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Lilium "Capricorn". Photograph from the slide collection of the late Hugh Redgrove, QSM, AHRIH (NZ), now lodged at the Auckland Regional Botanic Gardens.

Back Cover Picture:
Selections of *Hebe* (see p.20). *Photographs* J. Hobbs.
Upper "Wiri Gem".
Middle "Wiri Mist" (*H. albicans* x (*H. diosmifolia* seedling).
Lower "Wiri Dawn".

The Eastwoodhill Arboretum: A Study of a Major Botanical Resource and its Horticultural Potential

Mrs M. B. MacKay
Department of Horticultural Science, Massey University

Introduction

Ornamental horticulture involves access to, and knowledge of, a wide range of ornamental plants which can be used in various applications in the landscape. The Eastwoodhill Arboretum, near Gisborne, contains the most significant collection of such plants in New Zealand and represents an invaluable resource for ornamental horticulture in this country.

The Arboretum of 50ha is situated 35km from Gisborne. It was created by the late William Douglas Cook in an area that was typically used for sheep and beef cattle farming. The countryside is steep and, when unplanted, is prone to erosion. Cook acquired the property in 1910, and began to import and plant trees from about the late 1920s onwards. He used mainly northern hemisphere material, imported largely from Hilliers Nursery in England, although material also came from Duncan and Davies in New Zealand, some other nurseries, and from private sources. The collection is now mature. This, plus its great diversity, make it the single most important collection in New Zealand.

The property was purchased in 1975 by Mr H. B. Williams of Gisborne, who later entrusted the Arboretum and formed the present administration, the Eastwoodhill Trust Board. When Mr Williams purchased the property the Arboretum had seriously deteriorated and the status of the collection was unknown. Under difficult circumstances of both finance and labour, clearing work began and initial information on the collection was formulated[1].

The author first became associated with the Arboretum in 1984. By this time a great deal of restoration work had been carried out and it was clear that an assessment of the collection was needed.

Objectives of the Study

The initial objective of this study was to map and catalogue the Eastwoodhill resource. This would;

1. Facilitate the restoration of the Arboretum.
2. Identify potentially important horticultural plants and target these for preservation and/or development.
3. Facilitate the development of the Arboretum as an educational and recreational park.

Method

1. *Maps*

Initially no accurate map of the Arboretum at any scale existed. A 50x50m grid (0.25ha per square) had been partially surveyed onto the property about 20 years ago and was still largely in existence over about half the Arboretum. The corners of the grid squares were marked by survey pegs. The existing pegs were located, and the positions of the missing nearby pegs calculated.

The areas that had the partial grid in place were surveyed first. Old records that indicated the contents of some of those squares were available and these were used to form a base plan for plotting.

The base plan for the portion of the Arboretum which was not covered by the grid pegs had to be produced by another method. By this time an accurate drawing of the property at a scale of about 1:2000 had been prepared from aerial photographs[2]. A reduced copy of this map is shown in Figure 3. The existing grid position was plotted onto this drawing, and then extrapolated to project the positions of the remaining pegs that had not been physically installed (See Figure 4). This drawing with grid (1:2000) was then expanded to 1:200 to provide a suitable scale for plotting the trees in the remaining parks.

The Arboretum was mapped park by park by the methods described above. The grid existed and was used for the first series of surveys which covered Pear Park, Corner Park, The Circus, Cabin Park (partially) and The Gardens. The aerial photograph and extrapolation method was used for Orchard Hill, Douglas Park, and Glen Douglas, which were the second series of surveys. The aerial photograph drawing was later used to check the first series of drawings for accuracy.

The plans show placement of trees and other relevant features such as fences, paths, ponds and buildings. The name of each tree and its reference number are shown. The grid squares are indicated on each sheet. The location, park, sheet number, and relation of that sheet to others are shown.

To obtain complete coverage of the Arboretum, 36 plan sheets are required. This covers the eight parks, with 167 full squares and 16 part squares. The scale of 1:200 was used to adequately show individual plants although in some areas, where the planting is particularly intense, a scale of 1:100 is more suitable.

2. *Catalogue*

The catalogue is the written companion to the maps and provides an alphabetical listing by tree genera.

As each park was mapped an alphabetical listing of trees was extracted from each grid square and inserted into the master list, location and other data being carried with each entry. As the master list (that which was to become the catalogue) was formulated, it was checked against the existing information[1].

Each entry indicates tree location, source, date obtained, and identification status. The coding for each entry indicates whether or not the identity of each tree has been confirmed, and by whom. Thus the status of each tree is known and can be debated if appropriate.

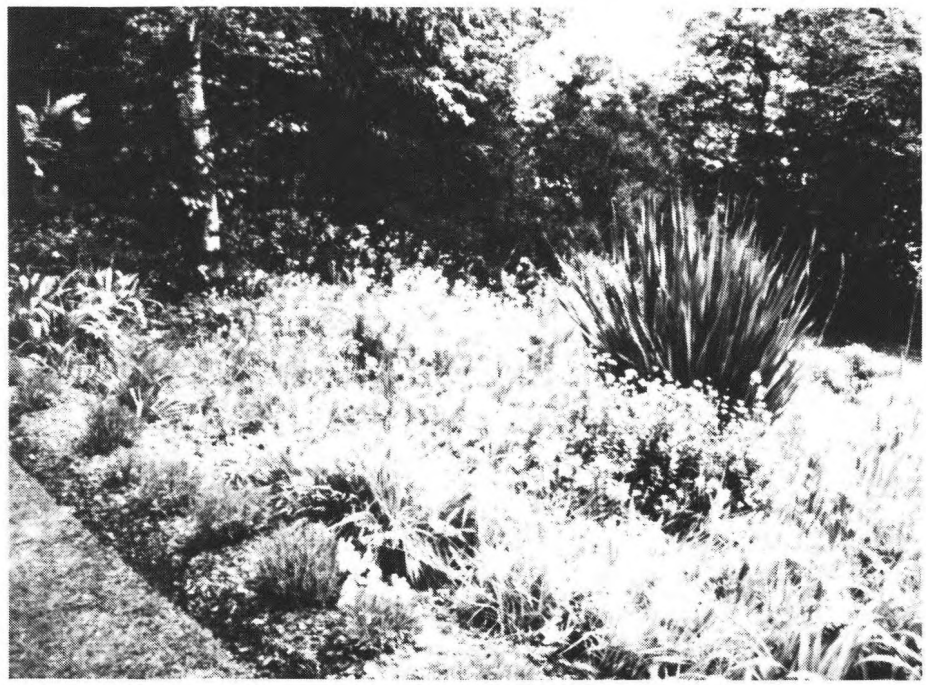

Fig. 1 A bed planting.

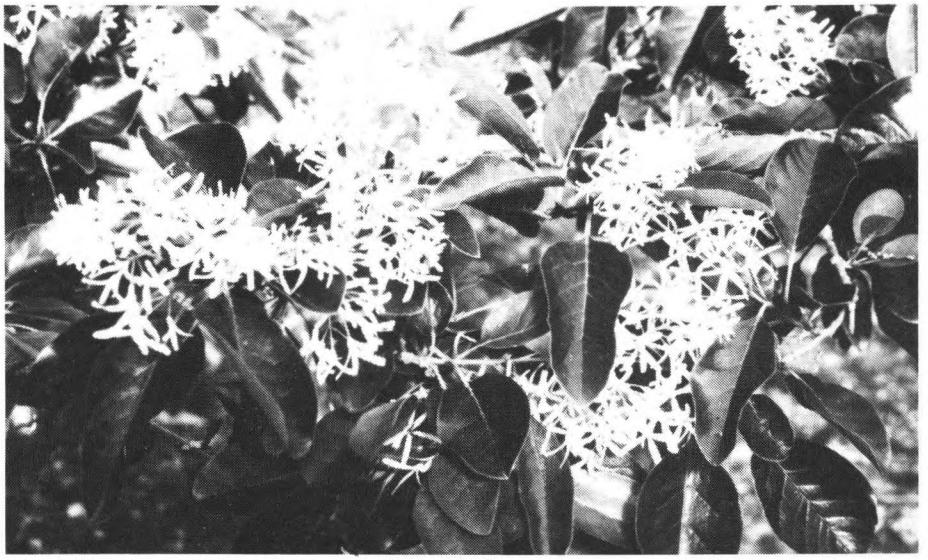

Fig. 2 Flowering *Chiomanthus retusa* in the Arboretum.

A copy of a portion of the catalogue illustrates these points.

Michelea figo (Lour) Spreng. (*M. fuscata)* PORT WINE MICHELEA, C7+MM, M3+MM, H11, M4+MM
Morus alba L. WHITE MULBERRY, not found Q9
M. cathayana Hemsl. H&S 1959, R3
Meuhlenbeckia complexa (A Cunn.) Meissn. not found K11
Myoporum laetum Fortst. NGAIO, K9+MM
Myrica cerifera L. 19
Myrica pennsylvanicum 15+GC
Myrsine australis (A Rich). Allan. RED MATIPO, D&D 1934, G10+MM K7 K8 M5 O9
Myrtus spp 18
Myrtus bullata Soland(ex A Cunn). K7
Myrtus communis L.
'Variegata' VARIEGATED MYRTLE, H&S 1946, not found 18

The system of entry is as follows:
Scientific name, Naming authority, COMMON NAME, Source, Date acquired, Location and confirmation codes.

Each entry follows this pattern, although source and date of acquisition may not always be known. In the example given above only *Morus cathayana, Myrtus communis 'Variegata'* and *Myrsine australis* can be quantified according to source and date acquired, the plants having been purchased from Hillier and Sons in 1959, Hillier and Sons in 1946, and Duncan and Davies in 1934, respectively.

The location codes are letter and number combinations that refer to a particular grid square. For example *Myrica cerifera* may be found at the location I9, which is in the Gardens. In the case of *Meuhlenbeckia complexa* previous information suggests that the plant should be present in the square K11 on Orchard Hill, but it has not actually been found in that location. It is important to record plants that are supposed to be present, but which are not found, as these are often eventually found nearby, or seedling material may be found at a later stage.

An entry such as M4+MM indicates that the plant has been found in the location square M4, and that the identity has been confirmed by MM, which in this case is the author. Those entries with just a location code indicate that the identity of the tree has not yet been confirmed.

In writing the catalogue in this way, as much as possible can be indicated about each tree in one publication. However, for the purpose of scientific study, other types of information are required to give a total picture of the collection.

3. *Support data*

As the Arboretum survey was conducted, a number of supporting documents and other types of information were developed.

(a) *Reverse catalogue*

A companion to the alphabetical listing is the reverse catalogue which lists the Arboretum according to the contents of each grid square. This reverse listing has been used to calculate the number of trees in each park, and in the Arboretum as a whole. It serves as a location reference and can be used when any specific park is under discussion.

(b) *The Herbarium and photographic records*

The herbarium is an essential tool in projects such as this one as it forms an important basis for reference. Presently the herbarium contains about 1600 samples. Each sample indicates the date collected, the location and reference number, and the name if known. An herbarium sample should contain as many aspects of the plant as possible, eg flowers, fruit, leaves.

In many cases herbarium specimens do not represent the plant particularly well (for example camellia and magnolia flowers do not press well to form samples). In this case photographic material is more representative. This has been used in conjunction with the herbarium material to provide an adequate description of many trees.

(c) *Descriptive data*

In the course of the project descriptive data have been gathered which have been used in identifying the trees (for example, flowering dates, leafing and leaf fall, fruit drop). This information forms an invaluable framework for further study of the Arboretum.

(d) *Reference materials*

Because of the diversity and rarity of many of the trees at Eastwoodhill it is often difficult to obtain useful botanical descriptions with which to identify many species. To this end a series of genera description files have been formulated. These files assemble the botanical description of the plant in question from several authors, and likewise indicate when there is no description available. Sources are listed so that points of identification can be debated where appropriate.

A number of reference lists are being formulated. One of these is a file which lists sources that contain an illustration of the plant in question. Other files list general bibliographical sources and contacts for further information.

Results and Discussion

The result of this work is a series of documents and other data which extensively describe the Eastwoodhill resource. These documents describe eight parks which contain approximately 2600 different species and cultivars of ornamental trees shrubs and climbers, a total of 7000-8000 individual plants.

The documentation is assembled so that a framework is provided for additional information as it comes to hand.

The completion of the description of the resource provides the foundation for the initiation of a number of activities in relation to the development of the Arboretum. At present two new projects are underway. One is planning an overall development strategy for the rest of the property owned by the Trust Board, which is adjacent to the Arboretum. The second activity will plan the detail of future development of the collection.

Copies of the arboretum catalogue can be obtained from the Curator, Eastwoodwill Arboretum. The 1:200 map sets and supporting documentation are not yet generally available, as they are components of the authors Doctoral thesis. These will be released on completion of the thesis. Information enquiries should be directed to the author.

General Conclusions

As of early 1989 the primary objective of this project has been met. That is, the Eastwoodhill resource has been mapped and described.

The completion of this objective has facilitated the initiation of several projects which will further develop this important resource for New Zealand.

Acknowledgements

[1]The author acknowledges the invaluable information provided by Mr R. J. Berry, Plantsman, Tiniroto, who prepared previous information on the collection, and assisted with plant data.

[2]The author acknowledges the assistance provided by Mr G. W. Clapperton, Curator, Eastwoodhill, who produced the 1:2000 map drawing from the aerial photograph, and who assisted with plant data on many occasions.

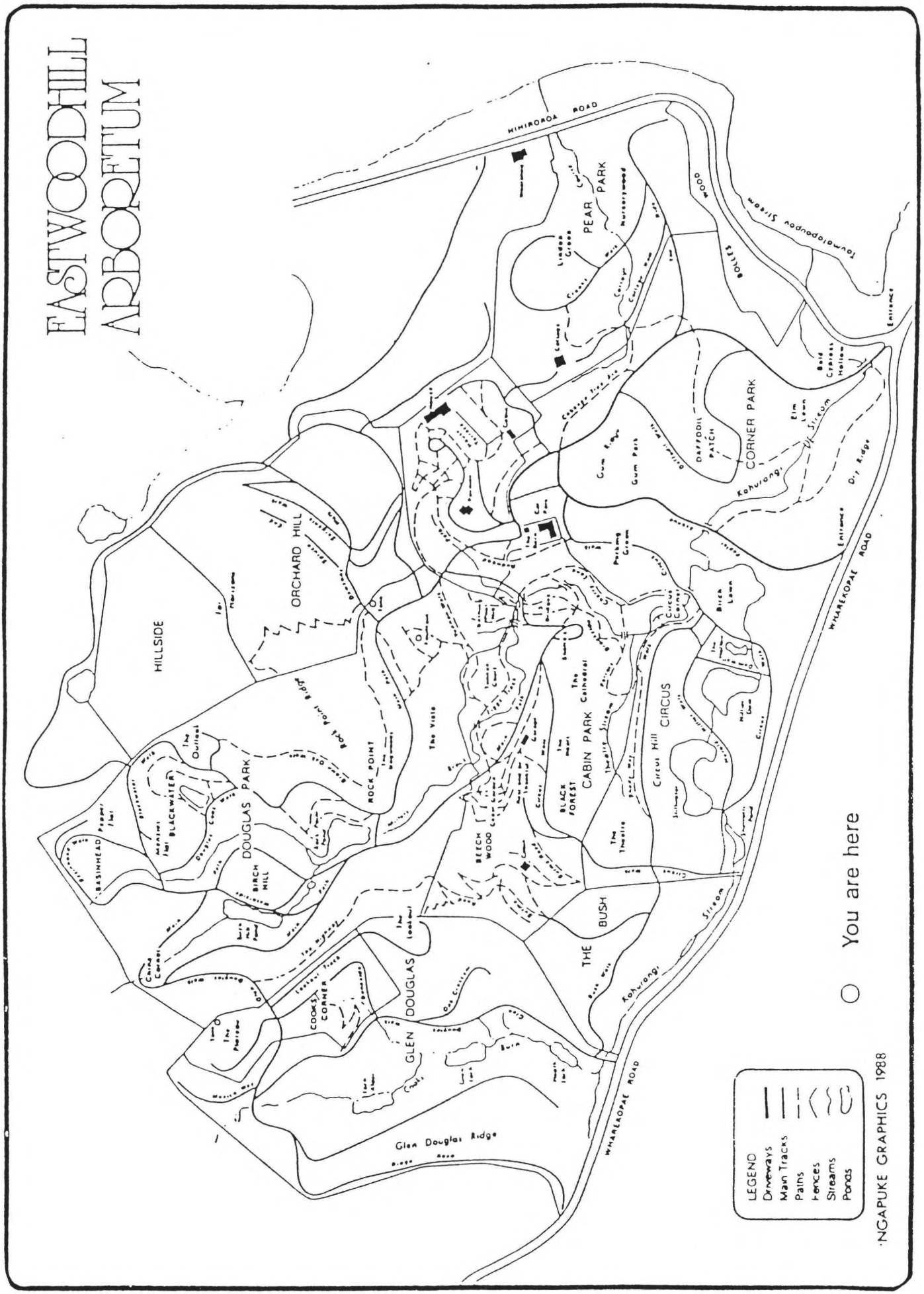

Fig. 3 Eastwoodhill Arboretum, Scale 1:4464. Produced from aerial photographs by the Curator, Eastwoodhill and Ngapuke Graphics, Gisborne.

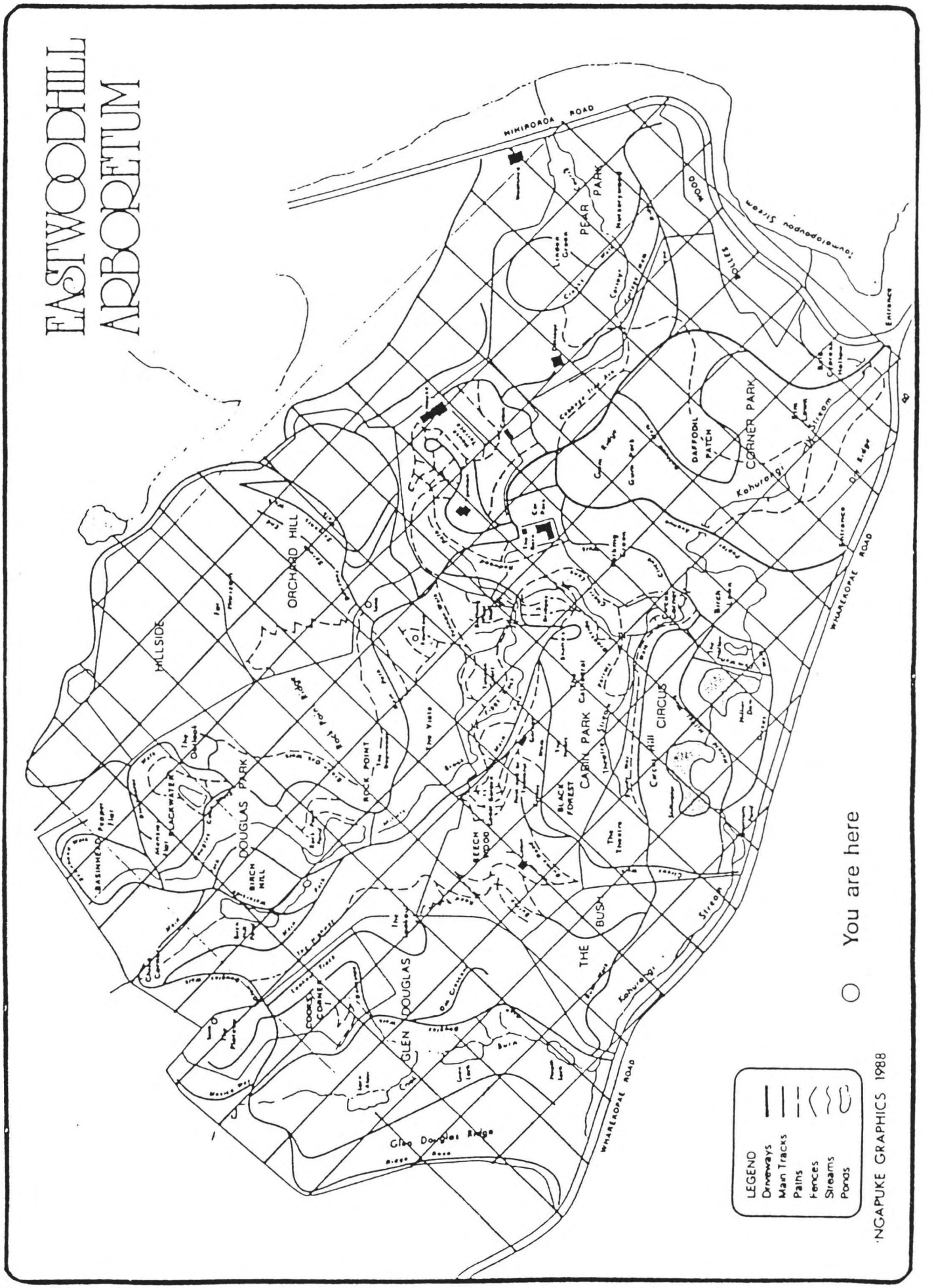

Fig. 4 Eastwoodhill Arboretum. Scale 1:4464. The grid overlaid on this map by the map drawn by the author formed the basis for the 1:200 maps onto which tree positions were plotted. (Adapted from Ngapuke Graphics, 1988).

Cordyline Cultivar Names — Three New Combinations

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Introduction

This short paper clarifies three nomenclatural problems for the "Cultivar Checklist for the New Zealand Species of *Cordyline* (Asphodelaceae)" published in this volume of Horticulture in New Zealand. Legitimate cultivar names are given to three different plants that until now have been known illegitimately as *Cordyline australis* 'Kirkii', *Cordyline banksii* 'Purpurea' and *Cordyline* Bronze Ribbon Hybrids respectively.

Cordyline australis 'Thomas Kirk'

Cordyline australis 'Kirkii' was first published in Duncan and Davies' Nursery Catalogue (1976). The plant is a dwarf form with short, branching stems that arise both as underground and aerial shoots; these form a low dense mound, reaching a height of about 1-1.5m. The origin of this interesting cultivar is unknown, but it has been in cultivation since at least the mid 1920s as it was listed in Duncan and Davies' Nursery Catalogue (1926), misidentified as *Cordyline terminalis*.

Under The International Code of Nomenclature for Cultivated Plants 1980 (I.C.N.C.P.) Article 27, the Latin cultivar epiphet 'Kirkii' is illegitimate because it was published after 1 January 1959. Cultivar names given after this date have to be a fancy name and not in Latin. A correct name, in accordance with the I.C.N.C.P. is here given to this plant.

Plate 1: An eight year old plant of *Cordyline australis* 'Thomas Kirk' showing its distinctive clumpy form.

Cordyline australis (Forst. f.) Endl. 'Thomas Kirk'

Syn. *Cordyline australis* 'Kirkii' (nom. illeg. I.C.N.C.P. Art. 27) (Duncan and Davies Nursery Catalogue [1976] as *Cordyline* 'Kirkii').

The botanical description, from an eight year old plant grown in a garden at Maori Hill, Dunedin, is: plant up to 50 cm tall, forming densely branched clumps of short, branching stems that arise from above and below ground. Stems up to 5 cm thick. Leaves 30-36 cm long x 2.5 cm wide, narrowed to petiole, both surfaces light green, mid-rib yellow-green on underside. Flowers not seen.

The new name is in keeping with the spirit of the old name "Kirkii". It is most likely that the name "Kirkii" honours Thomas Kirk (1828-98) who lived in New Zealand from 1863 until his death in 1898. He is regarded as New Zealand's leading botanist in the latter decades of last century and was the author of "Forest Flora of New Zealand" (1889) and "The Students' Flora of New Zealand and the Outlying Islands" (1899).

Cordyline Carse Hybrids Purple Strap group

The second name published here is for a group of hybrids currently grown under the name *Cordyline banksii* 'Purpurea'. As pointed out by Metcalf (1987) these plants "appear to be hybrids between *C. banksii* and *C. australis* 'Purpurea'." It should be noted that two separate combinations have to be made to provide a functional name for this group of plants.

First, a collective epithet is needed for the interspecific cross *Cordyline banksii* x *Cordyline australis*. Under the I.C.N.C.P., Article 18, a collective epiphet in modern language is being given; this name is *Cordyline* Carse Hybrids. The name honours Mr H. Carse (1857-1930), a school teacher of the Auckland region and an amateur botanist. He had specialist knowledge of ferns and sedges but was also interested in hybrid groups, publishing two names in *Cordyline* for interspecific hybrids.

Secondly, because this particular group of plants are red-bronze leaved and there is a degree of variation amongst seedlings (Metcalf, 1987) it is necessary to give these plants a group name (I.C.N.C.P., Art 26) rather than a single cultivar epithet. The cultivar "Purpurea", is not available because it has already been used for *Cordyline australis* 'Purpurea' (see I.C.N.C.P., Art 50). The group category being used here is intermediate between a species or collective name and cultivar name. The new group name is Purple Strap group.

These two combinations are:

Cordyline Carse Hybrids

A new collective epithet in modern language for all the progeny of the interspecific hybrid combination *Cordyline banksii x Cordyline australis* (I.C.N.C.P. Art. 18).

Cordyline Carse Hybrids Purple Strap group

This is a new group name (I.C.N.C.P., Art. 26) that includes an assemblage of cultivars of *Cordyline* Carse Hybrids whose common character is their red-bronze leaves.

Cordyline Xgibbingsiae Bronze Ribbon group

The final nomenclatural problem is a group of plants called *Cordyline* Bronze Ribbon Hybrids. A valid publication for this name has not been located, although the plants have been in cultivation for over 20 years. The name was applied by Mr O. Blumhardt of Whangarei to a group of plants bred by crossing a bronze form of *Cordyline pumilio* with a bronze form of *Cordyline banksii*. Of the resultant seedlings approximately 50% were bronze leaved; these he informally named *Cordyline* Bronze Ribbon Hybrids (the remaining 50% were green foliaged and discarded). Under the I.C.N.C.P. Art. 26 the name "Bronze Ribbon Hybrids" should be a group name as it refers to only bronze leaved individuals of *Cordyline Xgibbingsiae* Carse (which is the collective botanical name in Latin for *Cordyline banksii x Cordyline pumilo*). Therefore the new combination being made here drops the word "Hybrids" and replaces it with the word group. The new combination is given below:

Cordyline Xgibbingsiae Bronze Ribbon group

This name is a new group name (I.C.N.C.P., Art. 26) for those bronze leaved cultivars that are the progeny of *Cordyline banksii x Cordyline pumilo.*

Acknowledgements

I thank Dr Phil Garnock-Jones and Mr Bill Sykes for their comments and discussion on the draft of this paper.

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A Cultivar Checklist for the New Zealand Species of *Cordyline* (Asphodelaceae)

Peter Heenan

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(Prepared for the Nomenclature Committee of the Royal New Zealand Institute of Horticulture [Inc.])

Introduction

Cordyline is a genus of about 15 species of trees and shrubs found in the widespread localities of India, Australia and the Pacific. There are five New Zealand species all of which are endemic. Numerous cultivars of the New Zealand species have been named and are presented here as a checklist.

The worth of *Cordyline* species as garden plants is well known and does not need to be discussed here. However, this checklist does serve to illustrate the interest that British and European horticulturalists, of the mid-nineteenth to early-twentieth centuries, took in the cultivation of *Cordyline* species. During the year 1870-1925 numerous notes, short articles, and letters to the editor of the Gardeners Chronicle were written discussing their horticultural merits, cultivation requirements and flowering time. Many variations in plant form and leaf colour were also noted during this period; these variations resulted in 25 cultivar names (not including synonyms) being published for the years 1870-1922.

