Of Interest. Australian Conifers

As we have discussed in past articles, in recent years molecular (DNA) studies have largely replaced morphological work in determining phylogenic relationships between plant groups and therefore in many instances nomenclature. The conifers and gymnosperms have not escaped. Most of us conceptualise conifers as "cone" producing plants (admittedly some have fleshy fruit like "cones"), with wood built of tracheids and leaves that are small with single or parallel veins. Recent molecular studies, however, are now turning that on its head separating members of subclass Gnetidae with Pinaceae (the pine family) into a different clade from the others (Araucariaceae, Podocarpaceae, Cupressaceae, Sciadopityaceae and Taxaceae) (Ref 1). Gnetidae includes three relic gymnosperm genera, one, *Gnetum* has species with leaves with broad pinnate-reticulate venation and wood with vascular channels that look very much like primitive angiosperms.

Gnetum gnemon. Recent studies show that Pinaceae are more closely related to this gymnosperm and other members of Gnetidae than they are to the other conifer families. Photo Wikipedia

Convergent molecular evolution or homoplasy is the explanation given. The appearances of the other two genera *Welwitschia* and *Ephedra,* likewise, seem to bear little resemblance to traditional conifers. The phylogenic data also put Pinaceae (with Gnetidae) basal in the evolution of the conifers which is at variance to fossil evidence with the oldest Podocarpaceae fossils more than 100 million years older than the oldest Pinaceae ones.

The new phylogenetic relationships aside, and with some uncertainty as to the future correctness of the term "conifer", the following discussion leaves out the Gnetophytes and just refers to the traditional conifers now in 6 families: Pinaceae in the Order Pinales; Cupressaceae, Taxaceae and Sciadopityaceae in Order Cupressales: and Araucariaceae and Podocarpaceae in Araucariales. That includes about 615 extant species.

A casual glance at the distribution of the world's extant conifers, appears to show them as an overwhelmingly a Northern Hemisphere class with conifer species covering huge areas of North America, and Eurasia and no equivalent biome in the Southern Hemisphere. For the most part there, they are growing in conditions that are suboptimal to plant growth with unfavourable soils and especially harsh climates such as the boreal forests (taiga) at high latitudes or mountainous regions with similar climates further south.

Taiga and Boreal forest biome M. Baldwin-Smith, Wikipedia

These areas have short summers and relatively long cold winters so the advantages that angiosperms usually have with larger leaves with reticular venous patterns, and stems and branches with larger vascular channels, in those conditions become disadvantages. While that is true the extent and sheer volume of timber is far greater in the Northern

Hemisphere, and even the shape of what people perceive a conifer should look like, reflects species from those forests, in terms of variety and number of species, the differences between the two hemispheres are not nearly so stark.

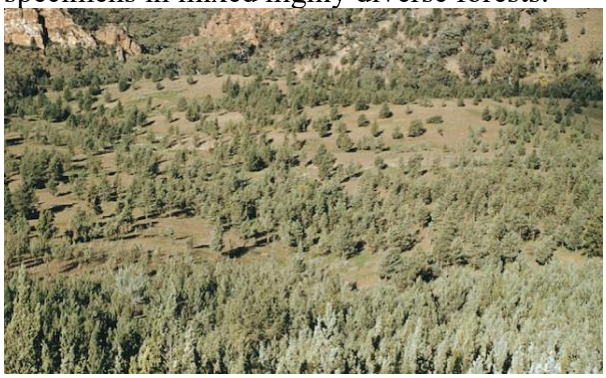
Abies sp., Coombe Wood, Mittagong showing the conical/pyramidal shape expected for a conifer.

The boreal forests whilst large in extent are dominated by relatively few species, mostly from the one family Pinaceae. Just a couple of species of spruce (*Picea*), larch (*Larix*), pine (*Pinus*) and to a lesser extent fir (*Abies*) predominate in them. Moving towards the equator, the extent of conifer dominated forest decreases and is still largely in inhospitable sites such as mountainous regions. Despite that, as a whole the variety and number of conifer species increases, and species of other conifer families become more evident such as the Cupressaceae and the smaller Northern Hemisphere family Taxaceae which now includes Cephalotaxus. In the lower latitudes, the conifers more often have to compete directly with angiosperms for survival though in some instances their longevity and infrequent disturbance events, helps them to dominate locally. For many though, particularly in the tropics, species exist as isolated trees and shrubs in mixed angiosperm dominated forests. The species in the tropics are often from Southern Hemisphere families and genera (Podocarpaceae and *Agathis*) that have moved north with adaptations that allow them to better compete with angiosperms such as larger, wider leaves and bigger seed attractive too and subsequently spread by birds and animals.

Agathis robusta. The large leaves with multiple parallel veins (L) helps it compete with angiosperms seen on the (R) growing in mixed tropical rainforest near Cairns, QLD.

