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ARTICLES

Front Cover Picture:
Kahili ginger (*Hedychium gardnerianum*), a handsome flower but also a menacing invasive weed threatening native forest areas especially in northern New Zealand (see page 10). Photograph A. E. Esler.

The Status of some Historic Cultivar Names in *Hebe*

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Introduction

Among New Zealand's native plants *Hebe* is arguably the genus that has most captured the imagination of horticulturists. Since the first hebes were introduced to gardens about 150 years ago (Metcalf, 1991; Chalk, 1988) many of the species have been cultivated and a very large number of cultivars selected and named.

The distinctiveness and worth of *Hebe* as a garden plant has long been recognised. In the first major work on the cultivation of native plants Cockayne (1924) devoted a chapter specifically to *Hebe* (then *Veronica),* and later (1929) transferred what he termed cultigens or garden species from *Veronica* to *Hebe.* Early nursery lists such as Baxter's Nursery cat. (1922, 1927), Duncan and Davies Nursery cat. (1925) and Horton's Nursery cat. (undated *c.* 1910) listed *Hebe* apart from other native plants. More recently the first book to be written on the cultivation of a New Zealand genus was devoted to *Hebe* (Chalk, 1988).

Today, many cultivars catalogued prior to the early 1930s are not available. For example, Baxter's Nursery cat. (1927) lists 120 hebes, and of these 72 (60%) are species and 48 (40%) are cultivars; of the cultivars only 14 (30%) are now in cultivation. Likewise, Bennett's Nursery list (*c.* 1930) has 151 hebes, and of these 85 (56%) are species and 66 (44%) are cultivars; of the cultivars only 21 (32%) are now cultivated. In both these examples a significant number (70% and 68% respectively) of listed cultivars are now only known as names in catalogues. For some the botanical status is yet to be determined. Fortunately, preserved in New Zealand herbaria are specimens bearing some of these names, although these are not necessarily representative of the original names as they may not have been correctly identified.

This paper clarifies the taxonomic and nomenclatural status for thirteen of these historic names. Five are horticultural names (Hort.) known only from herbarium specimens, two are treated as *incertae sedis* (uncertain position), one is accepted as a synonym of a species, and five are regarded as distinct cultivars and described for the first time. The publication of these names may bring to light new information and it would be interesting if some, in addition to *H.* X*dartonii* 'Dartonii', were found to be still cultivated.

Horticultural Names

Five of the herbarium specimens which were available for examination bore horticultural names (Hort.) not known to have been published. Such names have no formal status under the International Code of Nomenclature for Cultivated Plants (Brickell et al., 1980). However, the horticultural industry is rife with unpublished cultivar names so for accuracy and completeness the herbarium specimens accompanying these names have been checked; for each name the specimen is referrable to a species accepted in Allan (1961).

These five names, the herbarium specimens they are represented by, and the species they are identified as, are clarified as follows: *Veronica* 'Baxteri' Hort. (CHR 328484) = *H. canterburiensis* (J. Armstr.) L. Moore; *Veronica* 'McIntyreana' Hort. (Welt 13275) = *H. rupicola* (Cheeseman) Cockayne et Allan; *Veronica* 'McMahonii' Hort. (Welt 79884) = *H. decumbens* (J. Armstr.) Cockayne et Allan; *Veronica* 'Podofski' Hort. (CHR 328494) = *H. subalpina* (Cockayne) Cockayne et Allan; and *Veronica* 'Robertsii' Hort. (Welt 78982) = *H. subalpina* (Cockayne) Cockayne et Allan.

Incertae Sedis

For two of the names there is disagreement between the original description and the herbarium specimen. These names are treated as *incertae sedis* until further information becomes available that allows them to be linked with certainty to a particular plant.

H. 'Garviei' was a widely cultivated plant that was first described by Tannock (1924) as *Veronica* 'Garviei'. Tannock (1924) and Duncan and Davies Nursery cat. (1925) refer to the plant as a whipcord variety; but the only known herbarium specimen (CHR 328485), that was collected by A. Wall, has been identified by the author as *H. odora.* It is unlikely that Tannock and Duncan and Davies Nursery would have mistakenly assigned *H. odora* to the whipcord group. This suggests that Wall's collection was misidentified and does not represent *H.* 'Garviei'.

Various spellings have been given for 'Garviei': Bennett's Nursery list (*c.* 1930) as 'Garveyii'; Baxter's Nursery cat. (1927) and Duncan and Davies Nursery cat. (1925) as 'Garveii'; Tannock (1924) as 'Garvyii'; and herbarium specimen CHR 328485 as 'Gavii'.

The second cultivar treated as *incertae sedis* is *H.* 'Grahamii'. This name was first published in Baxter's Nursery cat. (1927, as *Veronica* 'Grahamii') where the plant is described as growing to four feet. This height contradicts that of a herbarium specimen (CHR 328488) labelled *H.* 'Grahamii' which has been identified as *H. dilatata,* a species with a low, decumbent habit. It would appear that the Wall specimen is a misidentification and does not represent *H.* 'Grahamii'. *H.* 'Grahamii' is not the same as *Veronica grahamii* Petrie, which is treated by Ashwin (in Allan 1961) as a heterotypic synonym of *Parahebe birleyi* (N.E. Brown) W. Oliver.

Synonym

The following published cultivar name is treated as a legitimate synonym of a species accepted in Allan (1961). For this name my main determination, the earliest reference, the representative specimen and any relevant notes are given.

Hebe 'Reidii' = *H. subalpina* (Cockayne) Cockayne et Allan. *Veronica* 'Reidii' (D. Tannock, *Rock Gardening in New Zealand,* 85 (1924) nomen nudum).

Representative Specimen: CHR 328495, *A. Wall*, Jan. 1923, cultivated Weatherstones.

Notes: The only references to this plant having been cultivated are listings in Duncan and Davies Nursery cat. (1925), Tannock (1924) and Kavka (1933); the last giving a brief description in German.

Distinct Cultivars

The following cultivars are accepted as being distinct and are described for the first time. With the exception of *Hebe* X*dartonii* 'Dartonii' they are not known to be in cultivation. No reference to *H.* 'Lady Fenwick' or *H.* 'Titan Hut' has been located but both are known to have been in cultivation and so are named and described here.

Hebe X*dartonii*

H. X*dartonii* (Petrie) Cockayne, pro sp. *Trans. NZ Inst.* 60: 470 (1929) = *Veronica dartonii* Petrie, *Trans. NZ Inst.* 55: 98 (1924).

Hebe X*dartonii* 'Dartonii'

Description: The following description is based on a plant cultivated at the Christchurch Botanic Gardens (accession 1914/78) (CHR 471137).

Branchlets glabrous, terete, stout, 10–20 cm long, *c.* 2.5–3.0 mm diameter; internode length 4x stem diameter. Leaves 20–25 x 5 mm, coriaceous, grey-green, elliptic-oblong; margin glabrous; apex acute; base attenuate. Leaf bud without a sinus. Inflorescence lateral, 18–26-flowered, up to 70 mm long. Bracts *c.* 4 mm long, ciliate on lower half, ± keeled, acute. Peduncle and rhachis with eglandular hairs; pedicel 1–2.5 mm long. Calyx lobes ± = bracts, ciliate, fused for 1/3 of length; anterior lobes slightly longer than posterior lobes. Corolla lavender, fading quickly to white; tube > calyx. Ovary and style glabrous. Capsule erect, *c.* 5 x 3 mm, pointed.

Representative Specimen: CHR 471137, *P.B. Heenan 48/91,* cultivated Christchurch Botanic Garden (accession 1914/78).

Parentage: A putative hybrid between *H. pimeleoides* var. *rupestris* and *H. salicifolia* (Moore in Allan 1961). A chromosome number of 2n=40 (M.I. Dawson pers. comm.) is consistent with the suggested parentage.

Notes: Several clones of *H. Xdartonii* have at various times been cultivated as is evidenced by herbarium specimens; for example, WELT 16799C, WELT 16800, WELT 13187, CHR 78104, CHR 328486, and CHR 97825. Moore (in Allan 1961) observed that this hybrid was well known in gardens at one time. It is also listed in Duncan and Davies Nursery cat. (1925) and Baxter Nursery cat. (1927). The plant described here as *H. Xdartonii* 'Dartonii' is the only clone of this hybrid to have been in cultivation in recent years. It has been misidentified at the Christchurch Botanic Garden as *H. pimeleoides* var. *rupestris* and more recently in a Wellington garden as *H. glaucophylla.*

***Hebe* 'Gowii'**

(Duncan and Davies Nursery cat., 22 (1925) as *Veronica* 'Gowii').

Description: This description is based on the only known herbarium specimen (CHR 205167).

Branchlets bifariously pubescent, terete; internode length twice stem diameter. Leaves 10–11 x 6–7 mm, glabrous, obovate apex obtuse; base cuneate; petiole glabrous. Leaf bud with a narrow, obscure sinus. Inflorescence lateral, simple or compound, many-flowered. Bracts *c.* 2 mm long, lanceolate, ciliolate; apex acute. Peduncle *c.* 10 mm long; rhachis 20–25 mm long pedicel c. 1 mm long. Peduncle, rhachis and pedicel covered in sparse eglandular hairs. Calyx *c.* 2 mm long; lobes ciliolate, with obtuse apex. Corolla tube 1.5–2 mm long, < calyx; corolla lobes *c.* 4 mm long. Ovary and style glabrous. Capsule not seen.

Fig. 1. *Hebe* 'Lady Fenwick' is not known to be in cultivation and is only known from this herbarium specimen (WELT 13526).

Representative Specimen: CHR 205167, *M. Talbot,* 4 June 1970, cultivated Malahide Castle, Dublin (as 'Goyii').

Parentage: The exact position of this plant within *Hebe* is difficult to determine. In a note on the herbarium specimen L.B. Moore states that it keys to near *H. canterburiensis* and that the leaves somewhat resemble *H. brockiei.* I keyed it to near *H. vernicosa,* a species closely related to *H. canterburiensis.* It is likely to be of hybrid origin, perhaps involving one or more of the above species as parents.

Notes: This plant is likely to have been named in honour of Gow who was an early plantsman in the Otago/ Southland area and may have been a friend of Hart and Darton (L.J. Metcalf pers. comm.).

Hebe 'Lady Fenwick'

Description: This description is based on the only known herbarium specimen (WELT 13526).

Branchlets stout, terete, with fine bifarious pubescence; internodes 4–5x stem diameter. Leaves 40–55 x 17–22 mm, oval to elliptic-oblong; petiole 4–5 mm long, glabrous; margin cartilaginous, pubescent; upper midrib pubescent; apex obtuse. Leaf bud with a sinus. Inflorescence a lateral raceme, exceeding leaves, 60 mm long. Peduncle 15–18 mm long; rhachis 40–50 mm long; pedicels 4 mm long; all with fine pubescence. Bracts glabrous, ciliolate; apex acute. Calyx *c.* 2.5 mm long; lobes sub-acute, glabrous, ciliolate. Corolla magenta-maroon colour (?); tube *c.* 3 mm long, > calyx; lobes 5 x 3 mm, sub-acute to obtuse. Capsule not seen.

Representative Specimen: WELT 13526, 29 January 1920, cultivated Mr H. Hart, Dunedin.

Parentage: This cultivar is very similar to *H. speciosa* but differs in two significant features; the branchlets have bifarious pubescence and the corolla lobe margins are glabrous. The plant is regarded as a *H. speciosa* hybrid, the other parent is not known.

Notes: There are no references to this plant having been in general cultivation.

Hebe 'Titan Hut'

Description: The following description is based on the only known herbarium specimen (WELT 78983).

Branchlets bifariously pubescent, terete, 50–60 mm long, *c.* 1.5 mm wide; internode length = stem diameter. Leaves 3–4 x *c.* 2 mm, sessile, patent, deltoid, thick, coriaceous; apex sub-acute; base truncate; margins glabrous. Leaf bud with a linear sinus. Inflorescence simple, lateral. Bracts *c.* 3 mm long, elliptic-lanceolate, ciliolate. Calyx *c.* 2.5–3 mm long; lobes ciliolate; apex obtuse. Corolla tube 3 mm long, > calyx. Ovary and style glabrous. Capsule not seen.

Representative Specimen: WELT 78983, *D. Petrie,* cultivated H.L. Darton ex Titan Hut, Garvie Mts.

Parentage: A hybrid between species from the Flagriformes (whipcord) and the Buxifoliatae groups of *Hebe.*

Notes: A note with WELT 78983 by H.L. Darton states that it grows to 15 cm high. Not widely grown as the only listing located is in Bennett's Nursery list (*c.* 1930).

Hebe 'Waikariensis'

(Duncan and Davies Nursery cat., 21 (1925) as *Veronica Waikariensis).*

Description: The following description is based on the only known herbarium specimen (CHR 328487).

Branchlets bifariously pubescent, terete, 50–80 cm long, *c.* 1.5 mm wide, erect; internode length twice stem diameter. Leaves (5)–6–8 mm long, sessile, patent, deltoid, thick, coriaceous, strongly keeled; apex acute; base truncate; margins ciliolate on lower half. Leaf bud with a linear sinus. Inflorescence a lateral raceme, with *c.* 20 flowers. Bracts 6 mm long, linear-lanceolate; margins ciliolate on lower half, narrowed to base with long eglandular hairs. Peduncle 3 mm long, sparsely covered with eglandular hairs; pedicel 1 mm long, densely covered with eglandular hairs; rhachis 25 mm long, hidden, densely covered with eglandular hairs. Calyx 2–2.5 mm long; lobes ciliate, linear-lanceolate. Corolla tube 3 mm long, ± = corolla lobes; corolla lobes appearing distorted or malformed. Ovary and style glabrous. Capsule not seen.

Representative Specimen: CHR 328487, *A. Wall,* Jan. 1923, cultivated Weatherstones.

Parentage: A hybrid between species from the Flagriformes (whipcord) and the Buxifoliatae groups of *Hebe.*

Notes: This plant is stated to be 15 cm high in Duncan and Davies Nursery cat. (1925) and Baxter's Nursery cat. (1927). A note on the herbarium specimen gives the origin as being possibly the Garvie Mts. It is listed in Baxter's Nursery cat. (1927) as *V. Waicariensis,* this is an orthographic error.

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Hebe 'Karo Golden Esk' — A New Cultivar

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Introduction

A new cultivar, *Hebe* 'Karo Golden Esk' (Fig. 1), selected and named by Botany Institute, DSIR Land Resources, is soon to be available to horticulturists. It is a superior garden plant selected for year-round colour and in particular its golden-green winter foliage, its outstanding performance in a variety of soil conditions, and its distinctive and attractive growth habit. This cultivar is a valuable addition to the range of hebes currently available, especially the whipcord species, their cultivars and hybrids.

History of Discovery

During March 1988 while undertaking a botanical survey of the Upper Esk Valley, Waimakariri River catchment, Canterbury, Dr. Brian Molloy, a DSIR botanist, discovered an unusual hebe amongst a population of *Hebe odora* on the margin of a tarn in the Nigger Stream, a tributary of the Esk River. The plant was about 30 cm tall with a straggly habit of growth and appeared in poor health, probably because of poor drainage. Although found amongst *H. odora* it was clearly not that species, nor did it look like *H. armstrongii* growing nearby on better drained sites. Dr. Molloy concluded that the plant was a natural hybrid between *H. odora* and *H. armstrongii* (see Fig. 2), as these two were the only hebes present and the hybrid was intermediate between them. Although the direction of the cross is unknown it is possible that *H. odora* is the maternal parent as the hybrid was found amongst a population of *H. odora*. Hybridism involving *H. armstrongii* had not been recorded before so the plant was something of a botanical curiosity. For this reason a few small branches were collected for propagation at the Botany Institute DSIR experimental nursery, Lincoln. The bulk of this wild hybrid was left intact.

Grown in a container this hebe formed an attractive, yellow-green to golden coloured, evenly foliaged plant, and its potential as an ornamental was evident. During the next three years this hybrid was trialled at the DSIR campus Lincoln where it has proved to be reliable under various garden conditions.

Description

This description is based on a plant raised from the original cuttings taken from the Upper Esk Valley.

Plant spreading, 40 cm tall and 80 cm wide after 3 years. Branchlets bifariously pubescent, terete, 20–30–(60) mm long, *c.* 1 mm wide, soft, flexible, yellow-green, becoming golden-green during winter; internode length ± = to leaf length. Leaves 2–3–(3.5) mm long, sessile, appressed when young, erecto-patent when mature, deltoid, thick, coriaceous; apex acute; margins glabrous; leaf bud with linear sinus. Inflorescence terminal, of up to 8 flowers. Bracts opposite, *c.* 2 mm long, ovate, weakly keeled, ciliolate, acute at apex. Peduncle *c.* 1.5 mm long, with eglandular hairs; individual flowers sessile, in opposite pairs. Calyx *c.* 3 mm long, ciliate; anterior lobes fused into a single obtuse or emarginate, ovate-oval segment, sometimes shortly split; posterior lobes keeled. Corolla white; tube > calyx. Capsule pale brown, latiseptate, ellipsoid, weakly veined, 4–5 x 2–2.2 mm. Seeds 2–(3) per locule, flattened, elliptic, orange-brown, (1.0)–1.3–1.7 x (0.7)–0.9–1.0 mm.

Representative Specimens: CHR 472217, *B.P.J. Molloy,* Nigger Stream, Esk River catchment, Canterbury; CHR 471136, *P.B. Heenan* 63/91, Cultivated Botany Institute DSIR Lincoln Experimental Gardens.

Parentage: *H.* 'Karo Golden Esk' is a natural hybrid between species from two different sections of *Hebe, H. odora* (Buxifoliatae) (tetraploid race) and *H. armstrongii* (Flagriformes). Its hybrid origin is supported by a chromosome number of 2n = 84 (CHR 471138) which is the same as both parents.

The name 'Karo Golden Esk' expresses three significant characteristics of this hybrid. Firstly, "Karo" is an acronym of "Known and Recorded Origin"; this name is to be attached to all cultivars released by the Botany Institute, DSIR, and indicates that these plants are correctly identified and named, their origin is known, and the recorded information about the plant is scientifically documented. The second word "Golden" refers to the foliage colour, in particular the golden-green winter colour. The final word "Esk" refers to the Esk River, the locality where the plant was originally discovered.

Similar Cultivars

Hebe 'Karo Golden Esk' is superficially similar to some whipcord hebe species, their named cultivars and hybrids. It is distinguished from *H. armstrongii, H. armstrongii* 'Winter Gold', *H. ochracea, H. ochracea* 'James Stirling', *H. cupressoides, H. hectorii* and *H. lycopodioides* by having only the top 8–12 pairs of leaves on each branchlet appressed to the stem, while those below this are spreading and diverge at an angle of between 45 and 60 degrees: in the

Fig. 1. Two plants of *Hebe* 'Karo Golden Esk' (left) and its presumed parents, *H. armstrongii* (right) and *H. odora* (centre background) at Lincoln. (Photo P. Heenan)

above-mentioned species and cultivars all the leaves are appressed to the stem, even on older branches. Its flowers are white whereas those of *H. cupressoides* and some plants of *H. armstrongii* are pale to strong mauve.

When compared with the named Flagriformes X Buxifoliatae hybrids in cultivation, *Hebe* 'Karo Golden Esk' is distinguished from the seldom grown *H.* 'Cassinioides' and the often grown *H.* 'Edinensis', *H.* 'Christensenii' and *H.* 'McKeanii' by the leaves. These four cultivars have all leaves erecto-patent, twice the size and never appressed to the stem as on the young branchlets of *Hebe* 'Karo Golden Esk'.

Hebe 'Karo Golden Esk' is clearly distinguished from the Buxifoliatae section of *Hebe*, and in particular *H. odora* and *H. odora* 'Anomala' by the leaves, for in these species they are several times larger, distinctly spreading, a dark green colour (new growth flushed red in the cultivar 'Anomala') and have a broad, usually heart-shaped, sinus in the bud.

Horticultural Assessment

In cultivation at DSIR Lincoln *Hebe* 'Karo Golden Esk' has been trialled in a range of soils which differ markedly in their texture, tilth and water-holding capacity. It has performed satisfactorily in heavy, moist, clay soils, and on light, dry, gravelly ones. However, like most hebes in cultivation it has performed best in average garden conditions where moisture is readily available and the soil is rich in organic matter and of excellent structure and tilth.

In three years of cultivation out-of-doors it has been subjected to ground temperatures of between –6°C to –8°C with no visible frost damage. Its parents, *H. odora* and *H. armstrongii*, are amongst the hardiest hebes, so like them it should be able to be grown in most localities in New Zealand.

The aesthetic qualities of *Hebe* 'Karo Golden Esk' are its soft, attractive, yellow-green and seasonally golden foliage that is unmatched by any other whipcord hebe or their hybrids.

The general appearance, apart from foliage colour, is reminiscent of *Coleonema pulchella* 'Sunset Gold', an Australian plant often grown today. Its uses in horticulture are as a general landscape or garden plant where its soft, golden-green foliage would be an ideal contrast amongst darker and/or larger leaved and flowering shrubs. Landscape gardeners with private companies or local authorities, could use this plant to great effect in mass plantings, as the even, quick-spreading growth provides ideal ground cover.

Fig. 2. *Hebe* 'Karo Golden Esk', and its presumed parents *H. armstrongii* (top left) and *H. odora* (top right), mounted for comparison on a herbarium sheet (CHR 472217) at Botany Institute DSIR Land Resources. (Photo R. Lamberts)

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Evaluation of Chinese Tree Species in Eastwoodhill Arboretum

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Introduction of exotic tree species is a most effective and economical way of expanding a country's forest resources and obtaining economic and social benefits. In New Zealand, Eastwoodhill Arboretum makes a great contribution to the collection of exotic tree species and preservation of plant resources. The tree species planted are potentially useful for timber, amenity, soil conservation and other goods and services. It is very important therefore to preserve the tree resources of the arboretum, so that useful species can be identified and propagated.

