THE ACCLIMATIZATION AND SELECTION OF NEW ZEALAND PLANTS FOR ORNAMENTAL USE IN EUROPE

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Abstract

Evaluation of New Zealand plants at Beaucouzé, near Angers, France, has subjected them to rapid natural selection for cold tolerance by periodic episodes of atypically cold winters. Evaluations at other locations in France has also defined the usefulness of the species in milder coastal regions and revealed specific and intraspecific variation of tolerance of alkaline soils. Genotypes with attractive ornamental features have been selected from surviving plants within several of the species. These selections have the potential, both directly or as parents providing cold hardiness, to provide ornamentals and amenity plants that are able to more reliably persist outdoors in a greater area of Europe. Species of particular promise include *Coprosma propinqua, Corokia cotoneaster, Melicytus alpina, Phormium cookianum, Plagianthus divaricatus* and *Podocarpus nivalis.*

1. Introduction

In 1986 M. Luc Decourtye of the Laboratoire d'Amélioration des espèces ornementales, at Beaucouzé near Angers, France, went to New Zealand to collect native plants of that country which had potential for ornamental use in western and southern Europe. He was mindful of the lower latitudes and maritime climate of New Zealand compared to the central point of his introductions and evaluations at Beaucouzé. This location is subject to periodic episodes of freezing winter temperatures caused by continental movements of cold air. Consequently Decourtye focussed his plant collecting on the higher altitude parts of the South Island, New Zealand. By doing this he increased the possibility of introducing New Zealand plant material more likely to be resistant to cold damage.

Decourtye sought a wide range of species, some from wild sources, and others represented by named cultivars selected for ornamental use. The most comprehensive part of Decourtye's New Zealand plant collection was grown and evaluated at Bois l'Abbé, Beaucouzé. An account of observations of cold damage to provenances and cultivars of 75 New Zealand plant species, mostly established outdoors at Beaucouzé in 1987, during the winters of 1987-88, 1988-89, 1989-90 and 1990-91 is given by Harris and Decourtye (1995).

Fortunately for the evaluation, the first three winters were typical for Beaucouzé. During these winters 'sous abri' or screen temperatures (at 2 m) did not fall below -7°C, and frost temperatures at 10 cm did not fall below-10°C (Table 1). Nevertheless these temperatures were lower than normally experienced in the natural ranges of most of the species in New Zealand, and 31 of them suffered significant cold damage.

In the 1990-91 the winter screen temperature fell to –10.9°C and the frost temperature fell to –12.5°C in a 10-day cold period that reached its peak on 8 February

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1991 (Table 1). This caused significant damage to 63 of the species, and for a proportion this damage was lethal. However 12 of the species tolerated these atypically cold temperatures and showed negligible damage.

Observations of the surviving plants at Bois l'Abbé, Beaucouzé have been continued to the present time. As well, a further planting of the most promising of the New Zealand introductions was made at La Rétuzière, an other field plot 25 kilometers away, in 1988. Episodes of freezing temperatures in the winters of 1993-94 and 1996-97 resulted in further discrimination in the cold hardiness of the New Zealand plant material. Results of the observations made after these winters are reported in this paper.

As well as the observations made at Beaucouzé, smaller parts of the New Zealand collection were also evaluated at Ploudaniel, near Landerneau on the Brittany coast and in southern France at Fréjus on the Mediterranean coast. In particular these three sites were used to evaluate the performance of 37 provenances of *Leptospermum scoparium,* raised from seed collected over a wide latitudinal and altitudinal range.

The results of the evaluations at the three sites in France clearly demonstrated variation for cold tolerance within *L. scoparium* (Harris and Decourtye, 1991; Decourtye and Harris, 1992). Observations made by Berninger at Fréjus also showed that high pH at that site was lethal to many of the New Zealand species introduced to there (pers. comm. 1989) and also showed significant variation between the *L. scoparium* populations in their response to the pH levels (Berninger, 1992). Further discrimination of intraspecific variation of cold tolerance in *L. scoparium* is reported in this paper, and suggestions are made that could aid the selection of wider edaphic tolerance of New Zealand plants grown in Europe.

2. Materials and methods

Origins of the plant material and locations of the evaluation sites referred to in this paper are given in Harris and Decourtye (1991; 1995). Climatic information from the meteorological station at Beaucouzé is given only for those periods of the ten year study when freezing temperatures fell to levels that provided further discrimination of the cold tolerance of New Zealand plants (Table 1).

Cold damage to plants was assessed on a 0 to 5 scale in observations up to 1991, but observations in recent years have been more descriptive. These observations have noted such responses as frost resistance, damage to younger shoots and death caused by low freezing temperatures. Most attention has been paid to those species not significantly damaged by the 1990-91 winter. In the course of these observations on cold response, notes have been also been made on responses to soil conditions and drought, and suitability for ornamental or amenity use.

3. Results

3.1. Extreme freezing temperatures (Table 1)

The first three winters were typical for the locality. All the species survived these winters, although a number of species, including *Arthropodium cirratum, Melicytus ramiflorus, Metrosideros excelsa, Coprosma areolata, C. crassifolia* and *Olearia lacunosa,* suffered severe cold damage. All these species were dead after the 1990-91 winter.

