

OCEANIC ARBORICULTURE AT THE MARGINS—THE  
CASE OF THE *KARAKA* (*CORYNOCARPUS LAEVIGATUS*) IN  
AOTEAROA

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In relation to plants, the story of the transition from foraging to food production is usually told from an agricultural perspective. As examples, the narrative draws on the evidence of morphological changes that have been set in motion by the cultivation of cereals and legumes, especially in “centres” such as the Middle East and East Asia. The phenotypic changes affecting heads of grains and pods of legumes are treated as indicators of “domestication”. Many definitions exist for this term, but the following is widely used by agronomists: “the continuing, human-controlled, evolutionary process of the modification of the genotype that has been operative since cultivation began” (Evans 1993:63). The subsequent importance of the complex stratified societies (“civilisations”) that emerged in these centres of domestication provides an unspoken justification for this regional focus. Because the crops lent themselves eventually to mass production and mechanisation, agriculture in the sense of mixed farming combining cereal cropping and stock raising is treated as the most significant form of food production of the past ten millennia.

The Middle Eastern/European agricultural tradition eventually encompassed additional food production systems, which instead of operating in fields, were confined to specific enclosures in close proximity to homesteads and settlements— we know these as gardens and orchards. As yet, the vegetable and fruit species that required such enclosure and intensive cultivation have not been found in domesticated forms in Neolithic food residues. Instead species such as garlic, lettuce, olives and grapes first appear in the Middle East in the Chalcolithic and Early Bronze Age (Fall *et al.* 1998, Leach 1982). The distinctive morphological changes that allow cereals and legumes to be recognised as domesticates are not necessarily present in garden and orchard plants. The manifestations of biological domestication vary according to the type of selection that occurs and to the part of the plant that is selected. For example selection for fleshier or sweeter-tasting fruit will not necessarily alter the morphology of any seeds that survive in archaeological deposits.

Thus phenotypic changes may not be as visible in garden vegetables or orchard fruits as in cereals, and this may impair our ability to recognise the presence of these food production systems at earlier periods or among groups categorised as hunter-gatherers. However, such changes are not the only clue to cultivation: the appearance of a species outside of its natural distribution range is often just as important an indicator of human intervention.

This article examines domestication in another region, Oceania, where cereal agriculture made little progress (until the arrival of European farmers) and where tree and root crops were domesticated many millennia before their first appearance in Eurasia. Our focus is on arboriculture. We trace its progress eastward to Polynesia, before examining the case of Aotearoa, where in response to the loss of important tropical tree crops Māori began to select and plant elements of the endemic flora, notably the *karaka* (*Corynocarpus laevigatus*).

#### OCEANIC ARBORICULTURE

The global importance of agriculture today, coupled with the late appearance in the West of horticulture (practiced in gardens) and arboriculture (in orchards), has led to an underestimation of the potential antiquity and roles these systems may have played in non-Western settings. For many years, researchers were unwilling to recognise that the cultivation of root crops in Oceania with techniques and tools that are more typical of gardening than farming was not agriculture. This was rather more than a semantic issue. The 18th century voyagers had commented favourably on the large, highly maintained gardens and plantations they saw in Tahiti and New Zealand; however 19th century observers reclassified these as components of primitive agriculture, requiring “improvement” (Leach 1997). In the 20th century, the adoption of Boserup’s influential model of food production saw gardening rank as pre-agricultural (Leach 1999).

Oceanic arboriculture, also referred to as agroforestry, fared even worse, even though it may have constituted a separate class of subsistence economy in Island Southeast Asia and Near Oceania (Latinis 2000), or was the intended end point of land use sequences that began with gardening (Kennedy and Clarke 2004:1-5). Aborigines’ influence on the composition of plant communities in northeastern Australia, in particular fruit- and rhizome-bearing taxa, was largely ignored while they were categorised as hunters and gatherers (Hynes and Chase 1982:38). Because no European-style orchard enclosures or mono-crop plantations were evident in the Pacific, the extent and importance of tree cropping in Oceanic production systems were underestimated by European observers. In Tahiti, food and fibre-producing

trees growing in house gardens were described, together with the more obvious coastal “plantations” dominated by economically valuable species such as coconuts and breadfruit (Lepofsky 1994). But most observers failed to see the extent of tree cropping in valleys and on wooded hillsides, mistakenly assuming the trees growing in the interior of many islands were all “wild” or “natural”. Early botanists were quick to note the presence of domesticated species such as bananas and breadfruit that were seedless, but seldom saw the cultivation practices applied to morphologically “wild” species in bush swiddens or along interior paths.

#### ARBORICULTURE IN MELANESIA

The ethnobotanist Doug Yen revealed the true extent of arboriculture in his landmark study of tree cropping in the Santa Cruz Islands, east of the main Solomon chain (Yen 1974). Tree species that the ethnobotanist Jacques Barrau had previously considered to be wild or naturalised sources from which fruits or nuts were “gathered” were found by Yen frequently to be cultivated and harvested. Yen confined his study of cultivated trees to “those species for which there is evidence of purposive seed-raising, the transplanting of naturally germinated seedlings or reproduction by the planting of vegetative cuttings” (Yen 1974:251). These cultivation practices did not all have to take place in village gardens or bush swiddens. They could occur beside tracks or on the sites of old villages. By concentrating on the 25 species for which there was evidence of cultivation, he sidelined the difficult question of which taxa were “domesticated”. A cultivated species need not show any obvious morphological difference from its wild relatives. It may, however, taste less bitter, or be easier to digest, or require less processing. Today we might find that a genetic difference explains its superior qualities, and without controlled trials we cannot know how a particular species may respond morphologically to the improved growing conditions provided by cultivation.

