The Domestication of New Zealand Plants

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Abstract

New Zealand plants have been mainly domesticated for their fibre and especially for their use as ornamentals. They have provided scant picking as food plants and as sources of pharmaceuticals. Maori needed to thoroughly explore the properties of native plants for they were essential to their traditional existence. Europeans were keen to use Maori knowledge of plants commercially and the fibre of harakeke-flax played a key role in the economy of New Zealand in the 19th and early 20th centuries. Just as keenly, Maori adopted plants introduced by the first European visitors for food and trade. European regard for ornamental plants led to plant collections made on Cook's first voyage being propagated and offered for sale as ornamental plants in England as early as 1776. Concerted effort to domesticate native plants for ornamental use started around 1920 and Leonard Cockayne played a key role in this. His work on the cultivation of native plants, his curiosity about their growth forms and physiology and his fascination about their propensity for hybridisation are all key ingredients for their domestication. Since Cockayne, many people have been involved in bringing native plants into cultivation. New Zealand and overseas horticulturists have had a keen eye for variant forms and chance hybrids of native plants and have been effective in propagating and marketing these to gardeners. Deliberate scientific plant breeding of native plants has been slower in its application. A special milestone was the hybridisation of *Leptospermum* cultivars discovered in the wild to produce novel bred varieties that was completed by Lammerts in California in the 1940s. The last 20 years has seen a more concerted effort to develop novel hybrids of native ornamental plants. For *Leptospermum* this has extended to hybrids with Australian species. There remains considerable potential for further hybridisation and selection of new cultivars from the resulting progeny. There is also potential in applying knowledge about genetic variation of the physiology of native plants to extend their range of garden use. For example, selecting to increase their cold hardiness would vastly increase their use in Europe. The impact of epidemics of pests and diseases on native plants points to selection of resistance to these as an important objective for the future. Of critical importance for future developments of their ornamental use and conservation is more information about the intraspecific genetic variation of native plants. Knowing about and retaining this variation is a key to realising further economic benefits from New Zealand's unique resource of native plants.

Domestication

Meanings of domestication include to naturalize and to bring under human control. In this paper I mainly restrict the term to bringing plants from the wild into cultivation, and there are several stages in this process.

First is recognition by people that a wild plant has properties useful to them as food, fibre for clothing or shelter, medicinal uses, or for their spiritual and cultural value. Use of plants for their ornamental properties fits into the category of spiritual and cultural value. It is this use that I will focus on.

An important motivation to cultivate is to bring plants close to where people live so that they are handy for harvesting. In the case where they are used as ornamentals it is bringing them where they can be readily seen. In cultivation, plants can be more readily protected from diseases and pests, and they can be managed to optimise the yield of their desirable product. Cultivating plants inevitably leads to learning about their growth and propagation. The cultivators of a domesticated plant pass on, information gathered in this way, from generation to generation.

Bringing a plant into cultivation often reveals genetic variants that do not survive the intense competition between plants in the wild. An astute cultivator will notice these variants and consider whether they have properties that enhance the desired use of the plant. The next step is to separately propagate a useful variant to provide a new cultivated variety or cultivar. It is important to remember that cultivars derived in this way are usually dependent upon cultivation for their survival.

Almost from the time people began to cultivate plants, hybrids have provided a rich source of new domesticated plants. Gathering of plants by humans and their disturbance to vegetation, particularly the cultivation of soil, brought genetically compatible species together and provided conditions where their hybrid-progeny could survive. Spontaneous hybrids between wild species of grass, notably wheat, rice and maize, provided carbohydrates suitable for human consumption that could be stored for long periods, and were a fundamental element in the progress of civilization.

Gregor Mendel's fundamental laws of heredity which form the basis of modern genetics and scientific plant

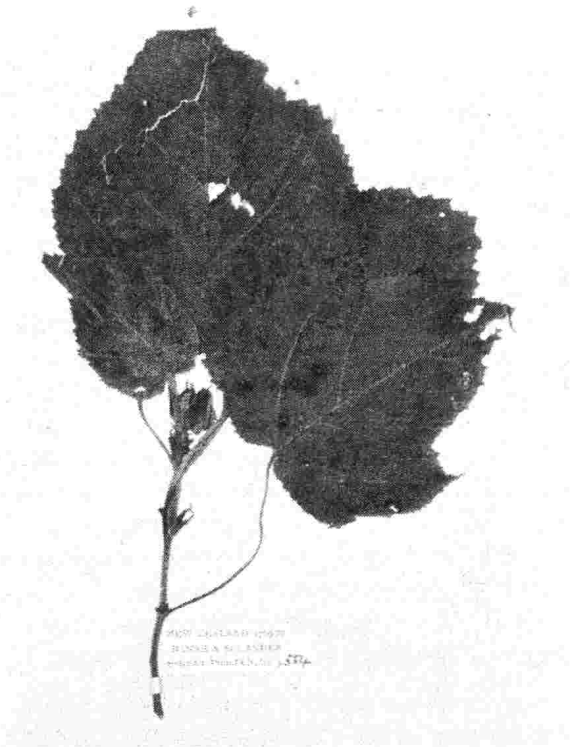
breeding were first published in 1865, but their importance was not recognised until 1900. Mendel's laws have been a powerful tool in the domestication of plants. In view of what comes later in this contribution, it is notable that Leonard Cockayne was advocating the application of scientific plant breeding to New Zealand phormium-flax as early as 1908.

