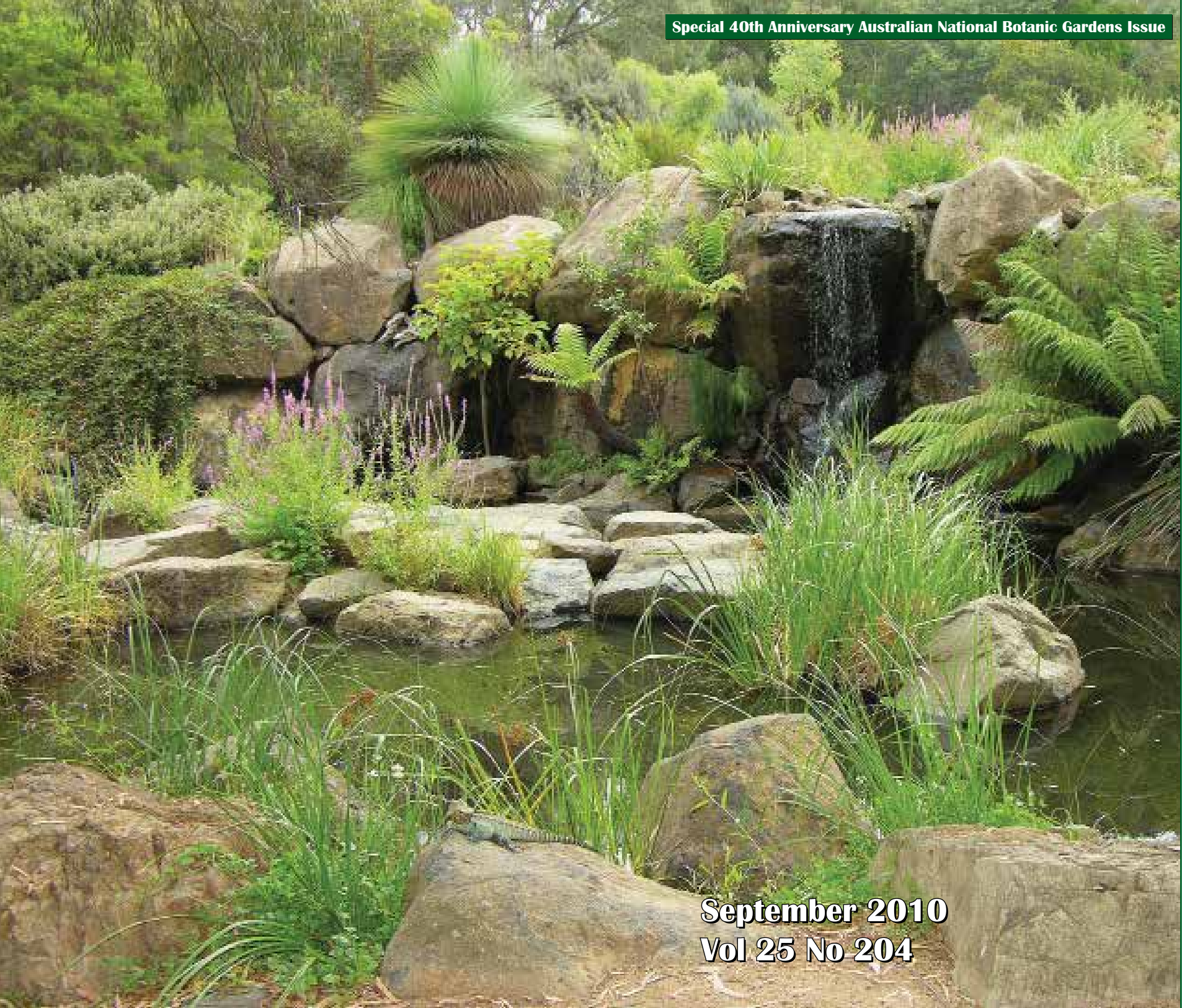




September 2010
Vol 25 No 204

Australian Plants

Contents

Introduction: the Australian National Botanic Gardens	295
Australian National Botanic Gardens: Some Personal	297
Reflections over 40 Years	
Australia's National Living Collection.....	302
Creating a Rainforest in Canberra.....	305
The Alpine Seed Research Project.....	310
The ANBG's Role in Securing Endangered Species:	316
a Focus on <i>Zieria obcordata</i>	
Pest and Disease Management: A Holistic Approach.....	321
The Evolution of the Australian Acacias	328
Pot displays with Sturt's Desert Pea (<i>Swainsona formosa</i>).....	333
Australian Plant Stories: Exploring Iconic Plants at the ANBG.....	335
Growing the Garden Out of the Grassland – The challenge of	338
a threatened community garden in a prominent public space	
Australian Native Plants Society (Australia) and	343
Member Society contacts	
Front and back cover photo: Barry Brown	

Australian Plants articles

Australian Plants is published quarterly to promote knowledge of Australian native plants. Contributions and offers to produce an issue are welcome. Please contact:

John Aitken and Merle Thompson
Editors, 'Australian Plants',
PO Box 5026, Old Toongabbie NSW 2146
E-mail edap@austrplants-nsw.org.au
Phone (02) 9631 4085 Fax (02) 9631 4293

All published materials are copyright, as directed, by the authors and photographers. Permission to reprint material must be obtained from the copyright holder.

Opinions expressed in the publication are those of the authors and may not represent official policy of the Australian Plants Society NSW Ltd

Australian Plants No. 204 Issue of Volume 25 which comprises issues 198 – 205.
Published quarterly and available nationally in 6,000 copies by the Australian Plants Society NSW Ltd

© Australian Plants Society NSW Ltd 2009 ACN 002680408 ISSN 0005-0008

Printed by Elect Printing, Fyshwick, ACT Print post approved PP226253/00017

Introduction: the Australian National Botanic Gardens

Dr Judy West

Judy is the Executive Director of the Australian National Botanic Gardens and has scientific expertise in plant systematics and phylogenetics, biodiversity informatics and conservation biology.

On 20 October 2010, the Australian National Botanic Gardens celebrates 40 years since the official opening of the Gardens. This issue of *Australian Plants* showcases the diverse work of the Australian National Botanic Gardens (ANBG). Starting with a reflection of the past 40 years from Murray Fagg, the issue highlights some of the ANBG's conservation, scientific and horticultural work on Australia's rich native flora.

During this International Year of Biodiversity, further attention is being focussed on reducing the loss of biodiversity. Botanic gardens contribute to the conservation of our biodiversity in various ways, including growing and studying endangered plants to improve knowledge of their basic biology and understand impacts and function in their ecological community. Paul Carmen's article on *Zieria obcordata* illustrates our practical collaborative efforts in species recovery.

In the coming years, we will continue to expand the diversity of native plant species in our well-documented *ex-situ* collections, both as live plants and germplasm storage in the form of seeds and DNA. Particular attention will be paid to species from endangered ecological communities in the region. Heather Sweet and Gemma Hoyle present our research and seed banking partnership focusing on the impact of climate change on the Australian Alps to increase our understanding and ability to achieve conservation outcomes in this vulnerable ecosystem.

Much of our botanical research takes place through the Centre for Australian National Biodiversity Research (CANBR), a joint venture between the ANBG and CSIRO Plant Industry. With some new researchers recently joining the team, and capitalising on our past 40 years experience in growing native species in the Canberra environment, we plan to enhance the interactions between taxonomy and horticulture through research projects targeting appropriate groups, such as the largely alpine genus *Craspedia* (Asteraceae). Interactions between taxonomy and horticulture are also evident through Joe Miller's work on Australian acacias. An important part of this work has been communicating the research to Gardens visitors via an

outdoor exhibition entitled the 'Tree of Trees'. Here visitors explore the evolutionary differences between acacias and how science is shedding light on the history of our biodiversity.

An overarching goal of the ANBG is to showcase Australia's plants and create an inspirational place for enjoyment and learning. Over the past 40 years, the Gardens have matured to a phase where certain sections lend themselves to further development or rejuvenation. David Taylor and Kaiya Browning's article highlights the challenges of engaging the public with a grassy woodland garden. Similar to the process of developing the Rainforest Gully, as described by Toby Golson in this issue, the ANBG's plan to develop an arid garden will progress through experimentation and phased advances to overcome the significant challenges of establishing plants under different climatic conditions.

There are many challenges ahead for the Australian National Botanic Gardens, and the following articles illustrate positive developments resulting from our conservation, science and horticulture activities and the learning opportunities that we provide.



Did you know that there is at least one species of banksia growing in every state and territory of Australia? The symbol of the Australian National Botanic Gardens is stylised and loosely based on *Banksia marginata*, the only species native to the Canberra region. This logo has been in use since 1978.

Australian National Botanic Gardens: Some Personal Reflections Over 40 Years

Murray Fagg

Murray has worked at the Gardens since January 1970. He is best known for the many books he has co-authored with John Wrigley, most notably the five editions of Australian Native Plants.

Few people have the privilege of working for one major garden for a period of 40 years: to see it opened, watch it grow and flourish, and still enjoy wandering its many paths on the weekends.

I had worked in three herbaria during my university vacations (Adelaide, Alice Springs, and Sydney) so when I arrived early in 1970 to start work at the Canberra Botanic Gardens Herbarium, I was not expecting it to be much different.

The big surprise on that first day was to find the Gardens totally devoted to Australian native plants. The impact was impressive as I entered the front gate. There I was presented with a sea of annuals, 100,000 of them, covering a range of different species. I had never seen anything like it before and nor had most of the visitors.

As I eased myself into herbarium work, I was surprised to find how integrated the herbarium activities were with those of the living collection. The aim was to have a herbarium specimen for every living plant in the Gardens and herbarium staff were responsible for the accurate labelling of the living plants.