In the case of three fruit-bearing species and two or three nut-bearers, Yen found that the Santa Cruz varieties were bigger than those on the larger Solomon Islands. He took this to be evidence of a greater degree of selection of planting stock by Santa Cruz cultivators (Yen 1974:278), and hence likely evidence of domestication. As for the bananas, there was no evidence that any *Musa* forms occurred wild on Santa Cruz, nor were any seeded fruits encountered—thus the genus fulfilled two major criteria of domestication: transportation by humans away from the area where the wild progenitor occurs, and loss of reproductive ability. But there were other useful tree taxa on the Santa Cruz Islands that existed both as wild and as cultivated specimens with no visible differences in fruit shape or size. Locals knew which were

better eating and transplanted their seedlings to village gardens. Yen found that the cultivators generally knew which species bred true to type and which required a separate pollinator. Though he could not extract more detailed concepts of selection from his informants, and considered that the process is “unconsciously applied” (Yen 1974:279), he nevertheless had metrical confirmation of larger sizes of several local Santa Cruz varieties.

In the case of nut-bearing trees, a consistent selection of the largest nuts for propagation might have led to this size increase, provided that the species were monoecious and self-compatible, and therefore capable of producing offspring like the parent tree. But in a fleshy fruit-bearing species, such as the “Otaheite” or *vi* apple (*Spondias dulcis*), the seeds are not the organ of interest and their size may bear no relationship to the thickness of the surrounding flesh. This is where the commonly reported Santa Cruz practice of transplanting seedlings rather than sowing seeds might permit directional selection, for seedling vigour is sometimes positively correlated with fertility (Crane and Lawrence 1952:164-65). Despite widespread cultivation in Santa Cruz, the fruit from cultivated *Spondias dulcis* overlapped in size with that from wild specimens, and the trees were “inseparable in appearance and dimension” (Yen 1974:264). In the Solomons and indeed most of Melanesia, Yen doubted that this tree was a “true domesticate”, being only occasionally gathered. However in Polynesia, beyond its natural range, the species was “undoubtedly a cultigen” (Yen 1974:265).

Although an increase in fruit/nut size relative to wild forms was not always a diagnostic trait of the cultivated trees of Santa Cruz, it nevertheless raised expectations among archaeologists that directional change might be evident in plant remains from archaeological sites in Melanesia. The finding of a large collection of anaerobically preserved seed and fruit remains (>10,000 items from 24 different taxa) from successive layers at the Lapita site of Talepakemalai provided an opportunity to investigate morphological change at one location through time (Lepofsky *et al.* 1998:1002). The statistical comparison included contemporary reference material from local cultivars, but not wild forms. Changes through time in three taxa were interpreted as the consequence of human “selection for larger cultivated fruits and nuts over the last three millennia” (Lepofsky *et al.* 1998:1013). However without consideration of the size range of the wild species, morphological variation might simply reflect the transfer of different varieties between islands, rather than *in situ* improvement. The difficult issue of which, if any, fruits/nuts might have been gathered from “wild” trees of strands and primary forest is not addressed. Lepofsky’s study of contemporary Mussau, Elouaua and Boliu Island arboriculture found that 26 species were cultivated in the extensive arboricultural zones. Several taxa also existed as volunteers, dispersed by

bats beyond the tree crop zones into the forest, or along the shore (Lepofsky 1992:197, 203). All forms of cultivation noted by Yen on Santa Cruz were also present in the Mussau Islands, including the weeding and protection of volunteer seedlings, transplanting of self-sown trees, the raising of selected seeds and vegetative reproduction. Given the gradient of practices, we should not expect a clear distinction between wild and cultivated on morphological grounds and instead accept that phenotypic differences are an uneven guide to domestication status.

#### ARBORICULTURE IN POLYNESIA

Beyond the natural range of the economically valuable tree species brought into (and allowed to slip out of) cultivation in Melanesia, the picture of Oceanic arboriculture becomes clearer. If an economic species of Melanesian or South East Asian origin was recorded by early botanists in Polynesia, i.e., outside of its natural range, notwithstanding whether it is now grown here or exists solely in a naturalised form, we may assume that at some point in its history it was cultivated; its presence testifies that it was selected for transportation (although we should not forget that “weeds”, or unwanted plants, were inadvertently included). There is little doubt that the Lapita colonisers travelled east with as many tree species as they did with root crops. However, for various temporal or cultural reasons, the long list of economic tree species of Near Oceania was reduced in size by the time that Central East Polynesia was reached. But this reduction in the number of cultivated tree species does not necessarily equate to a decline in the importance of arboriculture or in the extent of land devoted to tree crops. Prospects may be better for tracing the influence of human selection on the genotype of these transported species. Not only were they subject to constriction of the gene pool, but opportunities for genetic introgression from non-cultivated “wild” forms (Yen 1991:563, 1995:844) were no longer present.

