

Agathis robusta and *Agathis australis*



Left: The Qld Kauri *Agathis robusta*, planted in the Albury BG in 1910, is the largest recorded in the Big Tree Register. Note gardener. [1] Right: The NZ Kauri *Agathis australis*, named Tane Mahuta (Lord of the Forest), in the Waipoua Forest is the largest known in NZ. Photo: Prof. Chen Hualin, CC BY-SA 4.0, zh.wikipedia.org

Kauris (*Agathis* sp.) are conifers

Conifers, along with the other Gymnosperms (Cycads and Ginkgoes), first appeared about 300 Ma (Million years ago) at the end of the Carboniferous when the world's coal deposits were being laid down with the remains of the spore-producing trees of that period. The early conifers looked like modern Araucaria. These trees spread throughout the world and displaced their predecessors. The age of the seed plants had arrived. The conifers are a hardy lot. They survived the largest mass extinction the earth has known, 252 Ma, at the end of the Permian Period.

But more challenges lay ahead. Sometime in the next 50 Myr (Million years) one of Gymnosperms gave rise to the flowering plants, the Angiosperms. By 100 Ma, in the Cretaceous period, Angiosperms were widespread. And so the battle began - and still continues to this day. The flowering plants have many features that make them more successful in many environments, so their take-over of many habitats was complete by about 65 Ma at the end of the age of the dinosaurs. But in the world's harsh environments the conifers continue to not just survive, but flourish. They alone own the vast arctic tundra and the tree-line on the world's high peaks.

The number of conifer species is thought to have never been high. Today, there are 7 families, 68 genera, and 629 living species. The wood of conifers is called softwood, but it is not necessarily softer than hardwoods (from Angiosperms). For example, the hardwood Balsa *Ochroma pyramidale* in the Angiosperm family Malvaceae, is 15 times softer than Australian Cypress Pine *Callitris* in the Conifer family Cupressaceae.

While the conifer family Araucariaceae was world-wide, it and Podocarpaceae (Podocarps) are now mostly southern hemisphere, with a few species to the north of Australia. Cupressaceae (Cypresses) is in both hemispheres, while the other conifer families Pinaceae (Pines), Taxaceae (yews), Cephalotaxaceae,

Sciadopityaceae are almost completely northern. Six of the seven families (not Sciadopityaceae) have representatives in the gardens (GBG and EP).

Most northern conifers have hard cones and use wind to disperse seed. Only a third of southern conifers have hard cones, the others have flesh around the seed encouraging birds to disperse their seed. Most conifers have narrow leaves like Pine needles or scale leaves like those in the Cypress family. Araucariaceae and Podocarpaceae species have the ancestral broader leaves. Why? These 2 families have succeeded in competing in broadleaf forests where they spend their early life in the shade and need superior photosynthesis to cope. The Podocarps have even diversified in the last 100 Myr. The narrow leaves of the northern species help them shed heavy snow.

Today, there are about 230 species native to the southern hemisphere (including those that are in both hemispheres). The world's Angiosperms have 415 families, more than 12,000 genera and an estimated 352,000 species.

Kauris (*Agathis* sp.) are members of Araucariaceae

The family Araucariaceae has 4 genera and 39 species: *Agathis* (18 species), *Araucaria* (19 species), *Columbea* (only *Columbea brasiliensis*), *Wollemia* (only *Wollemia nobilis*). These genera are represented around the GBG Bunya lawn, except for *Columbea*.

This note focusses on the two Kauri species: the New Zealand Kauri *Agathis australis* and the Queensland Kauri *Agathis robusta*.

When they reach the forest canopy, these Kauris shed their lower branches leaving a straight non-tapering trunk, unlike most trees. Compare the large Queensland Kauri with the nearby Giant Redwood *Sequoiadendron giganteum*.

