HORTICULTURE IN NEW ZEALAND

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HORTICULTURE IN NEW ZEALAND

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Cornus florida 'Rubra' in Three Bridge Garden, Eastwoodhill. Photo Marion Mackay.

Genetic Engineering of Vegetables

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1. Introduction

Recent scientific advances in understanding the cellular and molecular biology of plants have resulted in the development of techniques that allow the genetic engineering of crop plants. By integrating these advances, it is possible to isolate genes from any source of DNA (plants, animals, microbes) and manipulate their regulatory regions so they will be expressed in a desired manner. It is also possible to insert these genes into a plant cell where they become integrated into chromosomes. These genetically modified or transformed cells are then regenerated into complete plants using tissue culture methods. The new gene is transmitted to following generations as a simply inherited character.

In this article we discuss these advances in relation to vegetable improvement. We consider the ways in which cloned genes can be transformed into plant cells, the manner in which transformed cells are identified and regenerated into plants and the characters of horticultural importance that can be manipulated via genetic engineering. We also summarise our progress toward developing this technology for 5 important vegetables in New Zealand.

2. Gene Transformation into Plant Cells

a) *Agrobacterium*-mediated transformation

The most commonly used approach for introducing foreign genes into plants uses the natural gene transferring ability of *Agrobacterium tumefaciens.* This soil-dwelling bacterium infects wound sites on plants and induces development of crown gall tumours by transferring a specific region of its Ti-plasmid, the T-DNA, into the chromosomes of plant cells (Fig. 1). These plant cells express the inserted T-DNA genes which encode enzymes in the phytohormone biosynthetic pathways (resulting in the tumorous growth) and cause production of opines. The *Agrobacterium* lives between the plant tumour cells and utilises the secreted opines as a source of carbon and nitrogen. Crown gall tumours therefore represent a highly sophisticated form of parasitism by *Agrobacterium.*

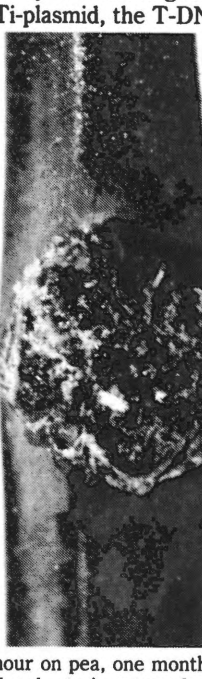

Fig. 1 A tumour on pea, one month after inoculation with *Agrobacterium tumefaciens.*

The *Agrobacterium* genes responsible for transfer of T-DNA to plant chromosomes are not located on the T-DNA itself. Instead they are located elsewhere on the Ti-plasmid and on the chromosome of *Agrobacterium.* Therefore "disarmed" *Agrobacterium* strains, incapable of inducing tumour formation on plants, can be produced by deleting the phytohormone biosynthetic genes from the T-DNA without interfering with their ability to transfer DNA to plant chromosomes. Furthermore, both the phytohormone and opine biosynthetic genes can be replaced by any other segment of DNA, which is then transferred into plant chromosomes in place of the T-DNA genes. Plant tissue is co-cultivated with the modified *Agrobacterium,* usually by brief immersion into an actively growing bacterial culture. After allowing 2-3 days for transformation events to occur, the plant tissue is transferred to a culture medium containing an antibiotic to eliminate the *Agrobacterium.* The transformed plant cells are then regenerated into complete plants using tissue culture technology.

This approach to transformation can be used for any plant that is a host for *Agrobacterium* and can be regenerated from individual cells. Hosts for *Agrobacterium* were thought to be limited to a wide range of dicotyledonous plants but this has recently extended to a few monocotyledonous plants.

b) Direct Gene transfer to Protoplasts

Plant protoplasts are "naked" cells without protective cell walls, produced by treating plant tissues with specific enzymes that degrade away the cell wall components. Because the cell wall provides mechanical support against the internal pressure of the cytoplasm, it is necessary to bathe protoplasts in solutions of equivalent osmotic potential to prevent them from bursting. Removal of the cell walls causes protoplasts to lose their characteristic shape and become spherical (Fig. 2). With appropriate culture conditions, protoplasts can be induced to resynthesise their cell walls and undergo cell division to form cell colonies. In many species these cell colonies can be regenerated into plants.

Plant protoplasts can be induced to take up naked DNA across their cell membranes. Transformation in this manner usually involves temporarily increasing the permeability of the cell membrane by treatment with specific chemicals (polyethylene glycol and calcium), heat shock and/or electroporation (high voltage pulse of electrical current). The majority of the DNA taken up by these "leaky" protoplasts remains in the cytoplasm of cells where it can be transiently expressed for several days. Occasionally this DNA becomes integrated into the chromosomes, and the cell colonies developing from such protoplasts are then stably transformed.

Transformation by direct DNA uptake into protoplasts is applicable to any species for plants capable of regenerating from protoplasts. However, even when protoplasts fail to undergo cell division, this technique is valuable for studying the transient expression of particular genes in protoplasts isolated from specific tissues of a plant.

c) Microprojectile Acceleration

This involves the use of a "gene gun" to fire small microprojectiles at high velocity into intact plant cells (Fig. 3). The microprojectiles are a fine powder of a metal such as tungsten or gold (1-3 mm diameter) which have been coated with the DNA of specific genes. These are placed on the end of a nylon macroprojectile (5mm diameter, 6mm long), which is accelerated under vacuum using a blank charge. The macroprojectile hits a stopping plate at high speed (387-526 m/s depending on the charge used). Although this stops the macroprojectile, the DNA coated microprojectiles pass through a small 1mm

Fig. 2 Isolated protoplasts from onion tissue.

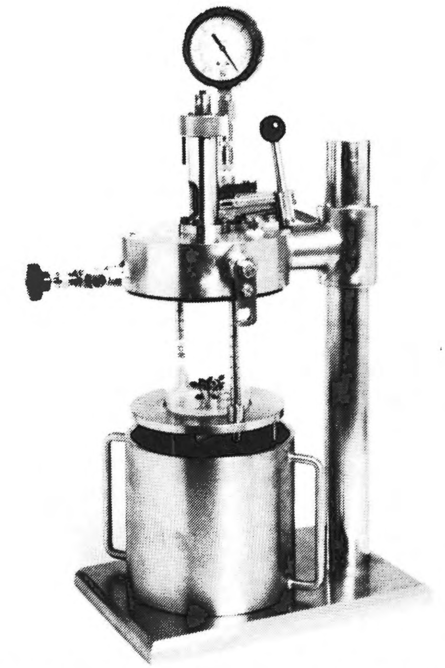

Fig. 3 A microprojectile accelerator for "firing" DNA coated "bullets" into plant cells.

diameter pore in the stopping plate. The microprojectiles maintain sufficient velocity under vacuum to embed themselves into a cell of the target plant tissue. Once inside a cell, the DNA is released from the microprojectiles and becomes incorporated into the plant chromosomes.

This method is applicable to any plant species which can be regenerated from individual cells. Its advantage is that tissue culture may not be necessary at all, because DNA coated microprojectiles can be fired into shoot meristems of seedlings. If DNA is delivered to the germline cells that give rise to eggs and pollen, then it should be possible to screen seedlings of the next generation for transformed plants.

d) Other Approaches

Transformation of plant cells has also been achieved using a range of other approaches.

- Fusing plant protoplasts with liposomes (artificial membranes) encapsulating plasmid DNA, or bacterial spheroplasts (bacterial equivalent to plant protoplasts) harbouring appropriate plasmid DNA.
- Macroinjecting of DNA into developing flower buds and its possible incorporation into germline cells.
- Applying DNA to recently pollinated stigmas with possible delivery to an egg cell during fertilisation.
- Soaking dried embryos from seeds in DNA solutions.
- Using laser guns to create minute holes in cell walls and membranes through which DNA can enter.

Some of these techniques require considerable technical skill, with only a small number of cells able to be treated; others are very inefficient. Although potentially useful, further development is required before these techniques can be used routinely for transformation of plant cells.

A different approach for transformation involves "infecting" plants with genetically engineered viruses that carry the genes to the plants. The virus spreads throughout the plant, with multiple gene copies per cell. The disadvantages include the narrow host range of most viruses, the limited amount of space in the viral genome for foreign genes, and the limited transfer via seed propagation.

3. Selection and Regeneration of Transformed Cells

Whatever approach is used for introducing genes into plant cells, usually only a small proportion of cells have undergone a gene insertion event. It is therefore important to have a method for identifying which plant cells have been transformed with the foreign DNA. This can be conveniently achieved through the use of genes which confer resistance to phytotoxic chemicals such as antibiotics. Such genes are known as selectable markers, of which one of the most popular is the bacterial gene, neomycin phosphotransferase. This gene confers resistance to kanamycin and related antibiotics by coding for an enzyme which detoxifies these chemicals via a phosphorylation reaction.

When the coding region of neomycin phosphotransferase is inserted between plant regulatory sequences (upstream promoters and downstream polyadenylation signals), a chimeric gene is constructed which is expressed in the plants. Plant cells so transformed become resistant to kanamycin; the recipient cells are cultured on a medium supplemented with kanamycin at a concentration which is usually toxic. Only plant cells that express the neomycin phosphotransferase gene can grow and multiply on such a medium. They soon develop into small colonies (Fig. 4), which can be picked off and transferred to a regeneration medium (Fig. 5).

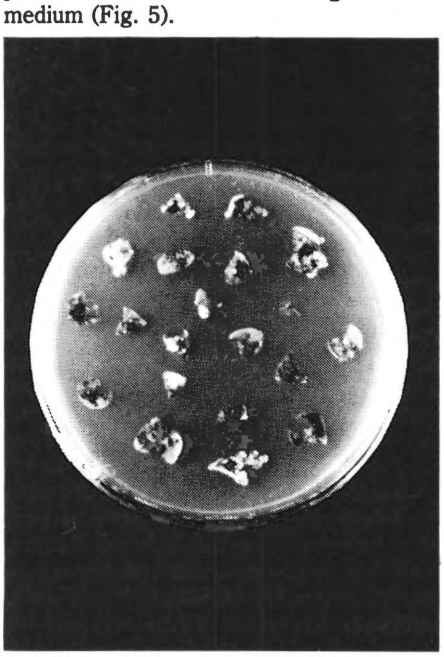

Fig. 4 Kanamycin-resistant cell colonies developing on potato leaves following *Agrobacterium*-mediated transformation.

This has allowed regeneration of transformed plants of many vegetables, including potato, tomato, eggplant, lettuce, celery, carrot, cucumber, broccoli, cabbage, bean, pea and asparagus. In addition to kanamycin resistance other useful selectable markers include genes conferring resistance to hygromycin, streptomycin, methotrexate, gentamycin, bleomycin, and herbicide-resistant genes (below).

The subsequent transfer of horticulturally important genes into vegetables can be readily achieved by positioning these genes immediately adjacent to an appropriate selectable marker gene. By repeating the above procedure of selecting for resistance to the appropriate phytotoxic chemical, the resulting regenerated transformed plants will, in most instances, also receive the desired useful gene.

Fig. 5 Regeneration of kanamycin-resistant cell colonies of broccoli.

4. Genes useful in Horticulture

Before a gene can be transformed into plants, it must first be isolated and cloned at the DNA level. If the gene has to be manipulated to achieve expression in a desired manner, then it is also important to determine the complete sequence of nucleotides along the coding region. This allows the required regulatory sequences to be correctly aligned with the coding region.

To isolate and clone a gene for a specific character usually requires an understanding of the protein product of the target gene. Unfortunately the biochemical basis of most characters in plants are poorly understood, and much research is required before genetic engineering of many characters is possible. For this reason, molecular biologists initially turned to the much simpler microbial systems as a source of genes.

a) Herbicide Resistance

The first character to be successfully manipulated in plants by genetic engineering was herbicide resistance. This was largely because the biochemical target sites of herbicide action are well known and the selection of cells with herbicide resistance can easily be achieved in microbial and plant cells by adding the appropriate chemical to the culture medium.

The three common ways in which herbicide resistance is manipulated are:

(i) By over-expression of the sensitive enzyme. A substantial increase in the cellular concentration of sensitive enzymes requires higher herbicide doses to inhibit enzyme activity. This can be achieved by increasing the copy number and/or the expression levels of the appropriate gene. An example is resistance to glyphosate.

(ii) By altering target sites. This involves the use of mutant genes which specify a slightly different enzyme which prevents the herbicide binding to, and inactivating the enzyme. These mutations often involve only single nucleotide substitutions, which result in a single amino acid change in the enzyme. The mutations must not interfere with the normal functioning of the enzyme. Examples include resistance to glyphosate and chlorsulfuron.

(iii) By degrading the herbicide. Resistance is achieved by inserting a gene coding for an enzyme that metabolises the herbicide into a non-toxic compound. Examples include resistance to bromoxynil, phosphinothricin and 2,4-D.

Although these approaches increase herbicide resistance in plants, only the last two usually provide sufficient protection against herbicides for use in weed control. However, all three approaches may have other applications, including:

(i) Maintaining genetic purity during seed multiplication of new cultivars.

(ii) Using herbicide resistance as a genetic marker for hybrid seed production.

(iii) Chemical thinning of crops following the blending of resistant and sensitive seeds.

(iv) Use for linkage of herbicide resistance to other important characters in crops, such as sex in asparagus where male plants yield better than female plants.

b) Virus Resistance

One of the most significant applications of genetic engineering to horticulture in the near future will be the production of virus-resistant plants. The transfer and expression of DNA sequences corresponding to certain genetic components of plant viruses can confer resistance to viral diseases via 3 strategies.

(i) Viral coat protein. The expression of viral coat protein genes following their integration into the genomes of plants has been well documented and has protected crops from infections of tobacco mosaic virus, alfalfa mosaic virus, tobacco rattle virus, tobacco streak virus, cucumber mosaic virus, potato virus X, potato virus Y, and soybean mosaic virus. The mechanism is not well understood. Hypotheses include interference with the unwrapping of viral genetic material (the first step in viral invasion of a plant), and the blocking of intracellular receptor sites in plant cells to which viral particles must bind to replicate.

(ii) Satellite RNA protection. Satellite RNA sequences are often associated with certain strains of RNA viruses and some are known to reduce the severity of viral disease symptoms. These sequences depend on the virus for their replication and are transmitted between plants as a component of the virus. DNA sequences capable of being transcribed into satellite RNAs known to alleviate specific viral diseases, can be transformed into plants. These plants are then protected from viral infection. This approach to virus resistance has been demonstrated for cucumber mosaic virus and tobacco ringspot virus.

(iii) Viral anti-sense RNA protection. Viral replication and expression can be inhibited if the plant is manipulated to produce anti-sense viral RNA. This involves transforming plants with DNA sequences in a reverse orientation so that the wrong DNA strand of the double helix is transcribed into RNA. This anti-sense RNA is therefore complementary to sequences of the viral genetic material, to which it may bind and inactivate viral replication. This strategy has been shown to reduce viral invasion of plants by cucumber mosaic virus and potato virus X.

c) Insect Resistance

Another important application of genetic engineering in horticulture is the development of insect resistant plants. Remarkable successes have been achieved by two techniques.

(i) Insecticidal BT proteins. The bacterium *Bacillus thuringiensis* produces a protein which is active against various insect pests. When ingested by susceptible insects, protease enzymes in the insect gut convert it to an active toxin. The insecticidal proteins from different strains of the bacterium target specific insect groups. For about 20 years, preparations of *B. thuringiensis* have been sprayed onto crops as a safe biological control measure against specific insect pests. Recently the genes encoding these insecticidal proteins have been isolated and cloned from several strains of *B. thuringiensis.* When these genes are transformed and expressed in plants, they produce sufficient insecticidal protein to protect crops against grazing insects. This approach has been successfully used against larvae of Lepidoptera (moths) and Coleoptera (beetles).

(ii) Proteinase inhibitors. When certain plants are mechanically wounded (e.g. by chewing insects) specific factors are released which induce the expression of proteinase inhibitor genes in the plant. These inhibitors target proteinase enzymes of insects and microbes rather than those of the plant, and are considered to be a defensive mechanism. They are thought to protect plants against insect attacks by interferring with the digestive enzymes in the gut of grazing insects. Proteinase inhibitor genes have been cloned from several plant species and their manipulation offers a novel approach for engineering insect resistant crops. For example, the transfer of the cowpea trypsin inhibitor gene into other plants has enhanced their resistance to a wide range of herbivorous insect pests.

Additional strategies for genetic engineering of insect resistance will undoubtedly be discovered. Knowledge of the biochemistry of secondary metabolic pathways in plants is improving. Eventually it will be possible to manipulate the levels of specific secondary metabolites to repel feeding or inhibit egg laying of insects.

d) Other Possibilities

Many biochemical pathways in plants are being researched from a molecular perspective. When genes are isolated and cloned they are usually transformed into an unrelated species in order to study their expression in isolation from their biochemical pathway. Although the emphasis is on the regulation of gene expression in plants, this research should result in many other applications of genetic engineering. Potential characters which will be routinely manipulated in the future include:

- resistance to other diseases and pests from bacteria, fungi, nematodes, etc;
- manipulation of pigmentation in various plant organs such as flowers, fruits, tubers, etc;
- improvement of nutritional quality of food sources, especially of amino acids deficient in human and animal diets;
- improvements in the sensory perception of foods such as flavour in onions and transfer

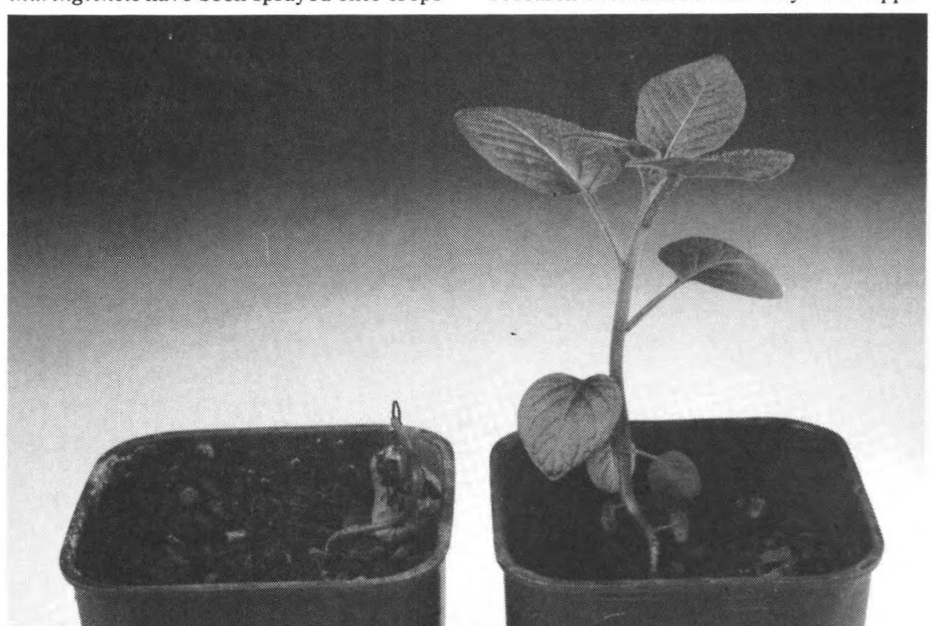

Fig. 6 Potato plants two weeks post spraying with the herbicide chlorsulfuron. Left - control 'CRD Iwa' plant. Right - a 'CRD Iwa' plant transformed with chlorsulfuron resistance.

of the gene for the production of thaumatin (a protein sweetner);
• the use of plants as "factories" for the production of novel industrial biochemicals;
• the induction of male sterility for hybrid seed protection;
• enhancement of post harvest fruit storage as recently achieved in tomato by using antisense versions of the gene for polygalacturonase which is responsible for cell wall softening during fruit ripening.

5. Genetic Engineering of Vegetables at Crop Research Division, DSIR

a) Potatoes

We have used *Agrobacterium*-mediated transformation to introduce foreign genes into potatoes. Kanamycin resistance provides a valuable selectable marker for identifying transformed potato cells (see Fig. 4).

Most of our work has involved the cultivars 'Ilam Hardy', 'CRD Iwa' and 'CRD Rua', although we have also regenerated transformed plants of 'Russell Burbank' and 'Maris Court'. The cultivar Iwa is especially amenable to *Agrobacterium*-mediated gene transfer and regeneration of transformed plants. Some of the other cultivars, especially Ilam Hardy, require further work to improve shoot regeneration.

We are now using this approach to introduce agriculturally useful genes into potato. Initially this work involved a herbicide resistant gene from *Arabidopsis thaliana* (a member of the cabbage family). When transferred into Iwa this gene confers up to a 1000-fold increased tolerance of chlorsulfuron (the active ingredient of the herbicide 'Glean') (Fig. 6). In the spring of 1988, we received approval for a small scale field trial on these plants. All five lines tested were phenotypically indistinguishable from the control plants. Several of them showed no inhibition of yield when sprayed with the recommended field application of chlorsulfuron (20 g/ha Glean). This clearly demonstrates that agriculturally useful genes can be transformed into existing potato cultivars without compromising field performance or yield.

We have also transferred the coat protein gene of white clover mosaic virus into potatoes. Because this gene has close homology with the coat protein gene of potato virus X, we anticipate that it will confer improved resistance to this virus, provided it is expressed at high enough levels. Currently we are also transferring the coat protein gene of potato virus Y (strain N) into a range of potato cultivars. During the next 12 months we hope to extend this work to include genes conferring resistance to potato leaf roll virus and potato tuber moth.

b) Peas

Legumes in general have been one of the most recalcitrant plant groups for regeneration in tissue culture. However, over the last 12 months we have developed a regeneration system for peas using immature cotyledons as an explant source. All the cultivars tested so far regenerate, although with marked differences in their response ranging from 10% to 60% of cotyledons producing shoots.

Peas are a good host for *Agrobacterium tumefaciens* (see Fig. 1), and this is the method of choice for transferring selected genes into peas. The above regeneration system is now being used in conjunction with disarmed *A. tumefaciens* strains for the development of a transformation system.

As an alternative method to transformation we have examined the potential of *Agrobacterium rhizogenes* to transfer genes into pea cells. Based on a similar principle to the *A. tumefaciens* system already mentioned (section 2a), *A. rhizogenes* induces the development of "hairy roots" rather than tumours. Using this approach we have selected transformed pea cells that have developed into kanamycin resistant "hairy roots". In some other species it is possible to regenerate shoots from such transformed roots and we are attempting this for these transformed pea roots.

When we have developed a transformation system for peas, we intend to transfer genes for pest and disease resistance. Our initial aim is to transfer the coat protein genes from pea seed borne mosaic virus and alfalfa mosaic virus. In the longer term we are interested in genes conferring resistance to other viruses (clover yellow vein virus, soybean dwarf virus and beet western yellow virus) and various insect pests (*Bruchus, Heliothis, Etiella*). The appropriate genes are currently being cloned by other DSIR Divisions.

c) Brassicas

The *Brassica* species of importance in New Zealand are *B. oleracea* (broccoli, brussels sprouts, cabbage, cauliflower, kale, etc.), *B. campestris* (turnip) and *B. napus* (rape and swede). These species are used for human consumption, as animal feed and as an oil source.

We are investigating a variety of approaches for transformation of *Brassica* cultivars grown in New Zealand. Initial experiments have determined the regeneration potential of these cultivars from protoplasts and from a range of explants. Shoot regeneration was obtained from protoplasts of 'Rawara' kale, 'Kapeti' kale and 'Giant' rape and from various explants of Giant, 'Oturu' and 'Rangi' rapes and Rawara and 'Medium Stem' kales. The regeneration trends observed are similar to those previously reported for other cultivars overseas, with *B. campestris* proving very recalcitrant to *in vitro* manipulation and regeneration. The techniques developed are now being used in transformation experiments with initial experiments aimed at the introduction of selectable marker genes.

We have transformed *B. oleracea* by the cocultivation of broccoli (cv. 'Green Comet') flowering stem (peduncle) explants with *A. tumefaciens.* This plant material is susceptible to several *A. tumefaciens* strains as shown by tumour formation after inoculation. From peduncle explants high rates of shoot regeneration (95%) were obtained, but when cocultivation experiments were performed, broccoli peduncle explants reacted adversely to the bacteria, and transformation was extremely difficult. However, a healthy transformed plant was obtained and grown to maturity.

Fig. 7 A kanamycin-resistant asparagus plant transformed via *Agrobacterium.*

The ability to regenerate shoots from both explants and protoplasts of these *Brassica* cultivars means that several methods of transformation can be used. For those cultivars which regenerate well from explants, cocultivation with *A. tumefaciens* or microprojectile acceleration will be used. Where regeneration from protoplasts is possible, cocultivation with *A. tumefaciens* or direct uptake of DNA is possible. When transformation of foreign genes into *Brassica* is routine, we intend to use this technology for the introduction of genes conferring insect resistance (especially insecticidal BT proteins against Lepidoptera larvae) and virus resistance (especially the coat protein gene from beet western yellows virus).

d) Asparagus

Asparagus is one of the few monocotyledonous species recorded as a host for *Agrobacterium.* Furthermore, asparagus cells grow well in culture and can be induced to regenerate into whole plants, even from isolated protoplasts. These results suggested that it should be possible to develop a range of transformation techniques for asparagus.

