fleshy orange stalks. Juvenile with leaves in two rows, and branches not weeping, adult leaves are 2–3 mm long, awl-like closely appressed to the branchlets. Branchlets are characteristically upturned at their tips. Bark grey and "hammer marked". Buttress roots. . . . . ***Dacrycarpus dacrydioides*** kahikatea/ white pine (65 m) PODOCARPACEAE

(b) Trees with black pear-shaped seeds projecting from red fleshy cups. Juvenile leaves not in distinct row, branches weeping, bark dark brown and coming off in large flakes. . . . . ***Dacrydium cupressineum*** rimu, red pine (60 m) PODOCARPACEAE

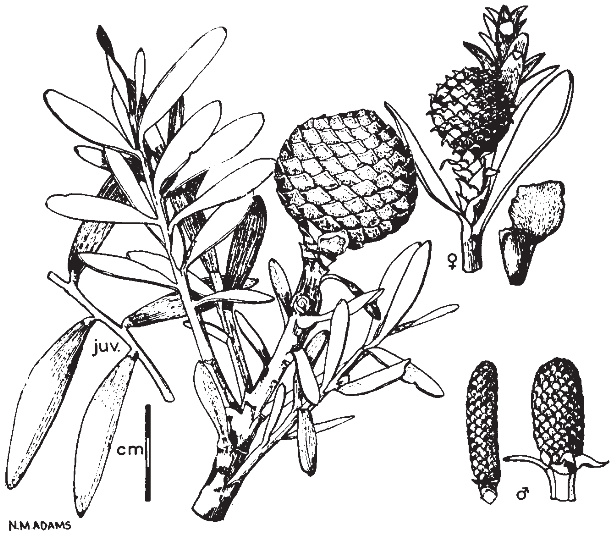
12. (a) Trees with ribbed seeds seated on orange fleshy cushions. Juvenile foliage large 15–40 mm long linear leaves. Abrupt transition to adult foliage consisting of 2–3 mm long, overlapping scale leaves, weakly keeled on back. Northern North island only. . . . . ***Halocarpus kirkii*** manoao, Kirk's rimu (25 m) PODOCARPACEAE

(b) Shrub showing abrupt transition from leafy juvenile shoots bearing linear leaves to narrow adult shoots with appressed scale leaves Juvenile leaves 5–10 mm long, 1–1.5 mm wide; fleshy outgrowth at base of ribbed seed white-yellow. . . . . ***Halocarpus bidwillii*** bog pine (5 m) PODOCARPACEAE

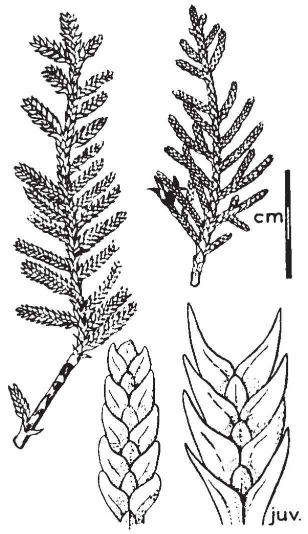
(c) Erect small tree, bark scaling off in small flakes, reddish silver beneath. Juvenile leaves 1–20 mm long; adult leaves with prominent keel on back. Fleshy outgrowth at base of ribbed seed orange (as for *H. kirkii*). . . . . ***Halocarpus biformis*** pink pine (9 m) PODOCARPACEAE

(d) Rounded bush or small tree with seeds half hidden in surrounding greenish fleshy scales. Bark thin grey to reddish brown not flaking, unfissured. Juvenile foliage on erect or spreading shoots. Adult leaves strongly keeled, shoot tips erect, seed subtended and half hidden by green to whitish green fleshy scale. . . . . ***Manoao colensoi*** manoao, silver pine (15 m) PODOCARPACEAE

