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18 December 2013

Dr Gerardo Fragoso
Environmental Grants Manager
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5 Young Street
London W8 5EH
UNITED KINGDOM

The Royal
BOTANIC GARDENS
& Domain Trust

Dear Dr Fragoso,

It is with great pleasure that I am sending to you the first year progress report for the Rainforest Seed Conservation project, a major capital project undertaken by the Royal Botanic Garden and Domain Trust at the Australian Botanic Garden, Mount Annan.

The Seedbank is housed with the new Australian PlantBank which was officially opened in October.

The report was prepared by Cathy Offord, Manager, Horticultural Research at the Australian PlantBank, and Liz Smith, Acting Philanthropy Manager at the Trust. If you have any questions about its contents or need any further information, please don't hesitate to contact Liz via email, liz.smith@rbgsyd.nsw.gov.au.

Please note that our 2012/13 annual report is now available on our website at: http://www.rbgsyd.nsw.gov.au/about_us/_nocache

On behalf of everyone at the Trust I would like to sincerely thank the trustees of Arcadia for their generous contribution towards the Australian PlantBank. This remarkable facility will become a major centre for plant science in New South Wales, Australia and the world.

Yours sincerely,

Dr Brett Summerell
Acting Executive Director
Royal Botanic Gardens and Domain Trust

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**Report to the Arcadia Fund – Year 1 of 5**

**The Rainforest Seed Conservation Project**

**Reporting period October 2012 – 31 October 2013**

***The issues our organisation seeks to address.***

The Royal Botanic Garden and Domain Trust (RBGDT) is a leading contributor and custodian of botanical knowledge and collections throughout Australasia, we also aim to share our discoveries and be at the forefront of international plant conservation. As part of the International Seedbank Partnership, the RBGDT is now playing a vital role in the global effort to conserve 25% of the world's plant species by 2020. Much of this work is taking place at the Australian PlantBank at our second Botanic Gardens' site at Mount Annan, south west of Sydney. This major capital project by the RBGDT was opened in October 2013 by Her Excellency, Professor Marie Bashir, Governor of NSW, and Environment Minister the Hon Robyn Parker.

The Australian PlantBank at the Australian Botanic Garden, Mount Annan

Australia is home to 14 per cent of threatened plant species globally and almost a quarter of that 14 per cent is in danger of becoming extinct. Rainforests in particular are amongst the world's most vulnerable ecosystems facing significant assaults from climate change, land use and plant disease. Scientists at the RBGDT in Sydney are working to address this potentially catastrophic loss.

<u>Seedbanking and the Rainforest Seed Conservation Project</u>

Traditional seed banking is considered the best way of conserving plants away from the wild (ex situ) however not all species, particularly many rainforest species, respond well to these techniques. With the number of threats to rainforests increasing at an unprecedented rate and the immediate challenge of Myrtle Rust, a disease that could wipe out a major component of Australian rainforests, there is an urgent need to prioritise the development of new technologies. If we fail to do so, significant numbers of rainforest species will be lost forever.

In the last few years, the Trust's scientists have begun preliminary research to apply new technologies such as cryogenic storage to rainforest species. Cryogenic storage preserves seed samples at temperatures between -80 and -196°C, significantly extending the range provided by traditional seedbanks.

The continuation of this research alongside the delivery of an ambitious program to collect Australian rainforest seed is a high conservation priority. The Rainforest Seed Conservation Project is the first project of its kind in the Australasian region; it will deliver significant outcomes protecting some of our most valuable plant species from extinction.

Through this project the Trust will undertake rainforest species conservation research and capacity building that will enhance significantly our ability to deliver wide reaching outcomes in the region and globally.

The Rainforest Conservation project contributes to a number of important conservation goals of the RBGDT. At the global level, it specifically contributes to targets for urgent and effective conservation of plant diversity, as articulated in the Global Strategy for Plant Conservation (GSPC, http://www.cbd.int/gspc/targets.shtml). In particular, the project addresses Target 8 (at least 75 per cent of threatened plant species in ex situ collections, preferably in the country of origin, and at least 20 per cent available for recovery and restoration programs). Engagement with key stakeholders of the Rainforest Conservation project and incorporation of rainforest examples in the Australian PlantBank will enable progress towards Targets 14, 15 and 16 of the Global Strategy for Plant Conservation (education, capacity building and public engagement).

At the 'local' level, the project contributes to the Australian and NSW State Government priorities. In particular, the NSW Threatened Species Conservation Act (http://www.environment.nsw.gov.au/threatenedspecies/tscact.htm) informs the collection strategy and research priorities of the Rainforest Seed Conservation Project, alongside other projects of the Australian PlantBank. Collection of plant germplasm e.g. seeds is considered a key process in the Threatened Species Priorities Action Statement and collections made for the Rainforest Seed Conservation project are likely to be incorporated into future recovery plans for threatened species.

***Specific outputs and major accomplishments during the year.***

A successful start to the project

The Rainforest Seed Conservation Project was launched in October 2012 at the Royal Botanic Gardens Sydney by the Minister for the Office of Environment and Heritage, the Honourable Robyn Parker. This event resulted in a number of widely distributed newspaper articles and radio interviews.