We have confirmed that *Agrobacterium* can induce tumour formation on asparagus plants. We have also selected tumourgenic cell cultures of asparagus capable of growing on hormone-free medium. Following cocultivation of asparagus tissue with a disarmed *Agrobacterium* strain carrying foreign genes, we have selected a kanamycin-resistant cell culture, from which phenotypically normal asparagus plants have been regenerated (Fig. 7). Proof that these plants are transformed has involved gene expression studies and DNA analysis of the foreign genes in these plants.

The aim of our work in asparagus is to develop glyphosate-resistant plants. Because asparagus is a perennial crop, weed control is often difficult. The ability to spray asparagus with glyphosate and kill weeds without damaging the crop should result in higher yields, as weeds compete for light, nutrients and water. Weeds also harbour insect pests of concern to quarantine authorities in export markets. Weed elimination should also minimise insects on harvested spears thereby reducing the need for fumigation of exported produce which often reduces the shelf life of asparagus.

e) Onions

We have recently established that onions, another monocotyledonous species, are a host for *Agrobacterium*-mediated transformation. We have induced tumour formation on onion bulbs using several strains of *Agrobacterium,* and demonstrated the expression of the opine biosynthetic genes in these tumours. Tumourgenic and rhizogenic cell cultures have been selected on hormone-free medium following the *in vitro* culture of tumour tissue from onion bulbs. In conjunction with tumour formation we have also transferred and expressed a foreign marker gene (β-glucuronidase) in these tumour cells.

Cocultivation experiments using seedling tissue of several onion cultivars with a range of *Agrobacterium* strains harbouring neomycin phosphotransferase genes, have demonstrated that a kanamycin analogue, G418, is superior to kanamycin as a selective agent. Because onion cells grow well in tissue culture and can be readily regenerated into complete plants, we intend to use this approach to select and regenerate transformed onion cells.

As an alternative approach to transformation, we are also developing a protoplast culture system for onions. To date we have achieved the isolation of intact viable onion protoplasts and the subsequent development of cell walls and microcallus cultures.

Our main interest for developing a transformation system in onions is for the genetic engineering of onion flavour. Another research project in our group is cloning the genes for key enzymes involved in the regulation of onion flavour (alliinase and -glutamyl transpeptidase). We are interested in manipulating flavour via enhancing gene expression, increasing gene copy number, and using antisense RNA approaches.

6. Conclusion

A range of techniques is available for introducing foreign genes into plant cells. A major limitation to exploiting these techniques for genetic engineering of crop plants is the requirement for effective cell culture protocols that allow efficient, large scale, and rapid plant regeneration from individual cells or protoplasts. Fortunately substantial progress is being made in this area.

When coupled with traditional plant breeding, genetic engineering offers considerable potential for the genetic improvement of crop plants. Plant breeders can now look beyond their traditional 'gene pools' for new sources of genes and think in terms of 'gene oceans'. Genetic engineering is currently being used in vegetables for the transfer of genes which confer resistance to herbicides, virus diseases and insect pests. In the future it is anticipated that a wide spectrum of characters will be manipulated by these techniques.

Acknowledgement

We thank Robert Lamberts and Sherryn Kelly for their photography and typing skills respectively.

THE BANKS MEMORIAL LECTURE, 1989

The Many Faces of Horticulture

Dr B. R. Cook
26 Eleventh Avenue, Tauranga

This lecture is presented in three parts — each complete within itself and each developing its own individual theme. The author is not by profession a horticulturist but a farmer who specialised to become a Veterinary Surgeon, who specialised to become a parasitologist, and who specialised to become an epidemiologist (the art of disease eradication). He thinks of himself as an enthusiastic, if somewhat inept gardener, in the traditional cottage garden manner, and his principal hobby is field botany.

PART ONE
Sir Joseph Banks

It seems appropriate that this lecture should commence with a broad account of the life of Sir Joseph Banks, emphasizing his associations with Australasia and with the rural economy. Sir Joseph Banks was a typical "Country Gentleman" and a most successful farmer. His family had a long tradition of public service. They were members of that social caste comprising lawyers, civil servants, public administrators, managers and clergy which, over the centuries had matured into one of the most useful, dynamic and conscientious elements in British Society. It is in terms of this social background that Banks' life should be interpreted and appreciated.

He was born in 1743. At age 9 he went to Harrow and, three years later to Eton. It was while he was at Eton that he first came to appreciate the singular beauty of the roadside and meadow flowers and throughout the remainder of his life he continued to admire, to collect and to employ collectors to study all living things, the communities within which they functioned and their environment, and to explore their possible uses, aesthetic, economic and medicinal to mankind. In 1760 he went up to Oxford University where he employed a lecturer to teach him Botany as a scientific discipline. In 1764 he inherited the family estates — his seat was Revesby Abbey in Lincolnshire. Two years later he made his first journey overseas to Newfoundland to study the people, the fauna and the flora. On the return journey he dallied awhile in Portugal. He travelled extensively in Wales.

From 1768 to 1771 he financed and led a scientific party of 9, accompanying James Cook in the Endeavour on his three year voyage of discovery around the world. The vast body of information recorded during this voyage persuade him that, by and large the floras of the northern hemisphere, the tropics and the southern hemisphere represented three quite unrelated populations each with its own independent evolutionary trends. He appreciated the wealth of useful plants and animals which were indigenous to the northern hemisphere and hoped that adequate searches would disclose as many, as diverse and as useful in the southern hemisphere.

Thereafter he took part in few major explorations and settled down to study the considerable body of material he had already collected, to encourage further exploration by others, and to promote the overall course of scientific enquiry.

In terms of his considerable knowledge and experience he became first a member, and later in 1778 the President of the Royal Society — the most prestigious scientific body in the Commonwealth. He remained its President for 42 years, retiring shortly before his death. During his long professional life he had been largely responsible for lifting horticulture from its minor status as a mainly domestic pursuit, tinged with magic and superstition, to the honoured status it enjoys today.

He died in 1820 at the age of 77 years and left no heirs.

The achievements of Sir Joseph Banks were real. They must be seen in terms of a deep rooted integrity of purpose — a quality he represented splendidly, and in terms of an emotional and intellectual search for excellence within the scope of his own special interests.

He was the Godfather of the British colonization of Australia, and more specifically of the Australian wool industry.

As a direct consequence of his activities as President of the Royal Society, British scientists amassed a substantial body of new information providing one of the significant foundation blocks about which Wallace and Darwin subsequently crystalised the whole gamut of biological knowledge into a single unified concept.

He was appointed Director of Kew Gardens in 1773 and this appointment provided dynamic encouragement to his collecting activities.

He became the trusted and admired friend of George III. He asked for no favours, he expected none and he received few other than the respect and companionship of the King. Together the two men remained deeply and sincerely interested in horticulture and farming throughout their working lives. In 1788 they conceived "The Patriotic Plan". This was a scheme designed to upgrade the quality of British wool. Wool from the British breeds of sheep was not suitable on its own for clothing fabrics. It had to be mixed with merino wool to make it suitable. Unleavened British wools like most New Zealand wools are suitable only for carpet manufacture or for the very coarsest types of clothing fabric.

The King and Banks planned to import merinos — cross them with British sheep and so fine down their wool so that it could be used for clothing purposes (i.e. produce a sheep similar to the New Zealand Corriedale). The essential problem was that Spanish law forbade the export of merinos from Spain. Eventually, after several false starts, Banks was able to capitalise on his personal experiences in Portugal and to utilise the "services" of professional smugglers who brought merino sheep across the border into Portugal and thence into England. In 1791 he received a gift of 40 selected merinos from the famous Negretti flock and by 1792 with the arrival of 47 more sheep from Lisbon the flock reached its working strength of between 200 and 300 animals. Any surplus stock were distributed to those farmers and landowners who could be relied upon to breed them as the King and Banks required.

In the event the experiment was not a success: the very high air humidities in Britain and the persistant rain encouraged a plethora of fungal and bacterial fleece rots, footrot and fly strike (as plague merinos throughout most of New Zealand to this day). The situation was salvaged in 1804 when the Rev. Samuel Marsden applied to Banks for pure bred merino sheep and was granted (in the first instance) 4 pregnant ewes. The King's "Patriotic Plan" which, ultimately had been such a failure in Britain, succeeded far far beyond all expectations in Australia. The merinos became established in that country and provided the basis upon which the Australian sheep industry is built:

the finest wool sheep in the world and the richest source of overseas revenue for Australia today.

The merino sheep in the South Island are not descended from Banks' sheep.

The foregoing account of the "Patriotic Plan" is the usual version given. But in fact these merinos were not the first but the second importation of pure bred merino sheep directly from Spain into England. The first occurred when Edward I was betrothed to Eleanor of Castille (1274). Within her dowry she brought three merinos which were released on the Dorset Downs and their genes are said to be responsible for the horns borne by the Dorset Horned sheep today.

Two personal stories:

One:

I asked my grandfather why he had emigrated from Britain during the 1870's. He told me that he had come from Huttoft on the Lincolnshire coast. His grandfather had told him that until Landlord Banks died, the fenland canals (drains) were properly maintained and the rents acceptable. But after he had died, his grandfather, a yeoman farmer renting land from the Banks Estate and their successors, found the rents and conditions of tenure steadily worsening and the drainage canals were not regularly cleared. After his father acquired the tenancies a series of very wet seasons occurred, the land became waterlogged and unfarmable and the old man (then a lad) emigrated to New Zealand.

Two:

I have been deeply involved with hydatid disease research since 1958. About the middle of the 19th Century the Icelandic folk had organised the only truly successful hydatid eradication scheme known. This is how the Icelandic scheme came about.

In 1872 Banks had dropped out from Cook's second voyage and was feeling very sorry for himself. He decided to lead a botanical expedition to Iceland — this had not been attempted previously. Once there he was appalled by the poor health of the people and the conditions under which they survived — living as savages — eating little but fish — growing no vegetables and with no appropriate fuel.

Some years later (1809) with Europe under the thumb of Napoleon, the Danes (whose dependency Iceland was) were in no position to relieve the desperate poverty of the islanders. As a further consequence of the war however, England was very short of oils and fats and Banks became involved in a scheme to purchase whale oil (tallow) in Iceland.

This initial suggestion developed into what might generously be described as a totally unauthorised intrusion (invasion) into the territories of another state. The entire episode was most improper and it is difficult to understand how anybody with Banks' experience would have been a party to it. Perhaps it was a measure of desperation. The difficulties created by the episode were ultimately resolved and Denmark accepted England's intervention until the Napoleonic regime had been eliminated.

It was not until 1830 that Denmark was in any position to retrieve her dependency and to face up to the dreadful condition of the Icelanders. To this end a Dr Schleisner was appointed to report on the health and the social conditions of the island. Hydatic disease and leprosy were rampant and infant mortality was so high that the population was dwindling. The Danish government reacted immediately to Schleisner's report and amongst the many reforms a Hydatid Eradication Scheme was organised.

At the moment the author is preparing a translation of Schleishner's report for publication in English.

In conclusion it may be said that the outstanding feature of Banks' career was, that as a young man he had the intelligence to identify a personal interest — a source of motivation, and that for the remainder of his life he devoted all the richness of his resources to just that one single interest. In doing so he created within the Imperial Establishment an environment within which other scientists could work and mature their own individual genius. And as a direct consequence, throughout the 19th century Britain could claim legitimately that she led the world in scientific research and development. This is his principle claim to fame. His second claim to fame is that he was personally responsible for the establishment of the Penal Colony in New South Wales and for providing the newly founded colony with a first class strain of merino sheep.

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PART TWO

The Role of Parks in the Development of an Effective National Awareness of our Native Flora

Some months ago I wandered through a straggle of misshapen gorse bushes down to the shores of a small mountain lake. On reaching the waters edge my lady companion gazed about her — at the fields — the lake — the encompassing mountains and then exclaimed "How wonderful are our native flowers! — How fortunate are we to have them about us — to share and to enjoy!"

I was somewhat surprised — I hadn't noticed any native flowers and looked about wondering where these beautiful plants might be and of which species. I did notice three adventives — gorse, doves foot geranium and a mouse eared chickweed in flower — but apart from some grasses that was all.

I know this lady very well. She had grown up in forest mill camps — she is a very able person — a person of considerable natural dignity — drive and initiative. So what has she meant?

I have come to the conclusion that she was reciting a formula — a sort of personal creed — a personal statement whose precise meaning and implications she had long forgotten. It was in a sense a ritual invocation to the forest Gods — but NOT to the forest. I now believe that she had never ever really seen the forest — she had never mentally divided "the bush" into any of its components — had never realised the relationships between the various species, how each component might be integrated with its fellows, she knew very few of the species by name — any name. In other words she was a New Zealander — who simply did not understand anything of the meaning of what the forest stands for — the forest as a complex dynamic living unit.

In all truth, exactly how aware are most of our fellow countrymen regarding the native flora of our country? After 150 years of colonisation and destruction how much do the majority of people really know or wish to know? And unless they have some knowledge, they are unlikely to possess very much understanding of its need for vigorous conservation. These are important issues. Upon the quality of this understanding alone rests any real chance of retrieving, rejuvenating and protecting not only the few remaining worthwhile areas of native vegetation but also the individual species which comprise them.

Yet, it is after all, our own flora — it is special and it is unique to New Zealand : it has evolved and survived in our own country — and in this country alone.

It appears that the principle reason why most New Zealanders have very little understanding as to what — if anything is so very special about the flora is that they see no reason whatsoever (that appeals to them) to be concerned about it. They travel overseas — but rarely observe the foreign floras — glorious though so many of them are and they appear to be incapable of establishing in their own minds any criteria by which their home flora should be judged.

All these attitudes appear to derive from those very early days when poor, land hungry colonists first poured into the country, and when most of the indigenous landscapes were still in their virgin state. In those days the native flora in all its many manifestations comprised a formidable barrier to survival. It was in real conflict with man. It was THE ENEMY — the great hurdle to be overcome and destroyed. These attitudes have survived — as ingrained as ever — an integral part of our national folk lore.

In the King Country I worked with settlers who used the term "weeds" to describe the native bush about us — not casually — but clearly defining their personal attitude to it.

Most New Zealanders appear to be quite indifferent to the natural history of their country — it plays no role in their day to day experience — it is not so much ignored as simply not seen to exist. In the Northern Hemisphere a different attitude exists. The author has lived in localities in the British Isles and in the North West United States of America where cornflowers, creeping and clustered bellflowers, violets and pansies, primroses and veronicas and many many other native species abounded. And when you looked into the cottage gardens — there they all were again — cultivated — cherished and adored. The New Zealander calls his natives "weeds". Yet, in his garden he grows the linear descendants of other peoples "wildies" — cultivated — selected and admired.

It is probable that few New Zealanders can name 10 native plants much less identify them and even less wish to. And as for the fungi, the ferns, the mosses, the lichens and the liverworts etc and not considering any of the creepy crawlies — these simply do not exist.

The concerned sociologist might say — the answer is simple — the people do not understand — they must be educated. But that is much too glib. For, before these people can be educated they must be motivated to be receptive to education and the means wherewith to educate them must be in place. It is these means which I shall now discuss.

There are in Tauranga many parks, each fulfilling its own special purpose. Some are simply show places. But others are full of personality — and children — always the setting for people enjoying themselves — doing their own thing — in their own way — living. And there is one other — which we do hope most of you have already seen or plan to visit — the Arboretum which is called "McLarens Falls Park" — set on hillsides running down to a splendid lake — the product of hard work continued over many years by devoted single-minded enthusiasts. It is always a joy to visit this park — it is alive — it seems almost to have a life of its own. And at this time of the year (autumn) can be truly gorgeous.

This park is seen as serving many roles. But the role so significant for the moment is that it might become a Model by which our people might be educated — our children, the adults and tourists passing through our country.

Now — I shall criticise this park — this lovely Park. I am going to criticise it in spite of its beauty — in spite of its quietness and peacefulness — in spite of the pride which so many Tauranga citizens have in it.

I shall criticise it by telling you that this park exclusive of some tiny remnants of the original forest cover possesses representatives of only 7.5% of all our native trees and shrubs. That is to say — at this stage in its development it would be quite impossible to demonstrate any one of the special characteristics of our native forest related either to is evolution, its distribution, its principle components, its distinctive features or to its conservation. In particular it would be quite impossible to demonstrate these qualities either to students or to interested adults or to visitors from overseas.

If it could be decided that the park should mature as an educational facility (in addition to its merits as a leisuretime amenity) it would need to demonstrate the many very special qualities of the New Zealand flora.

This flora is unique — there is nothing quite like it anywhere else in the world. It is special. It demonstrates how evolution may proceed in some special circumstances such as isolation — in the Southern Hemisphere — as a remnant of Gondwanaland — near enough to the Australian continent to receive the occasional colonizer. The New Zealand flora has evolved through a considerable range of latitudes, through many ice ages, through repeated submergences and upliftings — far from its nearerst neighbours. It demonstrates how a flora may evolve when subjected to minimum interference from and unrelated to any adjacent floras.

It is desirable that people should see the contribution that each of these issues has made — to persuade them to look only at the evidence for them but also at the consequences: — and then to understand.

If the Park is to mature in its role as an education facility it might demonstrate some of the special features of the indigenous flora. It might demonstrate the relative lack of coloured flowers; the frequency of white flowers; of small inconspicuous green flowers; of single sexed flowers and of wind pollinated flowers. Almost all the flowers are simple dish shaped blossoms, rarely specialised, and rarely tailored to pollination by specific pollinators (which in other floras have frequently evolved with the flowers). Brush blossoms are unusual as are those pollinated by mammals. Divaricating species are common and occur in many genera and many species pass through a juvenile foliage phase. Ramiflora is not unusual and natural interspecific hybrids are widespread.

The majority of our forest species have evolved on poor soils, deficient in phosphates and nitrogen. The majority are dependent on soil fungi (mycorrhiza) to gather the raw materials essential for nutrition and survival and to feed them into their roots. The flora has evolved in the absence of grazing mammals and in the absence of social bees. There are very few deciduous species.

The New Zealand flora has very limited capacity to colonise new regions. During the last 10,000 years since the last ice age it is estimated that the forest has not advanced more than fifty kilometres from the refugia within which it survived the cold. During the same period of time the northern European forests advanced 2,500 kilometres from Switzerland to northern Scandinavia.

The speciation and distribution of New Zealand species are very often the products of local conditions — geologic — geographic and climatic — reflecting the complicated history of the New Zealand land mass. The country has on one occasion been divided into an archipelago of at least nine islands — it has suffered many ice ages and displays a wide variety of altitudinal and geologic regions deriving from the tectonic interactions between the great continental plates.

Special features within the park might be groves of trees such as kowhais and miros attractive to birds: diverse strains of *Phormium tenax* illustrating the various types selected and propagated by the different tribal groups, *Cordyline terminalis,* the gourd, kaka beak and *Meryta sinclairii,* as examples of trees of economic and amenity value to the Maoris.

An opportunity would arise to demonstrate some rare or endangered species and the considerable generic diversity within many genera e.g. *Pittosporum* or *Olearia.* It could present species characteristic of other regions — North Island, the East Cape, West Coast of the South Island, or Southland for example.

If very many — but not necessarily all of these issues could be demonstrated within one park then that institution would acquire one further tier of usefulness adding to its general interest and might thereby contribute in an effective and positive fashion to the public appreciation of our heritage. And in the end sufficient New Zealanders might acquire such an understanding and sympathy for the flora that it might survive and not wither away into oblivion.

PART THREE

Horticulture in Various Unusual Roles

In this, the third and final section of the lecture the author endeavours to illustrate some points made during the two previous sections and thereafter to describe the professional advantages he has derived from his interest in botany, gardening and horticulture. This section was supported by a series of 35 millimetres slides and commenced by showing that although floras within the northern and southern hemisphere are each essentially self limiting entities, nevertheless, there is probably some occasional drift taking place between them. *Potentilla, Geranium* and *Hypericum* are examples of plants which may have recently found their way into New Zealand, over the equator.

On the other hand the southern genus *Pseudowintera* (horopito) has been in New Zealand for a very long time — suggested by the small green flowers and ramiflora.

Few if any flowers native to New Zealand are tailor made to suit the needs of special pollinators. But in the Northern Hemisphere the figworts (*Scrophularia*) are adapted specifically to wasp pollination. The orchid genus *Ophrys* has evolved showy flowers which imitate insects so exactly that pollination is effected when male insects attempt to mate with them. Photographs illustrated gardens ranging from natural assemblies of blossoming plants, to cottage gardens, to those most sophisticated of all gardens — the Persian and the Chinese styles.

Within the framework of his own garden the author sees its role as enhancing the wider view from his home rather than embellishing the appearance of the house from the road. This viewpoint is probably not one widely held.

He describes himself as an epidemiologist and in the course of his researches has used plant populations as models for studies into the structure of animal populations. The role of an epidemiologist is either to control or eradicate disease populations either by increasing opportunities for the host populations to survive, or by limiting the size and virulence of the disease causing populations. To this end it is essential that he should be able to recognise and to interpret the characteristics of natural populations. Since it is difficult to manipulate either animals or micro-organisms in experimental situations he has frequently used plants.

1. Many of the author's professional studies have been concerned with describing the manner in which the structure of populations is determined by the reproductive strategy of the species. For example the hydatid tapeworm *Echinococcus* is believed to be an obligate self fertilizing hermaphrodite. This means that every hydatid worm fertilizes itself and cross fertilization between two individuals never occurs. It was important to discover whether or not this was in fact true. Now, any population derived from such a mating strategy should resemble a clone. Many of our garden plants are clones — they are not derived from seeds but from cuttings — graftings etc, *Rhododendron* 'Pink Pearl', *Rosa* 'Peace' and *Lilium* 'Enchantment' are typical clones. Members of a clone are identical with each other because they have identical genes. Since it is quite difficult to carry out population experiments with virulent pathogens having a complicated life cycle such as *Echinococcus* it was decided to use selected plant populations. The idea was to breed these populations — to examine their structure by measuring and recording any differences between individual plants and then to see how this structure resembled the structure of the parasite population.

Violets were selected because they have two types of flowers — the well known pretty scented flowers pollinated by insects and produced early in the flowering season and cleistogamous or hidden flowers. These hidden flowers tend to be produced later in the season — they are most unlovely — greenish — no scent and do not penetrate above the leaves. No insects visit them — they also are obligate self fertilizing hermaphrodites. Seeds from cleistogamous flowers were collected from five different plants of *Viola odorata* in the south of England and Wales. In this way, five different populations were established and were compared with each other and with their "sibs". This experiment was successful and had important scientific implications.

2. If ever you are botanising in the Northern Hemisphere (for example in England) you may well discover many species of rose. The general advice given is that if you can put a name to a species of rose within two minutes searching through your field guide — well and good. If you cannot then it may be advisable to cease searching. Some rose species do have respectable fertilization routines where two pollen nuclei are required to produce a fertile seed. But many more species use only one pollen nucleus and do not bother about fertilizing the egg nucleus. The result is that some populations of the same rose species may go off at a tangent and evolve characteristics (often very beautiful) quite different from the parent stock. This form of reproduction produces populations whose structures are quite distinct from those derived from the hidden violet flowers.

This characteristic is quite widespread amongst the Rosaceae. The biddy biddies (*Acaena* spp) are a very good example. It is better never to tangle with them (in more ways than one) for this difficult genus includes many one off "species" (Miss Bryony Macmillan, DSIR, Lincoln).

3. There are said to be over 400 species of blackberry (*Rubus*) in Britain and some have very limited distributions. The author thought he might discover from where in Britain the New Zealand blackberries had been "imported". After identifying over 20 species and failing to identify many other types the attempt was abandoned. The native members of this genus are every bit as cantankerous (bush lawyers).

4. Many groups of plants have abandoned the fertilization of their eggs by pollen nucleii. The technical term is "apomixis", which is defined as reproduction by seed formed without fertilization. The common garden dandelion (*Taraxacum*) is an example. This species gives the lie to the widely held assumption that nature is both economical and conservative. The composite flowers produce vast quantities of good pollen and nectar — to no purpose — no pollen nucleii is ever utilised. "Apomixis" in plants is similar to "parthenogenesis" in animals.

This brief account summarises some of the characteristics which plant populations may display and which may be exploited by an "animal" biologist in the study of animal populations.

5. The author is partially colour blind. In an attempt to train his eyes to recognise the colour red he planted many red flowered plants in his garden where various backgrounds and the interplay of light might alter the texture of the colour. In 1978 this experiment was vindicated dramatically when he drove up the Otira Gorge and realised that the rata was in full flower, that he could see it — appreciate it and enjoy and marvel at such a glorious display. This was the first time he had ever identified a red flowering tree in full blossom, without assistance.

6. In England the biotic requirements of individual species are well documented — some prefer alkaline soils — some, acid soils. Others are indifferent to soil pH. And so, in Britain, it is possible to drive about the countryside and by noting the wayside flowers to make a rough assessment of the geological characteristics and soil pH's of each region. Generally speaking, the New Zealand flora is not so well known, (one of these days some conscientious genius will write a truly useful garden book describing the horticultural requirements of our flora).