Eastwoodhill, which was established in 1910, contains a total of 8000 trees belonging to approximately 2600 species and cultivars, 75% of them from the northern hemisphere. A significant proportion of the collection (42%) is of Chinese origin. In most cases the present generation has been propagated from trees introduced at an early stage in the development of the arboretum. Among them are some trees which are:

- rare and endangered in their native habitat such as *Metasequoia glyptostroboides, Davidia involucrata* and *Ginkgo biloba;*
- timber trees such as *Cunninghamia lanceolata, Populus yunnanensis, Populus szechuanica, Pinus tabulaeformis, Betula platyphylla* var. *szechuanica, Tilia oliveri* and *Tilia mongolica;*
- other important economic trees including *Eucommia ulmoides, Quercus variabilis* and *Pistacia chinensis;*
- ornamental trees such as *Acer ginnala, Acer griseum, Acer paxii, Acer wilsoni, Fagus englerana* and *Lonicera maackii.*

The Aim of the Investigation

There are more than 500 Chinese tree species surviving from over 1000 initially planted in Eastwoodhill Arboretum. How have those trees grown? We have tried to answer these questions, at least in part, by aiming to:

(i) evaluate which Chinese tree species have been successful in terms of survival, growth and health;

(ii) compare the climate and soils of Eastwoodhill with those from where the species originated in China;

(iii) recommend which species should be more extensively studied in New Zealand, on the basis of their biological and ecological characters.

Eastwoodhill Arboretum

Location: Eastwoodhill is 35 km from Gisborne and encompasses 65 hectares. The elevation at the homestead is 150 m, with higher ridges to the north and west. Latitude is 38° 33' north and longitude 177° 40' east.

Soil: Three soil types are present; Gisborne sandy loam, Waitaha sandy loam and Waihua sandy loam and sandy silt. All are derived to a greater or lesser extent from volcanic ash.

Climate: The climate is wetter in winter than in summer; the annual average rainfall is 1090 mm of which over 40% falls in the period May to August.

Relative humidity ranges from 57–78% in January to 71–87% in July. Average temperature of the coldest month is about 8.5°C, and of the hottest month 18.5°C.

A summary of some climatic factors at Eastwoodhill and relevant areas in China is given in Table 1.

Table 1. Climatic comparison of Eastwoodhill and source areas in China.

	Annual Rainfall (mm)	Temperature (°C) Annual Mean	Mean Maximum	Mean Minimum
Eastwoodhill	1090	13.7	38.1	-3.1
Yunnan	1096	16.0	31.0	-2.0
Sichuan	1146	17.0	34.0	0.0
Tibet	406	8.0	28.0	-15.0
Guangdong	1722	22.0	36.0	2.0
Hunan	1324	18.0	39.0	-6.0
Guizhou	1300	15.0	32.0	-0.8
Fujian	914	19.0	32.0	4.0
Inner Mongolia	303	5.0	35.0	-30.0
Shaanxi	578	14.0	42.0	-13.0

Yunnan, Sichuan, Guizhou, Hunan, Guangdong and Fujian provinces lie in southern China, where although there are wide variations, the climate is more similar to that of New Zealand than is the case with the more northern provinces.

Study Methods

Over 1000 tree species of Chinese origin were introduced to Eastwoodhill, mostly during the period 1936–1990. Nearly one hundred species (belonging to 50 families and 55 genera) of the 500 which survived were measured in January 1992. In each case the height was recorded, and the d.b.h. (diameter at breast height) of trees, or d.g.l. (diameter at ground level) of shrubs.

To record the growth status of trees, we classified them into three categories, A, B and C, according to their vigour and health.

A: the trees had made very good growth and the crowns were vigorous with dark green leaves. They were free of disease and insect attack.

B: the trees had grown normally and appeared generally healthy.

C: the trees showed decreasing growth rates, and usually some yellow leaves, branch dieback, or disease and insect attack.

Results and Conclusions

- Eastwoodhill Arboretum, the largest in the southern hemisphere, has been very successful in introducing tree species of Chinese origin and preserving genes of these species. This is apparent from the data presented in the Appendix.

We found that some Chinese species grow better at Eastwoodhill than they do in their original sites. Examples are:

Metasequoia glyptostroboides, Populus yunnanensis, Quercus variabilis, Pinus tabulaeformis, Acer buergeranum, Acer henryi, Abies delavayi, Davidia involucrata, Gleditsia japonica, Tilia mongolica.

- In most cases success was correlated with the similarity or otherwise of the climatic conditions between Eastwoodhill and the original site in China (Table 1).

That is to say, species from the warmer, moister areas in southern China are most likely to be successfully introduced to New Zealand.

This is interesting because there is predominantly summer rainfall in all parts of China, while at Eastwoodhill the rainfall peaks in winter. It is generally accepted that it is better to introduce species from a summer rainfall to a winter rainfall climate than *vice versa.* (Some of the major failures of species transfer have resulted from moving winter rainfall species to a summer rainfall environment). We believe this is one of the reasons for the success of many of the trees in Eastwoodhill introduced from China.

● Soil type is not an important factor in determining the success of introductions.

Soil types present in the southern region of China are: podzolic, brown forest, gleys, korichnevie, solonchaks, yellow podzolic, rendzina, red podzolic, terra rossa, and yellow lateritic. In the northern forest steppe region, chernozems, solonchaks, ziero-korichnevie are the major soil types.

In Eastwoodhill Arboretum the dominant soil type is pumice with certain fertility differences caused by vegetation. On bare pumice soil it is very difficult for tree roots to penetrate the pan. Where there are trees on such soils, the structure has been modified, but it is still hard during dry periods. Following prolonged rain it becomes too wet and liable to erosion.

There are obviously large differences in soil type between Eastwoodhill and the regions of origin of the Chinese tree species. Many of the trees of Chinese origin come from areas with better soil but nevertheless perform well on pumice. This indicates that soil is not the main factor which influences the introduction of trees between regions.

● Growth potential is a factor which may influence the introduction of species from different regions.

Some species from the forest steppe region in northern China, for example *Pinus tabulaeformis, Tilia mongolica, Quercus mongolica* and *Ailanthus altissima,* have all grown well, and in fact grow better at Eastwoodhill than in their home site, despite the differences in climate and soil conditions. The climate of the north-eastern forest steppe region in China is strictly continental. The annual range of temperature can be more than 40°C. Mean January temperatures vary from –7°C in the south to –27°C in the north, while the July mean ranges from 18°C in the north to 25°C in the south. The annual precipitation amounts to 650 mm in the east, decreasing to 470 mm farther west, and is unevenly distributed during the year, peaking in the summer months. The length of the frost-free season is little more than 100 days. The soil is grey forest soil or leached chernozems. The environment is equally harsh in the north western forest steppe of China, where *Tilia mongolica* grows. Mean January temperatures there range from –7°C to –22°C and those for July from 18°C to 24°C. This area is more arid too, precipitation ranging from 300 mm in the west to 600 mm in the east, approximately half of it falling in summer. The soil is ziero-korichnevie.

It is apparent that the environment is very different from that at Eastwoodhill yet *Tilia mongolica* and *Quercus mongolica* grow well there. We believe that *Quercus mongolica* and *Tilia mongolica* have adapted to the harsh environmental conditions in China, but when introduced to Eastwoodhill where there is plenty of rain and warm weather, growth potential is such that they flourish in the new environment. Another example is *Metasequoia glyptostroboides* which has been introduced to over 50 countries where it generally grows well for the same reason.

Suggestion for Further Studies on the Introduced Species in Eastwoodhill

Eucommia ulmoides is an important economic tree, the bark of which provides a valuable medicine in China. Demand for this product is much higher than supply in world markets. Natural distribution of the species is in Guizhou, Hunan, Sichuan and the southern part of Shaanxi. It is normally a slow growing species but further studies on good provenances and new cultivation techniques are warranted.

Quercus variabilis is a valuable economical tree. Its bark forms an important raw material for industry, and the timber is suitable for flooring. It makes good growth at Eastwoodhill. Studies on bark utilisation and production are worth considering.

Davidia involucrata is a widely introduced ornamental tree with big white flowers like pigeons standing on top of the shoots. In order to cultivate it more widely, propagation and breeding techniques should be studied.

Acer griseum, Acer ginnala and *Acer paxii* are ornamental trees valued for their beautiful bark, fruits and leaves. They should be extensively planted in gardens and parks.

Taiwania cryptomerioides is a protected species in China and is regarded as a valuable tree worldwide. The regions in New Zealand where it can be cultivated should be identified.

Suggestions on Species That Should be Introduced into New Zealand from China

Populus tomentosa is a native tree of China. It has a wide distribution range from Liaoning in the north-east of China to Gansun in the north-west of China. Its stems are straight and form is good, with resistance to drought and frost conditions. Its timber is suitable for furniture and construction.

Taiwania flousiana is a large tree. It can grow to a height of 30–50 m with a straight trunk and its rate of growth can exceed that of Chinese fir under the same conditions. The timber is suitable for decorative purposes.

Thuja orientalis cultivars are common in New Zealand gardens but the type species is rarely seen and is not present at Eastwoodhill. In China this species has a long life span and is suitable for afforestation on a wide range of sites with dry, wet, cold or windy conditions. It is an ideal species for high country plantations and shelter on the plains. Its timber, which is red to brown in colour, is hard and heavy. It is durable and has good mechanical properties. It can be used for decoration and flooring.

Conclusions

1. An arboretum is a place where trees and shrubs are cultivated for educational and scientific purposes. The plantings at Eastwoodhill were established with several aims: to enhance education, scientific research, the preservation of tree resources, etc. A considerable number of the species of Chinese origin have successfully achieved these objectives. One of the reasons for this success is that the introduction of trees from a summer rainfall region to a winter rainfall environment has a higher success rate than the reverse.
2. Some trees of Chinese origin should be studied more extensively such as *Eucommia ulmoides, Quercus variabilis,* and *Davidia involucrata.*
3. We suggest that New Zealand should introduce more trees from China such as *Populus tomentosa, Taiwania flousiana* and *Thuja orientalis.*

Acknowledgements

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Appendix

GROWTH DATA OF CHINESE TREES IN EASTWOODHILL ARBORETUM

Tree Name	Age	dbh or dgl[1] (cm)	Height (m)	Growth Status
Abies delavayi	41	35.2	19.5	A
Acer amplum	43	21.0	10.4	A
A. buergeranum	54	47.0	18.0	A
A. griseum	36	8.2	5.2	A
A. henryi	34	36.4	11.7	A
A. henryi	34	22.9	7.0	A
A. paxii	34	30.0	19.9	A
A. wilsonii	36	26.5	10.3	A
Aesculus indica	54	61.0	18.6	A
Ailanthus altissima	—	55.8	31.9	A
Alnus cremastogyne	4	6.8	7.4	A
Amelanchier asiatica	36	26.5	10.1	A
Betula ermanii	36	28.9	13.2	A
B. platyphylla var. szechuanica	—	—	18.4	A
B. albo-sinensis var. septentrionalis	—	12.8	9.4	B
Buddleia officinalis	43	9.0	5.5	C
Catalpa bungei	4	2.8	1.7	A
C. fargesii	36	27.7	5.6	B
C. fargesii var. dycloxii	36	32.0	18.2	A
Chionanthus retusus	—	1.5	1.1	—
Crataegus wilsonii	43	16.0	5.9	C
Cupressus funebris	57	54.8	20.8	A
C. fenebris	57	51.2	22.3	A
C. duclaxiana	4	1.5	3.4	A
C. duclaxiana	36	51.6	17.0	A
Cornus controversa	5	2.2	0.8	C
Cunninghamia lanceolata	57	61.8	18.4	A
C. lanceolata	57	66.5	29.2	A
C. lanceolata	57	89.0	24.6	A
C. lanceolata	57	51	18.1	A
C. lanceolata	57	63.2	27.0	A
C. lanceolata (understorey)	57	25	8.3	C
Davidia involucrata	36	40.5	17.2	A
Ehretia macrophylla	36	33.4[1]	21.9	B
Emmenopterys henryi	36	24.5	10.8	A
Eucommia ulmoides	40	27.5	16.8	A
E. ulmoides	35	9.9	0.9	C
Euonymus lucidus	44	52.5	16.3	A
Fagus englerana	40	19.5	7.6	B
Fraxinus chinensis	40	32.8	8.0	B
F. chinensis var. acuminata	40	19.0	—	B
F. chinensis var. rhynchophylla	36	24.7	5.3	B
Gingko biloba	36	30.3	18.1	A
G. biloba	36	21.5	13.7	B
Gleditsia japonica	36	28.0	9.5	B
G. sinensis	36	—	14.0	A
Glochidion sp. ex China	36	9.4	9.0	B
Glyptostrobus lineatus (pensilis)	41	—	20.4	A
Gordonia axillaris	—	33.8[1]	2.2	A
Ilex	36	21.2[1]	5.3	A
I. corallina	42	27.5	11.4	A
I. fargesii	42	29.3	7.4	A
I. ilicifolia	33	8.1	6.7	A
I. macrocarpa	36	19.8	6.2	B
Juniperus chinensis	54	45.7	17.2	A
J. formosana	43	22.2	7.6	A
Keteleeria davidiana	43	45.0	15.2	A
Koelreuteria integrifolia	58	29.0	11.5	B
K. paniculata	32	40.5	12.4	A
K. paniculata var. apiculata	58	49.5	17.4	A
Lagerstroemia indica	58	34.8	11.2	A
Liquidambar formosana	52	32.5	13.2	C
L. formosana var. monticola	32	—	22.2	A
L. monticola	31	42.6	12.6	A
Lonicera maackii	54	28.8[1]	5.9	A
Magnolia delavayi	53	90.0[1]	15.8	A
M. dawsoniana	41	47.3[1]	15.9	A
M. officinalis	27	30.4	11.6	A
M. officinalis var. biloba	27	11.5	6.3	A
M. sargentiana var. robusta	36	38.4	15.0	A
M. sprengeri var. diva	40	38.5	7.6	A
Malus yunnanensis	—	22.0	17.6	B
Metasequoia glyptostroboides	38	113.0	25.7	A
Morus cathagana	32	43.1	12.7	A
Paulownia lilacina	—	18.2	8.5	?
P. fargesii	—	29.6	9.2	A
Photinia beauvardiana	36	27.6	11.9	A
P. beauvardiana	36	23.8	8.0	B
P. davidsoniae	58	48.5	25.0	A
Picea wilsonii	43	12.6	10.3	C
P. brachytyla var. squamea	41	39.3	25.1	A
Pinus armandii	—	87.0	24.1	A
P. griffithii	51	67.0	26.5	A
P. tabuliformis	43	49.3	24.0	A
Pistachia chinensis	42	37.5	—	A
Platycarya strobilacea	33	49.0	17.5	A
Podocarpus macrophyllus	42	16.8	6.0	B
Poliothyrsis sinensis	34	14.5	8.1	C
P. sinensis	36	26.4	12.6	A
Populus simonii	35	39.4	17.6	A
P. szechuanica	36	30.5	20.0	C
P. szechuanica	36	58.0	15.9	A
P. szechuanica	36	68.5	23.0	A
P. yunnanensis	52	100.0	39.3	A
Quercus acutissima	42	52.0	15.5	A
Q. glandulifera	36	32.4	11.1	A
Q. glauca	40	28.0	5.5	C
Q. mongolica	36	62.0	23.9	A
Q. salicina	43	50.0	11.4	A
Q. semecarpifolia	41	45.0	18.7	A
Q. variabilis	42	61.0	29.6	A
Salix matsudana	44	98.0	21.8	A
Sycopsis sinensis	52	51.0	16.3	A
Taiwania cryptomerioides	29	20.5	15.0	B
T. cryptomerioides	36	59.0	19.3	A
Taxus chinensis	36	26.2[1]	6.4	C
Tilia mongolica	36	49.8	13.4	A
T. oliveri	36	46.0	11.9	A

[1] = shrub. Figures in column 2 represent diameter at breast height (d.b.h.) of trees or diameter at ground level (d.g.l.) of shrubs.

Wild Ginger: Aggressive Invader of New Zealand's Native Forests

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Introduction

Wild ginger *(Hedychium gardnerianum* and *H. flavescens)* was introduced to New Zealand in the 1860s and has since been cultivated on a wide scale as a popular ornamental plant. Ginger originated in the jungle margins of India and in Madagascar and has thrived in the mild, moist conditions of northern New Zealand. Both species have escaped from cultivation and have established and perpetuated in the wild. Kahili ginger *(H. gardnerianum)* in particular has subsequently invaded large areas of indigenous forest in many areas of the northern part of the North Island as well as elsewhere in New Zealand. The presence of large wild ginger infestations limits the recruitment of native plant species in forest areas and this is likely to result in long-term changes in the character and structure of invaded forest communities. Control measures are currently being implemented against wild ginger but the task of controlling ginger on a wide scale will be costly, difficult and time consuming.

This article is concerned with the invasion of kahili ginger only, as it is this species which currently represents the greatest threat to New Zealand native forest. The Waitakere Ranges, west of the city of Auckland (Fig. 1), are used as a case study area, chosen because the invasion of wild ginger had progressed further there than anywhere else in the country.

The Weedy Qualities of Wild Ginger

Several ecological characteristics of wild ginger contribute to its success as an aggressive invader of native forest. The species is ecologically versatile, has a high competitive ability, can recover effectively after removal of top growth, matures relatively quickly, produces abundant seeds which are efficiently dispersed, reproduces by vegetative means and is capable of persisting at sites of establishment for long periods of time.

Ecological versatility. Wild ginger can successfully establish and grow in a range of different habitats. Field studies show that the species tends to grow most prolifically in open, light-filled environments on forest margins and in clearings as well as in particularly damp habitats. However, ginger demonstrates a remarkable ability to tolerate low-light conditions and was found to be growing in semi-shade and even in the full shade beneath the forest canopy. This ability has serious implications in terms of the capacity of wild ginger to invade native forests. The species evidently has the potential to germinate and grow in widespread areas of the forest to which seeds are dispersed and there is thus a large scope for future increases in infestation levels of ginger.

High competitive ability. The thick, matted rhizomes (generally horizontal surface or underground stems) and dense foliage of wild ginger prevent the establishment and growth of the seedlings of other plants by depriving them of essential requirements such as light, soil moisture and growing space. Young native plants in the vicinity of wild ginger are smothered by the large biomass of this prolifically growing plant. The high competitive ability of wild ginger enables its persistence and even dominance within invaded environments.

Abundant seed production and efficient dispersal. Kahili ginger produces red-coloured seeds in great abundance during the autumn and winter months. Seeds counted on kahili ginger seed heads removed from plants in the Waitakere Ranges varied in number from 20 to 600 per seed head, depending on the light

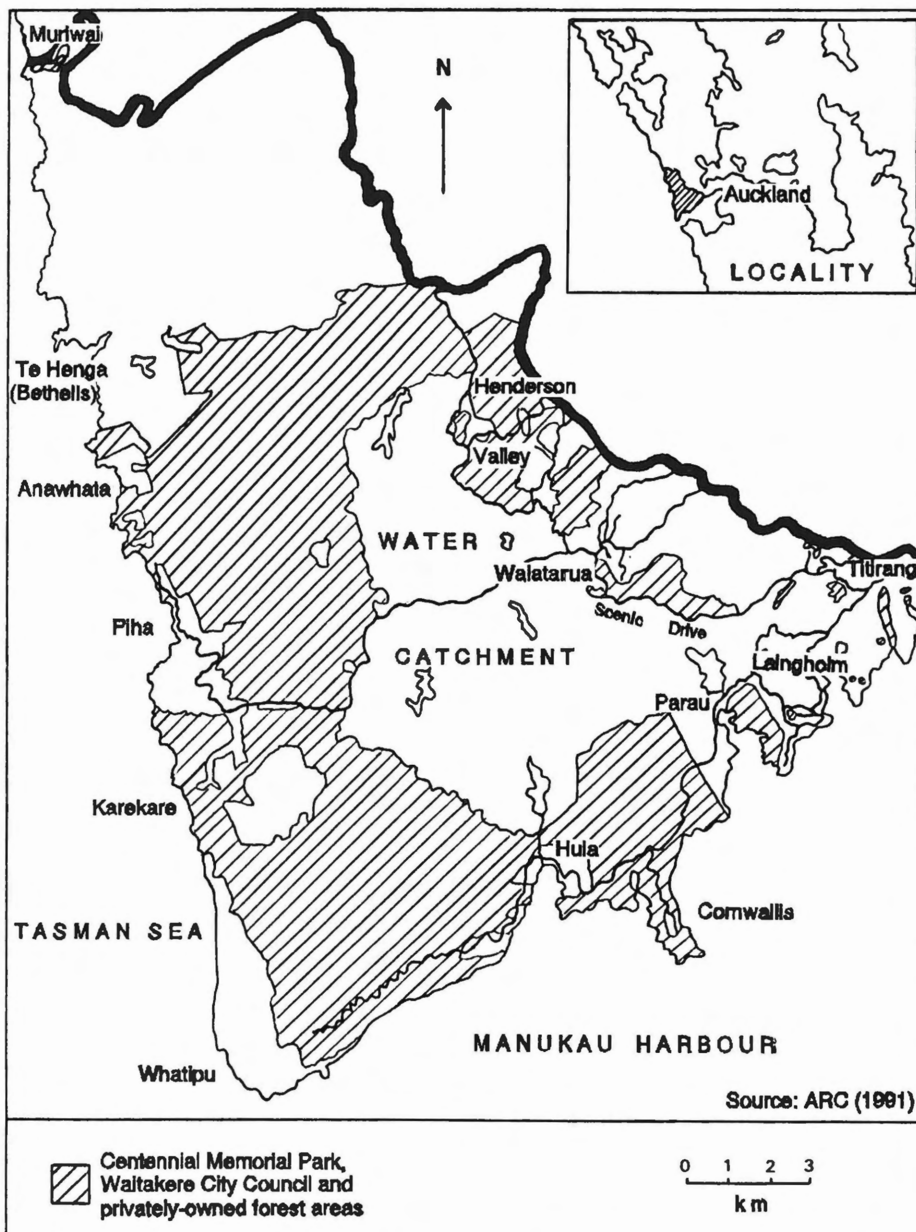

Fig. 1. Waitakere Ranges Ecological District.

conditions where the seed counts were made. Seed numbers of up to 900 per seed head have been recorded by Rhodes (1986). Seeds are dispersed efficiently by at least two bird species — the tui and the blackbird. The dispersal by birds of the abundantly produced seeds creates enormous scope for the spread of ginger into native forest.