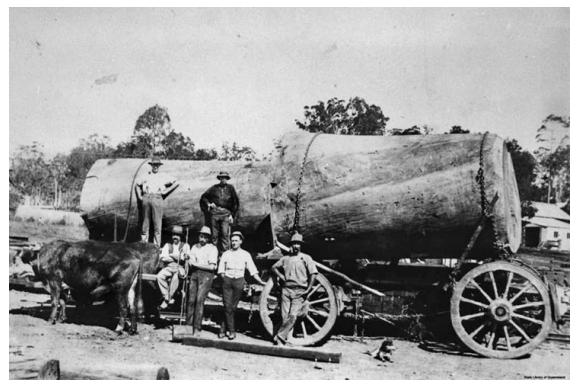
Young Kauri leaves have a waxy coating until the leaf has fully unfurled. This may protect the leaf from sunlight exposure until the cuticle (surface layer of cells) becomes robust enough to protect the leaf. In addition, the waxy surface repels water, and so may prevent the stomata (minute holes in leaves for releasing water vapour and taking in carbon dioxide) from being obstructed by water and dust.

Queensland (Qld) Kauri *Agathis robusta*

While it grows in the moist tropics, it is able to compete with the Angiosperm trees in drier sites, on ridges and higher slopes, and in soils with lower fertility.

When Qld Kauris were being logged, some were so large that a limit was placed on the size that could be taken by rail, in order to fit through tunnels. That limit was 22 feet girth (6.7m girth, 2.1m diameter).

Qld Kauri timber was used for cabinetwork, turning, joinery, furniture, shelving and violin and guitar bodies. These are all indoor applications, because it rots and suffers insect attack outdoors.



Photos from the top: 1. Largest Qld Kauri felled in Kin Kin area, 1918. Public Domain, www.bonzle.com.
 2. Large timber logs, probably Qld Kauri, were hauled by bullock team, Queensland c1905, State Library of Qld, Public Domain, en.wikipedia.org.
 3. Qld Kauri bark showing flakes that are shed. Kahuroa, Public Domain, en.wikipedia.org.
 4. NZ Kauri female cone one year old. Kahuroa, Public Domain, commons.wikimedia.org.

New Zealand (NZ) Kauri *Agathis australis*

The NZ Kauri grows to have a larger girth than the Qld Kauri and reaches a greater age. Young NZ Kauris have strong, tall, thin, tapered trunks, referred to as Rickers. 'Ricker' is a corruption of the name of the Baltic port of Riga where spars for sailing ship masts were purchased. When Napoleon prevented British access to Riga, they turned to the NZ Kauri and the young (100 year old) Rickers. Other Kauri timber was exported to build houses in Sydney and San Francisco. As well as being used for the structure and cladding, it was split for roof shingles.

The Maori revered Kauris and gave chiefly status to the tallest trees. The largest surviving tree is named Tāne Mahuta Lord (or God) of the Forest.

Kauri felling ended in state forests in 1985, just in time to protect the giants in the Waipoua forest in Northland. Rei Hamon was manager of the Thames Sawmilling Company and had the job of supervising the felling of a large kauri in 1961. He recalls, 'When that tree fell, it had been standing there for maybe a thousand years...I went back later to where it had been standing, and there were birds fluttering around there, kaka and kereru, that had nested in that tree for generations. That was the finish. I handed in my resignation. I vowed never to fell another healthy tree.'

Kauris in parts of NZ are threatened by the soil-born mould Phytophthora. Visitors to forests are asked to disinfect their shoes before entering and on leaving Kauri forests.

Maori story of creation

At the beginning of time Ranginui, the sky father, and Papatūānuku, the earth mother, clung together, trapping their children in the darkness beneath them. The strongest child, Tāne Mahuta (the god of the forest), pressed his shoulders against his mother and pushed upwards with his powerful legs, separating his parents and allowing light to enter and bring life to the world. Some northern Māori tribes say that his legs were the trunks of giant kauri trees.

Another Maori story: The Sperm Whale and the Kauri

Because of their huge size, both the sperm whale and the kauri are regarded as rangatira (chiefs) of their respective realms. Moreover, their bark and skin show similarities of texture, while kauri gum is like the ambergris found in the intestines of the whale. In times long past, a sperm whale came ashore and spoke thus to the kauri: "Kauri! Come with me to the sea which is fresh and cool." "No!" said the kauri. "You may like the sea but I prefer to stand here with my feet in the soil." "All right" said the whale "then let us agree to exchange our skins." So that is why the bark of the kauri is thin and full of resinous oil.