Within a few months of arriving I found myself on my first field trip. The Gardens saw its scope as national, so no one thought it strange that botanist Ian Telford and I would drive from Canberra to Townsville to collect plant specimens. But this was only a shadow of the staff's earlier field trips. Gardens staff drove a Kombi van all the way to Western Australia and, from time to time, a rotation of botanical and horticultural staff arrived or departed by plane. On all of these trips there was an emphasis on matching herbarium collections with cutting material and regularly air-freighting both back to Canberra.

There were drawers and drawers of index cards keeping track of these collections; some filed in numerical sequence of propagation numbers, while a duplicate set was filed in alphabetical order of plant name. Both linked living plants to herbarium specimens. How quickly we forget the tedious nature of record-keeping in the days before computers.

During that first year at the Gardens I watched from the herbarium window as thousands of misting nozzles were connected to copper pipes in the dry gully next door – the start of the transformation to today's Rainforest Gully.

The Opening

By October of 1970 I found myself as an official guide to the many dignitaries from Australia and overseas who had been invited to the opening of the Gardens by Prime Minister John Gorton. The car park was transformed to a sea of seats and afternoon tea was served in a huge marquee with red and white stripes near the entrance. It was remarkable that the 84 year old Bertram Dickson, who had planned the Gardens at the height of the Depression in 1935, was able to attend the opening.

The year 1971 saw a job change for me and the realisation of a dream. As a teenager I had lamented the fact that natural history museums rarely ventured into the world of plants and botanic gardens rarely did any interpretation. John Wrigley, the Gardens Curator, offered me the opportunity to become the education display officer and set up botanical exhibitions in the newly established display room.

John had always been keen to promote the educational role of the Gardens and, as far as I can tell, had been the first, in 1967, to install interpretive outdoor signs in any Australian botanic garden. The text was engraved in large wooden signs and they explained the family classification of the various taxonomic plantings.

Another initiative in 1971 was the production of the first volume of the booklet *Growing Native Plants*. This annual publication continued for 14 years, with all staff at the Gardens being encouraged to write horticultural plant profiles. At one time it was the highest selling Commonwealth publication behind the *Government Gazette*.

The Gardens was not purist in its attitude towards native plants and saw the potential for horticultural breeding. It welcomed the opportunity to host the Australian Cultivar Registration Authority from 1973 and sections of the Gardens were devoted to displaying cultivars. This has continued to the present.

Schools were a particular focus for the Gardens' educational programs. I remember John Wrigley personally running propagation classes at local schools and the success of these soon resulted in a horticultural staff member offering these to schools on excursions to the Gardens.

The need to teach kids about the natural environment resulted in the Nature Trail being developed in natural bushland at the top of the



In earlier years, routed signs were used to interpret the living collections. Photo M. Fagg



Mrs Effie Mullins with school students during the first propagation class conducted at the Gardens. Photo M. Fagg

Gardens in 1976. This was one of the first such trails in Australia and it is hard to imagine today, when they are now so common in national parks, that we were a leader in the field. Likewise the Aboriginal Trail, developed soon after, was a first in linking native plants with the rich cultural heritage of our Indigenous people.

In 1979 there was a name change from 'Canberra' to National Botanic Gardens and the now familiar logo with its Australia map and stylised *Banksia* was adopted; the genus chosen because it was represented in every Australian state and Territory.

The availability of huge rocks from the construction of a nearby highway offered the Gardens the opportunity to construct the first rockery for Australian native plants. I remember the management staff sitting around a contour model of the site, each positioning various sized balls of plasticine to get the final design. When it was completed in 1980, I flew above it in an Air Force helicopter to take photos and was impressed at how similar it looked to our plasticine model.

The Visitor Centre

The opening of the Visitor Centre by Prince Charles and Princess Diana in 1985 was certainly a highlight. My dream of promoting Australian plants in museum-style exhibitions now had a suitable venue and we had many innovative displays in the years that followed.

The Gardens started putting its living plant records into a computer database in 1984 and the herbarium data followed four years later. For me, the emerging internet sparked my imagination. Few people are aware that the Gardens launched the second website in Australia, only a few minutes behind the Australian National University, in 1993. My passion for promoting Australian plants suddenly had the potential to reach a much wider audience.

1993 also saw the signing of an agreement to merge the herbaria of the Gardens and CSIRO within a jointly managed institution now known as the Centre for Australian National Biodiversity Research. This brought together the curation strengths of the Gardens herbarium with the research expertise of CSIRO, a partnership that has endured to the present day.

With all these memories, I am reminded of the Gardens' mission, adopted in the 1980s 'to grow, study and promote Australian plants'. With one third of our plant species growing here in Canberra, Australia's largest herbarium, and the most comprehensive collection of plant photographs available on the web, I think we've done this pretty well.



Dr Robert Boden (centre) with Princess Diana and Prince Charles at the opening of the Visitor Centre in 1985. Photo M. Fagg



An aerial view of the rockery garden prior to planting. Photo R. Hotchkiss



Today, the rock garden is one of the visitor 'hot spots' in the Gardens. Photo Barry Brown

Australia's National Living Collection

Paul Carmen

Paul is the Collections, Planning and Development Manager and Registrar of the Australian Cultivar Registration Authority.

It is 40 years since the Australian National Botanic Gardens officially opened its gates to the public. What started out as the greatest experiment in the cultivation of Australian plants has turned into a rich collection representing Australia's unique flora. From the beginning, staff have been developing methods for growing plants from all over Australia which would not only survive in Canberra, but flourish in its clay soils and cold winters.

This article outlines some facts and figures about the Australian National Botanic Gardens' plant collection. It also highlights some of the knowledge which has been gained from ongoing experimentation and how this has been used to further the horticultural development of Australian plants.

At one time or another, more than half the species in Australia's flora have been trialled for the collection. There are currently more than 6,000 species in the collection, representing about a third of all known species in Australia's flora.

There are 75,000 plants in the collection with around 80 per cent of Australian plant families and more than 30 per cent of the genera represented. All states and territories are represented, including neighbouring islands such as Lord Howe and Norfolk. The collection holds around 70 per cent of all the species of iconic families of Epacridaceae, Proteaceae, Rutaceae and Myrtaceae. There are also over 400 cultivar collections, many with historical significance, as a result of its sponsorship of the Australian Cultivar Registration Authority.

Entrance to the Australian National Botanic Gardens
Photo: Barry Brown



Some of collections, such as the Sydney Region Gully Garden, represent geographic areas.
Photo: Barry Brown

The Australian National Botanic Gardens (ANBG) plays a significant part in the conservation of endangered species and has 180 threatened species in its collection, including some which are extinct in the wild. This nationally important *ex situ* collection is used as a source of plant material to boost *in situ* populations of endangered species.

There are many standout features within the Gardens' collection; all displaying the rich variety and diversity of Australia's flora. Overarching the Gardens is the eucalypt canopy, over 5,000 trees and more than 400 species, providing protection from the frost and, at the same time, creating a perfect habitat for many woodland species being grown. The Rain Forest Gully and the Rock Garden are two features which have made the Australian National Botanic Gardens famous across Australia and the world.

Much of the Australian flora is extremely variable with many species exhibiting different characteristics across their geographic range. Staff have travelled widely across Australia collecting specimens to record and display this variety. As a result, the majority of plants in the collection are of known wild origin.

There are over 15,000 individual clonal collections, each with their own history. There are records on where it came from, who collected it, when and how it was propagated and its cultivation history.



The Tasmanian Garden.
Photo M.Fagg

For example, since the early 1970s, the Australian National Botanic Gardens has played a leading research role in grafting. Grafting is an important technique helping overcome difficulties with the heavy Canberra soils and providing a possible solution for the effects of the cinnamon fungus, *Phytophthora cinnamomi*. Much of the cross genera research using the hardy and rot resistant *Westringia* and *Myoporum* rootstocks for *Prostanthera* and *Eremophila* has been carried out at the Australian National Botanic Gardens.

Today, most of the plants in the *Prostanthera* and *Eremophila* collections in the Gardens have been grafted. Many of these are more than 10 years old and growing well. As a result of the ANBG's work, grafting is now an accepted practice in the cultivation of these genera across Australia. This is just one example of the valuable work which has been carried out by the horticulturalists and researchers at the Australian National Botanic Gardens in the past 40 years. The living collections are one of its most important assets and the Australian National Botanic Gardens continues to maintain and enhance its collections to display a representation of Australia's biodiversity and relevant related flora, guided by national biodiversity conservation priorities.



The Gardens is the first botanic garden in Australia to display *Correa* 'Canberra Bells'. It has been bred by Peter Ollerenshaw and chosen as the official native plant to celebrate Canberra's 100th anniversary in 2013. Photo M.Fagg

Creating a Rainforest in Canberra

Toby Golson

Toby has been the Rainforest Gully horticulturalist at the Australian National Botanic Gardens since April 2000.

The Australian National Botanic Gardens Rainforest Gully has been one of the Garden's most popular attractions since it opened to the public in 1967.

Any winter visitor to the nation's capital will quickly appreciate the crucial limiting factors on plant survival. These factors include extreme minimums of -11°C and frosts for up to 54 consecutive mornings, like Canberra had in 1982. Below freezing temperatures occur as early as March and as late as November and, on occasion, last until midday. Added to this, the capital has an unreliable rainfall. While Canberra is meant to receive 600 millimetres per annum, during the recent eight-year drought it only received about 400 millimetres per annum. It is indeed a testament to the adaptability of plants that so many species have been successfully established at the Australian National Botanic Gardens.