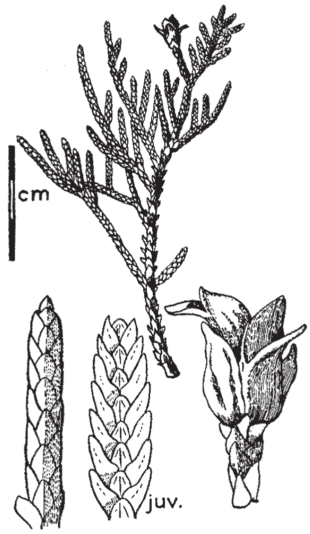
(e) Small tree, bark thin, grey, Juvenile foliage on drooping shoots; leaves of semi-adult stage bristling all round the shoot; adult scale leaves weakly keeled; shoot tips curving over and down. 2–3 yellow fleshy scale leaves subtending seed. . . . . ***Lepidothamnus intermedius*** yellow-silver pine (15 m) PODOCARPACEAE



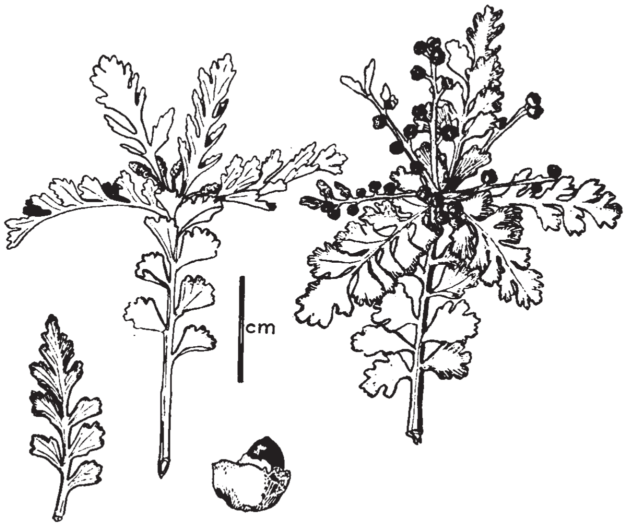
Kauri
(*Agathis australis*)



Kawaka
(*Libocedrus plumosa*)



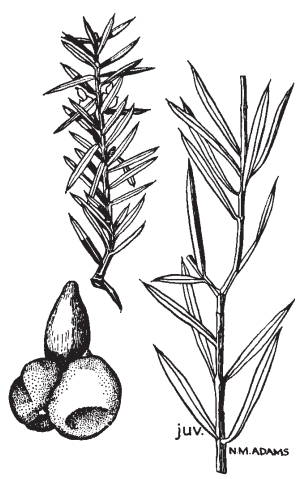
Kaikawaka
(*Libocedrus bidwillii*)



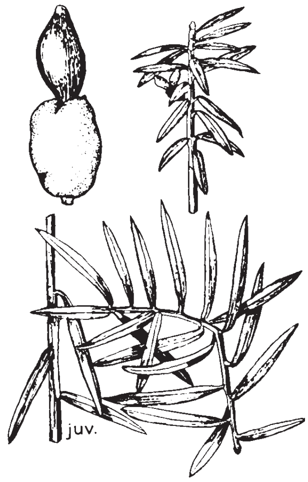
Tānekaha
(*Phyllocladus trichomanoides*)


Toatoa
(*Phyllocladus toatoa*)

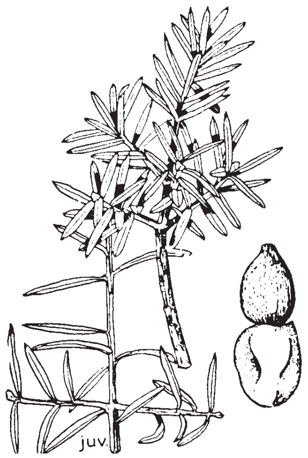
Alpine toatoa
(*Phyllocladus alpinus*)



