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Front Cover : The Arthur Hoyt Scott Amphitheater. A unique architectural space within a canopy of tulip trees *Liriodendon tulipfera*. The Scott Arboretum of Swarthmore College, Pennslyvania, USA. Photo Mike Oates.

The future of our urban parks and gardens

Having visited Europe recently I am more convinced than ever that, in New Zealand we have world class public parks and botanic gardens.. For many of our gardens and parks, however, we have reached a critical time. Many of the initial reasons for their establishment have changed. Their physical landscapes are in need of renewal, based on a new vision that will see them grow and develop over the next 100 years. A major part of this landscape are the framework plantings of coniferous and deciduous trees.

To enable this to happen a commitment is needed from the garden owners and managers for long term programmes to assess future needs, develop a strategic plan and then allocate resources over many years. It also requires trained landscape managers who can implement the plan and manage the changes, even though the results may not be evident until long after they have left. In the rush to train people who can manage businesses and human resource I wonder if we have overlooked the importance of training people to manage landscapes? It is also of concern that many important parks and gardens are in smaller rural towns where the managing authorities do not have the expertise on staff, nor the resources to embark on major garden restoration. Perhaps we should be following the lead of the UK Lottery Grants Board where millions of dollars have been allocated for public park restoration as part of urban redevelopment.

Our parks and gardens are an integral part of New Zealand's cultural landscape. They reflect our development as a nation since European settlement. A commitment for their future is needed now.

Mike Oates

A brief survey of the New Zealand and Tahitian Fuchsia Species

Ted Sweetman AHRIH

THE GENUS FUCHSIA

There are more than 100 species of fuchsia spread over the Central and South American continent and four species under sections Skinnera and Procumbentes native to New Zealand and Tahiti.

How they reached these South Pacific countries and became established has been the subject of much research and debate over the years. One fact is certain - they are a distinct group of species within the genus fuchsia - a part of the Onagraceae family along with such diverse plants as godetia, clarkia and evening primrose. These plants are just a few of the 675 plant species in that family.

In earlier days it was presumed that the fuchsia family first evolved during the Eocene period some 50 to 60 million years ago when all of southern South America was covered by temperate forests which continued on across Antarctica and to southern Australia. Although the separation of Australia from Antarctica began around 50 million years ago, the recent finding of pollen in South Australia dating back earlier than this period, makes it evident that fuchsia was established even before that period. Migration of fuchsia was possible across the South Tasman Rise from Antarctica up until approximately 38 million years ago. Until 80 million years ago New Zealand was also connected to Australia, and covered with temperate forests. Although there has been no evidence of fuchsia in N.Z. that far back, it has been established through pollen findings that fuchsia existed in New Zealand back to the oligocene period around 27 million years ago. It then extended up to the Pliocene period and into the Quaternary as referred to by Pocknall and Mildenhall in 1984. More than likely berries and seed from fuchsias that had become well established in Australia could have been dispersed across the Tasman Sea to N.Z. following the prevailing westerly weather patterns, and become established in their own right.

With New Zealand maintaining its temperate climate after separation, our native fuchsias, once established, flourished right up to modern times. With the coming of man, the natural predator, along with imported marsupials and other destructive animals, many of our native plants, including fuchsia, have suffered devastation in many parts of this country.

As for Australia, fuchsia became extinct during that country's drift northwards, due to the change in climate, therefore no fuchsia species now credited to that country.

One species alone in the Skinnera section of fuchsia, *F.cyrtandroides*, occurs on the South Pacific Island of Tahiti, and was first noted there in 1927. Very little is known of its early history, but it is thought that here again it could have originated from seed carried from New Zealand in the prevailing currents, to become established on this young island that dates back only 2 million years.

The fuchsia species that inhabit New Zealand and Tahiti are unique. They are nothing like their American cousins in foliage, flower or in some cases growth. Their pollen is bright blue, the only fuchsias to throw this pollen colour. They mostly flower from old wood, whereas those of South and Central America throw their flowers from new season's growth as do the hybrids and cultivars bred from species of those areas. One aspect they do have in common however is that their fruit is edible. In fact no fuchsia has yet been found that is not edible, be it species, hybrid or cultivar. Over the years, the berries have been used for making jams, included in cakes etc, wine or just eaten from the plant. During the time of the Conquistadors in South America fuchsia berries were a source of food for the inhabitants. A very pleasant sparkling rose wine can be produced from the flower petals of hybrid and cultivar fuchsias.

To detail the individual species of the fuchsia section Skinnera, it is only natural to commence with the most widely found example, *F.excorticata*, or to give its Maori name, Kotukutuku. Excorticata, named for its habit of excorticating its bark, is widespread throughout N.Z. and outlying islands, occurring naturally throughout indigenous forests from virtually sea level to an altitude of approx. 1000 metres or more. It is the largest known fuchsia species, growing into trees reaching a height of 12 to 14 metres, and strangely for this country, it is deciduous, pointing to its possible migration from lands afar. It is often found in large

Figure 1. Bark of *Fuchsia excorticata*

Figure 2. Flower of *F.excorticata*

groves, especially in damp places by stream banks, some trunks having a girth of up to a metre at their base. The trunks are often gnarled and twisted and easily recognised because of the habit of shedding their pinkish brown bark that hangs in festoons from trunks and older branches. When pealed, the new layer of bark is exposed as a lighter pinker colour. If this bark is again peeled the outer layer of wood is revealed, bright green in colour, and ice cold to touch.

The wood of *F.excorticata* has an attractive grain, but does not show its age in growth rings. It was used in the past for decorative inlay work in cabinet making. It is not a wood that easily burns, even when completely dry. *F.excorticata* is also recognised by its distinctive tapered leaves that are up to 100mm long, dullish green and slightly crinkled on the upper surface with a silvery grey surface beneath which also has a waxy surface layer. This unusual coloration on the reverse is caused by the absence of chlorophyll. The leaves have inconspicuous toothed edges with a pointed tip and slender stalk. The colour contrast can be quite dramatic when a breeze ruffles through the leaves. The leaves of *F.excorticata* are a favourite food of the imported predatory opossum, an Australian marsupial, which has devastated large areas of this interesting and attractive tree.

The flowers of *F.excorticata* are small, distinctive in shape, about 4cm long and grow singly on slender stems from the leaf axil, or even directly from the trunk or branches of the tree. In the warmer northern part of the country the flowering starts in late August, and in the southern part trees are still flowering in early December. When they first open the flowers are a soft green slightly streaked with purple, turning later to reddish purple. Female and hermaphrodite flowers appear on separate trees and each flower consists of a basal ovary joined to a funnel-shaped tube. This terminates in four sepals that are pointed and curve backwards, four small dark purple petals, and eight stamens. The ovary is cylindrical with a long slender style, usually longer than the stamens, and this is topped by a large globular yellow stigma. The hermaphrodite flowers have stamens comprising long reddish filaments and anthers that contain grains of bright blue pollen. The female flowers produce no pollen, the berries that follow, called konini in Maori, are dark purple when ripe, many seeded and pleasant to eat.

During the flowering season the birds that search for nectar in the flowers become quite discoloured by the blue pollen. These native birds are the tuis, bell bird, silver eyes, kokako and native pigeon. The kokako deserves a special mention as, like the kiwi, it does not fly. These birds would have been more common in the days when, because of New Zealand's remoteness, they had no predators. New Zealand had no contact with the rest of the world for around 80 million years, and it is only in the last few centuries that man and other predators arrived in the country. In early times, birds like the kiwi and kokako did not need to fly away from danger. The kokako runs up the trunks of the *F. excorticata* using feet and beak to reach the berries, then, after feeding, it gently glides back to earth. Until recent years *F.excorticata* flourished freely, but with the forest burning by Maori and later colonists, and with the colonists insatiable requirements for farming and settling purposes, coupled with imported animals, such as deer, pigs and opossums, many areas are now devoid of these plants. Action to reduce deer and opossums has taken place in recent years, because of their widespread damage to our forests and wooded areas, but much more effort is required to eradicate not only these but many other imported animals and insects that threaten our own wildlife treasures.

Joseph Banks, botanist, and Daniel Solander, biological recorder, who were on the first voyage of 'Endeavour' with Captain James Cook during 1768-1771, first discovered *F.excorticata*. They collected specimens on October 20th and 21st 1769, at what is now called Anaura Bay, north of Gisborne, followed by collection at Tolaga Bay, Mercury Bay and in the Bay of Islands. Collections were also made in Queen Charlotte Sound in the South Island, at Totaranui. Detailed descriptions of the plant matter collected were made by Banks and Solander and recorded, the original manuscripts being held by the Natural History Museum in London with a copy held at the Landcare Research Herbarium at Lincoln. Banks and Solander first gave the new plant the name of agapanthus (pleasant flower) however this was never published. On Captain Cook's second voyage to these shores in 1772-1775, another two botanists John R. Forster and his son George collected further specimens in Queen Charlotte Sound, either in November 1773 or October-November 1774 as these were the only times the botanists were on shore during the flowering season. Again the plant was not recognised as fuchsia, and the Forsters named it *Skinnera excorticata* in dedication to a percipient far seeing botanist, the Reverend Richard Skinner 1729- 1795 the rector of Bassingham, Lincolnshire.

The first botanist to correctly classify *Skinnera excorticata* as a fuchsia was Linnaeus the younger, who, in 1781, interpreted the sepals and floral tube as part of the flower's corolla and correctly identified the petals.

A natural variant of *F.excorticata*, which apart from its purplish red leaves and stems has similar features, is called *F.excorticata purpurea*. This variant is not widely found. But I have found examples in secondary growth on the West Coast of the South Island and on the southern slopes of Mt. Egmont in the Taranaki district of the North Island. It does not grow as large as *F. excorticata*, is not as hardy, and must not be allowed to suffer dryness. The leaves are bright purplish red on the upper surface with a purplish waxy silver on the underside, which again shows the absence of chlorophyll in that part of the leaves. The stems also have the purplish red colouring which continue to show even in the harder wood. The flowers are identical but smaller than *F.excorticata* and are an attractive reddish purple colour even in their bud stage. Again, the pollen is blue but tending more purple. With care, cuttings can be propagated from young spring growth, remembering that they must not be allowed to dry out. Frequent misting of cuttings helps.

