A CHANGING ROLE FOR THE ARBORETUM OF THE UNIVERSIDAD AUSTRAL DE CHILE (UACH)

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The Arboretum of Universidad Austral de Chile is playing an important role in cultivating some of Chile's most threatened woody plant species in order to establish *ex situ* conservation collections for research, education and to assist the restoration of depleted wild populations. Changing the way in which the Arboretum manages its plant collections, so that it can play a more effective role in conservation, has been an important output of a Darwin Initiative funded project run in collaboration with the Royal Botanic Garden Edinburgh. The three year project, 'An Integrated Programme for the Conservation of Chilean Threatened Endemic Plants' was started in 2002. This paper describes how the project has assisted in developing facilities in the Arboretum to propagate and grow some of Chile's most threatened plant species and includes details of six lesser known, threatened narrow endemics.

INTRODUCTION

In 2001 I spent 6 months training in aspects of managing living plant collections at the Royal Botanic Garden Edinburgh (RBGE). It was clear to me then that even in a world leading botanic garden such as Edinburgh it can be surprisingly difficult to establish well documented collections of threatened plant species for *ex situ* conservation. During my time at RBGE I was like a sponge, trying to soak up every piece of information. I wanted to prepare myself for the time when I would arrive back in the southern Chilean city of Valdivia and begin to curate a large arboretum and to manage its collections. Ironically, it was through the extensive collections of Chilean plants at RBGE that I was really to discover the richness of the Chilean flora for the first time.

Chile is often described as a biogeographic island, bounded to the west by the Pacific Coast, to the east by the high Andean mountain chain and to the north by the Atacama Desert. The 5082 taxa (Marticorena, 1990) native to continental Chile are relatively few compared with the richness of some neighbouring countries. For instance, Argentina has a flora of 8409 species, 21.3% of which are endemic (Zuloaga & Morrone, 1996 and 1999) and Peru has 18,143 taxa, of which 30.8% are endemic (Brako & Zarucchi, 1993 & Tryon & Stolze, 1994). However, the 2630 endemic taxa of continental Chile (51.7% of the flora, Marticorena, 1990 and Davis, 1997) is possibly the highest percentage of endemism for any South American country (accurate figures for Brazil are unknown). Central Chile, which alone has 3429 taxa (67.4% of the Chilean flora) is recognized as one of the 25 global Biodiversity Hotspots (Arroyo & Cavieres, 1997). This is because more than 1500 endemic species occur there (1605 in total) and only 30% (90,000km^2) of its primary vegetation remains. It is paradoxical that Central Chile has a relatively small surface area of natural vegetation protected by National Parks and

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Reserves compared with the temperate rainforests of southern Chile, where the diversity and number of endemics are considerably lower. Only 0.58% of Central Chile, which includes the political areas Regions VI to IX is protected, compared with Regions X to XII, which include southern Chile's temperate rainforests, where 16.5% of the land area has protection (Armesto et al., 1992).

This combination of high levels of endemism, combined with the number of threatened species and the lack of nationally protected areas to safeguard their long-term future, has influenced the Darwin Initiative project to focus its research on the narrow endemics of Central Chile.

THE ARBORETUM OF UNIVERSIDAD AUSTRAL CHILE (UACH)

The Arboretum of the UACh was established in 1971 by Dr Frederico Schlegel S. He was a well-respected lecturer and botanist of the Forestry Faculty. The 54ha site is situated on the western boundary of the university campus on the Isla Teja in the city of Valdivia, where it reaches an altitude of 54m above sea-level. The vast majority of the site (23.8ha) is covered with coastal Valdivian Rainforest which is dominated by impressive trees such as *Aextoxicon punctatum* (Aextoxicaceae), *Nothofagus dombeyi* (Fagaceae) and *N. obliqua* with an under-shrub layer consisting mainly of *Chusquea quila* (Graminae) and *Luma apiculata* (Myrtaceae) and climbers that include *Boquila trifoliolata* (Lardizabalaceae), *Lapageria rosea* (Philesiaceae), *Luzuriaga radicans* (Liliaceae), *Mitraria coccinea* and *Sarmienta repens* (Gesneriaceae). The average temperature is 12°C, (maximum and minimum can range from 34°C to -3.7°C respectively) and annual precipitation is 2.3m (most falls between April and September). The Arboretum provides an ideal habitat for growing a diverse range of Chilean native plants and species from other temperate parts of the world.