Prickly tōtara
(*Podocarpus acutifolius*)

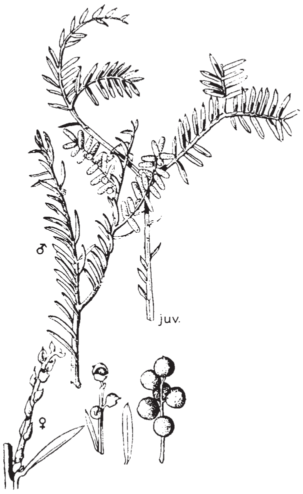


Thin-barked tōtara
(*Podocarpus cunninghamii*)

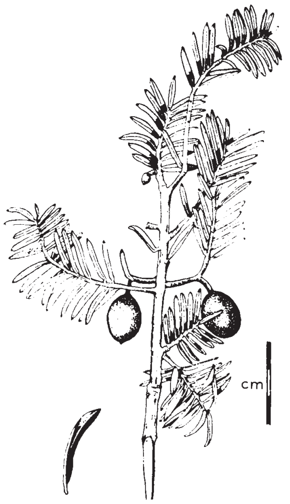


Tōtara
(*Podocarpus totara*)

Snow tōtara
(*Podocarpus nivalis*)



Mataī
(*Prumnopitys taxifolia*)

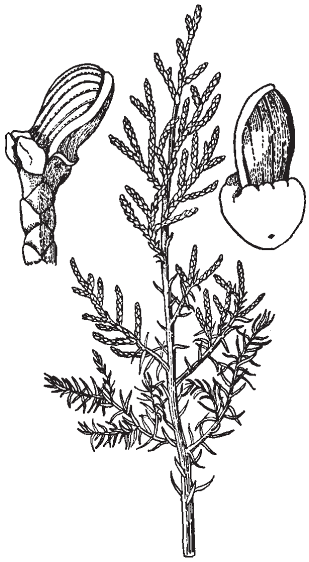


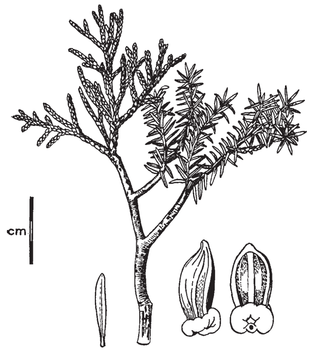
Miro
(*Prumnopitys ferruginea*)

Kahikatea
(*Dacrycarpus dacrydioides*)

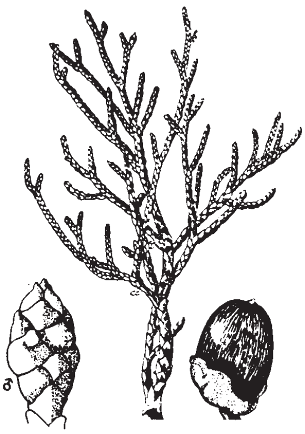
Rimu
(*Dacrydium cupressinum*)

Manoao
(*Halocarpus kirkii*)

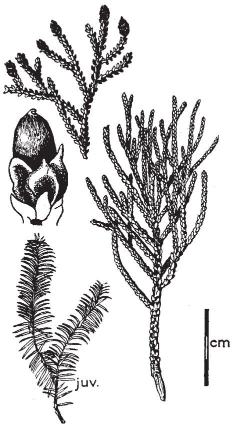

Bog pine
(*Halocarpus bidwillii*)



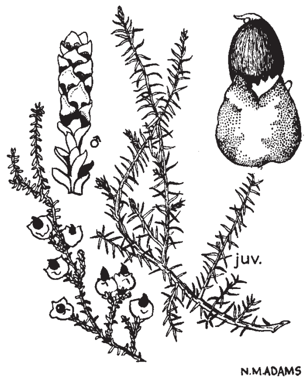
Pink pine
(*Halocarpus biformis*)



Manoao / silver pine
(*Manoao colensoi*)



Yellow silver pine
(*Lepidothamnus intermedius*)



Pigmy pine
(*Lepidothamnus laxifolius*)

Gymnosperm illustrations from *Trees and Shrubs of New Zealand* by AL Poole and Nancy M Adams, © Landcare Research New Zealand 1994.