The project has been given a tremendous boost by the opening in October 2013 of the new conservation facility, the Australian PlantBank, located at the Australian Botanic Garden, Mount Annan. The co-location of the seed bank, tissue culture, cryostorage and other science facilities within Australia's largest botanic garden, enables greater efficiency and outcomes from this world-class facility. The Rainforest Seed Conservation project is the flagship science program of the Australian PlantBank. Importantly, the Australian PlantBank has a major education function and

is open to the public to view interpreted scientific activities within the laboratories and seed bank.

The team is assembled

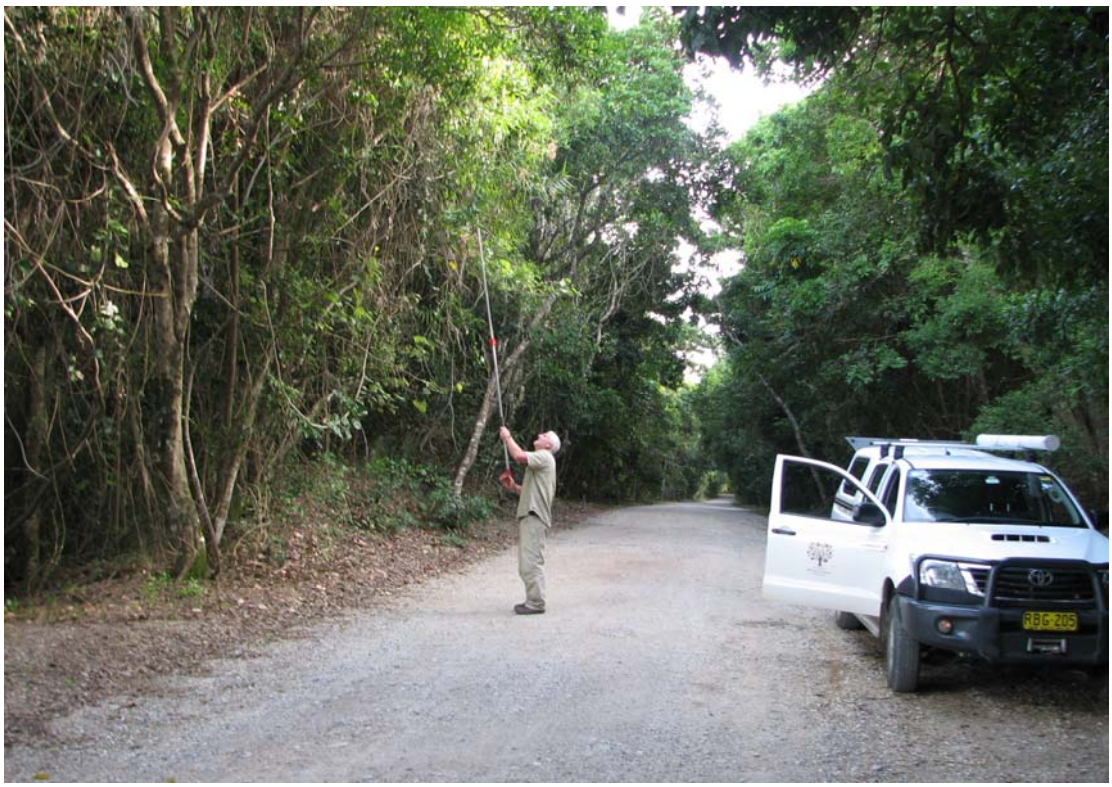
Following the official launch of the Rainforest Seeds project, recruitment began for scientific staff to conduct the project. Collection and seed analysis is led by Graeme Errington who has been working in this field for nearly 20 years bringing a wealth of experience to the project. Dr Amelia Martyn, an experienced seed researcher was appointed (pt) to develop and deliver the communication strategy for the project, including the liaison with networks and preparation and delivery of training. Dr Karen Sommerville has a strong background in germplasm conservation and was appointed to oversee the development of alternative conservation techniques - tissue culture and cryostorage. Amanda Rollason, who has many years of tissue culture and horticultural experience, provides technical support in the laboratory and nursery.

Further support is supplied by other science staff, especially germplasm conservation expert Dr Cathy Offord and restoration scientist Dr Peter Cuneo, as well as many other Australian and international collaborators.

Collection and storage of seeds and other material

Rainforest species, by their very nature, are difficult to collect. They are often in fragmented populations and many occur on private land and access has to be negotiated. Additional problems includes the recent rapid spread of Myrtle Rust that is affecting seed set of many rainforest species and the widespread and unseasonal bushfires. This makes the collection of rainforest species difficult but imperative. For these reasons we work with the foremost experts to plan and collect for this project.

As seeds of rainforest species ripen at different times, there were four trips to northern New South Wales at different times, and a number to more local rainforests around Sydney. A large proportion of these collections were threatened species, especially from the Myrtaceae family, many species of which are highly susceptible to the recently introduced disease Myrtle Rust. Indeed seed could not be collected from several species due to the devastating effect of the disease on seed production. These species will be considered for intensive study for alternative storage methods.