In the Southern Hemisphere, there is no equivalent to the boreal forests. Land with similar latitude is limited and, in any case, the family of conifers that dominate those forests, Pinaceae, is an almost strictly northern hemisphere one. One species, *Pinus merkusii* which ventures just south of the equator on the island of Sumatra, is the only species of some 220-250 species to do so. The dominant Southern Hemisphere conifer families are Cupressaceae, Araucariaceae and Podocarpaceae. Of these, Cupressaceae is cosmopolitan occurring widely in both hemispheres, Araucariaceae was also before retreating south with just a few species of *Agathis* moving north into Southeast Asia, and Podocarpaceae is a Southern Hemisphere family that has successfully moved north more widely. Unlike the Northern Hemisphere, conifer dominant forests are uncommon with most conifer distribution more fragmented and many species growing as isolated

specimens in mixed highly diverse forests.



Callitris forests and woodlands, Flinders Ranges, SA. Photo M. Fagg, NVIS Fact sheet, Australian Government

The *Callitris* (Cupressaceae) forests and woodlands of south-central QLD, central NSW and small parts of South Australia are some of the few sizeable areas where conifers dominate albeit with only a few species involved. To put it into perspective, forests cover about 17% of Australia (164 million Ha) but of that only 1.9 million Ha or 1.4% is predominantly conifer (*Callitris*) species. In comparison in North America at the beginning of the 21st century, about 25% of the land was forest with 72% conifer dominant. The percentage of conifers decreases as you go south but in Central America conifers still account for 25% of the forests. In Europe just under half the land is forested (includes Russia) with about 40% conifer dominant.

Apart from the *Callitris* forests and woodlands, in Australia conifers usually grow as inconspicuous trees and shrubs in mixed forests occasionally developing as emergent species. This creates the impression that they are underrepresented as a group. In fact, there are 39-42 different conifer species. The exact number of Australian species depends on the number of accepted *Callitris* sps. That number compares favourably with Europe (41 species) Moreover, there are only a handful of different conifer species in sub-Saharan Africa and none in the Congo basin. Admittedly New Caledonia has 43 species itself and Mexico has 90 conifer species in total and 43 different pines alone.

The greatest number of Australia's conifer species are found in the wetter forests of the east coast that stretches from Tasmania in the south, to far north QLD. The two relative hot spots are at each of the extremities of that range; in Tasmania and far north QLD with most of the species in those areas locally indigenous. In fact, with the exception of Sundacarpus amarus (also found throughout Malesia) and Araucaria cunninghamii (also found in New Guinea), all of Australia's conifers are indigenous.

Three families are represented. Cupressaceae, Podocarpaceae and Araucariaceae. Araucariaceae with 7 species has been covered in previous newsletters. In Australia it consists of 3 species of *Agathis*, 3 species of *Araucaria* and *Wollemia nobilis*. With the exception of *Wollemia nobilis* which was found in deep sandstone gullies near Sydney the rest are from the warm wet climates of the east coast and ranges of QLD. *Araucaria cunninghamii* occurs also in north eastern NSW. Tropical far north QLD is also home to four *Podocarpus species* (2 endemic), *Pectinopitys ladei* (syn. *Prumnopitys*), *Sundacarpus amarus* and *Callitris macleayana* which unusually for that genus prefers wetter environments close to rainforests.

Podocarpus dispermus, Atherton Tableland. One of two *Podocarpus sp*. endemic to far north QLD. It has large leaves for the species and brightly coloured fruit that help its distribution.

Tasmania has ten conifer species with seven species from five genera that are endemic. The ten species are *Athrotaxis cupressoides, Athrotaxis selaginoides* (plus a natural hybrid *A x laxifolia*) *Callitris oblonga, Callitris rhomboidei* and *Diselma archeri* from Cupressaceae and *Lagarostrobus franklinii, Microcachrys tetragona, Pherosphaera hookeriana, Phyllocladus aspleniifolius* and *Podocarpus lawrencei* from Podocarpaceae.

Phyllocladus aspleniifolius, the celery-top pine, is endemic to Tasmania. Molecular studies place *Phyllocladus* firmly in Podocarpaceae. Cradle Mountain NP.

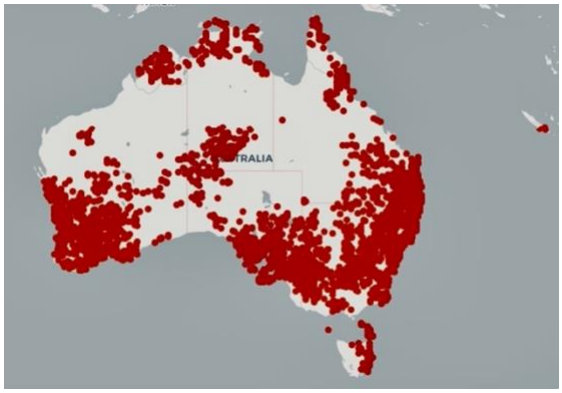
There are 3 Tasmanian species also found in other states. *Callitris oblonga* is found in two localized disjunctive populations in NSW (Northern and Southern Tablelands) in addition, while *Callitris rhomboidei* has a more extensive range growing in woodland along the east coast and adjacent tablelands from mid QLD through NSW and VIC to South Australia. *Podocarpus lawrencei* is also found in the alpine and subalpine areas of southern NSW and northeastern VIC growing from about 100 m above sea level to just below . In alpine areas it is a decumbent (lying on the ground) shrub barely 30 cm tall, but it can reach 15 m in subalpine regions such as the Errinundra Plateau.