The Rainforest Gully is located along about 350 metres of a dry sclerophyll erosion gully. The gully has relatively steep and at times, precipitous sides, with an east-south-east to west-north-west orientation. Its nutrient deficient, shallow clay and silt soils lie in an unstable colluvial of sandstone and quartzite. Prior to the development of this rainforest landscape, the area was relatively bare of vegetation and only carried water, occasionally in torrents, after rain. Clearing of the undergrowth and fallen tree logs commenced in the early 1960s.

By 1967, a small number of initial plantings had been completed and the area was designated for development as a rainforest, an idea conceived by botanist Betty Phillips. The choice of site was based on the ease with which an artificial microclimate could be established within the confines of the existing gully. Fast growing nurse species (*Acacia binervata*, *A. elata*, *A. melanoxylon* and *Eucalyptus viminalis*) were planted along the edges to quickly form an elevated canopy over the whole area. During this early phase, the battle against the cold was alleviated by the use of frost covers.

During development, low soil moisture content and low ambient humidity were pressing issues. The installation of an in-ground irrigation system and an extensive network of misting nozzles eliminated these issues. The irrigation and misting system trebled natural annual precipitation and

increased humidity to 80 per cent in the first metre above ground level. However, vastly increased watering led to the rapid decline of naturally occurring eucalypts which had been retained to provide shelter from the elements. Today, three large *Eucalyptus mannifera* are all that remain.

The higher moisture levels increased slope instability which was alleviated by placing large numbers of star picket-staked timber logs along the contours and improved by the construction of a network of stone walled paths. The rapid planting of the gully had an even greater effect, with new roots binding the soil. Fertilising was carried out through the widespread broadcasting of inorganics, such as nitram, and slow release products to new plantings. Subsequently, leaf and twig litter, usually left where it falls, has built up a sufficiently deep humic layer to mimic the nutrient recycling of a natural system.

Many of the early plantings of tree ferns were transplanted as part of salvage harvests from areas surrounding Canberra which were being cleared for plantation forestry. The visual predominance of acacias, remnant eucalypts and hundreds of *Dicksonia antarctica* and *Cyathea australis* treeferns in the gully initially gave the impression that it was transforming into a wet sclerophyll gully.

Initially the gully was developed as a generic 'rainforest' without recognition of the myriad of discrete ecological communities existing in Australia's rainforests. The harsh conditions encountered at the time saw the rapid domination of hardier species such as *Pittosporum undulatum*, many of which subsequently became weeds. The enthusiasm of botanist Ian Telford and Australian National Botanic Gardens Curator John Wrigley led to the diversity of plantings being enriched rapidly. These staff led a series of collection trips along the east coast from the early 1970s.



A 1971 photo showing the misting system in the Rainforest Gully Garden which created a microclimate. At this stage the majority of the trees were still eucalypts.

The experimental nature of the rainforest gully did result in many failures, but also many successes. Most species were being cultivated for the first time in such a harsh climate.

In the early 1980s, staff reorganised the rainforest gully plantings based upon an east-west traversing of the gully. This represented the variety of rainforest types from Tasmanian cool temperate to North Queensland montane. In keeping with wider Australian National Botanic Gardens priorities, the late 1980s and early 1990s saw an emphasis on conservation which reflected the significant number of rare and endangered rainforest taxa.



Toby Golson maintaining the epiphytic collection which requires a head for heights, as well as horticultural expertise.
Photo Barry Brown

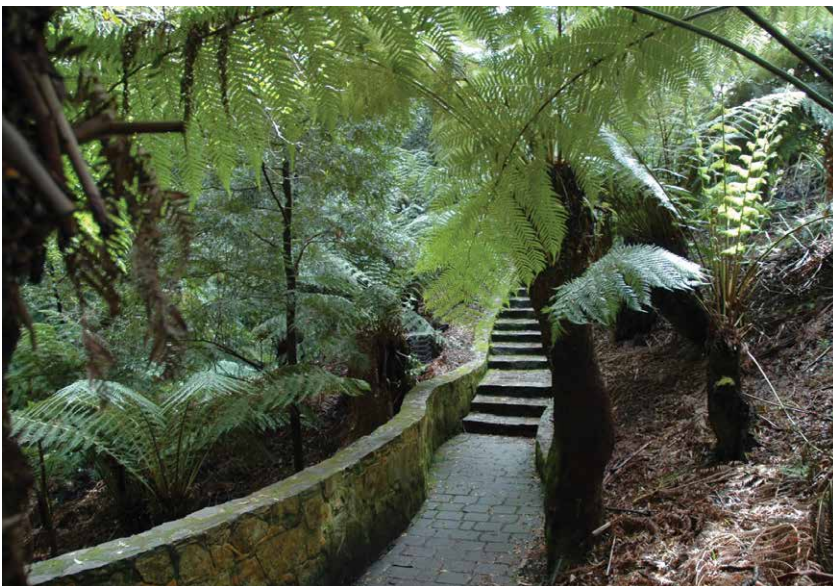
In the mid 1990s, the Australian National Botanic Gardens rationalised a large number of collections held in its glasshouses, resulting in the successful planting out of, amongst others, the extensive Australian and New Guinea rhododendron collection.

During the past decade, priority has been placed on developing the next stage of the rainforest gully. Particular attention was given to expanding the displays of epiphytes, lithophytes, ground herbs and palms. Shading vegetation has been lifted and/or removed to take advantage of the increasingly benign microclimate under the canopy. Temperatures here are around five degrees Celsius warmer than in the open. This method overcomes the issue of low light levels which impede the establishment of new plantings. The low light levels resulted from the necessary historical method of overplanting and a failure to thin out as plantings succeeded.

From 2001, under the guidance of collection's officer, Stuart Donaldson, extensive clearing commenced. Staff planted hundreds of new species in the spaces created, almost all of which continue to do well. Field trips along the NSW east coast ranges produced collections of epiphytic and lithophytic fern and orchid windfalls, large quantities of herb seeds such as *Alpinia arundelliana* and palms such as *Linospadix monostachyus*. These were then planted en masse with the intention of creating displays to mimic those found in a natural forest setting.



A view of the upper parts of the Rainforest Gully in 1971. Photo A McWhirter



A current view of the rich collection in the Rainforest Gully Garden. Photo Barry Brown

The Australian National Botanic Gardens is also seeking partnerships with other like-minded conservation organisations to exchange plant genetic material. It is thought this will help to safeguard threatened species and ecological communities. The ANBG is finalising agreements to work with both Mackay Regional Botanic Gardens and Mackay Region Society for Growing Australian Plants, as well as Gladstone Tondoon Botanic Gardens. These partnerships will aim to contribute to the conservation of the high altitude rainforest taxa of Eungella and Kroombit Tops respectively.

Managing the Rainforest Gully presents a host of challenges for the Australian National Botanic Gardens. Chief among these is managing this collection's water requirements. The project to access non-potable water from Lake Burley Griffin and connect to the Gardens will be completed later this year. It will provide an important resource to maintain the Rainforest Gully collection. Secondly, large windstorms threaten the collection and recent events have taken out several large trees. Ongoing tree maintenance and removal requires specialist resources and presents an ongoing occupational health and safety issue. Thirdly, the fungal disease *Armillaria* infests the eastern, or Tasmanian section of the gully, killing many mature trees. Trenches have been dug in an attempt to stop its spread. There are also several minor threats including hail storms, macropod damage and the gully's only significant insect pest, scale, which is controlled by pruning out. Chemicals are no longer used in any maintenance activities.

The Australian National Botanic Gardens is proud of the success of this most unlikely of creations, a rainforest in cold, dry, infertile Canberra. Some 800 taxa cohabit here, nestled under a canopy that, in places, reaches 40 metres above the gully floor. The gully is also home to a large variety of birds and other fauna. From a seedling transplanted from the New England rainforest in 1967 by Ian Telford has matured a grove of *Nothofagus moorei* now festooned with thousands of *Thelychiton falcorostrus* (syn *Dendrobium falcorostrum*) which put on a vivid display of flowers every October. A slice of the richness and variety of one of our nation's most striking groups of plants is here on display for the horticultural, botanical, educational, conservation and recreational benefit of all of us.

Thanks to Tony Barbaro, Stuart Donaldson, Murray Fagg, Catherine Jordan, Peter Ollerenshaw and Ian Telford for assistance with the research for this article.

The Alpine Seed Research Project

Heather Sweet and Gemma Hoyle

Heather Sweet is a horticulturist at the Australian National Botanic Gardens Nursery. She has worked at the nursery for 12 years and has been involved in alpine seed collecting trips over the last three years.

Dr Gemma Hoyle is a seed scientist and worked at the Millennium Seed Bank Project at the Royal Botanic Gardens, Kew before completing her PhD on physiological dormancy and germination of Australian forbs. She is currently a Postdoctoral Research Fellow at the Australian National University, in collaboration with the ANBG.

The Australian Alps, which extend from Mt Baw Baw in Victoria through New South Wales and into the Australian Capital Territory, have recently been added to the National Heritage List. The Australian Alps have been identified by the Intergovernmental Panel on Climate Change as critically vulnerable to climate change. As the climate becomes warmer and drier, some plants and animals will need to seek out cooler and wetter refuges to survive. This presents a real risk of extinction for many alpine species, as there are no cooler or wetter refuges available.

It is predicted that climate change will mean higher temperatures, less snow and more precipitation in the form of high intensity storm events for the Alps. Already the alpine region is experiencing higher summer temperatures, elevated ultraviolet light levels and reduced snow cover and depth (Hughes, 2003). In the areas above the treeline, the true 'alpine' areas, the plant communities that depend on extended snow cover and snow meltwater over the summer are at great risk.