Before we really got underway with the application of Mendelian genetics to the domestication of New Zealand plants we were confronted by the possibilities provided by knowledge of the structure of DNA put together by Crick & Watson in the early 1950s. From this, genetic engineering has developed, allowing the transfer of genes between organisms that cannot interbreed.

With the largely untapped potential for the further domestication of New Zealand plants by conventional scientific plant breeding, I see no immediate need to apply genetic engineering for their improvement. However it should not be overlooked that the New Zealand flora may contain unique genetic alleles that are useful for the further domestication of important economic crops.

An historical sequence is followed in this paper, but, as the story of the domestication of New Zealand plants is a long one, the paper will progressively focus on ornamentals, using *Leptospermum* as a particular example.

Fig.1
Herbarium specimen of aute (paper mulberry, Broussonetia papyrifera) introduced to New Zealand from the Pacific by Maori. It was collected in the Bay of Islands in 1769 in the course of Captain Cook's first voyage to New Zealand.



The Coming of the Maori

The ancestors of Maori brought the domesticated crops of their Pacific Island homelands with them in their ocean voyaging canoes when they came to settle in Aotearoa. Of these crops it is certain that five, the root crops *kumara, taro,* and *ti pore,* the gourd *hue,* and the paper mulberry, bark-cloth or tapa-tree *aute* (Fig. 1), were successfully established and were still in cultivation in the early period of European contact. The record for the yam, *uwhi,* is less certain.

Just as important in adapting plants for their purposes, early maori extended their knowledge of Pacific Island plants to the new but related plants they found in Aotearoa. A good example of this is the *kawa kawa* (*Macropiper excelsum*). The doubling of the name provides linguistic evidence that early Maori saw it as similar to *Piper,* the source of the narcotic drink *kava* of Pacific Islands.

As the introduced plants were acclimatised to tropical conditions and could be grown only in the warmest parts of Aotearoa, Maori had good reason to try and domesticate native plants. However, as food plants they provided scant pickings. Firstly, there are no native annual grasses. Annual grasses are the parents of the major cereal crops on which the great civilisations of the world were founded.

Secondly, without regular extended seasonal extremes of cold or drought, native plants do not need large underground storage organs to support survival during these stressful periods. Such storage organs provide carbohydrate that is fundamental to human nutrition. Instead, beyond where *kumara* could be grown, Maori were dependent on *aruhe,* the root of bracken, for most of their carbohydrate. Preparing *aruhe* was laborious and the prepared product was not particularly palatable. In a sense Maori domesticated bracken by encouraging its growth by burning, and there is evidence that they recognised stands of the species that provided the best *aruhe.*

Thirdly, in the absence of land mammals, and especially primates, it is suggested that there was no cause for native plants to evolve the large fleshy fruits that humans find delectable. In a sense early Maori had to get used to bird tucker, as the flesh of birds was for a while at least abundant, and Maori made good use of fruit that nature had designed to be distributed by birds.

The *karaka* stands out as the most notable of these fruits, and Maori domesticated this species, both by cultivating it and learning how to remove the toxins from its seeds before eating them. Associated with this domestication was the Maori tradition that *karaka* was introduced to Aotearoa as cargo of the ancestral ocean voyaging *waka.* Scientific evidence is that it is a native plant, distributed beyond its natural range in New Zealand when it was cultivated by Maori (Molloy 1990).

An even more remarkable story is the Maori domestication of cabbage tree, the *Cordyline* of botanists and the *ti* of Polynesians, as a food plant. They applied their knowledge of the Pacific *ti*, *Cordyline fruticosa*, which they introduced, to the native *Cordyline* species they found in Aotearoa. Beyond the harvesting of wild plants, several levels of domestication were applied to this group of species.

In the eastern South Island in particular, *Cordyline australis, ti kouka*, was coppiced on a 3 to 4 year rotation and the harvested stems steamed for 24 hours in large umu ti to produce the sweetener *kauru*. Steaming converted the carbohydrate fructan in the stems to very sweet fructose. Material processed in this way was stored dry until the time came to add it to fern root and other foods to improve their palatability.

Waikato Maori cultivated *ti rauriki*, the grass-like northern cabbage tree (*C. pumilio*) for the sweet carbohydrate of its rhizomes. Even more remarkable is *Cordyline* 'Ti Tawhiti', a dwarf non-flowering selection of *C. australis*, that was cultivated by Maori. This plant was the subject of an intense discussion amongst the leading botanists of New Zealand at a meeting of the Royal Society here in Wellington 100 years ago. It was saved from extinction because its dwarf form found favour with gardeners and it came to be known as *Cordyline* 'Kirkii' recording the interest Thomas Kirk had in the plant. Its origin as a Maori selection was forgotten until rediscovered in 1991 (Harris & Heenan 1991). The name 'Tawhiti' is equivalent to 'Hawaiki' and indicates the traditional belief that the plant was introduced to Aotearoa by the ancestral canoe of Maori. However, it is more probable that the name arose from it being moved around its native land as a domesticated plant.