Vegetative reproduction and recovery Ability. Vegetative reproduction is achieved by the spread of rhizomes which may branch out over extensive areas and can build up into deep beds reaching a depth of one metre or more. This form of reproduction means that once a ginger plant has established in a new location it can begin to spread laterally and can develop a sizable colony in its own right. This ability, in addition to the sexual reproductive ability, confers upon wild ginger considerable advantages as an invasive plant. Rhizomes also provide a means by which ginger plants are able to regrow after shoot removal or damage as new plants may develop from rhizomes discarded as garden refuse in forest areas or on forest margins as well as from plants which have been ineffectively controlled.

Persistence over time. Colonies of wild ginger can exist for extensive periods, with some colonies over 70 years of age showing no inclination of dying out (Craw, 1990). While in some instances colonies have been reported to die out when a tree canopy closed over them (Esler, 1988), the overall tenacity, active vegetative spread of the species and its capacity to tolerate shade favour the continued existence of plants that have invaded native forest.

Features of Invasible Forest Communities

Studies of the invasion of introduced plants at a general level suggest that characteristics of some natural communities make them more susceptible than others to invasion (e.g. Pimm, 1989; Williams and Timmins, 1990). Invasibility is influenced by both natural and human factors. The invasion of wild ginger in the Waitakere Ranges was found to be facilitated by several features of native forest communities in that area.

Fragmentation of native forests. Fragmentation of natural ecosystems by human activities into small remnants can enhance the overall susceptibility of an area's flora to invasion by introduced plants (Williams and Timmins, 1990). Compared with large forest areas, remnants have a longer forest edge with respect to area which is exposed to the external influence of human-modified landscapes. This higher edge/area ratio means that small forest remnants are comparatively more susceptible than larger areas to the import and spread of non-native plant propagules from surrounding areas of cultivation.

Fig. 2. Infestation of kahili ginger, Atkinson Park, Titirangi.

Native forest in the eastern parts of the Waitakere Ranges, in particular, is typically distributed in a disconnected pattern of regenerating remnants of widely varying shapes and sizes, owing to a history of logging, burning, and agricultural and urban development. Wild ginger is grown, whether intentionally or otherwise, in the majority of private gardens in these parts of the ranges (e.g. in Titirangi, Laingholm and Waiatarua). In these areas wild ginger has encroached into many forest remnants and has established successfully in these forests, sometimes forming a dominant component of the understorey layer. The fragmented forests of the Waitakere Ranges also tend to be more ecologically disturbed than other comparatively more isolated forests and this factor further assists the invasion and establishment of wild ginger.

Community disturbance. There is a well recognised tendency worldwide for alien plants to occupy and invade environments that have been disturbed or modified by human activity (Pimm, 1989; Heywood, 1989). The key effect of environmental disturbance is that it frequently leads to the increased availability of a limiting resource such as growing space or light. This can pave the way for invasion by non-native species if propagules of these plants are able to disperse into the community (Fox and Fox, 1986).

In the Waitakere Ranges disturbances such as vegetation clearance and the presence of walking tracks and artificial drainage courses lead to such resource changes as increased light levels, higher soil moisture levels and increases in available growing space. These disturbances are all favourable to the establishment and growth of wild ginger. Tracks and drainage courses also provide a means by which propagules of wild ginger may be transported into the native forests.

Successional stage. Susceptibility of a community to invasion by introduced plants is also related to the stage in succession which a particular ecosystem has reached. Communities in early successional stages are ecologically unsaturated and more open to establishment by new plant species. Late successional or climax communities are relatively resistant to new entrants (such as invasive plants) as available niches are filled and competition between species is more highly advanced (Pimm, 1989).

Secondary forests now occupy a large part of the Waitakere Ranges. Secondary successional processes which have been underway since timber milling, burning and farming ended have thus far led to the development of secondary broadleaf and tree fern forests, *Leptospermum scoparium* (manuka)/*Kunzea ericoides* (kanuka) scrublands with emergent *Agathis australis* (kauri) and podocarps. In these forests a dense tree canopy is generally absent and there is an abundance of canopy clearings because of the relatively short turnover cycle between generations. The resulting abundance of growing space and relatively high light levels within the forests and in clearings provide a highly suitable environment for the widespread invasion of wild ginger.

Patterns and Influences of Wild Ginger Invasion

Wild ginger has escaped from cultivation and has established successfully within protected native forest in the semi-urban suburbs of Titirangi, Laingholm and Waiatarua on the eastern slopes of the Waitakere Ranges, around the coastal areas of Muriwai, Bethells, Anawhata, Piha, Karekare and Whatipu, and near the Manukau Harbour settlements of Huia and Cornwallis. Large areas of native forest elsewhere in the Waitakere Ranges have, however, been excluded to date from the invasion of ginger and have thus mainly retained the indigenous character. Much forested park and water catchment land of the western and central ranges is sufficiently isolated from human settlement and the key areas of ginger infestation that a low degree of susceptibility to encroachment by wild ginger has been maintained.

Field studies show that ginger infestation levels tend to be highest in tracts of native forest which are fragmented, located side-by-side with sites of human settlement and which are relatively small in size. The level of ginger abundance in forests is generally greatest where the supply of ginger seeds from surrounding areas is most plentiful. In

Titirangi and Laingholm in particular the fragmented nature of native forests, the juxtaposition of human settlement and forest environments, the small size of many forest reserves as well as the extremely widespread occurrence of ginger in private gardens and on roadsides have enabled significant invasions of wild ginger to occur into many areas of native forest.

Vegetation surveys and transect studies show that distance into the forest in relation to the forest margin is the key factor influencing the amount of ginger growing at any particular site. Large infestations of wild ginger tend to be concentrated in close proximity (within 20 m) to the forest margin. Levels of infestation tend to decline beyond this point with a more scattered nature of distribution generally being apparent. In general, beyond a distance of approximately 100 m from the forest margin the distribution of wild ginger is very sparse.

A number of other influences on ginger abundance in native forest are superimposed upon this general 'distance-decay' pattern. These include the presence of interior forest edges and clearings, variations in light intensity and soil moisture and differences in native tree canopy type. In many field locations large clumps of profusely growing wild ginger were growing along track or stream edges and in canopy clearings created by tree-fall or vegetation clearance. Ginger establishment and growth tend to be favoured by the lighter environments along edges and in clearings and also by moist conditions on stream banks and in poorly drained areas. Fieldwork results also show that ginger often does not establish or at least does not grow beyond the seedling stage under tree fern or kauri canopies. A possible reason for this pattern is the dry, acidic nature of the fibrous litter layer beneath such canopies which could inhibit the establishment of ginger.

A further influence on the level of wild ginger infestation in any particular forest area is the time period over which the invasion has occurred. With the passage of time since the onset of invasion both the ginger abundance and the spatial extent of invasion are likely to increase.

Current and Potential Levels of Wild Ginger Infestation

In parts of the Waitakere Ranges wild ginger has invaded native forest to the extent that it has out-competed nearly all other forest understorey plants and become the dominant understorey species. Particularly in Titirangi and Laingholm very dense colonies of ginger plants with tough, extensive rhizome beds can be found growing in fragmented tracts of secondary forest. While such infestations are at present still relatively localised, there is massive potential for the expansion of these invasions into ever larger areas of native forest in the future, if control measures are not continued.

Fig. 3. Seeding kahili ginger.

An indication of the possible scope of future invasions of wild ginger is given in the consideration of ginger invasions in the Azores Islands of the mid-North Atlantic Ocean and in Hawaii. In the Azores wild ginger is a significant threat to the native laurel-juniper forest and has also invaded and led to the gradual death of entire woods of well grown pine and *Acacia melanoxylon* (wattle) trees (Roper, 1960). In Hawaii wild ginger has proved capable of forming dense stands even in the heavy shade beneath a native rain forest canopy and major infestations occur on several islands (Cuddihy and Stone, 1990).

The favourability of the Waitakere Ranges in terms of the climate (mild and moist) and of the native forest environment (often fragmented, disturbed and of a secondary nature) combined with the weedy qualities of wild ginger pave the way for ever higher levels of abundance of ginger at increasing distances from the forest margin. In the absence of control measures, this progressive spread of wild ginger through tracts of native forest would have an extensive and long-term impact on native ecosystems in the area.

Impact of Wild Ginger on Native Forests

The presence of invasive plants in protected natural areas represents one of the most serious threats to the perpetuation of these communities in many areas of the world (Heywood, 1989). In New Zealand, Esler and Esler (1986a, p.23) state that

"...forest remnants which have suffered from milling, burning and browsing are likely to be affected more seriously by the mixing of the alien and native floras than by all the past depredations."

The invasion by wild ginger in native forest has several adverse effects on the natural environment. The regeneration of native plant species is prevented in sites that are occupied by wild ginger, as not only are smaller plants in the vicinity of ginger suppressed by the large biomass of the plant (Esler, 1988) but also seedling establishment in these sites is severely limited. In addition, the large rhizome system of adult wild ginger plants is believed to absorb such large quantities of soil moisture, particularly during summer months, that moisture stress is placed on mature trees under or near which ginger has established (Craw, 1990; Smart, 1990). A further effect of wild ginger has been noted where prolific colonies of the plant have established in open stream bed environments and water flow is impeded (Esler, 1988).

The repression of native regeneration by wild ginger is likely to be the most significant impact of ginger on native forest communities of the Waitakere Ranges. Studies of the repression of regeneration by other forest invasive plants (Kelly and Skipworth, 1984: Macdonald, Loope, Usher and Hamann, 1989) show that this process can prevent the replacement of the forest canopy once forest dominants die, can lead to the disappearance of a diverse native ground layer and can reduce the species diversity of a forest community. Such effects are serious disruptions to the native ecosystem and may permanently alter the character of a plant community by influencing the process of succession. The development of a community towards a complex and diverse climax state may be hindered where large areas of the forest understorey are dominated by an invasive plant and where

Fig. 4. Rhizome system of wild ginger.

the regeneration of native species is subsequently suppressed on a wide scale.

Field results. Results of field studies undertaken to assess the impact of wild ginger on native seedling establishment indicate that native regeneration is repressed by approximately 90% amongst dense colonies of adult ginger plants. Although some native seedlings and saplings were found to be growing amongst wild ginger at all sample sites it is highly unlikely that such plants will develop to maturity, in view of the high competitive ability of wild ginger.

In the light of fieldwork results it is predicted that the replacement of the native forest understorey by wild ginger will have long-term effects on the successional processes of invaded forest communities, resulting in the formation of monotypic stands of ginger with the exclusion of all native plants in such areas.

At present the impact of wild ginger upon native regeneration is likely to be greatest in parts of forest areas which are near to the forest margin, in canopy clearings and along interior forest edges. On a broader level, effects are likely to be greatest in Titirangi and Laingholm and particularly in forest reserves in these areas which have been subjected to high levels of ginger invasion. If wide-scale control of wild ginger is not continued the conservation values of ever increasing areas of native forest will be considerably degraded as a diverse understorey and, ultimately, also the canopy are replaced by this highly successful invasive plant.

Control of Wild Ginger

A number of problems are associated with the control of wild ginger. These include physical problems which arise from the high levels of infestation present in many areas and the widespread nature of the invasion as well as problems associated with the resilience of the plant. The large, thick, deeply rooted rhizomes of ginger mean that mechanical control by digging is difficult, laborious and costly, with an added disadvantage being that plants are likely to regrow from any rhizome fragments not removed or left lying on the ground surface. Other problems of a cultural nature exist in the management of wild ginger. These include, for example, public apathy and a lack of co-ordination of control programmes.

Methods which have been utilised to date to control wild ginger in the Waitakere Ranges fall into two categories: manual/mechanical and chemical control. Manual and mechanical methods include: hand removal of ginger seedlings, breaking and slashing of ginger shoots, flower and seed head removal and digging. Chemical control has involved the use of a number of herbicides, but the sulfonyl urea herbicide 'Escort' has so far proved to be the only completely effective means of chemical control. Biological control is another option which is currently being considered for further control programmes.

The continuation and further development of an integrated approach to the management of wild ginger is probably the most appropriate policy direction to take, considering the range of physical and cultural measures which are necessary to effectively control wild ginger. The components of this integrated approach include not only control by manual/mechanical and chemical means but also follow-up procedures (e.g. replanting of native species), reduction of ecosystem disturbance, further research and the encouragement of public awareness and participation in control by further education initiatives.

Achievements of wild ginger control. A considerable amount of work has already been done in the Waitakere Ranges to control wild ginger. Residents, community groups, a Maori trust group and others have all been involved in digging out ginger infestations, both on forest margins and within the forest itself. Chemical control by Escort has been achieved on a wide scale across the Waitakere Ranges by local and regional councils, individuals and community and environmental groups. In June 1991 both kahili and yellow ginger were classified as class B noxious plants, making possible the enforcement of control on landowners. While many infestations of wild ginger have been eliminated through these efforts, a vast amount of time, labour and money is still required in order to sufficiently avert the spread of this aggressive invasive plant.

Possible targets of wild ginger control. The study of wild ginger invasion and control in the Waitakere Ranges concluded that total eradication of wild ginger in that area will not in fact be possible. A more practical objective of control would be to reduce the population of ginger to a level that would enable the invaded forest communities to perpetuate in only slightly modified form. This could involve:

i) the reduction of the population of ginger to the greatest possible extent in areas of highest conservation value and of relatively low infestation (e.g. much of the Auckland Regional Council Centennial Memorial Park land), in order to minimise the threat of future invasion and the impact of ginger on these native communities.

ii) the control of wild ginger as far as is economically possible in other forest areas where the level of ginger invasion is highest, particularly in Titirangi and Laingholm. In these latter forest areas many plants are likely to remain uncontrolled. If, however, major infestations and large plants are eliminated the impact of ginger on native forest ecosystems will be minimised.

Conclusion

Wild ginger has had great success as an invasive plant in the forest environments of the Waitakere Ranges, particularly in the past 5–10 years. The species has also invaded other areas of native forest in New Zealand, for example in Northland, Coromandel, and in the Egmont-Wanganui area. Esler (1986) ominously states that "... in New Zealand we are seeing just the beginning of an infestation" of wild ginger. The spatial extent of these invasions is likely to increase considerably over time. This increase will be related to the ecological characteristics of wild ginger and vulnerability of the many fragmented and often ecologically disturbed forest environments to invasion by introduced plants.

The impact of current and future infestations of wild ginger in New Zealand native forests on the regeneration of native species could be considerable, especially in places where ginger forms a major component of the forest understorey. In such areas, for example in many parts of Northland as well as in the Waitakere Ranges, the inhibition of native regeneration could ultimately result in the replacement of large tracts of native forest by solid stands of wild ginger. Effective management of this invasive plant is therefore essential and should involve the classification of wild ginger as a Class B noxious plant in *all* areas in which ginger has invaded or threatens to invade native forest. This would give greater credibility to management efforts and would be likely to accelerate the widespread control of ginger.

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Note: This article summarises the findings of a Geography MSc thesis completed by the author in February 1992, at the University of Auckland.

Plant Raisers' Award 1992

Mr Terence Charles Hatch, Pukekohe, received the 1992 RNZIH Plant Raisers' Award for achievements in the selection and introduction of different plants. Terry Hatch is an "old-fashioned" nurseryman, one who is interested in plants of distinction — connoisseur plants — rather than in marketing. His specialty is a wide range of perennials and bulbs. He is not content merely with introducing from overseas new and improved forms of plants but has been involved in a number of breeding and selection programmes. These have earned him recognition throughout the world. He has produced alstroemerias, dwarf watsonias, nerines, wallflowers, callas, osteospermums, all of them of considerable horticultural merit, and he continues to improve these and to work with other groups of plants such as cyclamens. Not all his successes have been formally named or described but the most outstanding include:

Alstroemeria 'Pink Joy'

Crosses were made of the original Dutch "Butterfly" hybrids, most of which are sterile. Three seedlings were produced and these were crossed further to produce a range of light to dark pink hybrids which are good garden plants and are also suitable for picking. The most notable is *Alstroemeria* 'Pink Joy'.

Osteospermum

Osteospermum 'Whirligig' (renamed 'Starry Eyes' by other nurseries)

Osteospermum 'Whirly Pink'

These are outstanding cultivars now widely grown in New Zealand, Europe and the United States.

Cheiranthus

Two very fine selections 'Joy Gold' and 'Winter Joy' are now widely distributed.

Nerine

N. sarniensis hybrids of the R.E. Harrison collection were crossed with the objective of getting bigger flowers of a better colour range, freely flowering and virus-free. Other aims were to get double flowers and polyploid plants. Two outstanding cultivars have so far been named:

'Anzac' — which has tall stems and large, brilliant red flowers, consistently in bloom on Anzac Day.

'Peace Dove' — this has long stems, up to 1.2 m tall, and large flower heads of soft (bridal) white tinged with pink. The plants sometimes flower twice in a season and the flowers are long lasting.

Work is continuing on *N. sarniensis* x *N. bowdenii* hybrids and crosses of nerines with *Lycoris aurea* and *Brunsvigia.*

Callas

A number of good *Zantedeschia* cultivars, notable for stem length and their suitability as cut flowers, were developed in the 1970s and released in 1983. These were named after fruits of the spirit.

'Faithfulness'	—	flame
'Gentleness'	—	pink
'Goodness'	—	gold
'Hope'	—	nectarine
'Joy'	—	copper
'Love'	—	salmon
'Peace'	—	rose

The names of some of these cultivars have subsequently been changed by other nurserymen.

One further selection, 'King Copper', with large copper flowers on long stems, has not yet been released.

Rhizosphere Microorganisms — Benefactors or Opportunists?

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Introduction

Microorganisms associated with plant roots have beneficial effects on plant growth by providing growth factors, plant-usable mineral nutrients from decaying organic matter, and by producing chemicals that inhibit the growth of root pathogenic fungi, bacteria and nematodes. Some of the microorganisms in the root zone may affect plant growth adversely by being pathogenic to plant roots or having inhibitory effects on root growth and development. In recent years researchers have been increasing their efforts to understand the biological activities of the root zone with a view to exploiting beneficial microorganisms for root disease control. Plant roots and the soil surrounding them form a complex environment inhabited by numerous groups of micro- and macro-organisms. Beneficial organisms include mycorrhizal fungi, nitrogen-fixing bacteria (rhizobia and free-living nitrogen-fixing bacteria), plant-growth-promoting rhizobacteria (PGPR, see later) and earthworms. Harmful organisms include root pathogenic fungi and bacteria, deleterious rhizosphere microorganisms (DRMO), soil insect pests and plant-parasitic nematodes. Most of the other organisms inhabiting the soil are regarded as having no direct effect on the growth and development of plants. This article briefly discusses beneficial and deleterious effects of rhizobacteria on plant growth.

Definitions

The rhizoplane: This term is applied to the root-soil interface, the surface of the root.

The rhizosphere: Refers to the region immediately surrounding the root and influenced by the root.

Rhizobacteria: Used to describe groups of bacteria that have co-evolved with plants and are able to aggressively colonise plant roots. They may have beneficial effects, deleterious effects or no direct effects on plant growth. It is important to differentiate rhizobacteria from other rhizosphere and rhizoplane bacteria which are frequently isolated from this region but are not true root colonisers. The latter may be transient or isolated by chance.

Plant-growth-promoting rhizobacteria (PGPR): This term describes bacteria that colonise roots actively and cause plant growth promotion. This is a relatively recent concept first described by Schroth and his co-workers (see Schroth and Hancock, 1981).

Deleterious rhizosphere microorganisms (DRMO): This term describes rhizobacteria and root-colonising fungi that are deleterious to plant growth but are not truly pathogenic.

Siderophores: These are compounds produced by soil bacteria, particularly *Pseudomonas* spp., which are able to chelate or take up iron. The chelating action of the compounds deprive root pathogens of iron and inhibit their growth and hence reduce their pathogenicity.