In New Zealand, the author studied tuberculosis in possums and cattle and believed that where the soils were alkaline there was no tuberculosis problem. In order to test such an observation he needed to know where alkaline soils might be found. He used *Senecio hectori* as a guide because it seemed to him to prefer limestone soils. This shrub presents a magnificent show of white daisies which can be seen for miles. Using the distribution of this species in the north-west South Island the author trapped wild possums and was able to show that his theory had considerable merit.

7. For many years the author has held the opinion that it should be possible to look over a natural environment and to be able to describe within broad limits the distribution of any infectious organism (bacteria or parasite) within the scene. With this objective in mind he attempted to train himself to interpret the environment in terms of component target species. He took as his model the Yellow Star of Bethlehem (*Gagea lutea*). This beautiful species was reputed to be very rare and to occur in only five places in Britain all of which were too secret to divulge. (This information turned out to be totally incorrect.) In any case, in all innocence he set out to find these five localities. All the information available was five lines of text in a popular field guide. It took three months to find the first *Gagea,* five hours to find the fifth and considerably less to find the 12th. The species occurs in isolated clumps comprising 100's of plants within a radius of about two metres. Only a few plants flower in each season. It prefers rich river silt — a shaded site and a limestone or chalk environment. Two sites were in gorges where the river periodically flooded.

This study inferred that it was in fact possible to interpret environments in terms of a single component — a single target species.

8. In later years when examining the inci-

dence and distribution of tuberculosis in cattle and other domestic animals on the West Coast of the South Island he identified the possum as the effective reservoir of the bacteria of tuberculosis. Thereafter, using his knowledge of the West Coast flora he was able to use this skill to interpret the differential distribution of possums throughout the forest, along the forest margins, the pasture lands and the mountain and beach environments and to relate those observations to the bacteria responsible for the disease problem. In this way a viable pattern of eradication could be advised.

Conclusion

The above account describes the use made by one rather eccentric individual of various gardening, horticultural and botanical interests garnered and developed over the years. It is essentially a personal story with implications which also are essentially personal. But it does illustrate the fluidity by which information and techniques can be manipulated by a concerned person to meet a pre-determined conclusion.

I thank you.

The Future of Horticultural Research in the Bay of Plenty

R. G. Lowe
DSIR Research Orchard, R.D. 2, Te Puke

Text of an address given to the Annual Conference of the Royal New Zealand Institute of Horticulture at Tauranga on May 19 1989.

Horticultural research in the Bay of Plenty is as wide ranging and varied as the range of crops currently grown here. Several DSIR Divisions put significant effort into research projects in the Bay of Plenty, notably:

Division of Horticulture and Processing (DHP)
Entomology Division
Plant Diseases Division
Plant Physiology Division

This paper will cover some of the field-based aspects of DSIR pomological research as it relates to fruitgrowing in the Bay of Plenty, based on the Te Puke Research Orchard. Kiwifruit breeding and rootstock evaluation are the main areas to be discussed.

DSIR Te Puke Research Orchard

Horticultural research in the Bay of Plenty was given more prominence when DSIR established a new Research Orchard at Te Puke in 1970 on 24 ha of land[1]. At that time citrus was a more significant crop than the newly emerging kiwifruit and there was a strong interest in alternative subtropical crops such as avocado, tamarillo and feijoa. The mild climate and deep, well-drained soils of the Bay of Plenty offered many potential benefits to the establishment of horticultural crops.

Shelter belts were a top priority at the new station and several types of shelter trees were established. Initial plantings covered a wide range of established and potential subtropical crops. Some of those early plantings have not survived and the emphasis is now on the main crops grown in the surrounding district. Current major plantings at the Research Orchard include kiwifruit, nashi, avocados and citrus as well as smaller plantings of feijoa, casimiroa and macadamia.

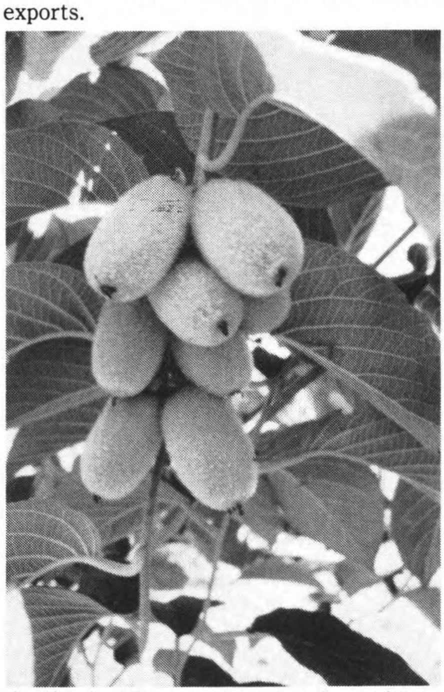
Today, the Te Puke Research Orchard is a substantial facility, operated by the Division of Horticulture and Processing (DHP) DSIR, and administered from the Mt. Albert Research Centre, Auckland. Other DHP Research Orchards are situated at Kumeu (Auckland), Havelock North, Appleby (Nelson) and Clyde.

Facilities at the Research Orchard have been expanded to cover expected requirements for the next few years and currently there are 13 local staff for technical and field operations. As well as trials carried out on the Research Orchard, many experiments are carried out on cooperating growers' properties and we are indebted to these people who support our work in this way.

The Research Orchard operates as a base of operations for many of the DSIR scientists who may come to set up and supervise trial work on the Research Orchard and on outside properties.

Kiwifruit

The total area planted in kiwifruit in New Zealand is estimated to be about 17,000 ha[2], and more than 60% of these plantings are in the Bay of Plenty. The majority of the older, more mature plantings are in the Bay and so the Bay of Plenty still ranks as the major producing region of the national crop. The DSIR research effort into kiwifruit reflects the national importance of the crop as the top earner of overseas funds from fresh fruit exports.



A. eriantha. Vines are vigorous and carry heavy crops of fruit covered with soft white hair. The flesh of the fruit is an intense green colour and the Vitamin C concentration in the flesh of fruit from some seedlings can be six times as great as that of Hayward.

In response to the gradual implementation of the "user-pays" policies from Government, the Scientific Research Committee of the New Zealand Kiwifruit Marketing Board (formerly the New Zealand Kiwifruit Authority) has put very significant resources into kiwifruit research over the last few years. The research budget approved for the 1989/1990 year was about $2 million, an increase of $0.5m from the previous year[3]. Research agencies such as DSIR and MAF carry out a substantial proportion of the projects funded from the Kiwifruit Marketing Board through this committee. The Scientific Research Committee is able to direct funding into areas of highest priority. DSIR and MAF also contribute substantial resources from central Government funding.

Quality is seen as paramount to maintaining the prime position in the market in the face of increasing competition from other kiwifruit producing countries. Southern Hemisphere countries, such as Chile, are selling kiwifruit in direct competition with fruit from New Zealand, and because of their climate they can market fruit ahead of ours.

Northern Hemisphere grown kiwifruit, while not directly competing, has the effect of shortening the effective selling period for New Zealand kiwifruit. While some growers in these other countries can produce fruit of a quality similar to ours, because of their lower minimum standards some poorer quality fruit can adversely affect overall returns in the marketplace.

Many New Zealand kiwifruit growers are under severe financial pressure after two unprofitable years in a row[4]. They look towards research to offer solutions to problems. The industry wants to improve cropping, reduce production and handling costs and still produce a quality product.

The Hayward cultivar, on which the success of the New Zealand kiwifruit industry is based, has also been the main cultivar grown in new plantings in other countries. The outstanding qualities of its fruit are:

- large size, with fine hair and attractive appearance;
- extremely good storage life — important for the shipping to distant markets;
- pleasant flavour.

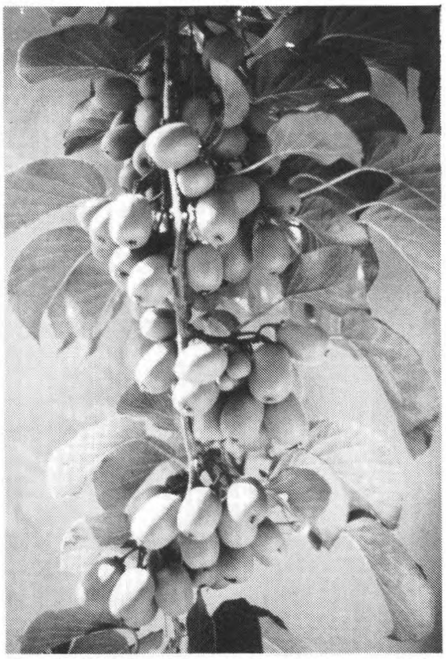
'Hayward' is not perfect and could be improved in several ways:

- genetic defects such as "Hayward mark" and "flat" or fasciated fruit can reduce the proportion of fruit which reaches export standards;
- sweeter tasting fruit would be an advantage in some markets such as Japan;
- new plantings are slow to come into cropping;
- flowering can be greatly reduced in seasons following mild winters
- the cropping potential is less than that of some other cultivars;
- careful pruning and management is needed to ensure regular crops — a plant with a compact growth habit is needed;
- the fruit mature relatively late in the season.

Kiwifruit Breeding

There is considerable potential for introducing improved cultivars into the New Zealand kiwifruit industry, both from a marketing and growing point of view. DSIR has been involved with fruit breeding over many years and effort into kiwifruit breeding has been expanding in recent years under the DHP Plant Genetics Section led by Dr A. Seal based at Mt Albert[5]. An equivalent of at least 9 person-years of effort is committed to kiwifruit breeding and related research.

The Scientific Research Committee of the New Zealand Kiwifruit Marketing Board has funded a range of projects to support the DSIR kiwifruit breeding programme over the last few years. A substantial effort was made in 1980 when the then New Zealand Kiwifruit Authority helped to buy more land at Te Puke to extend the Te Puke Research Orchard and enable substantial plantings of seedlings from new breeding projects to go ahead.



A. rufa. Fruit is hairless and has deep green flesh. Plants are precocious and set very heavy crops. Introduced from Japan.

1. Cultivar improvement

There is considerable potential for significantly improving the 'Hayward' cultivar. It is likely that useful mutations are occurring in the large population of 'Hayward' plantings on commercial orchards. Many of these mutations will go undiscovered because of the nature of kiwifruit cultivation:

- most fruiting wood is removed each winter in pruning;
- earlier maturing fruit could easily be overlooked since 'Hayward' fruit does not undergo any external colour change as it matures.

However a number of useful "sports" have been discovered by growers and brought forward for evaluation. Another approach is to try to induce useful changes by irradiating dormant scions which can be grafted and grown on to a fruiting stage. While it may not be realistic to expect to get all the desired changes in one mutation, small changes as outlined would increase the usefulness of 'Hayward' to the grower by extending the season and reducing growing costs.

At present DSIR has several hundred grafted plants arising from previously irradiated scions on the properties of co-operating growers. The majority of the fruit will be normal 'Hayward' but we hope to find some useful mutations in the future.

New techniques in biotechnology give us the ability to introduce single genes into plants without altering the rest of the genetic makeup of the plant. Desirable genes may soon be obtained from other species to confer special attributes on a cultivar or selection. This new technology offers us the chance to gain new attributes in plants without going through longer term traditional breeding methods.

2. Crossing programmes

The kiwifruit plant and all other known *Actinidia* species are dioecious. This fact means that initial crosses are made with little knowledge of what genetic contribution the male parent will bring to the population. Data collected from today's trials will give us more information in the future. Populations currently planted at Te Puke and planned for the near future arise from several targets for the programme:

- earlier maturing selections;
- hermaphroditic selections;
- novel fruit types;
- improved rootstocks.

(a) Earlier maturing selections

The aim is to develop selections of *A. deliciosa* to complement 'Hayward' and give an earlier start to the season. Two types of crosses give rise to the current population:

- early maturing female seedlings were crossed with early flowering males, all from a seedling population of *A. deliciosa* grown from seed introduced from China, the home of kiwifruit;
- 'Hayward' was crossed with early flowering *A. deliciosa* males.

Initial results from plantings made three years ago at Te Puke are very encouraging. The populations contain a number of seedlings with large fruit maturing early in the season. It should be possible to have kiwifruit selections which will have mature fruit ready for harvesting in early April. Field trials of any potential new selections will be needed to confirm their early promise.

New releases will need to have:

- fruit quality and flavour as good as 'Hayward';
- acceptable storage and shelf life;
- attractive fruit shape and appearance;

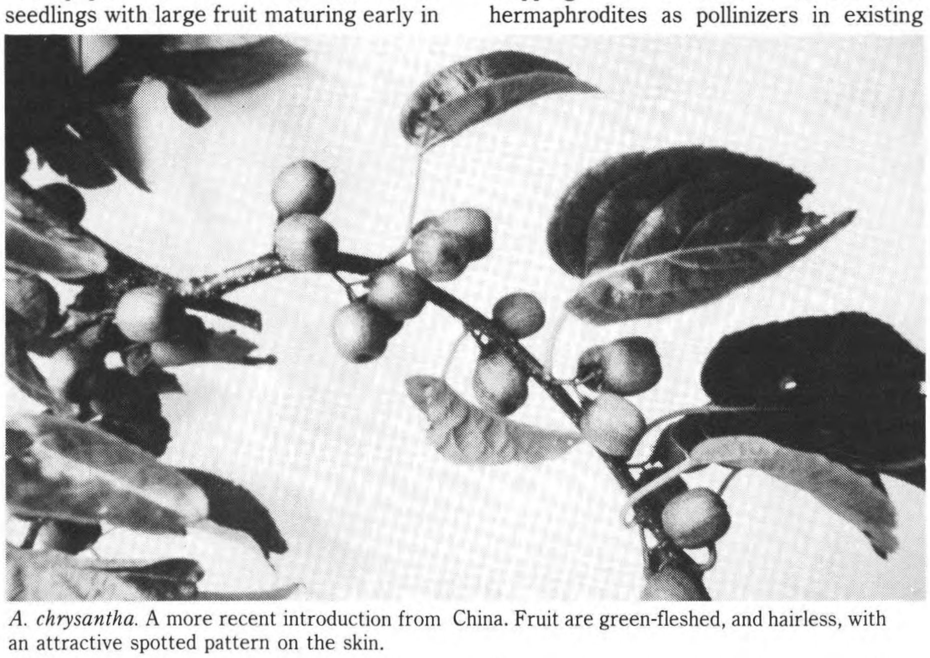
and preferably have:

- a less hairy skin;
- a vitamin C content as good as, or better than that of 'Hayward';
- a different fruit shape or appearance to distinguish it from 'Hayward';
- a precocious and regular cropping;
- a reduced winter chilling requirement;
- fewer genetic defects than 'Hayward' (i.e., flats and "Hayward mark");
- pest and disease tolerance as good as or better than that of 'Hayward';

(b) Hermaphroditic selections

While all known species in the genus *Actinidia* are dioecious, kiwifruit growers often find small fruit growing on sections of their male pollinizers. From the initial collection made at Te Puke of such fruiting males, crosses have been made using these plants as male or female parents or by selfing. Considerable progress has been made in increasing the size of the fruit: plants in the initial collection had fruit weighing only 20 - 30g, but fruit of over 100 grams (36 count) have been found on one seedling from the breeding programme[6 7]. Moreover, vines have been found on which all, or nearly all, flowers are bisexual and capable of setting their own fruit. These vines are therefore true hermaphodites rather than just fruiting males.

From the progress made in this area it appears quite realistic to expect the development of a true hermaphroditic plant which produces commercially acceptable fruit. If growers were able to remove male pollinizers from their orchards, up to 15% more fruiting canopy would be available for cropping. An alternative is to use such hermaphrodites as pollinizers in existing 'Hayward' plantings to increase overall production by eliminating non-fruiting males.



A. chrysantha. A more recent introduction from China. Fruit are green-fleshed, and hairless, with an attractive spotted pattern on the skin.

(c) Novel fruit types

Fruit from the different species in the *Actinidia* genus show a wide range of potentially useful characters which could be used to develop new fruit types distinctly different from the kiwifruit as we know it[8].

Useful characteristics such as:
- different skin and flesh colours;
- sweeter tasting fruit;
- different flavours;
- higher vitamin C content;
- hairless, edible skins;
- adaptability to different climates and soil types;
- improved pest and disease resistance;
- a wider spread of harvest times;
- heavier cropping characteristics

may occur in the *Actinidia* genus and we are fortunate to have some of the species in plant collections in New Zealand. Good progress has been made in developing green, smooth-skinned kiwifruit by hybridisation between species.

(d) Prospects for improved rootstocks

The majority of kiwifruit plantings were produced from scions grafted onto seedling rootstocks derived from seed from 'Bruno' fruit. The seedlings were easily raised in the nursery and produced vigorous plants which established rapidly in the field. 'Hayward' cutting-grown plants are also used as clonal stocks, but appear to offer little advantage other than reducing variation between plants.

Use of rootstocks selections might allow:
- earlier and heavier cropping;
- more compact growth;
- adaptability to different soil types and growing conditions;
- cold tolerance in cooler areas;
- pest and disease resistance.

Several approaches are being followed:

1. Selection from seedling rootstocks in commercial plantings. Among commercial plantings of kiwifruit, plants which appear to have superior cropping characteristics have been noticed. This effect may be due to site or establishment factors, but heavy cropping could be due to a superior rootstock. Surveys have been carried out and possible superior rootstock material collected for use in comparative trials.

2. Selection from the fruit breeding programme. We are screening our large population of seedling plants for potential new rootstocks. Plants showing reduced vigour or a compact growth habit are of interest. A very dwarfing selection is being tested as a rootstock for 'Hayward' in a trial planted two seasons ago.

A. polygama. Attractive smooth-skinned fruit which change colour from light green to yellow as they mature. Vines are cold-hardy and are being tried as rootstocks.

3. Use of compatible *Actinidia* species. A range of *Actinidia* species is being tested for compatability with 'Hayward'. The use of interstocks to overcome incompatibility problems is also being investigated.

We have identified one very promising selection which appears to have definite commercial potential. In a replicated trial at Te Puke, using 'Hayward' as scion, results after the third year of cropping have shown significant improvements when compared with a standard clonal *A. deliciosa* rootstock[9]. There are:
- heavier crops in the first three years;
- higher flower numbers per fruiting lateral.

This effect on cropping appears similar to that of the semi-dwarfing apple rootstock MM106. There was no reduction in the vigour of the vines on this new selection. Heavy, early cropping is most important to reduce the time lag between planting and production.

Conclusion

The kiwifruit is one of the most recently domesticated fruiting plants now in major production in many parts of the world. We can build on the success of the one cultivar 'Hayward' by modifying and adding to the range of cultivars available to the consumer and grower.

The genetic diversity in the *Actinidia* genus can be exploited by developing new fruit types to suit particular markets and growing conditions.

Continued support from the fruitgrowing industry and from Government will be necessary to keep New Zealand growers in the forefront of new advances in fruitgrowing. We cannot afford to wait for other countries to do the work for us. The Bay of Plenty with its advantages of climate and soil type is well placed to play a part in research efforts to bring new improved fruit cultivars to the consumer.

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Vitis rotundifolia

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A report on the early stages of its introduction to New Zealand

The genus *Vitis* includes two sub-genera : Euvitus (true grapes) and Muscadinia. There are two American species in Muscadinia, one of which is *Vitis rotundifolia.* It is a native of the Southeastern states of the U.S.A. from Virginia, south to Florida, west along the Gulf states to Mexico and south-central Texas, up the Mississippi River into Southern Missouri, along parts of the Tennessee River, and well up into the Blue Ridge Mountains.

Muscadinia species are identified by their tight, non-shredding bark with prominent lenticels, nodes without a diaphragm, simple tendrils which do not fork, and small, short clusters of berries that detach one by one as they mature. Seeds are oblong and have no beak.

Euvitis species have bark that is longitudinally striate-fibrose and shreds at maturity, pith interrupted by a diaphragm at the nodes, forked tendrils, elongated flower clusters, berries that adhere to the stems at maturity, and pyriform seeds with long or short beaks.

V.rotundifolia is extremely resistant to phylloxera and also resistant to pests and diseases including downy and powdery mildews and black rot. Consequently, selected cultivars are very popular for home planting. In the wild, most plants are dioecious, but cultivars with perfect flowers have been bred. However, some of the best cultivars have female flowers and require pollinators. Clusters are short and usually have five to twenty berries, but some cultivars, especially the perfect-flowered ones, produce large clusters. The berries are usually large and round and vary in colour. They have a distinctive aroma and a musky flavour. Because they ripen unevenly and detach when mature, their thick skins are an advantage because they can be harvested commercially by laying a cloth on the ground and then shaking the vines. (Olives are also harvested in this manner).

In recent years, the new improved varieties have been used for commercial plantings in southeastern U.S.A. They are grown as table grapes and for specialty wines and jelly. They yield an average of 14.5 tonnes per hectare and grow well in almost any type of well drained, fertile soil if the pH is between 5 and 6.5, and winter temperatures do not drop below minus 18° centigrade. They are late ripening and respond well to warm, humid summer conditions. The oldest and best known variety of *Vitis rotundifolia* is called 'Scuppernong'. It was found in North Carolina.

In November 1981, my late husband, Wayne Petley, visited an Alabama vineyard which grows five cultivars of 'Scuppernong' both for fruit production and for sale of plants. He had a permit to import these cultivars which he purchased and brought back to New Zealand. These went into closed quarantine at the Mt. Albert Research Centre, D.S.I.R. in Auckland. They stayed in quarantine until August 1984 when hardwood, heat treated cuttings of the five cultivars were sent to my nursery. My husband's fatal accident had occurred just a few months before the cuttings were released and they were to have been largely his concern. Therefore success with this project became very important to me.

The cultivars are 'Jumbo', 'Higgins', and 'Fry' which are females and 'Cowart' and 'Carlos' which are pollinators, and also bear fruit because they have perfect flowers.

'Jumbo' has large clusters of purplish black berries up to 3cm in diameter. They ripen mid-season to late. The vines are very vigorous. 'Higgins' has a very high production of pink to reddish bronze large berries, mid-season to late. 'Fry' produces very large clusters of greenish bronze berries up to 3cm in diameter which ripen mid-season and have a high sugar content. 'Cowart' is earlier ripening and has smaller purplish black fruit of excellent flavour in large clusters. 'Carlos' is also earlier ripening and gives a high yield of yellowish bronze fruit.

The cuttings from the D.S.I.R. had been in cool storage before being air freighted to my nursery on 14th August 1984. I started propagating them that evening. The only information I had on *V.rotundifolia* at the time was the booklet written by the owners of the Alabama vineyard and it was concerned with cultivation, vine training, pruning, etc., with no mention of propagation. I knew from my husband's visit to the vineyard that they propagated leafy cuttings under mist but the D.S.I.R. could only release hardwood, dormant, heat-treated cutting material so that there would be no risk of disease. I decided to prepare mostly nodal cuttings using two or three nodes per cutting, but I also tried a few internodal cuttings. I double wounded all the cuttings, dipped them in freshly prepared 0.4% I.B.A. solution and set them in our general potting mix which consisted of 75% fibremix and 25% propagating sand plus nutrients. This method had given good results in the past for *Actinidia deliciosa,* and hardwood cuttings from our own 'Albany Surprise', grape vines which were on the property when we purchased it in 1970. The next day I finished propagating and almost all the cuttings were placed under mist in our small, solar-heated propagating house. One tray of each cultivar was placed under mist in our large, cooler propagating house.

No cuttings rooted until 10th November 1984. From that date rooting was erratic. With most of the cuttings, bud burst took place long before rooting and only the leafy cuttings rooted. The base of the cuttings died and roots appeared internodally near the base of the remaining live tissue. There was only a little swelling and callussing. Many cuttings did not break bud and they died. Others produced leafy shoots but failed to root and eventually wilted and died. The losses were expected because I had written to the Alabama vineyard and they informed me that hardwood cuttings were very difficult to propagate.

Once rooting commenced, I inspected the leafy cuttings once a week. Those with roots were potted and put back under the mist for one week. After that they were transferred to the shaded back bench near

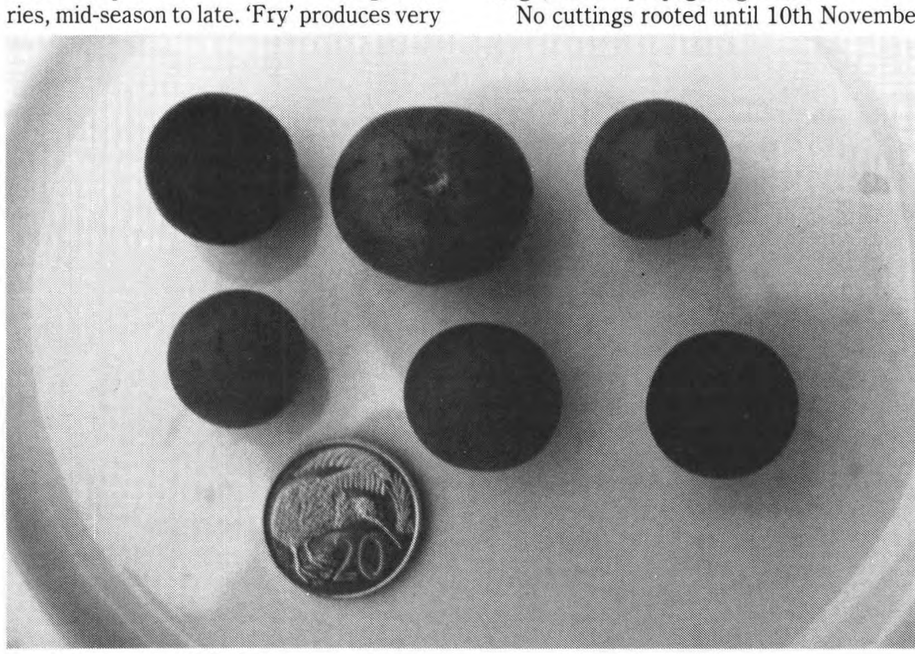

Fig. 1 *Vitis rotundifolia* fruit sent out from America.

the mist for at least a week and then they were mainly transferred to the shade house. A few were grown in full sun. The first batch was put outdoors on November 25th 1984 and it consisted of two 'Jumbo', one 'Higgins' and one 'Cowart'. The 'Cowart' was particularly valued as I had been worried that we would fail to root any pollinators and end up with a useless collection of female plants.