Presently there are 450 species cultivated in the Arboretum, represented by 175 genera in 95 families. Its key collections are Chilean and Asian Bamboos, *Nothofagus* spp. from New Zealand and Chile and North American conifers. The new emphasis is on establishing comprehensive collections of well documented threatened species from southern and central Chile. In the past the Arboretum had focused some of its activities on cultivating threatened native Chilean tree species however, like so many collections, few accurate records exist concerning the provenance of the plants. For example, the historical collections of *Berberidopsis corallina* are of little help in any future restoration work. Even though the origin of the three collections of this species are known, the information identifying the provenance of each individual has been lost. The Arboretum has impressive stands of threatened trees such as *Gomortega keule* (Gomortegaceae), *Pitavia punctata* (Rutaceae) and *Nothofagus alessandrii* all of which have been used extensively for educational purposes. Only partial provenance data is known for the first two species. For example, we know that the 29 trees of *Gomortega* were collected from Tome, but this represents a very large geographical area and the *Pitavia* are from Jardín Botánico Nacional in Viña del Mar, but for these there are no precise details. However, in the case of *N. alessandrii* the information is more precise

as it is known that the trees were collected from the relatively small protected area of Parque Nacional Los Ruiles.

SPECIALIST NURSERY FOR THREATENED CHILEAN PLANTS

Funding from the Darwin Initiative has made it possible to install BG-BASE, which is a relational database for managing plant collections. This system was installed at the very beginning of the project and included a three-day training session for the staff of UACh by the developer of the software programme, Kerry Walter. It took over one year to enter all the historical plant records and to assign locations for the plants within the Arboretum. With this achievement the Arboretum has a system for managing its collections and one which encourages a much higher standard of record keeping. The Arboretum had no facilities for propagating and growing on plants and the original idea of sharing the facilities with a sister project which was run on a commercial scale and located some distance from the Arboretum proved to be impractical. Over a period of two years and a cost of just £3,000 new facilities were built from local wood. At the arboretum staff and university students have built two small polythene houses, one for seed and one for vegetative propagation, and a large shaded area for potted plants. Underground heating and a simple misting system have also been installed. Some visitors to the nursery are perhaps disappointed to see such simple, rustic structures. Knowing that the project partner is a major European botanic garden, their expectations are of a high-technology nursery facility similar to that at RBGE. However, the aim is for the Arboretum to have

Plate 1. The new nursery facilities at the arboretum of UACh showing the shaded area for potted plants.

a small scale specialist nursery that is capable of experimenting with different aspects of propagation with a range of simple materials so that it can demonstrate effective low cost facilities to growers with small budgets (Plate 1).

Over three years and as a result of three, one month-long expeditions, most of the narrow endemics from southern and central Chile have been propagated at the Arboretum. Additionally, some of the more difficult species have been propagated at RBGE and returned to the Arboretum. The cultivation of these specialist plants has proved to be a great challenge but it has helped the UACh Arboretum to start to develop the necessary facilities and the protocols in order to cultivate the plants. Much of the field collecting has been guided by the use of BG-BASE and every collection has been supported by vouchered herbarium material. The top sets of these will be deposited at Universidad de Concepción (CONC), Museo Nacional de Historia Natural (SGO) & RBGE (E). Advanced plans have been made to develop specialist teaching and conservation plantings in the Arboretum. Some species will form small conservation breeding populations while others will form part of more novel ideas such as the creation of conservation hedges. For example, a hedge of the threatened species *Myrceugenia leptospermoides* is planned for the entrance of the Arboretum containing all genotypes from a single location of the species from Region VII. Other species are being grown in their taxonomic groups to help with teaching in the identification of critical families like the Myrtaceae and genera such as *Escallonia.*

SIX LESSER KNOWN NARROW ENDEMICS

The Darwin Initiative project has many aspects, all of which are focused on the long-term conservation of narrow endemics. Research is helping Chile to meet its requirements under the Convention of Biological Diversity and the Global Strategy for Plant Conservation (GSPC) (CBD, 2002; Rae, 2003, 2004). For instance, extensive fieldwork has been carried out in order to establish the precise distribution of each species and this information has been compiled for a publication which will include the details of 48 threatened species from Central and Southern Chile (Hechenleitner *et al.*, 2005). Although many species are still listed as Data Deficient (DD), good progress has been made in applying the new IUCN categories to most species. This is the first time that these categories have been used in Chile. Applying the categories helps Chile to meet its requirements for Target 2 of the GSPC. The project has also addressed Target 16 (networking for plant conservation). The Arboretum has made agreements with other Chilean collection holders such as Jardín Botánico Nacional, Viña del Mar and Jardín Botánico Chagual, Santiago to exchange material of threatened plants. Through the project the Arboretum is also addressing Target 8 of the Global Strategy – that 60% of threatened plant species be in accessible *ex situ* collections, preferably in the country of origin.