13. Collecting plant specimens for identification

For a conservation ecologist, an ability to identify the major and/or common native plants is very important. In some cases it is not possible to identify species in the field. In these instances, you may need to collect a small specimen (or take good photographs).

A herbarium specimen is a permanent record of a plant observation at a particular site, and may be useful to verify the identity of a plant. If you intend to collect plant material, you should follow the guidelines below.

Collecting

A collecting permit is required by law if you want to collect plant material from certain areas (e.g., national parks, forest/conservation parks, and scientific, scenic, nature, wildlife and special purpose reserves). Permission must also be sought in order to collect from places such as public gardens, council plantings, exotic plantation forest, private land etc. Permits/permission can be obtained from the appropriate administering authority (e.g., Department of Conservation, district or regional councils, forestry companies, private owners etc.)

Look around and familiarise yourself with the species that occur at a site. How abundant is each species?

Before taking any plant material, ask yourself whether it is appropriate to collect specimens:

- Do you have permission to collect specimens?
- How common is the plant at the site?
- Would taking a specimen destroy the plant?
- Do you think the plant may be a threatened species?
- Would photos be adequate?

If you do not have permission to collect at the site, you must gather information about the plant in other ways.

If you do have permission to collect, you may still decide it is inappropriate to take a specimen, depending on the answers to the questions above.

An ideal herbarium specimen must be as representative as possible of the population it comes from, it must have accurate collecting data recorded, and it must be well preserved.

A specimen can be one plant, a portion of one plant, or several small plants of the same species collected from a single site at the same time. Material collected from a plant at different times of the year must not be mounted on one sheet.

Each herbarium sheet must display one species only.

Do not over-collect or deplete populations of native plants by taking more material than is necessary. If a plant is scarce in an area, collect only small representative portions. Take care not to damage the surrounding vegetation or habitats in the process of collecting.

Choosing a plant specimen

Don't be tempted to collect more material than you really need. Keep in mind the size of your herbarium sheet. If a specimen is particularly large (e.g., a tree fern frond), it can be either folded to fit, or spread over two or more sheets.

Look at the plant and decide carefully which portions would most accurately represent it overall. Bear in mind such characters as:

- Characteristic vegetative features (leaf forms, stipules, ligules etc.)
- Reproductive structures (flowers, fruit etc.).
- Reproductive structures are often the most important characters used in plant identification.

Field notes

Every herbarium sheet should have an information sheet attached to it. It is important to gather additional information about the plant specimen at the time of collection. Colours, shapes, sizes and odours can change during the drying process, so it is important to note these features while the specimen (and your memory) is still fresh. The following basic details should be noted:

Name: Name of the collector.

Date: Date when the specimen was collected.

Locality: Be precise; use the following format: 1. Country, 2. Ecological region (e.g., Northland), 3. Closest city/town, 4. Name of property and/or area, 5. actual location (e.g., off edge of milking shed near pond). If you can, obtain a grid reference and altitude of the position (from a GPS unit or topographical map).

Habitat: Include details of the site where the plant was found e.g., physical conditions (wet? dry? exposed?), soil type (sandy? peaty?), aspect (north facing? south facing?) type of vegetation cover (tall forest? open pasture? scrub?), associated plant species.

Habit: Include details of form (e.g., tree, shrub, climber), height and/or breadth, abundance.

Stems: For tree species, "guesstimate" of height, note bark colour and texture, do buttresses occur, are there thorns? For herbaceous plants, note the presence of hairs and the smoothness, the shape of the stem in cross-section etc.