Early Maori found an abundance of fibre to meet their needs for shelter, fuel, containers, weapons, fishing lines and nets and clothing. For their clothing needs they found a new plant genus, *Phormium*, that provided leaf strips that could be used for plaiting and dressed fibre for an indigenous style of weaving. The Maori names for this genus, *harakeke* and *whaririki*, record that they saw it as having the properties of both *fara (Pandanus)* and *kiekie (Freycinetia)* which are amongst the most important fibre plants of the Pacific Islands.

Maori domesticated *harakeke* plants with special fibre characteristics suited to a variety of weaving needs. The varieties they selected persist today and their domestication for weaving purposes continues. This activity is central to the cooperative evaluation of Maori weaving varieties that is being undertaken by the national Maori Weavers organization Te Roopu Raranga/Whatu Aotearoa and Manaaki Whenua Landcare Research (Fig. 2).

Much more could be said about the domestication of *Phormium*. It is important to note that *Phormium* fibre

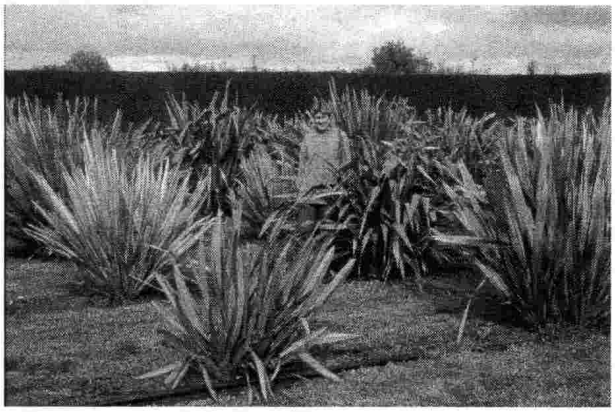


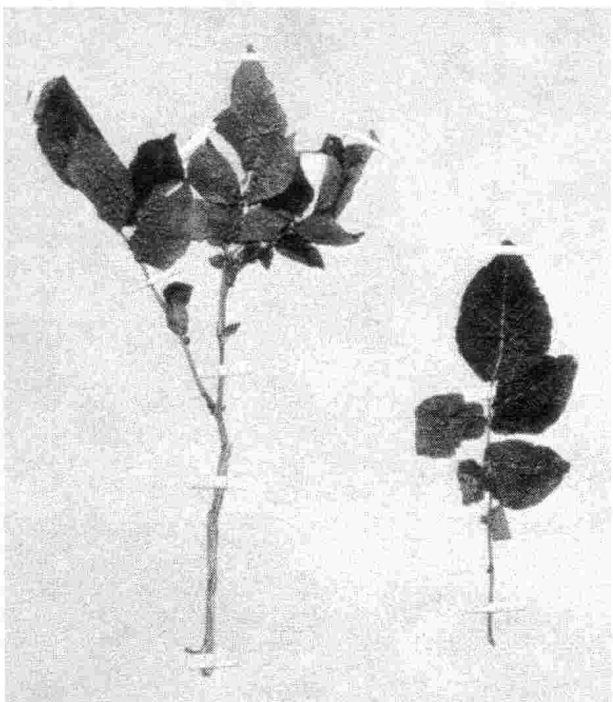
Fig. 2
Sue Scheele, leader of a research programme undertaken by Manaaki Whenua - Landcare Research and Maori weavers on the traditional uses of native plants, with Maori weaving varieties of harakeke (Phormium tenax) growing at Lincoln.

was for a time New Zealand's most important earner of overseas income. It also needs to be noted that Maori selected and cultivated variegated forms of *Phormium* for ornamental purposes. An example of this is the variety 'Parekoretawa' adopted for garden use under the name 'Radiance'.

The Coming of Cook

The early European explorers of New Zealand came on the lookout for raw materials and products of value to commerce and trade. This is reflected in Cook's account of his second voyage to New Zealand where he recorded that the most useful plants for future

Fig. 3
This herbarium specimen of potato (Solanum tuberosum), collected during Dumont D'Urville's exploration of Tasman Bay in 1827, provides one of the first records of crop plants Europeans introduced to New Zealand.



explorers would be harakeke for cordage, rimu for spruce beer and manuka for tea!

In turn, the early European explorers brought domesticated plants that were new to Maori. The most important of these proved to be the potato *(Solanum tuberosum)* (Fig. 3). It is important to remember that the Northern chief, Ruatara, was the first to make flour from wheat grown in this country. Maori quickly adopted potato as their major cultivated plant, further domesticated it for their own purposes, and were trading it in quantity by 1800. I suggest that those who claim that Maori had the potato before European do Maori a disservice. Had they had this plant, Tasman and Cook would have found the country more heavily and widely populated, and the course of the history of New Zealand would have been very different.