There does not appear to be any recognised recorded findings of purpurea, however it first appeared in a commercial catalogue from a Taranaki nursery in 1926. I have been growing it since 1988. A variegated form has also been seen, but is not in general cultivation.

The second species in the Skinnera section is *F.perscandens* which, unlike the larger *F.excorticata*, is a semi-trailing, climbing shrub and is of generally spreading habit, reproducing by new shoots which layer themselves to form further plants. It is not an attractive plant, and not readily noticed in the wild, especially in the dormant period, when it resembles a mound of twigs. It does not appear naturally in the warmer northern part of the North Island, but is found in several areas over other parts on the margins of lowland forest.

The strong main stems can grow up to 5cm in diameter, are sparingly branched and have a pale brown, flaking bark. Foliage is rather sparse and the leaves, carried on slender petioles, are pale green on the upper side, and whitish green on the reverse. The leaf is much smaller and thinner than its tree-like relation *F.excorticata*. The palisade tissue is single layered, and does contain chlorophyll in the tissue, along with foliar flavonoids as occurs in other South Pacific species. All have the same chromosome number. Flowers appear directly from the trunk or slim branches, either singly or occasionally in sets of two or three, and are held on slender stems. The flowers resemble those of *F.excorticata* but are shorter and not as slender. They can be male, female and hermaphrodite. The tube is green shading into a reddish brown, with sepals a reddish brown at the base shading out to green at the centre and tips. The small corolla is brownish purple and the stamens are prominent. The small berries ripen to a very dark purple colour, and are not as prolific as *F.excorticata*.

Cockayne and Allan first recorded *F.perscandens* in 1927 near Feilding in the Manawatu District. However findings of this plant were made by Joseph Hooker during 1867 in North Auckland, who originally called this plant *F.colensoi* after William Colenso, a missionary printer and botanist. This name was later given to another hybrid fuchsia mentioned later in this article, and so it became *F.perscandens*, alluding to its perscandent habit of growth. This plant was also discovered later by Kirk in 1899 and Cheeseman in 1875. It was never as widely distributed throughout N.Z. as *F.excorticata*, but findings were made in several different areas in the early years. Very few specimens can now be found in the wild, but the Cockayne and Allen finding was recently rediscovered in Feilding. When dormant and without their leaves, they generally

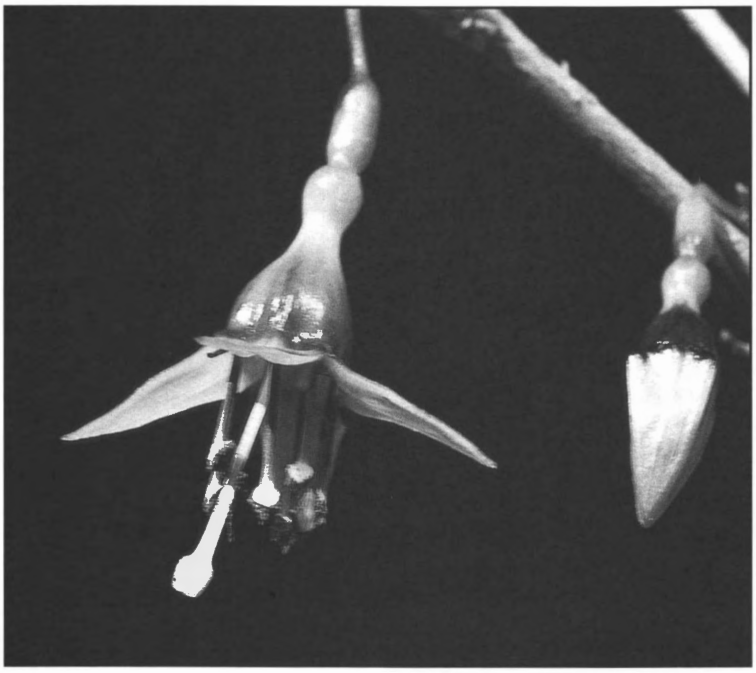

Figure 3. *F.perscandens* flower

Figure 4. *F.colensoi*

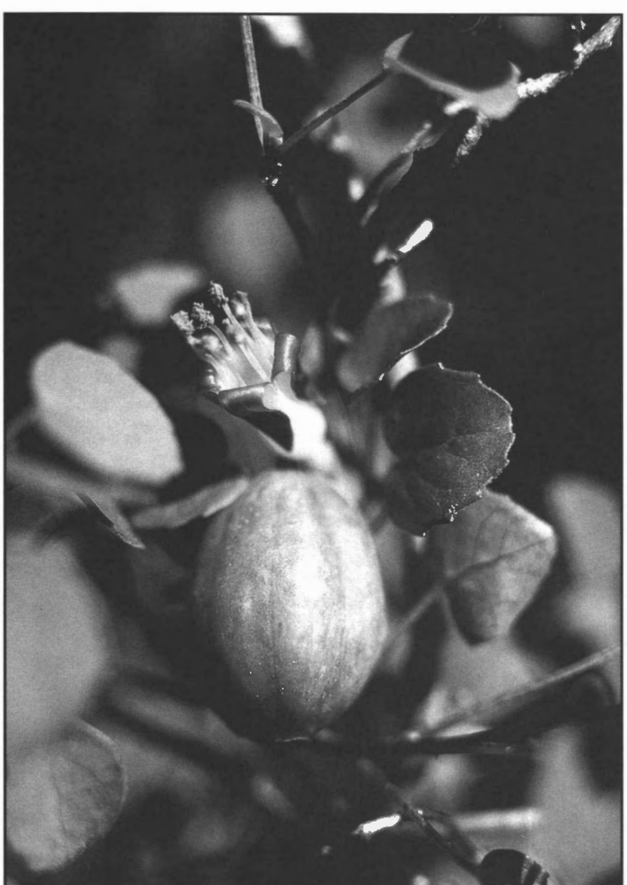

Figure 5. Berry of *F.procumbens*

Figure 6. *F.procumbens* flower

resemble a pile of dead sticks. *F.colensoi* earlier referred to under *F.perscandens* section, could be aptly termed a more shrubby version of *F.perscandens* and of course a much smaller plant than the tree fuchsia *F.excorticata*. Although earlier termed a species in its own right, it is now termed a hybrid thought to be a natural crossing between *F.excorticata* and *F.perscandens*.

The flowers are similar to its two supposed parents in both colouring and shape, but smaller and shyer in habit. Berries as well do not appear as prolific. The plant growth is really as an erect branching shrub with smaller, rounded, less pointed leaves It is not widely distributed throughout New Zealand, is not a showy shrub and as such not easily recognised in its native surroundings close to the lowland forest. Again with its two parents, it has been the victim of desecration by man and animal over the years, and is now quite rarely found.

F.cyrtandroides. The last species of the Skinnera section was discovered on the island of Tahiti in 1927, and was not described or named until 1940. It was found growing high up in the precipitous mountains of this beautiful island, which lies in the Pacific Ocean approximately 4830km north east of New Zealand towards South America. *F.cyrtandroides* is a little like New Zealand's *F.excorticata*. However, its leaves are more leathery, and so far it has been found to have only hermaphrodite flowers. It does not grow to the dimensions of *F. excorticata*. The trees grow to 5 m in height with a brown smooth bark that does not peel as profusely as the New Zealand species. The leaves are paler green slightly different in shape, and because of the shortage of chlorophyll, the undersurface has a lighter shading. The flowers are borne on the branches as in *F.excorticata*, with no bulging at the base of the tube. The fruit is of a similar size to *F.excorticata* but slightly different in shape and fairly scarce The plant is not readily found in its native Tahiti, except high up in the mountains, and its existence is endangered. It appears that little has been done to study its habits, either in Tahiti or overseas except for research by Dr Eric Godley of Lincoln University, Canterbury, and his results have so far not been readily available. It appears possible that this plant could have originated from seeds migrating from New Zealand and naturalised over the years on the island of Tahiti.

Section Procumbentes. Until recently the one fuchsia species in this section, *F.procumbens*, had always been included in the section Skinnera, but recent research has resulted in it now being placed in its own section.

Even to the lay person, this plant has characteristics all its own, and DNA testing by Dr. Systma during 1991 proved that it had distinct differences from the other species fuchsias in the Skinnera section.

The growth habit is of course very different to the other New Zealand and Tahitian species, being of a procumbent and rooting habit, with long slender trailing stems. The leaves are alternate, firm, membranous and circular or disk shaped and finely serrulate. Plants of *F.procumbens* can be female, male or hermaphrodite, with perfect and male flowers appearing on the same plant. The flowers are held erect from the trailing stems, have no corolla (petals) and are one of only two fuchsias to incorporate the colour yellow. As with the species in the Skinnera section, the blue pollen is very noticeable. Flowering takes place from October to March, depending on conditions existing where it is grown. The berry of *F.procumbens* is quite large and resembles an oblong plum, bright red on maturity, with a light waxy bloom. Several large seeds are contained in the berry, which is not as pleasant to eat as most other fuchsia fruit. The natural habitat for *F.procumbens* is the coastal regions of the northern part of the North Island, including the Coromandel and several of the outer islands of that area. Richard Cunningham, who died in 1835 before his manuscript description could be published, first discovered it in 1834 at Matauri Bay. His brother Allan later published this in 1839. In 1871, Joseph Hooker described what was felt to be a new species that had apparently been found growing on Great Barrier Island by Thomas Kirk. The flowers were a larger version of those described for *F.procumbens* and this plant they named *F.kirkii*. However, in later years it was proven that this plant was actually a male version of *F.procumbens*, therefore the name "kirkii" has been discontinued.

A natural variegated variant of *F.procumbens* has existed in New Zealand for some years now, and this has also occurred amongst cultivated specimens in England. The leaves of this plant are a soft dullish green with silver to white variegation It is a shy flowerer, with these flowers being smaller and paler than *F.procumbens*. It has few berries and not such vigorous growth.

Over the years it has always been referred to in fuchsia circles as "*F.procumbens* variegated", but the finder in England has now registered this version with the International Fuchsia Registrar as *F.procumbens* "Wirral" after the district in which the U.K. finder resides. He had at first registered the plant under the name of "Argentus" (variegated) but the International Code of Nomenclature decrees that from January 1959 plant names must be in the modern language, not Latin.