The Australian National Botanic Gardens (ANBG) is well-placed to work on alpine flora, being a mere two hour drive from Kosciuszko National Park. An ongoing ANBG seed collection effort in the alpine area of Kosciuszko began in the summer of 2006-07 at the instigation of renowned alpine researcher, Roger Good. Our collecting teams target plants that grow in the most threatened alpine ecological communities i.e. the short alpine herbfields, windswept and snowpatch feldmark and screes, and bog and fen communities.

Harsh conditions in the alpine environment mean that plants need to flower and produce seed or fruit in the few months between December and April. Consequently, they produce the spectacular flowering displays that bring thousands of tourists to the Alps each summer. Many alpine species are perennial herbs and small shrubs and do not need



Celmisia costiniana in bloom. Photos: Joe McAuliffe

to produce viable seed every year. This is a handy strategy for alpine plants as alpine conditions can make seed production very difficult.

From 2006, seed collectors have been returning each summer to the Alps, gaining valuable skills in alpine plant identification and an intimate



ANBG staff collecting *Rytidosperma pumila* on top of Mt Lee. Photo: Joe McAuliffe

knowledge of the alpine area. Collecting seed over a number of seasons not only decreases the impact of removing seed from the natural environment, but also overcomes the problems of seasonal variation in flowering and seed production and the high amount of seed lost to predation that occurs in some years. All seed collections are dried down to three to five per cent moisture content and stored in the Australian National Botanic Gardens Seed Bank at -20°C , in accordance with international seed banking standards (see Smith et al. 2003). A pressed specimen for each seed collection is taken to verify identification and is housed at the Australian National Herbarium in Canberra. The ANBG is making an important contribution to the conservation of alpine biodiversity by collecting and storing seeds from this vulnerable area and supporting alpine plant research and propagation. However, to ensure that alpine seed can be stored in the most appropriate conditions and can be germinated when needed, greater research is needed.

In October 2009 the Australian Research Council awarded a three-year linkage grant to the Australian National University to investigate Australian alpine seed and seedling ecology. The university, in partnership with the University of Queensland, is collaborating with the Australian National Botanic Gardens and the Friends to carry out this project. Researchers Dr Gemma Hoyle and Dr Adrienne Nicotra from the Australian National University, Dr Kathryn Steadman from University of

Queensland and Roger Good from the ANBG aim to find some answers to how alpine species may respond to future climate scenarios.

For the duration of the project, teams of staff and students from the Australian National University and the Australian National Botanic Gardens and volunteers from the Friends are making regular trips to KNP to collect seed and plant data. To date, this collaborative effort has resulted in 94 collections of 70 different species. The seeds are being used for research and added to the existing alpine conservation collections at the Australian National Botanic Gardens Seed Bank. Plants from our target list are identified in the field and mature, full seed, that is, those at the point of natural dispersal, are collected. All collections are routinely tested for viability on return to the laboratory. Viable or living seed is identified by a simple cut test or by staining with tetrazolium chloride. Seeds are then cleaned and dried in new drying room conditions (15°C and 15 per cent relative humidity) financed by the Friends of the Australian National Botanic Gardens as part of the project, before being packaged and stored at -20°C .

This is standard practice in conservation seed banks and seeds should remain viable in storage for at least 10 years.

Very little is known about the germination strategies of Australian alpine seeds, therefore we are carrying out experiments at the ANBG seed bank to investigate when alpine seeds germinate in the field. To do this we designed a 'move-along' experiment and seeds from 44 species are being progressively moved through temperature conditions designed to mimic the sequence of seasons that seeds experience post-dispersal in their natural environment (that is, summer $\rightarrow$ autumn $\rightarrow$ winter $\rightarrow$ spring $\rightarrow$ summer). Results indicate the majority of seeds from the Poaceae, Asteraceae and Carophyllaceae families are likely to germinate immediately post-dispersal. In contrast, members of the Apiaceae, Cyperaceae and Epacridaceae families did not germinate until after experiencing conditions that mimicked winter. These species appear to have dormancy mechanisms that postpone germination until after the winter following dispersal. Seeds that possess dormancy postpone germination until conditions are favourable for subsequent seedling establishment. In the Alps, such germination strategies would enable species to maximise the relatively short alpine growing season, or become incorporated into the soil seed bank. Uncovering treatments that alleviate dormancy enables stored seed to be reliably germinated for use in the future.

We are also carrying out experiments to find out which species form 'persistent' soil seed banks *in situ*. The ability to postpone germination



Astelia psychocharis fruit. Photo Joe McAuliffe

until more favourable conditions occur will be an important trait in a changing climate. We collected soil samples from Kosciuszko in late spring, after 'transient' seeds had germinated and before standing vegetation had seeded. These samples were placed in 'warm' and 'cool' glasshouse environments at the Australian National University and all seedlings that emerged were tagged for identification. To date, there has been less germination in the 'warm' environment which suggests fewer seedlings emerging from such soil in a future, warmer climate.

To make predictions about the impact of climate change on alpine plants, we are looking at species that occur at both high and low elevations in the alpine area. Altitudinal gradients offer insights into plant responses to climate change as lower altitudes mimic future growing conditions when compared to current higher altitudes. The ability of plants to alter their distribution in response to climate change will depend on their ability to produce and disperse seeds and time germination in order to maximise seedling establishment. We will look at how traits like plant size, leaf area, seed production, seed viability and germination vary along a natural altitudinal gradient in common alpine species, in order to make predictions about how a species will be affected by a future warmer and drier environment. Where seed numbers allow, we will investigate early seedling establishment under predicted climate change by growing seedlings under controlled glasshouse conditions designed to reflect 'current' and 'future' alpine growing seasons.

Seedlings are also grown on in the Australian National Botanic Gardens nursery, allowing our staff to trial cultivation techniques and assess the suitability of a wide range of alpine species for inclusion in the alpine sections of the popular Rock Garden. A new display of alpine plants will be developed in the Gardens and interpretive material using the scientific research and horticultural and community knowledge brought together by this project will increase public awareness, understanding and appreciation of Australia's alpine biodiversity. In addition, this project will increase our knowledge of optimal seed bank storage conditions for alpine seeds and timeframes that we can expect alpine seed to remain viable, enabling us to develop optimum protocols for Australian alpine seed conservation, *ex situ*.

This collaboration between the Australian National University and the Australian National Botanic Gardens on the Alpine Seed Research Project has another two years to run and we look forward to sharing the outcomes of our future research.

References:

- Hughes L (2003). Climate Change and Australia: Trends, projections and impacts. *Austral Ecology*. 28 (4): 423-443
- Smith RD, Dickie JB, Linington SH, Pritchard HW and Probert RJ (eds) (2003) *Seed Conservation: Turning science into practice*. London: The Royal Botanic Gardens, Kew.



Chionogentias muelleriana ssp. *alpestris*
Photo: Joe McAuliffe

The Australian National Botanic Gardens' Role In Securing Endangered Species: A Focus on *Zieria obcordata*

Paul Carmen

Paul is the Collections Planning and Development Manager at the Australian National Botanic Gardens and the Registrar of the Australian Cultivar Registration Authority

Professional horticultural staff from the Australian National Botanic Gardens (ANBG) work in collaboration and partnership with many organisations and people to conserve Australia's plants and associated ecosystems. This article focuses on one of the conservation projects that we are working on.

Zieria obcordata is a small, rounded shrub up to 50 centimetres in height, with distinctively aromatic trifoliolate leaves. This shrub is endemic to New South Wales and the known populations, at one site near Wellington and four sites near Bathurst, are small in number.

Z. obcordata is listed as endangered under both the Commonwealth EPBC Act and the NSW Threatened Species Conservation Act. The *Zieria obcordata* Recovery Plan (2007) highlights that there are approximately 220 known individual plants, all on private property, with the biggest population with over 100 plants being in Wellington. The main threats to *Z. obcordata* are weed invasion and chance environmental events such as drought, wildfire or the invasion of disease or pests.

In 2008, George Taylor advised that the number of *Z. obcordata* growing on his property, 'Bulbudgerree', near Wellington, had declined from around 70 plants to 8 resulting from the unprecedented dry weather in 2006. Consequently, a group of specialists were brought together to consider the issue.



Zieria obcordata
Photo Cathy Hook



Zieria obcordata seedlings growing in the cracks of granite boulders. Photo Kylie Bollard

In late January 2008, staff from the Australian National Botanic Gardens, Department of Environment, Climate Change and Water (DECCW), Burrendong Arboretum and a conservation volunteer met George Taylor at 'Bulbudgerree'. George took the group to a rocky hill with large granite boulders and showed the specialists the locations where plants had been previously tagged and an extensive search was undertaken. In all, 11 adult plants and 66 seedlings were found and all were in healthy condition. The adult plants were mostly small and many of the seedlings were in groups very close together, or in cracks in rock where it seemed unlikely that all would survive.

The Recovery Plan for *Zieria obcordata* does not recommend *ex situ* conservation of the species. This is due at least in part, to the previous failure of *ex situ* attempts. Nevertheless, it was decided that further attempts should be made to secure the remaining plants and seven collections of cuttings were made (with a maximum of 20 cuttings in each batch) and two seedlings were also collected.

Previous horticultural research by the ANBG indicated that *Zieria obcordata* cuttings had struck roots fairly consistently. However, there was a pattern of the struck cuttings dying after potting up. Transplant shock seemed to be the most likely explanation and with this in mind, strategies were put in place to try alternative techniques to overcome this problem.