Kauri gum from both Qld and NZ Kauris

Resin is the sticky aromatic sap produced by most conifers. Resin leaks from Kauri tree wounds and cones. As the resin dries it forms gum that can protect a wound from infection. As the gum is resistant to attack by fungus and insects it can remain in the soil for very long periods. Before 1770, Maoris dug this gum. In 19th and early 20th centuries displaced Maoris and settlers made a living that way. In the 1890s there were 20,000 people in the NZ gum industry. Digging gum was difficult as much was in swamps and Tea Tree forest. In the century to 1950, 450,000 ton of gum was exported from Auckland and in the year 1946-47, 45 ton of Qld Kauri gum was harvested. The gum was used for fire-kindlers, both in Europe and in pre-colonial NZ, for marine glue, for spirit varnish for furniture, and linoleum. Kauri resin was also used to produce turpentine. In NZ, when deposits of gum were dwindling, the gum-diggers began to tap live trees. However, when too much resin was taken, this killed the trees.



Photos from the top: 1. Rickers have recently shed lower branches, Waipoua Forest, Northland, NZ. [1]
 2. NZ Kauris flourish in the depleted soils of the ridge lines where Angiosperm competition is minimal. Coromandel Peninsula NZ. [1]
 3. NZ Kauris accumulate litter of bark flakes, leaves and cones. As it slowly decomposes the litter releases acid that impoverishes the soil and erodes rock. [1]



Both NZ and Qld Kauris actively impoverish the soil by leaking gum. This gum, and the litter of bark, leaves and cones releases acid as it decomposes. The acid dissolves soil minerals that are gradually leached away from the surface, making it difficult for Angiosperm trees to compete.

Many conifers produce gum. When the gum remains in soil for millennia it becomes fossilised into amber. The amber often traps plant parts, insects and other animals. This amber is polished or carved to create ornaments. Palaeontologists value amber because it preserves fossils better than most other means. An example is the paper, by Xing and colleagues, just published. It describes a piece of amber bought in a market in Myanmar. This amber shows a previously unknown (tri-pinnate) step in the development of dinosaur feathers leading to the modern (bipinnate) bird feathers.



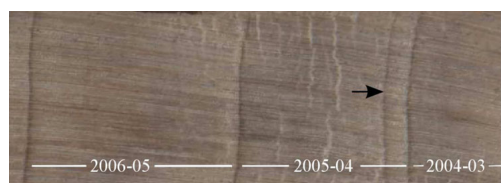
Wairere Basalt Boulders

Near the Hokianga Harbour, in Northland, there is a formation called the Wairere Boulders. (See photo) It is a rare rock formation of fluted basalt, that looks like a Karst limestone formation, similar to those in Vietnam, China and Madagascar, but it is basalt. This shapes are formed by acidic water flowing over the rock and slowly dissolving it. The Kauri forest produces forest floor litter composed of bark flakes, leaves and cones. As the litter slowly decomposes makes rain-water acidic.



How long can a Kauri live?

The only method to reasonably accurately determine the age of a tree is to count the growth rings. To do this it is necessary to either cut the tree down or to take a core (usually about 5 mm diameter) through to the centre of its trunk. To say the least, neither of these is likely to be very good for the health of the tree. Nevertheless NZ Kauris have been dated using tree rings. The oldest authenticated date of a tree is about 1,000 years. Given that this was not the largest of trees, some people expect the maximum age of a New Zealand Kauri to be 3,000 years.



Tree rings can also serve another, very important, service. The ring width indicates how good the growing season was, that year. By using recently felled trees, timber in old buildings and timber submerged in swamps, a continuous 4,500 year dendrochronological sequence has been assembled using NZ Kauris. This contributes to an understanding of the climate history of the North Island of New Zealand. In addition, much older trees have been found in NZ bogs, opening a window into the climate in the period 60,000 to 30,000 years ago.