The Rhizosphere Environment

The rhizosphere is a rich environment. Here the organic substances are constantly released from plant roots in the form of root secretions and shedding of root hairs and root caps. These become food for microorganisms. The nature and the amount of root secretions vary with season, soil moisture, diversity and age of plant species, etc. It is therefore a region of high biological activity compared with the rest of the soil. During seed germination and root growth many bacteria and fungi become closely associated with the rhizoplane and the rhizosphere. It has been found that during the first five days of the growth of wheat roots in soil, bacteria on the root surface increased about 100-fold, but over the next five days only increased about twofold (van Vuurde and Schippers, 1980). This decline in the rate of increase of the population may be caused by depletion of a nutrient or predation of the bacteria by other fauna such as amoebae. Clarholm (1985) advanced the hypothesis that the

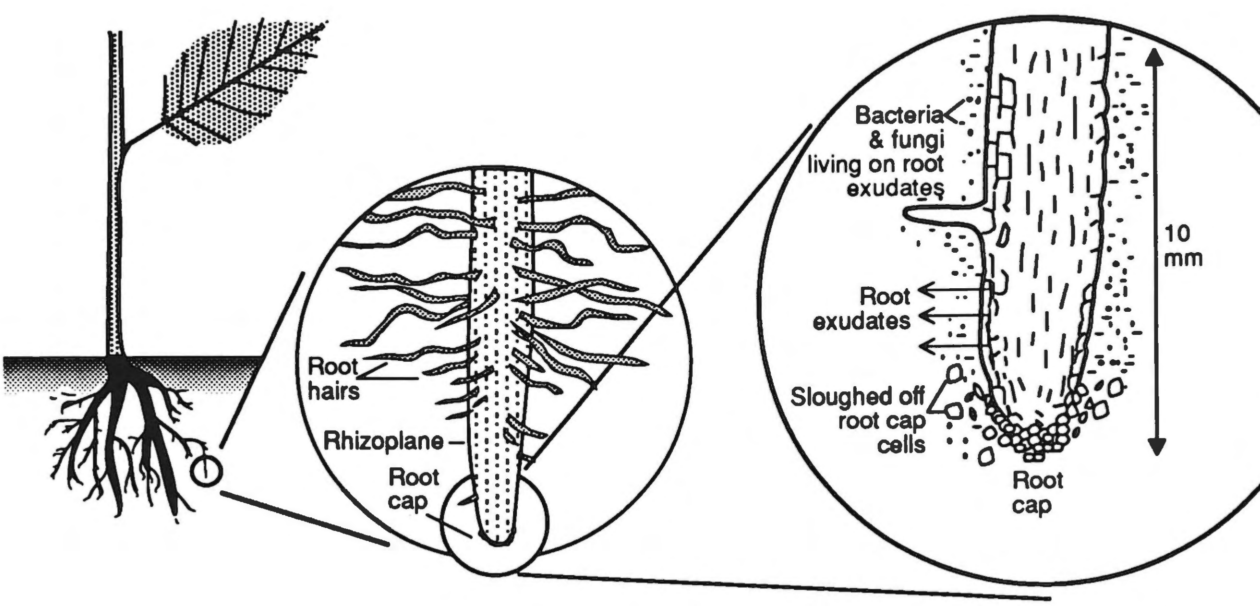

Fig. 1. A diagrammatic representation of the rhizosphere environment.

release of carbon dioxide by the large bacterial populations associated with plant roots acts as a trigger to attract soil amoebae. These amoebae graze on the bacterial populations and release nitrogen as a by-product which in turn is available for plant growth.

One of the most important functions performed by rhizosphere and non-rhizosphere microorganisms is the conversion of organic debris and litter into plant-usable inorganic forms, the mineralisation of nitrogen, phosphorus and sulphur. In this context, all heterotrophic microorganisms in soil can be regarded as indirectly beneficial to the growth of plants. Hormone-like growth substances produced by rhizosphere bacteria sometimes have favourable effects on plant growth. Brown (1972) has shown that various bacterial species from the rhizosphere of wheat produce substances with the properties of gibberellins and auxins that are able to stimulate plant growth.

Beneficial Microorganisms

To be effective, a plant-growth-promoting microorganism must be able to colonise the rhizoplane or the root surface aggressively and persist for long periods in the rhizosphere. A considerable amount of work has been done on rhizosphere bacteria possessing these characteristics. Over 10 years ago Schroth and Hancock (1981) summarised some of the key findings and these are still valid. It appears that 2–5% of the bacteria isolated from most root systems cause positive plant growth responses and these belong to the *Pseudomonas putida–P. fluorescens* group. Beneficial bacteria are able to colonise roots and develop populations of about 10^5 bacteria per cm which persist throughout the growing season. Some of these bacteria are crop-specific while others benefit a range of crops.

Several types of rhizobacteria have been found to have direct effects on the growth of soybean and canola (Kloepper et al., 1986). The most useful plant growth promoting bacteria belong to *P. fluorescens* or *P. putida* group. This has been confirmed in many studies carried out in different countries involving a range of crops. In many respects *Pseudomonas* is a good candidate to become a PGPR. These bacteria thrive on organic secretions from plant roots and they are able to colonise roots efficiently. Given the correct conditions they are able to move from one location to another. They also produce a vast range of metabolic products, including antibiotics inhibitory to many soil-borne plant pathogens, and plant-growth-enhancing hormones (Schroth and Hancock, 1982). The plant-growth-promoting ability of a bacterium may be due to one or a combination of factors discussed below.

1. *Production of antibiotics*

One of the mechanisms by which PGPR influence plant growth is by inhibiting the growth of pathogens or other undesirable organisms through the production of antibiotic substances. Fluorescent *Pseudomonas* spp. produce many types of antibiotics. One group of these compounds are iron-chelating, diffusible compounds called siderophores. These compounds are able to attract and chelate available iron in the rhizosphere thus inducing iron deficiencies in other microorganisms including root pathogens (Kloepper et al., 1980). Predictably, the antibiotic action of this group of compounds can be reversed by adding excess iron to soil (Kloepper et al., 1980). One of these siderophores has been isolated and identified and given the name Pseudobactin (Teintze et al., 1981). Colonisation of roots of flax (*Linum usitatissimum*) by *Fusarium* was reduced when this purified compound was applied to the roots.

The production of several other antibiotics by *Pseudomonas* spp. is well documented. Over 50 antibiotics and phytotoxic substances are produced by various *Pseudomonas* spp. and these are regarded as secondary metabolites (Lesinger and Margraff, 1979). Some of these compounds promote plant growth by inhibiting pathogens while others retard plant growth by directly interfering with the physiology of plants.

2. *Effective competition for space*

The primary mechanism by which beneficial bacteria increase plant growth when applied to seeds appears to be directly related to their ability to affect the potential colonisation by other microorganisms. Research shows that beneficial bacteria are able to establish in most areas of the roots including the root elongation zone. It appears that these bacteria are able to satisfy their nutrient requirements effectively, colonise the roots and exclude other microorganisms including major root pathogens and minor pathogens (see later). When large populations of PGPR are placed in proximity to germinating seeds, by pelleting or seed coating, the emerging root radicle will be colonised by these bacteria and they will be carried or mobilised along the growing root. Colonisation and competition will exclude many other bacteria and fungi.

Table 1. Some examples of successful biological control of root pathogens.

PATHOGEN	DISEASE	CROP	ANTAGONISTS	COMMENTS	REFERENCES
Fungal pathogens					
Gaeumannomyces graminis	Take all	Wheat	Fluorescent *Pseudomonas*	14% increase in yield	Weller et al., 1985
Fusarium oxysporum	Wilt	Carnation	*Alcaligenes* *P. fluorescens*	Severity reduced by 30% Severity reduced by 40%	Yuen et al., 1985
Sclerotium rolfsii	Stem and root rot	Peanuts	*P. fluorescens*	99% of plants protected in in green house	Ganesan and Gnanamanickam, 1987
Pythium ultimum	Damping off	Cotton	*P. fluorescens*	43% increase in seedling survival	Howell and Stipanovic, 1980
Armillaria	Root rot	Kiwifruit, Pine	*Trichoderma* spp.	Significant protection	Hill, 1990 Hill (unpublished)
Phompsis sclerotioides	Root rot	Cucumber	*Streptomyces* spp.	Root mass increased by 160%	Bochow, 1989
Bacterial pathogens					
Erwinia spp.	Soft rot	Potato	*P. putida*	50% and 75% reduction in soft rot in preplant and post harvest treatments	Colyer, 1984
Agrobacterium tumefaciens	Crown gall	*Prunus* spp.	*A. radiobacter*	Reduced the incidence of galling from 75% to 11%	Moore, 1977
Pseudomonas solonacearum	Bacterial wilt	Eggplant, Tomato	*P. fluorescens*, *Bacillus* spp.	49% eggplant and 36% tomato were protected in the field	Anuratha and Gnanamanickam, 1990

Table 1 shows some of the successful instances where beneficial bacteria and fungi have been used to inhibit root pathogens.

Disease-Suppressive Soils

Soils in which the development of specific soil-borne diseases are impeded to an *unusual* degree are called disease-suppressive soils (Schroth and Hancock, 1982). Disease-suppressive is a relative term. Soils where certain diseases are abundant are called disease-conducive and even in these soils there is a degree of natural control of root pathogens and they usually do not express their full potential in causing damage.

Two broad types of disease suppression have been recognised, natural disease suppression and induced disease suppression.

Natural disease suppression in soils is associated with particular characteristics that affect the microbiology of the rhizosphere. These soils are unaffected by cropping sequences. In contrast, induced disease suppression is usually independent of soil characteristics but depends on cropping practices. Induced suppression is expressed after several cropping generations. Growth of a susceptible crop for many generations is a prerequisite for the induction of disease suppressiveness.

Both forms of disease suppression usually result from the inhibition of root pathogen activity in soil. Such inhibition may be caused by the physical, chemical and/or microbiological characteristics of the soil. Abiotic factors that affect the survival of pathogens in soil include pH, clay content, soil type or even the salinity of soil that affect the survival of pathogens in soil. Disease-suppressive soils have also been found to contain large populations of bacteria known to antagonise pathogens.

Two important observations have been made concerning the suppressiveness of some soils: (a) the suppressive effect disappears upon biocidal treatments of soil such as methyl bromide fumigation, steam treatment or γ-radiation and (b) it can be restored by mixing a small quantity of suppressive soil into a previously heat-treated, disease-conducive soil (Alabouvette, 1990). These observations have challenged researchers to find the biological factors responsible for disease suppression. Experimental evidence is now available to indicate fluorescent *Pseudomonas* spp. are involved in the suppression of *Fusarium* wilt in soils (Scher and Baker, 1980). However no theory satisfactorily explains the disease suppressiveness of soils. It is likely that the microbial antagonists, whose roles have been established under experimental conditions do exist in soils and somehow contribute to make soils suppressive to at least *Fusarium* wilts (Alabouvette, 1990).

Deleterious Microorganisms

There are two major groups of rhizosphere microorganisms deleterious to plant growth. The first of these groups comprises the well known bacterial and fungal root pathogens. These include root pathogens which cause wilts (*Fusarium* spp.), damping off (*Pythium* spp.) root rots (*Phytophthora* spp.), and bacteria causing soft rot decay (*Erwinia* spp., *Pseudomonas solonacearum*). Discussion of these pathogens is beyond the scope of this paper. The other, lesser known, yet important group of microorganisms are referred to as the minor pathogens (Suslow and Schroth, 1982a), or non-parasitic pathogens (Woltz, 1978).

Minor Pathogens

Often the full production potential of new and improved crop varieties is not achieved in practice even when major diseases are apparently absent. A major reason for such a decline in production in the absence of major pathogens or nutrient deficiencies is the influence of so called minor pathogens. Some rhizobacteria and fungi are known to produce reductions in crop yields.

The minor pathogens have the following characteristics (Salt, 1979):

1. Unlike major root pathogens that invade roots, disrupt vascular tissues and permanently damage the nutrient and water uptake, minor pathogens invade only the juvenile tissues such as root hairs, root tips and cortical cells. Often the deleterious bacteria do not invade any tissues and their mechanism of action appears to be by the production of plant-growth-inhibiting substances. Roots absorb these compounds and they have harmful effects on the physiology of the plant.

2. They are widely distributed in cultivated soils and have a wide host range. Minor pathogens are normal components of the rhizosphere microbial flora but they far outnumber the populations of beneficial microorganisms or pathogenic fungi. For example 18–20% of bacterial isolates from sugarbeet roots have been found to be deleterious while only 3–5% of isolates were beneficial (Suslow and Schroth, 1982b). Since this work, deleterious bacteria have been isolated from many crop species including wheat, corn, lettuce and beans.

3. Damage to the host plant often depends on the environmental conditions and the vigour of the host. Seedlings in cold, wet soils are often damaged by fungi normally regarded as weakly or non-pathogenic.

4. Distinctive disease symptoms are lacking making it difficult to assess the losses caused by these organisms.

Deleterious strains of rhizobacteria can be found in a variety of taxonomic groups that include *Pseudomonas, Bacillus, Flavobacterium, Citrobacter, Enterobacter, Klebsiella, Achromobacter, Arthrobacter,* and *Chromobacterium* (Suslow and Schroth, 1982a).

Some strains of *Pseudomonas and Bacillus* spp. have been associated with seed decay, reduced germination, reduced hypocotyl and radicle elongation and stunting of plants (Suslow, 1982). *Pseudomonas* spp., because of their ubiquitous nature, are equally good candidates for DRMO. A toxin produced by *Pseudomonas* spp. has been found to inhibit the root growth of winter wheat (*Triticum aestivum*) (Fredrickson and Elliott, 1985). Suslow and Schroth (1982b) isolated deleterious rhizobacteria from sugarbeet roots and used these isolates to pellet seeds. They observed reduced seed germination, root distortions, root lesions and increased infection by root-colonising fungi, resulting in significantly decreased plant growth. Cyanide production by rhizosphere bacteria is considered to be detrimental for plant growth. Restricted development of potato roots in the field was suspected to be at least partly due to cyanide production by rhizosphere *Pseudomonas* spp. (Schippers et al., 1987).

The pathogenicity of these micro-organisms is difficult to demonstrate as their activities are highly dependent on soil pH, exudation patterns, temperature, moisture/rainfall, organic matter and soil texture. The association of these organisms to reductions in crop yield is also difficult to prove. For these and other reasons, crop losses caused by non-parasitic and parasitic minor pathogens have generated little sustained research effort or interest. Fortunately, this attitude appears to be changing.

Concluding Remarks

Very little work has been done in New Zealand to exploit the potential of rhizosphere microorganisms to promote plant growth. My colleague, Dr Robert Hill, has successfully used *Trichoderma* spp. to control *Armillaria* root diseases in a range of crops including kiwifruit and pine (*Pinus radiata*) in New Zealand (Hill, 1989, 1990; Hill, unpublished).

Overseas work to date shows that effective increases in product yield can be obtained by the use of PGPR. Most of these successes have been in annual crops where seeds or seed pieces (potato) are inoculated with the chosen bacteria and planted out. Through the comparatively short growing season, PGPR will protect the roots of the crop and the whole cycle will begin the following year. There is, however, scope for the identification and utilisation of potential biological control agents from perennial horticultural crops and pastoral soils. Indeed the highly dynamic soils from permanent grass/ clover pastures in New Zealand may harbour a great many microorganisms which could prove to be highly useful biological control agents.

The prospects for improved agricultural production through the use of beneficial microorganisms as biological control agents seems excellent (Davison, 1988). The advantages include improved crop yield, lower costs, greater choice for the farmer for crop rotation, and reduced dependence on man-made pest control agents. Trends show that in most countries, natural pest and pathogen control methods would be favoured over man-made chemicals by their environmentally conscious populations.

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Sir Victor Davies Award 1992

The Sir Victor Davies Award is an annual award made to a person under the age of thirty years who has demonstrated an outstanding plant knowledge in New Zealand. This may involve different aspects — propagation and production, cultivation, preservation, botanical study and research.

The recipient of the 1992 award is Beverley Joe, MAF Tech Consultancy, Pukekohe.

Beverley graduated B. Hort. Sci. from Massey University in 1989 and gained early commercial experience as production manager with Somerset Flowers, a floriculture company in Te Awamutu. This involved overseeing both greenhouse and outdoor operations covering five flower crops, two important facets being environmental control of the houses and production planning. The crops included ones which are produced in relatively small volumes in New Zealand at present for export: lisianthus, sandersonia, limonium and gentians.

The following year Beverley joined MAF Tech Consultancy and trained as a floricultural consultant. She is one of the few such specialists in New Zealand. The position requires a knowledge of a diverse range of flower crops, some relatively new as commercial crops in this country. The fields of consultancy include crop nutrition, pest and disease control, establishment of cut flower operations, budgeting and other technical information of both established and new crops.

Growth in the flower industry, particularly in the last five years, has meant a greater need for information with many new growers starting up with little or no previous knowledge in floriculture.

The task of a consultant is to encourage the implementation of the most effective production practices.

Beverley also has the added responsibility of liaising with other Government agencies on current issues facing the flower industry.

Beverley is thus establishing an important role in the flower industry and needs to keep up to date with new technology and overseas trends, information which can then be passed on to growers.

Royal New Zealand Institute of Horticulture Citations for the Award of Associate of Honour AHRIH (NZ) 1992

ROLAND WOODROFFE EARP

Roly Earp was born and raised in Te Puke, then a town servicing mainly dairy farmers and citrus orchardists. His lifelong interest in horticulture started with his schoolboy friendship with Grahame Bayliss, later to become one of the most innovative and technically far-sighted of early kiwifruit growers. Roly Earp joined his father in an accounting partnership but he retained a desire to work on the land. He would have liked a dairy or sheep property but, fortunately for the later development of the kiwifruit industry, he had insufficient capital. Instead he went into orcharding, partly because of his association with Grahame Bayliss and partly because, through his accountancy practice, he realised that kiwifruit exporting was profitable.

In 1959 he joined with Grahame Bayliss in buying a 54-acre dairy farm in Snodgrass Road, Te Puna West Point. Their proposed orchard broke with tradition in several ways: it was much larger than most existing orchards, it was planted entirely in kiwifruit, and it was planted entirely in 'Hayward' kiwifruit, the first major planting of the cultivar which is now the mainstay of kiwifruit industries throughout the world. Another unusual feature was the much higher frequency than normal of male plants, thus ensuring good pollination. Roly Earp freely admits that these technical innovations were almost entirely due to Grahame Bayliss. Mr Earp was quick, however, to pick up what he was taught and he soon became a proficient and well respected orchardist. He had a real concern for quality and his fruit has always had a well deserved reputation with exporters and the fruit trade. Furthermore, in his own way he has continued to follow innovative practices. For many years, he was a firm proponent of the use of chicken manure as an organic fertiliser. Later, he was to be an enthusiastic advocate of the importance of scientific research if the industry was to retain world leadership and it is most fitting that in 1984 a postgraduate research scholarship bearing his name was established.

With his large kiwifruit orchard coming into production in the mid-1960s, the next problem was the sorting, packing and grading of the ever increasing fruit numbers. It was here that Roly Earp started demonstrating his leadership. With two other growers he approached John Hancock in 1964 to develop the first orbital grader, the first piece of specialised equipment designed specifically for the kiwifruit industry.

In 1967, he called a meeting of exporting growers to discuss the marketing issues; in 1969, he became a member of the Tauranga Fruitgrowers' Association kiwifruit subcommittee; in 1970 he became a member of the Kiwifruit Export Promotion Committee; in 1972, at a large meeting of growers in Tauranga, he was elected Chairman of the Steering Committee to establish a suitable industry organisation. The fight was long, hard, and often acrimonious but throughout, Roly Earp was acknowledged, even by his antagonists, for his objectivity, for his genuine sincerity, his single-mindedness and his persistence. This persistence was most necessary because it was not until 1 November 1977, after dealing with three successive governments, that the New Zealand Kiwifruit Marketing Licensing Authority was promulgated under the Primary Products Marketing Act 1953. This authority was later renamed the New Zealand Kiwifruit Authority.

Roly Earp was elected first Chairman of the Authority and was to retain that position until his retirement in October, 1984. His leadership as founding Chairman was to see the kiwifruit industry develop into maturity. He again demonstrated his single-mindedness of purpose. His position was demanding — he had to attend countless meetings of the Authority, its committees and of the industry, he had to lobby politicians, and he had to travel hundreds of thousands of miles throughout the world. Many of his duties were onerous but he freely admits that some were much more pleasant — for example, sharing the stand at trade fairs with Lorraine Downs, the then Miss Universe.

Roly Earp has made a tremendous contribution to the kiwifruit industry and has been called 'Mr Kiwifruit'.

The Royal New Zealand Institute of Horticulture is pleased to make Roly Earp an Associate of Honour in 1992.

KATHLEEN JEAN VEAL

Kathleen Jean Veal developed an intense interest in plants in her excellent family suburban Auckland garden. As a child and then as a teenager, she pursued this activity gaining an ever broadening and deepening knowledge of plants and their cultivation. This interest extended further as she tramped extensively throughout New Zealand, noting and learning about our native flora.

Later she spent four years in Melbourne and made use of this opportunity to develop an extensive garden and to learn how to grow plants under a climatic regime very different from that of Auckland. This offered her the chance of gaining first-hand knowledge of the rich Australian flora, a valuable training as so many Australian plants are used in New Zealand gardens.

On her return to Auckland, she turned a piece of poor pasture into a fine home garden filled with the unusual. She has regularly obtained seed from overseas to evaluate plants in her garden and she has passed on the results to others. She is not content with merely superficial knowledge but has followed up her own observations by seeking background information through extensive reading. In the process she has acquired a fine collection of specialist botanical and horticultural texts.

Mrs Veal has had a long association with the Auckland Branch of the Royal New Zealand Institute of Horticulture and served as an office bearer for many years. She was an excellent secretary and treasurer. She has contributed significantly to the activities of the Institute and was elected a Fellow in 1977. For many years she was the editor of the Auckland Branch *Newsletter* and a highlight of this and other society newsletters was her many specialist articles describing particular species or groups of plants. These contributions have provided invaluable information for those seeking a deeper knowledge of plants of horticultural merit.

Mrs Veal is a registered show judge and she is firmly committed to the role of the Institute raising the standards of plant growing, presentation and appreciation. She has been a judge for many years and regularly assists horticultural and garden clubs throughout the northern region by judging at shows or by assessing gardens.

In more recent years Mrs Veal has devoted much energy to the development of the Auckland Regional Botanic Gardens. She served on a committee set up to plan and co-ordinate the events at the official opening in 1982. A year later, a meeting was held to consider forming a Friends of the Auckland Regional Botanic Gardens, and she was elected to the Steering Committee. At the first Annual General

Meeting of the Friends held in 1983, Jean Veal was elected Treasurer, a position she has filled ever since.

In support of the Gardens and the Friends, Mrs Veal has organised plant sales tables to assist with fund raising for additional Garden amenities. She has represented the home gardener on the Shrub Evaluation Panel since its formation in 1981. Recently she has spent much time taking a plant census of the gardens, identifying plants, checking their nomenclature and their positioning. Her many contributions to the Gardens, all on a voluntary basis, have been recognised by her being elected an Honorary Life Member, Friends of the Auckland Regional Botanic Gardens.