The exact date when *Cordyline* was introduced into cultivation is unknown. However, the dates of 1860 for *Cordyline banksii* and 1857 for *Cordyline indivisa* have been mentioned (Gardeners Chronicle, 1906). Hooker (1860) notes that "young live plants of two kinds" were imported, presumably from New Zealand, by Mr Standish of Bagshot, Surrey, England. One plant of each species was given by Mr Standish to Mr Hooker to be grown at Kew Gardens. Hooker (1860) also notes that they have a "a very young plant apparently of (*Cordyline indivisa*) from Mr Lee". Hillier and Sons (1977) without quoting a reference or authority give the introduction of *Cordyline australis* as "1823" and *Cordyline indivisa* as "about 1850".

The use of the generic name *Cordyline* and placement of the species in genera during the nineteenth and early twentieth centuries were often confused. Names erroneously applied by botanists included *Dracaena* and *Dracaenopsis*. *Dracaena* belongs in a different family (Agavaceae) and *Dracaenopsis* is a synonym of *Cordyline*. Horticulturalists and gardeners added to this problem by using the names *Dianella* (now Phormiaceae) and *Freycinetia* (Pandanaceae). In addition, various specific names were often applied to one species. One result of this confusion is that it is difficult to determine the correct name of cultivated forms because different authorities would often use different generic names and specific epithets for the same cultivar.

The main nomenclatural problem up until about the 1920's was that in Britain, Europe and America most plants cultivated under the name *Cordyline indivisa* were actually *Cordyline australis*. The outcome of this is that when a published name is encountered today there is no guarantee that the plant is what the name purports it to be. Further, although the cultivar descriptions may be adequate to distinguish some cultivars, by and large they are unable to be used for referring a cultivar to any particular species.

The problems outlined above are illustrated with two examples that are difficult to clarify because the plants are unlikely to be in cultivation today. The descriptions for *Cordyline indivisa* 'Atropurpurea' and *Cordyline indivisa* 'Veitchii' fit, almost exactly, the descriptions of *Cordyline australis* 'Atropurpurea' and *Cordyline australis* 'Veitchii' respectively. The only difference is the authority. For the two former names it is Nicholson (1886) and for the latter two names it is Bailey (1922). Given the confusion over these two species it is almost certain that the two *Cordyline indivisa* cultivar names are synonyms of their counterparts under *Cordyline australis*. Accordingly, they are treated as such in this checklist.

There are two groups of cultivars in this checklist that are particularly difficult to determine. Firstly, there are the variegated

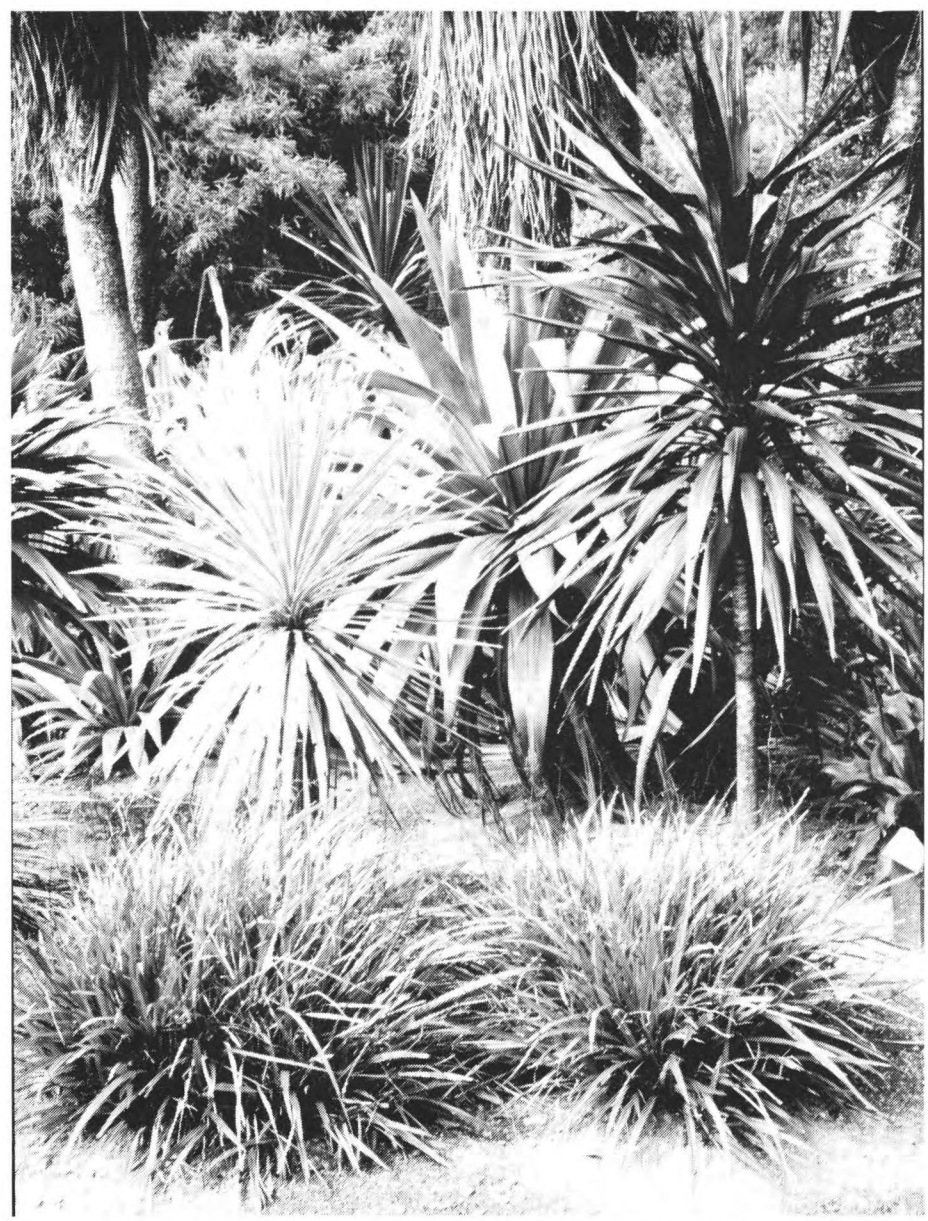

Plate 1: A collection of cabbage trees growing at Queen's Gardens, Invercargill. From left to right; *C. australis* 'Albertii', *C. indivisa* and C. Carse Hybrids Purple Strap group 'Purple Tower' (background trunks are *C. australis*).

cultivars of *Cordyline australis*. Undoubtedly there will be synonyms within this group but these are difficult to clarify today given the historical nature of the names, the often vague and inadequate descriptions and the fact that many of the plants are now not in cultivation. Cultivars that come into this group include 'Albertii', 'Argenteo-striata', 'Aureo-striata', 'Dalliereana', 'Doucetiana', 'Marginta', 'Rigoutsii' and 'Variegata'. A similar problem occurs with the red-purple and bronze leaved forms of *Cordyline australis*, for example, the cultivars 'Atropurpurea', 'Atrosanguinea', 'Cuprea', 'Lentiginosa', 'Purpurea', 'Red Robin', 'Rubra', 'Russellii', 'Torbay Dazzler', 'Torbay Red' and 'Torbay Sunset'.

Notwithstanding these problems this checklist attempts to bring *Cordyline* cultivars, both those currently cultivated and those of historical interest only, into line with the International Code of Nomenclature for Cultivated Plants 1980 (I.C.N.C.P.). For example, the orthography of latin epithets is corrected to be in accordance with the International Code of Botanical Nomenclature (I.C.B.N.) (I.C.N.C.P., Art. 28). Also, all cultivar names are enclosed within single quotation marks to make them distinct from botanical names (I.C.N.C.P., Art. 29). Because of the close historical relationship between horticultural cultivars and botanical species and the confusion between *Cordyline australis* and *Cordyline indivisa* this checklist includes both cultivar and botanical names as well as their synonyms.

In this treatment of New Zealand *Cordyline* cultivars two lists are given. The first alphabetical list is a quick reference index of all known cultivar and species names and it indicates any synonomy. Secondly, a bibliographic list gives all accepted names, their earliest known published reference, legitimate synonyms and where available a brief description.

In a checklist of this type there will undoubtedly be cultivars that have been overlooked. The author would therefore be pleased to receive any additional comments and information to that presented here.

Horticultural usages of names for which no formally published reference has been found are indicated by the abbreviation "Hort.".

Alphabetical List

In this list all cultivar and species names belong to *Cordyline* Comm. ex Juss. unless otherwise stated.

'Albertii' = *australis* 'Albertii'
'Argenteo-striata' = *australis* 'Argenteo-striata'
'Atropurpurea' = *australis* 'Atropurpurea'
'Atrosanguinea' = *australis* 'Atrosanguinea'
'Aureo-striata' = australis 'Aureo-striata' australis (Forst.f.) Endl.
australis 'Albertii'
australis 'Argenteo-striata'
australis 'Atropurpurea'
australis 'Atrosanguinea'
australis 'Aureo-striata'
australis 'Cuprea'
australis 'Dalliereana'
australis 'Doucettii' = *australis* 'Doucetiana'
australis 'Doucetiana'
australis 'Eeckhautei'
australis 'Forsteri'
australis hybrida Invalid Name
australis 'Kirkii' = *australis* 'Thomas Kirk'
australis 'Lentiginosa'
australis 'Lineata'
australis 'Marginata'
australis 'Parrei'
australis 'Purpurea'
australis 'Red Robin'
australis 'Rigoutsii'
australis 'Rubra'
australis 'Russellii'
australis 'Scheneideri'
australis 'Sir Victor Davies' = *australis* 'Albertii'
australis 'Torbay Dazzler'
australis 'Torbay Red'
australis 'Torbay Sunset'
australis 'Variegata'
australis 'Veitchii'
banksii Hook.f.
banksii 'Erythrorachis'
banksii 'Purpurea' = Carse Hybrids Purple Strap group
beuckelaeri C. Koch = *banksii* Hook.f.
'Bronze Elf' Hort. = *Xgibbingsiae* Bronze Ribbon group 'Bronze Elf' Hort.
Bronze Ribbon group = *Xgibbingsiae* Bronze Ribbon group
Bronze Ribbon Hybrids Hort. = *Xgibbingsiae* Bronze Ribbon group
calocoma (Wendland) Baker = *australis* (Forst.f.) Endl.
Carse Hybrids
Carse Hybrids Purple Strap group
Carse Hybrids Purple Strap group 'Purple Tower'
cheesemanii Invalid Name
'Cuprea' = *australis* 'Cuprea'
'Dalliereana' = *australis* 'Dalliereana'
diffusa Colenso = *banksii* Hook.f.
'Doucetiana' = *australis* 'Doucetiana'
'Doucettii' = *australis* 'Doucetiana'
'Edulus'
'Eeckhautei' = *australis* 'Eeckhautei'
'Erythrorachis' = *banksii* 'Erythrorachis'
forsteri = *australis* 'Forsteri'
Xgibbingsiae Carse
Xgibbingsiae 'Bronze Elf' Hort. = *Xgibbingsiae* Bronze Ribbon group 'Bronze Elf' Hort.
Xgibbingsiae Bronze Ribbon group
Xgibbingsiae Bronze Ribbon group 'Bronze Elf' Hort.
'Green Goddess'
hectorii Colenso = *indivisa* (Forst. f.) Steud.
hookeri Kirk = *indivisa* (Forst.f.) Steud.
Xhybrida
indivisa (Forst. f.) Steud.
indivisa 'Atropurpurea' = *australis* 'Atropurpurea'
indivisa 'Doucetiana' = *australis* 'Doucetiana'
indivisa hybrida Invalid Name
indivisa 'Lineata' = *australis* 'Lineata'
indivisa 'Purpurea' = *australis* 'Purpurea'
indivisa 'Rubra' = *australis* 'Rubra'
indivisa 'Veitchii' = *australis* 'Veitchii'
indivisa 'Vera' = *indivisa* (Forst.f.) Steud.
kaspar W. Oliver.
kaspar 'Green Goddess' = 'Green Goddess'
'Kirkii' = *australis* 'Thomas Kirk'
'Lentiginosa' = *australis* 'Lentiginosa'
'Lineata' = *australis* 'Lineata'
lineata var. *purpurascens* Incertae Sedis
'Marginata', = *australis* 'Marginata'
Xmatthewsii Carse
'Parrei' = *australis* 'Parrei'
'Prince Albert' = *australis* 'Prince Albert'
pumilio Hook.f.
'Purpurea' = *australis* 'Purpurea'
Purple Strap group = Carse Hybrids Purple Strap group
'Purple Tower' = Carse Hybrids Purple Strap group 'Purple Tower'
'Red Robin' = *australis* 'Red Robin'
'Rigoutsii' = *australis* 'Rigoutsii'
'Rubra' = *australis* 'Rubra'
'Russellii' = *australis* 'Russellii'
'Schneideri' = *australis* 'Schneideri'
'Sir Victor Davies' = *australis* 'Albertii'
stricta Hook.f. ≡ *pumilio* Hook.f.
sturmii Incertae Sedis
superbiens = *australis* (Forst.f.) Endl.
'Thomas Kirk' = *australis* 'Thomas Kirk'
'Torbay Dazzler' = *australis* 'Torbay Dazzler'
'Torbay Red' = *australis* 'Torbay Red'
'Torbay Sunset' = *australis* 'Torbay Sunset'
'Variegata' = *australis* 'Variegata'
'Veitchii' = *australis* 'Veitchii'
Charlwoodia australis G. Don = *australis* (Forst.f.) Endl.
Charlwoodia indivisa G. Don = *indivisa* (Forst.f.) Steud.
Dianella australis Hort. = *indivisa* (Forst.f.) Steud.
Dracaena aureo-lineata = *indivisa* (Forst.f.) Steud.
Dracaena australis Forst.f. ≡ *australis* (Forst.f.) Endl.
Dracaena australis Hook. = *australis* (Forst.f.) Endl.
Dracaena banksii Hort. = *banksii* Hook.f.
Dracaena 'Cuprea' = *australis* 'Cuprea'
Dracaena 'Doucettii' = *australis* 'Doucetiana'
Dracaena indivisa Forst.f. ≡ *indivisa* (Forst.f.) Steud.
Dracaena indivisa Hort. = *australis* (Forst.f.) Endl.
Dracaena indivisa 'Parei' = *australis* 'Parrei'
Dracaena indivisa 'Vera' = *indivisa* (Forst.f.) Steud.
Dracaena 'Rigoutsii' = *australis* 'Rigoutsii'
Dracaena 'Veitchii' = *australis* 'Veitchii'
Dracaenopsis australis ≡ *australis* (Forst.f.) Endl.
Dracaenopsis colocoma = *australis* (Forst.f.) Endl.
Dracaenopis indivisa = indivisa (Forst.f.) Steud.
Freycinetia baueriana Hort. = indivisa (Forst.f.) Steud.

Bibliographic List

Homotypic or nomenclatural synonyms are indicated by ≡, heterotypic or taxonomic synonyms by =. Synonymy of cultivars, which do not have type specimens, is indicated by "Syn.".

Cordyline australis (Forst.f.) Endl., *Prodr. Fl. norf.*, 29 (1833) ≡ *Dracaena australis* Forst. *f.*, *Prodr.*, 24(1786), ≡ *Dracaenopsis*

australis (Forst.f.). Planch., *Flore des Serres, (Ser. 1)* 6, 110, *subt.* 569 (1850-51).

= *Dracaenopsis calocoma* Wendland, *Bot. Ztg.* 17, 277 (1859) ≡ *Cordyline calocoma* (Wendland) Baker, *Jour. Linn. Soc. (Botany) Vol. 14*, 542 (1875).

= *Cordyline superbiens* C. Koch, *Wochenschr.* 2, 381 (1859).

= *Charlwoodia australis* G. Don, *Loudon's Hort. Brit.*, (1839).

(≡ *Cordyline australis* (Forst.f.) Endl. ?)
Notes: Detailed botanical description in Moore and Edgar (1970). *Dracaena australis* Hook. is listed by Regel (1859) as a synonym of *Cordyline australis* (Forst.f.) Endl.

Cordyline australis 'Albertii'
(L. J. Metcalf, *The Cultivation of New Zealand Trees and Shrubs (2nd Edition)*, 99(1987)).
Described as having "creamy yellow, striped leaves."
Syn. *Cordyline australis* 'Sir Victor Davies' Hort.

Cordyline australis :Argenteo-striata'
(G. Nicholson, *Illustrated Dictionary of Gardening (Supplement)*, 519 (1888)). Described as having "leaves linear-lanceolate, bright green, striated and occasionally margined creamy white".

Cordyline australis 'Atropurpurea' comb. nov.
Syn. *Cordyline indivisa* 'Atropurpurea' (G. Nicholson, *Illustrated Dictionary of Gardening Vol. 1*, 373 (1886)).

Notes: Described by Bailey (1922) as having the "base of leaf and underside of midrib purple".

Cordyline australis 'Atrosanguinea'
(A.B. Graf, *Exotica Series 4 Vol.* 2 (1982)). Described as having "tough leathery, narrow lanceolate leaves bronze, suffused with deep purplish-red".

Cordyline australis 'Aureo-striata'
(L. H. Bailey, *The Standard Cyclopedia of Horticulture Vol. 3*, 843 (1922) as *Cordyline australis* var. *aureo-striata*). Described as being "variegated with a number of longitudinal yellow stripes".

Cordyline australis 'Cuprea'
(A.B. Graf, *Exotica Series 4 Vol. 2* (1982)). Described as a "dark-leaved form with the slender leaves entirely a coppery reddish brown".
Syn. *Dracaena* 'Cuprea' (J. Fraser and A. Hemsley, *Johnson's Gardeners' Dictionary*, (1917)). Described as being apparently "a variety of *Cordyline australis*".

Cordyline australis 'Dalliereana'
(*L'Illustration Horticole Vol. 37, t.* 114 (1890)).
Notes: Described by Fraser and Hemsley (1917) as being "striped yellow".
Syn. *Cordyline indivisa* 'Dalliereana' (*L'Illustration Horticole Vol. 37, t.* 114 (1890)).

Cordyline australis 'Doucetiana' comb. nov.
Syn. *Cordyline indivisa* 'Doucetiana' (*L'Illustration Horticole Vol. 25, t.* 90 (1878)).
Notes: Described by Fraser and Hemsley (1917) as having leaves "edged and striped white".
Syn. *Cordyline australis* 'Doucettii' (*L'Illustration Horticole Vol. 35, t.* 40 (1880)).
Syn. *Dracaena* 'Doucettii' (G. Nicholson, *Illustrated Dictionary of Gardening (Century Supplement)*, (1901)).
Syn. *Cordyline* 'Doucettii' (S. W. Fitzherbert, *Gardeners' Chronicle*, 122-123 (1907), nomen nudum).

Cordyline australis 'Eeckhautei'
(J. Fraser and A. Hemsley, *Johnson's Gardeners' Dictionary*, 237 (1917)). Described as having "leaves green, gracefully recurved. 1899".

Cordyline australis 'Forsteri' comb. nov.
Syn. *Cordyline forsteri* (F. Mueller, *Select Plants Indust. Cult.*, 58 (1878)).
Notes: Described in Matthews Nursery Catalogue of New Zealand Flora (c. 1890) as "a robust variety of *C. australis*".

Cordyline australis hybrida
(Duncan and Davies Nursery Catalogue, (1925)). Described as "a cross between *australis* and *banksii*".
Notes: This name is invalid because under the I.C.N.C.P. hybrid combinations need a collective name (I.C.N.C.P., Articles 13-19).

Cordyline australis 'Lentiginosa'
(*L'Illustration Horticole Vol. 18 t.* 35 (1871) as *Cordyline australis* var. *lentiginosa*).
Notes: Described by Fraser and Hemsley (1917) as having leaves "tinted and spotted brownish-red".
Syn. *Cordyline* 'Lentiginosa' (Linden and Andre, *L'Illustration Horticole Vol. 17, t.* 35 (1870)).

Cordyline australis 'Lineata'
(G. Nicholson, *The Illustrated Dictionary of Gardening Vol.* 1, 372 (1886)). Described as having "fine, broad, gracefully recurving foliage".
Syn. *Cordyline lineata* Rodigas, *L'Illustration Horticole*, xi, 121 *t.* 590 (1893), nomen nudum illeg.
Notes: Listed by Rodigas (1893) as a synonym of *Cordyline indivisa* Steud. It is most probably a synonym of *Cordyline australis* 'Lineata' and is treated as such here.
Syn. *Cordyline indivisa* 'Lineata' (G. Nicholson, *Illustrated Dictionary of Gardening Vol. 1*, 373 (1886)). Described as having "leaves much broader than those of the type, about 4 inches broad; sheathing base stained with reddish-pink".
Notes: Although this cultivar is listed with *C. australis* 'Lineata' in Nicholson (1886) the two are most probably the same. Leaves 4 inches broad are much wider than typical *C. australis*, but narrow for *C. indivisa*. Given the early confusion between *C. australis* and *C. indivisa* this cultivar should be treated as a synonym of *Cordyline australis* 'Lineata'.

Cordyline australis 'Marginata'
(A.B. Graf, *Exotica Series 4 Vol. 2* (1982)). Described as having "leathery, olive green leaves prettily edged with creamy-white".

Cordyline australis 'Parrei'
(J. Fraser and A. Hemsley, *Johnson's Gardeners' Dictionary*, 237 (1917)). Described as leaves being "green with a red band beneath".
Syn. *Dracaena indivisa* 'Parei' *(Duncan and Davies Nursery Catalogue*, (1927) as *Dracaena indivisa* var. *parei*).

Cordyline australis 'Purpurea'
(Matthews Nursery Catalogue of New Zealand Flora, (c. 1890) as *Cordyline australis* var. *Purpurea*). Described as having "leaves a dull purple colour".
Syn. *Cordyline indivisa* 'Purpurea' (A.B. Graf, *Exotica Series 4 Vol. 2* (1982)). Described as being "tree forming with woody trunk usually clothed with foliage, toward apex a dense crown of broad, flexuous leathery leaves entirely suffused with bronzy purple; young growth sprouting from the base has foliage much narrower".

Cordyline australis 'Red Robin'
(*Omahanui Native Plants Nursery Catalogue 1990)*, nomen nudum.

Cordyline australis 'Rigoutsii'
(G. Nicholson, *Illustrated Dictionary of Gardening (Century Supplement)*, (1901)). Described as "a variegated seedling raised from *Cordyline australis*".
Syn. *Dracaena* 'Rigoutsii' (*L'Illustration Horticole*, 24 *t.* 50. (1896)).

Cordyline australis 'Rubra'
(G. Nicholson, *Illustrated Dictionary of Gardening (Century Supplement)*, 258 (1901)). Described as having "leaves bronzy, broader and more erect than the type. 1892. Habit more compact".
Syn. *Cordyline indivisa* 'Rubra' (A.B. Graf, *Exotica Series 4 Vol. 2* (1982)). Described as being "tree like with erect stem bearing a fountain a broad, flexible leathery leaves, entirely coloured bronze."

Cordyline australis 'Russellii'
(G. Nicholson, *Illustrated Dictionary of Gardening (Century Supplement)*, 258 (1901)). Described as having "leaves dull brown, with a yellowish midrib. 1897".

Cordyline australis 'Schneideri'
(J. Fraser and A. Hemsley, *Johnson's Gardeners' Dictionary*, 237 (1917)). Described as having "leaves narrow, dark green. Dwarf. 1899".

Cordyline australis 'Thomas Kirk'
(P. B. Heenan, Horticulture in New Zealand Vol. 2. No. 1 (1991)).
Syn. *Cordyline australis* 'Kirkii' nom. illeg. (*Duncan and Davies Nursery Catalogue* (1976) as *Cordyline* 'Kirkii'). Described as being a "low growing clump forming cab-

bage tree, attractive rich green foliage to base of plant. 1m".

Cordyline australis 'Torbay Dazzler'
(*Horticulture Week Vol. 27 No. 16* (April 20 1990). Described as "variegated red and green form . . .".

Cordyline australis 'Torbay Red'
(*Horticulture Week Vol. 27 No. 16* (April 20 1990)). Described as "variegated red and green form . . .".

Cordyline australis 'Torbay Sunset'
(*Horticulture Week Vol. 27 No. 16* (April 20 1990)). Described as "variegated red and green form . . .".

Cordyline australis 'Variegata'
(*Matthews Nursery Catalogue of New Zealand Flora*, (c. 1890)). Described as "variegated variety".

Cordyline australis 'Veitchii'
(L. H. Bailey, *The Standard Cyclopedia of Horticulture Vol. 3*, (1922)). Described as having the "base of leaf and underside of midrib bright crimson".
Syn. *Dracaena* 'Veitchii' Hort. (*Gartenflora*, 149 (1871)).
Syn. *Cordyline indivisa* 'Veitchii' (G. Nicholson, Illustrated Dictionary of Gardening Vol. 1, 373 (1886)). Described as being "similar to the type, but has the sheathing base and back of midrib a beautiful deep red".

Cordyline banksii Hook. f., *Gardeners' Chronicle Vol. 20*, 732 (1860).

= *Cordyline beuckelaeri* C. Koch, *Wochenschr. Vol. 8*, 91 (1865, as *C. beuckelaerii*).

= *Cordyline diffusa* Colenso, *T.N.Z.I. Vol. 15*, 330 (1883).

= *Dracaena banksii* Hort. (*Gartenflora*, 148 (1871)). Listed as being a synonym of *Cordyline banksii* Hook. f.
Notes: Detailed botanical description in Moore and Edgar (1970).

Cordyline banksii 'Erythrorachis'
(Baker, *Journal of Linnaean Society (Botany) Vol. 14*, 542 (1875) as *Cordyline* 'Erythrorachis').
Notes: Placed under *Cordyline banksii* by G. Nicholson, *Illustrated Dictionary of Gardening*, 372 (1886)). Described as having a "red midrib".

Cordyline Carse Hybrids
(P. B. Heenan, *Horticulture in New Zealand Vol. 2 No 1.* (1991)). Described as being hybrids between *Cordyline australis* and *Cordyline banksii.*

Cordyline Carse Hybrids Purple Strap group
(P. B. Heenan, *Horticulture in New Zealand Vol. 2 No 1.* (1991)). Described as being red-bronze leaved plants that are the selections from *Cordyline* Carse Hybrids.
Syn. *Cordyline banksii* 'Purpurea' (*Duncan and Davies Nursery Catalogue* (1952)). Described as having "purplish and strap like" leaves.

Cordyline Carse Hybrids Purple Strap group 'Purple Tower'
(L. J. Metcalf, *The Cultivation of New Zealand Trees and Shrubs (2nd Edition)*, 101 (1987) as Cordyline 'Purple Tower'). Described as "the leaves have a deep purple colour with a slight glaucous bloom".

Cordyline cheesemanii T. Kirk, *T.N.Z.I. Vol. 28*, 500 (1895), nom. illeg.
Notes: Not validly published because stated by the author to be provisional (I.C.B.N., Art. 34. 1. b). It was placed in synonymy of *Cordyline fruticosa* by Cheeseman (1906) and stated to be an introduced relic of Maori cultivation.

Cordyline 'Edulus'
(*William Martin and Son Nursery and Seedsmen Catalogue of Plants*, 24 (1906-7)), nomen nudum.