Fig. 4
Illustration of manuka (Leptospermum scoparium) made by Sydney Parkinson, artist on Captain Cook's first voyage to New Zealand. This species, initially included in the genus Philadelphus by the botanist on the voyage Daniel Solander, was grown as a garden plant in England within a decade of Cook's voyage.

Returning to ornamentals, New Zealand plants were brought into garden cultivation in England and Scotland within a decade of Cook's first visit in 1769. That they had also been subjected to varietal selection for garden use in this time is shown by entries for New Zealand tea or myrtle in the 1778 list of greenhouse plants offered by William Malcolm "Nurseryman and Seedman, Near Kennington Turnpike, Surry":

Philadelphus Aromaticus Latifolia	Broad-leaved Aromatic
Philadelphus Angustifolia	Narrow-leaved
Philadelphus Hirsutus	Hairy-leaved
Philadelphus Lucidus	Shining-leaved

Descriptions of *manuka* and *kanuka* in Solander's unpublished Primitae Florae Novae Zelandiae were named as *Philadelphus*. It is also on record that Robert Anderson of Edinburgh, sometime between 1776 and 1779 offered *Philadelphus aromaticus* for sale at the princely price of 7s 6d!

As a generalization it is safe to say that from Cook's time to the beginning of the 20th Century most of the further domestication of New Zealand plants was undertaken in Europe. A notable step was the first artificial hybrid to be raised between two New Zealand native species. This was *Hebe andersonii* 'Andersonii' now regarded as a hybrid between *Hebe stricta* var. *stricta* and *H. speciosa*. Isaac Anderson-Henry of Maryfield near Edinburgh, Scotland raised this hybrid in 1848 and its history is well researched by Peter Heenan (1994). The negative attitude to the use of native plants in the colonial gardens of New Zealand is made clear in Helen Leach's (1994) review of the history of gardening in New Zealand.

However ornamental use of New Zealand native plants in their home country was not entirely overlooked and Potts & Gray (1870) documented the cultivation of some of them in 1870. But it was not until the arrival of Leonard Cockayne that New Zealand plants had a high profile champion for their cultivation and structured domestication.

The Coming of Cockayne

We need to be grateful to Dr A. D.Thomson of the Centre for Studies on New Zealand Science History for the effort he has put into gathering and recording biographical information about Dr Leonard Cockayne. The brief coverage of Cockayne's key contributions to the domestication of New Zealand native plants that I give here is largely derived from his publications about Cockayne (Thomson 1978, 1982, 1983) and the archival records about Cockayne that he maintains.

My interest in Cockayne's work is biased towards his fascination with *Leptospermum*, his experimental work on the cold hardiness of New Zealand plants, and his involvement with promoting the use of New Zealand plants in gardens overseas. These are all subjects I am

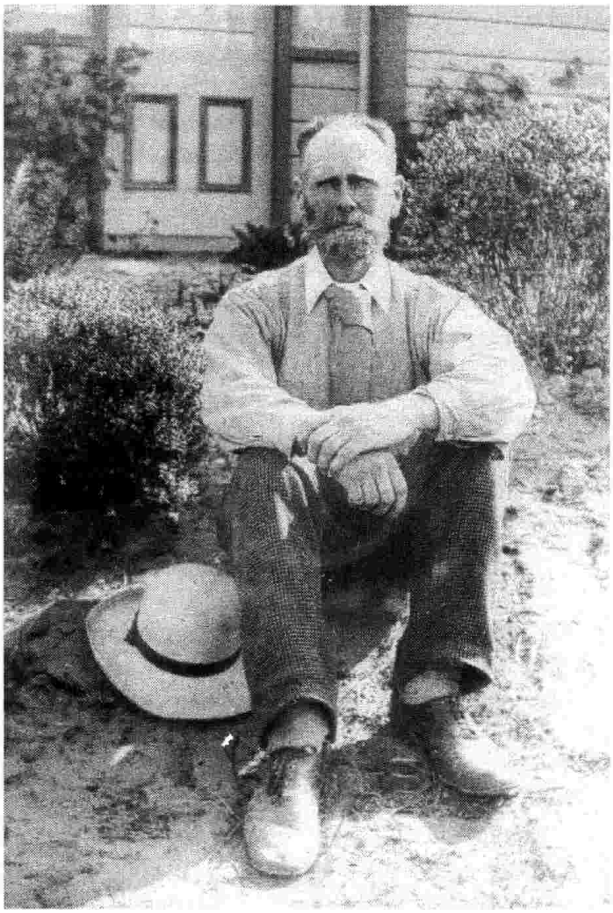


Fig. 5
Leonard Cockayne in the Tarata Experimental Garden at New Brighton, Christchurch. Cockayne lived there from 1892 to 1903, using the garden to study the taxonomy, ecology and cultivation of native plants.

involved with in my current research.