The South Pacific species of fuchsia do not carry any perfume, but do produce copious quantities of nectar at the base of the floral tubes This nectar is high in hexosus and low in sucrose

The New Zealand species fuchsia has been extensively researched by several learned botanists and researchers, including Dr Eric Godley of Christchurch, who, in association with Dr Paul Berry of the U.S.A., produced in 1995 an extensive paper entitled "The Biology and Systematics of Fuchsia in the South Pacific". This paper was published in the Annals of the Missouri Botanical Garden, U.S.A., in Volume 82, Number 4. The fuchsia world has been fortunate with the establishment of an international Research facility at Margam Park, Port Talbot, in Wales, where botanical specialists are carrying out in- depth research and testing of all known fuchsia species. This now gives the possibility, of course, to test any new additions to those already known to exist, and to verify the earlier work carried out. The South Pacific section of species fuchsia is sure to receive much attention from those connected with this establishment.

References: Godley, Dr. Eric, and Berry, Dr. Paul - 'The Biology and Systematics of Fuchsia in the South Pacific'.

Genetic engineering of crops: A basis for improved assurances of food safety[1]

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Abstract

Scientific advances in cell and molecular biology over the past 25 years now allow DNA from any source to be transferred into a wide range of other organisms. This technology offers immense opportunities to develop new crop cultivars with greater resistance to pests and diseases and novel quality attributes such as improved nutrition, longer storage, and colour. It has also raised concerns about food safety. This paper summarises the anticipated benefits and potential food safety concerns associated with this technology. When this new technology is compared to current food production practices it becomes evident that the risks from genetically engineered crops will be no different than the effects of growing, processing and consuming new cultivars from traditional breeding. Furthermore, the precision and power of molecular biology provides a greater level of confidence in the assurances that science can give when evaluating food safety issues of genetically engineered crops.

Introduction

Scientific advances in cell and molecular biology over the past 25 years have resulted in the genetic engineering of crops, a technology with potential to greatly accelerate the speed and extent to which new genes can be transferred to crops. In all major crop plants this "new" technology allows the deliberate transfer of specific cloned genes to single cells from which complete plants can be regenerated via cell and tissue culture. This technology offers immense opportunities to develop new crop cultivars with greater resistance to pests and diseases, improved quality attributes, and production of novel compounds in crops. It has also raised concerns about the environmental and food safety. This paper briefly summarises the anticipated benefits of genetic engineering of crop plants to producers, the food industry and consumers. The potential food safety concerns associated with this technology are also outlined. These risks are then put into perspective with the agricultural and food industry practices generally accepted for existing crops and genetic modification by traditional breeding. The information presented is summarised from some of our more technical reviews to which the reader is referred for more in depth information (1-4).

What is possible?

Virtually every crop plant has been genetically engineered somewhere in the world, although for many minor crops the methods are still relatively inefficient. For all major crops such as wheat, maize, rice, potatoes, tomatoes, canola, soybean, and cotton, the technology for DNA transfer is well established in many laboratories throughout the world.

The genes intended for transfer can come from any source of DNA. They can be from the same crop, from other plants, or from microorganisms such as fungi, bacteria and viruses. It is also technically possible to source genes from animals, including humans, or even develop totally artificial genes synthesised in the laboratory. When the genes originate from more evolutionary distant sources such as other kingdoms, it is often necessary to make specific changes in the base pairs of the DNA so that the gene works effectively. The transferred genes usually have a "chimeric" basis and are often made up of various functional components from genes derived from different organisms. These components not only include the DNA sequence that encodes the information to make the desired protein, but also a range of DNA "switches" and controls that are responsible for turning the gene on in plant cells at the desired level and location within the plant.

With the scientific and technological advances in the ability to isolate specific DNA fragments, transfer DNA into single plants cells, and nurture these cells back into complete plants, it is now technically possible to genetically engineer virtually all crop plants with any source of DNA.

Why do it?

Many of the new characters transferred by genetic engineering are similar to those being modified by traditional breeding, where genes from related wild species are often transferred. Why then is genetic engineering necessary? There are several key advantages of genetic engineering for crop improvement:

- Extending the source of genes from related wild species to any source of DNA. This provides new opportunities to complement the existing genes in the declining gene pools of traditional breeding.
- Direct gene transfer to elite plants and cultivars without repeated backcrossing. This allows the efficient development of new plant lines without the many generations of hybridisation and selection usually required to recover the desired plant.
- The transfer of single discrete genes, without the "linkage drag" associated with the transfer of many undefined and often undesirable neighbouring genes in traditional plant breeding.
- The specific design and development of new gene formulations. These can involve the matching of molecular switches (promoters) with the desired coding regions to target the expression of the new gene at a specific location within a plant. Alternatively, "reverse genetics" approaches can be used to "knock-out" specific functions in plants. This can be achieved by positioning the coding region of a gene in the reverse orientation relative to the promoter responsible for "turning the gene on".

In total, these advantages position genetic engineering as an important technology for the next "quantum leap" in crop improvement. Most of these advantages remain even when genetic engineering is used for gene transfer within a crop species, i.e. transferring potato genes between potato cultivars.

What are the benefits?

Most genetically engineered crop plants currently under development involve the transfer of genes conferring resistance to pests, diseases, herbicides, and environmental stress, as well as quality traits such as improved post-harvest storage, flavour, nutritional content, and colour. The resulting novel germplasm is predicted to allow plant breeders to respond much more quickly to the market need for new and improved cultivars, and satisfy the increasing consumer demand for a consistent supply of high quality, blemish-free grains, fruits and vegetables.

For production traits like pest and disease resistance the producers benefit by a reduction in pesticide use, the food industry benefits by a more uniform supply of high quality produce with less price fluctuations, which in turn is beneficial to the consumers. In addition, the resulting reduction of contamination of soil and water by reduced pesticide use is a benefit to the whole society. The improvement in many quality attributes provides immediate product differentiation advantageous to both producers and food industry, with a higher quality food being the positive outcome for the consumer.

What are the risks?

Potential food safety concerns associated with genetic engineering of crops can arise from three mechanisms:
- direct effects from the DNA and the expression products resulting from their activity
- secondary effects of gene activity
- effects from random insertion of the gene

Each of these factors can result in the production of new chemical constituents in the portion of the crop that is eaten. Alternatively, concerns may also arise from the reduction of specific constituents that play a significant role in reducing health risks (e.g. antioxidants).

Direct effects. The chemical components of DNA and the resulting RNA are called nucleic acids and are identical across all living organisms. With the exception of refined products such as oils and sugars, all foods contain nucleic acids. Therefore the physical presence of any new gene and the RNA made from it does not raise any new health risks over existing foods. When assessing the safety of food derived from genetically engineered crops, it is the protein products made from the transferred genes that need to be considered. If these proteins result in new components in the part of the crop that is harvested for food, the resulting food is no longer substantially equivalent to the previous product. This does not necessarily constitute a new risk because the direct protein products of the transferred genes are known and sensitive assays for their presence are usually available. Therefore, the amount and stability of these proteins can be accurately determined in the food harvested from crops, both before and after harvest, as well as during storage and food processing. Consequently, any potential toxic, immunological, or allergenic responses can be readily recognised, tested, and evaluated if health concerns are known to be associated with the specific proteins.

Secondary effects. Many transgenes introduced into crops encode the high level production of enzymes that catalyse biochemical reactions, which can potentially result in a range of secondary effects. Increased enzyme biosynthesis via transgene expression has been reported to deplete enzymatic substrate with a concurrent accumulation of the enzymatic product. Examples of altered metabolic flow-through in biochemical pathways, resulting in unanticipated increases or decreases in other biochemicals have also been documented. The expression of a new enzymatic activity in plant cells is also known to result in the diversion of metabolites from one secondary metabolic pathway to another. The possible occurrence of such secondary effects of transgene expression will depend on the key regulatory points and rate limiting steps in the biochemical pathways of plants. In general terms these are poorly understood, and can be expected to vary between crops as well as between cultivars and breeding lines within the same crop species.

Random insertion effects. The random insertion of transgenes into the chromosomes of plants raises the possibility of mutations disrupting or modifying the expression of existing genes in the plant. The most common event is expected to be inactivation of endogenous genes from the physical disruption caused by the insertion of the introduced DNA fragment. Another potential mutagenic event involves the formation of fusion proteins by read-through of the genetic code from flanking plant DNA into the inserted DNA (or vice versa). In most instances, such fusion proteins will result in the biosynthesis of nonsense expression products of no biological significance, and will be recognised by an incorrect size, biophysical property or function. A third, extremely rare possibility, is the activation of otherwise silent genes in plants. This may arise via read-through from highly expressed promoter regions of transgenes into coding regions of the flanking plant DNA. In this context, the possibility of activating genes that encode enzymes in biochemical pathways toward the production of toxic secondary compounds raises the most concern for food safety. An obvious safety precaution is to analyse the harvested food for any deleterious secondary compounds normally limited to the non-harvested organs of the crop plant or to closely related species. Nowadays, such analyses are already routinely performed before release of new cultivars in many crops developed by traditional breeding, without the need for formal regulatory procedures.

Are the risks new?

Are the food safety concerns outlined above any different from those widely accepted from the development of new crop cultivars via traditional breeding? It is important that these issues are put into perspective with the agricultural and food industry practices generally accepted both for existing crops as well as genetic modification by traditional breeding.

Direct effects. The piece of DNA intended for transfer during genetic engineering can be controlled in a very precise manner and limited to the exact minimal segment of DNA capable of conferring the desired character. This is in marked contrast to traditional breeding where undefined genes are routinely transferred between breeding lines, species and even genera. The parental lines used in traditional plant breeding often have large regions of uncharacterised DNA transferred from wild species. Only a small proportion of this transferred DNA is expected to carry the desired character, such as resistance to pests and diseases, and the vast majority of the transferred DNA involves neighbouring genes of unknown function. Modern cultivars of most major crop plants often contain large chromosome fragments of wild species. For example, in potato breeding the development of new cultivars has been facilitated by the transfer of genes from over 20 other *Solanum* species, with some cultivars possessing chromosome fragments from 4-5 different species.

Secondary effects. Any concerns about secondary effects of gene expression apply equally to the products of genetic engineering and traditional plant breeding. Such events have been documented to unwittingly occur in breeding programmes by the complementation of genes from different parental lines. A classic example of unexpected secondary effects in traditional breeding involves the development of novel fruit colours in tomato following introgression of genes from some accessions of wild species. Similarly, advanced potato breeding lines with novel, toxic glycoalkaloids in their tubers have been produced when wild species exist in their pedigrees. When a transgene is expressed in a crop plant, the biochemistry underlying the new character is better understood than for most genes transferred from wild species in traditional breeding programmes. This increases the opportunity to predict possible secondary effects, which can be investigated if hazardous situations are envisaged.

