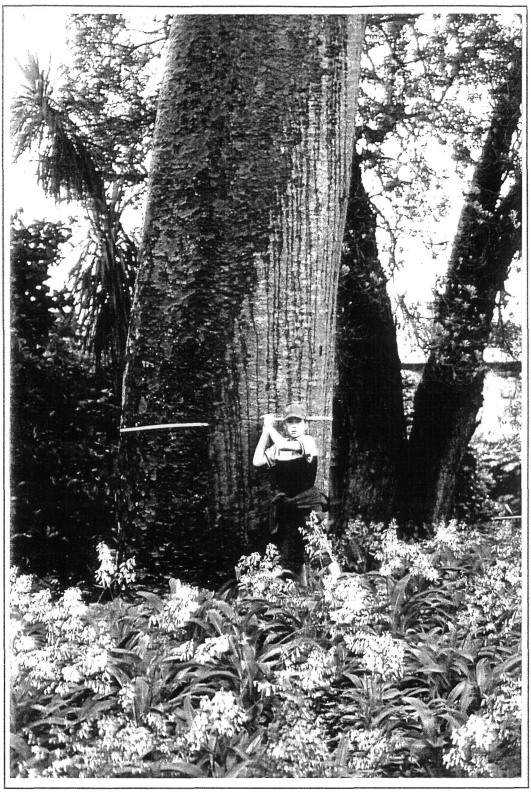

from the motorway 30 October 2000).

Warkworth

Maureen Young (2000) commented on the history and possible planting dates of the two Queensland kauri at Carran Road Warkworth, referred to in my original article. The possible planting dates are connected to Sir George Grey while he was on Kawau Island: 1862-1888. Maureen also recorded their DBH as: 88 and 113 cm – the latter a double trunked tree; measured January 2000. Maureen remeasured the DBHs of these trees for me on 5 November 2000: 89.1 cm, and 114.5 cm - the trunk of this latter tree starts to divide at breast height (where measured), but fully divides further up (M. Young pers. comm.).

Acknowledgements

I thank Steve Benham, Tony Palmer and Maureen Young for information about specific trees; the owners of the Orakei Road and Diocesan trees for access; and Robert Cameron for accompanying me and helping me to measure most of the trees mentioned.

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Young, M. E. 2000: Still more on Queensland kauri. Auckland Botanical Society *News-sheet* February 2000.

Fig. 1. Saved and made safer: the Diocesan School Queensland kauri and my assistant Robert Cameron, November 2000.

Araucaria heterophylla (Araucariaceae) and its relatives

Rhys Gardner, Graeme Hambly & Justin Kneijber

From any of Auckland City's vantage points one can see all around the distinctive shape of our noblest exotic tree, the Norfolk pine *(Araucaria heterophylla)* - tall and spire-like, regular but varied in detail, like sculpture by some artist set on affirming the Vibrant Spirit of the Individual Down Under. The abundance of these trees means that they could almost serve as landmarks for an out-of-town botanist, who might then be able to confirm his or her route by the less frequent occurrences of the tree's closest relatives, Cook's pine *(A. columnaris)* and hoop pine *(A cunninghamii)*, and its not quite so similar cousins, bunya-bunya *(A. bidwillii)* and monkey-puzzle *(A. araucana)*.

Suited to all but wet ground, Norfolk pines are true subtropicals, able to take anything in Auckland's weather (except, as was proved this August in Southern Cross Road, for an oversize bolt of lightning). Tellingly, in Britain the species is seen outdoors only as a single old individual at Tresco Abbey on the Scilly Isles, although it is otherwise common in Britain as a pot plant, under the ignominious appellation "house pine" (Mitchell 1994).

This article concentrates on the identification of the three commonly cultivated species of section

Eutacta, that is, Norfolk (Island) pine, Cook's pine and hoop pine. The bunya-bunya and the monkey-puzzle differ in belonging to sect. *Araucana*, whose members have much larger, flattened and very sharp leaves, and very large cones (that of the bunya-bunya is approximately the size of the child's head and is matched in the gymnosperms only by those of some cycads).