The cuttings were prepared with the following treatment: semi-firm cuttings 75 to 100 millimetres long, two to four sets of leaves, soft growth tips removed. Rooting hormone – Esi-Root® (1.6g/l IBA, 1.6g/l NAA) basal end dip for 20 seconds. Cutting media – Perlite (P500)/Cair, ratio 5:1, in 90 millimetre square pots placed on heated benches at 20°C with balance arm controlled mist.

The cuttings developed roots within six weeks and an extended 'hardening off' plan was trialled to overcome the threat of transplant shock. This involved holding over potting the rooted cuttings for an extra month in a low humidity environment with bottom heat and then potting up to 40mm tubes in a potting mix to which 30 per cent perlite had been added. The bottom heat was applied until the plants were clearly established (roots growing out the bottom of the pots) and developing new shoots.

Given the low numbers of cuttings in this trial (86), and the imperative of keeping the plants alive at all costs, no control plants were used. Therefore, it is difficult to confirm the effectiveness of this method. Nevertheless, it was observed that by using this method, these particular plants have survived better than any previously grown by the Australian National Botanic Gardens.

Given the reduced numbers of plants in Wellington, in what had been thought to be the main population, it was suggested that an assessment of the Bathurst population was necessary. Another trip was organised



Zieria obcordata in its typical habitat.
Photo: Cathy Hook

in April 2008 with the aim of gathering information to assess the condition of the Bathurst population. Three of the four known sites in the Crackerjack Rock district were visited. Field observations noted that the plants grew in mostly rocky locations in thin soils with a high proportion of decomposed granite, similar to the Bulbudgerie site. Population counts and assessments were made with a total of 250 plants found, including seedlings. It was also noted, in contrast to Bulbudgerie, the understorey was still largely intact and the plants were generally healthier and flowers had more pink tones.

Cuttings were collected from five plants in each location. Back at the Australian National Botanic Gardens nursery, all cuttings were prepared and when roots had developed two 'hardening off' trials were conducted. While the results of these trials were inconclusive, the hardening off processes employed had significantly increased the survival of all *Z. obcordata* cuttings grown and will continue to be used.

Soil samples were also collected from the Bulbudgerie and Bathurst sites and tests performed. The tests indicate that *Z. obcordata* has a tolerance of soils with a pH range from < 5 to >6 and can tolerate toxic levels of aluminium. This tolerance may be a competitive advantage, but may not be a preference. This suggests that *Z. obcordata* can exist in these extreme conditions, although it may do better somewhere else as observed with other endangered species which have been pushed to a tolerance limit in their growing range.

Since the initial field inspections, basic conservation actions have been implemented. In 2008, four hectares of the Bulbudgerie site was enclosed using a full size fence and all stock removed.

A follow up comprehensive population assessment at Bulbudgerie was undertaken in 2009. The plants numbers had increased from eight to 30 plants within 20 months, although fewer seedlings were found.

Since the initial field study, George Taylor located a second population on a hill to the north of Bulbudgerie and cuttings and soil samples were taken from this new population.

As of July 2010, the ANBG has 30 clonal collections of *Z. obcordata*. To date, the seven collections from Bulbudgerie represent almost 25 per cent of that population. The 200 plants in the collection represent a significant advance in knowledge about the cultivation of *Z. obcordata* and this collection has produced over 5,000 seeds which will be used for future germination research. In addition, following suggestions from ANBG staff, a translocation/re-introduction planting is being planned

within the fenced area at Bulbudgerree. It is hoped that some of the plants currently held in the ANBG, that were originally collected from Bulbudgerree, can now be returned to help re-invigorate this important endangered population.

Acknowledgements:

Many people have made significant contributions to this conservation work and special acknowledgement is given to:

Australian National Botanic Gardens – David Taylor, Craig Cosgrove, Paul Janssens, Joe McAuliffe, Sarah Fethers and Tony Perring

Department of Environment, Climate Change and Water staff – Peter Christie, Kylie Bollard, David Coote, Rob Armstrong, Garry Germon, Helen Knight and Geoff Robertson.

Central West Catchment Management Area – Peter Thompson and Andrew Knop

Burrendong Arboretum – Jim Dutton

National Parks and Wildlife Service Ranger - Gavin Newton

Conservation volunteer – Cathy Hook



The recovery of *Zieria obcordata* relies on a collaborative approach, here the team take a well earned break. Photo Cathy Hook

Pest and Disease Management: a Holistic Approach

Phil Hurle and Bruce Clarke

Phil Hurle has 21 years experience as a horticulturist at the Australian National Botanic Gardens and has a keen interest in pest management. He is currently working in the nursery implementing the integrated pest management strategy.

Bruce Clarke is a horticulturist with 12 years experience, seven of them at the Australian National Botanic Gardens (ANBG). His interests include horticultural ecology, landscape and planting design, plant propagation and plant conservation. Today he works at the ANBG's nursery in plant production and is involved with several threatened species projects there.

At the Australian National Botanic Gardens (ANBG), staff take a holistic approach to pest and disease management, relying heavily on using Integrated Pest Management principles and practices. Integrated Pest Management does not simply focus on possible problems such as weeds, pests or diseases. Instead it attempts to look at the whole process of plant production from start to finish, including nutritional and cultural requirements. It also aims to manage weeds, pests and diseases using any effective control method to reduce problems to acceptable levels. This is done with a view to avoid, or least to minimise, adverse environmental impacts.

The ANBG encourages a healthy environment rich in biodiversity so it has an increased resilience to such impacts as pest and disease outbreaks. Nevertheless, invariably there are times when some intervention is required; for example, where collections are at risk or aesthetics are seriously affected. We prefer to use chemical intervention as a last resort. In these circumstances, we use low toxicity chemicals to minimise the environmental impact and ensure the safety of visitors and staff.

The principles we employ include:

- observing and building an understanding of the organisms in our environment and their interaction with our plants
- establishing a level of tolerance to any pest or disease on a particular plant collection, or in an area

- making informed decisions when identifying and acting on problems, remembering an insect on a plant may not be a pest. Therefore, correct identification and an understanding of the insect's lifecycle is important before deciding upon its control
- selecting an appropriate control method that has no, or minimal, impact on the environment

History of pest and disease management at the Australian National Botanic Gardens

The initial approach to pest and disease management at the Australian National Botanic Gardens was based on modern horticultural practices developed after the Second World War. The general approach was to spray pests with chemicals that would poison them. Changes in practice occurred during the 1980s, following growing awareness of the potential environmental impacts of pesticide use.

Based on traditional methods, Integrated Pest Management emerged from the nursery industry. This method relies upon understanding the plants and their needs along with any other organisms involved, the observation and identification of pests and predators, and the manipulation of these to the benefit of the plants.

Since staff at the Australian National Botanic Gardens became aware of Integrated Pest Management, they have been encouraged to start observing problems and to manipulate beneficial organisms existing in the gardens. In the control of scale insect problems, for example, a variety of methods are employed:

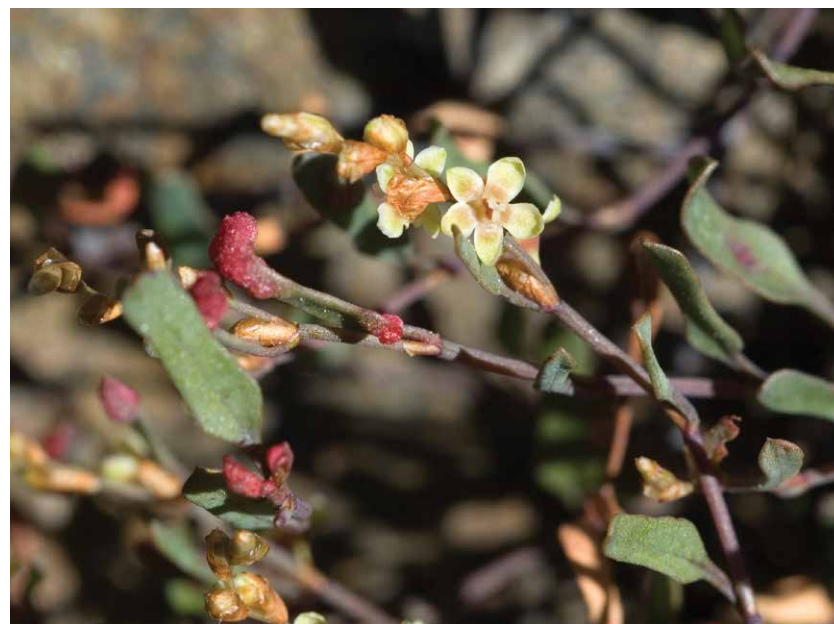
- encouraging lady beetles on to scale problems
- using sticky traps to control ants farming scale
- physically removing scales (where practical) and spraying with pest oils at the crawling stage.

Integrated Pest Management is also used in the ANBG's nursery. More emphasis is put on optimising plant health to enable plants to resist pest and disease attack. A policy dictating minimal use of systemic pesticides has been introduced. Staff are also moving towards using contact type pesticides such as soap sprays and pest oils. Natural predators are encouraged and some beneficial organisms are commercially purchased and introduced. For example, predators such as lady beetles are used to control mealy bugs.

Where we are now

Healthy plants are able to withstand pathogens much better than ones that are struggling. Consequently, the ANBG is investing time in Integrated Pest Management and monitoring is a very important part of the practice. An ability to recognise an organism as a real pest, as opposed to a just a bug on a plant, is important. Staff work collaboratively with scientists from the Australian Biological Resources Study, who are based at the Gardens. On occasions, a previously unrecorded insect is observed on a particular plant and this new discovery delights everybody.