Richard Johnstone collecting seeds at Toonumbar National Park, NSW

Leaf material of *Sterculia quadrifolia*, known as a traditional Aboriginal medicine, was also collected for Macquarie University to investigate its anti-bacterial qualities.

In all, 52 new collections were brought to the RBGDT. These were either banked as seed if deemed orthodox, or grown on in tissue culture or the nursery for further study. Twenty four species were also banked at the Millennium Seed Bank (MSB) at the Royal Botanic Garden Kew.

Research

All of the 52 seed collections were analysed for their storage potential through a series of experimental procedures. This process enabled the seedbanking of 24 species that would not otherwise have been collected nor stored. One group of Myrtaceae species were intensively studied for an honours year project and the results are being prepared for publication.

A list of species requiring alternative conservation techniques was developed and work began on 18 species in the living collection and 8 species in tissue culture. The new tissue culture and cryogenic facilities became operational in October 2013 and will greatly enhance this component of the project.

A view into the tissue culture laboratory from the Telopea Gallery.

***The impacts realised during the year, and how they have been measured.***

| **Collection** | **Target** | **Outputs** | **Outcomes** |
|---|---|---|---|
| Prioritisation of species to collect by consultation with relevant authorities. | 2013* | achieved | Working list of species to collect. |
| Total number of species to collect. | 50 | 52 | Contributions to the Trust's 2025 target. |
| Number of threatened species collected. | 20 | 17** | Contribute to the Trust's 2025 target (**lower than expected as emphasis on Myrtle Rust-affected Myrtaceae). |
| Data collection on public databases. | 50 | 52 | Information will be uploaded to PlantNET, the Atlas of Living Australia and the Seed Information Database. |
| Collect herbarium vouchers. | 50 | 52 | Contributions to the National Herbarium of NSW. |
| | | | |
| **Research** | | | |
| Diagnostic evaluation of species for orthodox seed storage. Number of species. | 50 | 52 | List of orthodox species to seedbank; improvements to storage protocols. |
| Investigate alternative conservation options for recalcitrant species. | 15 | 8 species in tissue culture and 18 in cryostorage - initiated and under ongoing investigation. | Alternative protocols for storage are being developed. |

| | | | |
|---|---|---|---|
| Priority species targeted for intensive study resulting in effective conservation ex situ. | 4 | 4 | Enable ex situ conservation of 'exceptional species' ie threatened species that are difficult to seedbank. |
| Enable collaboration on ecology, genetics and other biological research. | 4 | 2 PhD studies, 2 honours projects and a collaboration with evolutionary ecologist, Maurizio Rossetto | Maximise the potential uses of the collections. |
| | | | |
| **Germplasm storage** | | | |
| Store orthodox seeds | 35* | 24 | Contribute to target outlined in the 'collection section'. *The actual number was expected be quite variable due to results of the research outlined above. |
| Store species in seedbank, tissue culture, cryogenics or living collection | Up to 15 | 26 species being investigated - ongoing | Contribute to target outlined in the 'collection section'. **The actual number was expected be quite variable due to results of the research outlined above. |
| Contribute duplicate orthodox seed collections to the Millennium SeedBank. Number of species. | 35 | 24 | Contribute to the global seedbank partnership. |
| Explore Trusts potential to duplicate collections from other parts of Australia. | Strategy in place by 2016/17 | Initiated discussions with the Australian National Tropical Seedbank (Agricultural species and crop wild relatives), and two other botanic gardens. | Increased ex situ conservation. |
| | | | |
| **Training** | | | |
| Deliver intensive training as part of the Trust's Asia Pacific Capacity Building program. | 2 trainees for one month | 2 trainees from Vietnam for one month. | Share and develop knowledge in Asia Pacific; build linkages with and assist capacity of like organisations. |

| | | | |
|---|---|---|---|
| Deliver undergraduate training and work experience (days). | 10 | 73 | Raise awareness of issues with conservation. |
| Deliver training to post-graduate students and academics. | 4 | 4 | Raise awareness of issues with conservation. |
| Integrate rainforest conservation issues into post-graduate thesis projects. | 3 | 3 | Conduct rainforest species research. |
| | | | |
| **Communication** | | | |
| Conference presentations. | 1 | 3 | Communicate and exchange ideas and knowledge to peers. |
| General publications. | 2 | 3 | Gain recognition of the value of research and communicate scientific findings. |
| Interpretation. | | PlantBank rainforest interpretation successfully delivered. | Raise public awareness and buy-in. |
| Electronic media articles. | 1 | 1 | Raise awareness of conservation issues. |
| Website on the Rainforest project. | Construct | Constructed Oct 2013 | Information delivery. |
| Social media. | | Several Facebook stories on the Australian Botanic Gardens group page – viewed by over 2000 people. | Raise public awareness. |
| | | | |
| **Partnerships and collaborations** | | | |
| Support the Australian Seedbanking partnership. | Represent on the National committee. | Representation continued. | Establish the Trust as the centre of excellence for rainforest germplasm. |
| Maintain seedbanking partnerships with the MSB. | | 4 MSB staff visited Plantbank on separate occasions. | Build and maintain linkages with the global native seed repository; capacity building for both organisations. |

***The impact of our activities in the broader context and as compared to other organisations.***

<u>Commitment to data sharing</u>

Collection, field data and basic germination test information is being added to the central EMu database of the Royal Botanic Gardens and Domain Trust. The RBGDT have a commitment to share collection data through the Atlas of Living Australia (ALA). Staff of the Rainforest Conservation project are assisting RBGDT staff to share germination data through ALA, based on data standards agreed through the Australian Seed Bank Partnership.