Among the edible tree species, East Polynesians in the central island groups concentrated their attention on the coconut (*Cocos nucifera*), bananas (of both *Eumusa* and *Australimusa* types), *tī* (*Cordyline fruticosa*), *Pandanus* spp, the breadfruit (*Artocarpus altilis*), the “Otaheite” or *vi* apple (*Spondias dulcis*), the Tahitian chestnut (*Inocarpus fagifer*) and the Malay or mountain apple (*Syzygium malaccensis*). In Tahiti in 1769, the botanist Daniel Solander (n.d.) drew particular attention to the number of edible varieties of *tī*, breadfruit and bananas, and to the eating qualities of the chestnut, the *vi* apple and mountain apple. In its transference eastwards, the breadfruit had been selected not for its edible seeds, but increasingly for its starchy flesh. This, coupled with its suitability for clonal reproduction, led to a proliferation of largely

parthenocarpic seedless forms in East Polynesia (Ragone 2001, Yen 1985:316). The bananas were also dependent on vegetative reproduction, though their sterility was well established before they left Island Melanesia. The *tī* was so frequently grown from suckers, that it too was represented by increasing numbers of sterile varieties (Hinkle 2004). However, most of the other fruit- or nut-bearing trees were still able to be grown from seed or seedlings.

We can therefore safely assume that when the ancestors of the Māori left southeast Polynesia, they were familiar with propagation of tree species by seed and transplanted seedlings and were likely to have brought with them seeds of the *vi* apple and mountain apple, as well as chestnuts and coconuts. As in the Society Islands, these species were well established on Rarotonga, both in cultivated zones and naturalised in forested areas (Cheeseman 1903). Rather more important cargo would have been the suckers of bananas and breadfruit, the ceremonially important *tī*, and all the vegetatively propagated root crops. Fibre-producing plants probably included sterile varieties of *Pandanus* as well as the paper mulberry (*Broussonetia papyrifera*). Apart from the root crops, only the *tī* and paper mulberry survived to be recorded by the first European botanists to visit New Zealand. Arboriculture, despite its longer record in Oceania than arguably anywhere else in the world, had reached its nadir in Aotearoa.

This story of a steady decline in numbers of cultivated tree species through the course of settlement of the Pacific islands presents Polynesians as passive players accepting their losses. But such a characterisation ignores evidence of what has been referred to as “local domestications” within Polynesia. Yen believed that on Easter Island, the *titora* reed (*Scirpus riparius*) was transplanted into garden plots from the crater lakes, and that in Hawai‘i, “the endemic *Touchardia latifolia* was domesticated for its fibres in cordage manufacture” (Yen 1985:322, cf. Funk 1982). He went on to claim that in New Zealand selected forms of native flax (*Phormium tenax* and other species) were transplanted by Māori. In Yen’s opinion, the food-bearing native *tī* (*Cordyline australis*) and the *karaka* (*Corynocarpus laevigatus*) were also singled out for cultivation by the Māori. Yen concluded, “In an environment that was only marginally amenable to those tropical food plants introduced by the first New Zealanders..., a move towards domestication within the native flora is unsurprising” (Yen 1985:322).

In a later publication on the theme, Yen (1991:566) explained that he saw “the *control* of reproduction as the cardinal characteristic of domestication; the degree of control indicates the degree of domestication”. Comparing the range of husbandry practices applied to animals like the pig in New Guinea with the cultivation practices encountered in Melanesia, he emphasised the gradient stretching from plants and animals living in a wild state, to rearing/

raising (in which young plants or animals are brought in from the wild), to semi-domestication (in which fertilisation involves one wild parent), and ultimately to domestication (in which humans control reproduction) (Yen 1991:567). If Yen is correct that Māori were moving towards domestication of local flora, how far along this gradient had they progressed?

Cultivated *Cordyline* species have been the subject of recent investigations. In his book on the ethnobotany of the cabbage tree, Simpson (2000:144) listed six names of Māori cultivars, drawing on earlier descriptions of cultivated forms made by William Colenso and Elsdon Best. He stated that *tī para* (synonymous with *tī tawhiti* and *tī towhiti*) was a non-flowering selection of the New Zealand native species *Cordyline australis*, developed for its enlarged rhizome. However, in an endnote he reported that microscopically this affinity has not been supported (Simpson 2000:306). Although links between Colenso's provisionally named *Cordyline edulis*, which appears to have been the *tī tawhiti*, and the surviving sterile form *Cordyline* 'Thomas Kirk' have been convincingly argued by Warwick Harris and Peter Heenan (1991), much remains to be discovered about the identities of Māori *Cordyline* cultivars. Genetic analyses may provide new insights.