Nearly all writers of Floras and gardening books begin or end their treatment of sect. *Eutacta* by noting that the three species can be distinguished "only with difficulty". Their keys, if they exist (Corner 1988, Hill 1998; Lovett et al. 1986) depend largely on the form of the adult tree, a state of affairs that would hardly be tolerated in professions where precision is mandatory. Partly this is due to Flora-writers being too busy to do more than copy from one another; partly though the three species themselves are to blame, being disconcertingly alike in their foliage through variability particularly of the juvenile-adult kind.

We have found (actually, rediscovered) characters of various degrees of utility in the foliage and in the male and female cones, and we set these out below. Unfortunately, good characters for the seedling and juvenile foliage can only be hinted at.

Araucaria Juss.
Araucani, name of the Indian tribe of central Chile, whence the first-named member of the genus, the monkey puzzle, was obtained.

Tall evergreen trees, trunk single unless damaged (even then never with basal sprouts), straight to slightly curved; primary branches relatively slender and in regular whorls (supposedly usually in fives or sevens), in sect. *Eutacta* the lesser branches generally much less extended; ultimate branchlets leafy throughout, "like plaited cord" (sect. *Eutacta*) or scourge-like, shed as a unit, the leaves persisting on the axis even on dead material; leaves crowded, spiralled, subulate to scale-like, spiny or not, stomata present on both surfaces in broken longitudinal lines, often seen as white (resin-plugged) pores; in our three species: plants mono-ecious, the male cones on the lower part of the canopy and the females on the upper; male cones finger-like, pendent, the microsporophylls with a flattened to domed ovate or subrhombic apex; female cones fist-sized, perhaps usually erect, the scales with a brown membranous wing on each side and an upturned apical projection and bearing a single seed on the upper surface, the tip of this [strictly, the tip of the ovuliferous scale] defined by a triangular flattened or slightly fleshy projection, the ligule; seed somewhat or strongly hard-shelled (*A. cunninghamii, A. heterophylla*) or not (*A. columnaris*); cotyledons four.

Distribution 18 species. New Guinea (*A. hunsteinii* klinki pine, *A. cunninghamii* var. *papuana*); eastern Australia (*A. cunninghamii* and *A. bidwillii*); New Caledonia (13 endemic spp., all in sect. *Eutacta*); Norfolk I. (*A. heterophylla*); South America, from Brazil to Chile and west Argentina (sect. *Araucana:* monkey puzzle and the similar *A. angustifolia*).

Identification
After the notes below there are four keys that deal respectively with features of the foliage and the male and female cones; see Figure 1.

As we have said, each species exhibits a change from juvenile to adult foliage, and even quite old trees (at least of hoop and Norfolk pines), and especially if shaded, may have only juvenile and semi-adult foliage on their lower branches. Also, because of the size of these trees it will often be necessary to identify them using shed branchlets, and until one gets one's eye in for the variation in foliage it is only the rare branchlet that falls bearing spent male cones that can be surely be taken as being fully adult in character. We have produced below two foliage keys; mostly the characters are of the "rather more developed in X than Y" sort, so identification is essentially a matter of cumulative probabilities.

We have found that one of the best distinctions lies in the leaf margin. This was realized long ago by the great Italian botanist Filippo Parlatore, founder of the Florence herbarium; in monographing *Araucaria* for De Candolle's Prodromus (1868) he noted for each species' adult leaves:

A. columnaris... margine vix scabriusculis
[hardly scabridulous]
A. cunninghamii ... margine leviusculis
[more or less smooth]
A. heterophylla ... margine serrulato-scabris
[serrulate-scabrid]

Use of the marginal projections does have its drawbacks though: they are minute and x10 magnification is only just sufficient for their appreciation; they tend to be eroded from the older leaves; they are absent from juvenile foliage, so the almost entire-margined and rather narrow adult leaves of hoop pine cannot on this basis alone be distinguished from the similarly narrow semi-juvenile leaves of the other two species. There is of course the expected variability even around Auckland, and we know of one old Cook's pine tree (Western Park) where the marginal projections are almost as prominent as in a Norfolk pine.

In his revision of *Agathis* Whitmore (1980) promotes the microsporophylls (scales of the male cone) as giving the best specific characters, and, noting that old male cones persist for a long time on the soil

surface, asserts in Cornerian fashion that "the enquiring botanist needs but to seek below his feet for the evidence". This is true enough for our araucarias, and not only for the male cones (or male botanists); even though the megasporophylls (scales of the female cone) are winged and the trees tall it is rare that a few old ones cannot be located near the tree producing them. In fact, in *Araucaria* the female cone and the seed provide even more distinctions than the male cone does, as was realized, again long ago, by William Hooker (1852).