Staff of the Rainforest Conservation project are improving an existing in-house database to store a wider range of seed-related characteristics, including morphology, storage and desiccation tolerance. This Access database will store replicated germination test and screening data for collation and publication in journal papers. It may also prove useful in facilitating data sharing via ALA and the Seed Information Database.

Training

A large amount of training was provided to a range of sectors including local government, NGO's, academia and Aboriginal land councils. This included workshops on the conservation of rainforest species to representatives of the mining industry at the Australian Mine Rehabilitation Workshop (Adelaide, August 2013), the Australian Network for Plant Conservation seed-use workshop (Sunshine Coast, April 2013) and the Science Teachers Association (Parramatta, May 2013).

Intensive training was provided over one month to two staff from Bidoup Nuba National Park (BNNP) in Vietnam. The Australian Botanic Garden at Mount Annan has been working with BNNP for several years to develop Vietnam's first rainforest botanic garden near Dalat in the central highlands. The Rainforest Project provides excellent opportunities to enhance this and other relationships in the Asia Pacific region.

Communication

An article outlining the seed collection and analysis component of the project was published in the *Australasian Plant Conservation* journal in January 2013. (Please find a scanned copy of the article attached). This is the first of a series of articles for local and international journals that are being written on various aspects of the project.

Dr Karen Sommerville was awarded a Foundation and Friends of the Botanic Gardens Scholarship to attend and present her work at the International Symposium on Plant Cryopreservation held in Colorado in August 2013. The symposium was attended by the foremost exponents of this technique and she made many useful contacts and potential collaborations.

Dr Cathy Offord was invited (and funded) by Botanic Gardens Conservation International to be part of an expert panel to discuss the development of a global strategy for ex situ conservation of 'exceptional species', in Dunedin, New Zealand in October 2013. 'Exceptional' species are those of conservation concern, particularly threatened species that cannot be seedbanked and must have alternative conservation. The Rainforest Seed Conservation Project positions the RBGDT as one of the leaders in this newly emerging international conservation initiative.

A comprehensive public interpretation of the Australian PlantBank building was developed by a creative and scientific team, curated by Dr Cathy Offord. Issues about rainforest conservation values are central to the entire interpretive strategy.

There are over 200 separate components of this interpretation: signage on the public viewing walls of the laboratories and seedbank, in the adjoining 'living laboratory' of the landscape and the focal point the Diversity wall that engages the public in a creative and informative way with the importance of conserving biological diversity. A mobile phone app and dedicated internet microsite is being developed (funded by the NSW Environmental Trust) that allows visitors to delve deeper into specific topics.

Visitors enjoying the Interpretation Wall at the Australian PlantBank.

Partnerships and collaborations

The Rainforest Conservation project has partnered with the Australian Network for Plant Conservation to provide scientific input into training workshops. These workshops are utilised by groups addressing the targets of Australia's Biodiversity Conservation Strategy (http://www.environment.gov.au/biodiversity/publications/strategy-2010-30/index.html).
The Australian Strategy has targets for increasing participation of public and private organisations, including Indigenous peoples, in biodiversity conservation and restoration.

Several individual research collaborations were consolidated or initiated. With Evolutionary Ecologist Dr Maurizio Rossetto of RBGDT Sydney, we will be exploring the biogeographical significance of rainforest seed characteristics and give perspective on the effect of climate change and other species drivers.

Two PhD students are working with us on ecology of *Wollemia nobilis* – the Wollemi pine, a rainforest species of great conservation significance. An honours student is working on the genetics of this species using the ex situ collection. We envisage many more collaborations of this nature using the ex situ collections and other opportunities provided by the project.

***Progress of the project***

The Rainforest Conservation project is exceeding our original expectations in terms of the species collected and the quality of the information that is being generated. This has created great interest across a number of sectors and is firmly establishing the RBGDT at the forefront of this research internationally.

***Budgeted Expenses vs Actual Expenses (in AUS$)***

| Expenditure | Projected | Actual | Comments |
|---|---|---|---|
| Salaries (including on-costs) | 291,725 | 241,089 | While the reporting period for this acquittal is Oct 2012 – Oct 2013, the project was official launched in Jan 2013 (as previously agreed with Acadia). The later recruitment of staff for the project accounts for the under-spend in Year 1. |
| Travel | 15,000 | 13,831 | |
| Laboratory | 5,000 | 5,102 | |
| Asia Capacity Building | 10,000 | 0 | ACB began in 2013 with 2x 1 month Vietnamese traineeships (see table of outputs) but these positions were funded from Vietnam so the Arcadia allocation was not drawn upon. Planning for increased ACB is currently underway and staff will have a greater capacity to deliver now that PlantBank has opened. |
| **Total** | **321,725** | **260,022** | |
| | | | |
| **Income** | | | |
| Arcadia Fund | 115,000 | 115,000 | |
| Foundation and Friends | 87,215 | 87,215 | This included major donations from 2 individual donors |
| RBGDT contribution | 43,470 | 57,807 | |
| **Total** | **245,685** | **260,022** | |