Cordyline Xgibbingsiae Carse, *T.N.Z.I. Vol. 60*, 306 (1929) as *Cordyline Xgibbingsae.* Described as being a hybrid between *Cordyline banskii X Cordyline pumilio.*

Cordyline Xgibbingsiae Bronze Ribbon group
(P. B. Heenan, *Horticulture in New Zealand Vol. 2 No 1.* (1991)). Described as being bronze leaved selections of *Cordyline Xgibbingsiae.*

Cordyline Xgibbingsiae Bronze Ribbon group 'Bronze Elf' Hort.
Notes: Bred by Mr O. Blumhardt of Whangarei who back-crossed a selected form of the *Cordyline Xgibbingsiae* Bronze Ribbon group with a bronze *Cordyline pumilio.*

Cordyline 'Green Goddess'
(L. J. Metcalf, *The Cultivation of New Zealand Trees and Shrubs (2nd Edition)*, 99 (1987)). Described as having leaves which "tend to clothe the branches for some length, are fresh green in colour and broader than those of *C. australis*". Syn. *Cordyline kaspar* 'Green Goddess' Hort.

Cordyline Xhybrida
(*Matthews Nursery Catalogue of New Zealand Flora*, (c. 1890) as *Cordyline hybrida*). Described as "a cross between *C. indivisa* and *C. banksii*".

Cordyline indivisa (Forst. f.) Steud., *Nom. bot. (ed. 2)*, 1, 149 (1840) ≡ *Dracaena indivisa* Forst. f., *Prodr'.* 24 (1786), ≡*Dracaenopsis indivisa* (Forst. f.) Planch., *Flore des Serres Ser.* 1, 6, 132 (1850-51).

= *Charlwoodia indivisa* G. Don, *Loudon's Hort. Brit.*, 130 (1839)
(≡*Cordyline indivisa* (Forst. f.) Steud. ?)

= *Cordyline hookeri* Kirk, *T.N.Z.I. Vol. 6*, 245 (1874).

= *Cordyline hectorii* Colenso, *T.N.Z.I. Vol 25*, (1893) as *Cordyline hectori.*

= *Dracaena indivisa* 'Vera' (*Gartenflora*, 149 (1871)).
(*Cordyline indivisa* 'Vera' (G. Nicholson, *Illustrated Dictionary of Gardening Vol. 1*, 373 (1886)). Notes: Much of what was grown in America and Europe last century under the name *Cordyline indivisa* was actually *Cordyline australis.* The cultivar name 'Vera' was applied to the true *Cordyline indivisa* but listed under what was thought to be true *Cordyline australis*, that is *Cordyline indivisa.* The name *Cordyline indivisa* 'Vera' is referable to true *Cordyline indivisa.*

= *Dracaena aureo-lineata* G. Nicholson, *Illustrated Dictionary of Gardening*, 373 (1886), nomen nudum. Notes: The name was listed by Nicholson (1886) as a synonym of *Cordyline indivisa.*
Notes: Detailed botanical description in Moore and Edgar (1970). This species has been referred to in the horticultural trade as *Dianella australis* and as *Freycinetia baueriana* (non Endl.), see *Gartenflora*, 326-336 (1859).

Cordyline indivisa hybrida, Invalid Name
(*Duncan and Davies Nursery Catalogue*, (1925)). Described as "sport between *australis* and *indivisa*".
Notes: This name is invalid because under the I.C.N.C.P. hybrid combinations need a collective name (I.C.N.C.P. Articles 13-19).

Cordyline kaspar W. Oliver, *Rec. Auckl. Inst. Mus. 4*, 381 *t.* 68 (1956).
Notes: Detailed botanical description in Moore and Edgar (1970).

Cordyline lineata var. *purpurascens*
(*L'Illustration Horticole* 40: 190 (1893)).
Notes: Original publication not seen. Treated here as an incertae sedis.

Cordyline Xmatthewsii Carse, *T.N.Z.I. Vol. 57*, 91 (1926).
Described as being "a hybrid between *Cordyline australis* and *Cordyline pumilio*".

Cordyline 'Prince Albert'
(S. W. Fitzherbert, *Gardeners' Chronicle*, 122-123 (1907)), nomen nudum. Described as being apparently "a form of *C. indivisa*".
Notes: This is most probably a synonym of *Cordyline australis* 'Albertii'.

Cordyline pumilio Hook. f., *Gardeners' Chronicle, 20*, 792 (1860) ≡ *Cordyline stricta* Hook. f., *Flora Novae Zelandiae*, 257 *t.* 50 (1852-55) nom. illeg., non (Sims) Endl.
Notes: Detailed botanical description in Moore and Edgar (1970). In the original publication *pumilio* is spelt *pumilis;* this is considered to be a typographic error as the type specimen at Kew is labelled *Cordyline pumilio*, and Hooker spelt the name "*pumilio* in his "Handbook of the New Zealand Flora" (1864).

Cordyline sturmii Colenso, *T.N.Z.I. Vol. 15*, 331 (1883).
Notes: Listed as an incertae sedis in Moore and Edgar (1970).

Acknowledgments

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Irradiation of Fruits and Vegetables: Applications and Issues

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The process of food irradiation

Food irradiation involves exposing foods to ionizing radiation, either to gamma rays emanating from a radioactive source such as cobalt-60 or to high energy electrons from an electron beam machine. The concept is somewhat analogous to exposing food to microwaves in a microwave oven, though the equipment and effects are different. Only the gamma rays come into contact with the food, and there is no radioactive contamination. Doses of irradiation are quantified in terms of the energy absorbed by the product irradiated. An irradiation dose of 1 gray (Gy) corresponds to the absorption of 1 joule per kilogram. Doses of practical value in fruits and vegetables are in the range 0.1-2.5 kilograys (kGy).

Irradiation is expensive. Where a radioactive source is used it must be carried out in a special irradiation facility (Fig. 1) comprising a thick-walled concrete enclosure, safety features to exclude human access while the process is going on, a conveyor system to bring the product around the irradiation source, and the source itself. The cobalt-60 is typically housed in sealed metal tubes attached to a frame (somewhat reminiscent of a tubular steel farm gate). To allow safe human access, the source can be lowered either into a shielded trench or below 6m of water. In the simplest operation of a food irradiation plant, the food is conveyed around the radiation source and its speed, distance from the source and orientation, determine the total dose obtained.

Besides applications to horticultural produce, irradiation can have important functional benefits for foods generally and it is also used outside of the food industry, notably to sterilize medical products (e.g. plastic syringes, etc.). These other applications may have important influences on the availability and development of this technology for fruits and vegetables. For example, the Chinese plan to build a series of multipurpose irradiation facilities for processing both food and medical products (Wedkind, 1986). An irradiation facility would cost about £2-3M for a 500 000 curie plant (1 curie = 37×10^9 Becquerels; 1 Becquerel = 1 radioactive disintegration per second). The cost of irradiating food is difficult to predict and will vary depending on economies of scale, level of use of the facility, and other factors. However, one estimate has put costs between \$3-6 tonne^{-1} for low dose applications and up to \$100-150 tonne^{-1} for high doses (Ouwerkerk, 1982).

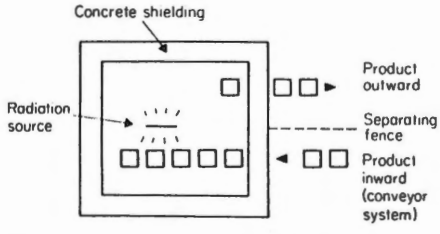

Fig. 1. Simplified irradiation facility.

Table 1: Irradiation: biological effects and functional benefits

Main biological effect	*Functional benefit*	*Dose(kGy)*
Inhibition of cell division	Prevents sprouting	0.1-0.2
Slowing of post-harvest physiology	Retards ripening/senescence (sub-tropical fruits)	0.25-0.75
Inhibition of fungal growth	Retards spoilage (soft fruits)	1.0-2.5
	Retards post-harvest growth (mushrooms)	
Reduction of bacterial population	Retards spoilage (especially in meat, poultry and fish)	1.0-3.0
	Decontaminates ingredients (spices, etc.)	up to 10.0
Elimination of *Salmonella*	Improves food safety (especially in poultry)	2.5-7.0

The major biological effects and functional benefits of irradiation are summarized in Table 1. With increasing dose, the biological effects range from inhibition of cell division, slowing of plant physiological processes, to destruction of living organisms (insects, fungi and bacteria). Some of the corresponding benefits in foods are inhibition of sprouting, shelf-life extension in fruits and vegetables, eradication of insects and larvae, shelf-life extension in meat and fish, eradication of *Salmonella* in meat, fish and egg products, and decontamination of spices and other food ingredients.

In all applications, the dose of irradiation is carefully selected in order to minimize any damage to quality. In fruits and vegetables, the use of higher doses than recommended can lead to excessive softening, surface lesions, and bleaching of chlorophyll (Massey, 1968; Maxie & Sommer, 1968; Monselise & Kahan, 1968; Hayashi & Kawashima, 1983). Many green leafy vegetables are unsuitable for irradiation.

Benefits in fruits and vegetables

Irradiation causes three main types of effects that are potentially useful in prolonging the storage- or shelf-life of fruits and vegetables.

- At very low doses (0.1-0.2 kGy), it prevents cells multiplying, thus stopping sprouting in potatoes and onions and extension growth in asparagus.
- At low doses (0.25-1.0 kGy), it slows down post-harvest physiology and retards ripening and senescence in sub-tropical fruits.
- At moderate doses (1.0-2.5 kGy), it inhibits mould growth, slowing down rotting in soft fruits, such as strawberries, and stopping cap opening and stipe elongation in mushrooms.

Horticultural produce comprises a wide range of plant species and anatomical parts with storage- or shelf-lives ranging from a few days to over one year. A wide range of factors affect the post-harvest quality and useful lives of horticultural crops. The main processes of deterioration are physiological ageing, fungal spoilage, water loss and further growth (sprouting, cap opening, etc.). Besides irradiation, other post-harvest technologies are available to slow these processes, such as fungicidal and other dips, waxing, chemical sprout inhibition, refrigeration, atmosphere modification in stores and packages, and appropriate packaging.

Up to now the storage needs of a particular commodity were catered for by combinations of these existing technologies. In some of its potential applications, irradiation complements these existing technologies and depends on them for its success; in some cases it would directly compete with them and, in other areas, it introduces possibilities which did not exist previously.

Sprout inhibition

Low doses of irradiation (0.05-0.20 kGy) can inhibit cell division in meristematic tissue and prevent sprout development (Heins, 1984). With both potatoes and onions, use of irradiation would compete directly with current technology using chemical sprout inhibitors such as isopropyl *N*-(3-chlorophenyl) carbamate (CIPC), isopropyl *N*-phenyl carbamate (IPC) and maleic hydrazide. The data in Table 2 compare sprout inhibition by irradiation and chemical means. Both methods can be used effectively (Diehl, 1977) and are regarded as safe (Anon, 1981a; Lynch, 1987). However, irradiation costs at least 1.5 times the capital and operating cost of chemical sprout inhibition (Heins, 1984) and is not

Table 2: Sprout inhibition by irradiation and chemical means: a comparative overview

Potatoes		*Onions*	
CIPC/IPC	*Irradiation*	*Maleic hydrazide*	*Irradiation*
Inexpensive	Expensive	Inexpensive	Expensive
Effective	Effective	Effective in large or small-scale use	More effective than MH at high storage temperatures
Residues regarded as safe	No chemical residues	Residues regarded as safe	No chemical residues
No side-effects	Problems for chip manufacture	No side-effects	Minimal side effects

suitable for use on a small scale. In addition, irradiation can cause problems in potatoes for frozen chip manufacture by increasing free sugars (leading to excessively brown chips) and increasing after-cooking blackening (Heins, 1984). These latter problems are the subject of continuing research (Thomas, 1981; Hayashi & Kawashima, 1983). In onions, internal browning at the base of the growing point can occur as a minor side-effect of irradiation (Grunewald, 1978) but this appears to be of no practical importance. Irradiation is superior to maleic hydrazide for sprout inhibition of onions exported to the tropics, where ambient storage temperatures are higher than in Europe, and the Dutch onion industry plans to use irradiation for this purpose (Heins, 1984). Apart from this latter application, irradiation does not offer economic advantages over conventional sprout inhibition. Its possible future use may depend on the attitudes of consumers and regulators to the wholesomeness of foods subjected to irradiation compared with foods containing chemical residues.

Inhibition of ripening and senescence

Inhibition of ripening and senescence in sub-tropical fruits, such as mangoes and papayas, is attractive because refrigeration cannot be used to extend their lives. Many sub-tropical fruits suffer serious chilling injury at temperatures less than 12°C but their storage-lives at 12°C can be doubled by treating with does of about 1 kGy. Increasing the dose to 2 kGy would also stop spoiling from moulds, but this dose causes skin damage. As a result, doses of about 1 kGy can be used in combination with hot water treatments to inhibit both ripening and mould development. Sub-tropical fruits treated in this way may be imported to Northern Europe in the near future.

Extension of storage-life in strawberries

A moderate dose of irradiation (1.0-2.5 kGy) inhibits mould growth, slowing down spoilage of soft fruits such as strawberries. The results of practical experiments designed to extend the storage-life of strawberries have been mixed. Results from South Africa (Broderick, van der Linde & Strydom, 1983), where the technology is already used commercially, indicate that a life of up to 20 days is possible at 5°C. This compares with the 6-7 days maximum chilled storage-life of non-irradiated strawberries in Ireland or the UK. On the other hand, results from Germany (Diehl, 1985) and the UK suggest that irradiation adds only 2-3 days storage-life with European cultivars. However, some recent unpublished data from the UK indicate that there are major differences between cultivars. While 'Cambridge Favourite' performed poorly, firm textured cultivars such as 'Elsanta' and 'Ostara' responded well. Dutch experiments suggest that a storage-life extension of 50-100% is possible using a suitable cultivar and combining irradiation with modified atmosphere packaging (Langerak, 1984) and this is probably the state-of-the-art. At the present time irradiation of strawberries seems most relevant to out-of-season producers distant from their main markets. In these situations irradiation may reduce product losses and enable less expensive transportation to be used.

Extension of storage-life in mushrooms

White, closed mushrooms are preferred by the consumer, but quality is rapidly lost through stalk growth, cap opening, enzymatic browning and desiccation (Langerak, 1972). Irradiation strongly inhibits cap opening and stipe growth (Langerak, 1972; Wahid & Kovacs, 1980) and results in substantial shelf-life at moderate refrigeration temperatures (Langerak, 1972). In a study of the effects of irradiation and packaging on the keeping quality of mushrooms, Langerak (1972) found that, after allowing for transportation, non-irradiated mushrooms remained at first quality for 1, 2 and 3 days at 20°C, 8-10°C and 3-5°C, respectively. Irradiated mushrooms held at the same temperatures remained at first quality for 5, 7 and 10 days, respectively. Thus irradiated mushrooms at 8-10°C had shelf-lives 4 days longer than non-irradiated mushrooms at 3-5°C. Such substantial technical benefits from irradiation could be important to a mushroom-exporting country like Ireland (estimated value of Irish domestic mushroom production in 1986 was IR£19.2M, of which IR£12.1M worth was exported fresh). If our major competitors begin to use this technology it will be essential for Irish growers to have the option of doing likewise.

Developments towards legalization of food irradiation

The beneficial effects of food irradiation have been demonstrated since the 1950s, but, because of the likely unease with which consumers and regulators would view irradiated foods, very extensive studies have been carried out to examine the effects of the process on the wholesomeness and safety of treated food. Part of this work has resulted in the legalization of the process in a number of countries for specific food items during the 1970s. However, a major step towards more widespread legalization of irradiation was made with the publishing of a report from the joint FAO/IAEA/WHO Expert Committee on food irradiation (Anon, 1981b). The committee concluded that irradiation of any food to any average dose of 10 kGy involved no toxicological hazard and presented no special nutritional or microbial problems. These conclusions are being reviewed by national governments and are likely to be widely adopted within the next few years. In the UK, the Burgin Report (Advisory Committee on Irradiated and Novel Foods, 1987) has agreed with the findings of the Expert Committee and recommended that there be a general clearance of food irradiation up to 10 kGy. An EEC Directive harmonizing legislation in EEC countries is in preparation. Both the Burgin Report and the EEC legislation either recommend or require adequate labelling. The draft EEC Directive states that irradiated food must be labelled 'treated with ionizing energy' and bear the logo in Fig. 2. In the US, low level irradiation of fruits and vegetables up to 1 kGy has been approved (Food and Drug Administration, 1986).

Wholesomeness of irradiated foods

The FAO/IAEA/WHO Expert Committee has addressed the issue of wholesomeness over almost 20 years. A wide range of irradiated foods was tested in animal feeding studies without adverse results and the chemical changes caused by irradiation were determined and assessed. Because a food process had never been evaluated in such detail before, the effects of conventional processes (freezing, canning and drying) were also assessed to see if these differed significantly from those due to irradiation. It was found that all processes produce a range of chemical products in foods, most of which are common to all processes, including irradiation. Each process also produces a few unique chemical products, which are called URPs (unique radiolytic products) in the case of irradiated foods. So, are URPs hazardous? They are not considered to be hazardous because:

- Their chemical structure suggests that they are safe.
- Animal feeding studies with irradiated foods show no adverse effects.
- Data from human feeding studies involving patients requiring irradiated germ-free diets show no adverse effects.
- While irradiation can produce mutagenic compounds, there is no evidence that foods irradiated below 10 kGy would represent any greater mutagenic hazard than many cooked foods.

Some controversy has been aroused by a study in which freshly irradiated wheat was reported to increase temporarily the incidence of polyploid lymphocytes (abnormal white blood cells) in malnourished children (Bhaskaram & Sadasivan, 1975). However, these data have been evaluated by several scientific committees and they have concluded that the work was statistically weak

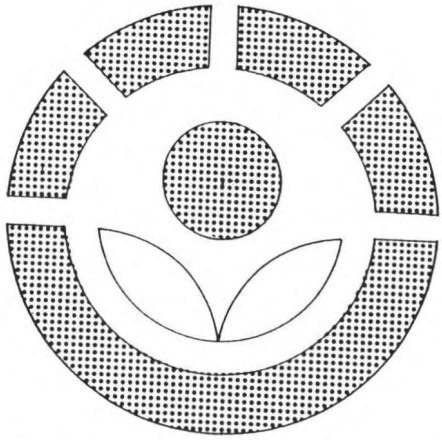

Fig. 2. Internationally agreed logo to appear on the label of irradiated foods.

and that the results obtained reflected natural variation.

Effects on nutrients

In common with all food processing and storage methods, food irradiation causes some nutrient losses. At low doses, losses are insignificant. At medium doses, losses could be similar to losses in canned foods, but could also be much less if the product is refrigerated during irradiation (Anon, 1981b). The Expert Committee did not consider that irradiation posed any special nutritional problems. However, if irradiated food were to become very popular and represent a significant part of the diet, the situation may need to be reviewed.

Consumer attitudes

In the UK, press coverage in the 'food and health' sector has generally been hostile to food irradiation, covering the technology under headlines such as 'Irradiation: who needs it?' (Anon, 1986a), and one magazine has organized a campaign against food irradiation (Robbins, 1986). In 1986, the British Market Research Bureau surveyed 923 housewives (Anon, 1986b); of these 42% had seen or heard something about the irradiation of food; more than half of this group (57%) disagreed with the use of irradiation; and 95% regarded clear labelling of irradiated food as essential. A more recent study for the London Food Commission found that 84% of consumers were against food irradiation. By contrast, several studies in the USA have indicated that 60-70% of consumers may be willing to purchase irradiated food (Bruhn, Schutz & Sommer, 1986).

One problem with most of these surveys has been that they were carried out in a theoretical way, without samples of irradiated and non-irradiated foods for consumers to examine and taste. A recent study in California, however, involved an evaluation of in-store responses of consumers to irradiated papayas (Bruhn & Noell, 1987). Irradiated papayas were available for inspection, tasting and sale. At two separate supermarkets, 66% and 81% of consumers were prepared to buy irradiated papayas. During the study, sales of irradiated papayas were 10 times greater than non-irradiated (double hot-water dipped) fruits.

Clearly more information and discussion on irradiation of fruits and vegetables and more contact with samples or irradiated produce will be required in Ireland and the UK before the true picture of consumer acceptability is known.

Detection of irradiated foods

The ability to detect reliably whether food has been irradiated is an important issue for consumers and regulators. The absence of a useful test might leave the consumer open to deception and prevent regulators from enforcing labelling requirements. In fact, it has been argued that irradiation of food should not be permitted without the availability of detection tests.

A rapid inexpensive test is required to tell whether the food has been irradiated and, if possible, the date of radiation received (Jeffries, 1983). As a result, scientists worldwide are looking for easily measureable changes in foodstuffs which are caused uniquely by irradiation. This has proved difficult, since irradiation causes relatively small changes in foods and some of these disappear during storage, while others are similar to changes caused by cooking, drying etc. Research to date suggests that no single test will be useful in all foods. Detection tests for irradiated meats and spices are at a fairly advanced stage of development but testing for irradiated fruits and vegetables requires considerable further research and development.

Most of the tests being developed are based on detecting either chemical or physical effects of irradiation. Among chemical changes the conversion of the amino acid phenylalanine to ortho-tyrosine in meat fibres seems to be close to practical application (National Bureau of Standards, 1986). Other chemical tests, for example those based on breakdown products of fats or of DNA, are at an early stage of development.

The most promising physical test involves measurement of electron spin resonance (ESR). The process of irradiation generates free radicals within foods. Most of these dissipate, but in denser materials, such as bone, free radicals are trapped and can be measured. Unfortunately, the stability of the ESR signal in products of high water content, such as fruits and vegetables, is very low, and it cannot be picked up 60 minutes after the irradiation has taken place. However, work is proceeding on denser portions of fruits and vegetables such as the calyx tissue of strawberries and apples.

Thermoluminescence and chemiluminescence, based on the effects of free radicals and excited electrons, are useful tests for detection of irradiated spices and are expected to be used by regulators in West Germany. Using these techniques irradiated spices are placed in water or heated; light is emitted in the form of a short impulse and can be measured (Heide & Bogl, 1987). Irradiated soil also produces these effects and they may be the basis for detecting irradiated vegetables which have minute amounts of soil attached, such as potatoes. Thus ESR and thermo-luminescence currently look like the more promising techniques for detection of irradiated fruits and vegetables, but considerably more research is required before they can be used reliably.

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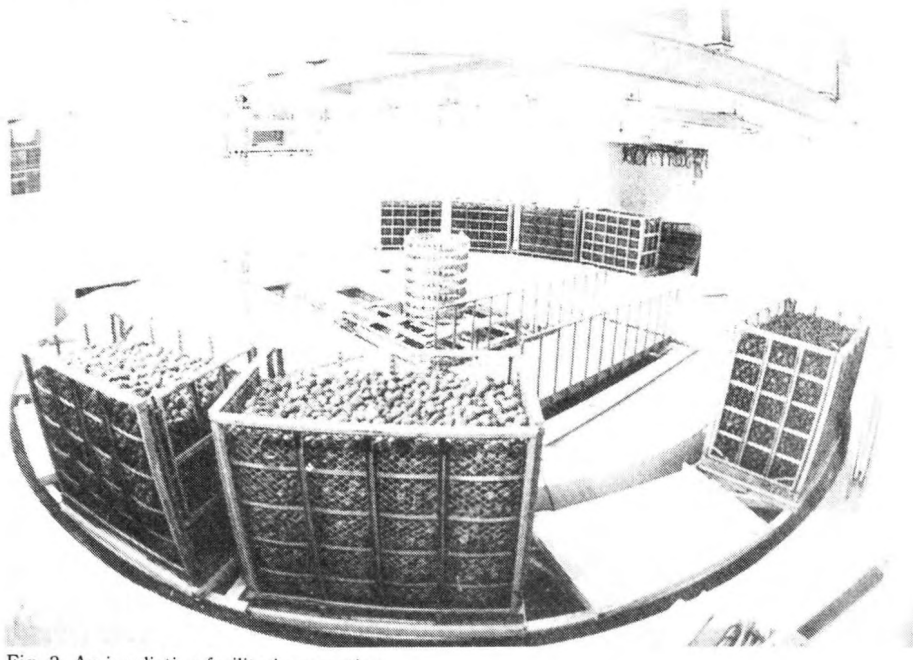

Fig. 3. An irradiation facility in operation.

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Grafting Grevilleas

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Introduction

The technique of grafting Australian plants has been used with success where there have been losses due to:

i) disease

ii) failure of more traditional propagating methods

iii) a lack of suitable propagating material

iv) failure due to climatic or soil conditions.

This paper outlines one specific technique where grevillea is grafted onto grevillea to produce a weeping standard.

Prior to discussing the technique and methods used it is relevant to understand something about the Botany and Horticulture of the genus *Grevillea.*

Grevillea in Horticulture

Grevillea belongs to the family *Proteaceae* and is included in the sub-family *Grevilleoidea.* This group includes many genera, some of the best known being *Telopea, Hakea, Banksia, Macadamia* and *Lambertia.* They are characterised by having flowers in pairs, with each pair of flowers subtended by a bract which is usually deciduous at the time of flowering. In Australia there are approximately 250 species of *Grevillea.* A large percentage of these occur in the south-western corner of Australia. There are 50 species in N.S.W, 35 species in Victoria and 40 species in Queensland. Tasmania has one species, *Grevillea australis,* which also occurs on the alpine country of Victoria and N.S.W. In Tasmania seven forms have been accorded varietal rank.

Grevillea is represented outside Australia in New Caledonia 3 spp. and in the Celebes, Indonesia. The Australian species *Grevillea glauca* and *G. pinnatifida* also occur in New Guinea, together with the endemic *G. papuana.*

It has been suggested that *Grevillea* first made its appearance on the floral stage during the late Cretaceous period, which is something like 80 million years ago. Even the botanists find it very hard to define the stages of development of *Grevillea.* Its closest affinity is to *Hakea,* and to a lesser degree *Finschia,* which does not occur in Australia.

Grevillea species are mostly confined to sclerophyll forests and heaths, only a few occurring in desert situations or in rainforests.

Grevillea and *Hakea* appear to have evolved in close association with each other. They sometimes have strong similarities in foilage, and in those instances can best be distinguished by the structure of the fruit, which is known as a follicle. *Grevillea* usually has a small follicle, which opens when the seed is ripe. In *Hakea* the fruit is a hard, woody capsule which remains on the bush and only opens after it is picked or a fire goes through the area. The two exceptions to this are *Grevillea candicans* and *G. annulifera,* which each have a round nut.

The genus has been subdivided into two groups by botanists as proposed by Bentham in "Flora Australiensis" Vol. 5 1870.

The section *Grevillea* contains such species as *Grevillea macrostylis, G. tripartita, G. nudiflora, G. platypoda* and *G. pectinata.* There is still a diversity in foliage, with very narrow lobing, very broad lobing, an extreme diversity in flower size and colour, style size and plant habit. This variation has resulted from interactions between the plants' ancestors and the environment.

The section *Manglesia* seems to be one of the most characteristically "West Australian" groups of the genus. It is characterised by small, dense clusters of white or cream flowers with very small styles dilated in the centre. They are often highly perfumed and are not well adapted to pollination by birds.

This group includes plants that are fairly well known: *G. tridentifera, G. glabrata, G. triloba, G. paniculata, G. vestita* and *G. biternata.* Although the group displays a wide variety of leaf forms, the floral structure is very stable.

It is interesting to note the variation in leaf form of *Grevillea.* In Queensland a large percentage of species have a large pinnate, fern-like leaf, with most plants being large shrubs or small trees. In N.S.W. there appears a dominance of simple leaves, either linear, obovate or lanceolate type leaves. In Victoria a large number possess holly-like leaves. In South Australia they have again in most cases simple leaves while in W.A. a complete range is found including simple leaves and holly-type leaves, but the very narrow divaricate type of leaf is common.