Cockayne came to New Zealand in 1881 at the age 25 and was a high school teacher in Otago for three years. An independent income from his father's will allowed him to purchase property at Styx in Canterbury in 1885 where he practiced horticulture. In 1892 he moved from Styx to establish his Tarata Experimental Garden at New Brighton, now a suburb of Christchurch, where he remained until 1903. At 'Tarata' Cockayne gathered plants from around the world and grew them together with native plants. During this time he built up his knowledge about the cultural requirements of native plants and variations in their form, no doubt with a keen eye for those variations that would be of interest to gardeners.

He gave up his garden 'Tarata' in 1903, and continued to live in Christchurch until 1914. The chronological course of his bibliography in the years 1903 to 1914 indicates that he traveled widely in New Zealand to study native plant communities and devoted a lot of time to writing. Much of this writing was to bring New Zealand plants to the attention of the general public. The foundations of his book 'New Zealand Plants and their Story', the first edition published in 1910, were in the form of a series of 10 articles published in the Lyttleton Times, the Dunedin Evening Star and the Auckland Star in 1906.

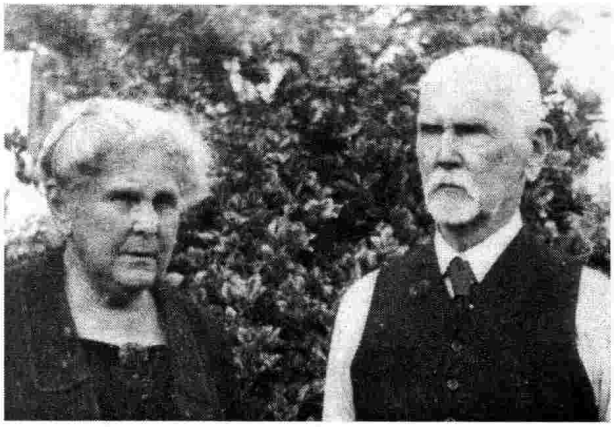


Fig. 6
Leonard and Maude Cockayne at Ngaio in 1932. Leonard Cockayne lived at Ngaio from 1917 until his death in 1934, during which time he was de facto Government Botanist

Cockayne moved to Wellington in 1914 and took up residence in Ngaio in 1917 where he lived until his death in 1934. During this time he was effectively the *defacto* Government Botanist, exercising significant national influence over the economic use and conservation of New Zealand plants and their communities. He continued to gather and cultivate native plants in his Ngaio garden although not on the scale he had practiced at 'Tarata'. Rather, his energies were applied to a considerable extent to the establishment of the Otari Open Air Native Plant Museum (now Otari Native Botanic Garden) in 1926.

Otari Native Botanic Garden

It is timely to reiterate the four subjects that were to be developed in the scheme for the Otari Garden. These follow the headings given by MacKenzie and Cockayne (1927) in their description of the purpose of the Otari Open Air Native-Plant Museum.

Fig. 7
Cockayne Heights at Otari Open Air Native-Plant Museum in the early years. Leonard Cockayne, who played the key role in defining the purpose of Otari, is probably the person on the right of the photo

The Flora. A collection of native plant species and their hybrids arranged in order of their taxonomic affinities and in regard to their life forms.

The Vegetation. Presentation of native plants in groupings representing native plant communities.

Horticulture. To show how New Zealand plants could be used in gardens.

Restoration of the original forest. To restore the forest remnant of Wilton's Bush to its original composition.

It is important that these purposes are not perverted to make the priority uses of Otari a pleasure garden and a place to express current vogues of landscape design and architecture with emphasis on visual experience and not the plants.

Cockayne's Contributions to Domestication

Having outlined Cockayne's horticultural history, with this as background it is useful to highlight the steps he took to domesticate New Zealand plants.

Taxonomy. By having a good knowledge of the taxonomy of New Zealand plants he was able to recognise new species when he encountered them, for instance the description of new species of *Astelia, Veronica* and *Celmisia* (Cockayne 1899).

Distribution and ecology. Cockayne had an extensive understanding of the distribution and ecology of native species in their natural communities and this was recorded in many publications culminating in 'The Vegetation of New Zealand' (Cockayne 1928). This knowledge was an important precursor to bringing native plants into cultivation.

Bringing plants into cultivation. Cockayne used his knowledge of native plants in the wild to actively bring species into cultivation and to record their suitability as garden plants. This work was brought together in the book 'The Cultivation of New Zealand Plants' (Cockayne 1924a).

Physiological basis of adaptation. Cockayne's first paper in a scientific journal was 'On the freezing of New Zealand alpine plants: notes of an experiment conducted in the freezing chamber, Lyttleton' (Cockayne 1898). This is a pioneering contribution in this field and shows he appreciated the importance of the physiological tolerances of plants in regard to both their ecology and successful cultivation.

Life-forms. Cockayne had a fascination with the life-forms of plants and particularly had an eye for the unusual and characters attractive to horticulturists. His first publication in an overseas journal provides a good example of this - 'On the sudden appearance of a new character in an individual of *Leptospermum scoparium*' (Cockayne 1907).