Foliage Keys

A. "Juvenile foliage", i.e. leaves rather awl-like, being laterally flattened and 4-edged (with a pair of lateral ridges as well as an upper and lower edge), thus each side of the blade having a lower half and an upper half.

Leaves relatively stiff and pungently spiny, in the most juvenile state patent and hardly curved; stomata almost as plentiful along the lower halves of the blade as along the upper halves; cotyledons c. 1.5-2 mm wide ..... **A. cunninghamii**

Leaves soft to touch (at least in seedlings, stiffer in semi-juvenile foliage of older plants), even in the most juvenile state somewhat falcate; stomata (at least in *A. heterophylla)* predominantly along the upper halves of the blade

Cotyledons 1-1.6 mm wide ..... **A. columnaris**

Cotyledons 2.5-5 mm wide ..... **A. heterophylla**

B. "Adult foliage", i.e. leaves relatively scale-like

Leaves relatively stiff and pungent; stomata on lower surface (and on upper surface too) reaching almost to apex but arranged in relatively few longitudinal lines (c. 10-20 lines at midway along leaf); leaf narrow-triangular to lanceolate, usually at least 3x as long as wide; margin at x20 slightly undulate or with a few projections to c. 0.01 mm long ..... **A. cunninghamii**

Leaves more flexible and not pungent; stomata on lower surface not reaching much beyond halfway along leaf, on upper surface arranged in relatively numerous lines (c.20-40 lines at midway along leaf); leaf lanceolate to broadly ovate

Margin of leaf (x 20) with projections to c. 0.05(-0.08) mm long, these us. relatively few; lines of stomata hardly developed in distal half of upper surface; leaf sometimes only slightly longer than wide, to c. 3x as long as wide ..... **A. columnaris**

Margin of leaf (x 20) with projections to c. 0.08 mm long, these us. relatively numerous; upper surface lines of stomata hardly developed in distal third (or even half) of leaf; leaf usually at least 2.5x as long as wide ..... **A. heterophylla**

Cone Keys

A. Male cones

Head of microsporophyll relatively deeply and irregularly incised on margin (i.e., both serrate and fimbriate), relatively thin and in the spent cone spreading to give the cone a fluffy appearance; spent cone c. 1.8-2.2 cm diam..... **A. columnaris**

Head of microsporophyll with relatively fine marginal incisions (± fimbriate only), relatively thick and domed and not widely spreading in the spent cone

Spent cone c. 0.7 cm diam ..... **A. cunninghamii**

Spent cone c. 1.3-1.8 cm diam..... **A. heterophylla**

B. Female Cones

Scale (megasporophyll) c. 3.5 cm wide, wing relatively firm (not translucent); apical spine not recurved; ligule conspicuous as a subfleshy curved-triangular projection; seed relatively large and the seed coat very strong (2-4 mm thick) ..... **A. heterophylla**

Scale (megasporophyll) c. 2.5-3 cm wide, wing ± translucent, apical spine recurved (in the mature (shed) scale); ligule an inconspicuous submembranous flap, appressed except at its tip

Apex of scale without a strongly marked transverse ridge above the apical spine; seed coat of negligible thickness..... **A. columnaris**

Apex of scale with a strongly marked transverse ridge between the apical spine and the ligule (thus in face view the spine appearing to spring from the middle of a ridged and wrinkled subellipsoid face c. 12 mm long and 4 mm deep); seed coat quite strong, 1.5-2.0 mm thick ..... **A. cunninghamii**

Notes On The Species

A. columnaris (G.Forst.) Hook. Cook's pine, native to New Caledonia. As the epithet suggests, the older trees of this species have something of a columnar appearance. This is because, compared to those of the Norfolk pine, their main branches are relatively short and are also rather bushy, that is, the ultimate branchlets tend to project all around the branch rather than being 2-ranked.

What the specific epithet fails to suggest is that the trunk of this tree is generally a curved or at least a leaning one. Corner (1988) says that this is seen in the cultivated Malayan examples, and not only of the Cook's pine there but of its two relatives as well. Indeed, in Auckland there is a notable example of a leaning Norfolk pine, the very large one at the Manukau Road/Epsom Avenue corner. Nevertheless the curvature of the Cook's pine trunk is a very useful field character.