#### THE CASE OF KARAKA

Our aim here is to explore Yen's contention that the *karaka* (*Corynocarpus laevigatus*) was also under cultivation by the Māori. *Karaka* is endemic to the New Zealand region and is found in coastal and lowland forests of the North and South Islands as well as the Chatham and Kermadec Islands (Wagstaff and Dawson 2000:134). It is a handsome tree, growing to 18 m in height with large, dark green leaves. The fruit is variable in size, ranging between 2-5 cm in length. The mesocarp is orange and fleshy with a distinctive sweet smell when ripe. A fibrous endocarp surrounds the large elliptical seed, which is poisonous in its raw state, containing the toxic glucoside karakin (Allan 1961:407, Bell 1974:328-29).

While *karaka* may have had some ceremonial use (Laing and Blackwell 1940:249) and may also have served as *tohu* 'landmarks' (Owen Wilkes, pers. comm.), it was of most value to Māori for its large seeds. Once the toxin was destroyed through steaming and soaking, these were an important food source. Colenso regarded *karaka* as:

...of inestimable value to the Maori as a common and useful article of vegetable food, second only in place to their prized kumara tuber; and I should have placed it before the fern root, only it is not so common, being confined to the vicinity of the sea... (Colenso 1880:25-26).

Along with *karaka*, Colenso (1868:347) listed *tawa* (*Beilschmiedia tawa*), *hīnau* (*Elaeocarpus dentatus*), fern root (*Pteridium esculentum*) and *pu(w)ha* (*Sonchus* spp.) as the most important of the New Zealand endemic plant foods. Similarly, Best (1942:36-53,68-86) put *hīnau*, *tawa*, *karaka*, *tutu* (*Coriaria* spp.), *raupō* (*Typha orientalis*) and fern root as highest in importance. Thomson (1859:152) gave fern root, *karaka* and *hīnau*. On the Chatham Islands, the absence of *kūmara* ‘sweet potato’ meant that *karaka* might have assumed even greater value than on the mainland. Skinner and Baucke (1928) listed *karaka*, fern root and *mamaku* (*Cyathea medullaris*) as the staple plant foods.

With an array of indigenous species available in New Zealand, what attributes made *karaka* a potential candidate for cultivation or domestication? Given that Māori and their ancestors were familiar with fruit and nut producing tree crops, *karaka*, bearing copious quantities of large, bright orange fruit, would have been immediately attractive. The flesh surrounding the fruit is relatively tasty in its raw state, and the processed seed is very nutritious. Trees are capable of producing fruit from around ten years of age or earlier (Molloy 1990:52) and the large seeds germinate readily and produce vigorous seedlings.

#### EVIDENCE FOR CULTIVATION AND TRANSLOCATION OF *KARAKA*

*Karaka* figures prominently in many Māori histories. For instance, in the early canoe traditions, migrants from the Aotea, Nukutere, Takitimu, Kurahaupo and Rangimata *waka* are said to have planted *karaka* at Aotea Harbour, Waioeaka, Mahia, Nuhaka and the Chatham Island north coast respectively (Anderson 2000:150-55, Best 1972:686, Shand 1896:26, White 1888:180). Later tribal traditions also tell of the translocation of *karaka*. For example, Kai Tahu traditions state that their ancestors “brought this tree [*karaka*] from the North Island to Kaikoura [where] it flourishes but very few trees of it are further south” (Beattie 1994:302).

Colenso, despite listing *karaka* as a wild food source, believed it was often cultivated as it was frequently found growing around old settlements and gardens. This observation is supported by more specific references:

Te Waiwhakaate was a pa on Kakepuku...below pa are karaka trees planted by Te Maungariri...[there is a] pa which belonged to Tuhua, fortifications can still be seen....karaka trees on it were planted by Tuhua....these were all kainga at the [Mt] Titiraupeka end of the Pouakani block: Whatapo, Te Weraroa, Pakaraka (where the ancestor of Ha planted a karaka from Kawhia)... (Native Land Court Minutes 1888a:264, 269, 198).

Elsewhere “plantations” of *karaka* are mentioned:

There is a kaka catching place at Mangakohekohe and a para reserve at Orohetakao, a similar one at Ngaurukehu; we also had karaka plantations when we lived there in large numbers and also at Waipawa... (Native Land Court Minutes 1888b:63)

Several authors have described the historic distribution of *karaka*. For example, Kirk described *karaka* as being:

... found on the Kermadec Islands and at the North Cape, whence it extends southwards to Cook Strait... and is found on nearly all the outlying islands both on the east and west coasts of the North Island, as well as in many inland localities. It is very rare in the South Island, being restricted to a few localities in the Nelson, Marlborough and Canterbury districts. In Nelson solitary trees are found near Collingwood and West Wanganui, but it occurs in some quantity on D’Urville Island. It is found sparingly in the lower parts of Queen Charlotte Sound and the Pelorus, in Marlborough; but in Canterbury it is confined to two or three localities on Banks Peninsula (Kirk 1889:173).

Cheeseman (1925:548) described *karaka* as abundant in coastal and lowland areas in the North Island and the Kermadec and Chatham Islands while in the South Island (Marlborough, Nelson to Banks Peninsula and Westland) he described it as very rare and local. On the west coast of the South Island, Townson (1907:391, 398, 407) reported only isolated groves from Cape Foulwind to Karamea and a few solitary trees on the banks of the Buller River—and these all in places with a history of Māori occupation. The similarity of these observations to the contemporary distribution (Figure 1) suggests that naturalisation and seed dispersal over the last 150 years has been limited (Stowe 2003:36).