Leaves: How are the leaves arranged (e.g., alternate, opposite, simple, compound), what is their colour, is it the same on both sides, shape, texture, and sheen. Is the plant evergreen or deciduous? Does it show heterophylly (different shaped leaves on the same plant, different adult/juvenile leaves)?

Flower and/or inflorescence (group of flowers): Note their size, shape and colour if they are present. Also note their position e.g., terminal, axillary. Is the plant monoecious (male and female flowers on the same plant) or dioecious (male and female flowers on separate plants).

Fruit / seeds: Note colour, shape, size, dispersal mechanism etc.

Other information: Anything not covered above that will help to identify the specimen.

What to do with fresh plant material

To minimise damage to specimens, fragile plant material should be placed **immediately** into a temporary plant press at the collecting site. Use an old telephone book or something with a hard cover and absorbent pages. Arrange the specimen on one page of the book, folding it over to the next page if it is too large. Close the book on the specimen and keep everything in place by securing the covers together with a couple of large rubber bands (cut-up car inner tubes are ideal).

More robust material can be placed into a large plastic bag with a moistened paper towel inside, and transferred to a plant press later.

Ideally, all specimens should be transferred to a plant press within 24 hours. If necessary, plant material can be kept in the fridge for a few days, but delicate objects are likely to deteriorate.

Specimens may then be deposited at one of the main herbaria in Auckland (Auckland Museum, AK), Wellington (Te Papa, WELT), or Lincoln (Landcare Research, CHR). If you are preparing the specimen for your own herbarium, follow the guidelines below for pressing and drying specimens. It is advisable to check with the curators of the herbaria before submitting material to them.

Pressing and drying plant material

When dry, plant material is brittle and difficult to manipulate. In order to finish up with a collection of useful herbarium specimens, you will need to be careful about arranging the fresh plant material in the drying paper and plant press. Once the drying process is finished, any mistakes are difficult to reverse.

1. In order to avoid mix-ups, a small temporary label indicating what the sample is, where it was collected from, or to which set of collecting notes it belongs, should be attached to each specimen before placing it in the plant press.
2. Place the fresh specimen on an open fold of newspaper (one thickness is sufficient). Take care to arrange the specimen so all features can be seen.
3. Place the single fold of newspaper containing the specimen between several more layers of drying paper (newspaper) or absorbent material.
4. Place a corrugated cardboard ventilator sheet (from a cardboard box) between the layers of drying paper to ensure an adequate flow of air within the press (Figure 1, overleaf). Several specimens in such an arrangement can be stacked on top of one an another to form the press.
5. Place the stack on top of a piece of 5-ply (or other wood) of sufficient size, and place another piece of 5-ply on the top.
6. A weight (heavy books, etc.) should then be placed on top of the stack so that a “reasonable” pressure is being applied to the plant material. Another good option is to “squeeze” the stack using ratchet tie-downs.
7. The drying process occurs most effectively in an area of warm circulating air. Good results can be obtained using a hot water cupboard, a radiator heater, or even the sun. However, it is imperative to change the drying papers regularly (i.e. change the papers twice a day for the first three days, then at least once a day until all the moisture has been removed from the specimens. Most plant material will dry within 1–3 weeks. However, drying times will

vary greatly, depending on specimen bulk, resins, succulence etc. Use of a microwave oven is not recommended as material tends to cook or catch fire. Seed viability may also be destroyed.