There is a single old *A. columnaris*, very tall and c. 80 cm dbh, in the lower part of Western Park, Ponsonby, which would date back one can suppose to the initial planting of the 1870s. The label of a specimen of it (ROG 5235, AK) suggests that on the opposite side of the valley here, on the slope below Auckland Girls Grammar School, there is another old Cook's pine, but that tree is in fact a poor example of a Norfolk pine.

The only other old *A. columnaris* we know of in the Auckland region are two in the Domain's araucaria grove, the larger being c. 90 cm dbh. Seeds can be found here germinating in the litter but there are no saplings or poles. On Kawau Island, on the headland on the south side of Mansion House Bay, are several young-mature trees (ROG 6961, AK), which just possibly could be naturalisations - the parent tree was not located but it would be curious if Grey had not tried Cook's pine among his many other ornamental and timber plantings.

Peter de Lange has pointed out to us that a fair proportion of the younger trees in the Mt Albert district are *A. columnaris*, for example two at the top (SE) corner of Unitec at Carrington Road, and another in "Rocket Park" at New North Road near Wairere Avenue. Perhaps the species has been promoted in the last decade or two by some local nursery, not quite truthfully, as a miniature Norfolk pine. (Fortunately for the dignity of the old school of one of the authors, the two young trees at its Alberton Avenue entrance are a well-matched, non-leaning pair of Norfolks).

Araucaria cunninghamii Ait. ex A.Cunn., hoop pine, native to Australia. We have seen few examples of this species in the city, and only two of these are old trees, one in Western Park by Ponsonby Road and the other in the "Monte Cecilia" property. The former, now very much in its last years though still making a few male and female cones, has puzzled many but its identification was obtained from Kew by Bob Cooper in 1964 (AK 103664).

Hoop pine gets its name from its coherent horizontal bands of hard rough bark which fall to persist on the forest floor. It has a distinctly Australian character in the rigidity and spininess of its leaves, even at the seedling stage (as noted by Graeme Platt on AK 235525); one can easily injure oneself when handling juvenile foliage (e.g., of the small tree at the south end of the Domain duckpond).

It is curious that there are no large old trees of hoop pine in the Domain's araucaria grove - an indication perhaps that this almost-tropical tree is not competitive in New Zealand. A fair-sized old specimen stands by Mansion House on Kawau Island. There are also three very fine trees in the Tauranga Boys High School grounds. The two nearest to Cameron Road (for some reason Burstall and Sale (1984) illustrate and talk about the site as if there were only a single tree here) have the characteristic bunched adult foliage, while the third tree, some way to the south, is equally large but is shaded by other large trees and is entirely juvenile.

A. heterophylla (Salisb.) Franco Norfolk pine, native to Norfolk Island. We New Zealanders have taken this tree to our hearts and homes, though it is rather surprising to see how many are still being planted on ever-smaller suburban sections. It does give a very satisfactory amount of shade and a non-irritant leaf litter and so is almost as suitable as radiata pine for parks and beachfront plantings; in the latter situation in the country it is planted at least as far south as Kaikoura.

The ultimate branchlets of Norfolk pine can be much larger than those of the other two species (to c. 85 x 1.7 cm), but particularly where these branchlets themselves branch distally, perhaps after being damaged, they may be much shorter and more slender, when they could easily be mistaken as coming from a Cook's pine.

The seed-coat of this species is very thick and strong, and we speculate that predation by the Norfolk Island parrot, a (now-extinct) large-beaked relative of our kaka, might have been the selective factor here.

At the right time of the year (September at least) fertile seed can be found beneath Auckland's Norfolk pines, but there is a complete lack of seedlings in such situations; one never finds them in overgrown shrubberies, old cracking masonry or in any of the other traditional hunting grounds. There are though three AK collections of wild plants, all being of seedlings coming up at the rear of beaches (Bay of Islands, Motuihe and Motutapu). Of course, abrasion is often a factor in helping seed to germinate but we doubt that this is so in the Norfolk pine, having found that seed gathered fresh off a Mt Albert lawn germinates copiously after several weeks in compost in a warm place. (We have also found that the corky head of the cone scale, which can be easily detached from the seed, acts to allow the scale to float, and that seedling germination will occur in fair quantity even after 10 days floating of the scale in seawater). Perhaps other factors, such as soil temperature or predation by slugs, snails and rats of the seedlings, are involved in the naturalisation of the species. At any rate, we botanists at least should take pride in the young forest of Norfolk pines now growing up to embellish the sandy waist of Motuihe Island (de Lange & Crowcroft 1999) - their vigour and beauty make an outstanding authentication of our Gondwanan subtropicality.