***2014 Budget***

| INCOME SOURCE | BUDGET ITEM | Year 2 |
|---|---|---|
| **Arcadia Fund** | Scientist | 108,098 |
| | ACB | 10,000 |
| | **Subtotal** | **118,098 (approx)** |
| **Royal Botanic Gardens Foundation (including funds already pledged from donors)** | Collector | 80,304 |
| | Travel | 10,400 |
| | Scientist | 21,620 |
| | **Subtotal** | **112,324** |
| **HSBC (in October 2013 HSBC Bank Australia renewed and increased their sponsorship commitment to the RBGDT. A portion of this will be directed towards Rainforest Seeds** | Technical Officer | 93,373 |
| | Laboratory | 5,200 |
| | Travel | 5,200 |
| | **Subtotal** | **103,773** |

| | | |
|---|---|---|
| **in 2014)** | | |
| **TOTAL PROJECT COSTS** | | **334,195** |

The Royal
BOTANIC GARDENS
& Domain Trust

12 December 2013

**ARCADIA FUND GRANT ACQUITTAL**
**for period OCTOBER 2012 - OCTOBER 2013**

This is to confirm that the Royal Botanic Gardens and Domain Trust (RBG&DT) incurred the following expenditure on the Arcadia Seedbank Project during the 12 month period October 2012 to October 2013:

| | |
|---|---|
| Salaries | $241,089 |
| Travel | $ 13,831 |
| Laboratory | $ 5,102 |
| Asia Capacity Building | $ 0 |
| TOTAL | $260,022 |

This was funded through the following income sources:

| | |
|---|---|
| Arcadia Fund | $115,000 |
| Foundation and Friends | $ 87,215 |
| RBGDT contribution | $ 57,807 |
| TOTAL | $260,022 |

The above information has been verified by examination of transactions in the RBG&DT's financial system and are found to be correct and to fairly reflect the financial flows that occurred.

Mark Anders
Finance Manager

12/12/13

Bronwyn Shead
Chief Financial Officer

12/12/13

# Australasian Plant Conservation

BULLETIN OF THE AUSTRALIAN NETWORK FOR PLANT CONSERVATION Inc

VOLUME 21 NUMBER 3 • DECEMBER 2012 – FEBRUARY 2013

Victorian Orchid Conservation

Seeds behaving badly: Conservation of rainforest species

Sowing seeds: bridging the gap between ex situ collections and reintroduction

Efforts to enhance populations of the Wee Jasper Grevillea: Successes and failures

The endemic flora of Norfolk Island: Conservation challenges on a remote oceanic island

Research and conservation initiatives for the vulnerable *Acacia carneorum*: a model for plant species conservation in Australia?

And much much more …

CONFERENCE EDITION

PLANT CONSERVATION IN AUSTRALIA: ACHIEVEMENTS AND FUTURE DIRECTIONS

### Bridging the gap

Key lessons learned from collaborative projects aimed at bridging the gap between the 'freezer' and a self sustaining plant population in the wild are:

- an ideal collection that provides options for conservation, reintroduction and research is 10 000 seeds or more, collected from multiple populations to represent the range and genetic diversity of a species
- the impact of wild seed collection on remnant populations may be reduced by using foundation collections from the wild to establish seed production areas and increase seed availability
- refining germination protocols and horticultural techniques at the outset will help determine the best method, and increase success, of reintroduction
- improved knowledge of the biology, ecology, and genetics of a species is required to guide further research and activities aiming to restore viable plant populations.

### Further reading

Offord, C. A. and Meagher, P. F. (Eds.). (2009). Plant Germplasm Conservation in Australia. Strategies and Guidelines for Developing, Managing and Utilising Ex Situ Collections. Australian Network for Plant Conservation Inc., Canberra.

Smith, R. D., Dickie, J.B., Linington, S.H., Pritchard, H.W. and Probert, R.J. (Eds.). (2003). *Seed Conservation: Turning Science into Practice*. The Royal Botanic Gardens Kew, Great Britain.

### Acknowledgements

Many people are involved in these conservation projects and their contributions are greatly appreciated.

# Seeds behaving badly: Conservation of rainforest species

*Graeme Errington, Peter Cuneo and Catherine A. Offord*

*Royal Botanic Gardens & Domain Trust, Sydney. Email: graeme.errington@rbgsyd.nsw.gov.au*

The aim of Rainforest Seed Conservation Program of the Royal Botanic Gardens & Domain Trust is to identify species that can be seed banked and those with 'bad' seed storage behaviour that require alternative ex situ germplasm conservation techniques. The exploration of the seed storage behaviour of seeds can be complicated and there is much to learn about how seeds from rainforests respond to seed storage treatments and how we should approach alternatives for germplasm conservation.