Potential for Horticulture

Some 150 of the 250 named species have been tried in horticulture. Many will adapt to a wide range of soil conditions, whilst some have limitations. In their natural environment grevilleas grow best in low rainfall areas associated with deep sandy soil conditions particularly in Western Australia, South Australia and in parts of Victoria.

In New South Wales it is interesting to note that *G. caleyi, G. laurifolia, G. acanthifolia* and *G. x gaudichaudii* do not grow well in light, low-nutrient soil types, yet in comparison *G. sericea, G. speciosa* and *G. longifolia* grow extremely well.

It is amongst the Western Australian species that we find a very long list of very desirable garden shrubs. Those with a wide range of growing conditions adapt satisfactorily in S.E. Australia. Species that grow in deep sand i.e. the northern sand plain species are often very difficult to establish in the East, whereas those that come from shallow soils are much more adaptable and adapt to either shallow or deep soils.

Therefore in selecting grevilleas for the garden particularly in S.E. Australia — CHOOSE YOUR SPECIES WISELY!

Experience has shown that a large number of the W.A. species suffer root damage during winter rains and that this is not evident until summer time when the plant is under stress. The plant is able to survive the cooler conditions but when summer arrives it cannot survive. In many instances it has been found that the plant has virtually drowned or that damaged roots cannot cope with high summer transpiration losses or the cause of death is the deadly fungus *Phytophthora cinnamomi.*

Materials and Method

Objective

To produce a 1.5m standard grevillea with a weeping habit using the spliced approach graft method.

Method

The distinguishing feature of approach grafting is that two independent self sustaining plants are grafted together. After a union has occurred, the top of the stock plant is removed above the graft and the base of the scion plant is removed below the graft. Sometime it is necessary to sever these parts gradually rather than at the one time.

Approach grafting provides a means of establishing a successful union between certain plants which otherwise may be difficult to graft together. It is usually performed with one or both of the plants to be grafted growing in a container. Rootstock plants in containers may be placed adjacent an established plant which is to furnish the scion part of the new grafted plant.

This type of grafting can be done at any time of the year, but healing of the union is more rapid if it is performed at a season when growth is active. As with other methods of grafting, the surfaces should be securely fastened together and covered to prevent drying of the tissues. The *spliced approach* method is outlined below.

Step 1

A single stemmed healthy, vigorous *G. robusta* approximately 1.8 metres in height being the rootstock.

The prostrate grevillea, *G.* 'Poorinda Royal Mantle' being the scion.

Both scion and stock were in an active growth phase, (i.e. early summer).

To perform the technique the scion material with roots intact was placed on makeshift shelves in the propagating unit at a height of 1.5m (see Fig. 1).

Step 2

With the scion material in place the rootstock was positioned so that it was directly

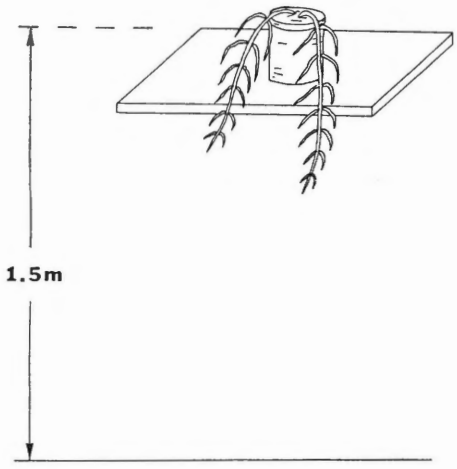


Fig. 1

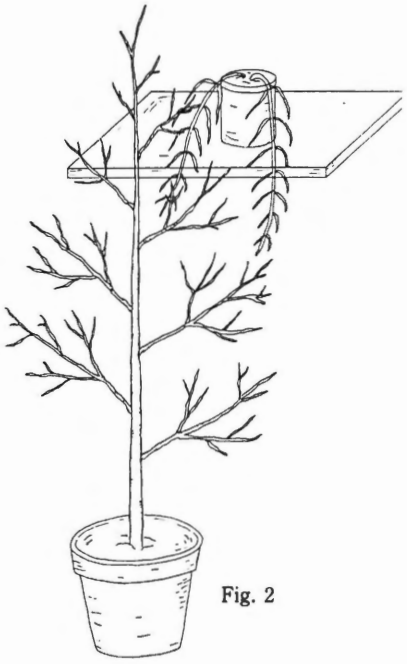
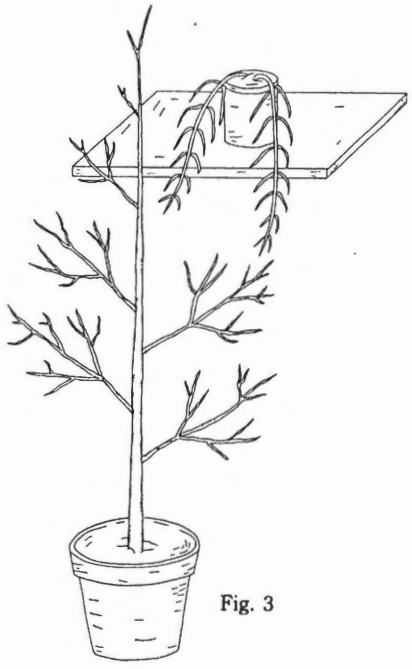


Fig. 2



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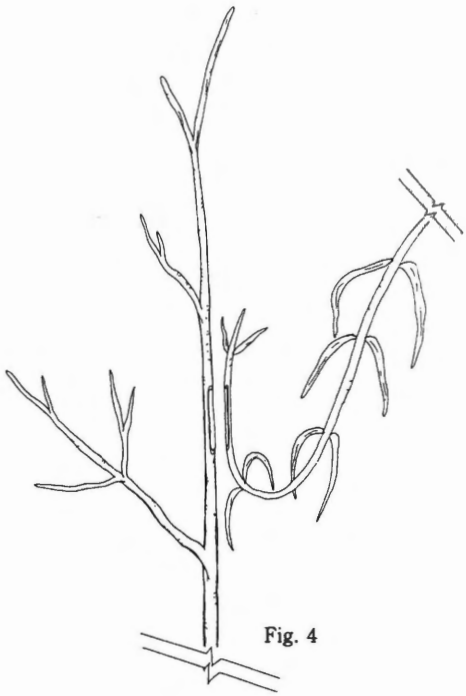
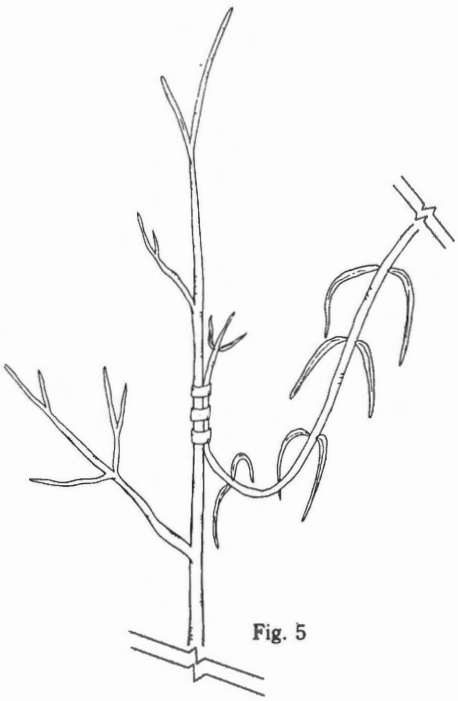


Fig. 4



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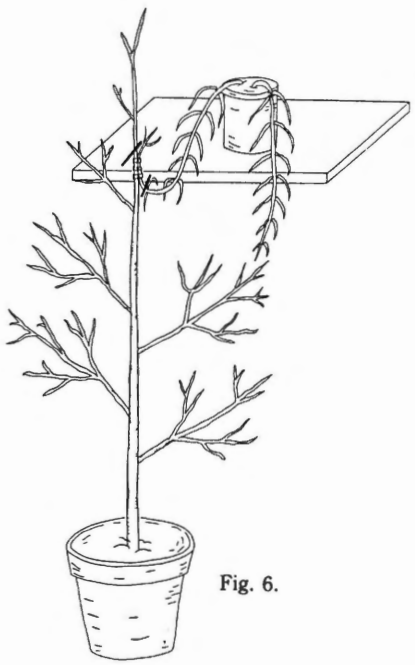

Fig. 6.

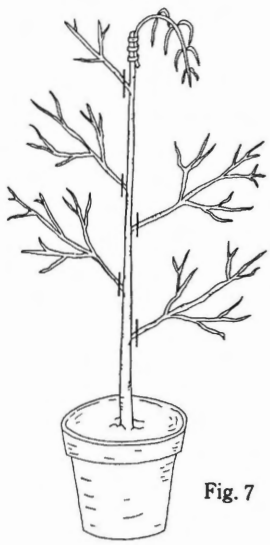

Fig. 7

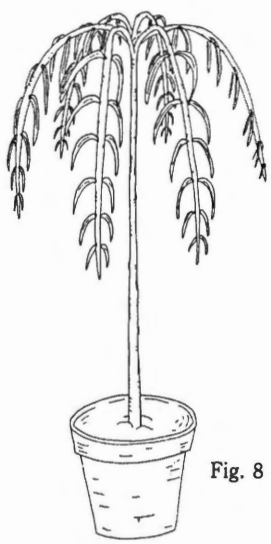

Fig. 8

Figs. 1-8. Steps in approach grafting to produce a standard grevillea using *Grevillea robusta* as rootstock and *G.* 'Poorinda Royal Mantle' as scion.

adjacent (Fig. 2). Along the section of stems where the graft was to occur, leaves, petioles, etc. were removed with a sanitised scalpel (Fig. 3).

Step 3

The cambiums of both the stock and scion were exposed for an approximate length of 30-50mm the cuts being made by using a clean, sharp, sanitised scalpel blade (Fig. 4).

Step 4

The cambiums of both stock and scion were united and tied with grafting tape (Fig. 5) then placed in the shade house for some six weeks to allow a strong healthy union to form. The atmosphere was kept moist with adequate but not excessive watering of both stock and scion.

Step 5

After six weeks the graft was carefully inspected to ascertain if union had occurred. If so the grafting tape was removed and the scion severed from its own roots with sharp secateurs making a good clean cut directly below the union (Fig. 6).

Results

Once the new "head" began to show vigorous growth, the top of the rootstock was removed with a clean cut directly above the union (Fig. 7).

As the head slowly enlarged it was tip pruned in order to encourage branching and create a full "head". Any lower leaves or branches were removed from the rootstock (Fig. 7) resulting in a healthy weeping standard grevillea (Fig. 8).

Discussion

The rationale behind using the spliced approach graft method is outlined below:

1. As a practical propagating exercise for the Corporation's 12 horticultural apprentices.
2. To propagate a supply of "Novelty" weeping grevilleas for a landscape beautification project within the city.
3. To assess the method under the climatic regime prevailing in Hobart.
4. To obtain a "special" form of plant material for use in the public landscape.

Many grevillea spp. under cultivation have proved themselves as reliable garden subjects. Others have proved difficult. These are mainly species from the drier, inland habitats which often prove difficult to propagate in South Eastern Australia.

Grafting is always a possibility as reliable stocks such as *G. robusta* appear to be compatible with most species as evidenced by projects undertaken at the National Botanic Gardens (Canberra) where *G. robusta* has been used as a successful stock plant for the production of weeping grevillea standards. Prostrate species such as *G. x gaudichaudii* have been grafted onto 2-3m *G. robusta* seedlings.

Through implementing this method a plant with a weeping habit was produced for use in the public landscape. The use of the technique varies — some weeping trees will grow as spreading shrubs if bottom worked but will show the true weeping habit and form an attractive tree if top-worked on to a clear stem, as in the method outlined.

This type of graft can also be used in the production of "Novelty trees". This is difficult to define, but essentially they are trees/shrubs that constitute an "unusual" scion/rootstock combination providing either more than one cultivar on a plant ("Family trees") or a plant providing an unusual effect.

The success rate in terms of union was 95% of the total number of grafts attempted. This was not unexpected considering the growth conditions of stock and scion and the climatic conditions prevailing in Hobart at the time — December/January.

Conclusion

As with other propagating methods there are limitations to methods of grafting, these include:

1. Methods that may require additional facilities to provide a controlled environment during the after care period eg. subjects propagated by bench grafting.
2. The need for reliable and skilled personnel who require training and consequently higher remuneration.
3. The additional costs involved in growing or purchasing rootstocks.
4. Problems resulting in delayed incompatibility between rootstock and scion.
5. Rootstocks that exhibit excess suckering resulting in a deterioration in the quality of scion growth over the years. This can often be prevented by 1) correct removal of suckers during the propagation stage 2) grafting lower on rootstock 3) using an alternative rootstock 4) removal of suckers soon after planting in the permanent site.
6. Possible changes in the normal habit growth. This can be desirable in many cases but in specialty items, such as dwarf conifers, the eventual height can be greater than originally anticipated with plants raised from cuttings.

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Hebe Breeding at the Auckland Regional Botanic Gardens

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The *Hebe* breeding programme at the Auckland Regional Botanic Gardens commenced in 1982, with the objective of developing new cultivars of superior appearance and garden performance. The susceptibility of many hebes to disease has severely limited their popularity, especially in areas with very humid climates. Septoria leaf spot (*Septoria exotica*) is common on many hebes, including *H. speciosa*, which has been used as the main source of bright floral colours such as magenta, pink, and purple. Many hebes are also attacked by downy mildew (*Peronospora grisea*), (Pennycook, 1989). Some species, eg. *H. diosmifolia*, and cultivars are generally free of such disease problems and this characteristic is sometimes imparted to their offspring. Many other species and cultivars have also been used with the expectation that some of the offspring will inherit the desirable characteristics of their parents without inheriting their weaknesses.

Nomenclature used follows that of Metcalf, (1987).

Developing the Programme

Desirable Characteristics

1. Greater disease resistance, under typical garden and nursery conditions.
2. Improved flower production:
- longer flowering periods (triploids possible)
- repeat flowering;
- increased flower quantity/flush flowering;
- reliable and predictable flower production;
- reduced cold and light requirements for flower initiation to occur, especially in warmer areas.
- a range of flowering times.

3. Improved floral appearance:
- greater colour range, especially pink and purple;
- large individual florets;
- branched inflorescences which should smother the plant;
- unbranched inflorescences possible in a range of lengths and habits (e.g. pendulous or upright). Those with a high density of flowers are generally most satisfying.

4. Attractive foliage, including:
- bronze, red and grey foliage;
- a range of other colours including various shades of green;
- a range of shapes, sizes and textures.

5. Attractive growth habit, including:
- compact symmetrical habit as young plants grown from cuttings for container use;
- neat, compact appearance in the garden;
- a range of habits from tall upright to spreading and pendulous.

6. Reliable garden performance:
- tolerance of heat or cold;
- tolerance of wind including coastal situations;
- tolerance of a range of soil types.

7. Acceptable nursery performance:
- rapid flowering from cuttings;
- vigorous growth;
- robust root development;
- symmetrical growth habit;
- long container life;
- tolerance of shade.

Selecting Parent Material

The variability within many *Hebe* species makes it important to use genetically superior material as parents. In recent years numerous accessions of wild material have been tested in cultivation at the Auckland Regional Botanic Gardens and outstanding clones are being introduced into the breeding programme. Important suppliers of new material have included Graeme Platt (Platts Nursery, Albany), Ewen Cameron (Auckland University), Terry Hatch (Joy Plants, Pukekohe) and Peter Heenan (DSIR Land Resources, Christchurch). I have also collected material in Northland and more recently from the N.W. Nelson region.

Interspecific hybrids have displayed great uniformity with most of their characteristics intermediate between those of the parents. More complex hybrids display greater variability.

Parents combinations are calculated to achieve a desired objective and these are often tested by raising a few seedlings to maturity.

Genetic incompatibility can occur. Moore, (1973) lists chromosome numbers of *Hebe* spp. Attempts to cross *H. macrocarpa* var. *brevifolia* and *H. macrantha* with various diploid species have so far failed to produce viable seed.

Methods and Techniques

Pollination of containerised plants under cover provides greatest control and convenience.

Hand pollination:
- stamens are removed from each flower before pollen is produced;
- pollination of basal flowers commences as they open and is continued until entire inflorescence is pollinated.

Seed collection and storage:
- seed capsules are collected immediately they become a brownish colour as seed dispersal is rapid once the capsules split. The period from pollination until seed collection has varied from 48 to 104 days. (average 70 days);
- storage is in a cool dry location until ripening and dispersal of seed is complete. Seed is usually ready for final sorting and sowing after a minimum of 1 month in storage. Viability exceeds 12 months.

Sowing:
- sown at moderate temperatures under cover (22-25°C);
- light required;
- no cold pre-treatment required and no periodicity of germination shown by northern species and hybrids. (May be different for alpine hebes).

Germination:
- commencement of germination has occurred between 6 and 53 days after sowing. (average 25 days);
- germination rates of hybrid seed are usually significantly lower than those of species;
- germination can occur sporadically over a period of several months, particularly with hybrid seed. Late germinating seedlings may exhibit different characteristics (e.g. vigour, etc.) than early seedlings and should be retained.

Transplanting:
- the earliest seedlings are ready for transplanting (into tubes etc) between 22 and 92 days after sowing. (average 51 days).

Flowering:
- the first flowers usually appear about 30 to 40 weeks after sowing.

Monitoring and Recording Performance at the Auckland Regional Botanic Gardens:
- Usually all the seedlings which germinate are pricked out and those which subsequently are infected by disease are culled immediately. The proportion which remains at planting time is almost always less than 50% and has been as low as 8%. Downy mildew heavily infects certain crosses — disease resistance at the seedling stage is usually retained at maturity;
- selected individuals are numerically coded. Flowering records and performance assessments are kept regularly;
- Selected seedlings are cutting-grown and tested at various sites. Only outstanding individuals with distinctive characteristics are eventually named and registered.

Characteristics typically imparted by some species when used as parents

H. speciosa:
- bright flower colours;
- long flowering period;
- winter flowering;
- when crossed with summer flowering varieties two flowerings usually result;
- variable inflorescences — simple or branched;
- high flower density;
- flowering reliable but may not flush flower;
- attractive glossy foliage;
- susceptibility to leaf spot.

H. diosmifolia:
- limited colour range;
- flush flowering;
- branched inflorescences;

Fig. 1 FH 76. Left: *H. diosmifolia* (branched inflorescence). Centre: *H. bollonsii* (simple inflorescence). Right: Hybrid between *H. diosmifolia* and *H. bollonsii*. This illustrates how most hybrid characteristics are intermediate between those of the two parents.

- high flower density;
- reliable flower production;
- attractive small foliage;
- freedom from disease;
- some shade tolerance;
- compact growth habit.

H. macrocarpa var. *latisepala:*
- purple or blue flowers;
- long inflorescences;
- high flower density;
- large flowers;
- susceptibility to leaf spot disease;
- upright growth habit.

H. obtusata:
- flower colours in a range from mauve to purple;
- prostrate/pendulous growth habit;
- susceptibility to disease (Downy mildew).

H. albicans:
- attractive fleshy foliage, occasionally grey;
- growth habit usually dense, possibly prostrate;
- freedom from disease;
- hardy;
- cold often required to induce flowering.

Characteristics typically imparted by some cultivars when used as parents

H. diosmifolia (pink):
- increased colour potential in the pink, rose to magenta range compared with typical *H. diosmifolia;*
- flush flowering.

H. diosmifolia 'Lilac Gem':
- purple flowers;
- flush flowering;
- attractive stems.

H. 'Lavender Lace':
- prolonged flowering;
- repeat flowering.

H. speciosa (bronze leaf reverse):
- bronze foliage, especially underside, is evident in most offspring;
- as for *H. speciosa* but less susceptible to disease.

H. speciosa (purple):
- purple flowers;
- as for *H. speciosa*, less susceptibility to disease.

H. speciosa (mauve):
- large plants, vigorous growth.

H. 'Wiri Jewel':
- as for *H. speciosa*, less susceptibility to disease.

H. 'Wiri Joy':
- pink to rose flower colour range;
- prolonged flowering;
- repeat flowering;
- flush flowering;
- compact growth habit;
- attractive glossy foliage;
- susceptibility to disease (Downy mildew).

H. 'Wiri Gem' and *H.* 'Wiri Charm':
- flower colours in shades of violet rose;
- long flowering periods;
- repeat flowering — winter and summer;
- flush flowering;
- branched inflorescences;
- small attractive foliage;
- compact growth habit;
- freedom from disease.

H. 'Pamela Joy':
- purple flowers;
- long flowering periods;
- repeat flowering;
- flush flowering;
- simple or branched inflorescences;
- compact growth;
- freedom from disease.

Successful Crosses

Seed of the following hand made crosses has been sown in the period between 14.3.84 and 10.4.90 and has germinated successfully (seed parent shown first, date of sowing in parenthesis).

Code	
AD	*H.* 'Amy' x *H. diosmifolia* (14.3.84)
AL/A	*H. albicans* x *H.* 'Amy' (14.3.84)
AL/BG	*H. albicans* x *H. franciscana* 'Blue Gem' (14.3.84)
AS	*H. albicans* x *H. speciosa* (mauve) (14.3.84)
Albl/A	*H. albicans* 'Boulder Lake' x *H.* 'Amy' (14.3.84)
LS	*H.* x *lewisii* 'Lewisii' x *H. speciosa* (mauve) (14.3.84)
LA	*H.* x *lewisii* 'Lewisii' x *H.* 'Amy' (26.4.84)
PC	*H.* 'Snowdrift' x *H.* x *carnea* 'Carnea' (14.3.84)
PL	*H.* 'Snowdrift' x *H.* x *lewisii* 'Lewisii' (14.3.84)
DC	*H. diosmifolia* 3/81 x *H.* x *carnea* 'Carnea' (14.3.84)
1	*H.* 'Wiri Jewel' x *H. diosmifolia* (pink) (1.3.86)
2	*H. bollonsii* x *H. diosmifolia* (pink) (1.3.86)
4	*H.* 'Wiri Joy' x *H. speciosa* (bronze leaf) (18.5.87)
5	*H. macrocarpa* var. *latisepala* x *H. speciosa* (mauve) (17.7.87)
8	*H. diosmifolia* x *H.* 'Wiri Jewel' (8.2.88)
9	*H. diosmifolia* 'Wairua

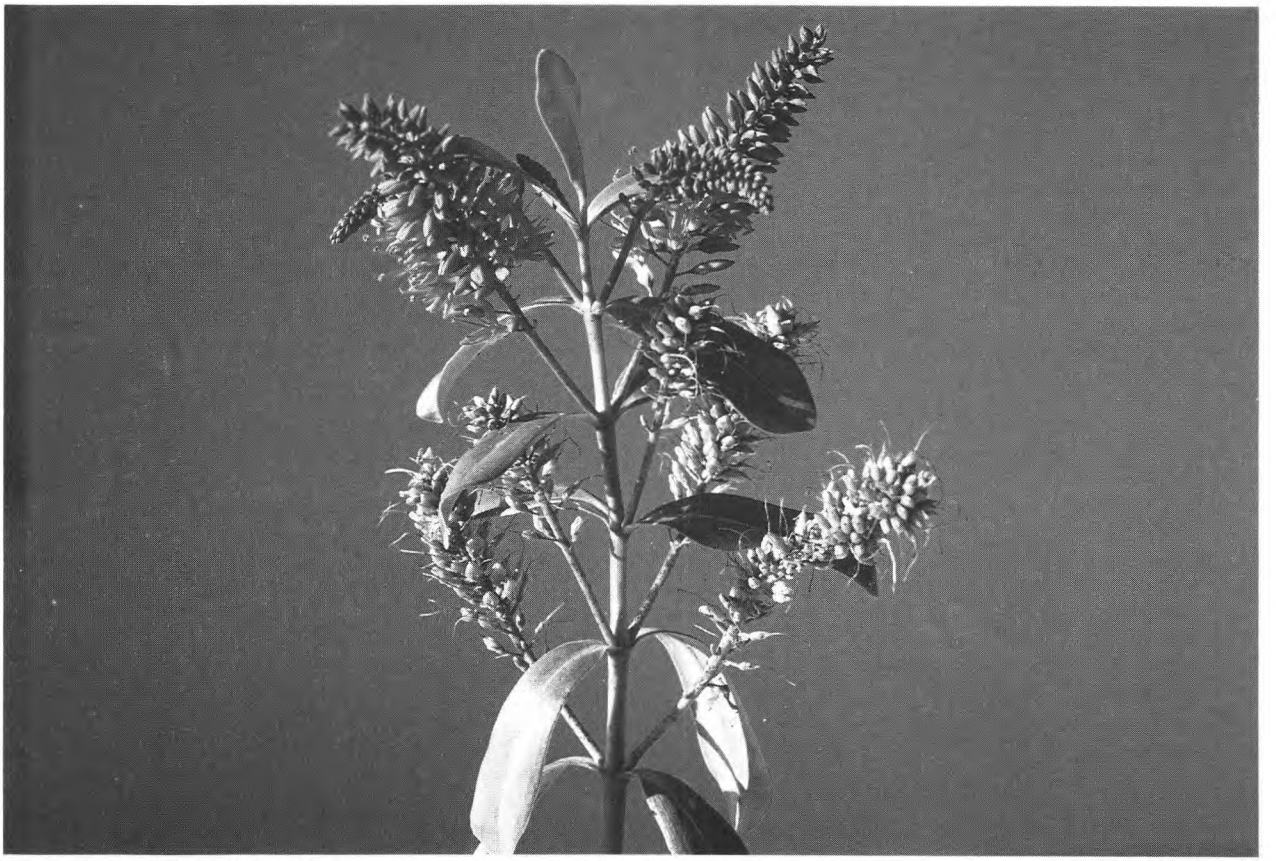

Fig. 2 FH 66. *Hebe* 'Wiri Vision' showing successive flowering, which is often characteristic of hybrids derived from *H. speciosa.*

Beauty' x *H.* 'Wiri Jewel' (8.2.88)

10 *H.* 'Lavender Lace' x *H.* 'Wiri Jewel' (8.2.88)

11 *H.* 'Wiri Jewel' x *H. diosmifolia* (pink) (8.2.88)

12 *H.* 'Wiri Jewel' x *H.* 'Wiri Joy'' (8.2.88)

16 *H. obtusata* x *H. speciosa* (bronze leaf) (7.6.89)

19 *H.* 'Wiri Spears' x *H. speciosa* (bronze leaf)

22 *H.* 'Wiri Gem' x *H.* 'Inspiration' (28.11.89)

23 *H.* 'Wiri Gem' x *H.* 'Wiri Joy' (28.11.89)

24 *H.* 'Wiri Gem' x *H.* 'Pamela Joy' (28.11.89)

25 *H.* 'Wiri Gem' x *H.* 'Lilac Gem' (28.11.89)

27 *H.* 'Wiri Gem' x *H.* 'Wiri Charm' (28.11.89)

28 *H.* 'Pamela Joy' x *H.* 'Wiri Charm' (10.4.90)

32 *H.* 'Pamela Joy' x *H.* 'Lilac Gem' (24.4.90)

35 *H.* 'Inspiration' x *H.* 'Wiri Splash' (18.4.90)

37 *H.* 'Wiri Charm' x *H.* 'Wiri Gem' (28.11.89)

41 *H.* 'Inspiration' x *H. diosmifolia* (pink) (10.4.90)

Hebe Cultivars raised at the Auckland Regional Botanic Gardens

'Wiri Joy' A32 (1982 *H.speciosa x H. carnea* 'Carnea' — 85cm x 120cm in 3 years). This variety bears some resemblance to *H.*'Inspiration' in habit and general appearance but the flowers are a most attractive rose pink. Flowering can exceed 8 months in duration from mid-November until the following August. Best planted in an open situation as downy mildew has occasionally been a problem.