The following are six very poorly known species that have been collected as a result of the field work.

Berberis negeriana Tischler (Berberidaceae)

This is one of 20 species of *Berberis* native to Chile, including Juan Fernandez Islands, and adjacent Argentina (Landrum, 1999 and 2003). This distinctive species was first described by Tischler in 1902 and placed under *Berberis serratodentata* by Orsi (1976). In a recent revision of Chilean and Argentinean *Berberis* Landrum (1999) recognises it as a distinct species. *Berberis negeriana* (Plate 2) is one of two Critically Endangered threatened Chilean *Berberis* species. *Berberis littoralis* which is the other, is endemic to the coastal areas of the Atacama Desert. It has only two locations (Hechenleitner *et al.* 2005). One is just south of Concepción, Region VIII which has up to 100 individuals, and the other lies about 60km further east where there are less than 10 individuals. In both localities its habitat is under severe threat due to tree cutting for fire wood and encroachment by surrounding commercial plantations of eucalyptus and pine. *Berberis negeriana* forms an evergreen shrub to 1m tall with orange-yellow flowers from October to December. Seed propagation has proved to be successful. Ripe fruits should be collected in March. The seeds must be removed from the pulp and soaked in cold water for 24 hours. We sowed the seeds in fine compost and placed them in a growth cabinet at a temperature of 20°C. Germination took about four weeks with a 20% germination rate. Propagation from cuttings is still unknown. The plants growing in the Arboretum are thought to be the first ever cultivated.

Plate 2. *Berberis negeriana*

Plate 3. *Gaultheria renjifoana*

Gaultheria renjifoana (Phil) Burtt & Sleumer (Ericaceae)

This gaultheria (Plate 3) is an evergreen shrub that has an even narrower distribution than *Berberis negeriana.* In common with that species it is also Critically Endangered (Hechenleitner *et al.*, 2005). First described by the famous Chilean botanist Philippi (1884), then treated as *G. insana* by Sluemer (1985) it has recently been reinstated as *G. renjifoana* (Munoz, 1987). It grows on forested slopes alongside one or two rivers in a very restricted coastal area south of Concepción. It is clearly very different from *G. insana* with decumbent branches, glabrous leaves with 17–28 obvious marginal teeth on each side and petioles 6–10mm long. It is estimated that less than 50 individuals remain in the wild. It has racemes of pure white flowers. Research has only just started to investigate how to propagate this species and we are hoping that as with other members of the Ericaceae, seed propagation will be relatively straightforward. Cuttings taken in December 2003 have not yet rooted.

Legrandia concinna (Phil.) Kausel (Myrtaceae)

This is one of the most decorative of the 28 species of myrtles native to Chile (Landrum 1981, 1988). It is an endemic shrub or tree and has a narrow, discontinuous distribution in the Andean and pre-Andean cordilleras in Central Chile where it grows in dense forests on poorly drained soils or close to watercourses. *Legrandia concinna* (Plate 4) has an altitudinal range of between 400 and 1000m. This highly ornamental species can reach up to 8m tall. It has pale, exfoliating bark reminiscent of eucalyptus. The flowers are pure white in colour and 25mm wide with long-exserted white stamens. With less than 1000 mature individuals in the wild, it has an IUCN category of Critically Endangered (Hechenleitner *et al.*, 2005). It is one of the easiest myrtles to propagate. Fruits should be collected from the end of summer until the beginning of autumn. The seeds must be removed from the pulp and then sown immediately under glasshouse conditions. Germination will take about 6 weeks. Vegetative propagation is also easy. Collect softwood cuttings in midsummer or semi-ripe wood in autumn and root under intermittent mist using a rooting hormone powder. After a year plants from seeds and cuttings can reach about 200mm tall.