Random insertions effects. These are not unique to genetic engineering, and do not present a new health risk over what can be anticipated from traditional plant breeding. Naturally occurring phenomena such as the activity of transposable elements (jumping genes), chromosomal rearrangements, as well as various forms of genetic recombination, can all result in identical "random" effects in plant genomes. Radiation and chemical treatments to induce chromosome rearrangements and mutations have also played an important role in plant breeding of most crop plants over the past 50 years. Gene introgression from wild species into crop plants often involves homoeologous recombination or induced translocations between chromosomes. Such gene transfers have a well documented history in cereal breeding, where specific genetic stocks are deliberately used to induce pairing and recombination between homoeologous chromosomes. Radiation treatments and cell culture are sometimes used to induce random translocations of undefined chromosome regions from a wild species to the chromosomes of crop plants.

Conclusion

Genetic engineering offers immense opportunities for efficiently developing new crop cultivars with improved characters such as greater resistance to pests/diseases and specific quality attributes. Despite the potential benefits of the technology, public concerns have been raised about the environmental and food safety of the resulting products. The well established and accepted practice of traditional plant breeding must serve as the key reference point for evaluating the perceived risks of gene transfer by genetic engineering.

In traditional plant breeding, gene transfer from wild species often involves the transfer of pest and disease resistance. In most instances, the biochemical basis for the transferred character is not known when a new cultivar is first developed. In some instances these resistance genes are subsequently associated with the accumulation of proteins such as antifungal hydrolases, ribosome inactivating proteins, proteinase inhibitors, lectins, and thionins, as well as a wide range of secondary compounds. As these mechanisms of resistance are fully elucidated, the genes responsible can be isolated and transferred between plants using genetic engineering. It is therefore ironic that the agricultural use of engineered crops containing these genes raises immediate concern, whereas the use of such genes in traditional breeding has been widely accepted for many decades.

When the attributes of traditional plant breeding and genetic engineering are compared, it becomes apparent that the risks from genetically engineered crops will be no different than the effects of growing, processing and consuming new cultivars from traditional breeding. Furthermore, the precision and power of molecular biology provides a greater level of confidence in the assurances that science can give when evaluating the environmental and food safety of genetically engineered organisms.

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[1] This paper was first published in the Proceedings of the N Z Diet Association 2000; 5: 42-4 and is reprinted here with kind permission of the editor.

Trees in the Wind
Harry Hart and the Greening of Lake Coleridge Settlement

By Derrick Rooney

Land was first acquired into public ownership in what is now the Lake Coleridge township area on the left bank of the Rakaia River in August, 1913, when an area of 133 acres, one rood, and four perches surrounding the generating station, and an area of two acres, one rood, and 17 perches adjoining the Peak Hill Road, were acquired by the Crown "for the development of water power." Work on the construction of a hydroelectric generating station, powered by water delivered from Lake Coleridge through tunnels and penstocks, had begun several years earlier.

Three further acquisitions, totalling 165 acres, were made in 1915 and 1916, bringing into public ownership a total of 298 acres, one rood, and four perches of land that included the power station, the slopes above it on which conifer plantations were later grown, the newly-established township, and its facilities and amenities. A final land acquisition, of some 35 acres and one rood west of the generating station and adjoining the"Rakaia riverbed, was made in June, 1975, for protection works. Much of this land has been returned to private ownership since the transfer to the Electricity Corporation of New Zealand in 1989, and the subsequent sale of the power station to Trustpower in 1999, but during the period when the plantings described here were made, the whole township was owned by the New Zealand Electricity Department.

A staff of more than 30 workers was employed at Lake Coleridge by the NZBD to manage and maintain the power station and its surroundings, and housing was built to accommodate these workers and their families. After the transfer to ECNZ, only six staff were retained at the power station. Most of the maintenance work was contracted out. Subsequently, the NZBD houses were sold, some to the workers who had occupied them.

The site is exposed to severe north-west gales, and to counter this pine shelter belts for workers huts and the putative Lake Coleridge township were planted in 1910. Subsequently, the early shelter belts were extended to a ring planting that surrounded the settlement area with broad belts of pines and cypresses. Most of these original belts were felled on their maturity between 1960 and 1980, and one block of *Pinus radiata,* adjoining the cemetery, reportedly returned the largest recorded volume increment of radiata pine in New Zealand (G,C. Baker, NZFRI, pers.comm.).

Amenity plantings in the township began in the 1920s during the era of Harry Hart, who was superintendent of the power station from 1924 until his retirement in 1954. An electrical engineer by profession and a treegrower by inclination, Harry Hart developed an interest in the potential of conifers for revegetation when working on power projects in the Sierra Nevada of California in the early years of the 20th century.

In his first few years at Lake Coleridge he was preoccupied with the administrative and technical problems of the power station, but an unpublished report written for the NZED much later, after his retirement, indicates that his intentions were clear from the outset. He walked over every inch of the catchment, he wrote, and found its vegetation sadly depleted. Thus in 1933 with the approval of his superiors, he fenced an area of 3.9 acres near the power station for experimental planting to determine the most suitable conifer species for revegetating the Lake Coleridge area.

Harry Hart's experimental plot is now known as the H.E. Hart Memorial Arboretum and contains about 130 conifer species planted by Harry Hart, plus a further range of mostly Chinese conifers in an extension planted in 1985 by the Central Canterbury Farm Forestry Association.

It is clear from notes kept by Mr Hart that he also played a major role in the establishment of the pine, larch, and Douglas fir plantations on the hillside above the power station (when harvested in the 1980s, these plantations returned stumpages of about $2 million), and in the selection and siting of the many amenity trees and shrubs[1], some of them rare or uncommon, that give the township its distinctive character.[2] The hand of the late Tom Gant, chief propagator for the former Ministry of Works nursery in Christchurch, can be seen in some of the post-Hart plantings. The New Zealand Forest Service, which maintained the plantations and arboretum from

Figure 1.

This dawn redwood, *Metasequoia glyptostroboides,* was planted in 1950, making it one of the oldest specimens of the species in New Zealand. Unfortunately, it lost its top, for reasons now unknown, in the late 1960s and has never fully recovered. However, it has considerable historic significance in the Canterbury region.

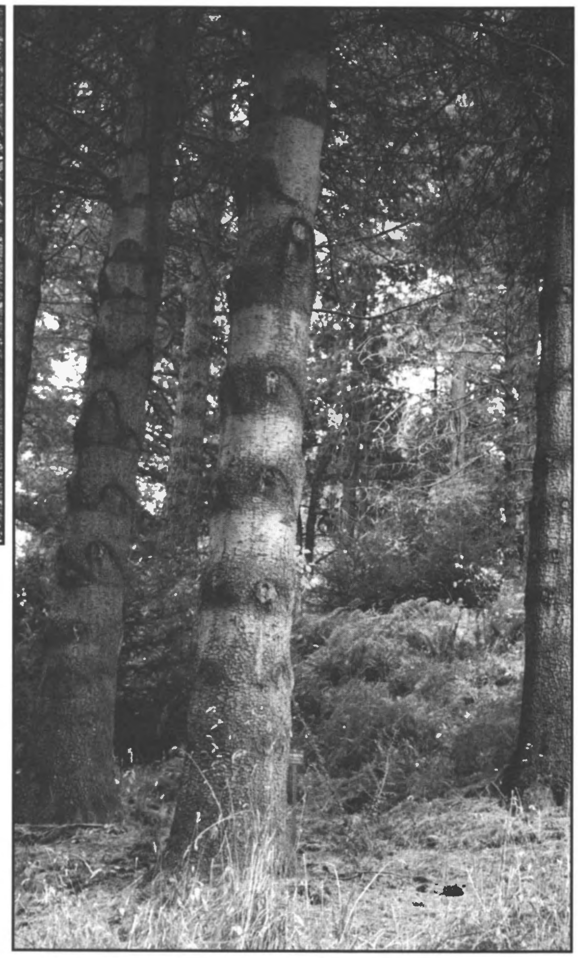


Figure 2.

The Hart Arboretum contains many fine stems.

the 1960s to 1989, when it ceased to exist, also planted trees and supplied some of the specimens planted in the arboretum by Mr Hart.

The arboretum, now owned by Trustpower but currently (July 2001) being offered for sale together with the surrounding plantations, is subject to a management plan[3] and administered by a trust. It is not considered in this article, which focuses on amenity trees within the Lake Coleridge settlement. For convenience, these will be discussed in discrete sections, but from a landscape and planning point of view they should be treated as a whole.

Harper Place

An island in the roadway holds a mixed planting of trees and shrubs, including several unusual species and cultivars thought to have been supplied by Mr Gant. These include a lemonwood *(Pittosporum eugenioides),* growing outside its normal range, an uncommon red-flowered honeysuckle *(Lonicera henryi),* and the relatively rare *Buddleja alternifolia,* a small deciduous tree with wand like branches smothered with fragrant, lavender-blue flowers in summer. The planting also includes several species of *Spiraea,* some little-known cultivars of the shrubby *Berberis x aggregata,* shrubby dogwoods *(Cornus* spp), and other ornamental flowering and fruiting shrubs.

Most important in this grouping, however, is the rare Californian manzanita tree, *Arctostaphylos manzanita.* Much admired for its distinctive cinnamon-brown bark, this species is rarely seen, in either public or private collections, because of difficulties in propagating and establishing it. The Lake Coleridge manzanita is the only specimen recorded in any garden open to the public in the Selwyn district, but unfortunately may have a limited life. Many branches and branchlets are dead.
Also of interest, at the junction of Harper Place and Riverview Terrace, is a fine specimen of English oak *(Quercus robur),* almost certainly one of the original Hart plantings. Its diameter, measured at breast height (1.3m), is 93.4cm[4]. The grounds of the Billiards Club in Riverview Terrace include one of the best of many cedars in the township and a large native black beech, *Nothofagus solandri.* The cedar, identified as Cedrus libani, cedar of Lebanon, is a squat tree with a dbh of 105cm.