Jean Veal loves plants and is continually seeking new ones to share with the Botanic Gardens and with her friends. From the time the first plantings were made at Manurewa in 1976, she has sought and passed on suitable plants and improved forms. She is a person of exceptional knowledge, and this knowledge she had always been willing to pass on to others. Her expertise is formidable and is illustrated by her assistance with the revision of *A New Zealand Handbook of Bulbs and Perennials* by the late Hugh Redgrove.

The Royal New Zealand Institute of Horticulture is pleased to make Jean Veal an Associate of Honour in 1992.

RONALD ANGUS PROCTOR

Born in Hawke's Bay on 6 June 1919, Ron Proctor was brought up on his parents' farm and gained his early education at Wellington College and Napier Boys High School. When the family moved to Christchurch in 1940 to begin growing commercial glasshouse grapes, his interest in horticulture began.

In 1959 he established his own business, the Papanui Garden Centre, and it soon became known as the place to go for rare and unusual plants as well as for sound practical information. During this time his interest in city beautification and the general improvement of the environment became one of his motivating forces. When the Papanui roundabout area was redesigned he was responsible for the landscaping and construction of the water feature fountain.

He joined the Canterbury Horticultural Society in 1945 and was elected to the Management Committee in 1959, a position which he held until his retirement in 1989.

As President of the Society from 1980 to 1983 he continuously promoted the annual garden competitions for which Christchurch is renowned. He was Chairman of the Commonwealth Games special garden competitions committee to promote the garden city image for this event. During the period of the Christchurch Festival he was convenor of the organising committee for the floral festival between 1984 and 1987.

For many years together with his wife, Mae, his home garden won many coveted awards of both the Canterbury Horticultural Society and the Christchurch Beautifying Association. He has been actively involved for many years in the registration and protection of trees.

As a long-standing member of the Papanui Rotary Club he was a prime mover and Chairman of the Committee for the development of the Hanmer Holiday Camp. The landscaping and planting of this complex has been his major concern.

For many years he has been vice-president of the Christchurch Beautifying Association and he is currently President of this 95-year-old organisation. He is patron of the Papanui Beautifying Association. He was the instigator in the establishment of the horticultural therapy unit at the Burwood Hospital Spinal Unit.

He has been a senior judge for garden and street competitions for more than 30 years and a judge at flower shows for a similar period of time.

Throughout his adult life Ron Proctor has devoted his energies to the importance of civic pride. His efforts in particular have reinforced the importance of ornamental horticulture as a principal factor in city beautification. For services to the community and to horticulture he was awarded the Queen's Service Medal in 1986.

The Royal New Zealand Institute of Horticulture is pleased to make Ron Proctor an Associate of Honour in 1992.

WILLIAM RUSSELL SYKES

From 1952 to 1957, Bill Sykes was an Assistant Botanist at the Royal Horticultural Society Gardens, Wisley, where he obtained his NDH in 1953, and gained a B.Sc. (Hons.) at London University (1960). In 1952 and 1954 the British Museum (Natural History) and the Royal Horticultural Society combined to send expeditions to Nepal and Bill was the RHS representative. This was shortly after the country was opened up to Westerners and collections were made principally round the (at that time little known) Dhaulagiri and Annapurna Ranges. Later he worked briefly at Kew, during the summer of 1958, checking entries for new editions of the Kew Hand-lists. In 1961 he joined Botany Division (Lincoln), DSIR (now DSIR Land Resources) as a scientist specialising in taxonomic botany.

Specialist interests include the taxonomy of tropical and subtropical South Pacific Islands, the taxonomy of cultivated plants in New Zealand and advanced dicotyledonous families, naturalised plants in New Zealand, poisonous plants, conservation of plant diversity, relationships between plants and climate and selection of species for horticulture.

His duties include writing of Floras, compiling botanical descriptions and keys, mapping, and describing the distribution and habitats of plants. He is widely consulted for advice on identification and many other aspects of horticulture, and for some years he has been involved in a taxonomy course at Lincoln University. He is New Zealand's foremost authority on plants of the Pacific and is widely consulted on issues relating to horticulture, ecology and conservation of these. In conjunction with MAFQual he is an advisor on weed legislation.

During 1988 he spent six months as an exchange scientist with the Guangxi Institute of Botany, Guangxi, People's Republic of China. He has also worked extensively in parts of the South Pacific, in particular the Cook Islands, Niue, Tonga ('Eua and Late group), Norfolk Island and the Kermadec Islands. This has included ecological studies, floristic surveys, and research on the effects of feral animals on flora. His work on the Kermadec Islands and on Norfolk Island (for the Australian National Parks and Wildlife Service) has led to greater understanding of conservation problems and management needs for these islands. Fieldwork on the Cook Islands and in southern Tonga are major contributions towards definitive floras for these regions.

He has published about 30 refereed papers and 50 reports.

He is a trustee of Eastwoodhill, a member of the Royal Society of New Zealand, the Botanical Society of New Zealand and the Royal New Zealand Institute of Horticulture. In 1961 he was made a Fellow of the RNZIH.

The Royal New Zealand Institute of Horticulture is pleased to make Bill Sykes an Associate of Honour in 1992.

ROBERT JAMES BERRY

Bob Berry was born in 1916 and educated at Tiniroto School, inland from Gisborne. His high school education was by correspondence. In 1936 he attended Massey University to study at their one year agricultural course, but his interest remained strongly in the study of plants and birdlife.

After taking over the family farm following the death of his father in 1954, widespread planting on the farm began. His considerable appreciation of aesthetics and landscape possibilities and the beautiful vistas and views over the on-farm lakes form a feature of Hackfalls Arboretum, as the property is known. The farm covers 850 ha, and as planting continued Bob became particularly interested in the genus *Quercus*.

A tour to Mexico with the International Dendrology Society (I.D.S.) awakened an interest in making a collection of Mexican oaks, and this was followed by several further seed collection expeditions there. His deep knowledge of plants has made him a highly respected member of several I.D.S. tours.

The tree collection at Hackfalls now numbers some 1,800 species, and is still increasing with seedlings collected from recent expeditions to the United Kingdom, United States and Mexico. It must exceed most other woody plant collections in New Zealand, and compares favourably with many world-wide. Bob enjoys taking people around his trees and rarely hesitates over a name, often adding details as to source, country of origin and date of planting to anyone interested. He still spends many hours studying and in updating his records.

Following the purchase of Eastwoodhill by Mr H.B. Williams in 1965, Bob Berry undertook to catalogue the extensive but overgrown collection there. This was a major work and involved the identification of many species unknown to him at that time. With typical, painstaking perserverance, and fired by the desire to increase his knowledge, unknown specimens were brought home for study and identification using his extensive library and records of plant purchases made by W. Douglas Cook, original owner of Eastwoodhill. As a result, all subsequent lists of plants at Eastwoodhill have been based on his initial fieldwork.

In 1975 Bob was appointed to the new Eastwoodhill Trust Board on the nomination of the Poverty Bay Horticultural Society (Inc.), and retained this position until 1986 when he was required to retire upon reaching the age of 70. During those eleven years his knowledge of the arboretum was of considerable value to the Board. He also put a great deal of time and effort into several revisions of the catalogue.

Bob Berry still has a strong interest in Eastwoodhill. He is a member of the newly formed Plant Management Committee, where his knowledge is a great help to all the members.

Eastwoodhill also benefits greatly from his generosity, having received many plants raised from seed from his collecting in Mexico and elsewhere. Hackfalls currently has about 150 species of *Quercus*, whereas Eastwoodhill has approximately 100 species.

Bob's quiet manner and immense depth of horticultural knowledge has gained him much respect among plant people both nationally and internationally.

The Royal New Zealand Institute of Horticulture is pleased to make Bob Berry an Associate of Honour in 1992.

Book Review

Gardening with Camellias, A New Zealand Guide by Jim Rolfe. Godwit Press Ltd, Auckland, NZ, 1992, ISBN 0-908877-21–8.

This beautifully illustrated book is both a history, detailing how the genus *Camellia* spread to the western world, and a useful guide to the interested grower, with detailed instructions on the cultivation and care of these versatile plants.

In recent years the camellia has become a popular garden plant, its appeal being intensified as selection and hybridisation have further enlarged the range of plants available. Very few books have been available of recent years to help the amateur with information on the care of camellias, and this book is a welcome addition to their ranks.

The 175 colour photographs of excellent quality serve not only for the purposes of identification for the interested buyer, but also show to great effect the many uses camellias can be put to in landscaping. Most of the photos, including a superb cover photo of *C. japonica* 'Fimbriata', were taken by Yvonne Cave FPSNZ and provide the quality of illustration that defines some garden books as 'coffee table books'. In this case, however, the illustrations are combined with a knowledgeable text to make an extremely useful and comprehensive guide of both practical and aesthetic value.

The first chapter of the book discusses the genus and its subdivision into over 250 identified species. Within the species there is much natural variation and new species are still being discovered, all of which adds to the versatility and wonderful breeding opportunities available to hybridists.

The history of camellia domestication is then detailed, from the origins of the genus in China, Japan, and South-east Asia, along with its subsequent spread to the Western world. New Zealand is fortunate in having excellent climatic conditions for growing camellias, and a considerable number of skilled hybridists. Cultivars from New Zealand have met with great acclaim overseas, both for garden merit and on the show bench.

The author then provides a helpful guide to growers on how to select the plants they desire on the basis of six characteristics — size, form, colour, flowering season, foliage and growth habit. Useful charts, such as that detailing growth habits will be very helpful to the novice grower who seeks a camellia for a specific situation. These charts are in each case well illustrated, and I consider them a very valuable feature of the book.

The chapter on growing camellias in the open ground discusses the wide range of situations where planting a camellia can be a useful solution to a landscaping problem as well as providing great pleasure as a beautiful object in its own right. The versatility of a plant that can be utilised for hedging, espaliering, ground cover, standards, as a specimen plant, or mingling with other plants in the shrubbery is well brought out in the discussion. The charts provided give useful examples for each type covering this vast range. Container growing is an area of ever-increasing popularity, helped by the great range of small leafed, small flowered and scented cultivars now being released by nurseries. The material in this chapter is covered in great detail, and will be very useful to those seeking information on patio planting or on providing interest in small enclosed areas.

Jim Rolfe's many years of experience in camellia growing are well displayed in the detailed section on propagation. Methods are clearly illustrated by line drawings and photographs. The range of methods open to the propagator, including cuttings, air layering, and different ways of grafting, are explained clearly and simply.

Pests and diseases are covered in a general fashion. Perhaps as this is a New Zealand guide more specific details could be given of preventive treatments available in this country. Once again the photographs used give graphic details of insect pests that enjoy camellias in their diet although the example given of leaf-roller caterpillar would appear to be a caterpillar of the white butterfly, not generally considered a great problem by the camellia grower.

A lengthy list covering eleven pages has also been included giving details of 400 camellia species and cultivars. I am not altogether sure of the value of this, which is the author's choice from the 30,000 camellias registered in the official nomenclature. Even in New Zealand, not all camellias grow well in all areas, and of course the buyer is always going to be restricted by availability. Some of those mentioned would be very difficult if not impossible to obtain.

Val Bieleski

The Banks Memorial Lecture 1992
The Chicago Botanic Garden

Roy L. Taylor
President, Chicago Horticultural Society
P.O. Box 400, Glencoe, Illinois 60022-0400

I bring you greetings from the Chicago Horticultural Society on the occasion of 100 years of the Wellington City Council ownership of the Wellington Botanic Garden. In 1991, we completed our centennial year of the Chicago Horticultural Society and the 25th anniversary of the Chicago Botanic Garden. I express a sincere appreciation to the members of the organising committee, particularly Mike Oates, Conference Convener, and to Richard Nanson, General Manager, Culture and Recreation Division of the Wellington City Council, for their kindness in inviting me to participate in this special programme of the Royal New Zealand Institute of Horticulture.

It is a pleasure to be back in New Zealand. It was nine years ago that my wife, Janet, and I attended the Pacific Science Congress held in Dunedin. We also had an opportunity to spend a week on Stewart Island, participating in a field programme jointly sponsored by the Australian and New Zealand Phycological Societies. At that time, the new flora of Stewart Island by Hugh Wilson had just been published, and it was a privilege to have Hugh Wilson with us at the time of this special week-long colloquium. New Zealand has a special warm spot for both of us, and we are indeed pleased to be back.

The Royal New Zealand Institute of Horticulture should be especially proud of its accomplishments. I thank you for giving me the opportunity to present the Joseph Banks Memorial Lecture tonight. I would also extend commendation to the Institute for organising this conference on *People, Plants and Conservation.* The topic is one that is germane to all botanic gardens, people and places today. It is particularly gratifying to see New Zealand taking a leadership role at how best botanic gardens and people can play a role for the future of this country.

I would like to spend a few moments talking about the role of botanic gardens today. Together with other living museums, botanic gardens serve as Wild Kingdoms in the City. In this sense botanic gardens have an enlarged responsibility and perspective to reach in the development of new programmes for the urban constituents that use garden programmes.

The garden can become a fulcrum for change and can give new meaning to economic development, social change, education and conservation awareness. Through such activities an increase in conservation ethics and science literacy can be achieved in our communities. These seem like very large goals and aspirations for a botanic garden, but when one sees the large number of people who partake of activities in botanic gardens and programmes provided by botanic gardens, it is not difficult to project these activities into both economic and social contexts. Clearly, gardens can play an effective role in education particularly in increasing science literacy and conservation awareness. New Zealanders are fortunate in that people still have a close affinity with their local and natural environment. This is not true in the growing megalopolises of North America and Europe. It is important that botanic gardens continue to strive to make people aware of the importance of their environment, even in such urban areas. I believe gardens should accept the challenge of participating in change within our communities. This should be at both the regional, national and international level. The development and programmes that we produce, obviously, need to fall within the terms of reference of our own institution. However, it is important, just as this conference is doing, to broaden our perspective of the role that botanic gardens can play in both our local and larger communities. Gardens can effect change in our larger community and we should accept that challenge as an opportunity for our institution.

Tonight, I would like to talk about an example of a public-private partnership. I will use my own institution as the example. The Chicago Botanic Garden is a programme of the Chicago Horticultural Society. The Society negotiated with the County of Cook of the State of Illinois to develop a site for a botanic garden in the greater Chicago region. Some 300 acres were set aside in 1965 of an existing 67,000 acres of Forest Preserves within the County of Cook for the express purpose of a botanic garden. The Society was given the mandate to manage and operate this programme. The size of Cook County is about the size of Stewart Island. The Population of Cook County is about 5.8 million with a greater metropolitan population of 8.5 million. The population within 40 miles of our garden programme is about 20 times that of the New Zealand population. This is important to remember, as I talk about the support and programmes that we are operating at the Chicago Botanic Garden.

Fig. 1. Education Centre with associated display greenhouses in winter. Chicago Botanic Garden.

The history of the Chicago Horticultural Society dates back 102 years when the Society was formed to meet the challenge of the forthcoming 1893 Columbian World Exposition to be held in Chicago. At that time, the Society wished to have a garden, but it was not until the early 1960s that the initiative for an actual garden was reinstituted. Prior to that time the Society had been active in running the Chicago Flower Show and had several outreach programmes within the city, but no actual garden to call its home.

The Garden's contract with the Forest Preserve stated that funds would be provided through a tax levy (what you call rates), specifically designated for the operation of the Botanic Garden. The Society would, as their part of the contract, manage the site and be responsible for the raising of private funds for the development of gardens and buildings on the site. The Society had to raise $1,000,000 in good faith money before the contract could be signed. This was raised in six months, as there was a great deal of interest and enthusiasm by the Board of the Chicago Horticultural Society for the new initiative. The Garden was established in 1965 and first opened to the public in 1972. The first major building, the Education Centre, was open to the public in 1976. The public-private partnership has served the public of County of Cook well with the development of both a botanic garden, as well as a zoo, operated and managed by the Chicago Zoological Society.

The Garden design and development was overseen by John Simonds of Environmental Planning and Design of Pittsburgh, Pennsylvania. Simonds was a well known landscape architect. He used the theme of water and land to develop nine islands in a lagoon system to provide the medium for the development of the Garden. It is important to remember the landscape in which the Garden is located was a wetland area with an associated oak savanna and prairie. This prairie concept is important in the development. The State of Illinois is known as the Prairie State. Although it was once completely covered with prairie, less than 1% is now found in natural prairie.

The Garden development was predicated by the fact that a large storage of floodwater had to be managed during storms, since we are part of the Chicago River system with a branch of the Chicago River, the East Branch of the Skokie River, running through our living museum. In that sense, we are physically connected to large portions of Cook County and Lake County, which is north of the Garden where the source of the river occurs. The use of land and water in the series of lagoons provided an opportunity for Simonds to develop a garden on the basis of land and water in the Chinese style. It also provided for extra storage of floodwater, in fact, increasing the 300-acre site by some 20% in flood storage capability over what was there previously. Thus, the Garden provides an important amenity to the surrounding communities during times of flood.

The present Plant Management Policy for the Garden recognises three principal kinds of collections. All land area at the Garden is designated as one of these three types:

1) Horticultural display — collections consisting of the typical garden types, such as rose garden, perennial garden, a dwarf conifer garden, fruit and vegetable garden, and generic collections.

2) Conservation display gardens — consisting of six prairie types, as well as a natural oak woodland and a flood throughway and floodplain along the east Branch of the Skokie River and a portion of the lagoons which the River feeds.

3) Research collections — consisting of a series of trial and evaluation gardens both for woody and perennial plants used for both short- and long-term evaluation.

At the end of 1991, 133 full-time staff and 19 part-time staff were active in the Garden. Our location is seasonal with severe differences in temperatures, ranging in excess of 35°C to more than minus 30°C. Hence, in the summer period, our regular staff is swollen by 35–40 seasonals. In addition, we have as many as 20 student interns or professional exchange individuals working during the year. The Horticulture Department is responsible for the maintenance of all the display, display collections and production facilities and employs 68 people. Urban Horticulture is responsible for Plant Information, and our off-site programmes employ 8 full-time people. The Education Department, a strong component of our programme, has 17 full-time people.

Research, which is not strong at present, has 6 full-time people. Development, Public Relations and Membership has 11 full-time people working to ensure we have an actively developing membership programme, as well as public support for our programmes. I would be remiss if I did not mention the 550 volunteers who serve to augment our staff and work in all areas of the Garden. Their participation makes it possible for us to achieve many of our special programme areas. The Board of Directors of up to 51 members and a Women's Board of 50 members are special volunteers supporting Society programmes.

The Garden is clearly a people-oriented place. Seventy percent of our budget currently comes from the Forest Preserve District of Cook County through the Botanic Garden operation fund. Thirty percent of funds are raised by membership, parking fees and other special programmes operated by the Society. It is our aim to continue to decrease the dependency upon the County tax base and to increase funds through programme activities and the development of substantial endowments for the Garden and programme components.

I would like to take you on a short illustrated trip through the Garden to show you the highlights of our programmes. It is probably most appropriate to look first at the Prairie and the reconstruction of the Prairie components. It should be remembered that we consider these parts of our conservation displays. They are extensively used by school groups in our environmental heritage training programmes. The gardens feature members of the sunflower or aster family — 10% of the natural flora of Illinois consists of species of this family. These plants provide the sparkle of the prairies, particularly in the fall of the year. We have developed three prairies at the present time: the Mesic Prairie, characterised by the large blue stem *Andropogon gerardii*; the Marsh Prairie, consisting of low-lying grass and sedge foundation plants along with a number of other special plants well adapted to that site; and the Oak Savanna characterised by the presence of *Quercus macrocarpa*, the Bur oak. This oak is unusual in that it withstands fire quite well. Fire was an integral part of the development of the prairie. In fact, we use fire as a technique for management of the prairie. In the early development of prairie components, the prairie is burnt each year. Now that the Prairie is becoming more established, it can be burned on a two- or three-year cycle, as it is necessary to destroy both woody and weedy plants that easily impact the early development of prairies.

Many people are interested in prairie-style gardening. It has become quite popular in the United States to include grasses and prairie plants in new home plantings. One can buy a can of so-called prairie seeds to achieve a prairie garden. However, it is not quite as simple as the label implies. To develop a balanced prairie garden in your home landscape takes considerable effort for the first five years before the landscape is stabilised. Then it becomes relatively easy to manage. It is important to rogue out exotic invaders, particularly woody species at an early stage, to decrease competition for the prairie plants because they do take time to become established. Our prairies have been planted by hand by our staff and by volunteers.

We have recently initiated the development of three additional prairie types: namely, the Gravel Hill, Sand and Fen Prairies. We have just completed the land sculpturing and formation of these sites, and it will be three to five years before these three examples of prairies will be completed. We are careful about using only seed sources from local areas for growing on stock plants for seed production. The volunteers assist staff with the collection and sowing of seed, the propagation of the plants and the eventual planting on the prairie sites. In addition, teams of volunteers and staff regularly rogue the various prairies to ensure their integrity. We have also been involved in re-establishing an oak woodland which is part of the only forested area on the site. It was determined through research and evaluation that this site was once a well established oak savanna. Through a management programme we are now burning on a regular basis. After a three-year programme, we have seen a marked change in the forest floor flora with a number of the species known to occur in an oak savanna beginning to reappear. We are excited about the prospect of this restoration programme. The woods are often used for educational programmes both at the school and adult level, as well as for specialised programmes such as bird studies or art courses.

From the basis of the prairie a new programme for the management of the East Branch of the Skokie River has developed and meadow management instituted. The programme is designed to increase the capability of sites available for bird nesting and for an increase in insect populations, such as butterflies. One of our concerns that we have for tree species planted within meadow areas along the river is trying to prohibit damage of tree trunks by rodents during the winter months. Perimeter mowing, as well as perimeter mulching around these trees has helped. Mulching also provides a good way to protect the tree from mower damage during the summer and conservation of limited water resources.

Through our work with prairie plants we have also begun to involve the use of natives in parking lot islands. Such plants are well adapted to drought conditions and do not require the sort of water ornamental plants might require. Some grasses and plants, such as asters, provide an excellent winter cover in these parking lot islands and provide a form and shape which doesn't impede vision, but provides interest during the winter period. Winters generally run from November to the end of March and into April, so there is a long period of time when it is important to have some form, texture and colour in areas such as the parking lot islands.