Myrceugenia leptospermoides (D. C.) Kausel (Myrtaceae)

Myrceugenia leptospermoides (Plate 5) has proved to be one of the most attractive Chilean myrtles to date. It is an evergreen shrub which is endemic to a small coastal area of Central Chile from Region VIII to Region IX. Here it is confined to humid or foggy habitats. It often occurs as an under-storey shrub close to rivers and lakes or on wet forested slopes. It is a very poorly known species with very few locations and only two of these have any sort of protection. Although it can reach a height of up to 2m tall, it tends to form a small delicate spreading shrub with pure white flowers in autumn. As these start to go over, the bright pinkish red hypanthium and sepals look very attractive against the remaining brilliant white flowers and deep purple fruits. As with all the fleshy-fruited

Plate 4. *Legrandia concinna*

Plate 5. *Myrceugenia leptospermoides*

species, seed should be sown as soon as possible after collecting. Carefully remove the outer pulp to expose the seeds and sow 5mm below the surface of seed compost. Germination will take 4–6 weeks at 16–18°C. Nodal cuttings 100mm in length can be taken from semi-ripe basal growth in late summer. Rooting takes one to three months; a rooting hormone may be used.

Ribes integrifolium Phil. (Grossulariaceae)

This is the only evergreen Chilean species of *Ribes* and is one of the poorest known woody plants in south and central Chile. It is thought to have an extremely narrow distribution from Region VIII to Region IX where it is only recorded from five locations. One of these is in the National Park of Nahuelbuta which is famous for its coastal population of *Araucaria araucana* (Araucariaceae). *R. integrifolium* (Plate 6) is a very ornamental shrub which grows to about 1.5m tall. In spring it has lemon-yellow flowers that are pink in bud which become suffused with pink as they mature. Seeds collected in late summer to early autumn can be sown in loam based compost and covered with 5mm of compost and then 10mm of coarse grit. With a temperature of between 10–20°C germination takes 4–10 weeks. Propagation by cuttings is possible with 40–80mm long, basal or nodal soft to semi-ripe cuttings with a heel. They must be placed in suitable compost with 18°C bottom heat. Rooting takes about 3–6 weeks, often with a 100% success rate.

Plate 6. *Ribes integrifolium*

Plate 7. *Valdivia gayana*

Valdivia gayana J.Rémy (Escalloniaceae)

This monospecific, endemic genus is restricted to localities near to Valdivia in Region X. It is a very distinctive plant with a very specific habitat of deeply shaded humid places, often on vertical slopes under large rocky outcrops. Its best known location is in an 8m deep dark cave where it grows in association with ferns and liverworts. Its conservation status is Data Deficient and detailed fieldwork needs to be carried out in order to understand its full distribution. It often forms a herb 200–300mm tall and when mature it forms a small sub-shrub with a few long, woody, sinuous hanging stems to 20mm in diameter. It has lilac-pink flowers born in axillary, few-flowered racemes (Plate 7). Much of the propagation for this species has been carried out at RBGE. Seeds should be sown in summer in compost with a high organic content, kept moist in a humid environment and shaded to avoid strong sunlight. Germination at 18–22°C takes 2–4 weeks with a success rate of 50–75%. Leaf cuttings should be taken in mid to late summer. Keep moist and very humid in a propagation bed with a bottom heat of 18°C. Rooting takes 3–6 weeks.

CONCLUSIONS

One interesting lesson that I have learned during the last three years is about the integral link that exists between taxonomy and conservation. For instance, two of the narrow endemics treated here, *Berberis negeriana* and *Gaultheria renjifoana*, were until relatively recently, treated in synonymy under two different species. The former was treated under *Berberis serratodenata* Lechler and the latter under *Pernettya insana* (Mol) Gunkel. Both these species have a wide distribution. Clearly *Berberis negeriana* and *Gaultheria renjifoana* are two distinct taxa with very narrow distributions that need urgent protection. Taxonomy can have a fundamental impact on conservation yet one rarely sees taxonomic impact listed as one of the potential threats to plants. There is one message that I would like to convey to my colleagues who helped me so much when I was training at RBGE and to any student who is undertaking similar training. This is that transfer of knowledge really does work. I have been able to apply a lot of what I learned from my time spent at Edinburgh. The greatest challenge has been to adapt it to a different environment and within a very limited budget. I know that the Arboretum of UACh has a long way to go in developing plantings that can support *ex situ* conservation, but I do feel that we have made an encouraging start.

Finally, a comment that I find especially encouraging is that given by Peter Baxter, Curator of Benmore Botanic Garden in Argyll, Scotland. When visiting the Arboretum recently he said that what impressed him so much about our achievements was the fact that even though we had a long way to go to achieve our ambition of establishing one of the best botanical collections in South America, we had managed the most important thing, and that was the establishment of the fundamentals for managing collections for conservation.

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