Buddiela alternifolia
Arctostaphylos manzanita
Quercus robur

Nothofagus solandri
Cedrus libani

Intake Road

Fine mature specimens near the lower Intake Road indude a scarlet oak, *Quercus coccinea,* a Colorado white fir, *Abies concolor,* one of several splendid examples of this attractive, drought-tolerant conifer within the township, and a Corsican pine, *Pinus nigra* ssp. *laricio,* with a dbh of 93.4cm. Another important tree in this area is the northern pitch pine, *Pinus rigida,* which is rare in New Zealand. Seed of this species was imported by Harry Hart from the United States in 1934.

One of the best groups of mature trees is on the lawn outside the Lake Coleridge Lodge. They include a massive Atlas cedar *(Cedrus libani* var. *atlantica)* with a dbh of 120cm, the biggest cedar in the township, and a multi-stemmed example of the Japanese red pine, *Pinus densiflora.* The group includes two other notable trees, a large Mediterranean stone pine, *Pinus pinea,* unfortunately robbed of one of its main stems by a norwest gale and consequently with a much-shortened life expectancy, and a stately Austrian pine, *P. nigra* ssp. *nigra,* with a dbh of 95cm. This stone pine is a much bigger, and before the storm damage was a better, specimen than those in the groups in the arboretum and the cemetery. A Weymouth pine, *P. strobus,* completes the group.

Abies concolor
Pinus nigra ssp. *laricio*
Pinus rigida
Cedrus libani var. *atlantica*
Pinus *densifiora*
Pinus pinea
Pinus nigra ssp. nigra

Power Station Area

The mature trees in this area contribute significantly to the character of the township.

A fine specimen of the uncommon Cox's juniper, *Juniperus recurva* var. *coxii,* grows beside the generating station steps, and near it are an unidentified holly cultivar, possibly *Ilex hendersonji,* and the Japanese umbrella pine, *Sciadopitys verticillata,* planted in 1949 by Harry Hart. This small, long-needled, very slow-growing tree is one of two seedlings obtained by Mr Hart from the Christchurch Botanic Gardens in 1941. The fact that Mr Hart grew both seedlings for eight years before considering either of them big enough to plant out is evidence of its very slow growth rate. The tree near the powerhouse is one of the best specimens in Canterbury and is also one of the few coning specimens. The second seedling, planted in the arboretum in 1951, is also coning but has not grown nearly as well and is much smaller.

Significant specimens in a mixed group on the lawn opposite these trees include a fine Colorado silver fir, *Abies concolor* var. *lowiana,* a white fir, *A. alba,* and a well-grown Scots pine, *Pinus sylvestris.* Also in this group are an evergreen Holm oak, *Quercus ilex,* and a deciduous oak identified as a variety of pin-oak *(Quercus palustris* var). At the eastern end of this lawn, near the toilets, is another rare juniper, *Juniperus formosana.* This small, shrubby tree has been badly affected by die-back and appears to have a limited life. Attempts will be made to have it propagated.

A fine row of mixed cedars stands immediately behind the swamp fence, and affords an excellent opportunity to study the differences between "pure" Lebanon cedar *(Cedrus libani* var. *libani),* the North African Atlas cedar *(C. libani* var. *atlantica)* and the Himalayan *Cedrus deodara.*

On the streambank, behind a privately-owned cottage, are three very large Douglas fir. An accurate estimate of their height is not possible because of surrounding buildings and vegetation. However, the biggest of the three stems was measured at 146.5cm at breast height. At the end of the row is a large Caucasian fir, *Abies nordmanniana,* the biggest measured in the township. Its dbh is about 111cm.

On the opposite bank of the stream, heavily shaded, is a kauri, *Agathis australis,* probably the specimen that Harry Hart planted in 1952. It is quite small, suffering from competition, and at some stage has lost its top, although a new leader has emerged. Nearby are two rare trees, a large specimen of the Italian maple, *Acer opalus,* distinguished from the common sycamore by its pinkish bark, divided into plates, and more bluntly lobed leaves, and a tall *Populus lasiocarpa.* The latter is a Chinese species notable for its very large, heart-shaped leaves and deeply furrowed bark. It is very rare in Canterbury collections. The only other mature specimen of Italian maple recorded within the Selwyn district is in the Adams Estate, Adams Road, Greendale. The Adams Estate is owned by the University of Canterbury. Italian maple appears to be hybridising with nearby sycamores at Lake Coleridge.

Juniperus recurva var. *coxii*
Sciadopitys verticillata
Abies concolor var. *lowiana*
Abies alba
Pinus sylvestris
Quercus palustris
Juniperus formosana
Abies nordmanniana

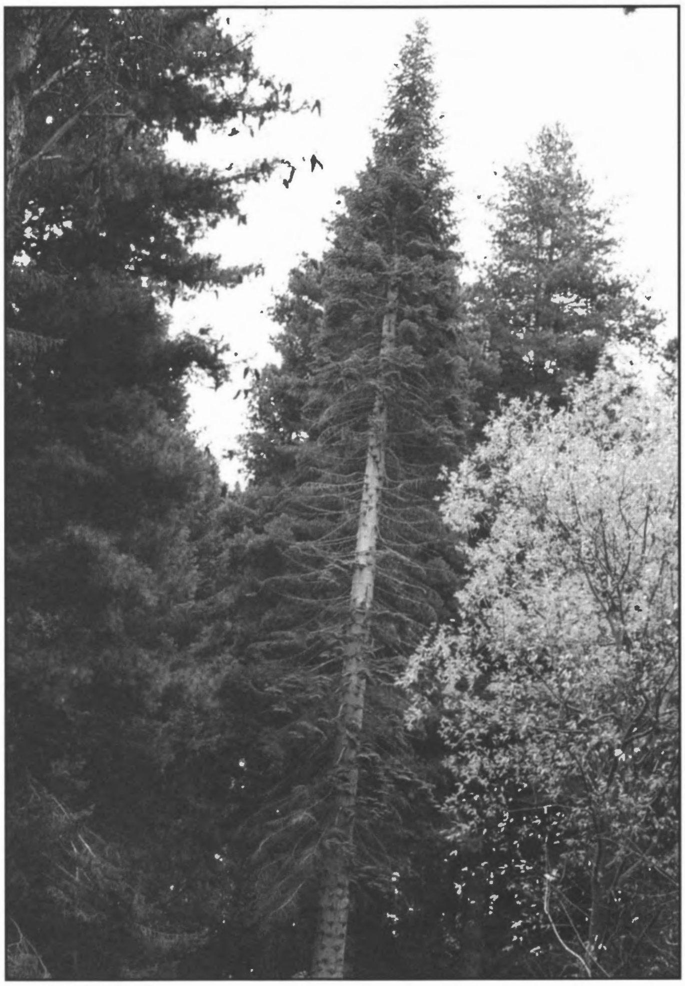


Figure 3

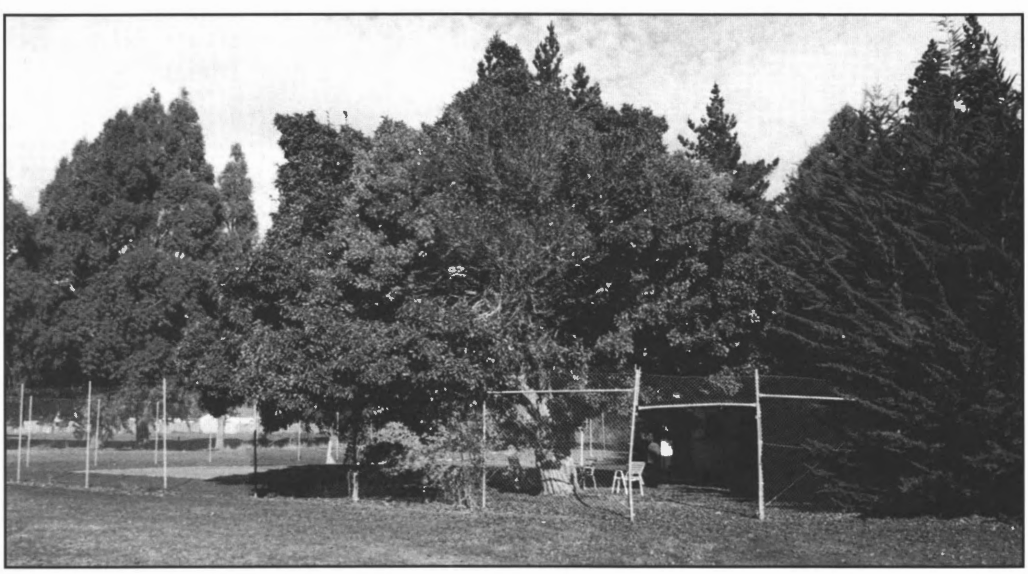
This Californian red fir, *Abies magnjfica,* middle of picture, is regarded by many foresters as one of the finest plantation-grown stems in New Zealand.

Figure 4

***Nothofagus antarctica, a* South American beech, in late autumn. This is one of six species of South American beech planted in a small experimental plot on a terrace above the street where Harry Hart lived.**

Figure 5

***Crataegus x Lavallei,* a relatively rare hybrid thorn, beside the old tennis courts.**



Pseudotsuga menziesii
Agathis australis
Acer opalus
Populus lasiocarpa

Cemetery and flat land behind houses

The right of way leading to the cemetery is sheltered on its western side by a belt of mixed radiata pine and *Eucalyptus viminalis*, some of which are notable for their height and straightness.

A group of mature big-cone pines, *Pinus coulteri,* near the graves, appears to be suffering from old age and overshading, symptoms of which include numerous dead branches and heavy coning. However, the species is spontaneously regenerating on the opposite slope, which is within the cemetery reserve.

A rare pine, well worthy of protected status, grows below the cemetery on the bank of the tailrace. This is *Pinus cembroides* var. *edulis,* the Mexican pinyon pine, renowned for its large, edible seeds. The size of the specimen reflects its very slow growth rate. The tree was planted in 1937 by Harry Hart, who raised it from seed imported in 1933 from Otto Katzenstein and Company, Atlanta, Georgia. According to notes kept by Mr Hart, it was 45cm tall in 1940, 90cm tall in 1945, and 2m in 1950. Growth has continued at a similarly slow annual rate for the last 47 years. Alas, it cones very sparsely, and the seeds in the cones lack embryos. Two other specimens were planted on the bank, but one died in 1939. The fate of the third is not known. Another coning specimen of this rare pine grows in the school grounds but it too produces empty seeds.