Although extreme minimum temperatures in the 1993-94 winter were no more severe than those in 1990-91, they occurred late in November a month earlier than is usually the case for prolonged episodes of freezing temperatures at the locality. Also the autumn had been mild and not conducive to the hardening of the plants. The winter of 1996-97 was clearly the most severe of the 10 years the plants were under evaluation with freezing temperatures more than 3°C lower than the 1990-91 and 1993-94 winters.

3.2. Cold damage in 1993-94 and 1996-97 winters (Table 2, 3)

All of the species that suffered negligible cold damage in the1990-91 winter also survived the 1993-94 winter with no damage even though the cold episode occurred early in the cold season (Table 2). However the lowest temperatures in 10 years that occurred in winter 1996-97 killed or seriously damaged the two trees of the *Malvaceae* family, *Hoheria angustfolia* and *Plagianthus regius*, which to that time had shown promise for screening or hedging. Their reliability as amenity plants therefore seems to be in localities where screen temperatures do not fall below -10°C. The related shrub, *Plagianthus divaricatus*, showed surprising cold hardiness considering its natural range in New Zealand is coastal, often in saline swamps. The provenance evaluated at Beaucouzé came from near the southern part of its range. It shows great potential as a hedge plant on coastal regions of Western Europe.

The subalpine shrub, *Podocarpus nivalis* has previously been indicated to be one of New Zealand's most cold tolerant woody plants (Sakai and Wardle, 1978), and it is interesting that the related trees, *P. totara* and *P. hallii* show similar hardiness. All three species are recognised as useful garden plants in New Zealand (Metcalf, 1987). *Discaria toumatou* and *Melicytus alpinus* (syn. *Hymenanthera alpina*) are both spiny shrubs that have not been popular subjects for New Zealand gardeners. Nevertheless their novel appearance may facilitate functional use as low defensive hedges. *Melicytus alpinus* is called 'Porcupine bush' and two distinct clones have been selected, one for ground cover and the other for a low hedge.

Of the eight *Coprosma* species evaluated at Beaucouzé, *C. propinqua* has shown the most potential for selections that can be grown widely in France. It provides attractive variations in fruit colour and plant habit. Although seriously injured by cold in the 1996-97 winter, *C. ciliata* offers drupes in the yellow to red range of colours. *Phormium* cultivars are widely grown in Europe, and many of these cultivars are hybrids between the two species of the genus, *P. tenax* and *P. cookianum.* Recent growth studies of *P. tenax* cultivars in New Zealand at sites covering a wide latitudinal range have shown significant cold damage to most of these at frosty sites. Thus the good performance of the provenance of *P. cookianum,* which came from the coldest end of the species wide altitudinal range, offers potential for selection of more cold hardy *Phormium* cultivars.

Many of the New Zealand plants significantly damaged by the cold of the 1990-91 winter still retain interest as suitable garden subjects for warmer parts of Europe, or for cultivation in systems where they can be protected in winter. A sample of the more promising of these species is given in Table 3. Some of these species have proven less hardy than their natural ranges would suggest e.g. *Nothofagus solandri* var *cliffortioides*, *Hoheria lyallii*. Progeny of *Hebe albicans* and *H. subalpina* have been proven as cold hardy representative of their genus. They provide useful parents to combine greater cold hardiness with the desirable flower colours of popular *Hebe* cultivars widely grown in Europe. Most of these cultivars include the tender *H. speciosa* in their parentage. Heenan (1994) demonstrated the viability of this breeding objective, but there remains the need to match the hybrids he produced to climates cold enough to induce good flowering and with humidity levels not conducive to mildew.

3.3. Intraspecific variation and selection

The progressive sorting out of cold hardy clones of *Leptospermum scoparium,* previously reported (Harris and Decourtye, 1991; Decourtye and Harris, 1992), was extended even further by the freezing temperatures of winter 1996-97. All the plants of the species were killed to ground level that winter and only 7 plants re-sprouted in spring. These survivors from 1200 shrubs established, were from the coldest montane sites of the wild populations of *L. scoparium* included in the study. The survivors have been propagated and their potential use is as parents to combine cold hardiness with the flower colours and forms of desirable ornamental *Leptospermum* cultivars.

Collection of several provenances within some of the species gathered together by Decourtye at Beaucouzé has proven very useful in providing a greater range of variability

from which to select ideal ornamental forms. As well as the examples of *Coprosma propinqua* and *Melicytus alpinus* mentioned before, *Corokia* (Table 3) is providing wide scope for selections varying in frost resistance, foliage and fruit colour and plant habit. Some of this variation is provided by the introgression between *C. cotoneaster* and *C. buddleioides*.

4. Discussion

Bringing a selection of populations of New Zealand plant species into an environment where they have periodically experienced lethal or near lethal episodes of winter cold has resulted in the rapid natural selection of the more hardy genotypes. This could not have been achieved without the support of long-term research objectives, which have allowed observations to be made on the plants for 10 years. During this time the ornamental features of the plants have been assessed, allowing the narrowing of the genepool to plants that have the potential to enhance the garden flora of Western and Southern Europe.