### Rainforests

Rainforests are important repositories of biodiversity that contain many threatened species of flora and fauna. Across the planet, rainforests also have important economic and cultural values. In NSW, rainforests cover less than 1% of the land area with around 30% of the pre-European extent lost. Many of the remaining remnants have been subjected to logging during past management. Some rainforest communities have been dramatically changed, with remnants occurring as small fragmented areas that are infested with invasive species and diseases such as the recently arrived fungus myrtle rust.

### Seed banking

Seed banking is an efficient and effective long-term ex situ conservation strategy for species that tolerate drying and storage at low temperature. Many rainforest species have large, fleshy fruits - characteristics that are commonly associated with poor seed storage potential. To date, there is limited understanding of the seed storage behaviour of rainforest species and as a result, these species are under-represented in seed bank conservation programs. Highly successful programs like the Millennium Seed Bank Partnership have focussed on dryland flora, with good reason, as a high proportion of the species from plant communities in these areas are suited to seed banking. By comparison there has been relatively little work on seed storage of rainforest species globally or within Australia.

### Seed storage behaviour

Roberts (1973) described two classes of seed storage behaviour: orthodox and recalcitrant. Orthodox seeds have increased storage longevity in response to decreased seed moisture content and decreased storage temperature, with maximum longevity at conditions of low moisture content (2-6%) and at a temperature of -20° C. Internationally many seedbanks have used these parameters to develop seed storage facilities for crop and wild species. In Australia, dominant plant groups such as Acacia and Eucalyptus have orthodox seed and long-term conservation seed banks such as the NSW Seedbank have developed extensive collections of these and other dryland species.

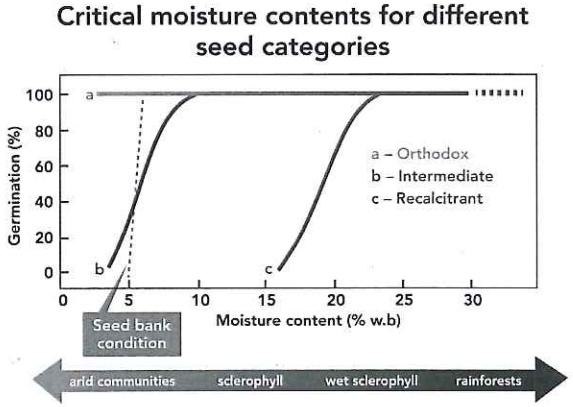
The term recalcitrant is applied to seeds that do not tolerate drying. This type of seed cannot be dried below a

relatively high moisture content without a significant drop in viability (this 'critical moisture content' varies between species), consequently recalcitrant seeds are not suited to conservation seed banking. Terms such as desiccation tolerance and desiccation sensitivity have been applied to the response of seeds to moisture loss. Seeds that can be dried to low moisture contents, 4-7% are termed desiccation tolerant. Desiccation tolerance and dormancy are two plant traits that allow seeds to develop soil seedbanks and survive until suitable conditions for germination occur. Desiccation tolerant seeds can be dried and stored at -20° C which extends the period of viability, and as indicated previously, these types of seeds are termed orthodox.

There is an important distinction between desiccation tolerant and orthodox. Some desiccation tolerant species, such as some Australian *Citrus* spp. and *Macadamia ternifolia* (Hamilton, *et al.*, 2010), have high oil content and this oil has a phase transition at freezing temperature and has the potential to cause a loss of viability as a result of low temperature storage, thus are not classified as orthodox species.

Since the initial classification of seed storage behaviour by Roberts, it has become clear that a number of species cannot be accounted for by the two existing categories of seed storage behaviour. Ellis (1990) proposed a new classification of intermediate seed storage behaviour. This classification is indicative of a spectrum of desiccation tolerance and seed storage behaviour, Figure 1. Seeds of the intermediate category can be dried to around 10-12% moisture content, but they are sensitive to storage at sub-zero temperatures.

The categorisation of some species is complicated by unusual seed behaviour. In paw paw (*Carica papaya*), drying induces a dormancy that may result in seeds being classified as non -viable or desiccation sensitive in a germination test. This is further complicated by crystallisation of lipids at sub-zero temperatures, which then require exposure to high temperatures before germination can occur. In *Azadirachta indica,* slow drying




*Determination of seed storage classification e.g. orthodox seeds maintain viability when dried to 5% and stored at -20° C (seed bank condition). Adapted from (Kew, n.d.).*

can allow seeds to be fully desiccation tolerant and stored at -18°C or less, but the seeds must imbibe moisture at high temperature (above 25°C), or they may suffer chilling damage (Kew, n.d.). These types of behaviours make it difficult to make general recommendations about the storage of intermediate species.

### Identifying seed storage behaviour

The main purpose of the Rainforest Seed Conservation Project is to identify orthodox species that can be seed-banked and to ensure they are adequately represented in our seed bank. Initially the desiccation tolerance of a species must be determined, and then further viability testing examines the response to storage at -20° C. There are a number of sources of existing information regarding seed storage behaviour, such as the Kew Seed Information Database and some general indicative characteristics that can be used to make assessments about potential seed storage behaviour:

- dry capsules and dehiscent fruits generally have desiccation tolerant seeds
- taxonomy – some families such as Dipterocarpaceae are almost exclusively recalcitrant but other families have a proportion of all seed storage behaviour categories e.g. Myrtaceae and Proteaceae
- wetter environments have a high proportion of recalcitrant species and drier environments have a high proportion of orthodox species (aquatic seeds are generally orthodox)
- seeds that are released during the wet season have a high proportion of recalcitrant species and seeds released during the dry season have a high proportion of orthodox species
- larger seeds tend to be recalcitrant
- seeds with very thin seed coats tend to be recalcitrant (determined by the seed coat ratio).