Popularization. Cockayne was very active in disseminating and popularising knowledge about native plants to the public to encourage them to value, conserve, and cultivate them. This was the main purpose of 'New Zealand Plants and their Story (1910) and the revised editions (1919, 1927).

Promoting overseas use. He promoted the use of New Zealand plants in the gardens of regions outside New Zealand, notably North America (Cockayne 1914a) and the British Isles (Cockayne 1924b).

Wild hybrids. Cockayne was skilled in discerning wild hybrids and meticulous in recording them. He emphasised the systematic and horticultural significance of these hybrids. Published in the year of his death, 'An annotated list of groups of wild hybrids in the New Zealand flora' (Cockayne & Allan 1934), is a classic paper in the annals of botany.

Scientific plant breeding. He advocated the application of scientific plant breeding to advance the domestication of plants as early as 1908. He specifically recommended that it should be applied to *Phormium* to improve flax fibre production. Cockayne's publications do not indicate that he made artificial hybrids, but his contemporaries and immediate successors in New Zealand botany certainly did. Allan (1926, 1929) published on F1 and F2 crosses of *Coprosma* and Allan & Zotov (1937) on an artificial cross of *Phormium tenax* and *P. cookianum*. There are a good number of more recent artificial hybrids reported.

Lammerts Leap Forward

Cockayne (1907) described the discovery in the wild of red-flowered manuka *Leptospermum* 'Nichollsii' near Kaiapoi, Canterbury, and later the discovery of a double-flowered white variant that was named L. 'Leonard Wilson' (Cockayne 1918). A colour illustration of L. 'Nichollsii' adorned the cover and provided the frontispiece for 'The Cultivation of New Zealand Plants' (Cockayne 1924a).

A significant step forward in the domestication of New Zealand plants for garden use came in 1939 when Dr W. E. Lammerts in California made a F1 cross that brought together the red-colour and double-petalled character. The F2 progeny of this cross provided a range of flower colours and degrees of doubling as well as variation in flower size, extent of flowering, and habit (Lammerts 1945). This unleashed the proliferation of ornamental cultivars of *Leptospermum*, which numbered 140 in 1991 and has increased considerably since.

Metcalf Milestones

With the proliferation of ornamental cultivars of native plants there was a need to keep track of them by the preparation of checklists. Lawrie Metcalf and the Nomenclature Committee of the Royal New Zealand

Institute of Horticulture began this in 1963 with a list of 76 cultivar names for *Leptospermum*. Peter Heenan has put together checklists for *Sophora*, *Cordyline* and *Phormium* since. A checklist of *Hebe* cultivars primarily compiled by Lawrie Metcalf is close to publication and will include near to 1000 valid names and synonyms. This work is critical to keep track of the progress of the domestication of New Zealand plants.

The first edition of Lawrie Metcalf's book *'The Cultivation of New Zealand Trees and Shrubs'* published in 1972 is an important milestone in the progress of domestication of New Zealand plants for garden use. In his introduction to the book he acknowledges the significance of Cockayne's *'The Cultivation of New Zealand Plants'*. It is important to remember that Cockayne covered the full gamut of trees, shrubs, climbers, herbs, grasses and ferns in a small book. Now we have a selection of books specifically dealing with these various categories of plants, and Metcalf's *The Cultivation of New Zealand Native Grasses'* published in 1998 is amongst the most recent of these.

A strength of *'The Cultivation of New Zealand Trees and Shrubs'* is that Metcalf used, and gave due acknowledgement to, plant taxonomic research and the consolidation of that in the Flora of New Zealand series. That he does not do this in the book on grass cultivation can be excused by the fact that *Volume V of the Flora Series on New Zealand Grasses*, written by Dr Elizabeth Edgar and Dr Henry Connor, was not published until January 2000.

Current Domestication of Native Plants

There is a lot happening currently towards the further domestication of native plants. I will not attempt to review this work here as I would inevitably overlook some important contributors and several of them are present at this conference. What is clear is that New Zealand nurserymen have a keen eye for variants of native plants. Where they have considered the variants would be of interest to gardeners they have been effective in propagating these, naming them for commercial purposes, and marketing them.

In recent years there has been a more scientifically structured approach to the breeding, selection and development of native plants for horticultural use, undertaken by people in different agencies. As the person on the platform I will give some examples of this from my own work, focussing on Leptospermum and aspects of this genus that would have fascinated Cockayne.

Hybrids

Cockayne and Allan speculated on the possibility of hybrids between manuka (*Leptospermum scoparium*) and kanuka (*L. ericoides*) (Cockayne & Allan 1934). In 1983 the Australian taxonomist Joy Thompson transferred kanuka to Kunzea lumping together in *K. ericoides* the Great Barrier Island endemic *L. sinclairii* and Australian plants formerly classified under *L. phylicoides* and other names.

Fig. 8
Kunzspermum hirakimata 'Karo Hobson Choice', the intergeneric hybrid between manuka (Leptospermum scoparium) and the Great Barrier Island endemic kanuka (Kunzea sinclairii).