The cold tolerance of most of the species will restrict their use as outdoor plants to the milder western and southern coastal regions of Europe. However, revelation of variation of cold hardiness within New Zealand plants opens the way for selections that will increase the area of Europe in which they can be reliably grown outdoors. Berninger (1992) revealed that in Mediterranean regions in particular many New Zealand plants will encounter alkaline soil toxic to them. By showing that there was variation of tolerance of this toxicity within *Leptospermum scoparium,* Beringer showed an aspect of the adaptation of New Zealand plants that has been little studied. Matching the wild locations of the provenances which showed the least chlorosis at Fréjus, indicates that they came from sites in New Zealand with soils derived from alkaline substrates. Consequently targeted collection, selection, and breeding of New Zealand plants from alkaline soils could further increase their area of ornamental use in Europe.

The programme initiated by Decourtye has now reached a stage where effort is being concentrated on development as ornamental or amenity plants of one or a few genotypes for each of a fraction of the species originally introduced. It is important that these selected genotypes are maintained, that records of their derivation are secure, and that they are effectively used as a germplasm source to advance the cold hardiness and ornamental value of New Zealand plants.

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Table 1 - Freezing winter temperatures that caused the first significant cold damage to New Zealand plants grown at Beaucouzé.

Winter	Extreme minimum temperatures °C (date of occurrence)		Comment
	at 10 cm	at 2 m	
1987-88	-9.0 (10 Dec 1987)	-6.5 (10 Dec 1987)	Typical winter extremes
1988-89	-9.1 (23 Nov 1988)	-5.6 (23 Nov 1988)	Typical winter extremes
1989-90	-8.6 (27 Nov 1989)	-5.6 (4 Dec 1989)	Typical winter extremes
1990-91	-12.5 (8 Feb 1991)	-10.9 (7 Feb 1991)	Prolonged severe cold late winter
1993-94	-12.0 (23 Nov 1993)	-8.0 (23 Nov 1993)	Prolonged severe cold late autumn.
1996-97	-15.7 (2 Jan 1997)	-13.7 (2 Jan 1997)	Prolonged severe cold mid winter

Table 2 - Cold damage in the 1993-94 and 1996-97 winters to New Zealand plant species not significantly damage by cold at Beaucouzé in the 1990-91 winter.

Species	winter response		Comment on use as garden plant
	1993-94	1996-97	
Coprosma ciliata	No dam.	Significant damage	Erect-spreading shrub –yellow orange drupes.
Coprosma propinqua	No dam.	Most plants not damaged.	Variable fruit colour (white to blue) and habit
Discaria toumatou	No dam.	No damage	Spiny, would provide an 1-2 m high defensive hedge
Hoheria angustifolia	No dam.	Killed	Small tree – for hedging and screens
Melicytus alpinus	No dam.	No damage	Ground cover, low hedge. Dislikes wet soil
Phormium cookianum	No dam.	Leaf damage, recovered well.	Useful as parent to breed cold hardy Phormium
Plagianthus divaricatus	No dam.	No damage	Dense, interlaced twigs, useful for hedges, screens
Plagianthus regius	No dam.	Top killed but resprouted	Vigorous, upright screen tree
Podocarpus halli	No dam.	No damage	Slow growing tree, tolerant of heavy, wet soil
Podocarpus nivalis	No dam.	No damage	Small shrub, ground cover, hedge
Podocarpus totara 'Aureus'	No dam.	No damage	Slow growing attractive ornamental tree cultivar

Table 3 - Cold damage in the 1993-94 and 1996-97 winters to a sample of New Zealand plants of ornamental interest that suffered cold damage in winter 1990-91.

Species	winter response		Comment on use as garden plant
	1993-94	1996-97	
Carmichaelia – 6 species	No damage	All killed	Unusual shrub-legumes of specialist interest
Cassinia leptophylla	No damage	Damaged - some killed	Interest in use as cut foliage/flower
Chordospartium stevensonii	No damage	Killed	Weeping tree-legume flowers pale lavender
Corokia cotoneaster	No damage	Many not damaged	High potential for selection of ornamental cultivars
Griselinia littoralis	Young shoots killed	Killed	A tree suited for hedging in coastal areas
Hebe albicans	No damage	No damage	Attractive compact low shrub, glaucous leaves
Hebe subalpina	No damage	Little damage	Densely branched shrub, bright pale green leaves
Hoheria lyallii	Severe damage	Killed	One of N.Z.'s few deciduous trees.
Notospartium carmichaeliae	No damage	Killed	Attractive shrub-legume, pink flowers
Nothofagus solandri var. *cliffortioides*	Slight damage	Top killed but re-sprouted	Main timberline tree in N.Z.
Olearia – 3 species	No or little damage	Killed	Composite-tree-shrubs, attractive flowers, foliage
Pachystegia insignis	Leaf necrosis	Killed	Composite shrub requiring sun and free drainage
Pittosporum tenuifolium	Limited damage	Killed	Hedging tolerant of poor soil and drought
Sophora species and hybrids	No damage	Killed	Small tree-shrub legume, attractive yellow flowers