The situation in Australia is different. In tropical and subtropical Australia, Kauris grow faster. In addition, in climates that are warm and receive rain throughout the year, growth rings are more problematic. The largest known Kauris in Australia are those growing in Gardens, such as the one in the Albury Botanic Gardens. (See photo.) Most of these are about 100 years old. Because conditions are often ideal, garden trees grow faster than those in the competitive environment of the forest. While the 100 year old trees are nearly the size of the largest Kauris cut down, they probably achieved this size more quickly. As a result, some suggest that Qld Kauris can live to 300.



Photos from the top: 1. Polished pieces of NZ kauri gum are sold at the Kauri Museum shop, Matakoho, NZ. Gadfium, CC BY 2.0, commons.wikimedia.org. 2. Wairere Boulders are basalt eroded into fluted shapes by acid derived from NZ Kauris, Horeke near Hokianga Harbour, Northland. [1] 3. An 8mm piece of Qld Kauri growth rings marked with hot growing seasons. The arrow shows a 'false ring' within the 2004-05 growing season due to a break in rainfall. Bjorn Boysen, CC BY 4.0, www.plosone.org 4. A cross-section of a Qld Kauri log marked with circles out to estimated age 600 years. Mueums Victoria, CC BY 4.0, collections.museumvictoria.com.au/items/401094 5. Seed of Qld Kauri showing its asymmetrical wing. [1]

There is a slice from a Qld Kauri in the Melbourne Museum that is labelled with circles out to 600 years. (See photo.) Recent research casts doubt on dating of Qld Kauris by rings alone. Boysen and colleagues, 2014, compared Oxygen isotope sequences and recent climate records with Qld Kauri core samples. This showed that if the growing season was split in two by a dry period, two rings are produced in that year. (See photo.) It is also known that a poor year can produce no ring.

Family: Araucariaceae

Genus: *Agathis*

Species and Common names: *Agathis robusta* Queensland Kauri, *Agathis australis* New Zealand Kauri

Origin: The Qld Kauri occurs naturally in Papua New Guinea and in two areas of Queensland, a southern population on Fraser Island and around Maryborough, and a northern population on the Atherton Tableland west of Cairns.

Today, the NZ Kauri occurs naturally in the North Island from 38.01° S (the latitude of Lara).

Locations in GBG: The large **Heritage-listed *Agathis robusta*** is on the boundary between the 19th and 20th century gardens. There is a young NZ Kauri in the Bunya lawn.

Origin of the names

An *Agathis*, probably either *A. dammara* or *A. borneensis*, was early noticed and exploited by representatives of the Dutch East India Company, and was described to science in 1741 by Rumphius as *Dammara alba*. This was before Linnaeus' 1753 publication of the *Genera Plantarum*. As the genus name *Dammara* was subsequently found invalid, the earliest valid name, *Agathis*, published in 1807, was adopted.

Agathis is Greek for a ball of thread, referring to the resemblance of the cone to a ball of thread.

robusta is Latin for 'strong', an allusion to the vigorous growth of the Qld Kauri.

australis is Latin for 'southern', referring to the NZ Kauri being the most southerly growing *Agathis*.

The largest Queensland Kauri

Largest living Qld Kauri in the National Register of Big Trees has a 2.1m Diameter (6.6m girth) (37m tall, 28m crown). It is in the Albury Botanic Gardens. (See photo.)

The largest NZ Kauri

Largest recorded NZ Kauri had a diameter of 8.5m diameter. It grew near Thames on the Coromandel Peninsula, NZ.

The largest living Kauri is Tane Mahuta (Maori for 'Lord of the Forest'). Tane Mahuta is 4.4 metres in diameter and 17.7 metres to the first branch. It grows in the Wiapoua Forest in Northland, NZ.

Many ancient trees are partly hollow.

Longevity of *A. australis*

Diameter is not a good indicator of age. Trees 100mm diameter can vary in age by 300 years.

Trees that survive competition, normally live more than 600 years and many probably exceed 1,000 years.

There is no evidence of greater than 2,000 years.