'Wiri Splash' A17 (1982 *H. brachysiphon x H.* 'Lavender Lace' — 40cm x 55cm in 3 years). A compact variety with attractive golden-green foliage which reliably produces a profusion of lilac coloured flowers in early summer (mid-November to early January). Disease resistant and suitable for massed planting and container use.

'Wiri Jewel' C72 (1982 *H.speciosa* selection — 85cm x 85cm in 3 years). Similar to typical *H.speciosa* in general appearance with the most notable difference being the undulating margins and pointed tips of the foliage. This variety was selected primarily for its relative resistance to leaf spot disease and it has been used extensively as a parent. The prolonged flower period commences in about January, peaks from March until June, then continues sporadically until about October.

'Wiri Spears' B40 (1982 *H.speciosa* (mauve hybrid) *x H. macrocarpa* var. *latisepala* — 140cm x 170cm in 3 years). This is a quick growing shrub which somewhat resembles *H.* 'Andersonii' but differs particularly in its more compact growth habit and relative freedom from disease. The long spear shape flowers of bluebird blue are produced abundantly from late January until May.

'Wiri Grace' B90 (1982 *H.speciosa* (mauve hybrid) *x H.stricta* — 140cm x 150cm in 3 years). *H.strica, H.speciosa* and *H.bollonsii* all appear in the pedigree of this cultivar which combines many of their most desirable attributes. In general appearance it resembles *H. stricta* but it is more compact, disease resistant and ornamental than typical members of that species. The long mauve inflorescences are most abundantly produced in January and February with sporadic flowering occurring until winter.

'Wiri Image' B7 (1982. *H. bollonssi x H venustula* — 100cm x 130cm in 3 years). This cultivar is distinguished by its compact habit and dark green lanceolate leaves which remain disease resistant even in Auckland's humid climate. The methyl-violet flowers are produced in November-December and again intermittently through winter. It is suitable for use in massed plantings or individually in a shrub border. It is popular as a container subject because of its symmetrical habit and disease resistance.

'Wiri Gem' 1/1 (1986 *H.* 'Wiri Jewel' *x H. diosmifolia* (pink) — 100cm x 130cm in 3 years). An attractive shrub with a neat symmetrical and somewhat upright growth habit. Flowering is intermittent over a period that can total 9 months and the flowers are a shade of rose. The inflorescences are usually branched and produced abundantly at the tips of the branches. The main flower period is from April until October with a brief flush in December. An outstanding variety for both gardens and containers with its abundant flowering and freedom from disease.

'Wiri Charm' 1/2 (1986. *H.* 'Wiri Jewel' *x H. diosmifolia* (pink) — 75cm x 130cm in 3 years). From the same cross as 'Wiri Gem' this variety is distinguished by its more compact and less upright habit, slightly undulating foliage with rounded tips and the flower colour which is a deeper shade of rose purple. The racemes are usually branched. Flowering occurs over a

similar period to 'Wiri Gem' but it is generally less pronounced in winter and more prolific and for a longer period in summer. Also outstanding for garden and container use and usually free of disease.

'Wiri Dawn' 4/3 (1987 *H.* 'Wiri Joy' *x H. albicans* (prostrate) — 45cm x 100cm in 3 years). A low spreading variety which will cascade if planted near a wall. The rose pink buds open to produce pale pink flowers with a white throat. The racemes appear over a long period in summer and again in autumn/winter. The narrow fleshy foliage is a pale shade of olive green. Suitable for use as a groundcover and as an attractive weeping container plant.

'Wiri Vision' 12/1 (1988 *H.* 'Wiri Jewel' *x H.* 'Wiri Joy' — 90cm x 120cm in 2 years). This variety combines some of the best characteristics of its parents. The attractive purple red racemes are produced over a long period in autumn/winter and again in summer with the peak flower period occurring in May and June. The foliage is distinctively undulating and somewhat revolute and is resistant to disease. As it flowers very rapidly when grown from cuttings it makes an attractive container plant. Also excellent in the garden where it forms a rounded shrub of rather open habit.

Other Hebes released by the Auckland Regional Botanic Gardens

***Hebe* 'Anne'** (1988 *H. speciosa* (bronze) *x H.* 'Wiri Joy' — 75cm x 10cm in 15mths). Similar in general appearance to *H. speciosa* but flower colour is pink and the leaf tips are pointed. The flowers are slightly deeper pink than *H.* 'Wiri Joy' and are produced densely on 8-10cm racemes over a long period, especially in winter. The colour of the foliage and stems resembles that of *H.* 'Wiri Joy'. The glossy leaves are about 8.5cm x 3.5cm and most resemble *H. speciosa* in size and shape. This disease resistant variety is excellent for the garden and containers. Raised by J. G. Hobbs at Mauku.

H. 'Sandra Joy' (1988 *H. speciosa* (bronze) *x H. macrocarpa* var *latisepala* — 90cm x 100cm in 15 mths). Rich purple flowers fading with age are produced densely on 12cm racemes over a long period, particularly in winter. The deep green leaves are about 10cm x 3.5cm wide and have a distinct reddish midrib and pointed tips. The foliage attractively contrasts the reddish brown stems. Disease resistant and suitable for garden and container use. Raised by J. G. Hobbs at Mauku.

Conclusion

The popularity of hebes as cultivated ornamentals is increasing worldwide. For example Denmark currently produces about 2.5 million potted hebes annually for the European market, and this number is expected to grow considerably. Interest both here and overseas will be stimulated by the introduction of outstanding new cultivars, whether they be hybrids or elite selections from the wild. The huge diversity within this genus provides breeders with many possibilities. Most breeding work has previously been undertaken overseas, but the far greater pool of genetic material available in New Zealand provides breeders here with an obvious advantage.

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Note: Further photographs on back cover.

Investigation into the Production of Oil from the Flowers of *Boronia megastigma* Nees

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Interest in growing *Boronia megastigma* in the Nelson region as an alternative crop began in 1984 when a pipfruit grower, A. E. Scott, returned from a tour of Tasmania and other parts of Australia where he saw the plant being grown for its essential oil content. Those who have grown this plant as an ornamental will realise its fickle nature and the often short duration of survival in the garden situation. However, DSIR began investigating the production of the plants, their growth and extraction of flowers, knowing that the meticulous husbandry of tobacco growers in this region would be a major bonus for producing a plant of this nature.

Establishing Plantings

Nursery plants were obtained and a small block planted on the research station. Flowers were harvested from these in the spring of 1985 and extraction work carried out by the DSIR Industrial Development at Gracefield. This planting lasted two seasons but lost a high percentage of plants from collapse and was abandoned in favour of a much larger planting on a different land area. On these a number of observations were made including: planting configuration, clonal types, herbicide and nutrient observations. Growth and yields from this block were sufficiently promising to approach a group of farmers which had expressed interest in essential oil production and to approach the Regional Development Council for assistance. Consequently approximately 0.2 ha was planted on five soil types/climatic ranges to evaluate how the crop would respond under these distinctly different conditions. The most successful has been on a block on Tahunanui sand, very close to the coast and with a naturally high water table of approximately 60 cm all year round.

Unfortunately the massive floods of August 1990 have had an effect on plants as several blocks were completely submerged, a condition the plants will not tolerate, and numerous plants have subsequently died. This had a large effect on the expected 1990 production which decreased to approximately 30% of the predicted yield.

Early in the observation it was concluded that there was a huge variation in flower potential and oil content of seedlings but until such time as fully evaluated clonal material is available a population of seedlings would be the quickest way into production. West Australian production is mainly gathered from heterogeneous seedling populations. Seed was imported from this source and treated to assist germination. For three years this treatment was highly successful and resulted in several thousands of plants. However, following this same procedure in 1989 gave no germination at all. Discussions with West Australian botanical garden staff indicated that this is not unusual and the seed can germinate even after 2 years in the soil. All seed sowings from 1989 have been retained and perhaps germination will still occur. The seed itself is very oily and this acts as an impervious barrier to moisture and a protection for the seed. From the earliest seedling plantings selections have been made primarily on high flower yield and then reselected on the basis of highest oil yield from extraction of the flowers. In the autumn of 1989 a contract was let with a Richmond nurseryman to produce cuttings from plants of the ten best selections and in late autumn 1991 a replicated trial will be planted using these.

Work to investigate tissue culture of boronia began at DSIR Crop Research, Lincoln, concurrently with the conventional cutting contract, and progress to date suggests that rapid multiplication of superior clones will be possible.

Once in the field cuttings grow rapidly and yields of 25-50 gm of flowers are possible in October following planting the previous November-December. Three year old plants at the most successful site have filled the between plant spaces (60 cm) and have also filled the between row spaces (120 cm) just leaving comfortable walking room. Plants are approximately 90 cm high and 80-90 cm in diameter.

Flowers are initiated in late autumn and buds develop throughout the winter, opening in late September and throughout October. Because development is sequential along the stems each flowering branch has flowers at many stages of development. This creates harvesting difficulties but by gently raking the branches with hand held steel combs it is possible to remove open flowers and large buds without taking off tight buds. This is important as it can improve harvests by 100% just by being careful. Heaviest yields in 1990 removed over 600 gm of flowers from a single mature plant. This may increase still further as bushes become older.

Plant Management

As *Boronia megastigma* flowers on new growth it is important to maintain young and healthy branching. Immediately following flowering shrubs are pruned to open up the plant centres, thin out growth and to facilitate spray entry and ease of harvest next season. Mechanisation in future may require changes to the system used at present but until this is necessary manual raking will continue. This system enables removal of up to 2 kg of flowers per hour, but this will increase once clonal blocks are established.

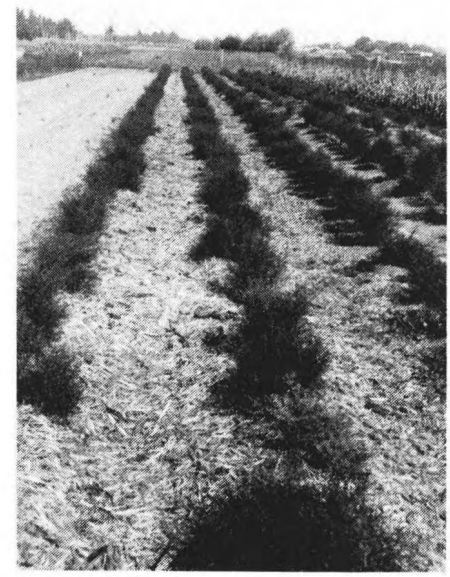
Extraction

Once the flowers are collected they are stored in sealed plastic bags, preferably under refrigeration until ready for extraction. Prior to the 1990 season, all flower was collected and steeped under hexane in polypropylene drums then the extract and hexane were separated using a climbing film evaporator. In 1990, DSIR Industrial Development built a hexane extraction unit capable of taking 150 kg of flowers at each extraction and this will be capable of taking all of the flowers for the next 4-5 seasons harvests. Correct flower storage immediately post harvest means that flowers can be bulked up over a period of 3-4 days to give most economic use of the extraction plant.

Hexane is used as the solvent to separate the oils and waxes from the flowers and, although this material is hazardous to use, it does give the most satisfactory extraction at this stage in the project from a cost/return point of view.

Following extraction a semi solid residue of wax plus oil is obtained from the flowers called "concrete" in commercial trade and this is separated from the residual hexane, washed and prepared for sale in this form, or the wax can be removed to give a pure oil (absolute).

Boronia absolute is the highly priced extract prized for its fine fragrance. The absolute is viscous, greenish brown with a strong fruity citrus bouquet which has a pleasant lingering aroma. The semi solid mix of wax plus oil is browner in colour. Chemically these products are a complex array of chemicals with ionones being of major importance. β ionone is clearly distinguished on gas chromatograph traces and boronia extract was the first recorded natural occurrence of this widely used perfume material. A major use of boronia "concrete" is in the food flavouring industry where it is



A planting of boronia.

used to enhance the natural fruit flavours of jams, conserves, preserved fruits and beverages.

From the New Zealand producers viewpoint, boronia extract is a low volume highly priced commodity with a high risk level throughout the production phase.

Pests and Diseases

Pests and diseases are a major problem with boronia especially the root rotting fungus *Trichocladium basicola* which causes plants to die over a period of 4-5 days from the time the first foliage symptons appear. A major trial to overcome this disease is being planted in summer 1990/91. In Australia plants are attacked by a rust that also has major effects on plant growth. While this has not been recorded in the Motueka gardens a small orange psyllid insect builds up in large numbers, particularly preflowering, and chews the leaves and flower buds out. A sooty mould develops on their resulting excrement so that plants can take on a black appearance not dissimilar to blight of manuka. Because of the desire to avoid spray residues in the resulting extracts, spraying has been kept well away from harvest time, and only spraying oil has been used to combat the problem. Green peach aphid can also be troublesome on fresh spring growth.

During the next 4-5 seasons farmers in the Motueka area expect to increase the current 1 hectare to 10 hectares from which 15 tonnes of flowers will be harvested and up to 150 kg of wax plus oil produced,

Several farmers in Nelson province are diversifying into essential oil crops and over the next few years expect to be able to offer complex and expensive products like boronia extract as well as products from other crops which are more easily grown but with lower returns.

Royal New Zealand Institute of Horticulture Citation for the Award of Associate of Honour

LEO CHANEL JOSEPH CLARK

Leo Clark was born in Marton in 1921 and received his early schooling in Timaru. It was at school that he first showed an interest in horticulture but army service during the Second World War interrupted his further study in this area. Leo Clark saw active service with the 23 Battalion in Egypt and Monte Cassino in Italy and returned to New Zealand in 1945.

He was one of the first rehabilitation students to take a short course in horticulture at Lincoln College prior to setting up on his own account to grow his chosen crop, chrysanthemums.

For a short period he worked at the well known Nairn's Nurseries in Christchurch and also at Coulls, Somerfield and Wilkie in order to accumulate some capital to assist his new venture. He was married in 1947 and with his wife purchased an acre of land in Bowenvale, Christchurch. From here he developed cultural perfectionism and established himself as a top New Zealand authority, exhibitor and judge of chrysanthemums.

Leo Clark's technical skills in growing chrysanthemums are recognised throughout New Zealand and overseas by growers and by Government scientific and technical personnel. He was instrumental in initiating year-round production and flowering of chrysanthemums in New Zealand and has raised many new seedlings, particularly new dwarf cultivars. He was the first to import the early flowering chrysanthemum into New Zealand.

For many years he was editor of the quarterly bulletin of the National Chrysanthemum Society. He has served on the executive of the National Chrysanthemum Society and is a past president of the N.Z. Nurserymen's Association. For many years he was Nurserymen's Advocate in negotiations with the Employers' Federation on industrial award deliberations.

For many years he was active on the Management Committee of the Canterbury Horticultural Society. He has exhibited successfully at shows in Canterbury and throughout New Zealand and is much sought after as a judge, lecturer and demonstrator on chrysanthemum culture. He is generous to a fault in the giving of his chrysanthemum flowers.

In 1969-70 he was associated with the formation of the New Zealand Flower Growers' Association.

Internationally he has judged chrysanthemums in Great Britain, Australia, America, India and Japan. He was the first overseas person to judge in Japan. Also he became President of the International Chrysanthemum Committee at its 1987 meeting in Japan. Leo Clark was instrumental in forming the Indian National Chrysanthemum Society and has been made a life member of that organisation in recognition of his services to it.

The National Executive are pleased to present the Award of Associate of Honour of the Royal New Zealand Institute of Horticulture in 1990.

THOMAS CARRICK CHAMBERS

Thomas Carrick Chambers was born in 1930 and was educated in Auckland. He studied botany at Auckland University, graduating with a Master of Science in 1954. His thesis was entitled 'Experimental Studies of the genus Blechnum'. Shortly afterwards he moved to Sydney where he completed a PhD in 1960, then onto Cambridge to take up postgraduate research. In 1961 he returned to Australia to take up a lectureship at the University of Melbourne. He became Professor of the Botany School at the University of Melbourne in 1966, a position he held for 20 years.

During his time in Melbourne he became involved in civic affairs as well as carrying out his university teaching and research. He helped to develop many parks and gardens throughout Victoria and was an adviser to successive Victorian State governments and the National Trust. Under his joint supervision the grounds of University of Melbourne were transformed into award winning gardens.

One special involvement was with Rippon Lea, as Chairman of the Gardens Committee. Rippon Lea is one of Melbourne's best known nineteenth century gardens now owned by the National Trust of Australia (Victoria). He was also associated with the Royal Botanic Gardens in Melborne, being Chairman of the Maud Gibson Gardens Trust and a special Research Trust. In 1978 he designed the eighteenth century cottage garden for Cook's cottage.

Despite heavy involvement at the University, restoration of historic gardens and the work of botanic gardens occupied an increasing amount of his spare time. In 1986 he was appointed Director of the Royal Botanic Garden in Sydney, a position he still holds. The position involves the management of 3 separate gardens in Sydney and 2 newly developed gardens outside the city. The two gardens outside the city were developed as part of the bicentennial celebrations. Mt Tomah is a 31 hectare garden 100 kilometres west of Sydney which focuses mainly on the cool climate plants of the Southern hemisphere. Mt Annan native garden and Arboretum, 45 kilometres south of Sydney, is a 500 hectare garden still in the early stage of development. The first 100,000 plants went in during the winter of 1988. It is thought to be one of the most ambitious botanical projects in the world with an estimated cost of $A21 million.

Over the years he has been involved with the Australian National Trust, was a member of 12 committees for the Government of Victoria and a member of 7 committees or boards for the Commonwealth Government of Australia. He has been an external examiner for the Botany Department of the University of Auckland for many years.

Professor Chambers has for many years been a popular and accomplished public speaker. In 1988 he presented the Auckland Botanical Society's annual Lucy Cranwell lecture on the topic 'Landscape into Art: Science with Education — The Role of Modern Botanic Gardens'.

The National Executive are pleased to present the Award of Associate of Honour of the Royal New Zealand Institute of Horticulture in 1990.

IVAN GEORGE RAINEY

Ivan George Rainey was born in Rawene, Hokianga Harbour in 1930. His great grandfather, Captain George Martin, had been Harbour Master and also a keen gardener. Camellias that he imported grow there to this day. Obviously an interest in plants was part of George's heritage.

In 1942 his family moved to Auckland where he completed his education at Mt. Albert Grammar School to University Entrance level.

In 1947 at the age of 18 he began work for A. W. Palmer — Nurseryman. Shortly after this the apprenticeship scheme was introduced and George became an apprentice and later their foreman. During the 12 years with Palmer's he experienced the wide range of activities and plants common to retail nurseries in those days. No doubt this experience has much to do with the nursery and plant knowledge that makes him today one of New Zealand's foremost nurserymen.

George left Palmer's in 1959 to start his own nursery on a 2.5 acre property in New Lynn which he purchased for 1250 pounds. Later he increased the area to 4.5 acres. The area spanned a gully and this difficulty was typically solved by terracing it all. Some years later after some overseas nursery visits, particularly to Monrovia Nurseries in California, he could see the need for expansion and moved his container nursery to Henderson in 1969. He was one of the first nurserymen in N.Z. to operate a solely container nursery, and overhead watering — "a practice that was known to damage plants". He has continued to develop his nursery over the years and it is recognised as one of the best wholesale nurseries in New Zealand.

N.Z.N.A.

George Rainey became an active member of the New Zealand Nurserymen's Association on the Auckland District Council in many capacities including that of Chairman.

He became a member of the National

Executive in 1964 and has served continuously ever since. He served as President for three two year terms in 1971 and 1972, 1978 and 1979, 1985, and 1986 where his leadership and Chairman's qualities proved unparalleled.

He could also see the value of N.Z.N.A. overseas travel tours and participated in several, and claims the knowledge gained was a turning point in his career. He has been and still is involved in arranging visits to N.Z. for nurserymen from many areas of the world.

George has always striven for trained and knowledgeable staff for the industry and in this regard has served for many years on the N.Z. Apprenticeship Committee as a representative of the New Zealand Nurserymen's Association.

He was also quick to appreciate the value of research and the lack of support by Government, and supported the idea of the N.Z. Nursery Research Centre, which became reality, and represented the New Zealand Nurserymen's Association for many years on this Committee.

George Rainey's dedication and service to the New Zealand Nurserymen's Association and the nursery industry has been immense, and it gives the National Executive of the RNZIH great pleasure to present him with the Associate of Honour of the Royal New Zealand Institute of Horticulture in 1990.

Affiliation of the New Zealand Arboricultural Association

A significant move in the co-operation and consolidation of New Zealand horticulture occurred with the formation of the New Zealand Arboricultural Association (NZAA), and its subsequent affiliation with the Royal NZ Institute of Horticulture. The formation of the NZAA fulfils a need felt by arborists to have a national body, and the Institute is pleased to offer formal co-operation and support to the new group.

It brings with it recognition of the pressing need for better care of trees in the New Zealand landscape. While the main focus will always be on the urban landscape, the principles involved in arboriculture are equally applicable in the countryside.

The NZAA has been established on a sound foundation, and its early initiatives suggest a well organised body which will go from strength to strength. The Institute offers its congratulations to the new Association, and looks forward to the group forging broader links with the Institute body and its constituent branches.

Introducing the New Zealand Aboricultural Association

Thanks to the considerable effort of a group of arborists and some members of the RNZIH, it is with great pleasure that I am able to introduce to you the newest affiliate of the Institute, The New Zealand Arboricultural Association.

The National Executive of the RNZIH passed a motion unanimously at their September meeting which reads as follows: "That the RNZIH recognise the incorporation of NZAA under the auspices of the Institute".

The birth of a professional body for arboriculture in this country has been for me a longstanding wish ever since I became a member of the RNZIH. But giving birth is a process of hard labour, and in this case help was needed far beyond RNZIH quarters. The concern of various practising arborists about the lack of unification amongst themselves combined with an ever increasing national awareness of the importance of trees are in my opinion the most important factors in the establishment of the NZAA.

Options and ideas were further moulded during last year's conference in Nelson, and the first National Executive was formed as follows.

Martin Herbert, Hamilton (Chairperson)
David Aitchison, Lower Hutt (Deputy Chairperson)
John Jury, Auckland (Secretary)
Bob Cowan, Rotorua (Treasurer)
Marcus James, Hamilton
Rob Graham, Wellington
Shane Potter, Tauranga
Chris Davies, Christchurch
John Wakeling, Hamilton
Frank Buddingh', Dunedin

Trees in the landscape are often treated like unwelcome step children. The evidence of maltreatment is all around us. We need appropriate education first of all to address this problem. Arborist training does now exist and enjoys full support of NZAA.

The NZAA Executive has been very active to date. A constitution has been drafted, as well as a code of ethics for arborists. The preparation of a national work standard for tree maintenance is underway. A library with specialist books has been established, and newsletters are being prepared for members. Articles of arboricultural interest will become a permanent feature in this publication, and various other initiatives are being given considerable thought, so they can be launched in the near future.

However, viability goes hand in hand with strength. That means more supporting members.

If you care for trees, help us! Write for more information, membership fees etc. to:
New Zealand Arboricultural Association
P.O. Box 16,
Lincoln University,
Canterbury.

Frank C. Buddingh',
F.Arb.A, Publicity Officer

A Message from the Chairperson NZAA

The first conference of the NZAA has now finished. Briefly I would like to thank the many people and organisations that have made it possible. Thanks to the RNZIH especially, with its input into all aspects of horticulture. Since obtaining a Royal Charter in 1939, the Institute has been instrumental in transforming the image of gardening into the multi-facet profession of amenity horticulture. I am sure that the new special relationship between the Arboricultural Association and the RNZIH will be positive towards the management of the urban treescape of New Zealand.

We know that in the past the management of this important resource has been lacking. Without the efforts of people such as Walter Feilding-Cotterell, New Zealand's first City Arborist, John Taylor, author and promoter of New Zealand's first Arboricultural course, and Frank Buddingh' in Dunedin we would be all the worse off.

Special note should be given to:
— Ian Gear, Head of Department, Agriculture/Horticulture, Waikato Polytechnic, for his vision in getting the first course in Arboriculture underway.
— Ed Chignell's work in organising Dr Shigo's visit during 1989.
— Praise also to the executive — J. Jury, our Secretary, Treasurer Bob Cowan, Newsletter Editor, Marcus James, and the support work of John Wakeling and Chris Davies.

So the seed has been sown. What is some of the business we have to look at in the short term?

1) Power of lobbying
— Powerlines.
— Resource Management Bill.
2) Theme, venue and speakers for next year's conference.
3) Education
— Arboricultural Diploma Course and National Certification.
— Video resource.
4) Guide to safety in Arboriculture.
— Labour Department Occupational Safety & Health, Lester Bell (final draft winter 1990).

We are now establishing arboriculture on stable ground: education and public awareness are the keys.

It is up to our association to maintain a professional image. How? By setting high standards of work, and by continuing to keep abreast of technical aspects within the industry.

This means we all have to make a commitment. There is plenty of work to be done, and very little time considering the difficulties — urbanisation, Dutch Elm disease, work standards, and care of aging trees. Working to our objectives we have an Association which has people with enthusiasm, drive, and a very special love of trees. Let's face it, we are different: I mean when you tell somone you climb trees for a living, what is their reaction?

Looking to the future:
— Perhaps through the International Society of Arboriculture, we must set up communication with our Australian neighbours, who have their own Association and training centre, eg Burnley, Melbourne. We should share resources, eg technical, educational, overseas speakers.
— Aim to set up smaller branches where numbers permit.
— Consider a Subcommittee to look at approved contractors.

We should question whether we use the same systems as used overseas.

As one body let us work together. In the words of the American Arborist, Prof. Chadwick: "There are two ways to get to the top, you can climb the tree or sit on the Acorn and wait for it to grow".

Martin Herbert, Chairperson.

Formative Pruning to Prevent Development of Narrow, Weak Forks and Included Bark in Trees

J. Wakeling
75 Brookfield Street, Hamilton

It is common to find in younger trees (2-8m height) a particular structural weakness in the branch of the tree. This is the presence of tight narrow forks and included bark. The fault is well illustrated in Fig. 1 and if uncorrected, will lead to progressive problems in the later life of the tree.

Causes

It is fashionable nowadays to blame everything on the genes and it is likely that in many cases tight forking habits are the result of poor stock selection.

A second reason appears to be the practice of inducing a premature crown in a young tree. This is often done by heading back the leading shoot at a height of about one and a half metres and allowing a bushy well-leafed specimen to develop. Such trees are more attractive to look at in the short term, but we should remember that most trees in our gardens form a natural crown at about two or three metres and that by forcing the tree to form a lower crown causes the tree to redirect its growth patterns. As well it makes life difficult for the gardener who has to avoid low branches in the course of horticultural duties.

Tight, narrow forks in themselves are not necessarily weak nor unattractive, in fact we actively seek that habit when we choose fastigiate trees and it is seldom that these trees give much trouble. Problems arise when the forks have embedded bark between the two branches and no connecting wood fibre. This can be seen in Fig. 2, where the bark continues down into the tree slightly more than 35cm. When the problem is allowed to go unchecked, the potential for branches to break out from their points of attachment is increased as the tree continues to put more weight onto unstable junctions. Figs. 3 and 4 show the type of damage caused by weak forking habits. Each of these examples had developed within secateur reach from the ground and if remedial action had been taken at the right time the damage would not have occurred. It is not always easy to identify whether a branch has embedded (included) bark, but it is useful to look for the following symptoms:

1. Staining/oozing of water from the fork. This fluid is not symptomatic of decay but merely the brew collected from rainfall via stemflow.
2. A "seam" of bark turned inwards to the trunk, or rough corky bark as in Fig. 5.
3. Unusual swelling of the trunk near the branch union.