Our screening process compares seed germination response to three treatments: fresh seed, dried seed and moist seed (stored for the same time period as seed takes to dry) based on the 100 seeds test (Pritchard, *et al.*, 2004). If the germination rate in the dried seed treatment is similar to the fresh seed, then the species is considered to be desiccation tolerant. Germination is tested again after storage at -20° C.

### Strategies for desiccation intolerant seeds

The seeds of some recalcitrant species can be stored at low temperature: 0-5° C, for up to 12 months for temperate species and 16° C for 3-6 months for tropical species (Kew, n.d.). The response to these treatments can be variable; some species germinate if the temperature is too high, and other species may suffer chilling damage. Alternative germplasm conservation techniques such as tissue culture and cryostorage may be suitable strategies but protocols can be specific and difficult to develop.

### Rainforest seed collection program

A key part of this seed conservation program is the collection of rainforest seed from wild locations. There are a number of advantages and disadvantages of seed collecting in rainforest habitats as opposed to dry-land communities. Asynchronous fruit ripening both within and between species offers a greater window of opportunity for collection across the year. This is an important factor when considering the need to process seed in a timely manner regarding potential viability loss during handling. A particular disadvantage is that some rainforest species exist as individuals spread across the landscape rather than closely clustered populations. This has implications for the effort required in maximising the genetic diversity of collections.

A high priority for the program is the collection of species that are affected by myrtle rust. First detected in 2010, myrtle rust has spread from the central coast of NSW to Victoria and far north Queensland. The rust has had a dramatic effect on some Myrtaceae species, such as *Rhodamnia rubescens,* which suffer defoliation and reduced flower and seed production. This may have profound effects for the long-term survival of these species. The seed storage behaviour of *R. rubescens* and many other affected rainforest species is not yet known. Future collection trips will focus on collecting, assessing seed and where possible storing seed from these species.

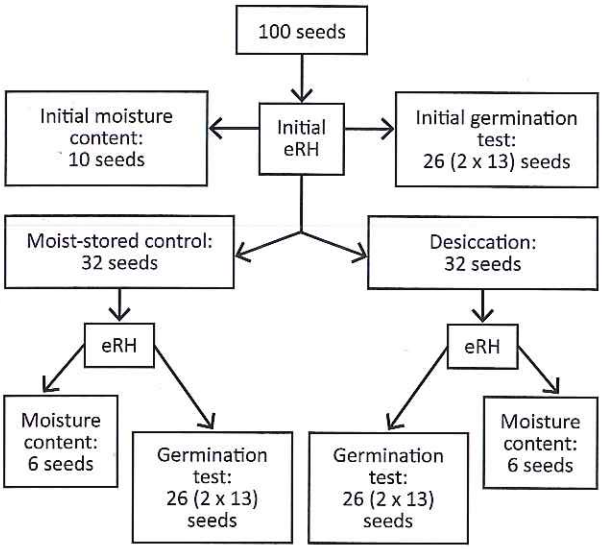



*Diagram of 100 seed test for desiccation tolerance (Gold & Hay, 2008). Equilibrium relative humidity (eRH) is a non-destructive measurement of moisture content, actual moisture content is calculated using an oven-dry method.*

### References

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# The endemic flora of Norfolk Island: Conservation challenges on a remote oceanic island

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### Introduction

Many islands throughout the world have suffered greatly from the arrival of humans and the inevitable introduction and naturalisation of exotic plants and animals. The viability of island endemic organisms is often severely compromised because of their small populations and inability to cope with competition and/or predation from introduced organisms. This is particularly so for remote oceanic islands located far from the resources required for adequate conservation works.

Norfolk Island was settled by the English in 1788, soon after Port Jackson (Sydney); it has therefore been subject to over 220 years of change and alteration to its natural environment. The Norfolk Island Group is an

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*Foundation & Friends of the* BOTANIC GARDENS

# EXECUTIVE DIRECTOR'S REPORT

## FEATURING THE AUSTRALIAN BOTANIC GARDEN

The Trust's LIVING Strategy has as one of its 'flagship' projects the development of the Australian Botanic Garden, Mount Annan, as a demonstration site for best-practice vegetation restoration. The near completion of the Australian PlantBank, which is crucial to this aim, is featured opposite, but, as fundamentally important as this Bicentenary Project is, there is much else already happening in the Australian Botanic Garden.

The reconfiguration of the Connections Garden, incorporating several themes – Plants and Time, Plants and People, Plants and Habitat, Plants and Wildlife – is almost finished. The reworking of the design was by Clouston Associates, who worked with staff in both the Australian Botanic Garden, Mount Annan, and the Royal Botanic Garden, Sydney. Dorothy and Alex Robertson, life members of *Foundation & Friends*, have generously contributed to the Garden's upgrade, which includes establishment of a Rare and Endangered Garden. The design and installation of interpretation materials will be completed over the next two years.