Perhaps the most interesting development generated by prairies has been the Naturalistic Garden of our display garden collection. The Naturalistic Garden is entirely composed of plants native to the State of Illinois and the garden is designed to inform people about not only plants, but also birds in the area and soil types. It is a garden of ideas for those who wish to develop their garden using Illinois native plants. A difficulty one has in a garden such as this is to ensure flowering and conspicuous plants are labelled. Your label programme must be an active one and one which is constantly changing throughout the growing season. This garden also presents a wonderful aspect and appearance during the winter months because of the presence of the grasses, large members of the aster family and other large herbs that have unusual habits. Dried elements of the plants are not removed until spring has arrived.

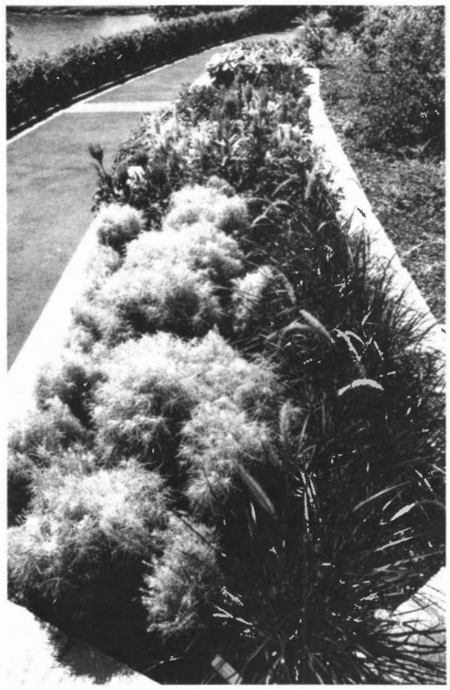

Fig. 2. Texture plants in raised beds of Sensory Garden. Chicago Botanic Garden.

Up to now, I have been concentrating on providing you with information about those parts of the Garden based on our environmental heritage — the Prairie — but the Chicago Botanic Garden is clearly a people/plant institution. People involvement is extremely important. The Heritage Garden which one enters when arriving at the Garden provides a glimpse back at a more traditional style of formal garden based on the garden at Padua, Italy. The large bronze sculpture of Linnaeus in the Heritage Garden reminds one of the scientific value of botanic gardens. We have first-person interpretation of Linnaeus' importance to botany and gardening during the summer months when a person in 1753 period costume invites people to join him in a walk around his garden. The Heritage Garden is divided into both classical systematic arrangement of plants by family, as well as plants from geographic regions. It is interesting for people to be able to visit with Linnaeus and to discuss how he developed his binomial system in a garden where these plant types can be easily demonstrated. The garden is an appropriate entry garden to our other garden areas.

A special people/plant relationship has been the development of the Sensory Garden. The Sensory Garden is designed for the visually impaired and provides an opportunity for a visually-impaired person to go through a barrier-free garden and experience both high-intensity-light plants which often have fragrance, to a woodland-type garden which is cool and refreshing with the sounds of birds present. The development of this garden includes an audio tape for visitors to listen to as they go through the garden. This tape programme is activated by a buried sound aerial system in the main walkway, so that as you go from one brick divider to another brick divider each zone has a special message about that part of the garden as you are moving through it. We have found this to be useful for people who are both sighted and who have visual impairment.

I have already mentioned we have to deal with a long, cold winter. We have ten conservatories designated as educational greenhouses. These are particularly heavily used by the more than 16,000 school children who visit the Garden on a regular basis during the year. We encourage students to learn about plants through touching. A touch-me cart has been developed that provides an opportunity for students to actually touch plants. Clearly, it is important to have a back-up production unit behind these carts, so plants can be replaced on a regular basis. The greenhouse programme is developing three principal theses: the needs of plants, how plants provide for man and how plants adapt. The greenhouses were recently completely renovated to provide these three themes. The staff from all areas of the Garden worked together to achieve the new programme which is based on an elementary school education initiative.

We have also instituted an integrated pest-management programme, following our renovation of the greenhouses. We are most pleased to be able to operate our greenhouses without use of herbicides or pesticides. We are able to do this through careful monitoring and by introduction of biological parasites. More importantly, I think, good care and attention to management hygiene has been important in decreasing the amount of damage in the greenhouses. That is not to say we don't have some damage. We are attempting to relate to our public and users of the facility that some blemishes and non-perfect plants, flowers or fruits are perfectly acceptable. We should not strive for perfection in a public facility where we can learn that diversity is normal for both plants and pests. Today, we have become too preoccupied with perfection, whereas perfection is rarely seen in our natural environment. We need to be able to explain to students and to the visitor that some damage and disease is perfectly normal and acceptable. When it becomes unacceptable, it is important to be able to find techniques and methods which will allow us to control and return the balance of the ecosystem.

We consider our gardens as outdoor classrooms. We are, after all, a living museum, and it is important to convey that to our students. We have developed two principal programmes for schools related to environment and conservation. The Education Environmental Awareness Programme (EEAP), based on seasonal change and diversity to our environment, serves as a special programme for local-area schools. The students visit the Garden four times each year — once during each of the seasons. They are encouraged to develop a local site in their own community where they can continue to monitor the changes and diversity that occur in a natural habitat. This programme has been recognised both locally and nationally. We are proud to be in the forefront of environmental and conservation education for students. We think students are the hope for the future. It is important the Garden plays a primary role and takes an initiative in the development of environmental education.

The second educational programme relates to a cooperative outreach education programme with Chicago city schools. We are about 22 miles from the centre of the City of Chicago. It is important for students in inner-city areas to have an opportunity to experience both natural environments and programmes related to plants. Cooperative OutReach Education (CORE) is designed to fulfil a goal of increasing science literacy within the urban school system. This programme has full-time staff that train teachers, as well as participate in city classrooms. Students participate in the development of a vegetable garden either at their schools or at the Chicago Botanic Garden. These vegetable garden programmes are overseen by a staff person, but each school group has two volunteers from the Chicago Botanic Garden working with them once a week in their garden during the growing season.

It is important to emphasise in both these programmes that children should have fun with plants. We try to ensure such activity through planned programmes.

We also operate other people/programmes in the city, such as Green Chicago. This programme initiates and develops community gardens for those that wish to utilise unused community space, such as vacant lots. This programme has now been running for 10 years and has been one of our great successes in the inner city. Again, people need to take an initiative. These programmes are based on a three-year cycle. During the first year there is a heavy involvement by the Botanic Garden. Decreased involvement occurs in the second and third years. It is planned to have the local community group assume full responsibility for the operation and maintenance of their garden after the third year. We also provide assistance to these programmes from our Garden Resources on Wheels (GROW) programme which consists of a travelling vehicle serving as a transportable teaching laboratory aid to our urban programmes.

In addition to both the educational and gardening programmes in the city, we also have pioneered the development of the use of plants in therapy. Our horticultural therapy programmes have now been involved with 51 institutions in the city. Primarily, the programme is associated with senior care centres or long-term care facilities for both young people as well as older people. Again, these are done under a contractual arrangement with the institution involved. It is a three-year programme with intense training during the first year with decreased consulting and guidance in the second and third year. The programme has at least one regular symposium each year for the professionals involved with each of the institutions. This programme takes place at the Chicago Botanic Garden and new techniques and methods are discussed and demonstrated. We have worked with the University of Georgia in the development of a series of video tapes supported by units published for the initiation and development of horticultural therapy programmes in institutions. These are available from the Chicago Botanic Garden.

Fig. 3. Daisy Garden of the English Walled Garden. Chicago Botanic Garden.

The emphasis on off-site programming both in schools and in gardening stimulated the development of a 20-acre island, known as the Fruit and Vegetable Garden at the Chicago Botanic Garden. This garden serves many purposes. It is a display garden for both contemporary, as well as heritage vegetables. It is a garden where one can see many different ideas for the home garden. Special facilities are available for display of herbs within a small museum. A small museum displays some aspect of gardening or agriculture. There is an outdoor kitchen demonstration area where well known Chicago-area chefs prepare fruit and vegetables grown in the Garden.

At the present time, our Plant Information programme is run by two full-time staff and 45 Master Gardeners, who are volunteers trained through a University of Illinois Extension programme. This service answers more than 20,000 plant questions a year. People may either bring their problems to the Plant Information office or more usually they phone in for information. It is sometimes difficult to determine the problem over the phone. This is a widely and well recognised public service programme. There have been a series of Plant Fact sheets produced by Plant

Information providing good information about problems common to Chicago-area gardens. These Fact Sheets can be purchased on site or requested by mail.

The Fruit and Vegetable Garden also features special programmes on weekends. We have had programmes such as the Fruit of the Month where one of our volunteers dresses up as the fruit of the month to introduce visitors to a special programme. We do demonstration programmes, such as learning how to compost. This is a contemporary issue and our programme is designed to help people resolve their home composting problems. Two years ago, the State of Illinois enacted legislation which prohibited the transfer of landscape waste to landfills. As a result, people have become quite interested and concerned about how they can compost and use their home landscape waste.

At the same time, the Garden initiated a new large-scale landscape mulching programme, utilising landscape waste from three local adjacent villages. These villages haul landscape waste in specially designed and labelled biodegradable bags with the Chicago Botanic Garden label on them. These are dumped at the Garden and processed, using large-scale machinery. The Garden uses the majority of the mulch produced, but that which is not used can be sold back to the communities. The community pays a tipping fee for disposal of this landscape waste. The programme is a profit centre for the Society.

You may find it strange to be talking about composting, but you should remember gardening does not have the same traditional ethic in the United States as you have here in New Zealand. Many people have never gardened, since they have lived all their lives in an urban area without gardens. It is important for the Chicago Botanic Garden to take a leadership role in providing information for our urban communities. This programme also provides an excellent way for the Garden to be seen as a good corporate citizen in the conservation of our resources.

The Garden uses its display collections to demonstrate ethnic diversity of our communities. In that sense, I want to show two gardens which demonstrate how a botanic garden can greatly increase visitation through development of ethnic cultural display gardens. The first example is a three-island Japanese-style garden called Sansho-En. Sansho-En literally means Three Islands. Sansho-En is a garden which is greatly admired by people throughout all seasons, since it is beautiful in the winter as well as in the summer. There are a number of special cultural techniques required in the maintenance of this garden. These techniques form important components of special educational programming. The Education Department can develop special programmes around the Japanese culture. Each year we have a Japanese weekend festival which our Japanese community is fully involved in operating. Such programming brings a new array of people to the Garden.

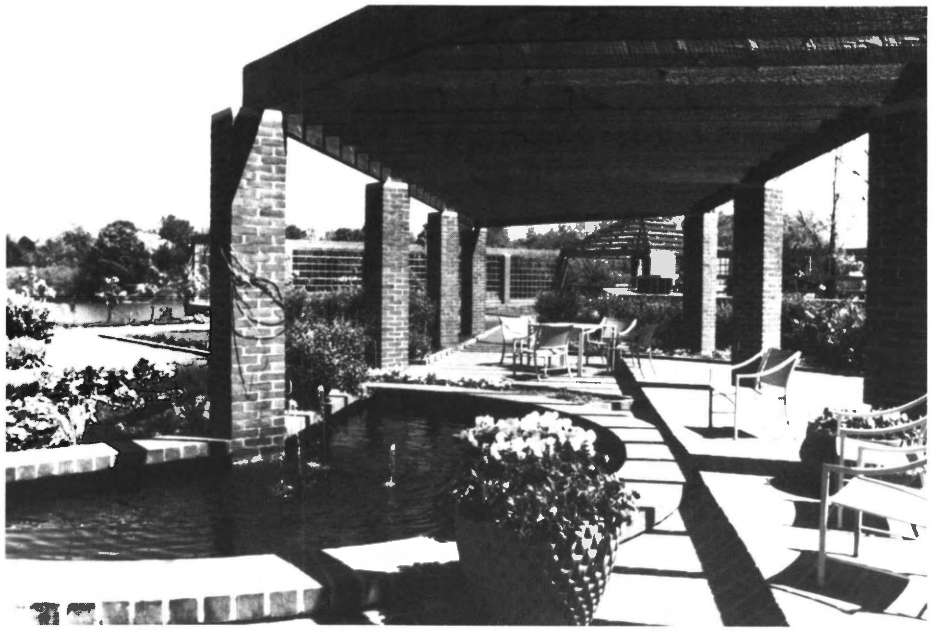

Fig. 4. Home demonstration and pool in Fruit and Vegetable Garden. Chicago Botanic Garden.

The second example is one we recently completed. In fact, it was dedicated on October 1, 1991 by Her Royal Highness The Princess Margaret. Our English Walled Garden designed by John Brookes, a well known contemporary English designer, demonstrates the traditional English style of gardening that is the basis for much of the gardening here in New Zealand and also in North America. One of the interesting aspects of the English Walled Garden is not only the use of traditional European plants in the garden, but also the installation of a number of native members of the aster family from Illinois in the Daisy Garden John Brookes incorporated into the English Walled Garden.

In a sense, we have come full circle. Our prairies have a large colourful component from the aster family which is part of our natural heritage and is also used in the English Walled Garden. We have also introduced grasses and other members of the Illinois prairie as part of the English Walled Garden programme. In a way, we have been able to bring a sense of Illinois into an English Walled Garden.

In reviewing our programmes, clearly, we are very much a people-plant partnership. We are fortunate to have very strong community support and a well articulated private-public partnership between a not-for-profit society, the Chicago Horticultural Society, and the Forest Preserve District of Cook County, a public body. We have dedicated volunteers in our Board of Directors, the Women's Board and our volunteers at large. We have a large and active membership.

Membership consists of either individual or family memberships and a membership specifically designed for corporations.

Donors play a very important role in the Garden, both on an annual appeal basis and for special capital campaign development drives. Donors are recognised differently from members in that they belong to the Linnean Circle. There are various levels of participation in the Linnean Circle. Many of our members are also members of the Linnean Circle.

Our staff are dedicated, innovative and supportive of the mission. The mission is important in the overall management of the programme. Our mission at the present time is as follows:

"To stimulate and develop an interest in, and appreciation for, and an understanding of gardening, horticulture, botany and conservation of natural resources by development of a variety of gardens, plant collections, and educational and research programmes of excellence while recognizing a need to provide a continuing aesthetic landscape experience at the Chicago Botanic Garden."

The staff develops a series of annual action plans within the parameters of our strategic planning process. There are 14 operating guidelines. (See Appendix I.) The principal goals are to achieve a greater degree of users, to increase presence throughout the community and to develop collaborative programmes.

The current programmes are designed to achieve and improve science literacy through plant sciences. This, in a sense, is part of our mission as a member of the greater museum community and was identified in the study, *A Museum For A New Century*, by the American Association of Museums. We hope to improve science literacy through our educational programmes, such as the Environmental Awareness Programme, the Cooperative OutReach Education programme with the Chicago public schools, an initiative with the Chicago Library and collaboratives with other midwest botanic gardens and arboreta. Such initiatives help us to fulfil the guidelines presented in the 1992 report of the American Association of Museums entitled *Equity and Excellence: Education and the Public Dimension in Museums.*

Today, the Garden stands at a crossroads to help improve the quality of life in our area. We are interested in the greening of America. We are actively pursuing this through our programmes, such as Green Chicago, the community garden programme and Garden Resources on Wheels. Through our Chicagoland Grows, Inc., a cooperative programme with the Morton Arboretum and the Ornamental Growers of Northern Illinois, a nursery trade organisation, we are introducing new plants to the public.

Through research activities, such as evaluating plants and providing new initiatives for propagation and development of plants, we will also provide a greater palette of plants for the greening of America.

Collectively, our programmes will help to improve the conservation ethic of our community and will build a more informed public concerning the stewardship of our environment through personal and political action. An example of such a programme is a new initiative with the Friends of the Chicago River to develop a new awareness of the importance of the wetlands and the importance of the river to our community.

It has been a privilege to address the Royal New Zealand Institute of Horticulture. I hope each of you associated with the Institute, and particularly those associated with botanic gardens or arboreta, will recognise the great challenge ahead of us with respect to the concern for environmental stewardship. Gardens and arboreta can play an important leadership role. Gardens can communicate and collaborate with other institutions and can stimulate the conservation of new areas for the long-term welfare of our communities.

Above all, remember gardens are for people. It is important that people should have fun and enjoy their garden. You can best learn about your environment and the people in it by enjoying the learning experience within the institution. I hope the *People, Plants and Conservation Conference* will yield great benefit to all citizens of New Zealand. It has been my privilege to be a small part of this important conference in 1992.

General References

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APPENDIX I

OPERATING GUIDELINES FOR THE CHICAGO HORTICULTURAL SOCIETY

1. Develop, maintain and exhibit indoor and outdoor living plant collections exemplifying the best plants for horticultural display and use in the Chicago area.
2. Provide stewardship of on-site conservation/display collections containing native and indigenous plants.
3. Increase knowledge and appreciation of plants through formal education programmes in disciplines of horticulture, botany and conservation of natural resources utilizing the collections on the physical site.
4. Arouse curiosity and create a public awareness about the Garden and its collections and horticulture through on-site public programming.
5. Serve as an off-site horticultural information resource to foster the therapeutic use of plants and gardening to a variety of constituencies.
6. Disseminate knowledge and information of the plant world and the Garden through the development of a horticultural, botanical and natural history library and archives, as well as an exhibition and acquisition programme of traditional museum collections.
7. Foster the development of original research in the plant sciences and conservation, emphasizing the practical problems of temperate plants and their use in horticulture, including special research projects initiated by individual scientists at the Garden.
8. Participate in and contribute to research, education and horticultural programmes through exchange and publication at regional, national and international levels.
9. Have an effective programme of services for ensuring a qualitative experience by visitors to the Garden.
10. Continue development of the active membership programme to support the Garden and its programme.
11. Provide the raising of private and public monies through a fund development programme.
12. Recruit and train skilled personnel either paid or volunteer through an effective human resources programme.
13. Manage the administrative and financial affairs of the Garden in a prudent and efficient manner, so that the goals of the Garden, the public and the Forest Preserve District of Cook County can be attained.
14. Conduct an effective public affairs communication programme to promote the activities of the Garden.

APPENDIX II

SELECTED LIST OF PLANTS PRESENTED AT THE TIME OF BANKS MEMORIAL LECTURE

Prairie Plants :

Andropogon gerardii Vitman
"Big Bluestem" — Family Poaceae

Quercus macrocarpa Michx.
'Bur Oak" — Family Fagaceae

Silphium terebinthinaceum Jacq.
"Prairie-Dock" — Family Asteraceae

Ratibida pinnata (Vent.) Barnh.
"Prairie-Coneflower" — Family Asteraceae

Liatris spicata (L.) Willd.
"Spicate Gay-feathers" — Family Asteraceae

Helianthus grosseserratus Martens
"Coarsely serrate Sunflower" — Family Asteraceae

Tradescantia ohiensis Raf.
"Ohio Spiderwort" — Family Commelinaceae

Turnbull Woods :

Trillium grandiflorum (Michx.) Salisb.
"Large-flowered Trillium" — Family Liliaceae

Mertensia virginica (L.) Pers.
"Virginia Bluebells" — Family Boraginaceae

Parking Lot Plants :

Schizachyrium scoparius (Michx.) Nash 'Blaze'
"Blaze Bluestem" — Family Poaceae

Pennisetum alopecuroides (L.) K. Spreng. 'Hamelin"
"Hamelin's Chinese Pennisetum" — Family Poaceae

Sporobolus cryptandus (Torr.) A. Gray
"Sand Dropseed" — Family Poaceae

Aster nova-belgii L. 'Professor Kippenburg'
"Kippenburg Aster" — Family Asteraceae

Heritage Garden :

Rosa 'Nearly Wild'
"Nearly Wild Rose" — Family Rosaceae

Sensory Garden :

Lythrum salicaria 'Morden's Pink'
"Morden's Pin Loosestrife" — Family Lythraceae

Betula platyphylla Sukachev Var. *japonica* (Miq.) Hara 'Whitespire'
"Whitespire Japanese White Birch" — Family Betulaceae

Japanese Garden :

Iris sibirica L. 'Caesar's Brother'
"Caesar's Brother Siberian Iris" — Family Iridaceae

Education Greenhouses :

Brighamia insignis A. Gray
"Brighamia" — Family Campanulaceae

Garden Visiting — Twentieth Century Local Tourism in Canterbury

Rupert Tipples and **Pamela Gibbons**
Department of Horticulture, Lincoln University

Visiting gardens has become an increasingly popular activity. The famous gardens of Britain are amongst the most visited of National Trust sites, with Sissinghurst and Scotney Castles' gardens receiving more visitors than any other of the Trust's properties. Sissinghurst alone receives 150,000 visitors per year (Brown, 1990, p.9). Garden visiting has been a regular feature since the establishment of the National Gardens Scheme in 1927 in aid of the charities supported by the Queen's Nursing Institute. As Jane Brown describes it:

"Enjoying oneself in the cause of a worthwhile charity has caught the public imagination, and thousands spend Sunday afternoons in summer garden visiting, to gardens large and small, where the elements of 'private' and 'ordinary' are an irresistible draw. The gardens in the scheme are of the widest variety, 1,700 in 1985, but the standard is also very high. They represent the best of British gardening, and to be included in their number is undoubtedly a status symbol of success." (1986 p.186).

Brown, writing from a British perspective, has also argued that gardeners are the major stimulus to other gardeners:

"Ten years of writing about gardening people — Gertrude Jekyll and Edwin Lutyens, Vita Sackville-West and Lanning Roper — have left me firmly convinced that gardeners are the chief inspiration of other gardeners, and that the more personable and distinguished the gardener is or was, the greater the fund of inspiration. The distinction is not necessarily in gardening terms, it is much more a matter of personality. Gardening tends to be a mature person's art; we come to it after doing other things, both for worldly and for psychological reasons. Making a garden tends to be part of that self-discovery that succeeds world discovery. Perhaps, as we become an aging society, our gardening passions — and the industry that surrounds them — will inevitably grow? At the moment when we become one with Europe will we become a nation of gardeners, a concept no European will ever understand? (Brown, 1990, p.1).