Remedies

There is really only one effective remedy and that is to prune away the offending branch while it is still small enough to be cut off with secateurs or loppers. Fig. 6 gives an idea of how the job should be tackled. It is important not to damage any bark on the remaining stem and so great care should be taken when making the final cut. The real difficulty which people experience is more psychological than practical. It takes an act of faith to cut away a branch which might make up one half of the crown of a newly acquired tree! It is very difficult to tell oneself that the visual effects will only last a short while. However, these decisions have to be made and if they are put aside until later then the problem only gets worse, as shown in Fig. 7. This *Liquidamber styraciflua* is in rather a bad way; note how the weak forks lean over a rather busy main road. In this case there appear to be four options available to the owner, none of which is entirely satisfactory. These options are as follows:

1. Do nothing. This has been a successful practice so far!
2. Put in a cable bracing system. This will alleviate the problem in the short term, but it is expensive and requires regular maintenance as the tree grows.

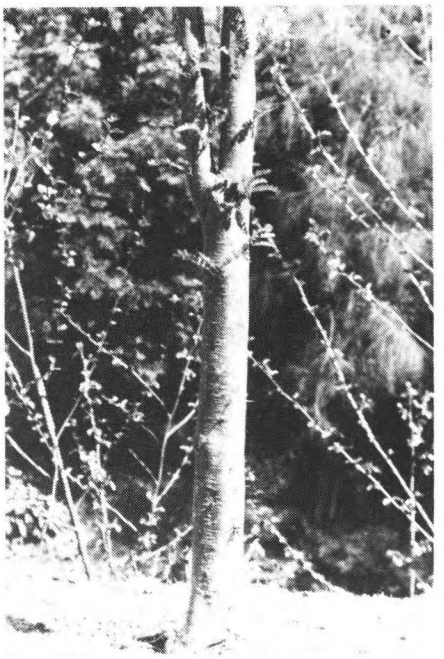


Fig. 1. Weak fork on *Gleditsia triacanthos*. Note the inward growing "seam".

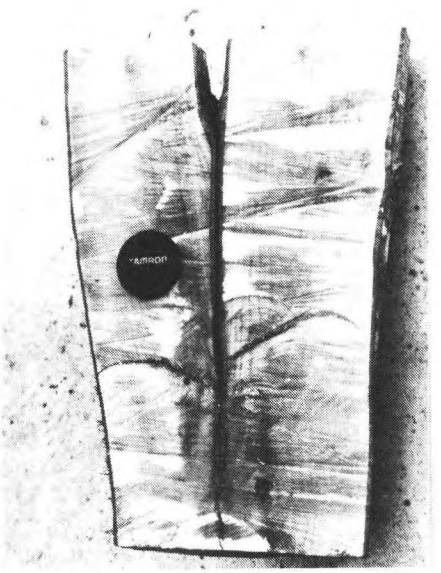


Fig. 2. Section through *Tilia sp.* fork showing included bark.

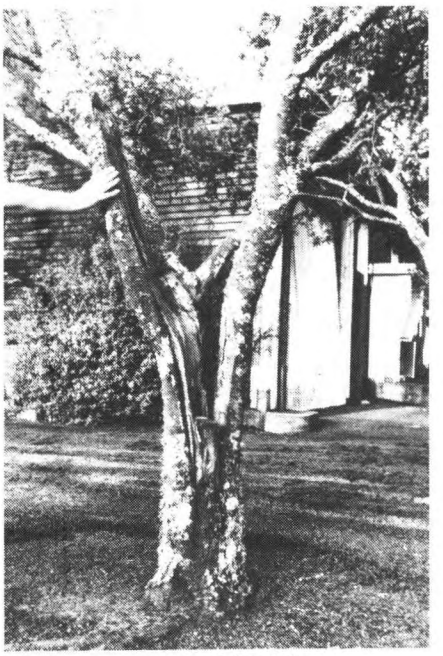


Fig. 3. A badly damaged kowhai.

Fig. 4. The home made cable bracing in this *Melia azederach* will not help the trunk knit together.

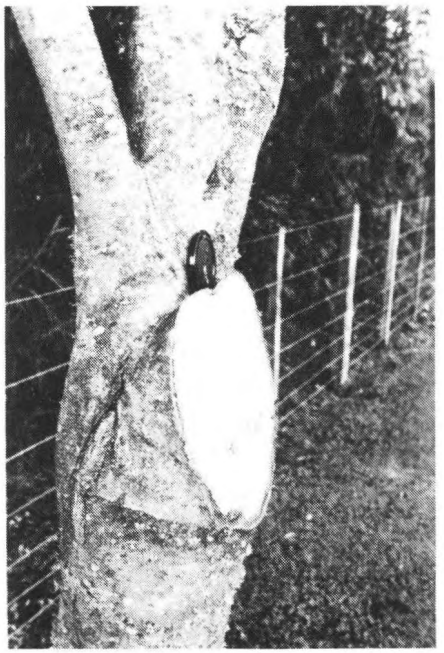


Fig. 5. Thick corky bark in the fork of *Fraxinus oxycarpa 'Raywood'*. The final cut could be at a slightly oblique angle to leave a smaller wound and more branch collar contact.

Fig. 6. Removal of a tight fork in *Gleditsia triacanthos.*

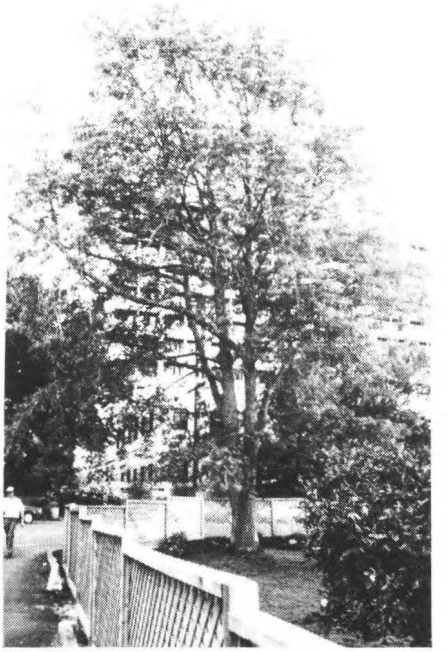


Fig. 7. The siting of this *Liquidamber styraciflua* tree with its defective branch structure poses problems.

3. Remove tree. While this does away with the problem it also robs the landscape of the product of many years growth, so it is essential to replace the tree with a suitable new specimen.

4. Reduce the size of the crown. Again this is only a short term solution and the problem is still there.

The one option which was not considered was the possibility of pruning one leader from the tree. This is not a viable choice because the resulting pruning cut would be too large ever to heal over correctly and the final shape of the tree would be truly ugly.

It is to be hoped that these notes will help readers to recognise weak forks and explain how to deal with the problems arising from weak forks so that their trees may grow to full size in a healthy, safe manner. If the work is too difficult to be done by hand tools, then call in a qualified arborist, or tree surgeon, who should be fully equipped to deal with heavier limbs.

Good accounts of the development of such tree faults and their prevention are given by Harris (1983) and Shigo (1986).

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Trees in our Urban Environment 'The Future Management'

The 1989 Ian Galloway Memorial Lecture

Martin Herbert
Waikato Polytechnic, Hamilton

The word 'tree' is small but one which evokes a multitude of different thoughts, feelings and emotions: beauty, anger, tranquillity, awe, annoyance — depending on personal experiences, which in turn mould attitudes. Today, possibly more than at any other time, there is a high level of interest in trees, which is reflected in the constant publication of books on the subject and the abundance of information produced by professional bodies and the media. The profession of the arborist has now become more widely recognised.

What is an Arborist?

The arborist is involved in the science of Arboriculture, the care and maintenance of trees in the urban environment. Since the tree is looked at as a thing of beauty, the tree's position in society is comparable to that of music, of drama, of poetry and of art. Thus the arborist is equivalent to the musician, the actor, the painter or sculptor.

The landscaper is equivalent to the composer, the playwright, the poet and the artist. The council official is equivalent to the art museum director, the symphony conductor, the theatrical producer and the publisher.

Both arborist and artist require technical skills and understanding of the scientific principles underlying their activities. But the daily work of the arborist contrasts dramatically with that of the musician, the artist, etc. Their occupations are more or less sedentary and safe but the arborist is not.

Only the arborist works with the daily risk of life and limb. Arboriculture is a profession with chainsaws that can cut the operator, chippers that devour the worker, high-voltage current, contact with which can cook the unwary, high places from which to fall (experience in Canada) and streets teeming with traffic, where every arborist often must stand.

The work environment is not forgiving. An additional high technical skill therefore is demanded in every good arborist: the skill of self-preservation. The saying about wartime pilots: "There are old pilots and bold pilots but no old, bold pilots" applies to the arborist. No amount of attention to safety can be too much. It needs to be spoken of daily. And, just as in driving a car, a little fear helps.

There remains a great deal of indifference towards trees (a lack of appreciation of what a tree does, what it needs and what it does not need) and an alarming abundance of evidence of deliberate action against the welfare of New Zealand's tree population.

How often has it been said — with earnest conviction — "We love trees, but — "and then a cast-iron case is presented for the removal of yet another tree?

Fires are lit at the base of trees, notices are nailed on them, houses, roads, footpaths, drains and walls are constructed under them, their branches are hacked off and their roots are cut away, they are festooned with cables and wires, they are chewed by animals, heavy building materials are stored under them, houses are damaged by them. They are stood in water, deprived of water, we drive machinery at them and, finally we cut them down for no other reason than sheer, wanton destruction.

It is actually desirable to be afraid, because, when one stops being afraid, one's life comes at once into danger.

But there's another side to this coin too. The arborist is deserving of two special kinds of high social respect. In our society, there's a high respect for the Fine Arts (music, poetry, drama, dance, painting) and Arboriculture deserves its share of that.

Arboriculture is a wonderful and challenging profession — a profession devoted to bringing beauty to all people, all the while facing personal danger and applying both high scientific knowledge and the special skills of safety under hazardous conditions.

Andreas Feininger (1978), the American photographer and writer, states: "Man's life, his origin, his uniqueness, and perhaps even the continuation of his very existence, are inextricably tied to the life of trees. Had there been no trees, it seems likely that the human race would never have come into being. Should the trees die, it is not inconceivable that man would become extinct."

We are all aware of the much-talked-about 'Greenhouse Effect' and how the politicians and nations toy with the world's tree cover.

So the removal of trees is not just harmful to the local landscape and environment but has global ramifications.

Although not spoken of in the current furore over the 'Greenhouse Effect', the removal of trees without replacement is surely a major contribution to the problem. Although the rapid increase in atmospheric CO_2 over recent years is largely blamed on the burning of fossil fuels, a large part of the problem is undoubtedly excessive removal of forest.

One solution is to plant more forests — on a huge scale. Fast-growing biomass forests. In the temperate zones, species like *Pinus radiata* and *Pawlonia*; in the tropics *Acacia, Leucaena* and *Gmelina.*

Unfortunately, in New Zealand we are faced with a reduction in forest plantings. This will be further affected by the selling of State forests to private enterprise.

What we need to do at all levels of tree management is to cultivate a much more positive attitude toward their care and perpetuation.

The Urban Setting

Let us now consider the urban setting. Any city will have a comprehensive development plan and the primary function of trees within this scheme will be to make a contribution to the beauty of the townscape.

Amenity is a state of mind. Is it possible to imagine a township without trees? Trees of themselves are a fundamental heritage. They are a link with the past and a promise for the future, a visual resource and a social benefit. They are a long-lived asset and a precious component in the way that our surroundings affect our lives. The township is the backdrop against which the most important part of life is enacted and therefore much care should be given to the promotion of a habitable scene which is viable and aesthetically desirable. Trees provide a setting for architectural features and screen unsightly intrusions. In this, they are the planners' and architects' remedy. The tree provides a unifying element and can absorb into a township the rudely obvious, functional but necessary industrial structures.

The planner has a basic problem in dealing with the continual succession of tree growth and death within a town. Man is a short-lived being and regards landscape and townscape as static, whereas both must be regarded as living and changing organisms. We are constantly reshaping our man-made environments and we need to ensure a succession of trees by preservation, tree care and continuity of planting.

No urban pattern survives in a healthy condition for long. It is degenerating imperceptibly through natural and physical causes and trees need to be treated as a continuing element in any townscape. They need to be managed and controlled and the principles are comparable with that of a sustained yield in a forest practice.

Tree development is slow and effects are obtained only by foresight and patience, allied to sensible management principles, operating over a long period.

Every township requires management plans, defining long-term objectives relating to its tree cover.

Important elements in the preservation of our trees are:
(1) The Town Scheme
(2) Legislation

(3) Attitudes of Architects/Developers
(4) The Professionals: Arborists/Planners
(5) Education
(6) A professional organisation whose objective would be to advance the study of arboriculture and give valuable input into these other elements.

I feel that it is now time to look to the future and appraise the standards and professional standing of the arboricultural industry, whereby the Architect, Developer, Local Authority and Tree Surgeon can cooperate and have similar aims for the preservation of our treescape.

There is now a real need to replace the image of the one-person unit with a chainsaw in the back of the pick-up, with that of a professional craftsperson.

Overseas, both in Europe and North America, there are associations which have been in existence for many years and one very important aspect of their work is to set standards. These standards would be available to everyone involved in the treescape.

Progressing from this, a registered list of contractors could be set up, whereby the local authority can call on a contractor who is capable of carrying out the work to its correct level, and pass on this information to the general public.

New Zealand is now in a situation where arboricultural education is making its input eg Waikato Polytechnic 20-week Craftspersons' course. These students will, hopefully, be having a major impact on the welfare of New Zealand's trees. But much more needs to be done, as the Tree Council in Auckland is doing, to improve further the status of the urban tree.

The first step is to make as many people as possible aware of the threat and of how serious it is. Of course, many groups and professional societies are already fully aware of the situation and have been for some time. However, despite all the good work that has been, and is being done, the task is only just beginning and complacency must be stifled.

Everyone who is concerned about trees is urged to adopt the following four principles to counter the threat to our trees:

(i) To treat all existing trees with great respect and to retain as many as possible. However, a realistic attitude must be applied to this approach. For example, trees can be very dangerous in some circumstances, even though, to the untrained eye, they appear to be in perfect health. A dogmatic view of 'all trees must be kept' can, in such cases, do more harm than good to the cause. The opinion of a competent arboriculturist is required, in conjunction with strict planning regulations.

Certainly, the RNZIH Tree Evaluation Scheme, recently compiled, will be most helpful, for it will provide a set standard for listing trees in district schemes and, through a comprehensive method of assessment, a value can be determined. For example: "Pohutukawa outside the Wellington Club, in The Terrace: $108,000."

Nationwide tree legislation is very important. The following contain clauses specifying tree protection.

Covenant Protection
Historic Places Trust Act 1980
Queen Elizabeth II Trust 1977
Reserves Act 1977
Tree Protection Notices
Town & Country Planning Act 1977

In some cities and boroughs, blanket protection has been used, for example Mount Eden, in Auckland.

There is also the proposed amendment to the Town and Country Planning Act, whereby preservation orders can be issued for individual trees.

(ii) To maintain existing trees to a high standard, such as removing dead or diseased branches and pruning regularly where space is limited. Sometimes careful surgery can prolong the life of a tree and is a viable alternative to felling.

(iii) To plant as many trees as possible as a regular exercise each planting season. Remember that only a certain percentage of trees planted will survive to maturity. Vandalism and natural causes will take their toll.

(iv) The trees that are planted should not be forgotten. They must be inspected and maintained. Stakes, ties and guards may need attention and watering, weeding and pruning will be necessary.

Dr Shigo from America recently visited New Zealand. He has been involved with trees for over 50 years and now most of his research has been passed on to those people involved in the care of our urban forests. If we looked inside a tree, and he alone has taken thousands of cross-sections to support his research, we would all soon realise that insects and micro-organisms are often secondary agents which attack weakened, wounded, improperly-treated, neglected and generally unhealthy trees. Poor tree health is a problem world-wide.

Fighting the secondary agents, which are often very obvious, or the symptoms of poor health, will not solve the basic problem.

We must start to attack the real causes, the starting points of poor health.

The major organisms responsible are PEOPLE!

The personnel involved with the urban tree — arborists, engineers, planners, architects, utility companies — all have a responsibility to learn about nature and trees.

For this reason, education is of major importance and any decisions on the management of our treescape should not be based on the "hit-and-run concept" but carefully thought out by qualified people.

Richard St Barbe Baker of Men of the Trees was a New Zealander who planted trees and praised their importance to all nations. I cannot better his philosophy.

"I believe that this generation may either be the last to exist in any semblance of a civilised world, or it will be the first to have the vision, the daring and the greatness to say: 'I will have nothing to do with the destruction of life, I will play no part in the devastation of the land, I am destined to live and work for peaceful construction for I am morally responsible for the world of today and the generation of tomorrow.'

"I have a dream of the whole earth made green again, an earth healed and made whole through the children of all ages and all nations planting trees to express their special understanding of the earth as their home."

(Ed: Since this lecture was delivered, the New Zealand Arboricultural Association has been formed and affiliated to the RNZIH).

Recording New Zealand Fruit and Nut Resources

M. Denton
Public Relations Officer, New Zealand Tree Crops Association
RD 1, Tokoroa

The New Zealand Tree Crops Association is firmly convinced that it is desirable to establish what New Zealand's plant resources are, and the Association has already taken steps to set up a recording scheme for fruit and nut trees. The Trees Crops Association is a group of people interested in promoting all aspects of growing trees which produce a useful crop. We have a membership approaching 3,000. We produce our own magazine, hold lectures and field days, and co-operate with a number of research facilities. Some of our members have commercial orchards, many others are hobbyists and home gardeners. We are scattered throughout New Zealand, and between us we have an interest in all the various fruit and nut trees.

Cultivar Recording

We have, in fact, been working on cultivar recording schemes, to a greater or lesser extent, for many years, probably ever since the Association was formed in 1974. Recently we decided that cultivar recording was so important we wanted to make it into a major project. We set up a special subcommittee to deal with it, and we applied to the Lottery Board for some financial assistance. The Lottery Board examined our proposals, and have approved a grant from their Heritage Fund to help us do the job. We used the occasion of the Garden World Festival here in Hamilton to launch this project to the public, and we intend to follow it up with publicity in newspapers and various horticultural magazines.

The Project

The late Dr Don McKenzie, formerly of the Havelock North Research Station, was also convinced that some of the older varieties have useful characteristics. His specialty was apples. He pointed out that many of the newer varieties were selected for commercially important reasons, such as tough skins to reduce bruising during bulk handling, uniform ripening time to minimise the number of pickings required, good storage characteristics so they will keep through the winter, and so on. He found that selection for flavour and texture tended to be neglected, and that disease-resistance had been given low importance by commercial orchardists, who tend to overcome this deficiency by very intensive spray programmes. He selected and promoted some of the older varieties that he felt had outstanding flavour and tree health. These are now known collectively as "Connoisseur apples", and if you are an apple eater you have missed a treat if you haven't tried varieties such as Tydeman's Late Orange, Telstar and Lawfam. Or the russet varieties Merton Russet and Egremont Russet. There's a partly russet variety named Freyberg, and an excellent cooking apple called Lobo.

There are many more interesting varieties in the older settled areas of New Zealand. But these are in danger of being lost with urban development, and when the bulldozers move in, very little is spared.

Of course we are not confining ourselves to just apples. We want to record ALL the different varieties of ALL the different fruits and nuts, and encourage the setting up of gene banks so they don't get lost. Any of the surviving older varieties are particularly interesting. The fact that they have survived so long probably indicates a resistance to pests and diseases. As well as this, they have been kept by their owners only because they were considered worth the space in their garden for the quality of their fruit. If they didn't measure up, they would have got the chainsaw treatment long ago.

Many other useful varieties exist as a result of more recent importations and breeding programmes. Researchers and nurserymen bring in a great deal of potentially useful plant material. But I am led to believe that very poor records exist on what has been introduced. The MAF records may simply state "Fig cuttings", or something equally vague. Plants with unrestricted entry are not even recorded. On many occasions in the past, plant material has been brought unnecessarily into this country, when the cultivars concerned were already present. Not only is this costly, but each introduction increases the danger of introducing unwanted pests and diseases into our country. Perhaps we should be thinking about recommending a change in recording procedures for plant importations, as a logical part of any plant collections scheme. Only by accurate recording of all future plant introductions can we keep up-to-date the lists of what is currently in New Zealand.

The Benefits

Many of these varieties, whether they are old-time survivors, or whether they are more recent introductions, will be useful trees in their own right. Many more of them will be valuable for some individual genetic component which may be needed for future plant-breeding programmes. So, by locating, recording and preserving varieties, we set up a chain reaction of benefits. At the top are Research Stations and other plant breeders; then come the propagators who bulk up the material and make it more readily available; then there are the people who grow the trees through to fruiting, and this includes home gardeners as well as commercial orchardists; and in the final instance, there are, of course, the people who actually eat the fruit and nuts. That might be you and I, or it might be a customer somewhere else in the world, if the product forms part of our money-earning export crop. But the people most likely to benefit are our children, and the generations to follow.

Need for Co-operation

We can carry out this project only if people will tell us what fruit and nut trees they know about. We are going to need a temendous amount of help from the public, and we are going to need a lot of publicity to get the message across. The most valuable replies we are going to get will be those telling us about collectors, or enthusiasts who have a range of different named varieties. But we want to be told the location even of single trees, if the variety is likely to be uncommon in New Zealand. We are even interested in hearing about unidentified or seedling trees, but only if they have unusual or outstanding qualities.

(Based on an address to the Plant Collections Workshop held jointly by the Royal NZ Institute of Horticulture and the Horticultural Education Centre of the Waikato Polytechnic, in Hamilton on October 13, 1989).

Book Reviews

Flowering Plants of New Zealand, by C. J. Webb, P. N. Johnson, W. R. Sykes, Botany Institute, DSIR Land Resources, Private Bag, Christchurch. 1990 ISBN 0-477-02584-6. Recommended retail price $39.95.

New Zealand's unique flora developed in isolation for eighty million years until the first humans landed here a thousand years ago. The special qualities of the flora are slowly being recognised by the New Zealand public, helped along by the attention given it by international stars like David Bellamy. In spite of this interest, many people are still ignorant about native plants, knowing only kowhai, cabbage tree and flax by sight. What's worse, many believe plants such as macrocarpa and willow are native. Not altogether surprising I suppose, given the introduced flora is almost larger than the native. However, it is a sad state of affairs and needs to be remedied.

DSIR Botany Division has made an immense contribution to our knowledge of native plants in the form of the Flora of New Zealand series. More recently their focus has shifted more towards the general public with the production of popular publications such as Threatened Plants of New Zealand by Wilson and Given.

Flowering Plants of New Zealand is aimed at the wider public and is written by three Botany Division botanists as a DSIR contribution to New Zealand's 1990 celebrations. It is in itself a celebration of New Zealand's flowering plants and is a real attempt to increase people's appreciation and knowledge of native plants. It is written for those with little or no knowledge yet contains enough to interest experienced botanists.

The book begins with an introduction to plant classification and nomenclature: why we need to use botanical names and why they change. It then discusses the development of the flora and its relationship with other countries that were once part of the ancient continent of Gondwanaland.

The next section deals with those vegetative and floral features useful when identifying plants. I found this section well written and easy to follow with excellent diagrams and photographs illustrating important features. The three photographs of *Fuchsia procumbens* showing, male, female and hermaphorodite flowers were particularly good. I did, however, have difficulty with the paragraph detailing the female flower parts and the difference between carpels and pistils. The book defines carpels as the circle of female parts containing the ovules: known collectively as the ovary. Above the carpels are the stigmas and styles. My understanding of the term carpel is the ovary *plus* style and stigma. This concurs with the definition given in Flora of New Zealand Volume 4. To confuse matters even more, the diagram of a typical flower adjacent to the text doesn't mention carpel at all but has the ovary, stigmas and style labelled along with the collective term pistil.

The major part of the book contains descriptions of 52 flowering plant families. Each family is set out on two pages (except Asteraceae, Orchidaceae, and Fabaceae with four), one page of text, and one page of photographs. I was impressed with the clear, easy to follow layout. The families are arranged in alphabetical order, and where necessary, relationships to other families are discussed and differences listed. Each description also includes two tables, one listing floral characteristics of the family, the other giving statistics of native and naturalised genera and species. In the descriptions of the Poaceae (grass family) and Cyperaceae (rush family), additional line drawings were included detailing the layout of flower parts. These were extremely useful and I would have liked to see similar diagrams used in other families, especially more difficult ones such as Asteraceae and Piperaceae.

For all its strong points, I found it a slightly frustrating book. It needs a rigorous edit to ensure standardisation between the families covered. It seems that each author was responsible for specific families. This shows in the writing style as well as the quality of the description and assumption of background knowledge. Inconsistencies have crept in which would be confusing to the reader. Take the description of new terms: before studying individual families, the reader should read the introduction in which most of the floral and vegetative characters are described. They can then study families in any order using the glossary if necessary. This poses a dilemma for the author: should terms be defined or should you assume readers will use the glossary? In most cases terms are defined if they weren't mentioned in the introduction. This does bring up problems of standardisation, however. Take the term divaricate: in Pittosporaceae, divaricating plants are described as plants with small leaved and tangled branches. In Rubiaceae they are described as small leaved shrubby species with numerous branches growing at wide angles and interlacing. The glossary concurs with the latter description but adds that small leaves are held inside the twiggy exterior. At the other extreme are new terms that aren't defined, for instance calyx. It was mentioned in Caryophyllaceae and Avicenniaceae yet there is no description of it in the introduction or glossary.

The book is aimed at a wide audience, many of whom have no botanical background. This means descriptions need to be clear with diagnostic features easily seen with the aid of a hand lens. This can pose a conflict for the scientist who has to explain differences in visible terms when the most important ones may be microscopic or even biochemical. In most cases the authors have stuck to easily recognisable features although I felt one or two would be very difficult for beginners to observe. Take Ericaceae, where the one unifying feature was given as the way the anthers release the pollen.

Common names are used throughout the text which I found confusing. In fact the authors discuss the use of common names in the introduction and suggest they are best used linked to a botanical name. Unfortunately they only stick to this in the illustrations. As an example look at the description of Fagaceae (beech family) which starts by talking about 'beech' trees forming the main canopy of much forest in New Zealand. No mention is made of *Nothofagus* until the next paragraph when the common name becomes southern beech. The description later mentions 'northern beeches' and 'European beeches'. Are these one and the same? We are left to guess.

I suspect that the book was prepared in a very tight frame to fit in with the 1990 celebrations. The authors are to be commended for putting together a book of this quality in the time available. It will appeal to a wide range of people from school students onwards. For me, it will be an essential reference and one I will recommend to others. I will, however, look forward to the second edition when many of the minor irritations can be removed.

Mike Oates

The Japanese Iris, by Currier McEwen, University Press of New England, Hanover, New Hampshire, USA, 1990. $US29.95.

There are some books that are immediately attractive. *The Japanese Iris* is one such book. It is not just that it handles well and is handsomely produced, that the drawings are good, that the colour plates are mostly magnificent, or, even, that it is well written. It is more that the author, Currier McEwen seems such an agreeable man who would, I imagine, be good company and good fun. His personality comes through in his writing.