A good example is the *Eriophyid* mite found on *Muehlenbeckia tuggeranong*; a rare and endangered plant only occurring on the banks of the Murrumbidgee River in the Australian Capital Territory. This group of mites is very often host specific, probably only occur on this plant and are also most likely endangered. The mites do not seem to cause any major setback for the plant; although, perhaps there is a loss of thriftiness towards the end of summer. The plant loses its leaves over winter so the mite numbers drop before another flush of leaves and growth in the spring and early summer.



Galls of an eriophyid mite on *Muehlenbeckia tuggeranong*. Photo M. Fagg

Methods used in the nursery

The Australian National Botanic Gardens apply careful hygiene practices to maintain a healthy environment, including:

- pasteurising the potting mix
- keeping watering wands and pots off the ground
- avoiding pot and mixes contamination with soil from the gardens (or 'dirt')
- avoiding water pooling to control fungus gnats
- keeping plants well spaced and in areas where there is good air circulation to keep airborne fungal pathogens down
- controlling weeds around the nursery to reduce over wintering spots for such pests as thrips and aphids
- maintaining a good mix of shrubs and trees to harbour birds and increase the chances of naturally occurring predators, as well as the surrounding bush which is a great source of surprise predators.

Regular monitoring is used to record pests and determine the level of acceptance of pests for each individual plant. Consideration is given to the pest, the plant species, the time within the season and possible existing predators. Aphids in early spring, for example, can have hover flies and wasps predating on them. By waiting a few weeks for the numbers of predators to build, an effective control can be achieved. An exception to this method is with young plants. These need to be sprayed with a weak mix of pest oil to control aphids and mealy bugs because they are susceptible to damage at such a young stage of growth.

Methods and beneficials used at the gardens

Specific controls:

- powdery mildew – ensure good air circulation around the plants. The staff use a milk spray once a week in cooler moist weather as a preventative method. Use a dilution rate of 1:9; note, a stronger rate is not recommended
- fungus gnats – Apply nematodes fortnightly as a curative and then monthly as a preventative. Nematodes enter the body cavities of the larvae and reproduce inside the grubs, thereby killing them
- white fly – Use a commercially available predatory wasp called *Encarsia formosa*. This is effective against greenhouse, silverleaf and ash whitefly

- caterpillars – use the bacteria *Bacillus thuringiensis*.

General beneficials used:

- lacewings are excellent predators. They lay their eggs on stalks to prevent the young from consuming each other. The larvae control aphids and mealy bugs. They have small spines on their backs to impale the remains of their prey and provide a disguise for themselves and then move around the prey. Note that the larvae are susceptible to ant attacks. The green lacewing is commercially available and the brown lacewing is naturally occurring
- mites are excellent predators and can be introduced to the plants. As mites can persist for quite a long time, they provide good background control against various pests. There are several that are commercially available. The soil dwelling mite, *Hypoaspis* sp. predaes on fungus gnat and thrip larvae. *Montdorensis* and *Cucumberis* mites are used against various thrips. *Victoriensis* mite is used as a general predator, while *Persimilis* is used against two spotted mite
- ladybird beetles are good at controlling scales and mealy bugs. *Cryptolaemus* spp. (most are purchased, but some are naturally occurring) are very good at controlling a wide range of mealy bugs. *Chilocorus* spp. feed on a wide range of scales.



Parasitised aphids on an *Olearia* species. Photo: Phil Hurtle



Hover fly
Photo: Bing Tan

- wasps predate on aphids. Although commercially available, there are good number that are naturally occurring
- hover flies are naturally occurring. They predate on aphids, especially in the spring.

Physical control methods:

- squashing scales, mealy bugs, caterpillars and aphids is a very effective control method and is especially good if the numbers are low (hence the value of regular monitoring)
- hosing leaves in warm weather can dislodge aphids and increase humidity which is unfavourable to two spotted mites. Although be aware, it can be favourable to powdery mildew
- use sticky barriers to control ants. Ant control is important when using predators because the ants are likely to protect their source of honey dew and attack anything likely to threaten this.

Chemical controls:

- if necessary, isolate plants and spray with a systemic insecticide. Leave for a few days and monitor for effectiveness
- Petroleum oil and Bio oils are used as a spot spray against small outbreaks, applied as needed and usually at the time of monitoring.

The Australian National Botanic Gardens' integrated pest management strategy is providing excellent results in terms of maintaining the health of the collections and encouraging diversity. Importantly, the use of an integrated pest management approach requires constant developing and refining as new challenges arise. Nevertheless, it is an approach to gardening that is more sensitive to our biodiversity, staff, visitors and the local environment.



Ants protect and care for honeydew-producing insects such as soft scales, increasing damage from these pests.
Photo: M. Fagg

Cryptolaemus control a wide range of mealy bugs
Photo: J. Gross

The Evolution of the Australian Acacias

Joe Miller

Dr Joe Miller is the research group leader at the Centre for Australian National Biodiversity Research (CANBR). The Centre is a joint venture between CSIRO and the Australian National Botanic Gardens and houses the Australian National Herbarium. The goal of its research is to understand the diversity, distribution, and evolutionary relationships of the Australian flora. Joe’s research focuses on Australian acacias with a goal of understanding how they have evolved in the Australian landscape.

Acacias are a critical part of the Australian flora. With over 1,000 species, they can be found throughout the continent and are especially conspicuous in the arid interior zones. Acacias are also famous in Africa and the Americas, but molecular systematic work has shown that the Australian plants are not closely related. This article briefly describes our understanding of the evolution of *Acacia* and in particular, provides an overview of some of our most recent discoveries of the relationships within the Australian acacias.

Acacias from around the world

Despite obvious convergence in a number of physical characteristics, the Australian acacias are not closely related to other acacias in Africa and the Americas. In general, all *Acacia* species have bipinnately compound leaves, at least as juvenile plants, and creamish-white to yellow inflorescences. Three major lineages or subgenera have been long recognized and these are summarized in the top three rows of Table 1. Importantly, the two major non-Australian groups both have species in Africa and the Americas. In other words, there isn’t an African lineage, an American lineage and Australian lineage - instead two lineages have both African and American species.

Table 1: A summary of the major lineages of acacias

Acacia in broad sense	Genus, pre retypification	Generalized Distribution*	Genus, post retypification
subg. <i>Phyllodineae</i>	<i>Racosperma</i>	Australia	<i>Acacia</i>
subg. <i>Acacia</i>	<i>Acacia</i>	Americas, Africa, Asia	<i>Vachellia</i>
subg. <i>Aculeiferum</i>	<i>Senegalia</i> sect. <i>Senegalia</i>	Americas, Africa, Asia	<i>Senegalia</i>
subg. <i>Aculeiferum</i> . sect. <i>Filicinae</i>	<i>Senegalia</i> sect. <i>Filicinae</i>	Americas	<i>Acaciella</i>
subg. <i>Aculeiferum</i> “coulteri group”	<i>Senegalia</i> sect. <i>Senegalia</i>	Americas	<i>Mariosousa</i>
subg. <i>Aculeiferum</i> “skleroxyla” group	<i>Senegalia</i> sect. <i>Senegalia</i>	Americas	Not presently recognized

By sequencing a small portion of the DNA from a large representation of the Mimosoid legumes, in which *Acacia* belongs, we can infer how the different lineages are related.

The large evolutionary distance of the Australian acacias to the acacias of Africa and the Americas is quite evident. The closest relative of the Australian *Acacia* species are species of the tribe Ingeae, such as *Paraserianthes lophantha*. Other genera more closely related are *Albizia*, *Calliandra*, *Lysiloma* and the monotypic genus *Faidherbia albida* which in the past was referred to as an *Acacia*.

Most systematic botanists prefer to place a generic name on groups of species that share an exclusive evolutionary history (monophyletic). Because of this each lineage (formerly a subgenus or section) has become a genus with a new name. In 2005 a controversial retypification of the type species of *Acacia* was accepted to the International Botanical Code. The result of this is the conservation of the name *Acacia* for the Australian lineage. The name changes are summarised in Table 1.

The Australian acacias

With over 1,000 species *Acacia* is the largest genus of plants in Australia. Plants can be found in most habitats and fill many environmental niches, especially in the arid zone.

Traditionally phyllode (a modified leaf) and inflorescence structures have been used to subdivide the species into groups. The major characteristics include the size, shape and nerve type of the phyllodes and whether the flowers are in a globose or spicate shaped inflorescence. These divisions have been useful in identifying acacia species, but have never been thought to be sufficient to understand their evolution.

DNA sequence data is now shedding light on some of the overall phylogenetic (evolutionary) relationships. It is clear that the species underwent a rapid radiation into its many forms. This is evident from the high degree of DNA sequence similarity among many acacia species. Nevertheless, the DNA data is indicating grouping of lineages. One of the highlights is that *Acacia victoriae* and its close relatives form one of the oldest lineages. This species is well-known as for its edible seeds and is the most often used in the native bushtucker industry. Also, a triterpene has been extracted from this species which slows cancer tumour growth in the laboratory.

The evolution of leaf forms

Most of the close relatives of *Acacia* in the Mimosoid legumes, the nearest relatives of the Australian acacias, have compound leaves.



Figure 1: There is diverse phyllode variation in acacias. Above, the collection on the left have a single main nerve, while the phyllodes on the right have two or more main nerves. All photos by J. Miller

When a phyllodinous acacia seed is germinated, the seedling leaves are not phyllodes, but are compound. As the plant grows, most will eventually produce phyllodes and, as mentioned earlier, most species (over 90 per cent) have a phyllode modified leaf as an adult. Therefore, there has been a major shift in leaf types in the Australian acacias and it is hypothesised that the evolution of phyllodes has occurred to slow water loss in a dry climate.