While *karaka* have been moved by European gardeners, most mature examples growing outside of horticultural contexts can be argued to result from natural distribution or Māori translocation. How can one distinguish between them? As Stowe (2003) demonstrates, it is possible to define on climatic grounds the conditions under which *karaka* reproduce themselves in lowland forests. If Māori were moving and cultivating *karaka* both within and beyond the natural range, these specimens are likely to occur in association with archaeological sites. Specimens occurring in areas where climatic conditions were suitable for unaided reproduction, and where archaeological sites are absent, are more likely to be natural components of the vegetation.

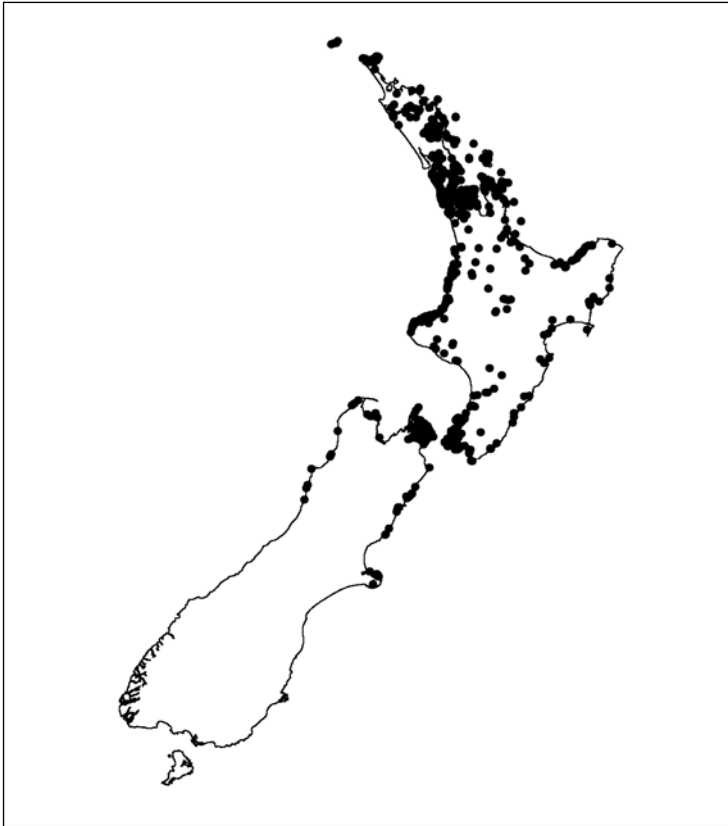


Figure 1: Location of *karaka* (*Corynocarpus laevigatus*) recorded on the New Zealand mainland and near-shore islands.

#### IDENTIFYING “NATURAL” AND “CULTURAL” *KARAKA*

To pursue this argument, spatial locations of *karaka* were collated and checked against a central database of archaeological sites provided by the New Zealand Archaeological Association. If a *karaka* tree was found to occur within 500m of an archaeological site, it was treated as potentially translocated and classified as “cultural”. If no association within this limit was found it was designated as of “natural” origin. Full details of methodology,

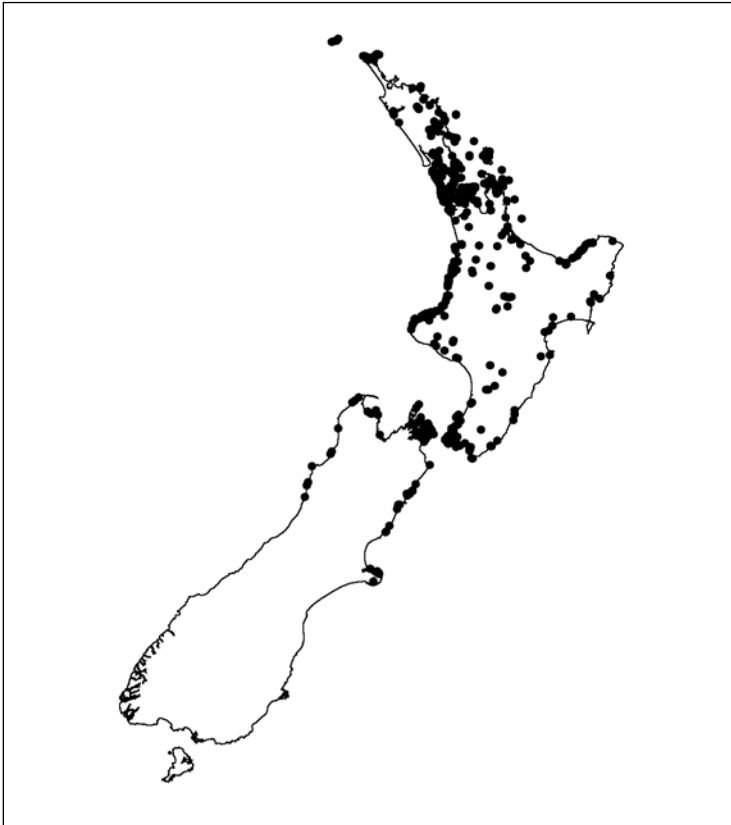


Figure 2: Location of “cultural” *karaka* on the New Zealand mainland and near-shore islands (“cultural” = trees growing < 500m from a registered archaeological site).