Once rooted, growth was vigorous so I stopped using our usual 10cm pot and potted them into square 2 litre pots. The last of the hardwood cuttings was potted on 2nd March 1985 so obtaining our first stock plants was a slow procedure. The final yield was: Forty one 'Jumbo' (the easiest to root and the most vigorous), eight 'Fry' and six 'Higgins' ... all females. 'Carlos' was the more successful of the pollinators and yielded fifteen plants while the 'Cowart' cuttings produced only nine plants.

The Te Kauwhata Viticultural and Oenological Research Station had also been supplied with hardwood cuttings by the D.S.I.R. around the same time that ours were received. Mr Gary Wood supervised the quarantine of the plants at Mt. Albert and he told me that the D.S.I.R. would keep their plants in quarantine there for one more year in case our cuttings failed. After supplying a second batch of heat treated cuttings to us in 1985 the plants would then be destroyed. I contacted Mr John Whittles, Technical Officer in Charge (MAF), at the Te Kauwhata Research Station when our plants were growing well and he told me that they had not been able to root any of their cuttings. I was worried that my small collection of plants might suffer some mishap such as hormone damage or vandalism so in February 1985 I delivered to Te Kauwhata two each of 'Jumbo', 'Carlos' and 'Cowart' and one each of 'Fry' and 'Higgins' for safe keeping and evaluation. Mr Whittles was extremely helpful and gave me photocopies of references to *V.rotundifolia* in their library and a list of recommended books on viticulture. He also gave me information on a suitable support structure.

On 15th February 1985 I decided to try leafy soft and semi-softwood cuttings from the more advanced plants. I tried a mixture of nodal and internodal cuttings and gave them a quick dip in a 0.3% I.B.A. solution. Despite heavy misting a lot of the leaves were burnt so the stock plants probably should have been removed from the shade house and grown in full sun for a while before propagation. Many of the softer cuttings had rotted after two weeks, but two 'Jumbo' had rooted and were potted. A week later fourteen more 'Jumbo' had rooted, as had one 'Higgins', and three 'Cowart'. The internodal cuttings rooted as well as, or possibly better than nodal cuttings so this was very pleasing (Internodal cuttings are quicker to prepare and use one less bud which is very important during the early stages of bulking up). Although I felt that it might be too late in the season, I took more cuttings on 9th March 1985. I expected approximately half the material to be too soft but I felt that it was worth trying at this stage.

The February and March 1985 cuttings rooted spasmodically and the last one was potted on 8th June 1985. These cuttings produced the following plants:

'Jumbo' sixty out of one hundred and sixty eight cuttings (35.7%)
'Fry' nine out of fifteen cuttings (60%)
'Higgins' ten out of twenty seven cuttings (37%)
'Carlos' twenty five out of fifty six cuttings (44.6%)
'Cowart' four out of twenty six cuttings (15%)

These plants were potted into 10cm pots and placed on the back bench of the solar propagating house where they grew on over the winter which was very mild. This bench gets the sun in winter and shade in summer.

Meanwhile the older plants from the hardwood cuttings had been given a topdressing of Sierrablen fertiliser in March and they were all in the shade house. One 'Cowart' had four bunches of flowers on 23rd March so I transferred it to the solar propagating house in the hope that some fruit might develop. On March 29th one more 'Cowart' and one 'Jumbo' had flowers so they were also put in the solar house. On April 25th two more 'Jumbo' with flowers were moved to the solar house. Only four fruit developed on one 'Cowart' plant and these reached the size of small marbles before dropping in frosty weather in August. Until then the winter was very mild and the bigger plants in the shade house were still in leaf.

On 3rd July 1985 a further and final supply of heat treated hardwood cuttings arrived from the D.S.I.R. This time I made all internodal cuttings, half of which were double wounded and the rest were split at the base. Splitting the base of *Actinidia deliciosa* hardwood cuttings had given good results at the Nursery Research Centre at Massey University so I thought it was worth trying on *V.rotundifolia.* Once again they were given a quick dip in 0.4% I.B.A. solution and placed under mist. At the end of July 1985, plans were underway to shift the entire nursery to a larger site in Whenuapai. A larger site was necessary if I was to continue with the *V.rotundifolia* project and there were considerable advantages in being close to Auckland city. The new site slopes gently to the north and Whenuapai was chosen partly because of its colder winters as I felt that winter chilling would possibly be beneficial to the grapes. The shift was a major undertaking but by Labour Weekend 1985 it was completed. In the previous three months, apart from shifting all our plants and nursery equipment, a bore had been drilled, a house was moved onto the site, a potting shed was built, and a new Brownbuilt Durolite tunnel house of approximately 100 sqm was almost completed. During the shift the 1985 hardwood cuttings were unfortunately stressed and very few rooted. This was very disappointing especially as I was hoping to boost our numbers of pollinators.

On October 7th 1985 all plants and cuttings had to be removed from the solar propagating house so that it could be taken apart and transported to Whenuapai. When I took out the *V.rotundifolia* plants which had been propagated in February and March I potted the bigger ones on into 2 litre pots. There had been some losses over winter, namely: eight 'Jumbo', two 'Fry', two 'Higgins', and seven 'Carlos'.

On December 8th 1985 the Durolite tunnel house was finally finished after several frustrating delays, so to mark the occasion thirty internodal 'Jumbo' cuttings were prepared, dipped in 0.3% I.B.A. solution and placed under the mist. During the rest of December and right through to 10th May 1986, leafy internodal cuttings were taken from all cultivars whenever the wood seemed suitable, in an all out effort to bulk up. A lot of the cuttings proved to be too soft and they quickly rotted. This coming summer I will be a lot more selective and discard the softer material. I will concentrate on bulking up the pollinators as fast as possible because they will be needed in large numbers if *V.rotundifolia* is to be promoted in New Zealand for home garden plantings. Because 'Jumbo' is so vigorous and the easiest cultivar to propagate by cuttings, I may decide to experiment with it as a root-

Fig. 2 Stock plants at Whenuapai. These were planted on New Year's Eve 1985.

stock and either bud or graft the weaker cultivars onto it.

New Year's Eve 1985 was celebrated by our first plantings in the field. Twenty 'Jumbo' and four 'Cowart' were planted for use as stock plants in a nursery block, in rows one metre apart. Planting continued during the New Year break until the biggest plants of all five cultivars were planted. It was disappointing not to have been able to do this sooner but the problems associated with shifting the nursery had been enormous. The area chosen is at the top of the property, where the soil is deep, free draining, red/brown loam. (Most of the soil here is 400 to 500mm of relatively free draining greyish loam on heavy clay subsoil.) The females were planted one metre apart and the pollinators, two metres apart. Each row contains only one cultivar to avoid mix ups when collecting propagation material.

Soil tests done earlier in the year showed that the pH was low (5.3), the soil was very deficient in Calcium and also deficient in Magnesium and Potassium. Phosphates and trace elements were well supplied. I had hoped to topdress with Ag.lime at the rate of 3000 kg/ha. in July and follow this with a further 200 kg/ha soon after, in combination with the mixture of fertilisers which had been recommended by the soil laboratory. There was to have been a further application of Ag.lime in October at the rate of 2000 kg/ha. However, as so often seems to be the case, this plan was not possible, so in mid September, Ag.lime was spread at the rate of 5000 kg/ha, together with the other fertilisers. Fortunately this gave good results.

During this first season in the open ground no attempt was made to train the vines. They were supported by 1 metre bamboo canes and summer/autumn pruning consisted of cutting back nearly all the shoots as soon as they were considered suitable for propagating up to 10th May 1986. At planting time some of the vines were flowering but they did not set fruit. Flowers were produced on the vines from time to time until as late as May and a few fruit set on three 'Carlos' vines in the field, and on one 'Cowart' which had been left in the container area in a 2 litre pot rather than risk losing the fruit during the shock of planting

Fig 3 Fruit on 'Carlos', March 1986.

out. The fruit on 'Cowart' did not grow very big but they ripened successively from 22nd April to 6th May. They were sweet and had a good very characteristic flavour which is hard to describe. During a busy spell, I forgot to check the fruit on the 'Carlos' vines and towards the end of May I was disappointed to see that fruit had ripened and dropped from one vine and had rotted on the ground. The fruit on the other 'Carlos' vines continued to grow but they did not ripen before the first frosts in June which caused them to drop.

Winter pruning was delayed until towards the end of August. I decided to keep one strong leader only per vine and completely remove the lower laterals, to encourage a strong permanent trunk and to make weed control easier. The remaining strong laterals were cut back to two or three buds and weak laterals were completely removed. I decided to use the lighter prunings as cuttings. This time I prepared longer internodal cuttings which were not wounded. They were given a quick dip in 1% I.B.A. solution and put under mist. I have found this to be a good method for some of the hard to root old fashioned roses. I was selective with the 'Jumbo' cuttings but used every scrap of the other cultivars. These cuttings are now starting to shoot but there is no sign of rooting yet. Some of the small, thin, softer cuttings have rotted. Bud break was uneven. On 29th August when I was pruning 'Carlos' some buds were breaking on a few of the plants but the other cultivars were completely dormant. Winter pruning was stopped after September 3rd as the sap was starting to run. This left two rows of 'Jumbo' unpruned so it will be interesting to compare them with the pruned plants. At the time of writing, (October 1986) the plants in the field have young shoots varying in length from 5 to 15cm. Growth on 'Carlos' is the most advanced and several 'Carlos' are in flower. A few 'Cowart' are starting to flower but there are no flowers on any of the females.

During the next few weeks, the plants propagated from December 1985 to May 1986 are to be graded and all those big enough will be lined out in the open ground.

In conclusion, it is hoped that the older vines will produce some fruit this season so that I will at least know that they are capable of fruiting in the Auckland area. Propagation will continue whenever possible and I will start training the older vines. I aim to have some support structures erected for the first plantings in our vineyard in Autumn 1987 as I feel that there will be a market for *V. rotundifolia* in New Zealand.

The Ornamental Plant Collections Association

Rob Cross

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Introduction

Ornamental horticulture in Australia, as in many other parts of the world, has suffered over the years from the loss of many fine species and cultivars of garden plants. Commonly, plants are lost through fashion changes, lack of publicity, propagating or cultivating difficulties, commercial pressure on nurseries and nurseries closing down. Plant collectors may move or die, or gardens with fine plant collections may be sold and no longer given adequate care. Whatever the reasons, the diminishing choice of plants available has affected the work and pleasure of professional horticulturists, landscapers, amateur gardeners and keen plant collectors. The Ornamental Plant Collections Association (OPCA) has been formed to help reverse this unwanted trend.

The Formation of the OPCA

In the mid-1980's a study of cultivars listed in old catalogues of Victorian nurseries was undertaken by the Royal Botanic Gardens, Melbourne. A master list of the cultivars that had been available was compiled from catalogues dating back to 1855, and the extent of the plant losses was made evident. For example, of 133 different *Clematis* cultivars listed, only 50 to 60 are presently available. ***Abutilon hybridum*** cultivars have suffered a five-fold decrease in the types available. There were once 62 cultivars, and now there are approximately 12. The variety of *Bouvardia* species and cultivars has fallen from 53 to only 5 or 6.

The Royal Botanic Gardens responded to the findings by convening a meeting of representatives of a number of organisations involved in or related to horticulture. The meeting, held in 1986, resulted in the formation of the Ornamental Plant Collections Committee, now known as the Ornamental Plant Collections Associations (OPCA).

The Objectives of the OPCA

Although a pioneer organisation in Australia, the OPCA has benefitted from the experience gained in Britain by the National Council for the Conservation of Plants and Gardens (NCCPG). The OPCA used the NCCPG as a model to formulate its objectives and the means by which those can be attained. Briefly the OPCA aims to:

> . . . maintain and increase the diversity of garden plants by registering reference collections of related plant groups, where worthwhile ornamental plants can be documented, investigated, and propagated. At the same time, the Association aims to promote the exchange of plant information between horticulturists, plant collectors, gardeners and other interested people.

Appendix 1 lists in detail, the objectives of the OPCA.

The OPCA's Preliminary Work

The registering of plant collections, each containing representatives of a particular taxonomic group, is central to the work of the Association, and it was one of the first tasks to be undertaken. The Collections serve as a repository for the species, cultivars and hybrids of a genus or part genus. They therefore have a conserving role, ensuring the continued existence of a wide range of plants. Initially, seven Collections were registered on a trial basis.

The completeness of the Collections was a factor in their choice for the trial. It is more desirable to register comprehensive Collections requiring less additional planting. However, other criteria governed the choice of Collections as well. The Committee thought it necessary to experiment with different types of management of the Collections. Two each of the Collections were held by local governments, private individuals and commercial nurseries. One was held by the Royal Botanic Gardens, Melbourne which is administered by a Victorian Government department. Figure 1 shows the collections registered by the OPCA as at June 1989.

Collection	Location
Cistus	Blackwood
Cistus	Merricks
Clematis	Tooma (NSW)
Correa	Bundoora
Crocus	Olinda
Helianthemum	Blackwood
Helleborus	Kyneton
Lavandula	Mt. Egerton
Pelargonium	Geelong
Prunus Sato-zakura Group	The Basin
Rosa	Malmsbury
Viburnum	South Yarra
Hydrangea (provisional)	Bowral (NSW)
Eucalyptus (Australian)	Coleraine
Camellia (species)	Donvale

Figure 1. Collections registered by the OPCA

The trial Collections were also chosen for their range of locations within the State of Victoria, allowing for variety in climates and environments. The practicalities of organising the statewide scheme from a central location in Melbourne could be monitored at the same time. Victoria is slightly smaller than New Zealand in area, so frequent site visits have been difficult for some of the Collections.

Part of the arrangements for registering a Collection involved the manager or owner agreeing to a list of conditions (Appendix 2). The list is a guide for management rather than a heavyweight legal document, and it takes into account such things as accessibility of the Collection, and mechanisms to ensure the plants in the Collection are not lost in the event the manager decides to relinquish OPCA registration.

The keeping of accurate records is of prime importance, and was one of the conditions of registration. It was this aspect that caused the greatest of problems with the Collectors. For some, especially those with large collections, the task created a lot of additional work. This was partially solved by recording only the most important information. It had not been envisaged that all the information could be recorded within a short period anyway.

The trial also revealed manpower shortages, which particularly affected the local government Collections.

The Committee is presently investigating a number of plant collections with potential for OPCA registration, and eleven are currently on the OPCA's 'reserved' list.

It is necessary to assess each potential Collection individually, but guidelines have been developed to assist the process. The guidelines are divided into four categories:

A. Taxonomic Considerations
   - degree of danger the taxonomic group is in
   - historical importance of the taxonomic group

B. Status of Collection
   - comprehensiveness of the Collection
   - permanency of the site

C. Geographic Considerations
   - suitability of the climate and soil for the taxonomic group
   - accesssibility of the Collection

D. Managerial Considerations
   - owner/manager is to have adequate knowledge of taxonomic group
   - continuity of ownership/management is preferable.

Although the National Council for the Conservation of Plants and Gardens now has close to 450 Collections, the OPCA, being ten years younger, is wary of expanding too quickly. Registration of Collections will proceed at a pace commensurate with the resources of the Association.

The OPCA Records

As mentioned above, the recording of information is an important part of having an OPCA Collection. Each Collector has been given record cards specially designed for the purpose (Figure 2). The information collected will greatly assist both botanists, horticulturists, and ultimately everyone with a keen interest in plants. For example, recording the plant's tolerances to various site conditions will allow optimum planting conditions to be recommended. Horticultural techniques can be designed to improve the growth of a particular species or cultivar. Landscape designers will be able to

**Rob Cross is now Secretary of the O.P.C.A. Francine Gilfedder is Project Officer.*

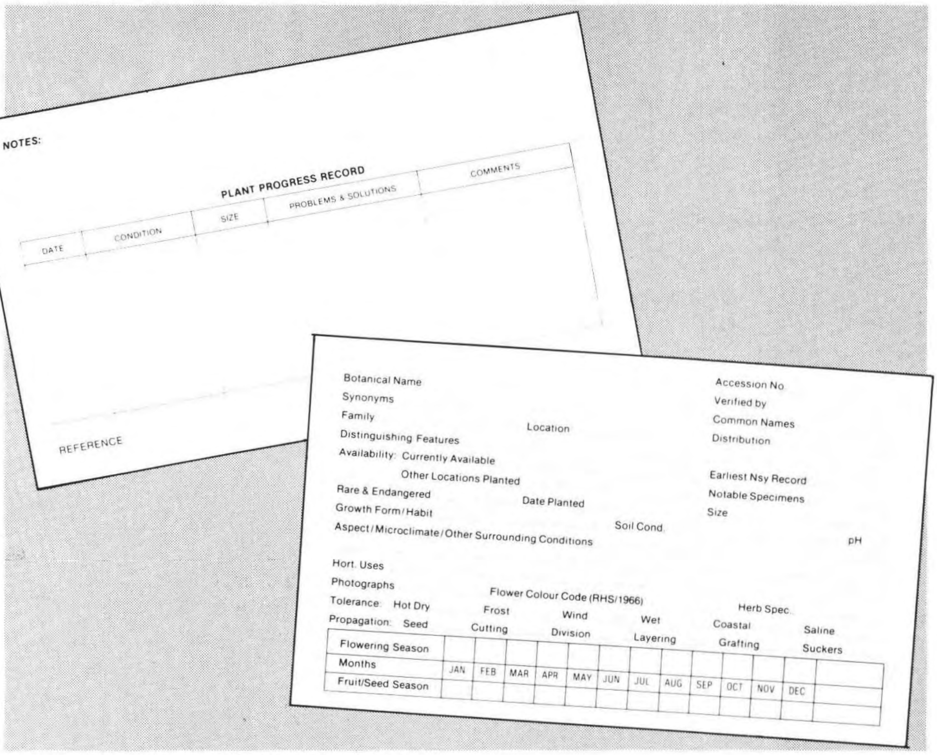

Figure 2. Plant Record Card for the OPCA

optimise the aesthetic contributions of plants in gardens, by knowing more accurately their habits, flower colours and flowering periods.

A computer database for all this information is currently being created. Such a mass of information could not be handled efficiently in any other way. It will also help the Association to achieve its objective of facilitating the exchange of plant information.

Related to the keeping of plant records is the accurate identification, naming and labelling of plants in the Collections. Each Collection will act as a reference, against which unknown species and cultivars can be checked. It is expected that plant nomenclature, which is so often confused, will be clarified as a result.

It can be seen then, that the Collections will have many more roles than a purely conserving one.

Propagation from the Collection

The OPCA encourages the propagation of plant material from the Collections. The wide cultivation of a species or cultivar is one of the best ways of guaranteeing its continued existence. It is planned to identify plants reintroduced into the nursery trade from an OPCA Collection, with the Association's logo. The purchaser will then be assured of the plants authenticity, and will be reminded that they are supporting the conservation of our garden plants.

The Organisational Structure of the OPCA

The two complementary and interacting groups of the OPCA are the Members and the Subscribers. The Members evolved from the original group of people that met in 1986. It is this section of the OPCA that has horticultural and botanical expertise. The professional bodies represented in the Members group are listed in Figure 3. There are also two horticulturally experienced individuals that are Members and the Collection holders will have two representatives.

Recently the OPCA Subscribers group was launched. It allows any interested person to be involved with the Association's activities whether they have a scientific background or can contribute skills such as secretarial, marketing and fundraising. The Subscribers will also benefit from the lectures, and Collection visits being organised. Genus, the newsletter of the OPCA was recently launched. The Subscribers also have a direct input into the decision making processes of the Members with the Chairperson, Secretary and Treasurer of Subscribers automatically becoming Members.

Financing the OPCA

The most important source of funds has been a National Estate grant from the Federal Government. It has enabled a project officer to be employed approximately one day per week since the middle of 1987. The Royal Botanic Gardens administers the grant, and also provides office space, office facilities, and very importantly has made available to the OPCA its technical resources.

The Nurserymen's Association of Victoria, the Australian Institute of Horticulture, and the Royal Botanic Gardens supported the preparation and the printing of the Association's brochure and letterhead. Recently, the Garden State Committee approved a grant for the OPCA.

Donations and subscriptions have been received since the Public Launch of the Association in October, 1988 and it is hoped to establish fundraising projects. Royalties from the sale of plants from OPCA Collections could be paid to the Association, for example. Potential corporate sponsors are being approached.

The real strength of the Association will be in its volunteers; the keen plantspeople who recognise the importance of the OPCA's work. Their value will be inestimable.

Royal Botanic Gardens, Melbourne (Dept. of Conservation, Forests & Lands).
The Nurserymen's Association of Victoria.
Victorian College of Agriculture and Horticulture — Burnley
Ministry for Planning and Environment — Heritage Branch
National Trust of Australia (Victoria)
Royal Australian Institute of Parks and Recreation — Victoria Region
Australian Garden History Society
Royal Horticultural Society, Victoria
Knoxfield Horticultural Research Institute (Dept. of Agriculture & Rural Affairs)
Melbourne and Metropolitan Board of Works
Garden State Committee
Australian Institute of Horticulture

Figure 3. Participating Organisations of the OPCA

The Future

With the foundations upon which it can build now in place, the OPCA's work is really just beginning. Good plant Collections need to be identified and registered, supplementary plantings organised, plant records kept, information collated and distributed, plants propagated, and much more. It could be an overwhelming task, but if the positive and encouraging response since the Association's public launch is any guide, the OPCA will have a long and productive future. It will play a very important role in the horticultural life of Australia.

APPENDIX 1

Ornamental Plant Collections Association Objectives of the Association

The objectives of the Association are to:

1. identify and register existing plant collections and individual plants of significance to ornamental plant collections.
2. assemble a data base of plants that represent the species and varieties of plants of ornamental value in Victoria.
3. identify from the data base, plants of particular value to ornamental horticulture because of their aesthetic, historical or other cultural or scientific significance with a view to including them in a Reference Collection.
4. identify and register individuals and organisations who either manage or own significant collections of plants useful for identification or propagation purposes or who have specialist knowledge of a particular group of plants.
5. give due recognition to, encourage, and liaise with, those organisations and individuals who own or care for the Reference Collections.
6. facilitate the retention, extension and provision of new Reference Collections and for them to be maintained and recorded in the best possible manner.
7. encourage the development of Reference Collections on sites experiencing the most appropriate climatic, edaphic and cul-

tural conditions and where good management and care of the plants can be provided.

8. encourage and, where appropriate, organise the reintroduction of significant ornamental plants which have been lost from Victorian horticulture and to include them in Reference Collections.

9. encourage the propagation, introduction and maintenance in cultivation of rare and endangered ornamental species to avoid the need for re-collection from the wild.

10. facilitate the supply of propagation material from plants in Reference Collections to nurserymen, institutions and other interested parties.

11. facilitate the photographing and documentation of the characteristics and performance of the plants in the Reference Collections.

12. organise or facilitate the accessibility of Reference Collections to specialists and to the general public according to conditions agreed to in writing between the owner and the Association.

13. provide assistance at the discretion of the Members, which includes, but is not necessarily restricted to financial support or help with voluntary labour, to enable the Reference Collection to be maintained and recorded to a satisfactory level.

14. make arrangements with owners of Reference Collections regarding the care and function of the Reference Collections and to set out the conditions required to be observed by the owners or persons entrusted with the care of Reference Collections.

15. remove from the Accreditation Register the Reference Collections which have been neglected or managed in such a manner, which, in the opinion of the Association, would warrant their removal from the Register.

16. inform and educate interested amateur and professional horticulturists and related disciplines and the general public as to the scope and purpose of the Reference Collections.

17. encourage publication of material of both scientific and general interest for the information of specialists and the general public.

18. collate and disseminate information on taxa included in the Reference Collections that have demonstrated or may demonstrate a potential to become environmental weeds.

19. liaise with the Royal Botanic Gardens and other government departments and organisations to assist in achieving the objectives.

20. liaise with specialist groups who have particular interest and knowledge of a plant group.