There have been at least two transitions in leaf form in which the adult plant maintains bipinnate leaves and never develops phyllodes. Also many species are plastic in their leaf morphology. Some species, such as *Acacia rubida*, will produce bipinnate leaves until the plant is two metres tall. In contrast, others, such as *Acacia longifolia* subsp. *sophorae*, will often have phyllodes on the second leaf.

By tracing the phyllodes development back to its seedling beginnings we can see patterns in leaf evolution. The Pullcheloideae lineage (Figure 2) is composed of many species that have very different adult foliage from bipinnate leaves, phyllodes, decurrent phyllodes and some plants without any leaves.

However, all these plants have a common seedling leaf morphology, that is very uncommon among the rest of the Australian acacias. The first two true leaves of these plants are both pinnate like the plant on the left in figure 3, while most of the other plants of the Australian acacias are like the plant of the right which a pinnate first leaf followed by a second bipinnate leaf.

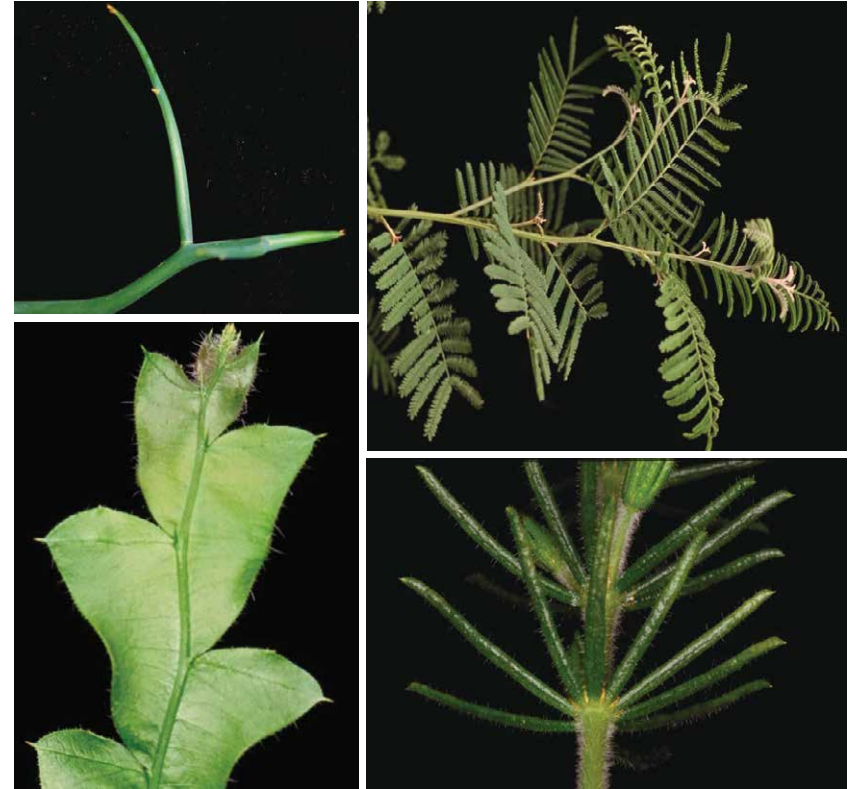


Figure 2. The adult foliage of members of the Pullcheloideae has a broad range of forms. The plant on the upper right demonstrates the bipinnate leaves found in this group, but these are also found in Botrycephalae, a distantly related group common to SE Australia.



Figure 3. The two common seedling forms of *Acacia*. The Pullcheloideae group has the seedling form found on the left. Most other *Acacia* seedlings are similar to the plant on the right.

Conclusion

The analysis of morphological traits such as leaf and flower type, combined with the power of evolutionary DNA analysis, allows insight into the how traits have evolved. These analyses are continuing to allow us to better understand why certain *Acacia* species are found in particular parts of the landscape and when these important modifications occurred.



The Acacia Gardens were some of the first developed at the Gardens in the 1960s. Now acacia is a major area of research for the Centre for Australian National Biodiversity Research, drawing on the Gardens' 286 species in cultivation. Photo M. Fagg

Pot Displays with Sturt's Desert Pea (*Swainsona formosa*)

Paul Carmen

Paul is the Collections Planning and Development Manager for the Australian National Botanic Gardens and the Registrar of the Australian Cultivar Registration Authority.

Sturt's Desert Pea (*Swainsona formosa*) grows in the hot, sandy areas of Australia. It is an annual which can produce outstanding floral displays over extended periods. Although much admired, the Sturt's Desert Pea can be difficult to grow outside its natural desert environment because it is prone to root rotting fungal diseases and pest attack.

In cultivation it has been suggested that plants survive longer if they remain disease and pest free. ANBG staff have carried out extensive research and experimentation on Sturt's Desert Peas to examine their survival in cultivation and prepare them for a potted spring display. Seed-grown plants grafted onto the more vigorous and rot resistant New Zealand plant, *Clanthus puniceus* (Glory Pea) were used for the experiment.

In March 2008, all the plants were potted up from 70 millimetre tubes and placed in twin-skin polytunnels on heated benches to enhance growth. Three fertiliser formulations were trialled (Nutricote® Grey, and Nutricote® Purple and Osmoform®) at the rate of 5kg³. In addition, an intensive tip pruning regime was carried out on all bar two control plants. This was done to assess how the plants responded to pruning (and not being allowed to flower), to maximise flowering potential and to keep them compact and easier to handle and transport.

In late July, all plants were assessed and it was noted that those grown with Osmoform® grew the fastest, had the most shoots and the best roots. Growing on and pruning through winter significantly increased the number of flowering stems over the control plants. Two different forms were observed - one prostrate form with few stems and a vigorous bushy form with some plants having more than 20 stems. The bushy plants continued to



Sturts Desert Pea, *Swainsona formosa* Photo M. Fagg



The *Swainsona formosa* pot displays were popular with visitors.
Photo: Barry Brown

grow more vigorously and performed best throughout the display. In contrast, the control plants only produced three to four stems each.

In early August, the best plants were selected for potting up to large waterwell pots and fertilised with the slow release Triabon®. The waterwell pots were then installed into 'tight fitting' terracotta display pots on the main concourse and near the café in mid September.

This 'pot in a pot' arrangement was chosen so that, if required, the waterwell pots could be easily replaced. Flowering began within two weeks and continued until September 2009 with most of the plants living for more than a year. This flowering period was far longer than any previous 'in ground' plantings had produced. The display was popular and well received by staff, Friends and the public alike.

The main challenges encountered during the display period were stem breakage, either from the wind or people handling them, and growth setback caused from the terracotta pots getting too hot during summer.

In conclusion, the experimentation with Sturt's Desert Pea plants proved very successful as a pot display and our handy hints for success with the Sturt's Desert Pea are: use grafted plants; apply lots of fertiliser and then prune, prune, prune and select only the bushy forms!

Acknowledgements

The Australian National Botanic Gardens would like to acknowledge specialist advice kindly provided by Kevin Handreck (Netherwood Consultancy), Manfred Jusiatis (Botanic Gardens of Adelaide) and Peter McKenzie (BushGrafts Nursery).

Australian Plant Stories: Exploring Iconic Plants at the ANBG

The authors of these short articles are volunteer guides at the ANBG

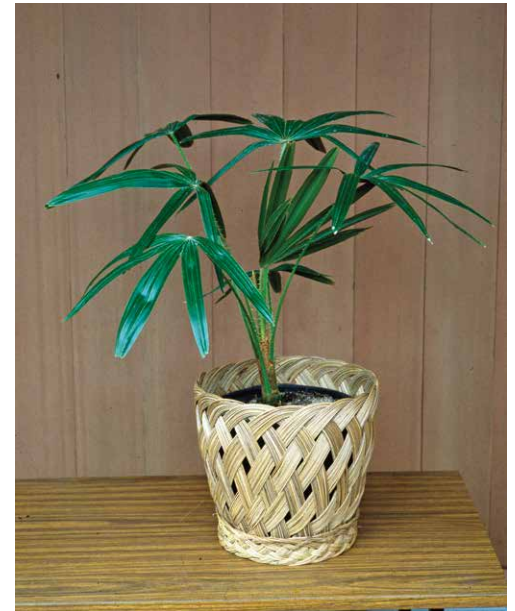
Thatch or Kentia Palm *Howea forsteriana*

Doug Laing

Of the four species of palm endemic to Lord Howe Island, the best known is *Howea forsteriana*, which forms dense lowland forests in some areas. *Howea* is named for the island and the species name, *forsteriana*, honours NSW Senator Henry William Forster, who was instrumental in obtaining female suffrage for Australia.

Seeds from the plant were sent to England as early as 1868. Kentia palms, as they were then known, were soon features of Victorian palm courts, ballrooms and hotel foyers and created a new industry for the island.

As a result of its appeal as a potted palm, the species has suffered heavy seed predation and is considered vulnerable by the IUCN (International Union for Conservation of Nature). Current exports number millions of seedlings annually.



Howea forsteriana is a popular potted palm.
Photo: M.Fagg

Queensland Bottle Tree *Brachychiton rupestris*

Pauline Wicksteed

Native to the Brigalow Belt of southern Queensland, the Queensland bottle tree *Brachychiton rupestris* is striking not only in appearance, but it has a long history of being remarkably useful. The tuberous roots have been tapped for water and the pithy fibrous inner trunk and seeds have provided food over the centuries for Aboriginal people. Explorers



Brachychiton rupestre being transplanted at the entrance to the Australian National Botanic Gardens.
Photo: Barry Brown



Nothofagus moorei. Photo: M. Fagg

Major Mitchell and Ludwig Leichhardt mentioned the nutritious gum obtained from chewing the woody fibres of the trunk. During drought, farmers use the nutritious foliage and the soft wood of the trunk to feed stock; this probably explains the survival of these trees in otherwise cleared areas.