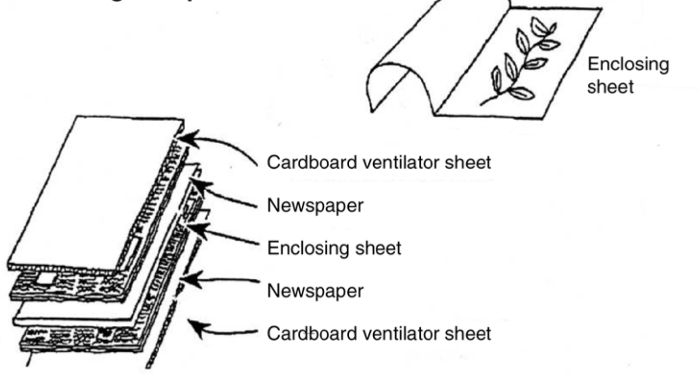
8. A useful test to use to ascertain when specimens are properly dry is to press the plant material to your lips. If it feels cold to the touch, or is limp and flexible, it will not be dry.

Mounting specimens

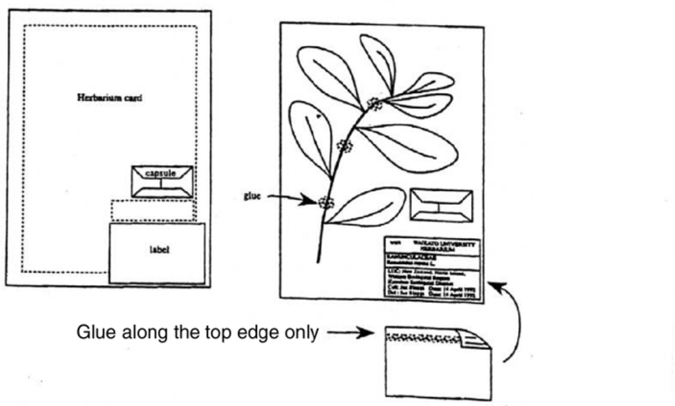
If you can, mount your specimens on card. This will display the specimen and data in a way that allows observation and detailed study, and also it will preserve the specimen. If you cannot get hold of card, then paper will do.

Make sure all working surfaces and hands are clean before starting this procedure to avoid making dirty marks on the herbarium sheet.

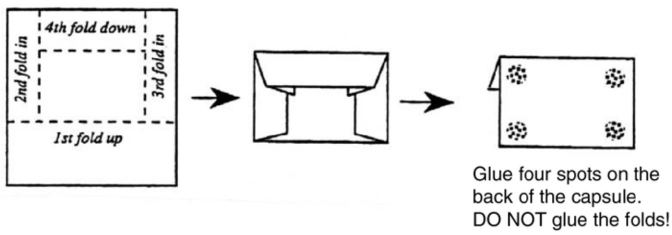
1: Pressing the specimen



2: Placement on the herbarium sheet



3: Folding a paper capsule



1. Remove all extraneous material from the specimen such as soil, mud, and any other plant species that may be mixed up with the sample.
2. Before gluing, arrange the plant specimen, label, and any paper capsules on

the sheet so everything fits without hanging over the edges (Figure 2). Bear in mind the following possibilities: Display the best side of the specimen, it may be necessary to remove some leaves to reveal obscured features. Turn some leaves over to show both surfaces. Large specimens can either be cut and mounted on more than one sheet, or bent to fit in a V, M, or N shape.

3. Once the arrangement is complete, apply PVA glue to selected areas on the underside of the plant specimen and place it on the card. Avoid gluing parts that may be useful in identification (e.g., nodes, floral parts). Instead concentrate the glue at internodes, stems, and leaf midribs. Use only enough glue to provide a firm attachment to the card or paper.
4. Affix the data label to the bottom right hand corner of the card or paper (see labelling specimens). Position it approximately 5mm from the edge, and attach by gluing along the top edge only. Note: Labels should be complete before being glued on the sheet.
5. Affix a paper capsule to the card if required. Fold and glue capsules according to instructions in Figure 3. Place small items, such as seeds, inside a small plastic bag in the capsule. If flowers are plentiful, remove several from the specimen and place them in the capsule for easy study.
6. Leave the specimen to dry on a clean flat surface. PVA glue takes about half an hour to set. Specimens can be kept in place with small weighted objects while drying.