A splendid row of mature specimen trees stands along the edge of the ditch at the back of the flat, grassy area behind the cottages. These were planted by Harry Hart, who lived in one of the cottages.

The rare Mexican white pine, *Pinus ayacahuite,* distinctive for its long, slender, curving cones, begins the row at the river end. Next to it is the biggest tree in the township, the Camden woollybutt, *Eucalyptus macarthuri.* This magnificent specimen, with a tall but also broad-spreading crown, had a trunk diameter at breast height of 180cm in 1998. Next in line are *Pinus ponderosa; Pinus jeffreyi,* a large manna gum, *Eucalyptus viminalis* (121 cm dbh), and a fine specimen of the Weymouth pine, *P. strobus.*

The row continues with another Atlas cedar, *Cedrus libani* var. *atlantica,* almost as big (at 117cm dbh) as the specimen outside the lodge and almost certainly of an age with it, and a wellingtonia, or big tree *(Sequioadendron giganteum),* which is 173cm dbh. The monkey puzzle *Araucaria araucana),* was damaged by fire some years ago when hay stacked underneath it ignited. It appears to be in good health but is probably permanently disfigured on its north-west side.

A black beech *(Nothofagus solandri)* and a Himalayan cedar *(Cedrus deodara)* continue the row. At 102cm dbh, this Himalayan cedar is one of the best examples of its species in the township. A shorter row extending at right angles from it towards the houses includes another fine Atlas cedar, measured at 105cm.

Five more large trees complete the row. These are a sycamore, a very large Spanish fir, planted in 1936 and some 120cm in diameter at breast height, a desert ash *(Fraxinus angustifolia* ssp. *oxycarpa),* another Colorado white fir *(Abies concolor),* and a heavily fruiting sweet chestnut, *Castanea sativa.* Outside the fence near the road verge is a fine specimen of scarlet oak, *Quercus coccinea.*

On a knob opposite, partially enclosed by a loop of the Hummocks Road, is a fine mixed planting of conifers and deciduous trees, including cedars, pines, Douglas fir, and poplars. Information received late in December, 2000, is that the owner, Trustpower, is to give this piece of land to the Selwyn District Council.

Quercus coccinea
Castanea sativa
Abies concolor
Fraxinus angustifolia ssp. *oxycarpa*
Nothofagus solandri
Cedrus deodara
Sequioadendron giganteum
Cedrus libanii var. *atlantica*
P. strobus
Eucalyptus viminalis
Eucalyptus macarthuri
Pinus ayacahuite
Pinus cembroides var. *edulis*

Swamp Paddock

Old aerial photographs confirm that most of the growth in this well-wooded area between the terrace slopes has occurred within the last 40 years, an observation further confirmed by growth rings on trees felled in autumn 2000 to make way for arboretum annex plantings. One radiata stump, shown by its ring count to be no more than 50 years old, measured 166cm in diameter. Its early growth rate in the light, sandy soil on a knob above the pond had been remarkable, with some an-

Figure 6

A magnificent, wide-spreading specimen of Camden woollybutt, *Eucalyptus macarthuri,* is probably the biggest tree in Lake Coleridge settlement. Its trunk measured I .8m in diameter at breast height in 1998.

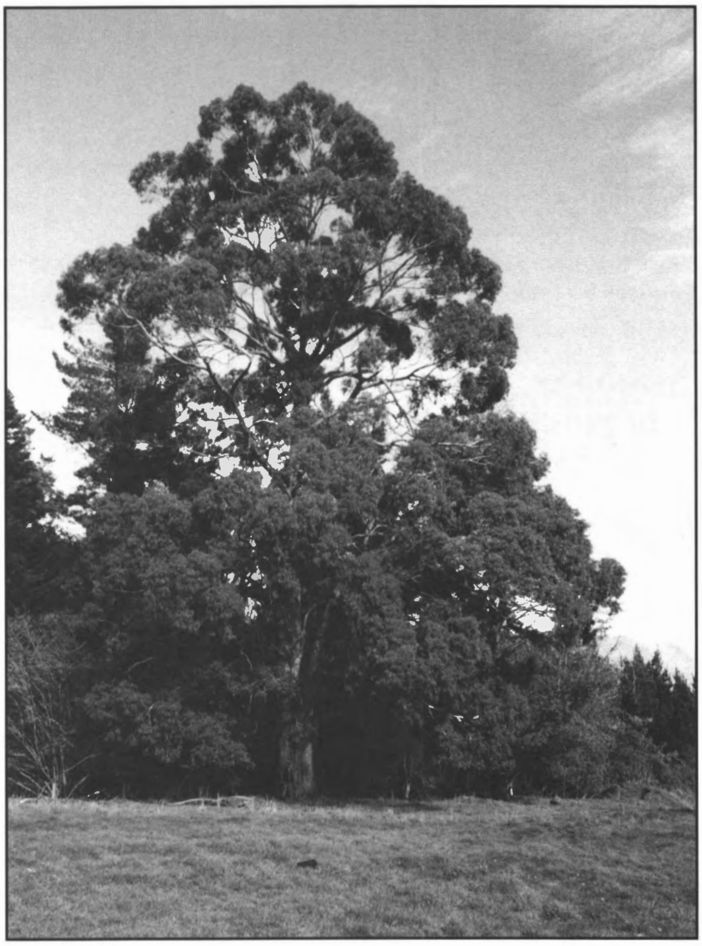


Figure 7

European aspen stems have made an attractive grove on the terrace site set aside for an arboretum annex.

nual rings measuring a remarkable 5cm. This tree had been 60cm in stem diameter at the age of 15. Unfortunately it was heavily branched from low down on the trunk and yielded no usable timber.

The slope on the western side of this area contains a number of important specimens, including tall trees of Australian alpine ash *(Eucalyptus delegatensis)* and Camden woollybutt that have been drawn up in the shade of a thicket of European aspen *(Populus tremula)*, some stems of which are among the biggest recorded for the species in New Zealand. A small stand of Japanese red pine *(Pinus densiflora)* is of interest, and there is an excellent specimen of Chinese poplar (the semi-evergreen *Populus yunnanensis)*. Spontaneous seedlings of Spanish fir *(Abies pinsapo)* were found here.

Harry Hart's notes record an experimental planting of South American beech species "behind No 1 cottage." This is presumably the rectangular area, next to the main path, that is enclosed by the remnants of a wire fence. The mixed species within this small plot include six of the nine South American beeches *(Nothofagus pumilo dombeyi, nitida, antarctica, alpina,* and *obliqua);* plus one of two dawn redwoods *(Metasequoia glyptostroboides);* an uncommon conifer, *Thujopsis dolobrata* 'Variegata', with its characteristic scattering of variegated foliage; and a rare shrub willow, *Salix acutifolia.* Both dawn redwoods are multi-stemmed. Harry Hart's notes record that the specimen in the beech compartment lost its leader before 1970. It was obtained by Mr Hart from the reserves department of the Christchurch City Council in 1950 and is thus of considerable historical interest, as it would have been from the original Chinese collections, distributed from the Arnold Arboretum in the United States. The species is the sole living representative of a very rare prehistoric conifer genus that has been described as a living fossil.

Deciduous trees of note further along the slope indude a tall walnut, a hybrid oak *(Quercus petraea' robur)*, a necklace poplar *(Populus deltoides)*, European beech *(Fagus sylvatica)*, elm *(Ulmus procera)*, a very tall sweet chestnut, desert ash, hornbeam *(Carpinus betulus)*, and European lime *(Tilia europaea)*. Outstanding conifers include two magnificent Grecian fir *(Abies cephalonica)*, planted in 1946, and well-grown Spanish fir and Atlas cedar. One of the Atlas cedars is a grafted specimen with exceptionally blue foliage. A plaque underneath it records that it was planted by Mrs Hart.

Also noteworthy are a magnificent Mexican cypress *(Cupressus lusitanica* var. *benthamii)* and a Mexican pine, *Pinus patula.* The latter, about 50 years old and about 144cm in diameter below the first low branch, was apparently obtained from the Christchurch City Council nursery. Harry Hart's notebook says that the seed was received from a Mr Taylor in California, but no record of it now exists at the nursery. Apart from its size, which is outstanding for a specimen growing so far south (this is mostly thought of as a North Island tree), the tree is notable for its bright yellow new needles and for the fact that it is a two-needle variety of a tree that is usually a three-needle pine.

Harry Hart's notebook also recorded the planting in this area in 1940 of a rare Chinese lacebark pine *(Pinus bungeana)* which by 1970 had attained a height of 20ft (6m). Unfortunately, this tree died before 1998. Its dead stems were removed during a cleanup in the winter of 2000. There are plans to replace it if a young plant becomes available.

Two specimens of the Californian coastal redwood *(Sequoia sempervirens)* were planted in this group in 1946 by Harry Hart, who recorded in his notebook in 1957 that they were "doing well." Both are now fine large trees, although the species, which favours a mild, humid climate, does not usually grow well in Canterbury.

Coleridge Downs Ltd, the adjoining sheep and cattle run which now owns this land, has agreed in principle to an arboretum trust proposal to manage this stand of trees as part of the Hart Arboretum and to initiate negotiations for a covenant or heritage designation covering the whole slope. Subject to a management plan and the removal of species of lesser importance, the group is worthy of collective preservation.

Some well-grown cedars, a large sugar pine *(Pinus lambertiana)*, and a few tree willows not yet identified, are of botanical or silvicultural interest on the area above this slope designated as the arboretum annex site. A large shelter belt of mixed pines, larch, and Douglas fir on the top slope includes *P. radiata, P.ponderosa, P.scopulorum,* and varieties of *P. nigra.*

Abies cephalonica
Thujopsis dolobrata 'Variegata'
Metasequoia glyptostroboides
Nothofagus spp
Populus yunnanensis
Populus tremula
Eucalyptus delegatensis

Abies concolor
Cedrus libani var. *atlantica*
Fraxinus angustifolia ssp. *oxycarpa*
Pinus lambertiana
Fagus sylvatica
Juglans regia
Sequoia sempervirens
Carpinus betulus
Pinus patula
Cupressus lusitanica var. *benthamii*
Castanea sativa

Hall Area

A flat area surrounding the community hall contains several species of interest. At the tennis courts the rare *Crataegus x lavallei* is spectacular when fruiting in autumn, and is worth preserving. Oaks planted in the vicinity of the hall include a scarlet oak planted in 1935 for the 25th anniversary of King George V, a pin-oak *(Quercus palustris),* well-grown Turkey oaks *(Quercus cerris),* English oak hybrids, and a more slender form of pin-oak *(Q. palustris* var).