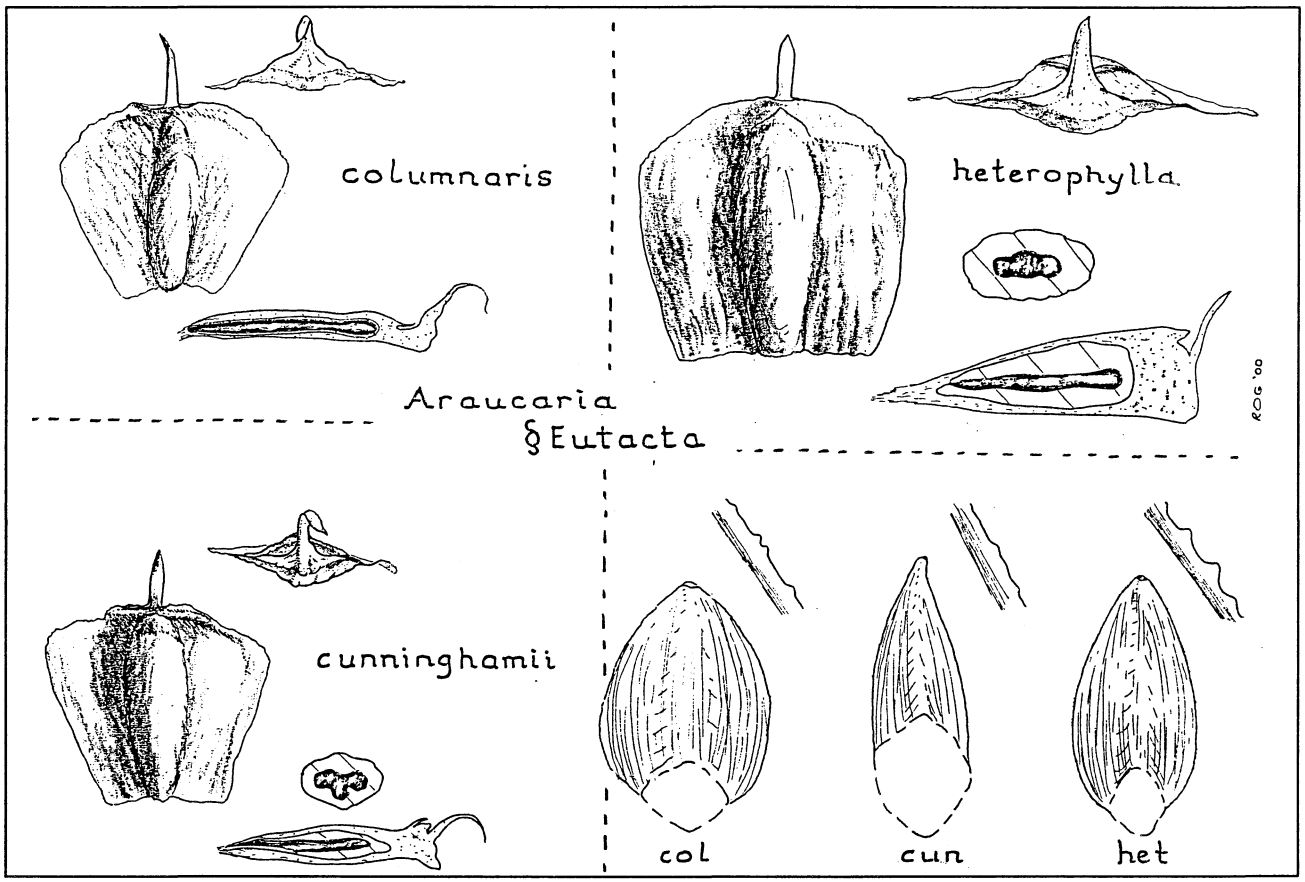

Figure 1 Female cone scales: upper (seed-bearing) side, and face view; x 0.9
Adult leaves (x c.7) with margin magnified (x c.70).

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