B. rupestre is starting to interest home gardeners as a pot plant and special feature and a number of nurseries are propagating plants from seed. Bottle trees are also being used for street tree plantings in towns throughout Queensland, such as Roma. They can reach twenty metres in height and two metres in diameter and they like well-drained soil. Once established, they are drought resistant and frost hardy. The Queensland government has legislated to stop further removal of bottle trees from public and private land.

Antarctic Beech *Nothofagus moorei*

Doreen Wilson

There are three endemic species of southern beech in Australia and these are from the family Nothofagaceae; one of several families with Gondwanan history.

Along the main path winding through the ANBG, there stands a sturdy *Nothofagus moorei* which is host to an abundance of ferns and the beech orchid *Thelychiton falcorostrus*. Much of the ANBG's living collections have wild origins and this outstanding tree started its life in Dorrigo NSW. It was collected by botanist Ian Telford in 1967. His field notes reveal that this young seedling was collected from an area surrounded by mature trees estimated to be forty feet (12m) high. This Antarctic Beech is now the collector's pride and joy and three decades later, when walking in the Gardens, Ian mused: 'I always enjoy walking out into the rainforest gully and looking into the *Nothofagus* grove'.

Growing the Garden Out of the Grassland – The challenge of a threatened community garden in a prominent public space

David Taylor and Kaiya Browning

David Taylor has been at the Australian National Botanic Gardens for 10 years as curator, landscape planner, horticultural manager and horticulturist.

Kaiya Browning has worked with at the Australian National Botanic Gardens for 10 years as a horticulturist looking after many diverse gardens and is now the resident landscape architect.

The Australian National Botanic Gardens' prominent grassy woodlands section is one of the first things visitors see entering the front gates. The aesthetics, relevance, suitability and legitimacy of this section as a horticultural feature has been hotly debated by staff, visitors, Friends of the Australian National Botanic Gardens and guides since the section was created over 20 years ago.



The existing woody grassland garden challenges visitors perceptions of a 'garden'. Photo: Barry Brown

Reactions to the presentation of this section vary to such extremes that, at times, it is hard to believe that people are talking about the same spot!

This is one of the best naturalistic re-creations of a grassy woodland anywhere.

When is this area going to be developed into a garden?

Has this section been abandoned?

Has this area been retained as a remnant, from prior to the gardens being developed?

Let's get rid of this and put something stunning and attractive in!

Considerable effort and resources have gone into establishing and maintaining this area. Consequently, some of these comments are confronting and present a challenge to us as horticulturalists and custodians of a garden for future generations. Perhaps it is really a prompt for us to think more about what we are growing, how we are displaying it to the visitor, how the area engages with people and what needs to be done to enable the area to appeal to a wider audience.

If we do not consider and develop a new way of presenting this theme, it will continue to be hard to justify the legitimacy of such a garden in a prime location.

It would be easy to relocate this garden and combination of plants to a less prominent and less contentious spot elsewhere. However, by doing this we would be taking the easy road in terms of dealing with the pressure and criticism. This misses the opportunity and the challenge to use a prime location to excite and engage a wide audience and tell the critical and inspirational stories about remnant vegetation, biodiversity conservation and a nationally listed threatened ecosystem.

Feedback and discussion with staff and visitors over the last 15 years have revealed diverse ideas about how we could make the area appeal to a wider audience through enhancing the horticultural impact, while maintaining the integrity of the threatened community and biodiversity conservation values. Some of these ideas include:

- Paying attention to the hard landscape design to create a horticultural canvas that will serve a future planting of the section should the grassy woodland theme be unsuccessful.
- Softening and 'naturalising' the boundary to the section by removing the harsh kerbs and replacing them with sympathetic rockwork
- Sympathetic paths through the section allowing visitors into the habitat to have an intimate experience of the plants.

- Bold structural elements, in both landscape and plantings, that excite and entice even in the non-flowering times of the year.
- Sustainable use of the landform to make efficient use of aspect exposure and drainage including a dry creek line meandering through the section and the capture and use of rainwater runoff for plants preferring wetter habitats.
- Interpreting the grassland and its message in a horticultural context and, in effect, making a garden out of a grassland with grassland species and themes.
- Deliberate and bold massed planting using eye catching species for visual impact to give the 'wow factor' throughout the year. For example, a copse of *Xanthorrhoea* grasstrees to provide structure, a sea of *Leucochrysum albicans* to light up the area with colour and intense use of structural plants such as *Lomandra*, clumping grasses and sedges.



A mass effect can be created using *Leucochrysum albicans*. Photo: M.Fagg

- Using materials and landform to add visual appeal which is independent of the season, including the bold, artistic and prominent use of rock outcrops.
- Carefully placing containers, such as painted and partly-buried pots, to showcase a seasonal display of smaller grasslands plants which can be lost in a large spreading garden. For example, using *Swainsona recta* for its uniqueness and delicate form, or vanilla and chocolate lilies for their delightful fragrances to tempt the senses.



Xanthorrhoea are a key feature of the woody grassland garden. Photo: Barry Brown

- Art installations based on threatened species from grassy woodland communities. Sculptures of the legless lizard, golden sun moth or the earless dragon would engage people with the story behind this threatened community.



Art installations, such as Fire and Water by Judy Watson in Reconciliation Place in Canberra, can be used to engage people with the landscape. Photo M. Fagg

We believe by changing our approach in this grassy woodland section, people will be encouraged to appreciate and debate the importance, values and stories of this threatened ecosystem and appreciate its unique flora. We hope that people will be inspired to consider grassy woodland plant species and horticultural features for their home gardens.

The ANBG is developing this concept of a horticultural grassy woodlands display over the next few years and we hope many of you will be tempted to visit the Gardens to watch this exciting project unfold.

Acknowledgments

We would like to thank Frances Verrier for her advice on the role of grassland ecology in horticultural design and Jim Croft for engaging in our many discussions and providing editorial assistance with this article.



The fragrance produced from a mass planting of *Dichopogon strictus* will provide a sensory experience for visitors.
Photo M.Fagg

Australian Plants may be received by membership or subscription

Membership: Contact the Secretary, listed below, of a Society.

Annual subscription: \$24.00 (A\$36.00 overseas) including postage to your address.

Contact: Subscription Officer PO Box 3066 Bowenfels NSW 2790;

Email: merleaps@bigpond.com; Fax: 02 6351 2384

Binders: To fit the holes drilled. \$6.25 plus \$5.00 pack & post in Australia.

Past Issues: Recently published single issues are \$3.95 plus \$1.20 postage in Australia.

Australian Plants Reference: Index to volumes 1–18, \$16.50 + \$5.00 p & p in Australia.

Bound Volumes: Past issues available. \$49.50 plus \$9.50 pack & post in Australia.

Mail Order Book Services: Contact Society Secretaries for information on services available.

AUSTRALIAN NATIVE PLANTS SOCIETY (AUSTRALIA) INC. (ANPSA)

President: Paul Kennedy: E-mail: hakeaholic@aapt.net.au

Secretary: Carolyn Edwards 765 Lemnos North Road Congupna Vic 3633

Email: jcedwards@mcmedia.com.au

Website: <http://anpsa.org.au>

AUSTRALIAN PLANTS SOCIETY NSW LTD

President: Graeme Ingall

Secretary: John Aitken

PO Box 5026, Old Toongabbie NSW 2146 Tel. (02) 9631 4085. Fax. (02) 9631 4293.

Email: office@ausplants-nsw.org.au Website: www.ausplants-nsw.org.au

THE AUSTRALIAN NATIVE PLANTS SOCIETY, CANBERRA REGION INC.

President: Jan Robbins. Tel: 02 6231 7391 Email: jrobbins@netspeed.com.au

Secretary: Vacant

Website: www.nativeplants-canberra.asn.au

SOCIETY FOR GROWING AUSTRALIAN PLANTS — QUEENSLAND REGION INC.

President: Lorna Murray: Email: lg.murray@uq.net.au

Secretary: Kelly Watts: PO Box 586, Fortitude Valley QLD 4006.

Email: secretary@sgapqld.org.au Website: www.sgapqld.org.au

AUSTRALIAN PLANTS SOCIETY, S.A. REGION INC.

President: Michael Anlezark, 25 Victoria Road, Clare, SA 5453. Tel. 0419 838 321,

(08) 8641 9118 Email: aalbg@portaugusta.gov.au

Secretary: Linda Gowing, PO Box 304, Unley, SA 5061. Tel. (08) 8303 8055 (w)

(08) 8388 3004 (h) Email: linda@shadygrove.com.au

Email: info@australianplantssa.asn.au Website: www.australianplantssa.asn.au

AUSTRALIAN PLANTS SOCIETY TASMANIA INC.

President: Mark Geeves

Secretary: Mary Slattery: PO Box 3035, Ulverstone MDC, Tasmania 7310

Website: www.apstas.com

AUSTRALIAN PLANTS SOCIETY (SGAP VICTORIA) INC.

President: Brendon Stahl: Tel. (03) 5236 3325

Secretary: Nicky Zanen: 9/51 Herbert St., Boronia 3155. Tel. (03) 0761 1933

Email: secretary@apsvic.org.au Website: www.apsvic.org.au

WILDFLOWER SOCIETY OF WESTERN AUSTRALIA INC.

President: Anne Pilgrim

Secretary: Jana Sturis: PO Box 519 Floreat WA 6014.

Office: Perry House, 167 Perry Lakes Drive Tel. (08) 9383 7979 Fax. (08) 9383 9929

Email: wildflowers@ozemail.com.au

Website: <http://members.ozemail.com.au/~wildflowers/>