Eucalypts include *E. delegatensis E. pulchella, E.macarthuri* and, in the school grounds, *E.viminalis and E.gunnii.* The school and surrounding grounds have been bought by Coleridge Downs, Ltd, and may eventually be used as an information centre. A plant of considerable importance within the school grounds is a large specimen of a shrubby conifer, *Cephalotaxus harringtonia* var. *drupacea,* the Japanese cow's tail pine. Native to mountainous regions of Japan and central China, this is a very rare species in New Zealand. Another group includes a pinyon pine and a Cox's juniper.

Cephalotaxus harringtonia var. *drupacea*
Juniperus recurva var. *coxii*
Pinus cembroides var. edulis

Botanical names used in this report are adopted from Rehder's *Manual of Cultivated Trees and Shrubs* New York, 1940; Silba's *Phytologia Memoirs VIII,* New York, 1986; *Flora of New Zealand,* Vol 4, Webb, Sykes, and Garnock-Jones, Lincoln, 1988.

The scientific expertise of Mr W.R. Sykes and Dr J.S. Sheppard was of considerable assistance in preparing this article, and is gratefully acknowledged.

[1]A full list of trees and shrubs propagated or planted by Harry Hart up to 1954 is among the records stored at the power station. Many of these plants, alas, have not survived.

[2]Harry' Hart kept a notebook for nearly 50 years and recorded in it details of the source, age, and growth rates of most of the trees that he planted. This notebook was given by Mr Hart shortly before his death in 1980 to the late Doug Dick, who was then secretary of the Central Canterbury Farm Forestry association. It is now held by the Centre Canterbury Arboretum Trust.

[3]Revised 1996 by G.C. Baker and D.W. Rooney

[4]All measurements listed in this article were taken in autumn, 1998.

How big is a tree?

Derrick Rooney

This question, frequently asked, looks simple and straightforward, but can be one of the most problematical for home gardeners.

What should you measure? The height? The spread of the branches? The trunk diameter? All three? Which is the most important? And how do you measure these things?

A large part of the problem is that the answers differ with the purposes for which trees are grown.

Mensuration, or the craft of measuring trees, is historically associated in New Zealand with forestry. The only full-time mensuration team in New Zealand was maintained by the old Forest Service, and one of its main tasks was the preparation of conversion tables from which log volumes could be calculated.

Many species of tree, particularly among conifers, vary in their growth habit in different parts of the country, usually by tending to grow taller and thinner in the north and shorter and bulkier in the south. The amount of taper in tree trunks can also vary from place to place. The tables enabled foresters to estimate, quite accurately, the volume of standing timber in particular plantations.

The mensuration team also made many measurements of outstanding specimen trees throughout New Zealand, and although it passed out of existence with the Forest Service about 14 years ago its records provide a useful historical guide to notable trees, both indigenous and introduced, at both local and national levels.

However, with the unavoidable philosophical bias towards forestry, these historical records have moulded the way in which New Zealanders look at trees. The emphasis was on over-all height and on trunk diameter, measured at nominal breast height (which varies between 1.2 and 1.5 metres internationally but is taken at 1.3 metres in New Zealand).

Basal area, another forestry technique used to measure stands of trees, is also oriented toward timber production. Sample plots are measured and averaged to calculate the percentage of each hectare of ground occupied by tree trunks. When heights and log tables are factored in, basal area can give a very accurate indication of the amount of standing timber.

Alas, neither of these techniques gives a clear indication of the actual size of trees.

The forester is primarily interested in log volume, and the forester's ideal tree is a single tall stem with little taper, a narrow crown, and light horizontal branches. A more desirable form for an ornamental tree, on the other hand, may be stocky and multi-stemmed, with a broad, spreading crown.

Arboriculturists, who deal mostly with urban and amenity trees, use over-all height and crown diameter as their primary measurements. These are much more useful data for home gardeners, to whom the amount of ground space covered by a tree and its top are more important than the volume of timber that it contains.

How do you make these measurements? Branch spread is easily measured, by simply running a measuring tape from several places at the perimeter of the branches to the base of the trunk. Make an average from the results, double it, and add the diameter of the trunk. To calculate the actual area covered by the crown of the tree, multiply the resulting number by itself, then by 3.14. To get the trunk diameter, run the tape measure around the base of the tree, and divide the result by 3.14.

Height is a little more difficult. Specialised, expensive equipment is needed for precise measurement, but a short piece of stick, or even a straw, can provide a close enough answer.

Attach a piece of paper to the trunk at a measured distance from the ground. Hold the stick vertically, at arm's length, and step back until the base of the tree and the top of the paper match the top and bottom of the stick. While standing still, move the stick, counting the number of times you do so, until you reach the top of the tree. Multiply the distance between the paper and the ground by the number of times you moved the stick. This will give you the approximate height of the tree. For example, if the paper were 2m from the ground and you moved the stick nine times, the tree would be 18m tall.

The Horticulture Industry Training Organisation – Where to From Here?

Mike Finlayson
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The New Zealand Horticulture Industry Training Organisation was formed in the early 1990s in response to the **Industry Training Act 1992**. The intent of the Act was that industry (rather than Government) manage its own training programmes, although some argue it was a cunning plan to get industry to pay for its own training programmes.

At the same time that Industry Training Organisations (or ITOs) were being established, the Government introduced a new system of training based on unit standards and a National Qualifications Framework. It was argued at the time that there were too many qualifications in New Zealand and that written examinations in practical trades such as horticulture only tested theory and not practical skills. Unit standards were supposed to mirror practical skills in the work place, although many of them were written as theory or knowledge skills and even worse, as a combination of the two. The Horticulture ITO developed unit standards and packaged these up into eleven different qualifications that were subsequently registered on the National Qualifications Framework.

The introduction of standards into tertiary education was an interesting move. The theory was that if very precise standards were written (as they are for say building a house), workplace trainers and polytechnic tutors across the country would always come up with exactly the same assessment results. However, the reality has been somewhat different and one need only listen to a group of tutors to realise that the interpretation of the standards differs quite significantly. Similarly the theory behind a national framework was that all qualifications would be either called a National Certificate (from Level 1-4 on the Framework) or a National Diploma (from Levels 5-7 on the Framework) for the sake of simplicity. Again the reality is somewhat different. Training institutions around the country are offering their own certificates and diplomas as well as National Certificates and Diplomas. In addition the universities have decided not to play ball with the new system at Level 8 (degree level) on the Framework.

Currently the ITO has 800 people (or 2% of the workforce) involved in training programmes across the horticultural industry in New Zealand. The majority of these people are studying towards National Certificates in Horticulture in the options: Amenity (34%), Nursery Production (20%), Fruit Production (16%), Landscape (10%), Organics (9%), Plant and Garden Retail (4%), Vegetable Production (4%), Floriculture (2%) and Forest Nursery (1%). In addition, around 35% of people are undertaking short training programmes that can lead into National Certificates. Typically these programmes involve training in pesticide safety (Growsafe), chainsaw safety, first aid, health and safety and communication.

If you gauge unit standards, the Framework and ITOs by statistics alone then the system can only be regarded as being an unqualified success. In June 1995 there were just under 18,400 people participating in industry training across all the ITOs. As at 31 December 2000 there were 63,000 people participating in industry training across all the ITOs and involving 22,000 employers. Over 6000 National Certificates were achieved in 2000 and $27 million in cash was invested by industry in training along with $65 million from Government. Despite the statistics, there are a number of challenges ahead for the Horticulture ITO. They are:

- Numbers of people involved in horticulture industry training have remained static over the past few years. It is difficult to say exactly what the critical mass should be but current numbers seem very low compared to the 8000 people involved in industry training in agriculture. Given a 28% increase in land in horticultural production since 1994 and major expansion in vegetable crops, apples, grapes and avocados in recent years it is difficult to see why numbers involved in industry training should not mirror this growth. However, perhaps the key question to address is what are the outcomes for people who complete horticultural training programmes? If they cannot find employment in the industry and have to go overseas to find work, then perhaps it may be best to limit the numbers of people trained in the industry.

- Only 46% of the training purchased by the ITO is actually being completed by students. There are a number of reasons for this not least of which is the very low credit value of the unit standards. The length of the qualifications may also be an issue. These issues will be addressed during the qualification review process underway at present. Interestingly unit standards tend to have the same effect as examinations in sifting and sorting people out.

- Only 25% of the ITO students are female despite the fact that they make up 44% of the work force. While the participation by females is higher than the average across all ITOs it does highlight a need to encourage women in horticulture industry training. Current initiatives are underway in the Plant and Garden Retail sector to encourage greater representation by women and this will be expanded into other sectors in due course.

- The average age of horticulture ITO students is 33. Probably of greater concern is that less than 6% of all ITO trainees are in the 15-19-age range. While apprenticeship training has been available through the ITO since its inception, the loss of apprenticeship wages being linked to that of a tradesperson has caused many employers to look for older staff. In other words there is not the financial incentive there once was for employers to take young people on board. The Government's Modern Apprenticeship Programme is aimed at getting more young people involved in training and modern apprenticeships in horticulture are now available through the ITO. The point remains that perhaps a financial incentive might have been a better carrot to employers to take on young people than the money made available for other aspects of the programme.

- Just under half of the ITO students come into the horticulture industry with either no school qualification or at best a 5th form qualification. Clearly there is a need for a more practical National Certificate at Level 2. There is also a need to consider addressing the public perception that horticulture is a soft option for those not doing so well at school. The credibility and clout of the horticulture industry in many ways is dependent on employers having a rigorous recruitment programme.

- There are many people in the horticulture industry who still mourn the loss of the cadet scheme and the old style apprenticeships where block course training forged friendships for life. Some of these people have turned their backs on the new system. The ITO must make the new system flexible enough to recreate some of the best features of the old system. In this respect, the Modern Apprenticeship Programme is probably as close to the old cadet and apprenticeship programmes as is possible to achieve.

The key challenge ahead for the ITO is to maximise the Government funding available for industry training. Whatever training system is in place and whatever its advantages and disadvantages, the key responsibility for any industry is to source the funds available and use the funding to best effect. Whether soil science, plant botany and pest, disease and weed control is delivered via unit standards or some other curriculum or examination prescription is almost irrelevant. The main point is that the training is actually delivered.