Garden tourism is not a new phenomenon. According to Batey and Lambert (1990, p. 12) the earliest garden tourist was John Leland, Henry VIII's antiquary, who commented on gardens as he encountered them. The first real garden tourist was John Evelyn, who not only wrote and translated gardening works but from 1654 visited gardens at home and abroad. These were noted in his diaries, perhaps the first example of what Urry has described as the objectification of the tourist gaze, nowadays usually by means of photographs, film or postcards (Urry, 1990, p.3). The first guidebook to a garden was produced for Stowe in 1744 and rival publishers rapidly filled the field with their competing works (Batey and Lambert, 1990, p.14).

Of late this form of leisure activity has become increasingly important in New Zealand. In the *Listener and TV Times* for 21 January 1991, it was reported that garden visiting was booming. Julian Matthews, Editor of the *New Zealand Gardener,* was quoted:

"Three years ago when I started as editor the idea of opening your garden to the public and charging them was a bit of a no-no. Now it's just taken off."

Commercial guides are now available to properties with gardens open to the public on a regular basis (McRae, 1989 and 1991; Bridge, 1989) and the extent of advertising of garden openings in the *New Zealand Gardener* each spring has increased substantially.

The Taranaki Rhododendron Festival is a good example of the developments garden tourism is undergoing. Over 120 private gardens are open to the public in November each year. Festival events for 1991 included New Zealand's largest competitive rhododendron show, a rose show, floral extravaganza, fashion parades, art exhibitions, nursery tours, a floral art show and a gardening seminar with prominent gardeners. The festival has entry concessions for purchasers of a 'Festival passport'. Local accommodation could be organised and obtained at concessionary rates during the festival to encourage garden tourists from outside the district.

Most recently the garden visiting craze has extended to Auckland with the Trinity Garden Festival (15–17 November 1991). Seventy-two gardens which are not usually open were opened to the public. The festival was to raise money for the completion of the Anglican Cathedral. Some gardens averaged 1200 visitors per day and $250,000 was raised. Also there was a good spin-off for the local garden trade. Garden centres reported good sales for the following two weeks, especially of rare trees and perennials (*Commercial Horticulture*, 1992(1) p.6).

Local developments in Canterbury— in particular, in the Christchurch area, as the 'Garden City of New Zealand' — have also been quite marked. To investigate this developing phenomenon an exploratory study of garden opening schemes was conducted in the spring of 1990.

Method

To facilitate this study, information on garden tours was gleaned from local newspapers and the Canterbury Horticultural Society to establish which garden opening schemes were operating. Six garden tours were identified at the period chosen for study. As far as possible both the owners of gardens open and the visitors to them were studied by means of self completion questionnaires distributed to both groups.

The questionnaires were developed by the authors without the benefit of pilot or pretesting. While such a practice is undesirable it became necessary as the critical dates approached and pressures of other work did not allow sufficient time for this development work. Both owners and visitors were asked to return their completed questionnaires in an addressed Freepost envelope. The questionnaires were designed to elicit both owners' and visitors' motives for garden opening and visiting and to classify that data by pertinent socio-economic variables.

Response

The total response level to the survey could not be calculated because the total numbers of garden visitors were unknown. Five of the six garden tours were studied. With variations between individual treatments questionnaires were completed by 12 owners from 17 on two of the tours, but unfortunately one group of tour organisers, after promising to list the gardens on their tour, did not provide the information. Usable questionnaires were received from 284 garden visitors from the garden tours studied.

Results

Garden owners were asked to describe their gardens in their own words. Their answers are given verbatim.

Coastal, small gardens less than 1/4 acre

'A garden with variety, though I do like a pattern,... it has grown around us.'

'1½ chains long, 55 feet wide with an old cottage at the waterfront end. No lawns. Brick paths and some paving and a small vege garden.'

'A small hillside garden filled with old roses and old perennials, and interesting (some unusual) trees and shrubs.'

'The main feature of the garden is brick and tile work, terraces and sitting areas which subdivide it into 4 or 5 distinct sub-garden areas.'

Inland, gardens 1/2–1 acre

'A plant lover's garden — a leafy 'green' jungle with lots of perennials, lots of interest; colour co-ordinated (landscape designer's own garden).'

'100 roses — many established trees, fruit trees, vege garden, bedding flowers.'

'Open space, low maintenance, green lawns. For family enjoyment!'

'Not very formal, bordered by trees, tennis court, indoor swimming poolroom. There is a perennial border, small rose garden, new shady walk, flowering shrubs, daisies, rhododendrons, and peony roses.'

Coastal, garden 1/2–1 acre

'Steep hill garden with rock outcrops.'

Inland, gardens greater than 1 acre in area

'Large expansive lawn — edged with variety of trees, shrubs and flowers, some specialised areas e.g. rose garden, white garden.'

'The garden consists of large established trees, underplanted with rhododendrons, azaleas and camellias.'

Gardeners' reasons for opening their gardens on the coastal tour were as follows:

'At request of and to assist school.'

'Requested by school.'

'By request and because we enjoy visitors and sharing plants.'

'To share, get feedback, ideas etc.'

'School fundraising.'

'For fundraising.'

For the inland area, which also had a school based fundraising exercise, the reasons were as follows:

'As part of fundraising for our local school.'

'We have not — once only as a favour to help raise funds for the school.'

'Fundraising for the local school — where our kids attend — plus some gentle persuasion.'

'As a fund raiser for the local school.'

'To support our local community — fundraising project for local school.'

'We were asked to.'

One gets the impression that some garden makers of the inland area particularly, only opened their gardens when prevailed upon to do so and would not have done so if not. Three of the six coastal gardens had been open previously, compared with only two of the six inland gardens. Only two of the garden's owners took people around when requested and both were in the coastal area. Visitors often wanted to talk to the owners but 3 of the 12 had chosen to absent themselves for the day. Only one inland garden had items on sale, and over $400 worth of plants were sold to help the fundraising activity.

The gardeners, who had allowed their gardens to be open, were asked to tick those of the following descriptions which best fitted their gardens (Table 1).

Of the 284 respondents who had visited the gardens studied 84% were female and only 16% were male. Most garden visitors were aged 50 or more, but a quarter were aged less than 40. Most did their visiting chiefly by car, but one quarter travelled by bus.

Most of the garden visitors had travelled considerable distances to the gardens being visited. Just over a quarter had travelled over 50 kilometres, and another 20% between 20 and 49 kilometres. Just over one third had travelled 5–19 kilometres (37%).

While the majority of visitors classed themselves as urban dwellers, over a third said that they came from a rural area or town. Few came from provincial towns, but most lived in the suburbs, presumably of Christchurch (55%). Only 6% said that they lived in the city itself.

All respondents were asked why they were visiting the gardens included in the tour being studied (Table 2). Each respondent could reply freely to this question. Many did at length and it has not been possible to process some of this information. To facilitate computer analysis where an individual gave multiple reasons the first or most important three reasons were encoded for computer analysis. At least 283 gave a reason for their garden visit, 175 gave two reasons and 62 three reasons. These reasons were all pooled for the subsequent analysis, thus the total is 518 reasons for garden visitation.

Four reasons stood out as to why people were participating in a garden tour. First, they loved gardens (15% of reasons); secondly, they were interested in the general ideas used in the gardens (13%); thirdly, they were keen to support the fundraising activities concerned (12%); and fourthly, they wanted to see other peoples' creations (10%). But if these categories were amalgamated a third of all reasons related to 'interest in the ideas', 'seeing other creations and planning own garden', 'learning about the plan' and 'inspiration'. This would tend to agree with Brown's assertion that gardeners tend to be the inspiration of other gardeners.

During their visits half of the visitors made purchases. Plant purchases were the most frequent, slightly more than half of them were for individual specific plant species, while slightly less than half were for several species or the undifferentiated category 'plants'. Some 4% were for tea or cakes and some 9% for multiple purchases.

Visitors were also asked what particularly appealed to them about the gardens visited. Again their first three reasons were accepted. Unlike the reasons for going on the tour these were much less clear, with the consequence that any resultant summary must cover more categories (Table 3).

The most significant reasons given for visiting these gardens were ones intrinsic to the nature of the gardens. For example, the most common reason was related to the nature of the trees the garden contained (14%) — their age, size and the way in which they were blended together. The second most common reason related to the extent of the garden (12%) — its size, spaciousness, openness, big lawns and perhaps park likeness. Then people were concerned with the colours and a few with the aromas emanating from its flowers and foliage (6%). As well they were concerned with scale, with the physical layout and design — the landscape. Garden differences were frequently the subject of comment — the variety of plants and planting, and the individuality of individual layouts. Two other features which merited favourable comment are the informality, natural looks and woodland parts of many of the gardens

Table 1. Characteristics of gardens open to the public on these tours.

Type	Coastal	Inland
Formal	0	0
Spring garden	2	3
'English' garden	1	3
Cottage garden	3	1
Bedding displays	0	2
Specialised plantings	2	1
Rose garden	3	2
Colour co-ordinated	2	2
Largely evergreens	0	4
'Bit of everything'	1	0

Table 2. Reasons for garden tourists' visits to gardens.

	Number	%
Love of gardens	76	15
Interest in ideas	65	13
Help for fundraising / Plunket	62	12
See other creations	53	10
Planning own garden	36	7
Enjoyment	28	5
What others achieve	18	3
General interest	17	3
Learn about plan	13	3
Inspiration	10	2
Social outing	10	2
Other reasons	113	22
Total	518	100

Table 3. The appeal of the gardens visited.

	Number	%
Age, size and blending of trees	70	14
Size, spaciousness, openness, park-like and big lawns	59	12
Colours and scents	32	6
Layout, landscape and design	35	7
Plant and shrub variety	38	7
All different, variety and individuality	26	5
All the work done	18	4
Rhododendrons, azaleas	21	4
Peacefulness, relaxing, quiet and tranquil	19	4
Informality, natural look, woodland areas	24	5
Beauty	17	3
Specific garden types - hillside, cottage, rockery	15	3
No answer	13	3
Other reasons	126	25
Total	511	100

(5%), and calming character that they possessed — their peacefulness, quietness, tranquillity and relaxing character (4%). Thirteen visitors did not give any reason for the gardens' appeal and approximately 25% of the reasons given to this open-ended question were too individual to be included in the above categories.

Besides asking visitors for their opinions as to the reasons why they went on the tours and what particularly appealed to them, they were asked to score 12 statements on a five-point Likert scale: strongly agree, agree, undecided, disagree and strongly disagree. Ratings to these statements are given in the accompanying histograms 1–12 (Fig. 1). The twelve statements were:

1. I came on this garden tour mostly as a social occasion.
2. I came on this garden tour to look at the range of garden material it is possible to grow in this area.
3. I came on this garden tour to look for ideas I can put into practice in my own garden.
4. I came on this garden tour to support the organisation running the tour.
5. I came on this garden tour because I go on these tours every year.
6. I am interested in opening my own garden to the public so I am coming on this tour to see how my garden compares with other gardens.
7. I entered the garden competition myself, unsuccessfully, so I need to see where I have to improve my garden to be successful next year.
8. I think gardens are extremely important to Christchurch/ Canterbury so I am supporting the gardeners by coming to visit their gardens.
9. The gardens on these tours are always so beautiful and well kept I go away feeling relaxed and refreshed.
10. People on the tours and the gardeners are always so friendly.
11. I came along on this tour because both the gardeners and other garden visitors are keen to give gardening tips which I find most useful.
12. It restores one's faith to see such beautiful gardens.

They were generated by the researchers from their knowledge of garden visitors and from the opinions of those visitors canvassed before the survey was

Table 4. Urry's characteristics of tourism contrasted with garden tourism.

Urry's Baseline Characteristics of Tourism	Garden Tourism
1. Tourism is a leisure activity — the opposite to regulated and organised work. Acting as a tourist — being 'modern'.	Normally a non-work activity at weekends, especially for older, retired people.
2. Tourism relationships imply moving to and staying in a destination. Journey — Period of stay — New place(s).	A day tripping activity involving travel outside immediate locality.
3. Journey to and stay in sites outside normal places of residence/work. Stays: Short term/temporary followed by return home.	Sites visited are other peoples' gardens which are viewed on day trips. Stays 'away' are unusual.
4. Places gazed on not directly connected with paid work. Normally some distinctive contrasts with paid/unpaid work.	Gaze on gardens — a major leisure activity for older age groups which, although it involves physical labour, is often regarded as leisure rather than work.
5. Substantial numbers in modern society engage in tourist practices. New forms are developed to cope with the mass character of the tourist gaze. The contrast is individual travel.	Not usually mass tourism as in organised groups — considerable individual independence. Gardens are often available only for 'special occasions' — access may be an issue.
6. Places are subject to 'gaze' and involve the anticipation of intense pleasures which are different to 'normal'. Anticipation is socially constructed and sustained in New Zealand by the TV/Film/literature/magazines/records/video, all constructing and reinforcing the gaze.	Pleasures of smell and sight — particularly of natural beauties, colours/shapes and designs — 'God's creation'. Not actively sustained in New Zealand by the electronic media but actively supported in print.
7. Tourists gaze on features of land/townscape making them different to 'everyday experience' — out of the ordinary. More sensitive to visual elements in the land/townscape which are visually objectified and then captured in photos/film/postcards etc enabling endless recapture and reproduction.	Mostly more extensive and exotic than normal ¼ acre section can permit. Bigger trees, wider range of shrubs and other plantings, perhaps older and more mature.
8. The gaze is constructed through signs — tourism is the collection of signs which confirm 'typical' behaviours.	Perhaps the orderliness of gardens confirms social order?
9. Tourism 'professionals' arise reproducing ever new objects of the tourist gaze. These form a hierarchy from the interaction between competing promoters and changing views of 'good' taste among visitors.	Gardening is so far a largely undeveloped facet of New Zealand tourism. Has it potential for generating $ from overseas tourists?

Fig. 1. Reasons for undertaking garden tours.

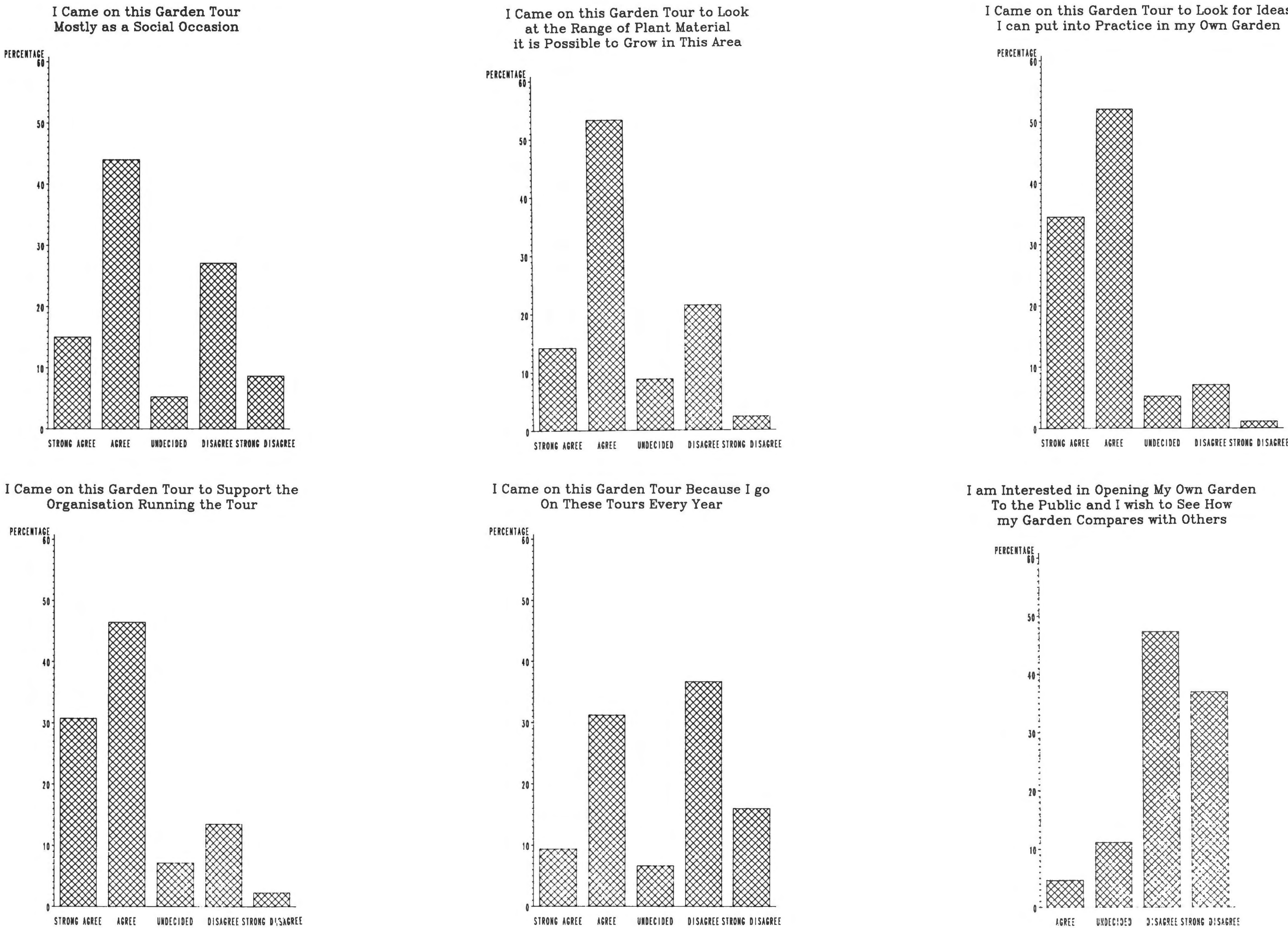
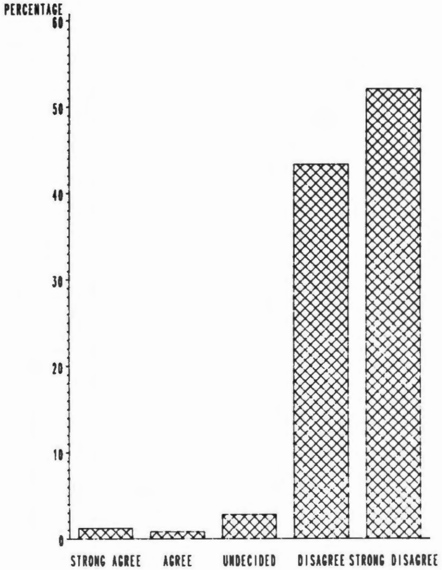
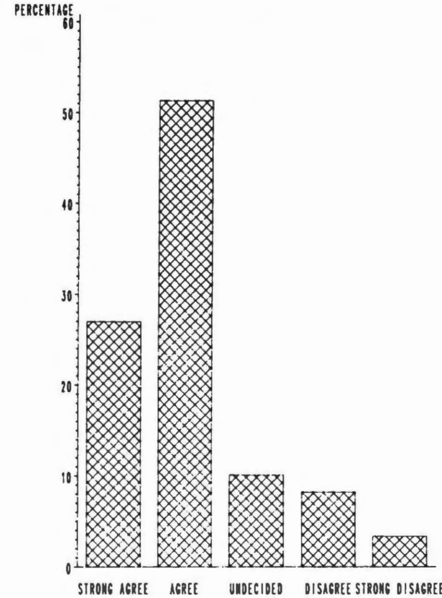


Fig. 1 (contd). Reasons for undertaking garden tours.

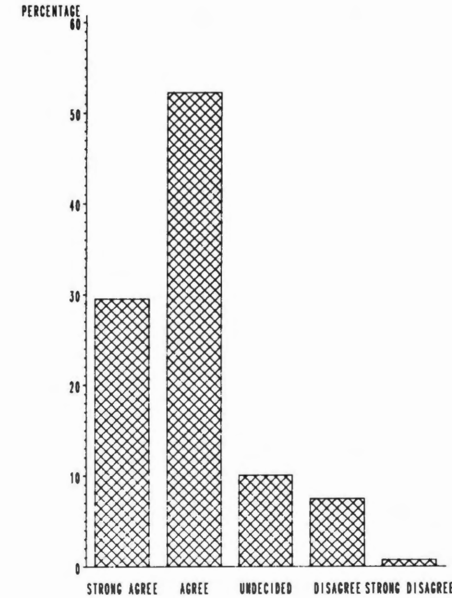
I Entered the Garden Competition Myself,
Unsuccessfully and I Need to see Where
I Have to Improve my Garden



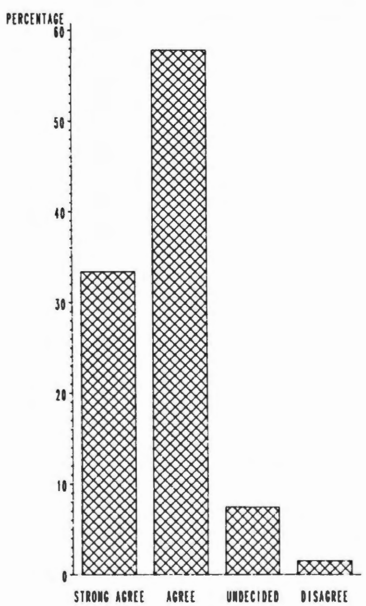
I Think Gardens are Important,
So I am Supporting the Gardeners



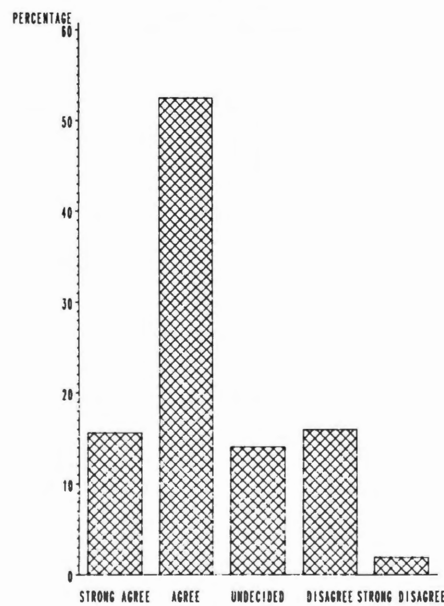
The Gardens are so Beautiful,
I Go Away Feeling Relaxed



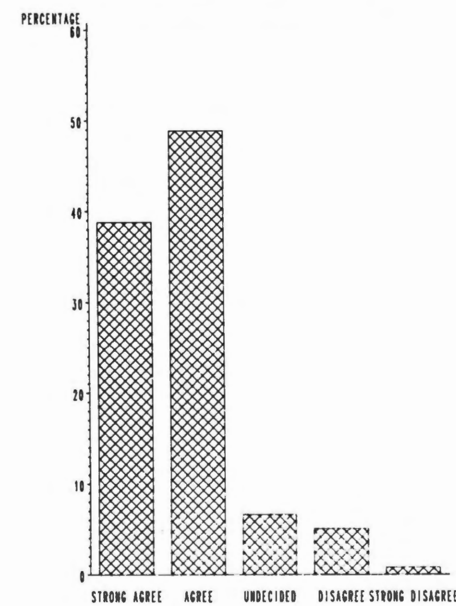
People on the Tours
and the Gardeners are So Friendly



I Came on this Garden Tour
to Receive Gardening Tips



It Restores ones Faith
to See Such Beautiful Gardens



conducted. They were not pre-tested in this exploratory study.