Labelling specimens

It is essential that you include a label with every specimen. The data label is a very important part of a herbarium specimen. It contains information that the plant specimen cannot show by itself. Look carefully at the example below and be sure to follow the same format.

Note: Labels must be clearly worded and legible. Correction fluids or masking tapes should not be used on herbarium labels as they can deteriorate and peel off over time. Labels should be filled out by the collector where possible.

EXAMPLE OF A SPECIMEN LABEL

NTHLPOLY	NORTHLAND POLYTECHNIC, WHANGAREI, NEW ZEALAND
Family: Fabaceae **Scientific name:** *Sophora tetraptera*	**Common name:** Kowhai
Place of collection: New Zealand, Northland, Whangarei, Pukenui bush, by creek outside D.O.C. hut. **Grid reference:** NZMS 260 S14 123 456	
Collector: David Attenborough	**Date collected:** 14 April 2006
Determinator: David Attenborough	**Date of identification:** 14 April 2006
General information and notes: A small spreading tree commonly found throughout the country. Member of the nitrogen-fixing family Fabaceae, found throughout the temperate regions of the world. Growing in macadamia nut orchard under the shade of totara and matai trees. Often flooded area. Flowers absent.	

Identification books

FERNS AND LYCOPHYTES

To make the most of identification keys in the books mentioned below, it is useful if you have a fertile portion of your fern specimen to work with, and if possible, a whole frond from base to tip. Some fern species have separate vegetative and fertile parts, and there is often a range of variation in size, colours, and shapes within a species.

Brownsey, P.J. and Smith-Dodsworth, J.C. 2000: **New Zealand ferns and allied plants**. Bateman.

Crowe, A. 1994: **Which native fern?** Viking Press.

Heath, E. and Chinnock, R.J. 1974: **Ferns and fern allies of New Zealand**. A.H. and A.W. Reed Publishers.

GYMNOSPERMS

To identify gymnosperms, it is useful to have samples of both adult and juvenile leaves, male/female cones/fruit, and some idea of the appearance of the bark.

Salmon, J.T. 1980: **The native trees of New Zealand**. Reed Publishing (NZ).

Salmon, J.T. 1986: **A field guide to the native trees of NZ**. Reed Publishing (NZ).

Poole, A.L.; Adams, Niall M.; Adams, Nancy M. 1994: **Trees and shrubs of New Zealand**. Government Printer, Wellington.

Smith-Dodsworth, J.C. 1991: **New Zealand native shrubs and climbers**. David Bateman.

Wilson, H. and Galloway, T. 1993: **Small-leaved shrubs of New Zealand**. Manuka Press.

ANGIOSPERMS

Some books contain perfectly workable keys based on vegetative characters. Generally however, most identification keys for angiosperms are based on floral or fruiting characters. This means it is to your advantage to collect examples of both flowers/fruit and vegetative parts where possible. Use fresh plant material during identification. Plant characters are often altered and manipulation is difficult when plant material is dried and/or wilted.

Crowe, A. 1997: **The life-size guide to native trees and other common plants of New Zealand's forest**. Viking Press. (Good for angiosperms and gymnosperms).

Dawson, J. and Lucas, R. 2000: **Nature guide to the New Zealand forest**. Godwit.

de Lange, P.; Rolfe, J.; St George, I.; Sawyer, J. 2007: **Wild orchids of the lower North Island**. Department of Conservation, Wellington.

Salmon, J.T. 1980: **The native trees of New Zealand**. Reed Publishing (NZ).

Salmon, J.T. 1986: **A field guide to the native trees of NZ**. Reed Publishing (NZ).

Poole, A.L.; Adams, Niall M.; Adams, Nancy M. 1994: **Trees and shrubs of New Zealand**. Government Printer, Wellington.

Johnson, P. ; Brooke, P. 1989: **Wetland plants in New Zealand**. DSIR Publishing, Wellington.