Iris Species in New Zealand

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There are no iris species native to New Zealand, although four Libertia species are iridaceous plants. Well before the establishment of the New Zealand Iris Society, more than 50 years ago, iris plants, bulbs and seeds were brought here and established well. Some would say too well as *Iris pseudacorus* and *Iris foetidissima* are now prohibited imports, and the current list of permitted imports includes only 78 iris species. The Society managed to increase the original smaller list by about 20 species two years ago and now has an application before the Environmental Risk Management Authority (ERMA) to further increase this list. We have provided evidence that another 104 species are or have been in New Zealand. Progress is discouraging, but as all those wonderful people who attended Symposium 2000 will testify we are not about to give up.

The Society supports the biosecurity regulations and agrees that we do not wish to add to the problems caused by 70 million possums and a range of exotic plants like ginger (in the far north), *Clematis vitalba,* banana passionfruit vine and tradescantia which threaten to strangle or suffocate reserves and native forest remnants. It seems difficult however, to persuade the authorities that irises like *I. korolkowii* or *I. galactica* are just not in the same league.

Although the situation is frustrating for gardeners wishing to grow a wider range of iris species a major advantage has been that the Society was forced to undertake an inventory. The list was compiled by a search of the literature, word of mouth and Group endeavour and may never be complete, but already it does provide a valuable resource.

Most of the better known bearded species grow well throughout the country although the forms of *I. germanica* confuse. *I. croatica, I. cypriana, I. mesopotamica* and *trojana* grown from seed bloomed for me for the first time last season, but Symposium visitors declared that none were 'true.' Although growing from seed is an absorbing pastime one has to wait a long time to prove that the seed was correctly labelled. I also doubt *I. taochia* but the foliage is so attractive it may be worth trying to pass on this attribute. *I. pallida* subsp. *pallida* grows well and we have two other forms, very pallida-like except in colour being dark blue and pink, but so far we have not been able to identify them more closely. *I. albicans has* naturalised in at least two areas - Northland and Central Otago - and both populations are healthy and vigorous.

The smaller bearded species are all well represented although they tend to be short-lived unless given fresh ground at regular intervals. One of the forms of *I. pumila* grown here is a SUSLIK seedling. The flowers are particularly iridescent, a quality rarely seen in modern cultivars. Such rarities as *I. timofejewii* may still flourish here. I have seen it bloom, but not in this garden.

In Section Psammiris *I. bloudowii* and I.*humilis* are in several other gardens but *I. mandschurica* only at the Dunedin Botanic Gardens. Most of the Oncos have been tried here but prove difficult to keep alive after flowering. Perhaps we relax then, but after bloom care seems particularly crucial. I have bloomed *I. lortetii* var. *samariae,* but the only pure onco here now is *I.sari* and it has not yet bloomed. *I. susiana,* however, has been growing well in the Hakataramea Valley since the 1960's, and blooms most years. Recently it was successfully shifted to its owner's new home. The operation was carried out over two years - once half the clump was established, the rest was relocated. The new planting is in a similar situation, dry and sunny and under the eaves of the house where it keeps dry in the winter. The harsh climate of this near high country location possibly contributes.

Regelias have also grown here and may still be cherished, but I have not seen any in bloom. There are no records for the two species in Section Hexapogon and although seed of various pseudoregelias has been offered in New Zealand I cannot be sure that any survive.

The Lophiris or crested iris do, however, flourish here. *I. latistyla* has probably never been here and it is doubtful that *I. formosana* survives but the rest do extremely well including *I japonica* f: *pallescens* which was imported from Canada some time ago. This grows very lushly for me and although it does not bloom well every year it can produce a stunning display. I *lacustris* is not a strong stayer, but efforts are being made to increase stock of this rather rare Evansia. Huge clumps of *I. wattii* grow well in the Dunedin Botanic Garden and the Rangitikei area north of Wellington. Havelock North on the east coast of the North Island seems a particularly favorable areas for crested iris.

In Series Chinensis *I. henryi* never seems to have reached these shores, but most of the others have been tried. *I. minutoaurea* does very well in an Invercargill garden and survives and sometimes flowers here. *I speculatrix* may still exist in the Hamilton Botanic Garden. The late Berry Judd grew this species particularly well, but most attempts to establish it elsewhere failed. Ron Goudswaard is tending the latest attempt and we all wish him great success as although one occasionally sees it listed we are not permitted to import fresh seed.

Iris verna has a precarious existence but delegates at the Otago Alpine Garden Group's Springtime Symposium last year saw it in bloom in one of the Dunedin tour gardens. My plant looks robust, but has not yet flowered.

Iris ruthenica was probably imported by Carl Teschner, a leading rock garden and alpine specialist in Dunedin 50 years ago. Many attempts to grow this species from seed produced plants of *I. hookeri* or *I. sintenisii.* After some grumbles in the NZIS Bulletin I was presented with two clumps reliably labelled *I. ruthenica.* Now that I am confident one of these was correctly labelled, I am mystified at the confusion. Brian Mathew in 'The Iris' clearly describes the grassy bright green leaves which are very distinctive. Unfortunately, *I. ruthenica* resents disturbance and my plant does not set seed. I have tried selfing it and shall continue to do so, but it is difficult meanwhile to distribute this attractive species more widely. It is a permitted import, but the few seeds I acquire every year merely increase my stock of *I. sintenisii* (the blue-grey form). All the setosas grow well here in a rather confused array. *I. hookeri* is enchanting and popular and some charming forms of var. *arctica* perform reliably.

Siberians are wonderful garden plants and some of the species, particularly *I.chrysographes, I. clarkei,* and *I. delavayi* are increasingly sought after. I have agonised over the accurate identification of *I. forrestii* and *I. wilsonii* and was somewhat relieved when Tomas Tamberg (pers. comm) said he doubts anyone has either species which exactly matches the original description as they hybridise so freely. I grow a dwarf form of *I. forrestii* which is a very pleasing and floriferous rock garden plant.

There are no records of *I. phragmitetorum,* but *I. typhifolia* is well represented. It does, however, seem to flower well in its first year, but only reluctantly thereafter.

Pacific Coast native iris do very well here, but most are unnamed hybrids. Attempts to import named cultivars proved an expensive failure. The species are well distributed in New Zealand but several are no longer permitted imports. My collection, grown from wild-collected seed, seems to be settling in after a tentative start, but these have yet to bloom.

Iris missouriensis (syn. *I. longipetala)* is well represented, but variable. Mary Richardson in Upper Hutt grows the most attractive form I have seen in bloom.

Apart from *I. pseudacorus* other Laevigatae species are permitted and widely and successfully grown. Strangely enough, the only species permitted in Series Hexagonae is *I. hexagona* which I have never seen in bloom. New Zealand has a specialist Louisiana nursery and *all* the species flourish here although they are more reluctant to bloom in the colder areas of the South Island.

Iris prismatica succeeds well even in my drier than optimum conditions. The white form bloomed exceptionally well last season but plants of var. *austrina* have not yet obliged.

Although some speakers mentioned spuria species I was disappointed that no-one offered to present a paper on this subject at Symposium 2000. It seems a particularly interesting series. Some blooms are so vibrant and the fragrance of *I. graminea* a seasonal delight. Even though spurias resent disturbance my collection was relocated to a special bed last year so that I may study them more closely. Although there were few blooms, the different foliage and habit make me optimistic that some will prove to be correctly labelled.

Some of the larger species like *I. crocea, I. orientalis* and *I. spuria* subsp. *spuria(?)* have naturalised in various areas and most of the species are widely grown in gardens. In the 1999 bloom season, before its move, *I. graminea* flowered particularly well, the blooms concentrated in the centre of the plant and forcing the foliage aside like a giant posy. The variety *pseudocyperus* is less exuberant but flowers most years.

I. kerneriana, however, I find very difficult to keep and am constantly growing fresh plants from seed. The best flowerings I have seen have been in the south of the South Island and I wonder if it needs moister and cooler conditions than I can provide. *I. pontica* continues to elude me, even though it is reported to grow in New Zealand. *Iris sintenisii* with metallic violet-blue often solitary flowers always looks as though it clings precariously to life. I have seen other forms which are taller and more exuberent and the blue-grey form can develop into very large clumps.

I. spuria subsp. *maritima* is another favourite - not very free-flowering yet, but the plant is beginning to look more established.

None of the Tenuifoliae are permitted imports, but the seed of several species has been in New Zealand. I have not, however, seen plants. *Iris lactea* is permitted and the various forms are widely grown.

There are no records of the Syriacae, but many of the unguiculares are in cultivation and some have naturalised in large colonies. *I. lazica* is not on the permitted list although I have plants which I hope will soon reach flowering size. There is some confusion about the various forms of the other unguiculares especially one known as *I. cretensis* with needle-like foliage. It is apparently a plant which totally resists any disturbance. The Cretan form is better known. The white form appears more short-lived than the others.

Only *I. decora in* the Subgenus Nepalensis is permitted and commonly grown. It seems to have a tendency to dwindle and maybe requires better nourishment.

I. serotina has not been recorded although Jean Stevens used to grow *I. boisseri.* Xiphium species are grown although *I. tingitana* is only easy for some.

Of the Junos only 7 are permitted imports but many of the others have succeeded for a time. *I. bucharica, I. magnifica* and *I. vicaria* grow successfully in several gardens and Maria Fairburn, co-ordinator of the National Iris Collection has a wonderfully floriferous plant of *I. cycloglossa.* Having a reputation for difficulty is an incentive to grow these interesting irises and Tony Hall's presentation at Symposium 2000 provided further inspiration.

Most reticulatas succeed here, and flowering as they do so early in spring, are much loved. The best populations of *I. reticulata,* however, are to be found in orchards or largely untended gardens where they multiply and bloom happily year after year. There is no record yet of *I. winkleri.*

I. dichotoma (syn. Pardanthopsis dichotoma) from seed from Mongolia grew but has succeeded further north.

Gwenda Harris owns Otepoto Garden Nursery which specialises in iris species and a variety of hybrids and cultivars. Otepopo is situated in North Otago just south of Oamaru in the South Island. The garden is fertile, relatively sheltered and most frosts are light. North Otago can, however, be subject to prolonged drought.