results and discussion can be found in Stowe (2003). Figures 2 and 3 show the New Zealand mainland and near-shore island distribution of “cultural” and “natural” *karaka* respectively. The greatest overlap between the two groups was in Northland and Auckland. The majority of trees on the North Island coast south of Bay of Plenty in the east and Waikato in the west were “cultural”. Trees in inland and/or upland areas such as Taupo and Waikato, as well as on the east and west coasts of the South Island, were also exclusively associated with archaeological sites.

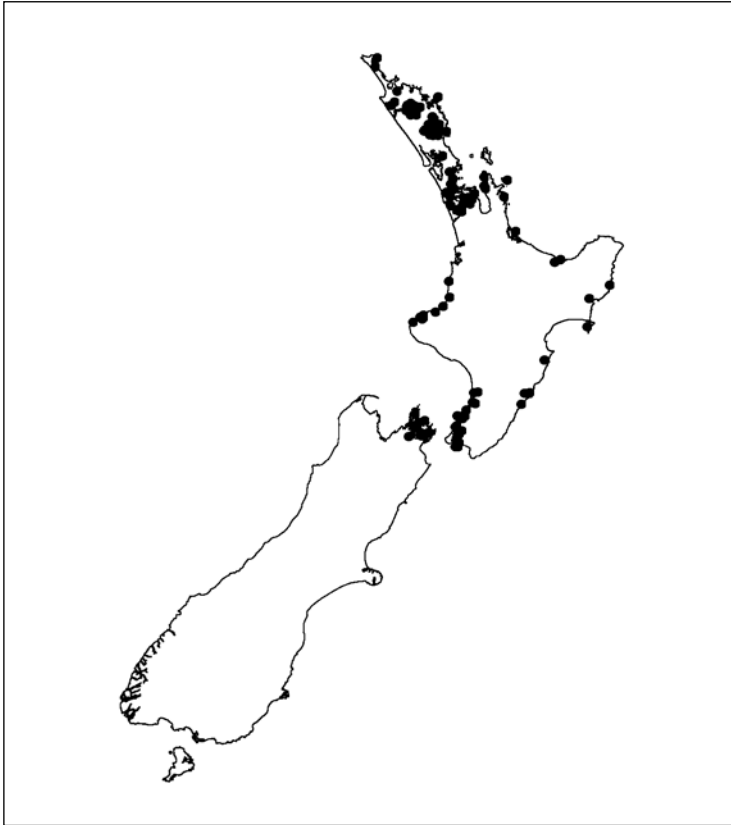


Figure 3: Location of “natural” *karaka* on the New Zealand mainland and near-shore islands (“natural”= trees growing > 500m from a registered archaeological site).

The majority of “cultural” occurrences of *karaka* (84%) were with one or a combination of *pā* (22%), midden (23%), terraces (21%) and pits (18%). *Karaka* are over-represented on *pā* sites in comparison to the frequency of *pā* in the archaeological database. The distribution of “cultural” *karaka* also strongly reflects the location, and limits, of *kūmara* production on the New Zealand mainland (Walton 2002). Further support for the widespread cultivation of *karaka* comes from occasional records of co-occurring species



Figure 4: “Cultural” *karaka* grove at the Panau Classic Māori village site (N36/72) on Banks Peninsula.

with ethnobotanical significance. Taro (*Colocasia esculenta*) was growing near presumed Māori plantings of *karaka* at Te Toto (coastal Waikato) and on Little Barrier Island. *Rengarenga* (*Arthropodium cirratum*) was recorded as present with *karaka* at Oaro in Kaikoura, and has been recorded in close proximity to *karaka* and habitation sites in coastal Wairarapa and Hawkes Bay (Harris and Te Whaiti 1996:274, 276, 280). *Rengarenga* is rare in these areas and may once have been cultivated by Māori (Colenso 1880:30). Additional species that could be considered unusual included *pōhutukawa* (*Metrosideros excelsa*), which co-occurred with *karaka* near terraces and *pā* at Lake Taupo, and *whau* (*Entelia arborescens*) that was found growing at the margins of its distribution with “cultural” *karaka* on *pā* sites in Taranaki and near middens at Kaihoka Inlet, northwestern South Island (Stowe 2003:50).

When climate estimates were fitted to the distribution data and the climate profiles compared (using a multivariate linear discriminant function), highly significant differences were found between what had been classified as “cultural” and “natural” *karaka*. “Cultural” trees were found on sites with greater solar radiation seasonality, greater atmospheric evaporative demands

and greater soil and atmospheric moisture deficits than “natural” trees. “Cultural” *karaka* also tended to occur in windier locations and closer to the coast than “natural” *karaka*. Discriminant analysis also provided another means of classification, with a combination of climate and spatial variables resulting in 85 percent of populations correctly grouped into either category, confirming the validity of the distinguishing criteria. In addition, most of the remaining “natural” trees in the lower North Island east coast, Wellington and Marlborough areas (see Figure 3) were reclassified as “cultural” based on the climate data.