Between far north QLD and Tasmania on the east coast or nearby ranges there are two more *Podocarpus* species. *Podocarpus elatus* grows to 30 m in and around rainforests from far north QLD south to Jervis Bay in NSW. There is a disjunctive population in Arnhem Land NT. The other species is the shrubby *Podocarpus spinulosus*, a diminutive shrub rarely reaching 2 m in height. It generally grows as an understory shrub in sandy nutrient poor soils in sclerophyll forests.

Podocarpus spinulosus an understory shrub in sclerophyll forests. Here it is at risk of periodic flooding and bushfires but is able to regrow from underground lignotubers.

Occupying a similar environment to *P. spinulosus* on the other side of the continent is the related *P. drouynianus*. It grows in the higher rainfall areas of south-west WA, principally in the sandy or gravelly soils of jarrah/marri forests (Eucalyptus marginata and *Corymbia calophylla*). A relic species holding on in a drying climate prone to bushfires, it has like *P. spinulosus* developed strategies to cope with drought and fire. I intend to cover the Australian Podocarps more fully in the next newsletter.

The largest genus in Australia and that with the greatest range is *Callitris* (Cupressaceae). Following molecular studies, the genus now includes the 3 WA previously classified as *Actinostrobus* giving 15-18 Australian species. Three species also grow in New Caledonia.



Distribution of *Callitris* sps in Australia. There are also 3 species in New Caledonia. (Australian Virtual Herbarium)

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There are species such as *C. macleayana* that grow along the east coast and ranges with rainfalls approaching 2 m per year but like their Northern Hemisphere family counterparts *Cupressus* and *Juniperus*, some *Callitris* species are adapted to hot, dry regions. None approach the somewhat unique *Cupressus dupreziana* of the Sahara living where the average rainfall averages 30 mm annually, but several survive and grow well in regions of high evaporative loss with rainfalls from 300-600 mm per year. The inland form of *Callitris columellaris*, (DNA studies suggest *C. glaucophylla* should be reinstated) can survive in regions with as little as 200 mm per year.

C. columellaris (syn. *C. glaucophylla*), Larapinta Trail, NT. Here the rainfall averages 275 mm per year.

These conifers have developed several strategies to survive in these regions. They have small needle-like or scale-like leaves which are usually appressed to the stems. The persistent bark is hard and compact. Some species such as *C. tuberculata* have developed wood that is one of the most embolism resistant in the world. To grow in the nutrient-poor soils they have mycorrhiza that enhance nutrient uptake and to reduce competition, its roots and leaves produce an exudate that inhibits the growth of other species (allelopathy).

Callitris endlicheri, Nattai NP near Sydney. Growing on an elevated rocky sandstone ridge, (as they usually are), here only a few survived the bushfires on 2019/2020.

As mentioned earlier, *Callitris* sps are the only conifers in Australia to grow in extensive conifer dominant or co-dominant (with *Eucalyptus* and/or *Acacia*) woodlands. The most common species is *Callitris columellaris* (syn. *C. glaucophylla*). It generally grows with a number of understory plants, but it should be noted that much of the woodland is open woodland with scattered trees and <20% crown cover. While *Eucalyptus, Casuarina* and *Acacia* are generally fire tolerant, *Callitris* is not and survives by re-seeding from serotinous cones (open after fire). Frequent fires can therefore prevent recovery.

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Tree Treats – *Athrotaxis,* another Tasmanian oddity.

For many years *Athrotaxis* was the sole Southern Hemisphere member of the defunct family Taxodiaceae until that family was mostly subsumed by Cupressaceae. Members of that former family were separated from Cupressaceae because their leaves were helically or alternately arranged and their seed cone bract scales also arranged helically but in 1941 *Metasequoia glyptostroboides*, a species closely related to *Sequoia* was discovered with its leaf and seed cone bracts arranged oppositely as they were with members of Cupressaceae as it was then. And so, in 1976 James Eckenwalder who considered the differences between the two families only minor, made the case that the two families should be combined under, Cupressaceae for reasons of priority of that name.

Since then, molecular studies have supported that decision. Of interest the previous Taxodiaceae subfamilies are the basal lineages within that family with Athrotaxidoideae sister to the subfamily that includes *Metasequoia* and *Sequoia*. So intriguingly for *Athrotaxis*, its nearest relatives are still in the Northern Hemisphere some 10,000 km away. It is believed to have diverged from other Cupressaceae conifers 150 million years ago.

The 2 recognised species, *A. cupressoides* and *A. selaginoides* were first described in D. Don in 1838 from samples sent as usual for that time, by Mr. R. C. Gunn. The name is derived from the Greek *athros* = crowded and *taxis* = arrangement referring to the crowded overlapping arrangement of the leaves.

Athrotaxis selaginoides demonstrating the crowded overlapping leaves. Cradle Mountain NP.