While studying, within species variation of New Zealand manuka and kanuka, I came across a plant in a population of *Kunzea sinclairii* from Mt Hobson, Great Barrier Island that had characteristics intermediate between this species and *L. scoparium*. This has been confirmed as a sterile intergeneric hybrid and has been named *xKunzspermum hirakimata*. (Fig. 8). Anticipating this plant might be of interest to gardeners it has been given the cultivar name 'Karo Hobson Choice' (Harris 1993).

Cockayne & Allan (1934) noted as remarkable the occurrence of hybrids between New Zealand and Australian *Olearia* species in gardens in Scotland and New Zealand. In the course of studies of *Leptospermum* at Landcare Research, first a chance hybrid between two Australian species was discovered (Harris et al. 1995), and subsequently deliberate crosses were made between other Australian species. Plant variety rights have been taken out on three of these hybrids and these have been released as the commercial cultivars L. 'Karo Spectrobay', L. 'Karo Silver Ice' and L. 'Karo Pearl Star'.

Related to these studies at Landcare Research, Murray Dawson has produced hybrids between the Australian species *L. spectabile* and the *L. scoparium* cultivar 'Pink Lady'. Recently, crosses made by Crop & Food Research Institute have produced a new hybrid cultivar derived from *L. scoparium* and the Australian species *L. rotundifolium* and released as the Galaxy series. In the domestication of *Leptospermum* these interspecific hybrids rank in importance with the

discovery of red-flowered manuka and Lammert's F2 hybrid cultivars.

Cockayne was fascinated with plant form, and was especially intrigued by the variation and plasticity of manuka. It is a theme he returns to several times in New Zealand Plants and their Story (Cockayne 1910). An extreme form of habit variation is the marked change from a divaricate juvenile form to a non-divaricate adult form that is expressed by 11 New Zealand species. This is known as habit heteroblastism (Philipson 1964).

Another significant step in the ornamental diversification of *Leptospermum* was the development by Duncan & Davies, New Plymouth, of the 'Nanum' series of cultivars named after New Zealand birds. I have used these dwarf cultivars in crosses with Australian *Leptospermum* species, the first between *L.* 'Huia' and a small prostrate form of the Tasmanian subalpine species *L. rupestre*. From the progeny of this cross made in 1990 a dwarf-prostrate pink-flowered floriferous selection has been made that makes a very attractive pot or rockery plant. This plant has been given the name *L.* 'Lilliput' (Fig. 9), but it is slow growing and commercial propagators have not yet taken it up.

Fig. 9
Leptospermum 'Lilliput' a dwarf-prostrate pink flowered hybrid between a small prostrate form of the Tasmanian subalpine species L. rupestre and the nanum cultivar L. scoparium 'Huia'.

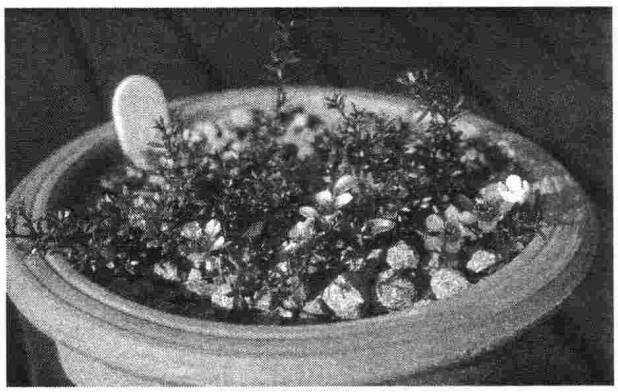


Fig. 10
An adult shoot arising from the nanum form of a hybrid between Leptospermum scoparium 'Kiwi' and the Australian species L. lanigerum. The adult shoot grew to overwhelm the nanum phase of the plant.

In 1993 I made a series of crosses of a range of Australian species using the erect red-flowered cultivar *L.* 'Donna' selected by Jack Hobbs and the dwarf 'Nanum' cultivar *L.* 'Kiwi' as the seed parents. The progeny of the 'Kiwi' crosses produced a proportion of dwarf plants similar to the seed parent. But unexpectedly, some of these dwarf plants have abruptly produced erect shoots that are similar to the pollen parent (Fig. 10). This has been most apparent in a cross using *L. lanigerum* as the pollen parent. In effect these plants are showing habit heteroblastism.

This characteristic has also been shown by the 'Nanum' cultivars, but has been dismissed as 'reversion'. The indication is that it is a genetically controlled character and that 'pure stable dwarf forms' could be selected. It also indicates that the plasticity of manuka in the wild that fascinated Cockayne has a definite genetic as well as an environmental component.

Cold hardiness and selection for use in overseas gardens

In promoting the use of New Zealand plants in the gardens of the British Isles and North America Cockayne was very mindful of their limited cold hardiness. In 1986 Luc Decourtye a leading French breeder of fruit trees and woody ornamental plants came to New Zealand seeking material to diversify the range of ornamental plants available in France. He focussed his attention on plants of the higher, inland parts of the South Island.