Taken together, these results suggest that before human intervention, *karaka* was restricted to the northern North Island, with human cultivation and translocation extending its natural range to the lower North Island and the upper South Island (Molloy 1990:48-49, Stowe 2003). Population genetic or palynological investigations could provide further insight, as the following two recent studies show. While *karaka* is under-represented in pollen cores (Macphail and McQueen 1983), the first appearance of its pollen at two North Island sites (north Taranaki and Kaurenga Valley, Coromandel) was found to coincide with the onset of fires associated with Māori forest clearance (Byrami *et al.* 2002:521; Wilmshurst *et al.* 2004:11-12).

Similar evidence points to the human introduction of *karaka* to both the Kermadec and Chatham Islands. On the Kermadecs, *karaka* is locally common on the north side of Raoul Island and North and South Meyer Islands but rare or uncommon elsewhere (Sykes *et al.* 2000:101). Prehistoric archaeological sites are confined to the north and west coasts of Raoul (Johnson 1995:6, 98) and a number of probable Polynesian plant introductions also occur in this area: candlenut trees (*Aleurites moluccana*), *tī* (*Cordyline terminalis*) and *Oxalis corniculata*, a possible weed introduction (Sykes *et al.* 2000:104-5, 122-23, 152).

The same interplay between *karaka* and archaeological sites can be observed on islands in the Chatham group. On the northern half of Chatham Island (Rekohu), archaeological sites are common and *karaka* is abundant—often occurring in large, mono-specific groves (Simmons 1964:57, 64-67). Sparse groves were also recorded historically on the south west coast near The Horns and north along the coast to Point Durham and Waitangi (Begg 1977:18, 21-22). Conversely, *karaka* and archaeological evidence are both rare along the south coast. No fossilised wood identified as *karaka* has ever been found, and its pollen has only been found in surface sediments close to existing groves (Dallas Mildenhall, pers. comm.). On Pitt Island (Rangiauria) archaeological sites are fewer and found mainly on the east coast from Tupurangi south to Glory Bay. *Karaka* is correspondingly common only in 5-6 km of coastal

forest along the eastern coastline in the Hakepa area, with occasional groves to the south near the lowest reaches of the Waipaua catchment. Mangere and South East, two small islands less than 3 km from the coast of Rangiauria, were the focus of seasonal birding expeditions but were unlikely to have supported a permanent human population (Richards 1972:355, 370-71). *Karaka* is present in very small numbers on these islands but are thought to be contemporary introductions (Amanda Baird, pers. comm.).

#### A CASE FOR PARTIAL DOMESTICATION

The transplanting of a desirable species can be seen as a first step toward domestication as it requires conscious selection and cultivation. Equally it may point to more active manipulation of plant communities, but without any necessary intention to bring *karaka* to the same level of dependence as the transported tropical domesticates. Nevertheless, there is evidence that Māori were moving towards at least semi-domestication in their cultivation and manipulation of the *karaka*.

*Karaka* is gynodioecious, consisting of hermaphrodite individuals with perfect flowers and female individuals with pollenless flowers (Phil Garnock-Jones, pers. comm.). Such a breeding system has obvious implications for the productivity of *karaka* under cultivation. For example, the transplanting of a single seed provided no guarantee that any fruit would result if it turned out to be a female and there was no pollen source nearby. If it was hermaphrodite, fruit could still be produced but yields were likely to have been smaller as hermaphrodite trees appear to set less fruit than females (Phil Garnock-Jones, pers. comm.). However, the common practice by Māori of planting *karaka* in groves would have ensured that there were sufficient males in the population to provide pollen. Furthermore, once the trees were established in sufficient numbers, optimum fruit production could have been achieved by manipulating the sex ratio. It is unclear whether early Māori had knowledge of different sexes in relation to plants (see for example Beattie 1994:193-94), but it is possible that they knew what to do, i.e., under what conditions *karaka* produced good yields, without knowing why.

Similarly, changes in fruit morphology, nutrient content, or taste could have been achieved via human selection. While gynodioecy tends to promote out-crossing (fertilisation with pollen from another plant), a strategy of always selecting large seeds for cultivation or vigorous seedlings for transplanting could lead to directional changes in morphology or fecundity. There is some evidence for this with *karaka* growing on or near *pā* sites in Taranaki reportedly having larger fruit than those growing in natural stands (Platt 2003:29). One old tree growing on Okoki Pa, Taranaki, has seeds double

the size of “normal” *karaka*, and several trees around it in various stages of reverting to smaller seed size (Simpson 1994:16, 18-19). On the Chatham Islands, there are indications that *karaka* also bears larger fruit than on mainland New Zealand (Stowe 2003:23, 34). Selection may also have been in the direction of smaller stature and fruit. For example, the variety of *karaka* named *oturu*, said to have been planted at Patea by Kupe, was similar to ordinary *karaka* but of low growth and with smaller leaves and berries (Anderson 2000:150). Selection for these traits may seem unusual, but it is possible it made harvesting easier, or perhaps the fruits simply tasted better or were less toxic. This possibility reinforces the point made earlier that morphological changes may be an uneven guide to domestication. However, it is worth noting that one of the relatives of *karaka*, *Corynocarpus cribbeanus*, was historically cultivated on Santa Cruz in the Solomon Islands. This species also showed fruit size variability, with trees close to former village sites inland shedding extra-large, ovoid fruit, which apparently were a domesticated type (Yen 1974:265-66).