Increased visitation to the Garden (up from 83,500 in 2011 to nearly 320,000 in 2012 – an increase of more than 380 per cent), as a result of the abolition of entry fees, has led to the need for the installation of a number of new facilities and other infrastructure. The most recently completed is a large outdoor shelter between the western side of the Connections Garden and Lake Fitzpatrick, a building handed over on 17 July. There is already interest in hiring the new facility, one of a number of revenue streams used to support the conservation work of the Trust.

In the midst of this thriving south-western region of Sydney, the Australian Botanic Garden, Mount Annan, has a momentum that is gathering pace. The country's largest botanic garden, celebrating its 25th anniversary this spring, embodies the critical mix of science, horticulture, education and recreation tantamount to the role of major botanic gardens worldwide.

**Professor David Mabberley**

Dr Karen Sommerville (*left*) and Amanda Rollason in the PlantBank laboratories

# THE AUSTRALIAN PLANTBANK IS READY TO OPEN!

AFTER FIVE YEARS OF PLANNING, FUNDRAISING AND CONSTRUCTION, THE AUSTRALIAN PLANTBANK IS EFFECTIVELY COMPLETE AND SCHEDULED TO OPEN IN OCTOBER. MORE THAN 700 PEOPLE AND HUNDREDS OF DONORS, SPONSORS AND MEMBERS HAVE CONTRIBUTED TO BRINGING THIS CONCEPT TO LIFE. NOW A MAGNIFICENT WORLD-CLASS SCIENCE FACILITY IS READY TO ENABLE OUR SCIENTISTS TO TACKLE PLANT CONSERVATION HEAD ON. JOHN SIEMON AND CATHY OFFORD REPORT.

Dr Amelia Martyn

Dr Karen Sommerville in the PlantBank laboratories

While the Australian Botanic Garden, Mount Annan, readies to formally open the building, a new chapter in the history of science in the Royal Botanic Gardens and Domain Trust begins. As an integrated facility, the Australian PlantBank will allow us to better address conservation of diminishing biodiversity of Australia and the Asia-Pacific region.

The Royal Botanic Garden has always played a key role in seed collection, storage and use of Australian plants. With a land use changes, the threat of climate change and the need to feed an ever-growing global population, one of the largest scientific challenges facing us is the appropriate use of plants while conserving them in their fragile ecosystems. There are many facets to this challenge, but it is widely acknowledged that seed science and seed conservation play a major role.

Sir David Attenborough described the global Millennium Seed Bank Partnership, of which the Trust is playing a major role in Australia, as "perhaps the most important conservation initiative ever". In 2010, this global partnership had banked collections of 10 per cent of the world's dryland flora. With a target of 25 per cent of dryland species stored in a seedbank by 2020, we turn our attention towards an important group of plants that is under great threat but can not be easily seedbanked.

Much of the world's biodiversity is held in rainforests. Many rainforest species complete their lifecycles in wet environments and have large fleshy fruits and seeds that, unlike their dry-land counterparts, lose viability when they dry out. This means they are not suitable for conventional seedbanking procedures, which require seeds to be dried to moisture contents of less than 10 per cent. Indeed, many rainforest species germinate almost as soon as they fall from the plants, or they may have complexities such as a stony endocarp, which is a protective layer around the seed.

With funding from *Foundation & Friends*, the Arcadia Foundation and several other benefactors, researchers at the Australian Botanic Garden have begun to collect and assess Australian east coast rainforest species for their ability to be dried and seedbanked and to develop alternative conservation techniques.

## BENEFITS OF SEED AND PLANTBANKING

- A source of material for research into seed and plant behaviour, genetics and climate-change response.
- Conserving threatened species or those from threatened habitats.
- A source of plants for horticulture, agriculture, pharmaceutics and restoration of degraded lands.

Our collectors scour rainforests for rarely collected species and return the seeds to the laboratory. If the species is so rare or seeds so few, only the most basic tests are conducted. Yet the test sequence is designed to glean the maximum information from the minimum number of seeds. If seed is deemed to survive the drying procedure, it is tested for how long it can be stored in sub-zero temperatures. Some species survive for only a short period in the freezer, even when they do survive drying. The mechanisms behind this behaviour will be studied in future years.

For species that cannot be seedbanked by traditional means, we are exploring alternatives. A major feature of the Australian PlantBank is the cryogenic store, where plant material, such as seeds, embryos and shoot tips, will be stored over liquid nitrogen. Each species behaves differently in this procedure and requires different pre-treatments, which need to be determined. Cryostorage has been used for years for storing viable animal tissue, such as human embryos, and while its use in plant conservation is in its infancy, it offers great hope for the future.

The rainforest seed conservation project focuses on eastern Australian species, but we envisage that through such programs, the Australian PlantBank and the Trust will have a greater role in plant conservation in the Asia-Pacific region to build on the existing role that our botanists play. Already, our scientists are delivering training in plant collection and conservation through groups such as the Australian Network for Plant Conservation.

**Explore PlantBank during our Members' only tour on Thursday 10 October. See page 29 for more information.**