21. set up within the Association a Subscribers group which will comprise those persons who will support the attainment of the objectives of the Association.

22. initiate, promote, support or oppose legislative or other measures connected with or affecting the aforesaid objectives.

23. initiate, promote or support research and development of the taxa held in the Reference Collections.

24. do all such other things as are incidental or conducive to the attainment of the above objectives.

APPENDIX 2

Ornamental Plant Collections Association Ornamental Plant Collections — Conditions of Registration

Organisations accepting responsibility for a Collection are asked to agree formally to the following conditions:

1. To maintain in the Collection an agreed minimum number of specimens of each species and cultivar.

2. To add to or otherwise improve the Collection so that it shall remain as representative as possible.

3. To maintain accurate records and lists of the plants, and to label and/or map the individual plants or plant groups in the Collection concerned.

4. To co-operate with the OPCA in occasional inspections of the Collection and the recording system, and to provide a brief annual account to the OPCA detailing changes that have occurred in the Collection.

5. To try to ensure that the Collection shall be maintained in good health.

6. To provide material for herbarium specimens where possible and allow photography of the Collection for record purposes by the OPCA or their authorised representatives.

7. To pass on enquiries about the OPCA and matters related to conservation to the OPCA as quickly as possible, and to maintain a stock of leaflets on the OPCA and make these available to interested visitors.

8. To provide reasonable quantities of propagating material on request from the OPCA or other body authorised by the OPCA. This will help ensure that the taxon will remain in cultivation. The OPCA recognises that the sale or distribution of propagating material shall remain the responsibility of the holder of the Collection, but considers it to be highly desirable that propagating material shall be made available from Collections. The holder of a Collection has the right to restrict the amount of propagating material provided to any firm or individual: the Collection should not be looked upon as a convenient "stockground". No propagating material of a plant subject to Plant Variety Rights may, however, be distributed without reference to the OPCA which shall liaise with the Plant Variety Rights Office to check the legal position in each case.

9. To give sufficient notice of relinquishing OPCA registration or total responsibility for the Collection, so that the possibility of continuing the collection can be maximised, subject to the Collector's approval, by the transfer of plant material or by its propagation.

10. To relinquish responsibility for the Collection if the OPCA considers that the foregoing requirements are not being carried out satisfactorily.

The following points are also drawn to the attention of the Collection holders:

1. In certain cases, a parallel or complementary Collection may be designated by the OPCA.

2. If Collections are not open to the public, reasonable access should be allowed to individuals or groups with a particular interest in the Collection concerned, at the request of the OPCA. It is desirable that the Collections are open to the public periodically.

3. It is desirable that Collection holders should co-operate with the OPCA in the development of literature about the Collection.

4. It is desirable, where appropriate, Collection holders should try to produce selfed seed for long term storage in a Seed Bank.

The Advantages of Computerised Records for Plant Collections

Alison Evans

Botanist, Dunedin Botanic Gardens, DCC Parks and Recreation Dept, Box 5045, Dunedin

With the Personal Computer now affordable ($2000 - $4000) by many botanic gardens as well as individual plant collectors, computerised plant records have become a realistic option.

What are the advantages over an index card system in having a computerised database of your living collections? In a word, efficiency. Although it may take some time to select hardware and software and devise a record form, once done, record management will be forever streamlined.

The reasons for this greater efficiency are:

DATA INPUT — is much faster with a computerised database than with an index card system. All data entry and alterations, including correcting mistakes and updating records can be done in a matter of seconds for each record. Also, software often allows shortcut ways of entering information that is repeated through many records e.g. genus, family names, plant source, planting site etc.

RAPID INFORMATION RETRIEVAL — this is one of the most useful features of computerised databases. Fields can be retrieved in almost any combination to answer questions about the living collections that would otherwise have taken hours of tedious sorting through index cards, maps, ledgers and libraries to answer. You may want to know, for example, how many plant families and species are represented in your collections of South American plants; how many trees in your garden are over fifty years old; what species you took cuttings of in the second week of March last year; what *Rhododendron* hybrids have *R. griffithianum* as a parent — the answers to all these questions can be found and printed out in a few seconds.

There is a bewildering range of hardware and software to choose from, and your choice will be governed by factors such as cost, compatibility with other systems in your organization, ease of use and supplier backup. In the Dunedin Botanic Garden all these factors played a part in the choice of an IBM clone (Turbo XT system) with a 20 Mb hard disk, mouse and dot matrix printer. The advantage of a hard disk is that you load all your software, databases and other work onto it, making them readily and easily accessible. The software currently used in Dunedin is *Reflex Database Manager* by Borland — it is a relatively low cost ($250 in 1988) package that is very flexible and easy to use. Some of the most sophisticated software packages such as *BG-Base* and *Paradox* are relational, with separate files linked together by shared fields. Others, such as *Reflex*, are non-relational, so that only one file can be accessed at a time.

Designing your database record form is the trickiest part of the whole exercise. Efforts have been made to internationally standardise the fields used for plant records so as to facilitate information exchange between botanic gardens. The Botanic Gardens Conservation Secretariat has sponsored the development of the International Transfer Format (ITF) for botanic garden records. The ITF was carefully considered for the Dunedin Botanic Garden but was not finally used as a whole, although some of its fields are incorporated in our record form. It was decided that the ITF's fixed fields length and the coded data that many of its fields required were not suited to our everyday needs. Although international standardisation is the ideal, in practice the information storage needs of each botanic garden are different and record forms will inevitably reflect this.

The following example shows the plant record form developed for the Dunedin Botanic Garden. It includes all the data kept for each accession i.e. details of nomenclature, source, propagation, distribution, habitat, provenance, labelling, planting and conservation status.

Doubtless this record form will be modified as needs in the Dunedin Botanic Garden change — but this will be a simple matter of altering form design — with no loss of stored data. The ease of alteration of record layout is another major strength of computerised databases. With a card index system improvements to the record form are usually prohibitively time consuming, inhibiting further refinements.

Explanation of field names

ACCNO — accession number — the unique number given each new accession. It comprises a year and a serial number, the latter is assigned in consecutive order of acquisition and begins at one each year. We regard an accession as including all plants from the same seed lot or cuttings from one or more individuals of a taxon. When repropagation of an accession occurs the original accession number is retained. In some botanic gardens a new accession number is issued at each repropagation, but in our case the benefits of doing so did not justify the extra record keeping and time involved.

ACCDATE = accession date

ORDBY = Initials of staff member who ordered the accession or accepted it if donated

SOWDATE = date seed sown

PROPLOC = location in the Propagation Section

PROPNOTES = special propagation instructions etc.

CUTDATE 1 - 3 = dates cuttings taken

Example Plant Record Dunedin Botanic Garden

ACCNO: 86301 ACCDATE: 3/04/86 ORDBY: AJM

SOWDATE: 3/06/86 EPD: 4/88 PROPLOC: flat 4
PROPNOTES:

CUTDATE 1:	CUTDATE 2:	CUTDATE 3:
CUTNO 1:	CUTNO 2:	CUTNO 3:
POTDATE 1: 3/25/86	POTDATE 2: 2/26/87	POTDATE 3:
POTNO 1: 32	POTNO 2: 6	POTNO 3:

FAMILY: Myrtaceae INFRAGEN:
BOTNAME: Eucalyptus stricta
VERIFIER: DESCRIPTION: mallee 2 — 5m
SYNONYM:
CULTIVAR:
PARENTAGE:
COMNAME: Blue Mountains mallee ash

DISTWILD: NSW, Vic
HABITAT: open forest on sandstone

SOURCE: RBG Sydney
SORACCID:

PROVENANCE: W LOCOLTED: NSW — track to Kalong Falls, Kanangra Tops
FIELDNOTES:

COLLECTION: Australian BEDNO: A 12
PLANTSITE: behind seat
PLANTDATE: 8/30/88 PLANTNO: 3 LABELDATE:
DEADDATE:
NOTES:

DUPMAT: IUCNCAT:

CUTNO 1 - 3 = numbers of cuttings taken at corresponding CUTDATE
POTDATE 1 - 3 = dates seedlings or cuttings tubed or potted
POTNO. 1 - 3 = numbers tubed or potted at corresponding POTDATE
FAMILY = plant family name in full
INFRAGEN = infrageneric rank e.g. section, subsection, series, subseries. Consists of the name of the subgeneric rank and the accompanying epithet. This field is used for species in large genera, such as *Rhododendron,* where subgeneric classification is given on plant labels.
BOTNAME = botanical name, comprising generic, specific and infraspecific epithets. The infraspecific rank is abbreviated to var.,ssp.,f. Intergeneric and interspecific hybrids are indicated by x in appropriate places. The certainty of identification of a taxon is given by aff., cf. etc. BOTNAME includes any group names (categories between species and cultivars). Because *Reflex* will search for any specified character combination within a text field, it is not necessary to have separate fields for each taxon of the botanical name.
VERIFIER = the name of the person who verified the identification of the plant. This field is left blank if the accession has not been verified.
DESCRIPTION = brief notes about the plant's dimensions, features etc.
SYNONYM = other validly published botanical names currently in general use
CULTIVAR = the cultivar name, enclosed where appropriate in single quotation marks. Having cultivar data in a separate field facilitates retrieval of this information independently of species data.
PARENTAGE = the parentage of hybrids written in alphabetical order of generic/specific names and with the seed parent, where known, denoted by *
COMNAME = common name(s) in general use
DISTWILD = the natural range of the plant = country or geographic area
HABITAT = the habitat of the plant
SOURCE = the person, institution or business that the accession was acquired from, and the country in which this source is based (if outside New Zealand).
SORACCID = the accession code of the supplying botanic garden or scientific institution.
PROVENANCE = coded as: w = known wild origin, c = known cultivated origin, u = unknown origin
FIELDNOTES = (for wild provenance accessions) details of collection site e.g. altitude, aspect
COLLECTION = the name of the collection(s) that the accession is planted or displayed in
BEDNO = the collection coded bed number where the accession is planted or displayed e.g. A 14 = Australian collection Bed 14
PLANTSITE = description of the precise location of the plants in the bed
PLANTDATE = date planted
PLANTNO = number of individuals of a particular accession planted
LABELDATE = date accession was permanently labelled
DEADDATE = date accession was lost to the collection
NOTES = e.g. transplanting, site conditions, pest/disease treatments etc.
DUPMAT = type of duplicate material available coded as: s = seed, v = vegetative
IUCNCAT = IUCN conservation category of accession worldwide coded as: space = no information, E = endangered, V = vulnerable, R = rare, L = local, I = indeterminate

If your collections are expanding rapidly (e.g. by 1000 or more accessions annually), computerised records offer the greatest advantages. In Dunedin the paper record forms of the manual system begun four years ago, now occupy forty-two large ring binders. Computerisation will therefore keep the volume of these records within practical bounds. You may decide the same for records of your plant collections.

Recommended Reading

IUCN, 1987: *The International Transfer Format for Botanic Garden Records,* Hunt Institute for Botanical Documentation, Carnegie Mellon University, Pittsburgh.
Ogilvie, F. M. P., 1983: *Reference Systems for Living Plant Collections,* Department of Architecture Heriot-Watt University Edinburgh, Scotland.

Book Reviews

Flora of New Zealand, Volume 4, Naturalised pteridophytes, gymnosperms, dicotyledons, by C. J. Webb, W. R. Sykes, and P. J. Garnock-Jones, Botany Division, DSIR, Christchurch, New Zealand, 1988, 1365 pp. $80, overseas NZ$88.00.

Over recent decades we have been fortunate in the regular appearance of volumes of the "Flora of New Zealand". From the 1960's to the 1980's there have been two on desmids, one on lichens, and four on pteridophytes and/or seed-plants, whether native or introduced. Seven volumes is almost as many as were published in all the previous history of botany in New Zealand. But although a Flora is not now a rare event, each one is still a milestone in the history of New Zealand science; and the present volume is no exception. It deals with 1470 species of naturalised ferns and naturalised dicotyledonous flowering plants. It describes them, gives information about their history and distribution in the country, and shows how to differentiate them one from another in keys and illustrations. It is the first time that there has been a Flora of these plants since H. H. Allan's "Handbook of the naturalised flora of New Zealand" in 1940.

This book is of course essential for anyone working on naturalised plants, whether in town or country, gardens, parks, reserves, roadsides, fresh waters, river beds, dairy pastures, high country runs, and so on. But it is also a contribution to our knowledge of native plants and is necessary for students of them. If a genus includes both naturalised and native species (such as *Senecio*), then all the species are described. Of the 397 native species involved many are described only briefly because they have been satisfactorily treated in earlier volumes, but others are more extensively dealt with and much new information is given about them. As examples one notes the revised treatment of *Acaena* contributed by Bryony Macmillan, or the wise reduction by Colin Webb of the five species of *Cassinia* recognised in Allan's Flora to one variable species, *Cassinia leptophylla. Gunnera* is also well pruned.

Any keys which I have tried have worked well, and the comments after the species descriptions are useful and interesting. In the large Families such as the Rosaceae the synopsis showing sub-families and the introduced genera belonging to each is most instructive. And I was glad to find the Families arranged in alphabetical order. After all the book is to help identification not to demonstrate some phylogenetic system by using only a selection of the Families. The black-and-white drawings (contributed by five artists) and the coloured plates are usefully designed to show differences between related species.

The list of names of the authors of species with their standard abbreviations is useful to have, but even more useful would be a note on the derivation of each generic name. Most of us parrot these off without knowing what they mean, although the name often gives a clue to some outstanding character of the genus or is of historical or literary interest. But if derivations are given it is essential to go back to the original description to find out the intention of the creator of the genus. Guessing is no good, however formidable the scholarship. Thus, since the *Flora Novae-Zelandiae*, the derivation of *Olearia* has been given by New Zealand authors (including Wall and Allan) as some variant of Hooker's "from *Olea*, an olive-tree, which some species resemble." The latest variant is: "the *Olearia* tree daisies take their very name from their tomentum — *Olea* is the genus of the olive, which has silvery tomentum on the underside of its leaves" (*New Zealand's Alpine Plants, inside and out*, by Bill and Nancy Malcolm). Yet if Hooker had looked up Moench's original description he would have read: "In memoriam Joannis Gotbofredi Olearii, auctoris —" etc. etc. In other words the genus *Olearia* commemorates a man called Johann Gottfried Oelschlaeger whose account of the plants of Halle appeared in 1668 and who was known as Olearius because his name means "oil-presser".

The expense of writing this work has been borne by the Dept of Scientific and Industrial Research — the salaries, the typing, the accommodation. But then it looked as if this good ship was going to be spoilt for the proverbial ha'porth of tar. There was no money for publication. The situation was saved by a grant in liberal terms from the Miss E. L. Hellaby Indigenous Grasslands Research Trust. Miss Hellaby was one of the three children of the founder of the Meat Company based in Auckland, and her personal fortune is the basis of the Trust named after her.

With this volume and a good hand lens a sizeable chunk of The Plant Kingdom is waiting to be explored. Nor does one have to go to the headwaters of the Motu or the steppes of Central Otago to do it. And if we think that we know all about the weeds under our hedge or on the nearest vacant section this book will show how wrong we are. And it will also introduce us to a most interesting group of plants, some benevolent, some malevolent, but all long-distance travellers, colonists, and survivors, just like the people who brought them here. For I must emphasise that this work represents much more than just a book about weeds. It is a record of one of the most significant periods in the history of the vegetation and flora of New Zealand. For millions of years the plants colonising the New Zealand region came over the land. Then, as New Zealand became isolated, the plants came over the sea by the agency of wind, currents, and birds, and this still continues. But over the last few hundred years and particularly the last two hundred a whole new flora has colonised New Zealand. This was due to the activities of another species, *Homo sapiens*, the most efficient plant disperser of the whole Animal Kingdom. Elsewhere I have called this the Cookian period because almost all these introductions by man directly or indirectly have occurred since Cook's voyages. Volume 4 then, deals with anthropophytes using that term in a wide sense.

Colin Webb (who was the coordinator and editor), Bill Sykes, and Phil Garnock-Jones, are to be congratulated for their documentation of the most important period in the history of our wild plants since Glacial times.

Eric Godley AHRIH

A Growing Matter: An Inventory of the Vegetable and Native Plant Seeds of Aotearoa/N.Z. Compiled by Ann Bell, New Zealand Coalition for Trade and Development, P.O. Box 11-345, Wellington.

The New Zealand Coalition for Trade and Development (NZCTD) is a non-profit organisation which informs and educates people about poverty, affluence and injustice. It is opposed to Plant Variety Rights legislation, saying no person or organisation should have the right to own another living evolving life form. They contend that PVR has accelerated genetic erosion by putting genetic resources into private hands, including the large multinationals that can afford to spend a lot of money developing new cultivars. Not everyone will agree with these views on PVR, but the reality is that, for whatever reason, genetic erosion is occurring at an alarming rate and urgent steps are needed to stop it.

This publication takes an important first step by providing an inventory of vegetable seeds and native plants available in New Zealand. Ann Bell carried out an exhaustive survey of seed firms, nurseries, public and private gardens and Universities to produce this invaluable resource. Such work will be of great use to the N.Z. Plant Collections Scheme which is currently being established.

The text is clear and easy to read and includes some excellent cartoons on collecting and storing seed. Contents include: Vegetable plant breeding and plant variety rights legislation in Aotearoa/NZ; the Food and Agricultural Organisation-sponsored international system of genebanks; a list of vegetable cultivars, with seed/plant supplies and availability; a list of native plant resources; and practical guidelines for small-scale seed saving.

All in all, a useful publication at a reasonable price.

Cost N.Z.: $24.75 each, Overseas: $22.00 each. Postage & Packaging: N.Z.: $1.50, Overseas $3.00 (surface), $7.00 (airmail South Pacific), $11.00 (airmail W. America, Europe).

Economic Native Plants in New Zealand S. G. Brooker, R. C. Cambie and R. C. Cooper. Christchurch: Botany Division, DSIR, 1988. ISBN 0-477-02526-9. $18.35 (inc. GST, post and packing in New Zealand). Available from Botany Division, DSIR, Private Bag, Christchurch.

Most of the world's really important crop plants have been grown for hundreds or even thousands of years and are now dispersed widely from their natural centres of origin. Many garden plants, especially those of temperate regions, have likewise spread around the world.

The early colonists who came to New Zealand brought plants with them. The Maori introduced some crop plants such as the kumara, taro and the yam and managed to keep them in cultivation, perhaps for a thousand years. The journals of Cook and of Surville indicate that the Maori also cultivated a small number of indigenous plants such as the kowhai ngutu-kaka (*Clianthus puniceus*) for its flowers and the karaka (*Corynocarpus laevigatus*) for its fruit.

The European colonists in turn brought many more economically important plants and they also brought ornamentals, plants that reminded them of the countryside and the homes that they had left, plants that made their new surroundings less strange and less threatening. The introduction of plants to New Zealand continues today. Our gardens are still very dependent on the plants brought mainly from Britain, not just the plants coming from Europe but also those that were introduced to Europe from North America, Asia or other Southern Hemisphere countries.

We are therefore accustomed to grow in the one garden, plants from different parts of the world, although there is now an increasing tendency to grow our own native plants. New Zealand plants are well adapted to our environmental conditions and they are resistant to, or tolerant of, many local pests and diseases. Many of them are attractive or interesting plants. More important, perhaps, they give a special and recognisably New Zealand ambience to our landscapes. Some plants have become almost ikons — the cabbage trees of Russell Clark, for example, leave us in no doubt that his paintings are of New Zealand. What was once strange or different now gives us a feeling of security, an awareness of place. Thus for New Zealanders one of the important attributes of our native plants is their very familiarity, the fact that we have grown up with them. As a result we tend to forget that in other countries these plants may actually appear strange, novel, or even exotic.

When we think of the origins of our garden plants we usually think of introduced plants and how they have come to us from other countries. Too often we forget that the movement and transfer of plants can be a two way process. The first part of *Economic Native Plants of New Zealand* provides a valuable and most interesting corrective: it gives a brief account of the early investigations of the New Zealand flora and then describes the attempts to introduce these plants into cultivation in Europe. This part of the book can usefully be read in conjunction with Bruce Sampson's *Early New Zealand Botanical Art*.

The exploration of New Zealand revealed a whole new flora to European science and it is difficult for us now to realise how exciting it must have been to be a botanist in the late eighteenth century, during the nineteenth century or in the first part of this century. New plants kept pouring in, first from the Americas, and then from Australasia, Southern Africa and Asia. It was not just the botanists who were excited — the interest of horticulturists was also aroused and collecting trips were made to bring back living material, especially from temperate regions where the plants are well suited to the climates of Europe and North America. Travelling to strange countries and obtaining herbarium specimens was hard enough but it was much harder to collect propagating material and get this home still alive. Subsequent propagation and establishment were even more difficult.

It is astonishing to learn from *Economic Native Plants of New Zealand* how little time elapsed between Cook's first voyage and New Zealand plants being grown, illustrated and described, and even offered for sale in Europe. The *Endeavour* arrived at what Cook named Poverty Bay in 1769 and seeds collected in New Zealand were back in England by 1771. The kowhai (*Sophora tetraptera*) had flowered by 1779 and was illustrated in a plate published in 1780. It was again illustrated the following year, this time in *Curtis's Botanical Magazine*, and was being offered for sale by London nurserymen by 1783. Even more remarkable, *Leptospermum scoparium* was being offered for sale by nurserymen in 1778, the price of 7s 6d no doubt indicating its rarity. Some plants (e.g. what we now know as *Haloragis erecta* and *Tetragonia tetragonioides*) were described and illustrated from plants raised from seed. The authors detail how seeds from Cook's third voyage were widely distributed throughout Britain and to some of the great botanical gardens in Europe.

The more spectacular plants deservedly received much attention. The text accompanying the plate of the kowhai in *Curtis's Botanical Magazine* (tab. 167, 1791) stated, "A finer sight can scarcely be imagined than a tree of this sort ... thickly covered with large pendulous branches of yellow, I had almost said golden flowers; for they are of a peculiar richness, which is impossible to represent in colouring ..." According to *Index Londinensis* seven illustrations of the kowhai were published before 1800 and another seven by 1840. *Clianthus puniceus*, raised from seed gathered by the missionaries, obviously created an even greater impression when it first flowered — it was figured nine times between 1835 and 1838. John Lindley wrote in the *Transactions of the Horticultural Society of London* (2nd Series, vol. 1, 1835, tab. 22) that if *Clianthus* proved a hardy plant, "... its extraordinary beauty will render it one of the most valuable species that have been introduced of late years ..." It is unfortunate that many of our choicer plants are just not sufficiently hardy to survive European winters, but, as nurserymen such as Graeme Platt have suggested, this problem might be overcome by use of more suitable ecotypes. Less impressive plants were also figured, and Bruce Sampson in *Early New Zealand Botanical Art* notes that 135 New Zealand species have so far been illustrated in *Curtis's Botanical Magazine*, a fair representation of our flora.

The initial introductions of New Zealand plants to Europe were mainly as seed. Not all such introductions were successful: seed of the flax, *Phormium tenax*, was taken back to England by Banks and Solander but did not grow. It was not introduced till 1788 or 1789, when living plants were taken back to Europe, and it was being offered for sale by 1804. The flax is a very tough plant, however, and it was only after the invention of the Wardian Case that most plants were able to survive the rigours of the long sea voyage to Britain. Some of the first plants sent back in this way were collected by naval ships but soon nurserymen working in New Zealand started sending plants to Kew or to some of the enthusiastic private collectors.

To record the introduction of New Zealand plants into cultivation overseas requires painstaking searching of available nursery catalogues and the immense horticultural literature of last century and the first part of the twentieth century. *Economic Native Plants of New Zealand* provides a good introduction to that literature. There is also an account of the horticultural uses made of New Zealand plants in different countries. The *Hebe* has been particularly well received — a *Hebe* Society has been established in Britain to promote the genus, and several million *Hebe* plants are produced each year by Danish pot plant growers.

New plants continue to arrive in Europe. An advertisement in the May 1986 issue of *The Garden (Journal of the Royal Horticultural Society)* extolled *Xeronema callistemon* claiming that it was "... one of the world's rarest plants, which, since its discovery in 1924, has never been available commercially". Although described as a "must" for plant collectors the price of £32.85 per plant must surely have limited its appeal.

The growing of native plants in our own gardens receives comparatively brief mention. This is a topic that deserves fuller attention. The missionaries planted native trees and since then, enthusiastic amateurs have recognised the ornamental qualities of our flora. It seems, however, that it is only in recent years that horticultural fashions have changed and that native plants have become abundant in urban gardens. Perhaps there is a link between our enhanced awareness of a national identity and this greater appreciation of New Zealand plants.