I provided Decourtye with seed from the collection of

Fig. 11
Luc Decourtye with New Zealand provenances of Hebe (foreground) and Leptospermum (background) under evaluation for cold hardiness at Angers, France.

provenances of *L. scoparium* from a wide latitudinal and altitudinal range in New Zealand that were then growing at Lincoln. Decourtye raised plants from this seed and grew the plants at three localities in France with contrasting winter temperature regimes (Fig. 11). This study showed marked variation of cold tolerance within *L. scoparium* that was related to the origin of the provenances (Harris and Decourtye 1991, Decourtye and Harris 1992). It showed that breeding and selection could markedly extend the range and reliability of use of New Zealand plants in the gardens of Europe and North America.

Essential oils

Extraction of economic products from New Zealand plants in sustainable systems has had a checkered history. Both the flax fibre and the *Solanum laciniatum* alkaloid solasodine industries came to an end through the combined effects of plant disease, undercutting by cheap third world labour, and substitution by synthetics.

However there is hope for an essential oil industry based on the New Zealand tea-trees especially from an East Coat manuka chemotype which has pharmacologically effective oils. Assays undertaken by the Plant Extracts Research Unit of Crop & Food Research, of the manuka and kanuka provenances from Australia and New Zealand that I assembled at Lincoln showed significant regional variation of essential oil content (Perry et al. 1997a, b).

I believe that for this sunrise industry to have a sustainable future there needs to be further domestication of these tea-trees by breeding, including interspecific hybrids, and selection for improved yield of the desired oil constituents. The undesirable alternative is an exploitative non-sustainable industry providing a product of unreliable quality.

Future Prospects for Domestication

Cockayne's contributions to New Zealand were built on his British heritage and particularly his knowledge of English gardening (Thomson 1983). These influences remained with him to his death. It is recorded that he said late in life that if he had his time over again he would have been a breeder of lilies! His first public lecture in New Zealand, given in 1892, was entitled 'The Daffodil'. It is recorded that at this lecture he recited Wordsworth's well-known poem 'Daffodils' that starts:

'I wander'd lonely as a cloud
That floats on high o'er vales and hills'

So if Cockayne could allow himself such poetic license so can I to introduce the points of this final section.

We wandered lonely in the cloud
That floats along as Aotearoa
Where all we saw were
Blighted manuka,
Yellowing harakeke, and
Declining cabbage trees -
Beside the pasture,
Beneath the Pinus radiata,
Faltering and dying
In the roaring fourties

Of course this is a very pessimistic outlook for the future, but in view of what has happened to native plants and their communities in recent decades, it could become true if we do not persist with remedial actions.

In looking to the future I make four points:

Pests and diseases. There is no doubt that our native species are becoming victims of new pests and diseases or are being grown in situations that make them more prone to old ones. Breeding and selection for resistance to these is a good option to overcome this problem. It may be necessary to look for resistance in related overseas species as has already been done for *Leptospermum*.

Conservation of alleles of genes. I have asked people if there are any plant genes endemic to New Zealand. The answer to this question is probably no, but there are likely to be many alleles of genes endemic to this country (alleles are alternative states of a gene, for example those determining variants of flower petal colour).

Our focus for plant conservation has been on saving rare and endangered species from extinction. Common widespread species are ignored in this respect. But it is very likely that these common species contain rare alleles prone to extinction.

Consequently it is important to conserve populations of widespread species that are representative of their full environmental range and genetic variation. That way we are more likely to retain the genetic building blocks needed for further domestication of native plants.

Domestication for restoration. An important theme of this conference is the restoration and management of native vegetation. Effectively this involves processes of domestication as native plants and their communities are being used to satisfy human needs and aspirations.

We have to accept that we can not return native vegetation to its primeval state. In the span of human affairs the primeval environment of New Zealand has been irreversibly changed - in fact it was never constant.

For example, phosphate fertilization has brought about widespread changes to our soils and native plants have difficulty in competing with plants that have evolved in phosphate rich soils. To save native plants in natural communities we will have to actively assist

their adaptation to these changed conditions.

The greatest economic value of native plants. In our review of the Domestication of the New Zealand Flora Peter Heenan and I concluded *"It is through their conservation in natural communities by long term support and further enhancement of the New Zealand parks and reserves systems, that New Zealand plants will have their greatest economic realisation."* (Harris & Heenan 1992).

Cockayne had expressed very similar opinions at the 1901 Conference of New Zealand Fruitgrowers and Horticulturists (Thomson 1978). To quote:

"The most valuable asset in our colony was the scenery, and if we destroyed our forests the scenery would be no longer an asset" and "....it was of as much importance to look after their native plants as the fruit industry".

To end, this one page publication of Cockayne's (1914b) that appeared in *The New Zealander* in 1914 speaks for itself:

The Bush a Priceless Possession

However little the average New Zealander may know about the plants of his country, few there are who cannot raise some enthusiasm regarding the "bush," as the forest is everywhere called. To old and young it is a delight - the stately trees; the birds, fearless of man; and above all, the wealth of ferns appeal to all. But that this forest is a unique production of nature, found in no other land, is not a matter of common knowledge, though truly it has many claims to be considered a priceless possession.

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