He is not, however, too amiable or unfailingly kind and at times a crotchety note does emerge. The chapter on insect and other pests concludes: "Finally we come to the problem of the garden visitor who does not know the rules of good garden manners. One should not hesitate to ask that handbags, camera bags and the like not be carried into the rows ... Fortunately today's fashion styles do not encourage the visitor to wear the wide loose skirts common some years ago. One can still remember with dismay the havoc caused when a visitor in one of the "ballerina skirts" turned quickly. The billowing, twirling skirt could take off a dozen blossoms. With fashion's trend to narrower skirts and, especially slacks, the problem of inappropriate dress has rarely been a danger in recent years and the main hazard continues to be the dangling bag, with as runners up, unsupervised small children and unleashed dogs." Clearly, you are expected to behave when you visit Dr Currier.

The author was for many years Dean of the School of Medicine at New York Univer-

sity. Now, almost 90, he writes well with easy authority and ready wit. His text is straightforward, clean and economical and his definitions and choice of words often most apt — "nicely organised, compact form", "single flower of flaring, rather tailored form", "ruffled white form and dark blue-violet edging". There is a good glossary of terms and it is a delight to find a horticultural book that is properly referenced, with citations to specific comments in the text and allowing those interested to read more widely.

One of the most appealing features of this book is its strong emphasis on the history of the Japanese iris and its place in Japanese culture. This allows us to understand better the aims of the early Japanese breeders. For example, a very special use of the Higo iris was in the ritual of the Act. A well-grown potted iris of suitable type was taken inside and placed in front of a golden screen. The follower of the ritual meditated as the flower slowly opened and changed hour by hour. Against such a golden background flowers of pure white or single colours were considered to be more beautiful than those with pale colours or patterns. A single magnificent bloom was more suitable than a branched inflorescence. Now that Higo irises are more widely grown outside, the requirements of breeders have changed.

There is also an account of the history of the Japanese iris in the United States. This will probably be of less interest to readers in this country but, together with an appendix, it describes how the Japanese iris was taken from its homeland and distributed throughout the world.

I found the chapters dealing with the classification of the Japanese iris to be rather less satisfactory. I would have liked fuller descriptions of the most closely related species. Furthermore, in the first chapter, that dealing with the history of the Japanese iris in Japan, we are told how Japanese irises were classified as Edo, Higo or Ise types, according to their geographic origin but the distinguishing features of the flowers of each type are not described until the third chapter. The classification of modern hybrids is summarised very clearly in the fourth chapter.

The chapters covering cultivation, use in the garden, pests and diseases seem comprehensive and contain much common sense. Throughout there is stress on the value of Japanese irises as garden plants and this is emphasised by the thirty two colour plates. The photographs are almost all excellent technically and the blooms displayed extraordinarily beautiful.

Dr Currier has devoted himself to the Japanese iris for more than thirty years and has gained much success as a hybridiser. Thus he has four times won the Payne Award, the highest Award of the American Iris Society. About a quarter of *The Japanese Iris* is devoted to an authoritative account of hybridizing, the handling of seeds and seedlings, the evaluation of seedlings and the registration of cultivars. These chapters may be of little practical value to the home gardener but they are definitely worth reading, especially the appraisal of what makes a "good" garden plant.

I enjoyed *The Japanese Iris*. I doubt that I would ever be inspired to attempt breeding but it has encouraged me to contemplate making another bog garden, this time for Japanese irises.

A. R. Ferguson

New Tree Biology Dictionary, by Alex Shigo, 1986. Shigo and Tree Associates, Durham, New Hampshire, U.S.A.

Written in 1986 the dictionary complements Shigo's monumental arboricultural textbook, A New Tree Biology.

The Dictionary is a 132 page, soft cover, quick reference to tree terms, topics, treatments, problems and their proper care.

It is thorough, alphabetical in format and detailed in its explanation. Like a New Tree Biology it explores new concepts such as the Three-tree concept which elaborates on the levels in a tree's life, 1) the young tree that is mostly branches, 2) the mature tree with well developed trunk and crown and, 3) the community tree in the forest connected by root grafts or myccorhiza.

There are no pictures but the text is well illustrated with word pictures that conjure up examples and answers.

Shigo on vandalism. "The vandal will never go away, and no amount of punishment will deter them. There are two ways we may be able to reduce tree injuries caused by vandals: 1) do not plant trees with large lower branches near walkways, 2) use proper protection for trees." He proceeds to explain, in practical ways, how best to deal with causes and effects. Good, practical advice written in simple, straight-forward English.

Did you know that a small burl-like, dimpled structure on hardwoods such as *Acer saccharum* is called a bird's eye? What is Kino and slime flux? You will find the answers, in detail, are in the dictionary.

Bob Edwards

The New Zealand Kitchen Garden of European Origin: A Preliminary Study

Helen M. Leach
Department of Anthropology, University of Otago

Of the thousand year span of human occupation in New Zealand, the first 800 years saw people of the Polynesian cultural tradition adapting what had been tropical or sub-tropical plants to our temperate climate. In the last 20 years archaeologists have made considerable progress in unravelling the prehistory of Maori gardens (Leach 1984). In comparison the kitchen garden tradition of the European settlers has been sketched in from selected rather than systematically assembled sources (e.g. Leach 1984), or has been touched on within surveys of gardens in general (e.g. Strongman 1984). It deserves a much more detailed study.

Sources

As Challenger indicated in his 1978 article, some seed and nursery catalogues are held by New Zealand libraries, though there are many gaps to be filled. There are better holdings of newspapers, many of which published regular kitchen gardening advice, along with news of horticultural shows and advertisements. Handbooks and calendars designed for New Zealand conditions were published from as early as 1853 (e.g. Wilson 1853, 1856, Hay 1867, Strongman 1984: 35). The diaries of pioneer settlers are often full of the toil, rewards, and disasters of kitchen gardening under unfamiliar conditions (e.g. George Jupp 1851-60 in Taranaki, F. S. Pillans 1850 in South Otago) or the daily and seasonal tasks of food preparation and preservation (e.g. Catherine Squires 1859-1912, in South Otago and Southland). Paintings and photographs reveal some of the structures associated with kitchen gardening, such as fruit walls and conservatories (e.g. Strongman 1984: 111). Pioneer and early settlers' museums contain items of horticultural material culture, although many old tools have probably been discarded as 'junk' before reaching museums.

There is clearly no shortage of material for garden historians who have time to work from primary sources; however they need some prior knowledge of the terminology of gardening techniques, and of fruit and vegetable varieties. They should also be familiar with the history of gardening in Britain, the chief source of the horticultural tradition of the 19th century European settlers. For historians of the kitchen garden in particular, it is advisable to follow the produce beyond the garden, establishing for example how it was prepared and served, whether it formed part of everyday meals, or whether it was destined for the competition showbench rather than the kitchen (as in the case of certain gooseberry varieties in the late Victorian era) (Scott-James 1981: 88-9).

The British Background

As the basis for this section, the popular magazine *The Cottage Gardener* has been chosen as a sample of garden writing from the mid 19th century. Founded in Britain in 1849, its name suggests that it was designed to provide gardening advice to the lower middle classes and working classes. Its contents, however, included in the year 1851 only one article per month on the 'allotment farms' held by factory workers and ordinary labourers on the outskirts of large industrial towns. In contrast, *The Cottage Gardener* published weekly articles on 'New Plants', 'The Fruit Garden', 'Greenhouse and Window Gardening', the 'Hothouse Department' and 'The Kitchen Garden'.

Material for the latter section was written by "Mr J. Barnes, Gardener to Lady Rolle, Bicton, Devonshire" and "Mr T. Weaver, Gardener to the Warden of Winchester College". Not only was it addressed to experienced gardeners with access to glass frames, greenhouses, hand lights (cloches), forcing pots and mushroom sheds, but the diversity of crops mentioned in the weekly calendar implied both large gardens and the desire to eat a greater range of vegetables than those grown in the allotments. At this period crops such as asparagus, globe artichokes, blanched endive, beetroot, cucumber, melon, capsicums, tomatoes, mushrooms and forced seakale were quite clear markers of higher social status.

In 1851 *The Cottage Gardener* recognised at least three types of garden. The first and clearly most important to its readers was the large kitchen garden. This was walled, or at least enclosed by hedges, was well equipped with glasshouses, frames, 'lights', clay pots and forcing pots, and was maintained by one or more experienced, possibly professional gardeners, with additional assistance. The hot beds on which the frames were placed were usually four feet high piles of dung and leaves, turned several times before the cucumbers, melons and vegetable marrows were planted on them. Illustrations of the beds and their glass superstructure suggest that at least two people would have been required to prepare them and move the frames into place. In walled gardens where fruit trees were espaliered against the inside walls, the labour costs of pruning, tying and nailing, as well as providing frost protection, would have been even greater. Davies (1987: 28, 33) gives an illustration of the 19 garden staff who maintained the Chatsworth estate which included formal kitchen gardens of nearly seven acres.

In contrast to the elaborate kitchen garden with its heavy investment in plant and labour, the second type of garden recognized by *The Cottage Gardener* was the cottage garden of the agricultural labourer. There was strong regional variation in its size and contents. In affluent counties where landowners had made adequate provision for cottage gardens after the enclosure acts of the 18th century (Scott-James 1981: 22-3), labourers were able to grow fruit trees (apples, pears, plums and cherries), and small fruits (gooseberries, currants and strawberries) as well as the usual range of vegetable crops. Those on 2 acre plots were also able to keep a cow and pigs (*The Cottage Gardener* 1851: Oct. 30). Mr R. Errington (Gardener to Sir P. Egerton, Bart. of Oulton Park) was highly critical of the standard of many of these gardens:

> "This autumn we have passed scores of cottage-gardens, where the owner had been either too idle or too ignorant to plant his early potato ground with some useful greens or Swedes. Now this is scandalous, and were we landlord to such holders, we should really threaten either to raise their rent or to provide a fitter tenant, painful as such proceedings must be to every well-intentioned person."
>
> "Again, the state of the bush-fruit in some of these gardens is really infamous, and cannot arise from sheer ignorance. Rows of gooseberries may be seen, with the couch-grass dangling triumphantly over the stunted ruins of what was once a useful and profitable bush . . ." (*The Cottage Gardener* 1851: Oct. 30).

This criticism is reminiscent of Cobbett's complaints about some of the miserable gardens encountered in the course of his rural journeys 1821-1832 (Cobbett 1912 I:18). In the southern countries, however, from which New Zealand later derived numerous immigrants, what became idealised as the cottage garden of the early 20th century with its mix of fruit, flowers and vegetables, found its likely forerunner (Cobbett 1912 I: 87, 230; II: 226).

The third type of garden the allotment, had been in existence in Britain since the late 18th century. By 1851 it was "principally devoted to roots, greens, and other annual matters" (*The Cottage Gardener* 1851: Oct. 30), some of which were grown for city markets. Potatoes, brassicas, onions, broadbeans, runner beans, peas, carrots, parsnips, celery and leeks were supplemented with lettuce, spinach, Jerusalem artichokes and rhubarb. After potatoes, the brassicas were clearly most important. They included several different types of cabbage (drumhead, savoy, coleworts), kale, swedes and other forms of turnip, Brussels sprouts, and sometimes broccoli and cauliflower. These allotment crops shared certain attributes: they were

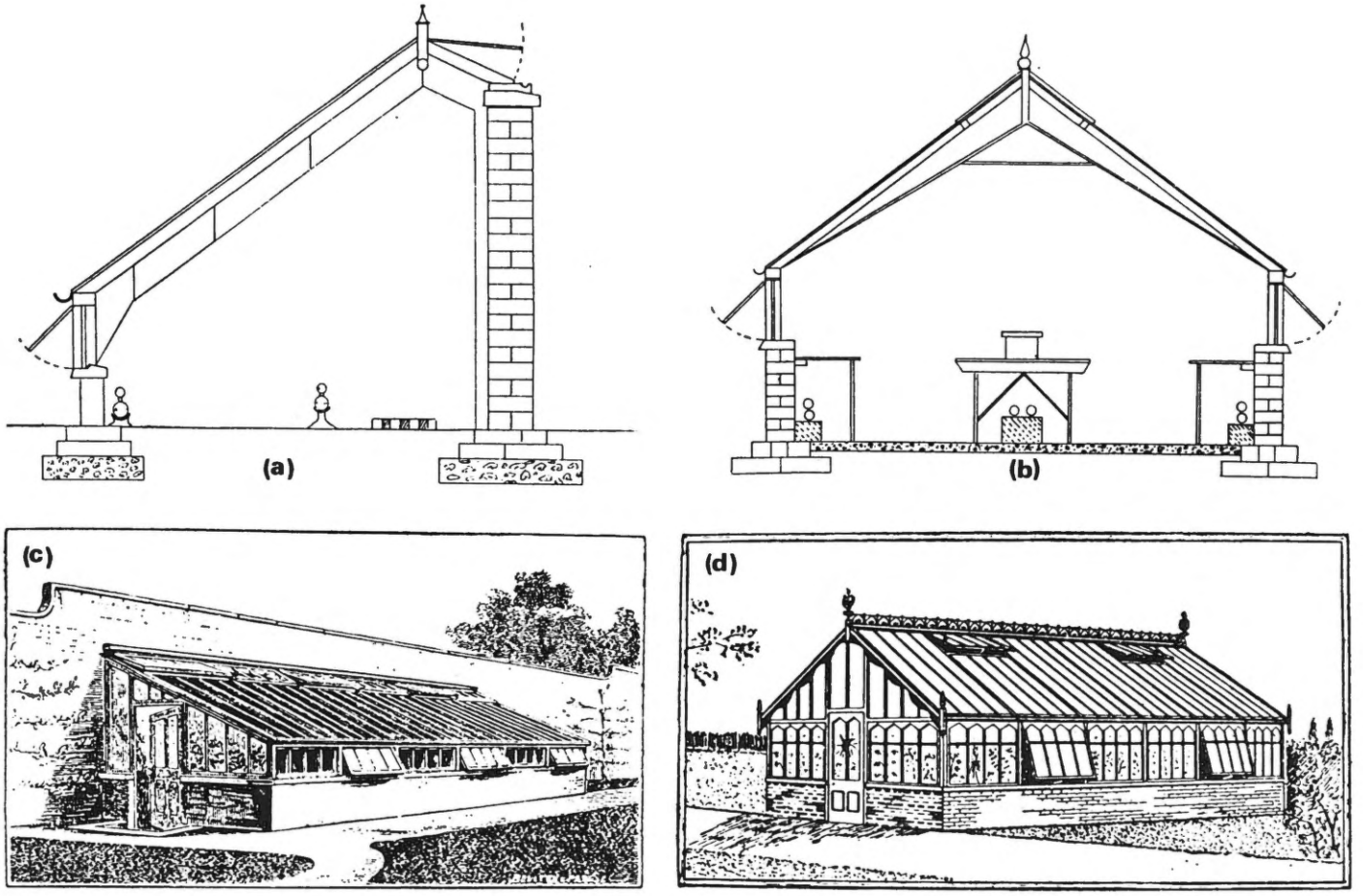


Fig. 1 Profile of a typical British lean-to glasshouse (a), a span-roofed plant house (b). From Newsham 1908. A lean-to glasshouse (c) and a span-roofed conservatory (d) illustrated in Murphy's "Gardening in New Zealand" 1907 are clearly based on British models.

hardy or else quick to mature, they did not require the shelter of walls or hedges, and they did not require hot beds or glass frames for successful germination.

The Transplantation of the Victorian Kitchen Garden to New Zealand

Although the term 'allotment' was applied to the 1-2 acre plots surveyed off at Wadestown in 1842 for town labourers, these parcels of land were sold rather than rented (Leach 1984: 117). With cottages built on them and fruit trees planted, they were closer in concept to the English cottage garden than the city outskirts allotment. New Zealand did not adopt the allotment system, probably because the usual pattern of detached houses on quarter acre sections provided sufficient space for most gardening interests. Under the special circumstances of the Second World War, the cultivation of public land and vacant sections by women's service organisations to provide vegetables for orphanages and military camps, was probably the closest New Zealand has come to non-residential amateur vegetable gardening (Taylor 1986: 1064-5, 1070-1).

As might be expected most early-mid 19th century New Zealand vegetable gardens fit the model of the cottage garden of the southern English countries. Surviving photographs confirm the mixture of fruits, small fruits, vegetables and flowers, either in front of the cottage (as in parts of Kent) or at the rear of the section. Norton's garden at Tory Channel (illustrated in Leach 1984: 115) and the Frear property in Hamilton (Anon 1988: 114) are examples of the survival of the former type to the later decades of the 19th century. In the more fashion-conscious areas, the front and side gardens were normally reserved for ornamentals.

It should be added that cottage gardens were of necessity the first type to be reproduced in New Zealand because they required no investment in glass structures or high walls and could be worked in seasonal bursts by settlers who had many other tasks and duties. The first kitchen gardens of the Canterbury sheep stations were simple cottage gardens, in keeping with the first small dwellings on them, made of sod or rough-sawn timber. However as the income from these huge runs climbed, their owners commissioned both new houses and gardens to reflect their social position. To some it represented a return to the garden style of their family estates in Britain. To the self-made men it meant the adoption of the style appropriate to their new status.

Thelma Strongman has documented how professional gardeners were employed at Ilam by 1852, and at Mt Peel in 1867. The Ilam gardener raised prize-winning cucumbers "the largest of which measured 58 centimetres in length" (Strongman 1984: 44). The duties of the first gardener at Mt Peel

> "were that he should manage properly a conservatory, melon and cucumber frames and take entire charge of the flower garden and the rest of the kitchen garden as required ..." (Strongman 1984: 90).

These professional gardeners worked with nearly all the facilities they had been used to in Britain. They often had heated conservatories, glass frames, and pip-fruit store-houses (Strongman 1984: 41). At Orari two vine houses were installed, using fresh dung as a heat source (Strongman 1984: 55-6). Sea-kale forcing pots were made at the local Glentunnel brickworks (Strongman 1984: 84, 96). Walled kitchen gardens were extremely rare, however, and this may be owing to the costs of construction and materials, together with a more favourable climate which did not require peach and apricot trees to be trained against walls and protected by glass superstructures (Strongman 1984: 46).

The transplantation of the formal kitchen garden and the cottage garden from Britain to New Zealand was accomplished with only minimal disruptions. Seed failures were common in the early years, due to poor storage conditions, but by the 1850s-60s local seed merchants and nurserymen were able to supply a good variety of vegetables and fruits. For the rest of the Victorian era and until the 1930s, public demand was for exactly the same range of vegetables as in Britain. There was, however, increasing divergence in the varieties, since New Zealand seedsmen were importing from other countries in addition to Britain. The Dunedin nurseryman William Reid stated in his 1876 catalogue that

> "My Stock of Seeds, that cannot be

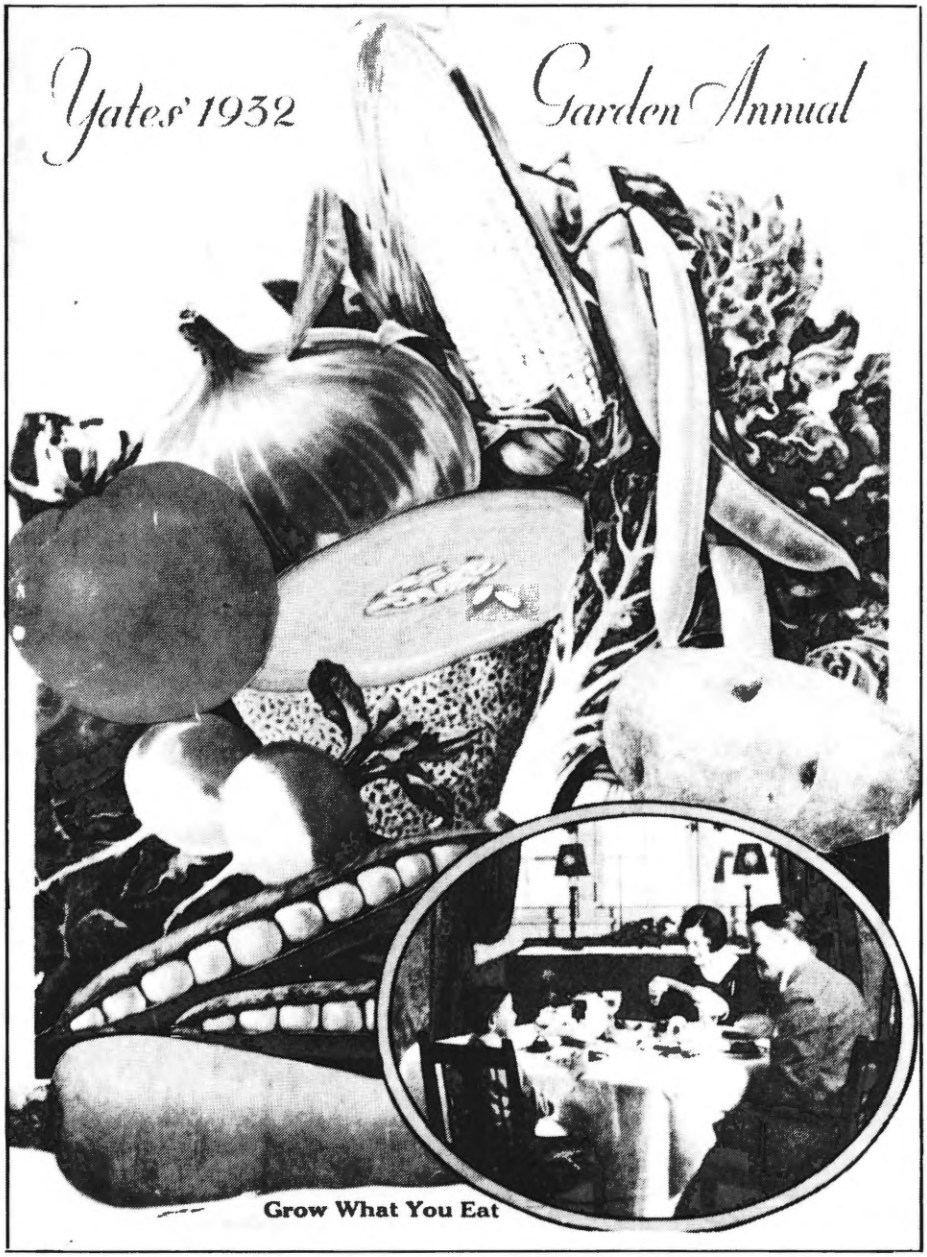
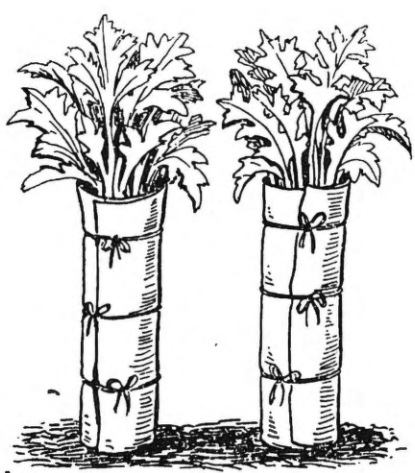


Fig. 2 Distinctive plants of the New Zealand kitchen garden such as silver beet and sweet corn appear on the cover of Yates' 1932 Catalogue.

a

Section of celery trench, showing a root cleared of sprouts at the base and the tie removed, operations that must be attended to before earthing up is completed.



b

Blanching celery with paper bands.

Fig. 3 During the 1940s some New Zealand gardeners still blanched celery by earthing up (a), or tying in paper collars (b). From McPherson and Pye n.d. pp56,57,100,101.

raised in the Colonies, is selected for me from the best seed growing districts in England and Germany with the greatest care." (Reid 1876: 1).

The Range of Vegetables

A useful check on vegetable preference can be made by comparing British gardening handbooks with contemporary New Zealand publications, and performing a similar operation with recipe books. For the purpose of this research five British gardening publications (1829 to 1913) were compared with seven New Zealand sources (1851-1952) (for details see Appendix 1). After establishing that the vegetable range was nearly identical until the 1930s, 12 New Zealand recipe books from the First World War to the 1950s were checked for the appearance of the new vegetables which marked divergence from the British tradition (Appendix 2).

In the 1930s it was the silverbeet, sweet corn, pumpkin/squash and kumara that made New Zealand kitchen gardens begin to look distinctive. Silverbeet was not strictly a new vegetable since it had been grown in Britain from the 16th-18th centuries before being eclipsed by other greens in the 19th century. The kumara had a long prehistoric tradition of successful growth in Maori gardens where it was joined by pumpkin/squash and corn in the early 19th century (Leach 1984: Chapter 6). In the north chokos gained acceptance through their prolific growth, although they do not appear in recipe books with a national circulation until much later (e.g. Flower 1968: 38-9).

Sea-kale was no longer included in New Zealand recipe books after the 1920s, though it was mentioned in gardening handbooks until the early 1950s. Jerusalem artichokes and kale slowly declined from their former popularity over the same period. Since the Second World War we have seen the introduction of green sprouting broccoli, along with green celery which does not require blanching. Oka yams have become popular in the South Island while green peppers and garlic have gained wide acceptance in the warmer regions. Culinary fashions, influenced by the interest in ethnic or regional cuisines, have played a major role in the adoption of garlic and capsicums, and the trend to the consumption of marrows at courgette or zucchini size. Interest in rare and 'gourmet' vegetables shifted in the 1980s from salsify and scorzonera to Florence fennel, Asian greens, and radicchio.

Gardeners' Attitudes to Combating Pests and Diseases

When William Cobbett published *The English Gardener* in 1829, he found it necessary to introduce the subject of diseases within one particular chapter, that on fruit. However he chose that section to add his views on "divers mischievous insects which do injury to the herbaceous plants of the kitchen-garden" (Cobbett 1980: 211). Several of the fruit tree problems, such as mildew (powdery), 'gum', and canker were tackled by surgery. Insects like woolly aphids (called cotton blight), aphids ('lice') and caterpillars ('maggots') were treated with soap and tobacco juice washes, tobacco

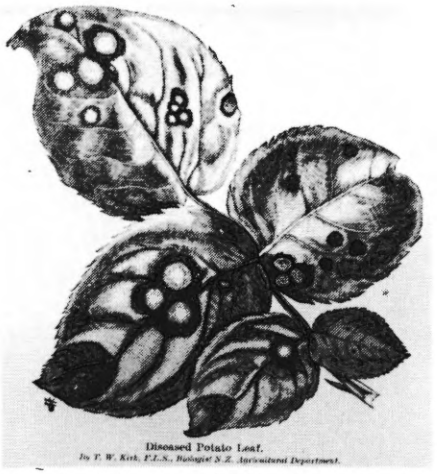


Fig. 4 T. W. Kirk, the New Zealand Government Biologist, produced this representation of the early signs of potato blight (*Phytophora infestans*) soon after its first major epidemic in this country. From Murphy's "Gardening in New Zealand" 1907 p.275.

fumigation, or laborious application of mercurial ointment. Ants were destroyed with boiling water, and red spiders in hot-houses were deterred by plentiful syringing. Cabbage caterpillars were to be shaken from the leaves, crushed underfoot and the affected plant fed to the pigs. Hot lime powder (quick lime) was laid to kill slugs, while grass-grubs ('rook-worms') were left to birds to eradicate. Cobbett knew of no deterrents to wire-worms, though wood lice and earwigs could be trapped. It is apparent that walled gardens, frames and hot-houses with their plentiful crevices in which insects could over-winter were particularly at risk. Rats and mice also benefited from this shelter, coming out at night to eat strawberries, grapes and other dessert fruit.