The last statement met with agreement from 49% of visitors and 39% strongly agreed with it. Visitors generally believed that the gardeners and people on such tours are friendly (58% agreed with the statement, but only 33% agreed strongly). Most also agreed with the statement about looking for ideas to implement in their own garden (52% agreed and 34% agreed strongly). The first significant division in opinion occurred with the level of support shown for the organisation running the tour. While there were still a majority who agreed with the statement (46% agreed, 31% strongly) there was a division of opinion. Some disagreed with the statement (16%, but only 2% strongly).

Less strong agreement was given to the two statements concerning the beauty of the gardens and their relaxing nature (statement 9), and to that concerning the importance of gardens and their local significance. Less strong agreement was given to the benefits of such tours for seeing the trips as a social occasion. While the majority again agreed with the statement (44% agreed and 15% strongly agreed) there were a significant number who did not (27% disagreed and 9% strongly disagreed). A less marked bimodal distribution also occurred for statement 2 concerning the range of plant material which would grow in the area (53% agreed, 14% agreed strongly and 22% disagreed and 2% disagreed strongly).

Garden visitors basically disagreed with the remaining statements. Statement 5 led to the most divided opinions. People either agreed or disagreed with the statement relating to whether they went on such garden tours every year, and slightly more disagreed than agreed. People were quite clear in their disagreement with the statements relating to wanting to open their own gardens to the public and wanting to find out how to do better for the garden competitions.

Theoretical Background

Urry has written recently of the 'tourist gaze' and this seems to be a useful concept to use in analysing garden tourism. He provides a very useful baseline description of many of the key phenomena of tourism which has been converted into tabular form for ease of comparison with the key aspects of garden tourism (Table 4).

Discussion

The scope for the development of garden tourism is at present unclear. In some cases it appears as though garden tours cannot be organised for the same gardens too often. Nor is it clear how the effects vary regionally. Do other areas have as strong interests in their gardens? Some evidence suggests that Auckland, Waikato, Wairarapa and Otago may have but this could be the subject of further investigations.

At what point would the market become saturated? Are visitors satisfied with their opportunities to purchase plants, food and crafts? New Zealand has not moved as far as Britain in this area. The National Trust has staffed shops at its major sites, selling not only memorabilia of the site but also an extensive range of National Trust products. These include many goods which could be said to meet with Urry's idea of the tourist visually objectifying and capturing their memories in pictures, postcards, table cloths etc.

Is this something attractive only to the internal New Zealand tourist or is it of interest to overseas visitors too? Informal evidence suggests it does have some overseas interest. There is some evidence of farmers' wives entertaining busloads of tourists to lunch. Busloads of tourists are reputed to visit the gardens of the Sanitarium Factory in Christchurch, which are much photographed. There does seem to be some interest, but little co-ordination. Perhaps the 'First Garden City' (Tipples, 1991) should make a concerted effort to introduce its visitors to the beauties of its gardens and those of its surrounding province.

Acknowledgement

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New Zealand Flora at the Royal Botanic Gardens, Kew

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Outline History of the Gardens

Toward the end of the 17th century, King William III constructed a palace near the boundaries of the present day Kew Gardens. He employed George London, a well known Kensington nurseryman to landscape the grounds. In 1759 William Aiton was employed to take charge of them and the numbers of rare specimens increased rapidly. When Aiton published his Hortis Kewensis, some 5,600 plants were in cultivation.

After King George III ascended to the throne in 1760, he commissioned Capability Brown to redesign the landscape. Brown did away with much of the original garden and replaced it with sweeping lawns dotted with clumps of trees. More than a decade later, Joseph Banks was made the new horticultural adviser. Banks had recently returned to Britain after his voyage to the South Seas aboard the *Endeavour*. The Gardens' reputation in horticulture and botany steadily grew in these years until 1820 when Sir Joseph Banks and King George III died. The destiny of Kew was then in the hands of Aiton's son, William Townsend Aiton. For the next twenty years the future seemed unstable and unpredictable.

William Hooker, a professor of botany at Glasgow University, petitioned the government to become the new director. His aim was to convert Kew into a powerful means of promoting natural science for the nation. In 1840, he was eventually granted a directorship. The Garden was extended and opened to the public. At Hooker's death in 1865, his son Joseph (already assistant to him for ten years) took charge. It was his principal ambition, like his father, to secure Kew as a centre of science, especially taxonomy. Joseph began studying medicine, primarily to help his chances of taking part in botanical expeditions as a ship's doctor. At the age of twenty-one he joined Captain Clark Ross's Antarctic expedition aboard the *Erebus*, later to return to write the very first comprehensive account of the flora of New Zealand. William Thiselton-Dyer became adviser after Joseph Hooker, but his career ended when he resigned from the post through a confrontation with his staff.

Sir David Prain, an eminent authority of Indian botany, became the new director. In 1922 Sir Arthur William Hill built an extension to the Herbarium, and in 1952, Sir Edward Salisbury opened the Australian house. Sir George Taylor's era (1956–1971) saw the acquisition of the property at Wakehurst Place, Sussex, to be administered as a satellite garden.

Understandably, past directors have influenced the shaping of Kew with their own goals and aspirations. Presently Professor Ghillean Prance, Director since August 1988, and formerly at the New York Botanic Gardens USA, is involved in particular with efforts to conserve the Brazilian rain forest.

Sir Joseph Banks and the Voyage of the *Endeavour*

Joseph Banks was born in 1743. He came from a family of landed gentry in Lincolnshire whose background was one of politicians. His great grandfather, grandfather and father had all been Members of Parliament. Joseph showed no interest in politics. Instead, from a very early age, his love of natural history became a strong passion. At the age of nine he was sent to Harrow and four years later to Eton where his interest in plants was aroused when given a copy of Gerard's Herbal. At seventeen years of age, he was sent to Oxford to study Greek and the classics. The chair of botany was occupied by Dr Sibthorp but his department was in a state of disorganisation.

Banks wished to engage a lecturer in botany at his own expense. Fortunately Sibthorp had no objections and Banks went to Cambridge to engage Israel Lyons. A year later his father died and left the family fortune for him to inherit on his 21st birthday. The young Banks left Oxford, moved to London, and met a number of friends who were to shape and influence his future. Daniel Solander was to be such a companion. Solander, a Swedish student of Carl Linnaeus, was in England to establish Linnaeus' system of classification. About this time the Royal Society was preparing an expedition to the South Seas, headed by Captain James Cook aboard the *Endeavour*. Banks' friendship with Lord Sandwich (First Lord of the Admiralty) and his talent for natural history, presented him with the opportunity to join the expedition. Solander was also to accompany him and they were to be away from Britain for three years.

The mid 18th century was a time after war in Europe for Great Britain to devote her energies to the improvement of the nation. In particular, King George III had a strong desire to extend his subjects' geographical knowledge. The chief aim of sending the expedition in 1768 was to observe the transit of Venus, and to record botanical and zoological discoveries. A vessel was commissioned to be fitted out and Lieutenant James Cook was entrusted in command. On 26 August, the *Endeavour* sailed from Plymouth. Their first port of call was the Madeira Islands. From there they sailed to Rio de Janeiro, and then southwards to Tierra del Fuego, spending the New Year ashore. They sailed around the Cape and then north to Tahiti in time to record the Transit of Venus over the sun's disc. In early July Cook headed for New Zealand and in October the *Endeavour* made its first sight of the North Island. The crew first went ashore at Poverty Bay, so named by Cook because if offered very little in the way of food or water. But for Banks and Solander, *Discaria toumatou, Macropiper excelsum, Cassinia leptophylla, Myoporum laetum,* and *Calystegia tuguriorum* were collected. Some 40 species in total, including *Sophora microphylla, Passiflora tetrandra* and *Rhabdothamnus solandri* (the sole representative of the Gesneriaceae in New Zealand) were discovered. On 20 November, Cook anchored in the Hauraki Gulf and then sailed to the Bay of Islands. By this time the plants on the north-eastern coastline had been relatively well documented. Rounding the North Cape on Christmas Eve and proceeding down the west coast, Cook did not stop once to go ashore. On 12 January they were abreast of Mount Egmont and here Banks noted in his diary that with their glasses they observed plants which "bore much resemblance to flocks of sheep". These were the vegetable sheep, later to be described as the genus *Raoulia,* by Joseph Hooker. Reaching Ship Cove at Queen Charlotte Sound, they remained there for 22 days. *Coprosma australis, Aciphylla squarrosa,* and *Metrosideros umbellata* were named from this location. The ship then passed through Cook Strait and up the east coast of the North Island to complete the circumnavigation of the island. It was a frustration for Banks that Cook later circumnavigated the South Island with so few stops.

In total 360 specimens were made and Sydney Parkinson, the artist aboard the expedition, completed 205 drawings of them. Much of his work was incomplete due to the sheer scale of the undertaking. Their homeward route was via Australia, Indonesia and Cape of Good Hope, reaching Deal, England, on 12 July 1771.

Johann and George Forster

Exactly one year later, Captain Cook's second voyage on the *Resolution* set sail. This time Johann Reinhold Forster and his son George accompanied the voyage as botanical explorers. In 1776 Johann Forster left Poland with his young son in search for a better life in England. By the time of the second voyage to the South Seas, he had established himself as one of the best read and most discerning of leading naturalists in Britain. The *Resolution* anchored in Dusky Sound in March 1773 for six weeks. It was too late in the season to study plants in flower so the collecting fell short of expectations. Nevertheless, *Earina autumnalis, Leptospermum scoparium* and *Olearia oporina* were discovered and illustrated by George Forster. The genus *Forstera,* a subalpine herb, was also described and later named in honour of these two men. After their return home, the herbarium specimens were distributed to numerous botanical institutions around the world, and a book describing 75 new genera (31 of the new types originated from New Zealand) was published. Although the Forsters had no direct connections with Kew, their work on the taxonomy of the flora was considerable.

Kew in the 1990s

Today Kew Gardens promote the mission "to ensure better management of the earth's environment by increasing our knowledge and understanding of the plant kingdom" through world-wide research on plants and their eco-systems, and also through display and interpretation to the public by means of living collections. Kew was one of the first botanic gardens to recognise the need for botanical institutions to be involved with conserving our natural plant resources. It has hosted two international conferences on the subject. From these developed a co-ordination body, an arm of the Threatened Plants Committee of the International Union for Conservation and Nature (IOCN). Its task is to trace plants on the verge of extinction and endeavour to prevent loss of the species. Over 1000 botanic gardens around the world are members and contribute to a network of information.

The Climate, and the Living Collections

In the mild Thames Valley where the gardens are situated at sea level, an average of 600 mm of rain falls per year. The acid soil at Kew (pH 5.0) is fine river gravel, some twenty feet deep, over hard London clay. The top soil dries out rapidly in hot weather. Because the river Thames flows along the western boundary, water can be pumped in times of drought to irrigate specific specimen trees. Water from the mains supply has a high alkaline content from the salts absorbed by the chalk hills that form the Thames basin. It is therefore put through a de-ioniser for acid-loving plants. Alternatively, rain water, which is stored in underground tanks, is used.

The average winter minimum temperature is minus 4°C, and the maximum in summer, 24°C. However, these figures have not been typical the past five years.

Fig. 1. *Clematis marmoraria* growing in the Alpine House, Kew Gardens.

The Alpine Unit

Within the alpine unit a representation of New Zealand's alpine flora is maintained. Mr Brian Halliwell (recently retired Assistant Curator of the department) played a major role in procuring the collection. In the 1970s he made a number of expeditions to New Zealand (and Tasmania) to collect both seed and living plant material. The department has continued to liaise with the New Zealand Alpine Society, and fresh seed is received frequently.

In April 1981, the Alpine House was built and opened for public viewing. The pyramid-like shape (14 m square and 7 m high) has proved very functional for the cultivation of high altitude species. Its foundation wall is surrounded outside by a moat which acts as a rain water storage. Ventilation covers 50% of the roof surface and is automatically controlled. A heating system ignites when temperature drops below 6°C. Internally it is landscaped with Sussex sandstone, incorporating a waterfall and pond, bog area, peat gully and a traditional show bench. A prominent feature of the design is the refrigerated bench, divided into two sections. Soil temperature in the Arctic section is maintained at 0°C, and overhead high-pressure sodium lamps extend the day length. The second section of the bench is for equatorial alpines. The sand is kept at 5°C at night and 18°C during the day to mimic the diurnal phenomenon that tropical mountain plants experience. In practice, the section is not entirely restricted to equatorial alpines. The rare *Ranunculus crithmifolius* subsp. *puciflorus* is maintained here. This subspecies is native to the South Island from a single location in the Malvern County, Canterbury. Its natural habitat is one of semi-stable limestone debris, at an altitude of 600 m. In accordance with the International Union for Conservation of Nature Resources, its status in the wild is vulnerable. The location was declared a Reserve in 1954, to help prevent further decline of the population, from animal and human encroachment. For cultivation at Kew, a compost of 4 parts loam, 4 parts alkaline, 4 mm grit chippings and 1 part peat, is used in 12 cm clay pots.

The landscaped features of the house are planted with reference to habitat in the wild. *Clematis marmoraria* (Fig. 1) which is planted in the alkaline scree, was discovered for the first time in 1970, growing on only two mountain ranges in north-western Marlborough. Introduced as seed to Britain in 1982, this interesting species rapidly secured a place in cultivation among alpine enthusiasts. *Raoulia subsericea* was collected by Brian Halliwell in 1974 from the Torlesse Range above Porters Pass (1280 m), Canterbury. The vegetable sheep are rather curious and arouse interest from the public when they develop into large cushion plants. This species is easy to cultivate on the scree in the alpine house. However, they are best replaced with young stock plants

Fig. 2. The Rock Garden, Kew Gardens.

every four or five years. Cuttings are easily raised, taken almost any time of the year. *Myosotidium hortensia* are grown in 30 cm deep clay pots, and exhibited on the show bench. Numerous attempts have been made to establish plants outdoors in the woodland garden, but these have never been successful. In pots under cool alpine glass they flourish with rotted cow manure added to their otherwise loam base compost. The first record of cultivation in Great Britain of *Myosotidium* was in 1829, but plants were not exhibited by the Royal Horticultural Society until 25 years later.

Outside the Alpine house is a paved section with sink gardens and tufa rock as an added feature. Tufa rock is a popular alternative cultivation method for alpine growers in Great Britain. It is a light, porous form of limestone resulting from precipitation of mineral springs of calcium and magnesium carbonate with traces of aluminium, silica and iron. The texture varies from soft and crumbly to hard. Medium hardness is ideal so excavation of small holes for planting is easy. Drainage is excellent, but sufficient water is retained for growing the smallest of lime-loving alpines. In autumn 1988, seedlings of *Myosotis arnoldii* were transplanted to tufa. The seed was donated by the New Zealand Alpine Society in 1987, having been collected from Benmore (the type location) in the Marlborough district at between 762 m and 1067 m. *Gentiana saxosa* has also performed well in tufa. In the wild it occurs near coastal rocks and sand dunes from about Latitude 42° southwards.

The Cambridge Cottage

This garden is a partially walled area creating a micro climate offering shelter from cold buffeting wind. *Clianthus puniceus* is hardy enough to survive a moderate winter on this south-facing aspect. The kaka beak was introduced into Britain by Mr Richard Davis, who sent seed to the Rev. John Colman on the Isle of Wight. However, the more recent introduction to Kew was donated by Gordon Collier, from Titoki Point, Taihape. Seed came via him from the International Dendrology Society's expedition in 1990.

Phormium tenax is also cultivated on the south-facing Dutchess Border adjoining the cottage garden.

Jospeh Banks was impressed with New Zealand Flax and with Maori usage of the fibre. He came home to Britain with grand ideas for its usage in Europe, but seed failed to germinate. It was not until 1789, when it was re-introduced, that it was propagated successfully.

Sophora microphylla was planted at Kew before the Second World War, probably about 1935. Sadly no firm records of its origin exist. In spring it normally flowers profusely, followed by copious amounts of fertile seed. However *S. microphylla* at the Chelsea Physic garden in London is believed to be the original progeny from Banks' collection. It flowered there for the first time in 1780.

The Rock Garden

The Rock Garden (Fig. 2) was built to primarily provide a home for a collection of European alpines bequeathed to Kew in 1882. The concept of the original design was to represent a Pyrenean mountain valley in miniature. Major renovations in 1929 had the original limestone rock (that proved too heat absorbent) slowly replaced over a span of 30 years with Sussex sandstone.

Bulbinella angustifolia seeds and grows in peat-enriched pockets of a west-facing gully. Formerly in Liliacae, Kew (after the dramatic revision of the family) has re-positioned *Bulbinella* in the Asphodelaceae. In the wild it has an interesting distribution, found only in South Africa and New Zealand inhabiting damp subalpine herb fields. Four of the six species endemic to New Zealand are almost hardy enough to be cultivated outdoors in Britain. *B. angustifolia* is the more prolific and hardy.

Aciphylla squarrosa is the only species of wild spaniard established on the rock garden. The remainder of the collection require more attention grown in pots inside the nursery. Early explorers in New Zealand frequently referred to these plants as in extensive thickets which were difficult to penetrate. Such areas still occur but have mostly been reduced by fire and animal attack. Even such a formidable species as *A. squarrosa* may be eaten down to a low cushion by rabbits.

To the south end of the rock garden in the woodland area, a most spectacular New Zealander, *Ranunculus lyallii*, delights in the cool, shaded atmosphere. Its branching stems produce large, white, semi-double inflorescences, with golden stamens. The glossy green, bold foliage is spectacular alone. Some years it flowers exceedingly well at Kew, and in others, for no apparent reason, it decides to sulk and exhibits very little growth. This species was described by Dr Sinclair, who sent the seed home to England in 1866. It was recorded as having taken five years to germinate.

The Princess of Wales Conservatory

In the late 1960s the initial idea and plans for a new conservatory were proposed. Twenty years on in the summer of 1983, construction began on the new 4490 sq m of glass. Four years later in July 1987, Her Royal Highness, The Princess of Wales, declared the building open.

The house is a complex of ten separate habitat zones, ranging from mangrove swamp to the Namib desert. It is constructed of concrete, aluminium, glass and steel, all designed to make maximum use of sunlight for heating. Ventilation, screening, humidification and heating are all computer controlled.

Within the temperate zone, *Cyathea medullaris, C. dealbata* and *Asplenium flabellifolium* are New Zealand plants. The former specimen came from Pukekura Park as a live young plant, accessioned in 1981. It now measures approximately 2.5 m in height. *A. flabellifolium* is a stout rhizomatous fern, forming clumps in the under growth. In its native habitat it is found growing from coastal to montane regions in open and shaded places, from Lat. 35° southwards.

Fig. 3. The Temperate House, Kew Gardens.

The Temperate House

Work on this very fine example of Victorian architecture began in 1860 and took some 40 years to complete. In the mid 1970s it underwent massive structural repair, and was closed to the public for five years (Fig. 3) before re-opening in 1981.

Planting was rearranged geographically. The New Zealand section is now viewed in the North Octagon where the minimum winter temperature is 6°C and ventilation is by louvres in summer. *Xeronema callistemon* is truly at home in the collection, flowering consecutive summers, although no more than two spikes have ever been recorded. The more recent accession of this plant came to Kew in 1990 via the Matawhero Nursery (Department of Conservation) North Island.

Unfortunately, it is yet another example of plants in peril. The last few remaining populations are endemic to the Poor Knights and Hen and Chicken Islands. These northern off-shore Islands are now Reserves protecting these impressive tussock-forming herbs.

Fuchsia procumbens covers ground space and scrambles among other foliage in the Temperate house, as it does in the wild. This unusual semi-deciduous fuchsia is one of four native to New Zealand, and is found at as few as twenty distinct sites. These range from the North Cape, and south to the Coromandel Peninsula, usually growing in grassy coastal turf. This is another species under threat from livestock, and also the spread of kikuyu grass, *Pennisetum clandestinum*. Being hermaphrodite does not help its plight. In a survey of thirteen populations undertaken by Dr E.J. Godley, five were found to lack plants of the opposite sex.

The time has come once more for major renovations to the collection in the Temperate house. There is an opportunity to re-design planting themes, add new accessions (some of which are sadly endangered) and make even more impact to the public, of the most distinctive and interesting flora of New Zealand.

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Correction
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Figure 1. Caption should read "*Salvia argentea*".

Column 1, paragraph 3. Cultivar name should read "Black Knight".

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