I have concentrated on those parts of the book dealing with the scientific description and introduction of our plants. The main focus of the book is, of course, the New Zealand plants that are of real or potential economic value. The Maori of pre-European times used many indigenous plants but then once the Maori were here they really had little option. Bracken roots probably provided the main staple for many communities, and the most important plant they cultivated, the kumara, is not a native plant but one that they had brought with them to New Zealand. The early European visitors and settlers logged the forests and for a time flax was an important trade commodity, but apart from the grazing of the tussock grasslands of the South Island, there has been little sustained use of native plants in New Zealand agriculture of horticulture. The authors correctly point out that the use of our indigenous forests has largely been one of exploitation. Essentially all our vegetables, almost all of our pasture plants, most of our ornamentals, all our arable crops, and almost all the trees in our managed forests have come from other parts of the world. This is not really surprising. The New Zealand flora contains about 2000 species of higher plants and most of the world's food is provided by only 20 or 30 species. Even comprehensive lists of the plants used by man usually include only a few thousand species. New Zealand plants may be a valuable source of chemicals but most of the economic uses listed by the authors are limited, or are likely to be the basis of only small or very localised industries. I doubt that most of the potential uses proposed are worthy of much more than cursory examination. One interesting possibility, the use of cabbage trees to produce fructose, has probably been doomed by the appearance of a new disease.

Economic Plants of New Zealand has a somewhat utilitarian appearance as it has been produced by laser printer. However, the binding is strong, the text is clean and very legible and the real compensation is the remarkably low price — at $16.85 plus $1.50 post and packaging, this book is most certainly a bargain! I noted a few typographical errors but most of these unlikely to mislead. I have not attempted to check the bibliography systematically, but those references I did check are correct. With almost five hundred citations, this will be a most useful starting point for future scholars. It is therefore a pity that the titles and full pagination of most papers have not been given. Furthermore, subsidiary authors are often listed inadequately as *et al.* and in other cases more details would probably make it easier to obtain material through interloans. There is a good index of plant names.

The illustrations are mostly taken from Thomas Kirk's *Forest Flora of New Zealand* of 1899, although some accompanying detailed sketches have, at times, been removed from the plates. The drawings have suffered in reproduction — all have a starkness lacking in the originals and those of *Alectryon excelsus, Aristotelia serrata, Laurelia novae-zelandiae* and *Lophomyrtus bullata,* in particular, have lost much detail and subtlety of shading. Nevertheless, these reproductions will have served their purpose if readers are encouraged to go back to Kirk's *Forest Flora.*

Economic Native Plants of New Zealand will be a useful reference for those wanting a quick summary of chemical studies into New Zealand plants. It also provides information on the former use made of these plants by the Maori or the European colonists. To those interested in the horticultural uses of our plants or in the history of the discovery of the New Zealand flora it collects together much new information. In some ways it is an irritating book because the often abbreviated comments force the reader back to the original literature. That, however, is also a measure of the book's success — I found that as I read it I was continually diverted to search for more information in a fascinating and diverse literature.

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Citations for the Award Of Associate Of Honour AHRIH (NZ) 1989

The title of Associate of Honour is conferred on a person who has rendered distinguished service to horticulture. The number of Associates shall not exceed sixty at any one time. Associates of Honour are entitled to use after their names the words 'Associate of Honour of the Royal New Zealand Institute of Horticulture Inc' or the distinguishing letters 'AHRIH'. The following people were made Associates of Honour at the A.G.M. of the Institute in May 1989.

HUGH REDGROVE

Hugh Redgrove started off in Horticulture as an apprentice in the United Kingdom at West Kent Nurseries, Seven Oaks. The Nursery specialised in perennials but also grew glasshouse chrysanthemums and pot plants in winter. His father purchased the nursery three years later and built the business up, and in the 1940's merged the nursery with another and the business became Redgrove and Patrick Ltd with two nurseries plus a town shop. One nursery specialised in perennials, the other grew trees, shrubs and roses. The nurseries exhibited at the Chelsea Show and never missed a show until World War Two. After the war there was a lot of landscape work for his business cleaning up and landscaping large gardens which became overgrown and neglected during the war. In 1951 he decided to wind up the business and he came to New Zealand.

In 1952 Hugh Redgrove arrived in New Zealand and soon after took up a position with F. M. Winstone (Merchants) Ltd. He spent about three to four months in the shop before being appointed manager and was then sent out to run the nursery at Shore Road. He spent the next 25 years there as a manager before retiring at the age 75.

Winstones Garden Centre was known throughout New Zealand for a wide plant range, including rare and unusual plants and good gardening advice. In fact its affectionate name in the trade was 'Kew Gardens'. Winstones also ran a landscape planning service started by Hugh in the late 1950's.

Hugh Redgrove served on many committee's for the New Zealand Nurserymans Association and Royal New Zealand Institute of Horticulture. The RNZIH took up his suggestion of making awards to plants that perform well in New Zealand conditions. He served with Arthur Farnell on what was the Award of Garden Excellence (Age) Committee. Age was set up to recognise the importance of outstanding plants and many fine plants were given the award. It was based on the Royal Horticulture Society Awards in England.

Hugh Redgrove has extensive collections of research material. He has kept records over many years and has scrap books of articles, folders of catalogues and notes from lectures and talks. He has an extensive photo library, filed in steel cabinets under broad categories like, perennials, conifers, trees and shrubs. He also has an extensive horticultural library with over 400 reference works.

Hugh Redgrove has been responsible for introducing many ornamentals to New Zealand gardens and introducing new plants to gardeners through his writings. He made three trips back to England in 1974, 1977 and 1978 and on each trip collected different plants to bring back to New Zealand. Such plants as *Carex* 'Evergold', *Deutzia* 'Rosealind', *Hebe* 'Oratia Beauty', *Hebe* 'Orme', *Hebe* 'Amy', *Helichrysum* 'Limelight' and many others.

Hugh Redgrove has had a deep red glossy foliage variety of Rhododendron named after him by the Pukeiti Rhododendron Trust.

He has had a deep influence on the trade here for 36 years and continues to be active in horticulture with the New Zealand Nurserymans Association, the Auckland Branch of the Royal New Zealand Institute of Horticulture, the Auckland Regional Authority Botanic Gardens and other engagements.

In recognition of his long service to horticulture Hugh Redgrove was awarded the Queens Service Medal in 1987.

Hugh Redgrove has through his enthusiasm for plants and horticulture made a lasting contribution to horticulture and gardening in New Zealand.

PETER TAYLOR

Peter Taylor comes from a family background steeped in orcharding. His great grandfather established the family orchard in Conroy's Gully near Alexandra in the 1860's, which was one of the first three orchards in the area. Peter, a fourth generation orchardist first got involved in the industry in 1957 when he was selected to go to Australia for a year on the Young Orchardist Exchange, run by the New Zealand Fruitgrowers Federation with some sponsorship from the Apple and Pear Marketing Board and Fruit Distributors Ltd.

On his return Peter soon took up an active interest in fruit politics as a member of the Earnscleugh Fruitgrowers Association, and has been an Otago delegate to Federation Conferences since 1967. He spent just over 10 years as Chairman of the Dunstan Fruitgrowers Transport Committee and was a member of that Committee for several years after.

In 1968 Peter was elected to the Otago District Fruit Advisory Committee. He became Chairman and the Director for Otago on the New Zealand Fruitgrowers Federation Board in 1974.

Peter Taylor was nominated as the federations representative on the National Research Advisory Council in 1979 and remained a member for six years.

In 1982 Peter was elected President of the New Zealand Fruitgrowers Federation and is presently in his second term of office. It was Peter Taylor who in 1982 steered the change in the structure of the Federation into sectors with the amalgamation of the citrus and subtropical Council.

Peter Taylor also steered the separation of Fruitfed "commercial" away from the Federation "political" in 1985, and is presently chairman of Fruitfed Ltd. He was a member of the Energy Advisory Council for 3 years, and as President of the Federation played a significant part during the development of the Horticulture Export Authority (HEA) Bill. Once HEA became an Act of Parliament, Peter was one of the first representatives to be selected. He continues to be the Federations representative on the HEA.

Peter Taylor has played a major leadership role on the Summerfruit (Stonefruit) Industry being the initial chairman of its Sector Committee. More recently he played a major part in bringing this sector under the Horticultural Export Authority as a product group.

He has been Chairman of the Summerfruit Export Council since 1987, and has travelled to Japan on several occasions on behalf of this industry to negotiate market entry for cherries and more recently nectarines.

He has also represented the fruitgrowing industry in China 1985 and in Europe 1987.

Peter Taylor has made a major contribution to New Zealand's fruitgrowing industry.

RAYMOND HAROLD MOLE

Raymond Harold Mole started his academic training at the Oaklands Horticultural College in St Albans, England and continued at the RHS garden at Wisley. He obtained the Wisley Diploma and the National Diploma in Horticulture (intermediate). He obtained the NDH(NZ) in 1971.

In 1955 he moved to Southern Rhodesia where he developed a 400 acre estate into a botanic garden which included a pinetum and arboretum. In 1962 the Mole family came to New Zealand and Ray joined the staff of the Wellington City Council, Parks Department as Curator of the Otari Open Air Native Plant Museum, a position he holds today.

Since 1962 Ray has turned his interest in New Zealand native plants into his life's work. This has been through his work as Curator of Otari as well as many countless hours out of work time giving lectures, writing articles and leading field trips.

In his job as curator he has continued the development of Otari, and expanded its educational role especially amongst the young people. He acted as a catalyst for the opening of an interpretive centre at Otari, a facility which has been of great value to people of all ages. It is also used for the increasing parties of school children that visit the garden.

He has increased the plant collection at Otari with frequent trips to nurseries (for new cultivars), parks and other areas. He has also advised on management of native bush such as that administered by the Taihape Borough Council.

Ray Mole has been involved in a wide range of horticultural activities, mainly involving the use, propagation and protection of native plants. His horticultural interests have included lecturing, escorting field trips for WEA and assisting botanical societies with field trips, plant care information and identification. In the winter, many weekends are taken up supervising volunteer groups assisting in the beautification of Wellington's coastal areas, parks and road verges.

Ray has always had an interest in those native plants not commonly grown as ornamentals. He believes that many of these are of great value in the garden and are not used simply because they are not well known. To encourage their use he has grown many of them at Otari and written articles for the NZ gardener on such natives as *Alseuosmia, Senecio greyii, Metrosideros carminea, Carmichaelia spp., Muehlenbeckia astonii* and many more. He also delivered the 1984 Banks Memorial Lecture on the subject, in a talk entitled "A Survey of NZ Trees and Shrubs of Horticultural Value".

Ray has also had a long involvement with horticultural education and until this year was responsible for the training of apprentices at the Wellington City Council. He has marked Trade Certificate examination papers for over 10 years for the TCB and has also been an examiner for the RNZIH Oral and Practical exams.

Ray Mole's knowledge of New Zealand's native plants is world wide. In 1976 he was awarded the Associate of Honour of the Royal Horticultural Society in England in recognition of his work at Otari. This award is limited to 100 recipients at any one time. In 1980 Ray was awarded the Loder Cup for encouraging the use of native flora throughout NZ and particularly in Wellington. Ray Mole has made a significant contribution to Horticulture in New Zealand.

GARDEN HISTORY SECTION

Isel Park — a Woodland Garden

Bryan Douglas
836 Atawhai Drive, Atawhai, Nelson

Introduction

"Finest wood-lot in the Dominion" was used to describe a tree-covered area of 4.85 hectares (12 acres) in 1959. That year, for £14,000, an old river-stone and brick house and the almost impenetrable 4.85 hectares became the property "for the enjoyment of the residents of Nelson". Today, Isel Park stands proud on the list of New Zealand's better-known parks. The people of Nelson hold it in high regard; it is a great source of enjoyment to them and the thousands of annual visitors to Nelson. To understand the present-day Isel we must look at its past.

History of Isel

Thomas Marsden was born at Kensingham, Cumberland, England in 1810. He purchased sections of land from the "New Zealand Company" which was engaged in settling a new country; then he and his wife sailed to New Zealand on the "Prince of Wales" arriving at the infant town of Nelson in September 1842. They took up their land option, built a house on their town section, and started raising a family, one son and two daughters.

The New Zealand Company records show that section 50, Suburban South, was selected by Mr Robert Walkinshaw with the Order of Choice No. 46, but as he was an absentee owner, the Company awarded Section 50, together with Sections 45 and 47 to Thomas Marsden as his rural choice, making him the largest land owner in Nelson. In 1848, Marsden and his family settled on this rural property of 376.3 hectares. He, along with the other land purchasers, had to wait until 1852 to get their Crown Grants because of financial difficulties which had beset the New Zealand Company.

Marsden erected buildings and cleared and farmed the land. For three years he was a member of the Provincial Council of Nelson, and he was a loyal supporter of the Church of England to which he gave a section of land for the erection of a church. This beautiful church, — built with stone taken from the stream running through the Marsden property — still graces the entrance to what is now know as Isel Park.

In 1876, Mr and Mrs Marsden and an infant grandson were nearing a railway crossing at Jenkins Hill while en-route to Nelson by carriage when a passing train frightened the horse, and the carriage was upset, throwing all occupants onto the road. Thomas got up, apparently unharmed, then accompanied by Mrs Marsden, he carried his grandson towards Bishopdale. After walking about 400 metres, he asked a young lad standing near-by, to hold his grandson as he felt faint, where-upon, he collapsed and died. Thomas Marsden was sixty six years of age.

At the death of his father, James Wilfred Marsden took over the Stoke property. James, born in 1844, was one of the first scholars to attend the "Nelson College". During his life, he made two trips to England, periodic visits to Australia and other parts of New Zealand.

It is not known for certain when the name "Isel" was given to the Marsden property, but generally, it is believed that the name "Isel" was taken from an estate "Isel Hall", in the north of England. Neither Thomas, nor James appear to have had any association with Isel Hall, except, maybe as a visitor at some stage. The Cyclopedia of New Zealand, 1905, states: "Mr James Wilfred Marsden; Sheep Farmer, Isel, Stoke." Also, that: "Mr James Marsden has a property of 400 acres (161.88 hectares) with a frontage of 53 chains to Waimea Road, and is capable of grazing 2 sheep to the acre, namely, English Leicesters, Romney Marsh and Shropshire Downs, all pure bred. The Downs are the oldest stock in N.Z. and the originals were imported by Mr Sellor in 1862. The Leicesters are from a flock of Mr P. Thilkold, of Inglewood, Canterbury, and the Romney Marsh, from flocks of Mr Allen in the Wairarapa. In addition to his sheep, Mr Marsden grazed 50 head of cattle. The land is nearly all ploughable and fields splendid crops of barley, wheat and turnips. Mr Marsden's homestead is complete in every respect, and his outbuildings, stables and granary, sheep dip and yards are spacious and modern in style."

James Marsden married late in life and had no children. About 1880, under James' direction, the front of the original house was rebuilt in brick and stone; the stone taken from the stream (Poorman's stream) running through the property. Then, about 1905, a large new addition was built on the south-western corner. This was to house a valuable collection of chinaware, paintings and furniture that James and his sister Francis inherited from Joseph Charters Brown, of England.

In his younger days, James was considered a hard worker with a great interest in his trees; farming his property, and exhibiting his flock of stud sheep in the annual shows of the Nelson Agricultural Association of which he served a term as President in 1896. He was rather reclusive in his later life, but was remembered as a courtly old gentleman with two great loves: his trees and his extensive library. James was known to have a profound knowledge of New Zealand trees and birds, and an enclyclopaedic mind. During this time, the farm, except the homestead and front paddocks were leased with an agreement laid down that the land was to be kept clean, the fences and two windmills to be kept in good order and certain groups of trees were to be preserved.

Front entrance to Isel Park. The heavy-trunked tree framed by the gate posts is *Pinus radiata*; one of several that are probably the earliest planted in New Zealand.

The obituary to the death of James Wilfred Marsden was published in the Nelson Evening Mail, February 17 1926, and said: "His farm was conducted on sound and progressive line, and was a model of neatness. Situated among picturesque English and native trees, was the fine homestead, and the whole property could easily be taken for a part of delightful rural England." The obituary also goes on to say: "His interest in forestry, material evidence of which can be seen in the fine selection of trees surrounding his homestead, was shown in his desire that the land, among other things, should be used for the introduction and cultivation of useful and ornamental trees and shrubs; and his stipulation that the Manuka, Birch, and other ornamental trees on the property should not be interfered with as they added greatly to the beauty of the estate."

James left a substantial estate with many public bequests, the two main bequests concerning his property were: the residence and 52 acres (21 hectares) of land went to the Nelson Diocese with a stipulation that the trees around the estate be treated with solicitous care; also a considerable sum of money. Prior to James' death, it had been his intention to donate 65 acres (26.3 hectares) ". . . of very best land for experiment and research in agriculture and forestry . . ." to the Cawthron Institute. Due to the Government's attitude at the time, the donation was not taken up, but now, this land was bequeathed to the Cawthron Institute for its original purpose, and in addition, they received, James' valuable library of books and paintings.

On receiving their bequest, the Diocese Trust Board intended Isel as a permanent residence for the Bishop of Nelson, and to establish a Theological College there. The slump conditions of 1930 forced the Diocese Trust Board and the Cawthron Institute to have their bequests revoked and they sold their bequested properties.

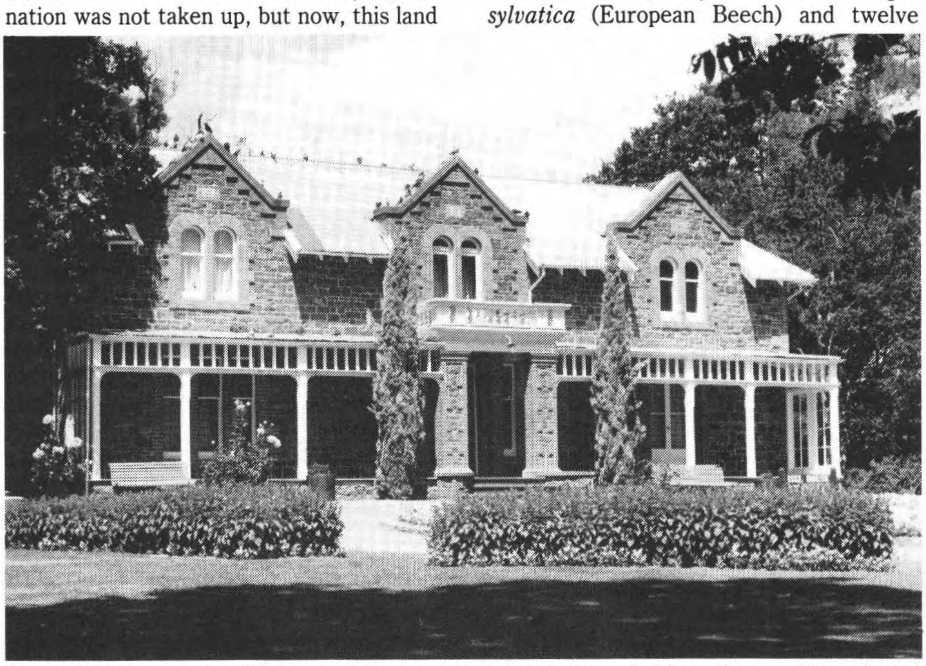
Mr Archibald Nicholls bought Isel house and 12 acres (4.85 hecatres) which included most of the trees. The house was maintained and some alterations were made to the grounds, but Archibald Nicholls' love of trees, prevented several attempts to fell the trees. During the war years 1939-1945, a camp was established among the trees of Isel for New Zealand military personnel serving at the nearby Nelson airfield. Only one tree was felled to allow space for development — nothing now remains of this camp.

In 1959, the Waimea County Council were negotiating with Mr Nicholls to purchase Isel, but Stoke was ceded-to, and brought within the boundaries of Nelson City; the City Council completed the negotiations and purchased Isel for fourteen thousands pounds. At that time, the 4.85 hectares, now extremely overgrown, and almost impenetrable was recognized as: "the finest woodlot in the Dominion". Under the administration of Mr Dennis Leigh, the then Superintendent of Parks and Reserves for the Nelson City Council, work started on transforming what was a wilderness into what we see today — probably the finest woodland garden in the country — and given the name "Isel Park"

The Origin of the Trees

Thomas Marsden planted his first trees at Isel in 1845; they were: three *Fagus sylvatica* (European Beech) and twelve *Quercus robur (syn. Q. pedunculata)*. The next plantings were in 1848 when he moved to Isel, then in 1850 (200 trees), 1856 and 1865.

Thomas, then James were good farmers, and both had a love for trees. Parts of the property were swampy and marginal for farming. These marginal farming areas were mainly on the south-side of the homestead, which was also the direction of the prevailing southerly winds. This is the side where most of the trees were planted.



Front of Isel House today. The tree just showing at the left of the house is *Magnolia grandiflora*; planted c1865. Now a well-shaped specimen. The two upright conifers on each side of the front door are more recent plantings. The down stairs rooms at the front of the house are administered by the Nelson Provincial Museum and contain china and furniture from the Marsden estate. The upstairs rooms are used by the resident caretaker.

Stories are told of ship's captains being commissioned to bring exotic plants from the lands they visited. No factual records can be found to substantiate this claim that the trees in Isel were acquired this way. An article in the Nelson Evening Mail, 15 March 1966, stated that: William Songer, (The suburb of Stoke was named by Songer) a former gardener at a vicarage in southern England, came to the new colony as a personal servant to Captain Arthur Wakefield, and that he had carried seeds from Tendering Park, the ancestral home of Sir Charles Rawley. Thereafter, the vicar's wife continued to send out seeds to William Songer, including seeds from the Crystal Palace Exhibition in 1851. It is believed that trees from those seeds grow in Isel today.

What we do know, is that the earliest settlers brought with them a great variety of plants, mainly as seeds, to supply their necessities of survival, as well as plants to remind them of home. Ruth Allen, in her book 'Nelson: A history of Early Settlement' vividly describes and lists the wide variety of grains and vegetables that were on show at the first Nelson Anniversary in February 1843.

Neil McVicar arrived in Nelson in 1844 and by 1850 was selling a wide range of fruit trees, specimen and forest trees, shrubs and roses. *Eucalyptus globulus* (Blue Gum) was first offered for sale in 1845. In 1848, William Hale landed at Nelson fully equipped to start business as a nurseryman, and by 1850, he was offering a wide range of vegetables, fruit trees and bulbs, including "Liliums, newly imported from France". William Hale's catalogue of 1853 was advertising 10,000 fruit and forest trees. This was the year that he introduced Monkey Puzzle seed; *Araucaria imbricata* as it was then known. He sold his business, returned to England for a holiday, then came back to start a new nursery. By 1865, he was offering herbaceous perennials, roses, forest and specimen trees and a vast range of fruit trees. William Hale's brother John, in 1880, was importing new types of trees and plants from France, Holland, Japan and Tasmania. Exporting plants, especially native plants, was carried out by those early nurserymen, and not just from Nelson. There were many other nurserymen engaged in the same business around the country.

No records exist to say where Thomas or James Marsden acquired their trees, but as many of the trees in Isel, were listed by those early nurserymen, it would appear that most, if not all came from that source.

Isel's Trees Today

Why were Isel's trees described in 1959 as "The Finest Woodlot in the Dominion"?

In 1926, the obituary to James Marsden described a "Picturesque English" scene: an estate with well-cropped land and pasture and well endowed with stately trees. By 1959, all (except one very large *Cupressus macrocarpa* still growing on the frontage of St. Barnabas' Church) of the Marsden-planted trees outside the present boundaries of Isel had disappeared. The trees that remained around Isel House, had by virtue of their early planting dates, made them some of the oldest or largest trees of their kind growing in New Zealand. Also, there was no known area in New Zealand, which supported such a concentration of different species in these categories.

During 1963, the New Zealand Forest Service conducted a survey of Isel and plotted the locations of 201 trees. Several of the oldest trees were not recorded on the plan which still exists. Unfortunately the lists of details accompanying the plan can not be found.

St. Barnabas Church at entrance to Isel Park. The head stones are:
White cross at left is the grave of James Wilfred Marsden, died February 17, 1926; and his wife Mary Rose Marsden died April 11, 1930.
Black obelisk is the grave of Francis Charters Marsden, sister to James. She died March 12, 1918.
Grey cross at centre is the grave of Thomas Marsden, died December 21, 1876.

The Forest Research Institute, Mensuration Report No. 21, 1974 (Unpublished), of Historic and Notable Trees of New Zealand, by Mr S. W. Burstall, deals with Marlborough, Nelson and Westland. This report lists the major trees with their Dbh (Diameter at breast height) and their height in three categories. These are:

Exotic Historic Trees of Local Interest
Notable Exotic Trees of National Interest
Notable Exotic Trees of Local Interest

Trees growing in Isel and recorded in the Mensuration report are listed below. Imperial measurements have been converted to metric. Measurements were carried out in 1969 unless otherwise stated.

Exotic Historic Trees of Local Interest

Sequoiadendron giganteum (Californian Big Tree). Dbh. 193cm, hght. 38.4m, c1856. An open-grown tree. This is one of the earliest known plantings.

Notable Exotic Trees of National Interest

Carpinus betulus (Common Hornbeam). Dbh. 86.4cm, hght. 20.1m, c1850. The largest of three. This is the largest of this species known in New Zealand.

Ilex aquifolium (Common Holly). Diameter at 30.5cm, 76.2cm, hght. 13.7m, spread 9.1m in 1967, c1850.

Liriodendron tulipifera (Tulip Tree). Dbh. 134.6cm, hght. 33.5m, c1850. A splendid tree. The tallest recorded in New Zealand.