Selection for traits other than seed size, such as nutrition or taste, is also possible. Unfortunately, there is no comparative data on the nutritional value of presumed “cultural” and “natural” *karaka* kernels. However, there may be some regional variation in the food value of the flesh with higher lipids, protein, ash, carbohydrate and fibre levels found in fruits from the Chatham Islands and Orongorongo Valley (Wellington) compared to those from Auckland (Dijkgraaf 2002). While the kernel was of greater value to Māori, the fleshy pulp was also utilised (Colenso 1880:25, Kirk 1889:171). Skinner and Baucke (1928:367) wrote that on the Chatham Islands the pulp was considered “sweet and wholesome when eaten raw, or as dried into a flour and patted into cakes with bird fat or whale oil”.

Control of reproduction is another feature of domestication, with some plants (e.g., breadfruit in East Polynesia, and bananas) becoming totally dependent on human cultivation. Obviously, this is not the case for *karaka*, which is not parthenocarpic and has to be grown from seeds or seedlings. However, with trees taking possibly ten years to produce fruit, methods of inducing early yield may have been investigated. Interestingly, Colenso (1880:17) wrote of being informed by “an old priest (*tohunga*), the secret tabooed way to make a young *karaka* tree, on its being so transplanted, become fruitful”. How this was done was not recorded but ringing (removal of a narrow ring of bark) to encourage the formation of flower buds and the setting of fruit (Shewell-Cooper 1949:198-201), and manipulation of nutrients and other environmental factors are well-known methods for inducing early fruit production. In Stowe’s survey, several large *karaka* trees were observed

with bark strips removed vertically up the trunk. This may have had a similar effect to half-ringing formerly practised on reluctant fruit trees (Shewell-Cooper 1949:200).

\* \* \*

Polynesian migrants to Aotearoa compensated for the loss of some of their tropical tree crops by harvesting fruits and seeds from the native arboreal species they encountered. Archaeological and ethnohistorical evidence exists for widespread use of *karaka*, *hīnau* and *tawa* fruits. While the latter two continued to be harvested from the wild, the *karaka*, possibly less widespread in the pre-human landscape than either *hīnau* or *tawa*, was taken into cultivation. This increased its availability in geographic terms and its overall yield as a species. Drawing on their knowledge of arboriculture, Māori more than doubled the range of the *karaka* by transporting and sowing seed in new locations or by transplanting seedlings. They did this with sufficient planting stock to overcome the risk of having female trees without a pollinator.

Though transportation beyond the natural range is confirmed by this study, certain other indicators of domestication were not present—for example there was no loss of reproductive function, simply because the seed was the organ of interest to the cultivators. Little evidence exists for named varieties. However Platt (2003:29) found that some trees growing in association with *pā* sites had larger fruit than trees observed in natural forest associations. Stabilising a variety normally precedes its naming, but in an out-crossing species where genetic introgression from wild trees was a possibility in northern regions, only cloning ensures that like begets like. There is no evidence that Māori reproduced *karaka* vegetatively. But since it was the seed that was the object of “improvement”, the chances of maintaining improved forms were enhanced by selecting large seeds for propagation or by transplanting vigorous seedlings found growing beneath desirable trees. Having to wait up to ten years to see the effectiveness of the selection slowed down the process of “improvement”. Given the much shorter period of time that Māori had to work with *Corynocarpus laevigatus* compared to the occupants of Santa Cruz who were cultivating *C. cribbeanus* over millennia rather than centuries, it is not surprising that a group of named regional varieties had not emerged.

Where did the *karaka* fit in Doug Yen’s (1991) continuum from wild to domesticated? Māori simultaneously used wild *karaka*, while raising seedlings transplanted from the wild (step two). In some areas outside the natural range, they had moved on to the third step, semi-domestication, to the extent that partial control of reproduction may have been exercised in the

management of numbers of hermaphrodite and female trees in the planted grove. However, full control of reproduction (step four) in this gynodioecious species would have required the practice of cloning. We should not assume that given time *karaka* cloning would automatically have occurred. The domestication process does not inevitably lead to complete dependence on human intervention for successful reproduction. However, the survival of Polynesian gardening in Aotearoa against climatic odds suggests that a strong gardening tradition capable of absorbing new cultigens was in existence. Perception of the *karaka* as a garden species seems likely.

Some other native plants were not so resistant to reproductive control. The cloning of flax varieties (*Phormium* spp.) and varieties of *tī* (*Cordyline* spp.) was certainly practised and must count as a form of domestication. Attention should also be given to other potential local domesticates or semi-domesticates as sources of fibre, timber, cosmetics or adornment. Whether or not full domestication was reached in native tree species, the case for the continuation of Oceanic arboriculture in its most southern outpost is unquestionable.

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