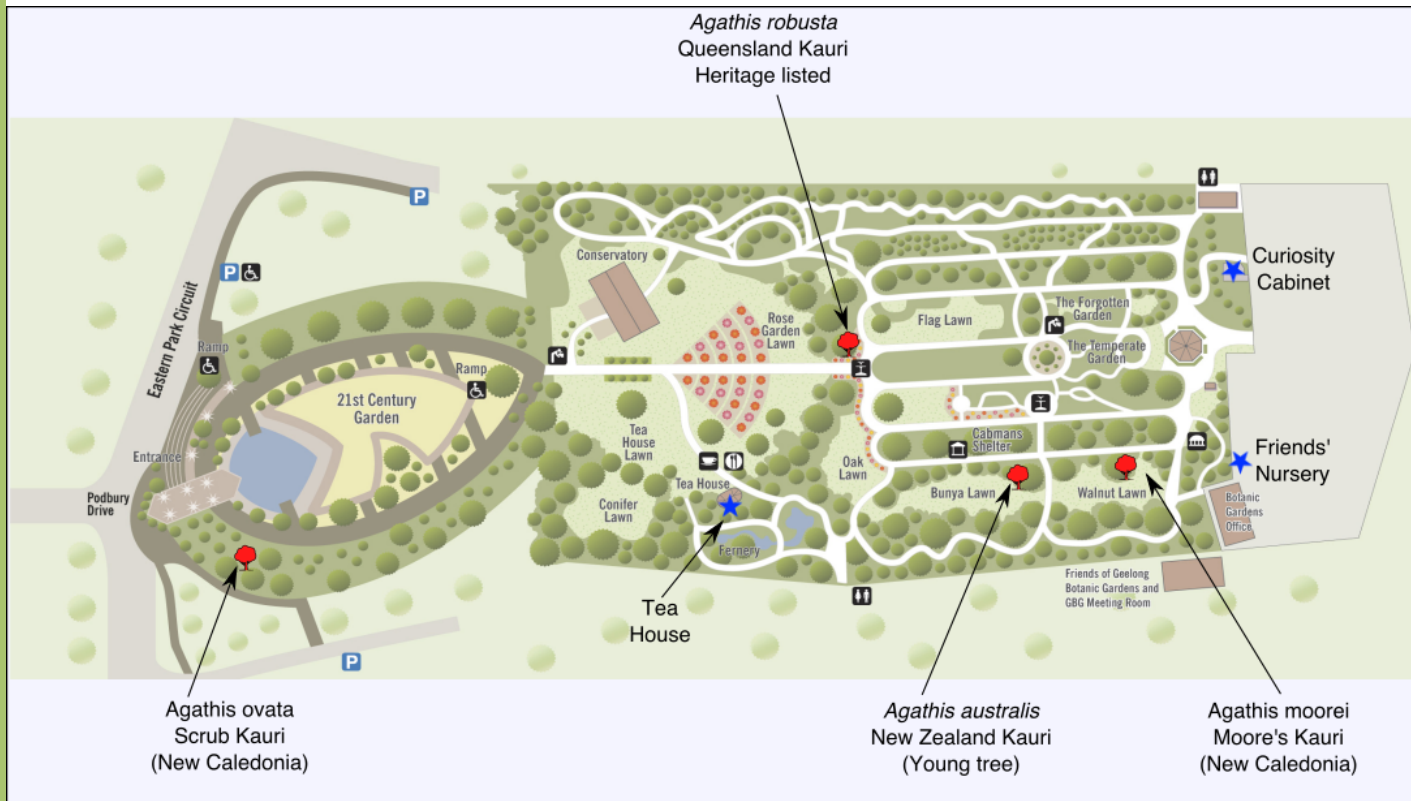
Longevity of *A. robusta*

The faster growing Qld Kauri can live to between 300 and 600 years.



Before tramways and roads were built, NZ Kauri logs were transported down river valleys by an artificial flood. This was created by opening the gates of a driving dam to carry logs down to a harbour. This is a model of a driving dam. [1]

Geelong Botanic Gardens Map



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Photographs

[1] Where no other acknowledgement is given, the photo is by the author



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