By the mid-19th century *The Cottage Gardener* was recommending soapsuds for carrot and onion grubs, and suds or tobacco fumigation to kill green aphids. Soot water was applied for root grubs. Mildew could be combated by mixtures of chimney soot and well-slaked lime, or dry wood ash with added sulphur. Soot, cinder ashes and quick lime were mixed to deter slugs and snails. But for the most devastating disease of the century, the potato blight, there was as yet no cure nor protection. First noticed in the south of England in 1845, it attacked every known variety. Its effects were sometimes counteracted by planting early, by cutting off and burning the infected haulms before the tubers were affected and by careful storage of the tubers above ground. It was not until the end of the 19th century that Bordeaux mixture (copper sulphate and slaked lime) was applied to potatoes during the cool damp weather in which late blight spreads. This mixture was developed in 1882 to combat a downy mildew epidemic which afflicted French vineyards from 1870 and which also spread there from America (Ainsworth 1981: 112, Fish n.d.: 51).

Initially growing conditions in New Zealand were free of many of these pests and diseases. In his survey of New Zealand's prospects Hursthouse (1861: 207) wrote that "no indications of blight have yet been noticed". He described rusts and mildews as comparatively unknown, though caterpillars were sometimes "seriously injurious" (Hursthouse 1861: 204). Early Wellington settlers had found grasshoppers troublesome in mid-summer (Leach 1984: 114). The late blight eventually reached New Zealand about 1892, though the first major epidemic did not occur until November 1904 (Cockayne 1907). Woolly aphid infestations were first noticed in apple trees in Nelson about 1850 and had become widespread by the 1870s (Hale 1955: 44). Mussel scale was particularly prevalent in the South Island while codlin moth became severe in Auckland (*Appendix to the Journal of the House of Representatives* 1902: I-12B). Syringing the trees with a mixture of kerosene and soapsuds was recommended for scale, while woolly aphid clusters at the base of young trees were painted with undiluted kerosene. At the same period, New Zealand's abundant peach trees succumbed to leaf curl in the 1880s, and plum trees became subject to silver leaf disease. To control the leaf curl Bordeaux mixture was applied until copper oxychloride became the preferred treatment after its development in the 1930s. Silver leaf disease had to be controlled by surgery.

For most of the 19th century, while New Zealand gardeners enjoyed relatively disease-free conditions, European gardeners and vine-growers were forced to combat a series of introduced diseases with simple, readily available remedies such as soot, lime, soap, sulphur and tobacco. Towards the end of the 19th century, however, the chemical industry had much more potent compounds to offer gardeners. In 1894 it was advocated that pea seeds be rolled in red lead to prevent damage from mice. *The Horticultural Note Book* (Newsham 1908) gave formulae for arsenate of lead ('Sugar of Lead'), and acetoarsenate of copper ('Paris Green'), both used on fruit trees. For glasshouse fumigation this book provided details on the use of carbon bisulphide, hydrocyanic acid gas, and sodium cyanide. Caustic soda was the basis of certain insecticidal washes. Interestingly, organic insecticides derived from hellebore roots, quassia wood chips, tobacco leaves and pyrethrum flowers were also described. Bordeaux mixture was "one of the most useful and effective fungicides", while paraffin (kerosene) emulsion was similarly praised as an insecticide (Newsham 1908: 376-386). Lime sulphur re-appeared after 1906 having been the basis of various mixtures used in the first half of the 19th century against fruit tree mildews (Ainsworth 1981: 109).

As pests and diseases progressively reached New Zealand, gardeners and orchardists looked to Europe and America both as a source of potential afflictions such as *Phylloxera*, and for possible remedies. In response to the severe codlin moth damage to commercial apple crops in the 1890s, and to the threat of *Phylloxera* introduction, an Orchard and Pests Act was passed in 1896. As well as controlling plant importation it declared that orchardists who did not treat their trees each winter for apple-scab and codlin moth were committing an offence. The Act was amended in 1903 to include American blight (woolly aphid), mussel scale and red mite. Occupiers of all gardens and orchards were required to "do whatever is necessary in order to eradicate disease . . . and prevent the spread thereof". They had to notify the Secretary for Agriculture within 48 hours of discovering a new disease. Inspectors were empowered to use force if necessary to gain entry to gardens and orchards.

Before the 1903 Act became law there was some concern in Auckland whether codlin-moth could be eradicated. As a result an old codlin-infested orchard was purchased at Otahuhu and trials made of various sprays over two seasons, especially Paris green, 'arsenic and soda' and 'arsenite of lead'. The resulting codlin-free fruit (90-95% of the crop) was sold to defray costs, and infected apples were given away as pig food (*Appendix to the Journal of the House of Representatives* 1902: I-12B; 1903: I-12). In recognition of the difficulties of treating codlin-infected orchards, the 1903 Act made it lawful "to sell or offer for sale in the Provincial District of Auckland . . . fruit which is affected with codlin-moth to extent of not more than five per centum". The Orchard and Garden Diseases Act of 1908 re-

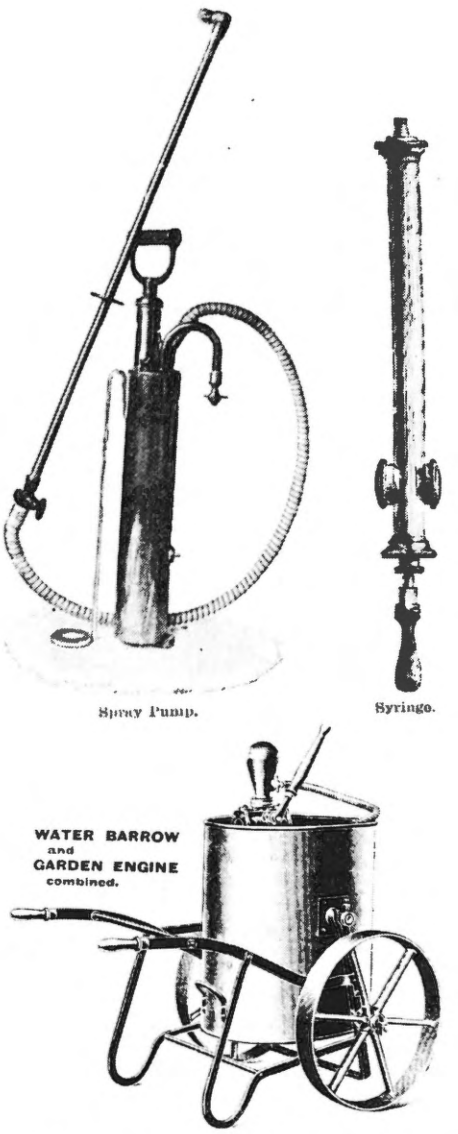


Fig. 5 Spray pumps available in New Zealand before the First World War. From Murphy's "Gardening in New Zealand" 1907 pp297-8.

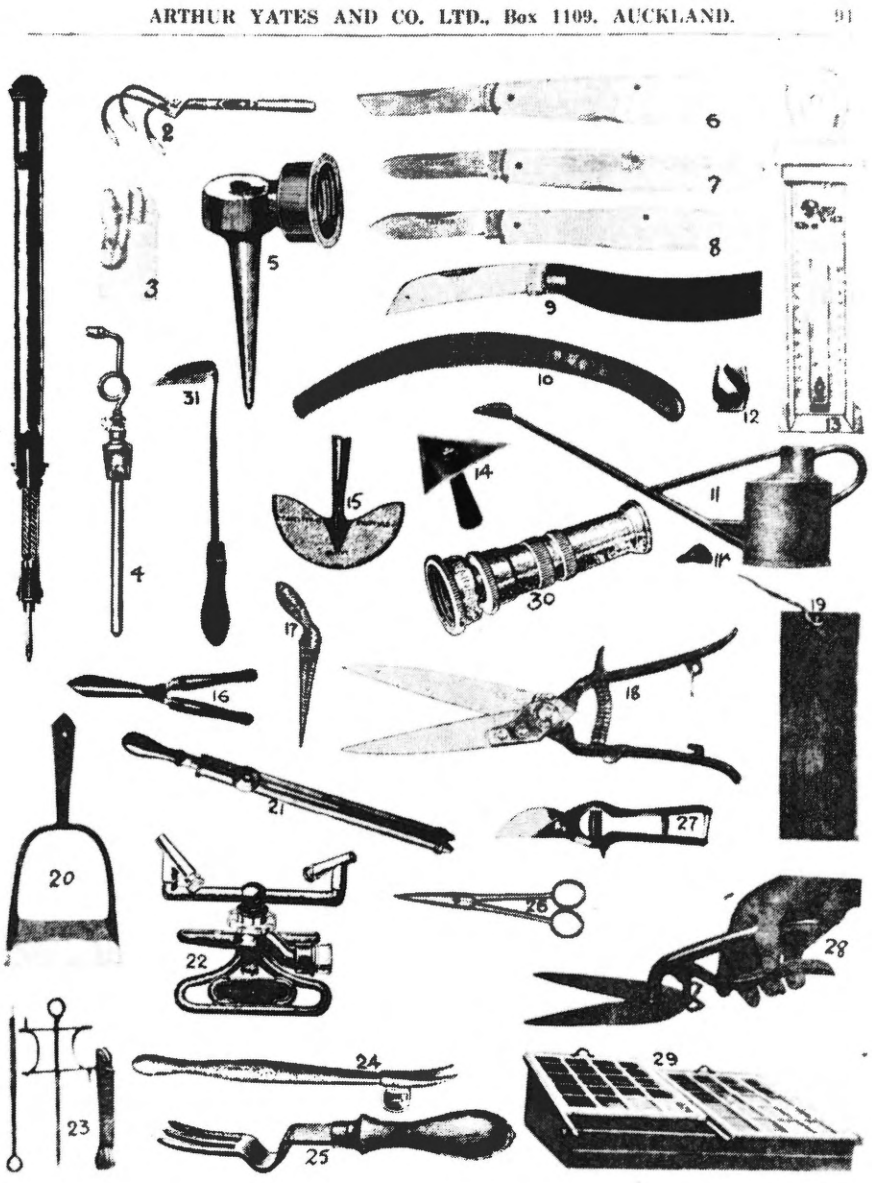


Fig. 6 A selection of gardening tools illustrated in Yates' 1932 Catalogue pp91,93.

pealed the earlier two. Judging by the new and longer schedule of pests and diseases the existing legislation had been ineffective in controlling their spread once in New Zealand. However the regulations (1903) Act have been successful in keeping out fruit flies.

All the late Victorian remedies continued in use in New Zealand until the Second World War, including the arsenical compounds trialled at Otahuhu. The *Star Garden Book* (6th edition ca 1935) recommended kerosene emulsion, boiled tar water, lime sulphur, soot, caustic alkali wash, nicotine fumigation, Paris green and arsenate of lead.

The most significant change in garden pest control was the introduction of DDT after the war. In 1952 the Department of Agriculture bulletin on *The Home Vegetable Garden* described DDT as the replacement for derris dust (Kennelly 1952: 204), especially for caterpillars.

The 1961 *Yates Garden Guide* (1961: 354) wrote

> D.D.T. and Derris Dust are harmless to us but a poison to many leaf-eating pests. On the other hand Arsenate of Lead, which was frequently used before the advent of D.D.T. is a deadly poison."

The 1968 *Christie Glasshouse Guide* recommended DDT for caterpillars, wire worms, cutworms and earwigs. It was also a component of mixtures sold under the names Pestmaster and Gardenmaster (Christie 1968: 126-8).

By the 1970s DDT was suspected of causing serious pollution (de Vaus 1973: 33). It became a restricted pesticide in 1983, but only in relation to farmland. Home gardeners were free to continue its use as follows

> "5.(2) Any person may apply DDT, chlordane, or lindane, without a permit or other authority . . . in or around any residence or garden if the package in which that insecticide is packed for sale does not contain more than 60g of active ingredient and no more than 1 such packet is used in one application."
>
> (*1983 Pesticide Regulations*

Public opinion and ecological awareness have undoubtedly done more to discourage DDT use than these permissive regulations. Lead arsenate and nicotine sulphate were also withdrawn from sale in the late 1970s as the insecticides malathion and lindane (available since the early 1960s) proved their potency.

The latest trends in the marketing of 'remedies' are to emphasize the natural organic pesticides such as pyrethrum or derris, and to rename the synthesized fungicides and pesticides so that they become user-friendly (e.g. Bravo, Target, Shield, Gild, Mavrik, Gardenmaster, Rose Spray). One range of 'natural insecticides' promoted in 1989 packaged the same product (comparable to a soft soap) in six different containers for specific purposes (*Consumer Home and Garden* 1989 5:2). It is interesting to note that soft soap was recognised in 1908 as having "proved itself to be invaluable as an insecticide" (Newsham 1908: 385).

In many respects attitudes to the eradication of garden pests and diseases have reflected wider human values and attitudes. In the early Victorian era many pests were physically removed by trapping, sluicing, or scalding.

Thus the health of the garden depended on the Victorian virtues of industrious and regular labour, and vigilance. With the onslaught of new fungous diseases spread by faster communication over former ocean barriers, gardeners and agriculturalists turned to industrial chemists for efficaceous formulae. Although they recognized the potency of chemicals such as arsenic and cyanide, there was no fear or even knowledge of residues. The problems of safely applying the mixtures were seen as challenging technological ingenuity rather than threatening human health. Humans' faith in their ability to wipe out plant pests and diseases without poisoning their own food persisted until the era of environmental awareness began in the 1970s. Fear of pollution and toxic residues is linked to a loss of public confidence in pharmaceutical manufacturers and the chemical industry. The ring of distrust now extends to oil, and mining companies. It is a sobering thought to consider how three of the pollutants widely publicised in the 1980s (DDT, lead, arsenic compounds) have been sprayed or dusted on to fruit and vegetables in home gardens and orchards for between 20 and 70 years.

Attitudes to Nutrition of Vegetables and Fruit Trees

The principle of replenishing soil nutrients after cropping was well known in the 19th century: "There must be an annual addition of animal or vegetable decomposing matters, to restore to the soil the carbonaceous matters taken from it by preceding crops" wrote the Editor of *The Cottage Gardener* in 1851 (Feb. 27). Not surprisingly 19th century gardeners differentiated many types of organic manure, recognising their distinctive qualities and concentration. William Cobbett (1980: 15) was of the opinion in 1829 that dung was "not the best sort of manure for a garden", because it "creates innumerable weeds" and makes "garden vegetables coarse and gross compared to what they are when raised with the

aid of ashes, lime, chalk, rags, salt, and composts". He preferred to use dung as a well-rotted component of a compost consisting of road-side shovellings, weeds, ash, lime, rags and salt.

Readers of *The Cottage Gardener* for 1851 were encouraged to have manure pits which were described in the July 3 issue as

> "a general receptacle for all sweepings, rakings, trimmings, and refuse of all kinds, as well as the soap-suds from the washhouse, and all house-sewage. Where a pig or cow is kept the drainage of these places is also conveyed to the same place. Dust or charred-dust, wood-dust, or old tan . . . are placed in this pit to absorb the accumulation of moisture."

From time to time such pits were emptied and spread over the garden. Similar components went into the manure heaps or 'middens' of the allotment holders, along with coarse vegetation and seed-bearing weeds pre-charred within an earthcovered bonfire. Such middens were to be covered with soil in warm weather so the ammonia (recognised as the source of nitrogen) would not escape.

In Cornwall, soot and sea sand were used as a potato manure (*The Cottage Gardener* 1851: July 17), while night-soil "mixed with ashes and other refuse" was considered best suited for cabbages, asparagus, rhubarb and other leafy crops (July 17). There is no suggestion of any revulsion to the use of human wastes in either the Victorian or Edwardian era; indeed they were forked into flower beds (Newsham 1908: 121-2). Seaweed was a common manure in coastal areas, sometimes applied with lime (*The Cottage Gardener* 1851: Feb. 27).

The making of hot-beds for raising tender crops or mushrooms required large quantities of decomposable materials, selected for the particular task, and heaped about four feet high. Stable litter and dead leaves in equal proportions (Garner 1894: 15-16) were most common, though spent hops, flax mill refuse or used tanners' bark also generated heat. After the bed's heat was finally expended, this well-rotted matter was dug into the garden, a valuable addition. Liquid manure was also popular throughout the 19th century, brewed from cow, sheep or deer dung (*The Cottage Gardener* 1851: Jan 23). In Edwardian times house slops were recommended (Fish n.d.: 46).

The growth of agricultural and industrial chemistry saw the discovery of the principal elements which play an active part in plant nutrition (especially through the work of the German chemist Liebig). The importance of the phosphate component of bones was recognised as early as 1774 (Davies 1987: 50). Increasing demand for pulverised bone to rejuvenate old pasture led to the importation of large quantities of human bone, exhumed from European battlefields or removed from catacombs. But bone meal was an effective fertiliser only where soils were sufficiently acid to dissolve the phosphate components. Following Liebig's 1840 experiment which used sulphuric acid to make bone phosphate water soluble, the first superphosphate manufacturing plant opened in England in 1842. The process was also applied to calcium phosphate nodules mined from natural deposits (Davies 1987: 51-2).

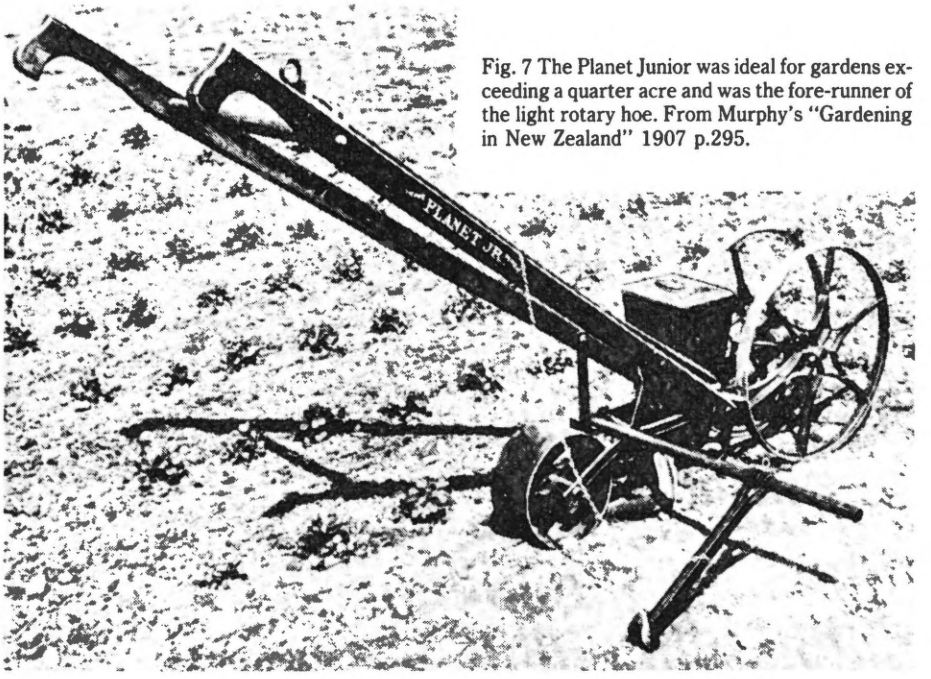


Fig. 7 The Planet Junior was ideal for gardens exceeding a quarter acre and was the fore-runner of the light rotary hoe. From Murphy's "Gardening in New Zealand" 1907 p.295.

The year 1840 also saw the first importation of guano from the Chincha Is. off South America. This type of guano was rich in both nitrates and phosphates and considering the slave labour conditions of its extraction, it could be landed in Britain at a competitive price (Davies 1987: 54-5).

Increasingly, industrial by-products were turned to agricultural uses. Gas lime was the spent lime left after coal gas was purified. It contained lime sulphide but could not be used fresh. Basic slag, a by-product of steel making, consisting of 30-40% lime phosphate, was ground extremely finely for dressing heavy, acid soils. Sulphate of ammonia was made by mixing the ammonia liquor from coal gas manufacture with sulphuric acid. Steamed bone flour, a by-product of gelatine extraction, was also used (Newsham 1908: 113-127).

By the turn of the century gardeners had had sufficient experience with these artificial products to form rather mixed opinions about their value. Garner (1894: 11) wrote

> "Some persons have great faith in chemical manures, most of which, if good and properly used, are no doubt beneficial."

He believed that

> "Where farmyard and other manures are difficult to obtain, the following will make a splendid substitute for it — viz., nitrate of soda, two parts; muriate of potash, four parts; and phosphate of lime, six parts." (Garner 1894: 112-3).

The nitrate of soda would have been mined on the Pacific coast of South America, the muriate of potash may have been extracted from kainit, a natural salt mined near Stassfurt in Germany, and the phosphate of lime may have originated as basic slag or calcium phosphate nodules. In 1908 Newsham was still of the opinion that

> "Farmyard manure or dung is the most valuable manure at the disposal of the cultivator of field or garden crops . . . " (Newsham 1908: 117).

He knew that the mineral fertilisers had certain drawbacks. Nitrate of soda, for example, "if applied frequently without other manures . . . will exhaust the soil", and sulphate of ammonia may burn foliage (Newsham 1908: 113).

The value of mineral and artificial fertilisers was widely appreciated by New Zealand farmers by the 1920s, particularly basic slag, phosphates and lime (Smallfield 1970: 15, 17). But there is little evidence for the use of any artificial fertilisers in New Zealand gardens until suburban sprawl and the decline in horse transport in towns made them economical alternatives. Even those trends were confined to relatively few locations until after the Second World War. In a pre-war *Star Garden Book* (ca 1935), cow manure was recommended for light land and "long stable manure for heavy, retentive soil" with occasional dressings of "soot, lime, and wood ashes, by way of a change" (Fleming n.d.: 231). If artificial or chemical manures were "worth buying at all", Fleming recommended that they contain "all three of the essential manurial ingredients". But he admitted that "when judiciously applied, especially while the crops are growing, they often act like magic" (Fleming n.d.: 232). By now plant nutrient science had been simplified for the home gardener to nitrogen for leaves, potassium for roots, and phosphate for fruits. Lime was seen as beneficial for sweetening sour soil and releasing soil nutrients. Fleming gave formulae for a complete dry fertilising mixture and a liquid fertiliser based on artificial components.

Over the next two decades (1935-55) there was a shift in word usage: the meaning of 'manure' contracted to cover animal and plant matter (such as dung and green manure), and 'fertiliser' became the preferred designation for what had previously been called artificial manure (c.f. Pritchard n.d.: 7; McPherson and Pye n.d.: 21; Kennelly

1952:18). Access to cheap supplies of animal manure continued to decline and soon after the end of the war, Pritchard noted that this fact, coupled with

> "The quick crop response to the use of artificial fertilisers, has led many growers of vegetables to neglect the replacement of organic material in the soil. It is now being realised that the continued use of these fertilisers, without organic manures or organic matter replacements in the soil, can lead only to disastrous crop yields." (Pritchard n.d.:6)

McPherson and Pye promoted the compost heap as the substitute for animal manure, giving instructions for layering it with soil, lime, and ashes from burnt hedge clippings and potato tops, keeping it moist, and turning it two or three times. They believed that

> "Its value as a fertilising agent is scarcely recognised as much as it should be . . . " (McPherson and Pye n.d.: 31).

By 1952 Kennelly reported that

> "In recent years the making of compost in home gardens has become increasingly popular and important"

attributing this trend to mechanisation on farms and to urban growth (Kennelly 1952: 38).

Though suburban gardeners were now regular users of artificial fertilisers supplemented by compost and green manure crops, the writers of *Yates Garden Guide* for 1961 believed that there was still room for increased sales of fertilisers such as their own product Plantonic. After pointing out that fresh animal manure can cause rank growth or "actually kill plants", they reprinted a newspaper article entitled "Starvation Diet in the Home Garden". This claimed that

> "While composts and manures must be accorded their place in soil management they are inadequate to ensure proper mineral nutrition of plants — and must be supplemented by fertilisers." (*Yates Garden Guide* 1961: 10).

Victorian kitchen gardeners would have found this statement unbelievable!

Organic gardening has gained many converts in New Zealand over the last two decades, and has recently been boosted by 'green' awareness linked to ozone depletion and the predicted greenhouse effect. Horticultural suppliers have now recognised the strength of this movement. Yates included for the first time a section on Organic Gardening in the 61st edition of *Yates Garden Guide* (1987), and Coopers and Yates are currently promoting a range of fertilisers, pesticides and fungicides under the name 'Nature's Way'.

Fish fertiliser is advertised as an "all purpose natural plant food", while seaweed extract is a "natural organic growth stimulant" (*Yates Talking Points* 1987(2): 16). Blood and bone is a "natural, organic form of nitrogen and phosphorus" (*Yates Talking Points* 1985(2): 1). Liquid and dry fertilisers are sold as tailor-made for an increasing range of plants including citrus, lawn, rose, tomato, acid-lovers, flowering houseplants, foliage houseplants, shrub and tree, orchid (flowering and growing). Where these are made from artificial compounds, stress is placed on the fact that they are "balanced, fast acting, easy to use" (*Yates Talking Points* 1985(2): 2). In keeping with the restricted range of each type they are sold in small quantities and inevitably at much greater unit cost. For example, in 1989 'pelletised' sheep manure was sold in 10kg bags costing $9.65 per bag.

Manure water.
Diagram showing the method of using either soot or dung.

Fig. 8 Liquid manure was a popular booster for green vegetables, as illustrated by McPherson and Pye during the Second World War.

Conclusions

With so much of the primary material yet to be analysed, it would be premature to draw conclusions except in the most general terms. What proved unexpected was the minimal divergence from the British kitchen garden tradition until the 1930s. Variety differences aside, New Zealand vegetable tastes and garden practices developed in parallel with those of the British from the mid 19th century until the Depression years. The beliefs behind these practices underwent similar transformations, especially in relation to the role of industrial chemicals in home garden management. Although some environmentalists might interpret the rise of the organic gardening movement as marking the end of an era of industrial input, horticultural suppliers are adapting their products and promotional material to ensure respectability and sales.

Many aspects of garden history deserve separate research, for example garden technology and its relationship to garden size and plant range, the decline of home vegetable growing since 1960, the contraction in numbers of vegetable and fruit varieties available to home gardeners, the role of school vegetable gardening and horticultural societies, and the influence of newspapers and television in moulding public tastes. At another level of enquiry questions of gender roles, class mobility and ethnic identity can be studied in relation to gardening. Of immediate concern, however, is the need to safeguard the materials from which garden history will be written in the future, in particular trade catalogues and handbooks, and the personal diaries and notebooks of gardeners, all of which are poorly represented in our public archives.

Acknowledgements

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Appendix 1:
Garden Sources in Chronological Order

UK Cobbett 1980, 1st published 1829
UK *The Cottage Gardener,* conducted by G. W. Johnson, Volume V 1851 London: W. S. Orr and Co.
NZ Jupp (1851-60)
NZ Wilson 1856
NZ Reid 1876
NZ Matthews, G. 1876 Catalogue [Hocken Library]
UK Garner 1894
UK Fish, n.d. (between 1903 and 1914)
UK Newsham 1908
NZ *Star Garden Book* ca 1935
NZ McPherson and Pye n.d. (between 1940 and 1945)
NZ Kennelly 1952

Appendix 2:
New Zealand — Published Recipe Books

Trinity Jubilee Fancy Fair Cookery Book 4th ed. 1923, Timaru: Timaru Herald (1st ed. 1914)
The Universal Cookery Book 5th ed. 1925, ed. Mrs J. Beaton, Dunedin: Mills, Dick & Co.
Jubilee Cookery Book 1933, Church of S. Mary, Mornington, Dunedin
Primmer, M. S. 1926 *The Up-to-date Housewife.* Coulls Somerville Wilkie.
Economical Technical Cookery Book, Dunedin. [?1920s]
Colonial Everyday Cookery, revised ed. (14th) Whitcombe & Tombs [early 1920s?]
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