Picea sitchensis (Sitka Spruce). Dbh. 132cm, hght. 43.9m, c1850. The tallest of this species known in New Zealand.

Pinus canariensis (Canary Island Pine). Dbh. 91.4cm, hght. 42.7m, c1850. One of the best looking of this species in New Zealand.

Pinus nigra cv. *maritima* (Corsican Pine). Dbh. 114.3cm, hght. 37.5m, c1850. Considered one of the most outstanding exotics in New Zealand.

Pinus palustris (Pitch Pine). Dbh. 83.8cm, hght. 36.6m c1850. The largest of this species known in New Zealand.

Pinus radiata (Radiata Pine). Dbh. 185.4cm, hght. 47.5m c1850. Along with other Radiatas in Isel, these could have been the first planted in New Zealand.

Sequoiadendron giganteum (Californian Big Tree). Dbh. 116.8cm, hght. 48.5m, c1856. An excellent forest-grown tree with the first branches at about 34.4m.

Notable Exotic Trees of Local Interest

Acacia melanoxylon (Blackwood). Dbh. 12.2cm, hght. 16.5m, c1850.

Cupressus macrocarpa (Monterey Cypress). Dbh. 162.6cm, hght 28m in 1973, c1850.

Fagus sylvatica (Common Beech). Dbh.78.7cm, hght. 20.7m, c1845.

Morus nigra (Black Mulberry). Dbh. 56cm, hght. 9.1m, c1850.

Pinus pinaster (Maritime Pine). Dbh. 101.6cm, hght. 32m, c1856.

Pinus jeffreyi (Jeffreyi's Pine). Dbh. 78.7cm, hght. not recorded. c1865.

Pinus torreyana (Solidad Pine). Dbh. 119.3cm, hght. 34m, c1850.

Populus deltoides (Cottonwood). Dbh. 155cm, hght. 36.6m, c1850.

Populus nigra cv. italica (Lombardy Poplar). Dbh. 160cm, hght. 35.4m in 1963, c1850.

Pseudotsuga menziesii syn. Ps. taxifolia. (Oregon Fir). Dbh. 122cm, hght. 46.3m, c1850.

Quercus coccinea (Scarlet Oak). Dbh. 66cm, hght. 15.2m, spread 18.3m, c1850.

Quercus robur (Common Oak). Dbh. 112cm, hght. 21.3m. The largest of twelve planted c1842.

Quercus borealis maxima (Red Oak). Dbh. 61cm, hght. 16.5m, spread 15.2m, c1850.

Mr D. H. Leigh, Superintendent for Nelson's parks and a Mr W. H. Jolliffe were co-authors of a "A Working List of Historic Trees of the Nelson Province", and both assisted Mr Burstall when he compiled the Forest Mensuration Report. The information in both reports was very similar, but four trees were listed as "Notable" in the Working List but did not appear in the Mensuration Report. These were:

Araucaria bidwillii (Bunya-Bunya). Dbh. 102cm, hght. 26m, c1850.

Cedrus atlantica 'Glauca' (Atlas Cedar). Dbh. 89cm in 1959 (No height recorded). c1850.

Pinus wallichiana (Bhutan Pine). Dbh. 76.2cm in 1969 (No height recorded). c1850.

Sequoia sempervirens (Californian Redwood). Dbh. 114.3cm in 1962 (No height recorded). c1850.

The Working List refers to one hundred and eleven additional trees, all planted between 1845 and 1865 which have now reached noble and majestic proportions. They cover a wide range of species.

Disaster

Cyclone Alison struck the Nelson Province in March 1975. For thirty six hours, "Winds of the Century" tore Isel (and other properties) apart. Afterwards, it was impossible to walk through most of Isel as the litter of trees and branches lay some 3.5 metres deep. Fourteen trees completely uprooted; six trees snapped-off at ground level ninety two trees moderately to seriously damaged, some snapped-off between three to 27 metres up. A total of one hundred and eleven trees were affected — about one third of the total number in Isel. Thirty four trees were damaged beyond help; they had to be felled.

Isel Park's historic and arboreal qualities were seriously affected. The final tally of damage to trees on the "Notable and Historic" list was: one tree (*Araucaria bidwillii*, c1850) blown down, one tree (*Pinus wallichiana*, c1850. The only specimen of this type in the park) had to be felled, six trees were seriously damaged but saved, and one tree was moderately damaged. As for the trees recorded as "notable" or "historic" in the "Working List", three were destroyed.

One week after Cyclone Alison, another storm raged to cause considerable damage to Nelson, but Isel only sacrificed one tree (*Betula pendula*, c1856) this time. There was a profound effect on Isel. Not only the trees suffered, but the under-plantings of azalea, rhododendron, camellia and many other specimens were totally destroyed in places. Today, Isel is still recovering.

Isel Park Today

Although no one welcomed the storm damage to Isel Park, nature opened up new challenges, and gave the opportunity for adding to the park's unique historical and arboreal qualities. A policy was set to replace Isel's losses with trees and shrubs which are rare, or exhibit unusual qualities, or are of high horticultural merit. Isel was already established with colourful spring displays, now this would be reinforced by the careful introduction of new interests. One of the largest collections of rhododendrons — enhanced by tropical species — is now growing in the park. There is a fine collection of cacti, and additional interest for visitors is created with the Nelson Provincial Museum being established there.

Today, Isel Park stands as a living monument to those early settlers who had foresight and a love for trees and to the staff of the Nelson City Council Parks and Recreation Department who have, since 1959, nurtured Isel to the extent that it can still proudly claim title to: "The Finest Woodlot in the Dominion", and can lay claim to the title: "Isel — one of the most outstanding woodland gardens in New Zealand".

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Early Importations of *Pinus Radiata* to New Zealand and Distribution in Canterbury to 1885: Implications for the Genetic Makeup of *Pinus Radiata* Stocks. Part I

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Note nomenclature. Although early records often refer to *Pinus insignis* this paper uses *"Pinus radiata"* or "radiata pine" throughout. Archaic, manifestly incorrect or misspelled names of other species are reproduced in quotation marks.

Introduction

Pinus radiata D. Don shows great variability between individual trees. This genetic variation as scientists have shown, gives the species the potential for genetic improvement through selective breeding[1]. This has been achieved in New Zealand, where naturalised stocks have formed the base of an elaborate and scientifically based selection programme. While intensive breeding began around 1950, the story of genetic improvement in New Zealand begins with the introduction of the species. This introduction was almost certainly completed by 1885, since when no significant radiata plantings are known to have come from imported seed. In the meantime there have certainly been some genetic shifts, independent of the breeding programme.

Even though the breeding programme is well advanced, a knowledge of the genetic history of the species in N.Z. would be valuable background information for tree breeders, apart from being of considerable scientific interest.

To understand the genetic history of our present New Zealand radiata stocks, it is necessary, to re-extend and re-evaluate our knowledge of plantings that may have contributed to this make-up, the origins of seed for these plantings, the relative size of the seed lots and their subsequent distribution on arrival. Only with such knowledge can the genetic changes since introduction be clearly identified and properly understood.

An historical evaluation is particularly appropriate with the Millwood Press release of the book "The Botanic Garden Wellington" which shows that there was a major Government importation and distribution of conifer seed from the Geological Survey (GS seed) for the years 1870-1885[2]. During this 15-year period, some 56lbs of radiata seed was distributed, a factor unknown (albeit suspected) in forestry circles. It seems as if this GS seed, with its wide distribution, could have had a major bearing on the genetic base of commerical *P. radiata* used in this country today. This paper, therefore, pays further attention to this seed and distribution, particularly in Canterbury.

The paper takes a cursory look at provincial areas such as Nelson, Manawatu and Matamata which have made some contribution to commercial radiata stocks, but in other provinces GS seed distribution has not yet been investigated.

Nor have some pieces of relevant legislation been duly studied. M. Roche, for instance, states that a detailed examination of the effects of the 1871 Forest Trees Planting Encouragement Act has yet to be made[3]. Some of the GS seed distribution may well be linked to this Act. And in Auckland, the provincial 1874 Highways Act, which operated instead of the Forest Trees Planting Encouragement Act, may be linked to the secondary distribution of GS Seed from the Auckland Domain Board, (Acclimatisation Society) the provincial centre for GS seed. Old radiata trees on Devonport's Mt Victoria and on Mt Eden, for example, are the result of a provincial grant in 1875 to the Devonport and Mt Eden Highways Boards[4]. One Board, the Grafton Highway Board, according to the N.Z. Herald 3 June 1875, bought trees from the Auckland Domain Board.

In 1876 seven Highways Boards received provincial grants — North Shore, Devonport, Parawai, Onehunga (Greenhill Reserve of Jellicoe Park) (Fig 1), Managapiko near Te Awamutu, and Ngaruawahia where today several old conifers can be seen in their domain. With the abolition of the provinces in 1876, central Government's 1871 Forest Trees Planting Encouragement Act and its amendments operating in Canterbury, Nelson and Otago now applied to the Auckland province and elsewhere in N.Z.

Fig. 1. Radiata on One Tree Hill Auckland c. 1905. At least 3 *P. radiata* were planted on the summit of the Hill in 1873-74 just prior to Devonport's Mt Victoria and Mt Eden being planted. Only one tree remains today, an excellent example of the species ability to survive for 115 years under considerable exposure. It would be interesting to know the source of these trees.

The GS Seed — Summary

Government introduced 48 species of conifer seed during the years 1870/1885[5]. There was as yet no State Forest Service, so the seed came to Dr James Hector, Director of the New Zealand Geological Survey. Hector was also Director of the Colonial Museum and Manager of the Wellington Botanic Garden and he used his pervasive influence to distribute the seed. It went throughout New Zealand, recipients being members of both Houses of Parliament, Acclimatisation societies, Domains, Botanic Gardens, Schools, cemeteries, runholders (often members of Parliament), some nurserymen, and even settlers, in reply to advertisements. This distribution went even further and there were secondary distributions from agencies such as Acclimatisation Societies, Domains etc. In Canterbury, for example, a large number of Domain Board plants which were distributed were raised from GS seed sent from Wellington.

The 1873 Annual Report of the Botanic Garden Board said "That from the success of raising imported conifer seed in the Wellington Botanic Garden 100,000 trees must have been dispersed in the Colony"[6]. In 1883/84 The Annual Report said "a vast amount of progress is quietly being made in stocking the Colony with forest trees"[7]. Of the 48 species introduced for this period two were particularly successful — radiata and macrocarpa (*Cupressus macrocarpa*). From the 56lbs of radiata seed introduced and distributed the yield for this 15-year period would be, if we use F.R.I. estimates of 20,000 radiata seedlings/kg, around 500,000 seedlings[8]. Photographs and postcards dated around 1902-1910 demonstrate the success of conifer introductions, particularly radiata, for the period 1870/1885 and the landscape change they brought to New Zealand. (Fig 2).

An appreciation of the qualities and value of radiata and its effect on the landscape, as well as its value for providing timber and shelter, was slow in coming. In 1884 Thomas Kirk, appointed the first Conservator of Forests and a member of the Wellington Botanic Garden Board, must have been aware of the success of radiata in the Wellington Botanic Garden which by this time was harvesting and distributing some bushels of seed off 14 year old trees, yet he did not press for its use. In 1885 John Buchanan, also closely connected with the Garden, was disparaging in his remarks on possible use of radiata[9], an attitude which seems to have prevailed among foresters for the next twenty years.

By 1896, when Prime Minister Seddon called the Timber Conference, radiata and macrocarpa, much of which was attributable to GS distribution, had already made a huge impact on the New Zealand landscape although little had been done to encourage public afforestation. Some milling was now taking place[10].

Fig. 2. A fine example c.1902 of New Zealand's landscape change dating from the 1870s and the successful introduction of radiata pine.

Seed Production — the age of trees coning

The local availability of seed and the phasing out of seed importations is extremely relevant to radiata distribution. When nursery stock was expensive this could rule out the ready local availability of seed. The converse, however, need not be true as cheap nursery stock would not prove local availability of seed. English catalogue prices for radiata in 1875 range from 6/- per dozen, for 9" - 12" plants to 2/6 to 3/6 each for 4' - 5' high plants[11]. These prices are relatively high in relation to N.Z. catalogue prices for the same time. Does this indicate that English-produced seed was not readily available in quantity?

Ten years is accepted as an average for radiata coning. This accords with how Wellington Botanic Garden was by 1884 harvesting and distributing some bushels of seed from 10-14 year old trees[12]. However, the age of onset of worthwhile cone production can vary a lot according to site and to provenance — in the latter connection the Monterey provenance seems to produce cones rather later on, and the very earliest collections seem to have been from Monterey rather than Año Nuevo. Some young Monterey trees can be relatively shy seeders (12a).

Radiata is introduced to cultivation — England, Australia and New Zealand

It appears that radiata first came into successful cultivation when, in 1833, seeds and specimens, collected by the Scottish explorer David Douglas, a gardener employed by the Horticultural Society of London, were sent to England. They were grown in the society's garden at Chiswick and by 1838 were 3'-5' tall. Kensington nurseryman Richard Forest, that same year, had trees for sale 21s to 100s each. By 1847, to overcome the high price being charged for plants, gardeners were urged to graft slips of it on to the Scots pine[13]. This was one of the beginnings of a 19th-century worldwide interest in conifers which became manifest in most of the public gardens in newly-established British colonies and which can still be seen today. Hooker remarked in the 1869 Kew Bulletin "It is a curious fact that the rage for introducing coniferous trees into English parks and gardens has almost extinguished the culture of all but a few deciduous trees".

During 1850-51 a further direct importation of radiata to England came from collector William Lobb who sent back cones and seeds from Monterey to his employer James Veitch at Exeter in Devon[14]. Further conifer cones and seeds (unspecified) were sent from California in 1854-57, while large quantities of Wellingtonia seed were sent in 1853. Lobb continued to stay in California after his contract with his employer expired in 1857. Despatch of plants, similar to the 1858 Kew consignment continued to reach England from time to time until Lobb's death in San Francisco in 1863[15a].

Sir Thomas Acland at Killerton in Devon benefited from these expeditions because Killerton, originally laid out by James Veitch's father, with its lime-free soil and sheltered position, made an ideal trial-ground for most of the new discoveries. The first *'Wellingtonia'* in England reputedly planted at Killerton in 1854[15b] were from two living plants brought back by Lobb in 1853 but these failed to survive.

Significantly for New Zealand, in 1859, and again in 1863, it was from James Veitch that J.B.A. Acland of Mt Peel, in Canterbury acquired and sowed seed of radiata[16]. From the same source, in 1862, by way of a Wardian Case Acland received a specimen of *'Wellingtonia'*[17]. Acland did, however, order some plants from Australia and these too may have come in Wardian cases. A three-year-old "insignis plant", reputedly bought from Shepherd and Co. Darling Nursery in 1859 had, by 1970, reached a height of 50.1m[18]. It is still extant. In 1865 Acland imported 10 species of conifer seed from Veitch and 25 conifer plants from Shepherd and Co. Next year three-year-old radiata plants were imported from Camden Nursery in N.S.W.[19] — these would have cost 5/- each[20]. Conifers, particularly radiata, were succeeding at Mt Peel.

If 10 years is allowed for radiata to cone the earliest that seed distribution from these two introductions of radiata to England might be expected, is 1843 for London and about 1862 and 1866 for Veitch. It is unlikely, therefore, that Ackland's seed received from Veitch in 1859 was harvested in Devon. More likely it was from a later consignment sent by Lobb to Veitch. The same would apply to the 1863 seed sent to Acland.

Australia

Until now, early introductions of American conifers to Australia would seem to have come from England rather than direct from California. Bannister[21] found no evidence for early radiata imports direct from California to Australia. In 1853 the newly appointed Victorian Government botanist Baron von Mueller was collecting Australian plant material for the herbarium at Kew[22].

Through his correspondence with William Hooker at Kew a close relationship developed between the two men. In 1857 Mueller was appointed Director of the Melbourne Botanic Garden. The Annual report for that year, states that "A Pinetum will be reared". Kew would have contributed to the extensive pinetum Mueller established in the garden. Unfortunately the Melbourne Garden archives were destroyed and Kew, while recording that packets of seeds were sent to many developing botanic gardens, did not identify the species. In 1859, two years after his appointment as Director of the Melbourne garden, Mueller, according to Bannister,[23] distributed radiata "most extensively" in Victoria and other parts of the continent. If this seed came from England it ties in closely with J.B.A. Acland's receipt of seed from Veitch in Exeter. J.G. Veitch visited the Melbourne Garden in 1866 so Veitch's nursery in Exeter, and its branch in London together with Kew, appear to have played a significant role in the distribution of radiata to Australasia.

Hobart's Royal Botanic Garden does not list radiata in 1855 but it records it there for 1857 along with 26 other pines[24]. Their archives record a Wardian-case introduction of pine species from England about this time. Eight years later in 1865 their radiata coned and seeds were sent to the Melbourne Botanic Garden[25].

Although Bannister knew of no direct link with California for conifer introductions, it is now known that in 1851 a Mr de Murrant of California sent seeds of pines (unspecified) to Charles Moore, Director of the Sydney Botanic Garden[26].

Feilding (1957)[27] investigated (in some detail) the introduction of radiata to Australia. He gives the earliest recording as 1857 when the Director of the National Herbarium, Sydney, received one radiata per the ship "Duncan Dunbar". This ship sailed from Plymouth and London and arrived at Sydney 13 December, 1857*. Feilding goes on to suggest that the shipment may have included one or more radiata plants for the Melbourne Botanic Garden since it is listed there for 1858. Coincidentally, 1857 appears to be when the Hobart Botanical Garden received their plant(s). These are all records of plants from England. Two years later, in 1859, Mueller distributed the species most extensively in Victoria, which presupposes that he was distributing seed or plants raised from seed received about 1857. No evidence has been found concerning a seed source. Mueller, according to Feilding, is credited with introducing radiata to South Australia, but the earliest confirmed date for its introduction there is 1866. That year an avenue of radiata was planted in the Adelaide Botanic Garden[28] soon after Mueller's 1865 Annual Report recommending radiata for avenue planting. By 1878 these had attained a height of 50 feet. The 1867 Annual Report for the Adelaide Botanic Garden, while not naming radiata, advocates the use of Californian pines for parks and approaches to the city instead of gums[29]. For such a recommendation to be made it seems likely that South Australia received radiata before 1866 and that Mueller's 1859 distribution in Victoria extended to South Australia. J.B.A. Acland's three-year-old radiata imported from Shepherd & Co. N.S.W., would have been raised from 1856 radiata seed and thus appear at present to be the earliest record of insignis seed in Australia. The source of Shepherd's seed is unknown but exchanges of plants with the Melbourne Garden were frequent. Kew and Veitch are likely English sources but a direct importation of Californian conifer seed to Mueller and Australian nurserymen for 1856 may yet be found, for by this time some trade was established between Australia and America. "American Bacon" was sold by nurseryman Lang when he first arrived in Ballarat in 1856 and traded in general stores[30]. In 1862 Mueller did receive Californian pine seed from San Francisco nurseryman C. Walker[31], while Shepherd and Co. were also in receipt of direct imports of seed[31a]. The Kew Bulletin in 1868 mentions that a Dr Walker supplied them with unspecified plant material.

It is possible that Mueller received packages of seed earlier than 1862. During the 1860s "some 36,000 conifer seedlings (mostly cypresses, pines, araucarias and *Sequoiadendron giganteum* (*Wellingtonia*) were propagated in the Gardens and distributed around the State"[32].

If the Hobart Botanic Garden first coned radiata in 1865 then we could expect radiata trees in Victoria and New South Wales to be doing the same. An 1866 Camden Nursery catalogue gives a cost of 5/- per plant. Lower prices in an 1868 catalogue would tend to confirm that locally produced seed like the Hobart seed was by now becoming available although equally it could suggest receipt of a quantity of seed from California.

Old radiata resembling those planted in N.Z. for the period 1870-1885 can be seen in the Hobart Botanic Garden and the Launceston region of Tasmania (Figs 3 and 4). However, at Entally House, a National Trust Property near Launceston, a Californian redwood said to date from the 1820s[33] and radiata from the 1840s[34] do not reconcile with present understandings of the distribution for these two species and should be re-examined.

New Zealand

During the late 1850s and early 1860s Sir George Grey was a regular recipient of plants and seed (which included pines) from William Hooker[35]. With a large collection of conifers established by 1862, Grey presumably received his radiata from this source. Burdon, on a recent but purely visual examination of radiata at Mansion House, Kawau Island has said Grey's radiata appear to be straight Monterey. In origin this would accord with a London source for early trees. In 1863, Auckland nurseryman David Hay advertised radiata 2'-4' at 3/6d. An earlier undated Hay catalogue lists radiata 3'-4' at 7/6d each. Challenger reservedly dated this catalogue as 1860[36], but 1862 is possibly more accurate since an 1860 Hay's advertisement in Chapman's Almanac lists only pines of European origin[37]. Hay's "Priced Catalogues" advertised in Chapman's monthly, Volume 1 (August 1862), may be referring to this catalogue and since it shows a significant increase of conifers over Hay's earliest list in the 1860 Chapman Almanac, 1862(?) is the date accepted in this article. It remains a mystery as to where David Hay acquired seed to enable him to advertise 3'-4' plants at 7/6d each in 1862(?) and 2'-4' plants at 3/6d in 1863. Hay, although born in Scotland, was married at St Giles-in-the-Field, Middlesex in 1840. He was then 25 years of age. A few years later he moved to Gloucestershire before emigrating to New Zealand in 1855. His profession at the time of his marriage is not known but if he was a gardener or attached to a nursery near London then he may well have known John Veitch, also of Scottish descent, who, in 1832, established the London branch of his father's Exeter firm. He may have heard of the success of the Douglas-introduced radiata seed at Chiswick. No evidence has been found to link David Hay with America before his emigration, so it seems likely that it was from England that he first obtained his conifer seed. The firm's connection with America came later, especially in the mid 1880s with the importation of the Burbank plum from the Burbank nursery in Santa Rosa. Descendants of David Hay have failed to shed further light on the subject. When in 1874 Hay collected radiata cones[38], Hector was releasing large quantities of Californian seed and plants from Wellington. Sir George Grey's presumed acquisition of radiata in 1860/61 followed closely upon Acland's in 1859[39].

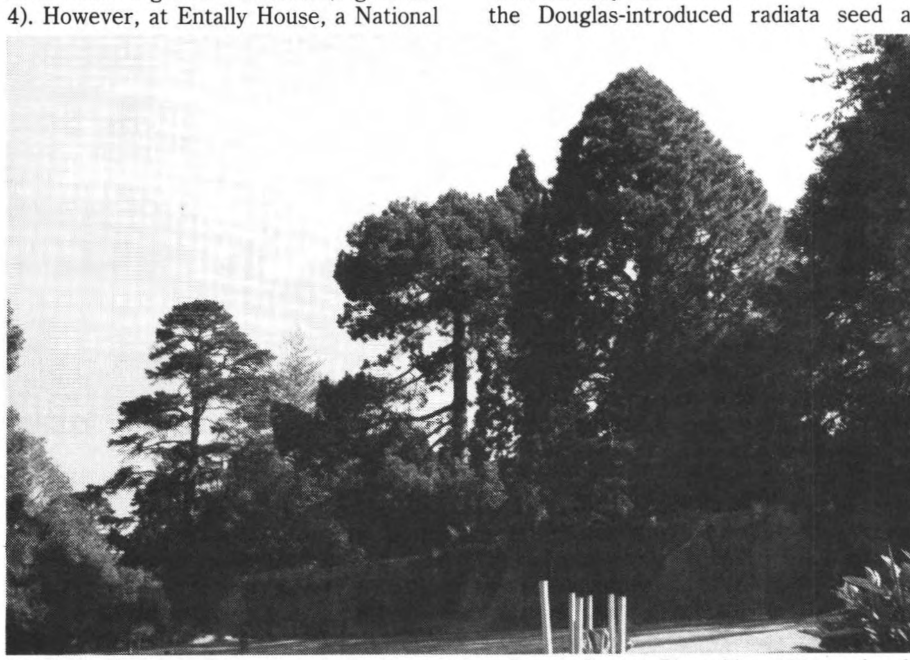


Fig. 3. Conifers, including radiata, in the Royal Hobart Botanic Garden. Planted late 1850s and early 1860s.
R. W. Shepherd 1986

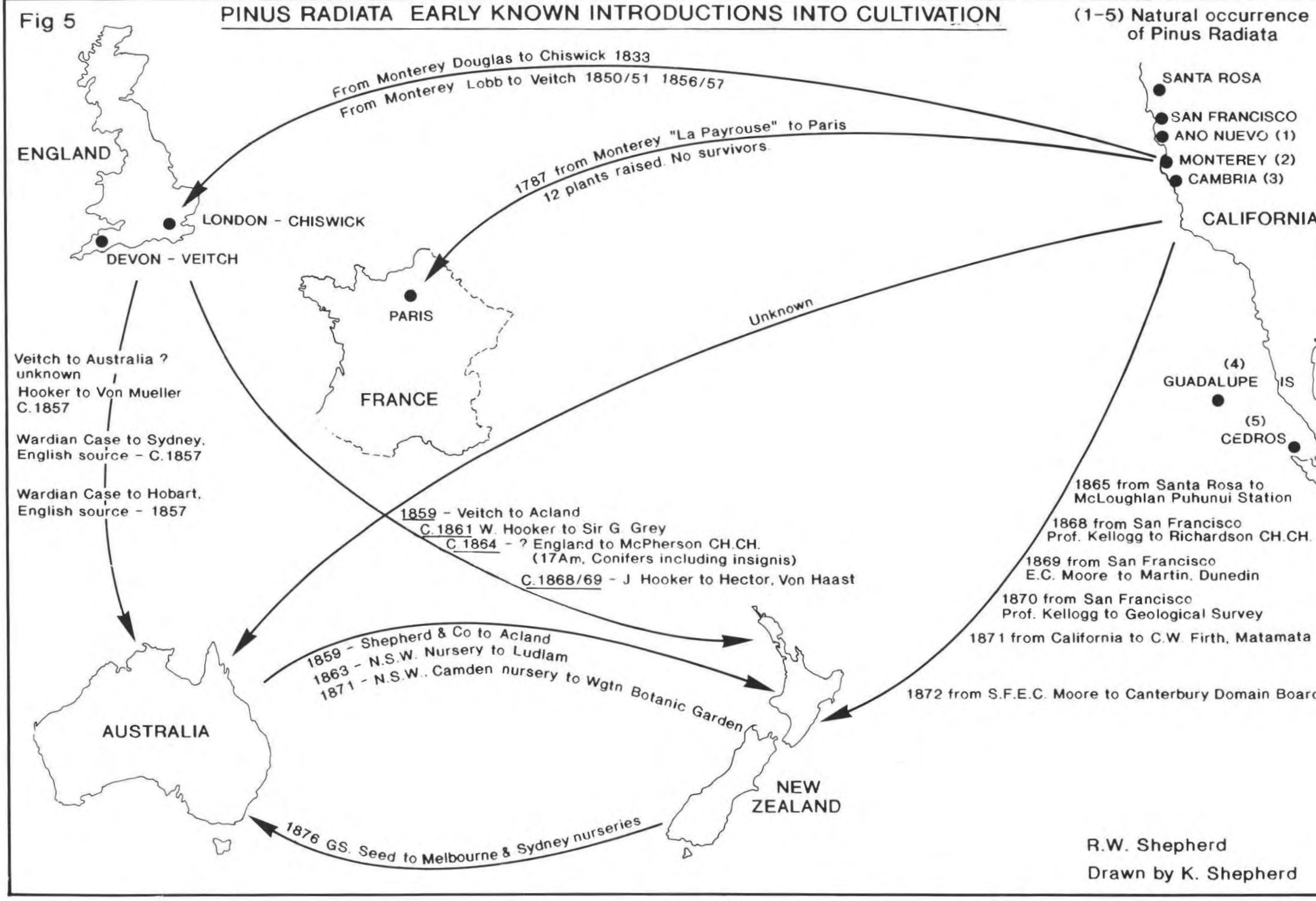
*While studying the Sydney Botanic Garden archives in October 1989 the author noted an earlier record via 1 insignis plant from Kew, 1 insignis plant received from Veitch in 1854. Two plants were received from Honolulu in 1860, while seed was received from Veitch in 1862.

Andrew Sinclair, appointed New Zealand Colonial Secretary in 1845, may, according to researcher John Adam, hold the clue to the source of Hay's seed. Adam suggests that Sinclair while studying medicine in Paris may have first seen radiata trees raised from a cone collected in the neighbourhood of "Monte-Rey" and sent in 1787[40] by a gardener named Colladen of the "La Payrouse" to the Museum of Natural History in Paris. According to Burstall, however, only 12 plants were raised and all failed to survive[41]. In 1837, Sinclair collected *Pinus Sinclairii* now considered a synonym of *P. radiata* at "Tepic" (sic) in California[42]. Adam's theory re Sinclair's possible involvement with radiata introduction to N.Z. and with Hay is, at present, conjectural, particularly as Hay's arrival in Auckland in 1855 coincided with Andrew Sinclair's retirement and travel abroad for a period. Sinclair did return to New Zealand in 1858, ostensibly to gather more material for Joseph Hooker's forthcoming Handbook of New Zealand Flora. If, before his return to N.Z., William Hooker discussed with Sinclair the recent defection of William Lobb with his employer Veitch, then it is possible that a direct Californian link for nurseryman Hay came about at this time. Another possibility is that Hay's ship on route to New Zealand in 1855 called at Sydney where nurserymen from N.S.W. may have provided an American contact address. Hay may even have used Australian nurseries for the initial stocking of his own nursery in Auckland. Nairn's 1932 Banks lecture confirms that the firm imported largely from California, and from leading firms in Britain and Australia. One N.S.W. firm, Shepherd and Baptist, (Shepherd & Co) advertised in the N.Z. paper, The Southern Cross in the 1860's.

Fig. 4. Mature radiata outside Launceston, Tasmania, closely resembling New Zealand trees planted in the 1870s. R. W. Shepherd 1986

In Christchurch in 1862, H. J. Tancred and Mr Edward Reece, both of Windmill Road, had radiata[43], while in Wellington both Ludlam and Mason had established it by 1865. Potts in Canterbury, although known for his conifer plantings, did not establish it until 1866[44]. Sources of these specimen trees may well have been from the Australian nurseries, Shepherd & Co, Camden of N.S.W. or Lang & Co. in Victoria, although English sources cannot be discounted. The Gardener's Chronicle, 1 July 1865, carried an interesting account "Gardening in Canterbury, New Zealand". Written by Walter Tipler it lists seventeen American conifers including "insignis" which his employer MacPherson, of 'Hawthornden' Christchurch imported at great expense from England. A recording for an 1877 Canterbury milling of radiata from twenty-seven year old trees[45] is decidedly suspect particularly when Swale in 1858 wrote that the only pines he saw there were *Pinus pinaster*[46]. Campbell-Walker (1877) refers to inspecting 10-15 year exotic plantings in Canterbury, i.e. 1962 and 1867 plantings. Only the latter could have contained appreciable radiata. After

Fig 5 PINUS RADIATA EARLY KNOWN INTRODUCTIONS INTO CULTIVATION



1865, however, it became common knowledge that conifer seed could be readily obtainable from Californian nurserymen.[47]. Between 1865-67 Robert Rhodes of Christchurch introduced, according to Barnett, "12 varieties of conifers" from San Francisco.[48].

An important early Auckland planting occured at Puhunui Station near Papatoetoe, the radiata seed (thought to be

Of the Canterbury nurserymen, the firm Duncan and Son were known to Professor Kellogg[53]. Presumably Kellogg, or some contact of his, was their source of radiata seed. Until 1867 Duncan and Son operated as seedsmen only, but with the purchase of 5½ acres of land off Ferry Rd they then commenced nursery production. Their first catalogue, of 1870, advertises "80 varieties and species of conifers". It would appear

Californian nurseryman E. C. Moore, supplier to Dunedin nurseryman W. Martin with Otago's first Californian conifer seed.

Coning, even from Acland's 1859 seed or plants from Shepherd & Co. would not have occurred much before 1870, so imported seed would seem, up until this time, to be the most likely source for all the foregoing. American sources therefore identified to date are "Santa Rosa", and from San Fran-

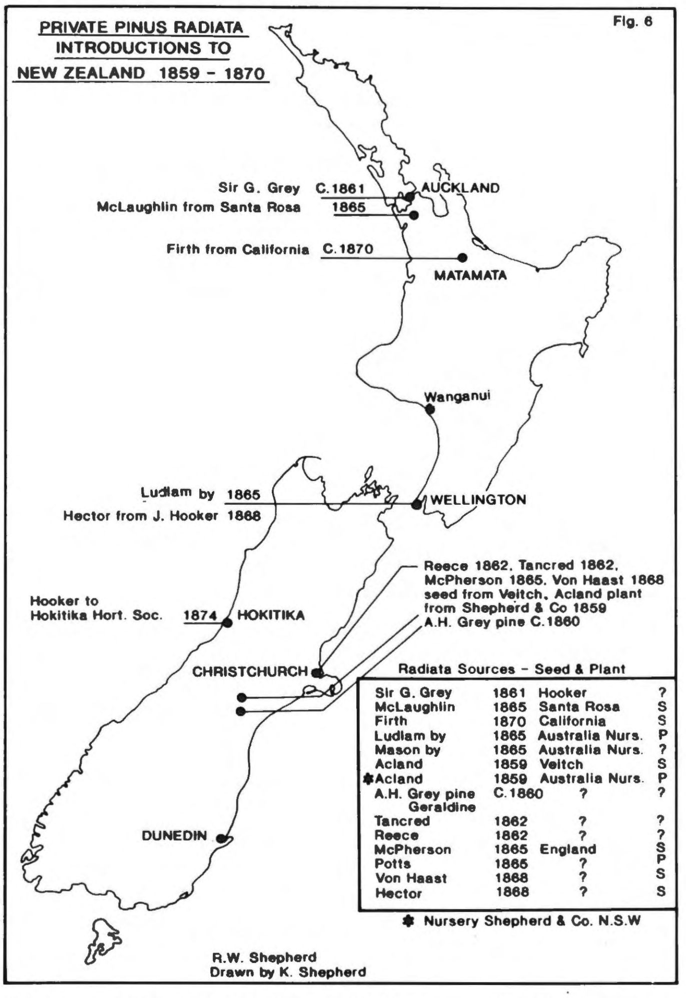


Fig. 6

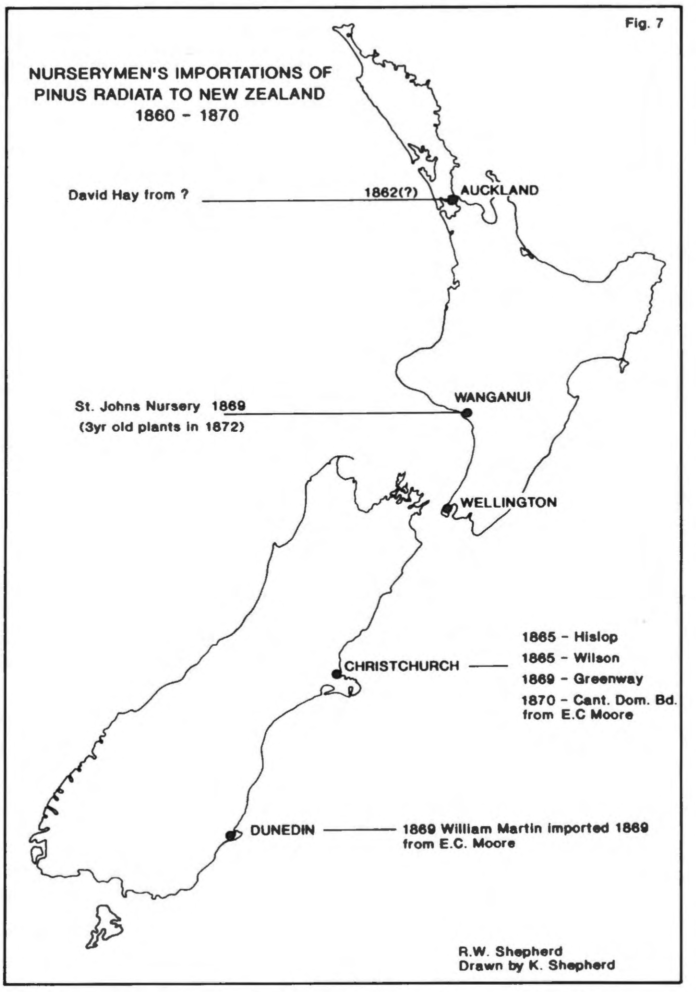


Fig. 7

½lb approx) being imported from the Santa Rosa area in 1865[49]. Significantly, Luther Burbank, the nurseryman who later supplied Hay with the "Burbank" plum operated from Santa Rosa. In 1959 Bannister believed Burbank had earlier acquired the seed of radiata from Monterey. With 1865 Puhunui radiata seed coming from Burbank and by allowing a minimum of 10 years for coning, Burbank's trees must have been planted by or before 1855. C. W. Firth 1874 gave a detailed description of a Matamata planting of conifer seed (quantity unknown) presumably obtained from America in 1869/70[50]. A similar date applies to Wanganui's St John's nursery which advertised 3-year-old plants in 1872[51]. In 1868 Edward Richardson, resident of Christchurch and owner of Albury Park, received some seed, probably a small quantity, from California's leading botanist Professor Kellogg.[52] In January 1869 the Dunedin nurseryman William Martin introduced the first Californian conifer seed to Otago. It came from the firm E. C. Moore* and contained radiata.

*Error in "The Botanic Garden, Wellington" book gives C. M. Morris. E. C. Moore is correct.

that this was about the time when they made contact with Professor Kellogg, possibly learning his address from Richardson. Andrew Duncan was active in the C.H.S., a member of the Canterbury Philosophical Society, Mayor of Christchurch in 1869, a member of the Provincial Council from 1868-1873 and a member of the committee with Wilson & Hislop which advised on the Planting of the Tree Belts (Press, 14 May 1867). Duncan and Son supplied conifer plants to the Wellington Botanic Garden in the 1870's but the firm's interest increasingly became more "glasshouse"-orientated. Nurseryman William Wilson had radiata for sale in 1865, while J. Greenaway advertised "a fair stock" for 1869.

The source of the radiata seed for these two nurseries is not known. In 1872 Wilson said of radiata "It is rapidly raised from seed either from England or California but is a comparatively recent introduction and little is known about its timber"[54]. The same year the Canterbury Domains Board said, in reply to receiving GS seed, "*Pinus insignis* was becoming common in the Province".[55] In 1872 the Domain's Board received additional conifer seed, including radiata, from

cisco (Professor Kellogg, E. C. Moore, and Miller and Sievers). Knowledge of these Californian seed sources may be linked to some of the importers, e.g. Martin, Pharazyn, Duncan, W. Wilson and Firth, being members of the New Zealand Institute. There is also the question (raised by the story of the GS seed) of some interconnections among Californian suppliers. Various seed shops and nurseries in and around San Francisco were visited by W. Gray when purchasing seed for Hector in 1871.[56] Significant also is the fact that both Miller and Sievers and Professor Kellogg sent plant material to Kew in the 1870's and 1880's. It is more than likely they supplied Kew with plant material earlier than this.

Some radiata seed as well as plants may have come from Kew. In the late 1860's and early 1870's Hooker sent parcels of both American and Indian conifer seed to New Zealand, some of the seed being purchased at auction in London[57]. The 1869 Kew Bulletin records that 9386 packets of tree and shrub seeds were sent back to the U.S., N.Z., Australia and South Africa. It goes on to say that in the previous year extensive correspondence with H. Capron Esq., the

Commissioner of the U.S.A. Dept. of Agriculture, had resulted in a vast number of American seeds, especially those of California and the Rocky Mountains, being procured and distributed to the colonies. Known recipients of Hooker seed were Hector, Julius von Haast, and in 1874, the Hokitika Horticultural Society. The latter evidence would suggest a Kew origin for radiata on west coast mine tailings and not that of miners bringing in seed from California or even from Australia where radiata would just be beginning to cone[55]. Von Haast gave this seed to the North Canterbury Acclimatisation Society although 1868 seed received by him was given to the Christchurch Domains Board.

Diagrams have been drawn to summarise the above-mentioned radiata distributions. Figs 5-8.

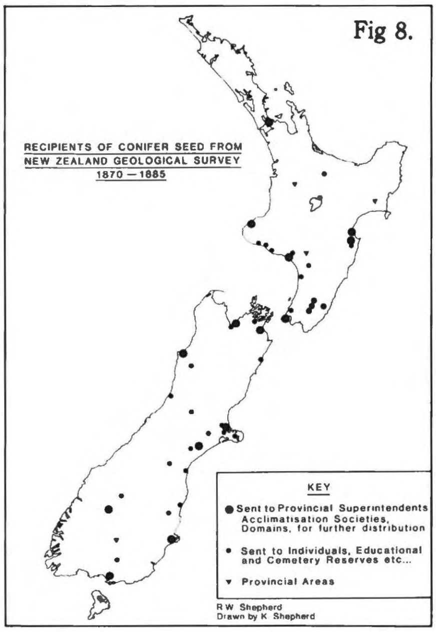


Fig 8.

Fig. 8 shows the distribution of conifer seed through the Geological Survey. This does not cover the secondary distribution of seed through provincial or other agencies. Shepherd and Cook have covered the pattern for Wellington's provincial seed distribution for this 15-year period[59]. What was the provincial distribution in other centres? Because of comparatively early settlement and the need for shelter and firewood extensive planting was carried out in Canterbury. As this in turn would make the area a major source (*sensu lato*) for locally collected seed, Part 2 of this paper will focus on the provincial area of Canterbury.

Part 2 will be published in the next issue of the Journal.

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The Principles of Restoration and Conservation

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It is worth beginning by reminding ourselves about the nature of gardens and of garden making. Compared with the other visual arts, gardens have the extra dimension of time: they are dynamic, always changing, developing and decaying. Now this is not an inconvenience — it is a positive quality, and in the final analysis what we like about gardens. Although much of the structure and the detail of gardens is transient, growing plants are constantly renewing themselves. Gardens, then, are never static or complete — they consist of a series of overlapping life cycles. Nor are they ever perfect and if you visit somebody's garden what do they say? "You should have been here yesterday, or last week, or last year!"

It has been said "A garden is not an object, but a process", and that is very near the truth. When making a garden we are not constructing a finite object but imposing a new ecology, which continues to exist only as a result of human intervention, i.e. consistent upkeep. Alexander Pope said "In all let Nature never be forgot". Thus there is a different relationship between design and upkeep in gardens compared with other works of art. Many of the greatest gardens, the most imaginative and the most original, were not designed to a blueprint but developed gradually according to a unique concept, consistently applied. Such gardens are the realisation of an ideal, stage by stage, with variations dictated by the site, the climate and changing circumstances. This might be during the lifetime of one individual or during the tenure of a succession of owners, spanning several generations. Goethe said that English gardens are not made to a plan but from a feeling heart. This was true in the 18th Century, as at Stourhead, where the garden was made piecemeal by Henry Hoare and then further developed by successive generations of the family. It was also true of later gardens like Hidcote, where there was no overall plan at the outset.

With gardens, design, development and upkeep are all indissolubly linked and part of the same process.

If they are to be preserved, all gardens must be constantly restored. Restoration differs from conservation and upkeep only in degree, and for both purposes, a management plan and an understood conservation policy are essential. These should be conceived for the preservation of the essential characteristics of the garden in its own right, as a work of art, rather than as a resource to be exploited for other purposes. Many gardens can be seen gradually turning into what might be termed "stately stockbeds" for the propagation of plants for sale, or being disfigured by inappropriate sports, car-parks, cafes and restaurants. Some people cannot see a piece of open space without wanting to put a golf course on it!

There is nearly always an unavoidable change of use or change of circumstances to be contended with. New functions must be accommodated — they may often be the means for the garden's survival. The advent of visitors is itself a profound change of a garden's use, e.g. Sissinghurst, which was made with just the family in mind, is now visited by over 100,000 people a year. This is a fundamental shift of emphasis and one purpose of the plan should be to ensure that the impact is minimized — also to lessen the effect of modern intrusions, buildings, roads, noise, etc.

The extent to which changes of this kind can be effected without destroying the essential qualities of the garden can be decided best by an analysis of the garden's original purpose and by an understanding of its original inspiration.

Fundamental in conserving and restoring gardens is the need to establish the availability of resources, physical and financial, now and in the future, and to determine the managerial, the statutory and the physical constraints which apply on that particular site. However obvious, it is still worth repeating that consistent and skilled upkeep is crucial for gardens. At least 70% of the cost of running gardens goes in labour, and skill is extremely difficult to come by, quite apart from the cost.

A valid policy and a workable plan are possible only through a thorough knowledge of the garden, its contents and its history. Again, Alexander Pope said, "Consult the Genius of the Place in all" — i.e., look at the site and research it. Generally speaking, plans, maps and pictures are more useful than descriptions and written accounts, but however thorough the documentary research, the picture is incomplete without a field survey. In 1978-80 The National Trust pioneered garden surveys in England, first at Osterley Park, Middlesex, where the subsequent management plan has now been written and the work of restoration is in progress; also at Wimpole Hall, Cambridgeshire, where, too, a great deal of work has been done. To date, about 18 gardens have been fully surveyed using teams recruited under Manpower Services Commission schemes (people who would otherwise have been unemployed). The new profession of garden archaeology is fast developing. The process consists of a measured survey of all fixed objects, trees and trees stumps, and all artefacts. The survey also covers soil, site and climate. By careful analysis of the data, documentary evidence can either be validated or disproved, and for this reason the field survey should be carried out as far as possible in conjunction with the documentary research. Ideally the two should be going on at the same time. Analysis of the trees, their species, sources and their ages, can provide valuable information about the phases of planting and of who planted what, and when; the advent of each new generation can often be discerned in this way. The survey can also reveal potential problems, e.g. in the age range of trees and their health; it is necessary to take measures to see that the balance of ages in plantations is well spread out. Furthermore, British gardens contain the greatest riches of cultivated plants in the world. In gardens which are substantially intact the plants need very careful consideration: accurate identification, accurate cataloguing, and notation of collectors' numbers, in order to provide a basis for future conservation and development of the plant collection. All this information should make it possible to establish the full history of how the garden was formed, how it was designed and how it was subsequently changed. Overlays of additional features usually exist in old gardens and it is necessary to consider their quality, their impact and their importance in order to make a coherent management plan.

There is more to discovering the "Genius of the Place" than painstaking research and diligent scholarship. Since the 18th Century the greatest gardens have been made as the expression of an original idea, the realization of an ideal. It is essential to try to determine the original concept and the motives of the people who made it. Without this the unique quality of the garden is liable to revert to a stereotype of the period or to be unduly affected by those directly in charge. It is the differences between gardens and not their stylistic similarities that need to be concentrated upon. But for every decision, every piece of work, a subjective assessment is needed too. In the final analysis gardens are things to enjoy. We should not be afraid to use our own judgement in this and we should not be intimidated by the minutiae of historical precedent when circumstances may have changed.

Much of gardening is accidental and one of the traditions of English gardening lies in recognizing the happy accident and knowing when to retain it. Much turns on the contribution of the overlays and the value of evidence of continuous occupation. Policy must be affected by the perceived value of what exists: this is the main factor affecting the practicability and the desirability of total restoration. The essential quality of many older gardens lies in the sense of continuity that they convey, and this quality should be cherished where it exists. Above all it is essential to be courageous and positive. If we wait for the historians to finish their work they never will. Action may result in some mistakes, but in gardens inaction and vacillation will certainly lead to disaster. In the end, most garden work is reversible, at any rate in the short-term. It is the irreversible decisions that should receive particularly careful consideration, especially about the removal and alteration of architectural features.

For their conservation, gardens need constant replanning and renewal. They need firm and decisive management, and the criticism of advisers and others who came with a fresh eye and an understanding of the garden's history. But without the skill, the dedication and the enthusiasm of head gardeners and their staffs nothing could be achieved. It is upon the calibre, training and supply of gardeners that the future of our gardens overwhelmingly depend. If we wish to conserve gardens we should look to fostering and preserving gardeners!

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REGISTER OF GARDEN HISTORY RESEARCHERS IN NEW ZEALAND

RESEARCHER	**AREA OF RESEARCH**
J. Adam 5a Athens Road Onehunga Auckland 6	1. Origin and evaluation of parks. Public: The Auckland Domain (Government Domain or Auckland Park); Albert Park; Mount Victoria Domain (Flag-staff Hill); Mount Eden Domain or Maungawhau; One Tree Hill Domain; Howick Domain; Western Park; Jellicoe Park (Greenhill Reserve) Private Parks: Ellerslie Gardens; Vauxhall Gardens and Willow Strawberry Gardens, Devonport. 2. Parks and street tree planting history, (1860-1900), of Auckland and Waikato.
C. Challenger Kereru Okuti Valley RD2 Little River Canterbury	19 century NZ nursery catalogues.
Dr R. Ferguson Division of Hort and Processing DSIR Mt Albert Private Bag Auckland	19 century fruit introductions to NZ.
Dr K. R. W. Hammett 488C Don Buck Road Massey Auckland 8	Development of plants under cultivation, esp Dahlia, Dianthus, Sweet Pea and Polyanthus. Development of the nursery industry in NZ. Collecting nursery catalogues to be lodged with the DSIR library at Mt Albert and for exchange with other libraries maintaining such collections.
K. J. Nobbs 5 Homestead Rise Aparangi Te Kauwhata	Early plant introductions and the work of the missionaries. Development of an historic plant collection at Te Kauwhata.
Mrs R. W. Shepherd 19b Homewood Ave Karori Wellington	19 Century Wellington nurserymen and plant introductions to Wellington 1840-1880 *Pinus radiata* introductions to NZ 1850-1865.
Dr R. Tipples Dept. of Hort Landscape and Parks Lincoln University Canterbury	Life and work of Alfred William Buxton, nurseryman and Landscape gardener.
Joyce Waters 24 Thane Road Wellington 6003	19 century introductions of Rhododendrons to NZ