AUSTRALIAN FLORA FOUNDATION

fostering research into
the biology and cultivation
of the Australian flora

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President's Report 2011

Here is the President's Report which was presented to the Foundation's Annual General Meeting by Dr Peter Goodwin on 12th December 2011:

Highlights this year:

1. We have welcomed a new member of Council, Dr Tina Bell. Tina received an Australian Flora Foundation grant in 2006 to help with her studies at Melbourne University on mycorrhizal associations in the Fabaceae (see http://www.aff.org.au/AFF2_Bell_Fabaceae_mycorrhiza_final_summary.htm). She was appointed Senior Lecturer in Fire Ecology at the University of Sydney in March 2010, and has accepted our invitation to join the Council of the Foundation.
2. We have approved a total of $55,360 in research grants, of which $18,360 is for continuing grants, and $37,000 for new grants. The new grants are to:
    a. Alexandra Bowman, University of Adelaide, for a project titled 'Fallen logs: creating patchiness in chenopod shrublands of South Australia'.
    b. Professor Corey Bradshaw, University of Adelaide, for a project titled 'Identifying cost-effective reforestation approaches for biodiversity conservation and carbon sequestration in southern Australia'.
    c. Patricia Fuentes-Cross, University of Adelaide, for a project titled 'Understanding the distribution of genetic diversity in South Australian populations of Quandong (*Santalum acuminatum*), to inform genetic resource management and future domestication activities'.
3. What is probably a record number of final reports have been received this year. Final reports on Australian Flora Foundation research projects have been received from:
    a. Dion K. Harrison, University of Queensland: Understanding the biochemical basis of flower colour in Australian native *Ptilotus* and *Gomphrena*
    b. Tina Bell, University of Melbourne: Mycorrhizal associations in the Fabaceae: are they really needed?
    c. Margaret Johnston, University of Queensland: An evaluation of the temperature and daylength requirements of Australian potted colour species

   d. E. Charles Morris, University of Western Sydney: Mechanical constraint model of seed coat dormancy in *Grevillea*.
   e. Professor Robert Henry, Southern Cross University: Impact of climate on the genetic diversity of native species using *Microlaena stipoides* as a model
   f. Peter Wilson, National Herbarium of NSW: Reproductive biology of the Magenta Lilly Pilly (*Syzygium paniculatum*) and its implications for conservation
   g. Amelia Martyn, The Australian Botanic Garden, Mount Annan, NSW: Germination of Australian alpine species and implications in a changing climate
   h. Professor Hans Griesser, University of South Australia: Plasma discharge treatment for improved germination of seeds and killing of fungal spores on seed coats
   i. Jon Luly, James Cook University Townsville: The status of the waddi tree (*Acacia peuce*) in Queensland
4. Young Scientist prizes were awarded to students giving the best talk or presenting the best poster at the December 2010 meeting of the Ecological Society of Australia
   a. Talk: Sam Wood, University of Tasmania, Age and growth of a Tasmanian temperate old-growth forest stand dominated by *Eucalyptus regnans*, the world's tallest angiosperm
   b. Poster: James Camac, University of Melbourne, Global warming, fire & Australian alpine plants: catastrophe or resilience?
5. Two Newsletters were produced and distributed through the efforts of our Secretary, Ian Cox: Newsletter 13 in January 2011, and Newsletter 14 in July 2011.
6. The final reports, as well as summaries and interim reports, publications arising from grants, details of grants, details of Young Scientist awards, Newsletters and much else can be found on the Australian Flora Foundation website http://www.aff.org.au/

And finally my thanks to each of you, and particularly to those on the Council, for your work fostering the aims of the Foundation. A particular thanks to Jenny Jobling, our Treasurer and Ian Cox, our Secretary, who did much of the 'heavy lifting'.
Peter Goodwin

How will weeds respond to climate change?

Dr Michelle Leishman*

By now the general community is very aware of climate change and has become familiar with once-unfamiliar terms such as greenhouse gas emissions, carbon trading and sustainable energy. However fewer people are aware of the likely impacts that climate change will have on ecosystems, habitats and individual species. The planet is currently facing the triplewhammy of climate change, land clearing, and invasive species, yet we know relatively little about the likely effects of these factors acting together.

Is it likely that invasive plants (weeds) will do better or worse under climate change? The answer depends a lot on the weed in question. Climate change includes the direct effect of elevated CO_2 on plant growth, the direct effect of changed climate (such as increased temperature and reduced rainfall predicted for SE Australia), and the indirect effects of changes to species interactions (such as pollinators, seed dispersers, herbivores) and to ecosystem processes (such as nutrient cycling). But here are some generalisations that we can use as a starting point:

1) ***Elevated CO_2 is likely to favour fast-growing species***. Many weed species have characteristics that enable them to grow fast to take advantage of open spaces and to outcompete other species. So it is likely that these fast-growing weeds will get an even greater advantage under higher CO_2 conditions.

2) ***Elevated CO_2 is likely to favour vines***. Vines are a plant growth form that is particularly responsive to additional CO_2, largely because all the additional carbon captured can go directly to growth rather than to storage in wood. Many exotic vines are considered to be transformer species, dramatically affecting native ecosystems, and they are listed as a key threatening process under the NSW Threatened Species Conservation Act.

3) ***Climatic envelopes for species will shift towards the poles or to higher elevations***. The current climatic conditions at any particular site will slowly change e.g. with a 3^{O} increase in temperature, Sydney will have a climate like that of Port Macquarie. Plants will need to adapt to the changing climatic conditions, move or face extinction. Many weed species are tolerant of a wide range of climatic conditions and are also particularly good at dispersing (e.g. many weeds have wind-dispersed seeds or have fruits that are dispersed long distances by birds). Thus it is likely that weed species are likely to do relatively better under a changing climate than many native species that have limited climatic tolerances and limited dispersal ability. Of course, in the past plants were able to move around the landscape as climates changed. However with current climate change, the rate of change is much faster than previously experienced, making life even tougher for plants with limited dispersal ability. Furthermore the landscape is no longer covered by continuous vegetation so that plants have the added problem of having to disperse across a landscape that is now developed for housing or primary production.

4) ***Disturbance favours weeds***. Many weed species are particularly good at dispersing to and establishing in open spaces, such as along roads and in cleared areas. Climate change is likely to result in additional disturbances on both regional scales (such as more storms, flooding & bush fires) and local scales (e.g. death of plants due to extreme events such as heatwaves or frost). It is likely that the fast-colonizing and fast-growing weedy species will best be able to take advantage of open spaces created by these disturbances. For example, Athel Pine was able to invade river systems of Central Australia after the dramatic 1974 floods, *Miconia* species have been able to invade a much larger area following Cyclone Larry in Queensland, and many weed species (such as pines & broom) flourish after fire.

There are other miscellaneous factors that may contribute to weed success under climate change. For example, the horticultural industry is keen to promote ‘drought resistant’ plants for gardens. In 1996 Mexican feather grass was introduced into Victoria as a ‘drought resistant’ grass. It has since become very invasive and $39 million has been spent trying to eradicate it. Similarly the biofuel industry is set to expand dramatically, however some of the biofuels being considered are known to be highly invasive. On July 30 2010 *The Australian* reported ‘The jatropha bush seems an unlikely prize in the hunt for alternative energy, being an ugly, fast-growing, poisonous weed. Hitherto, its use has principally been as a constipation remedy. Very soon, however, it may be powering your car. Almost overnight, the unloved *Jatropha curcus* has become an agricultural and economic celebrity with the discovery that it may just be the ideal biofuel crop, an alternative to fossil fuels for a world dangerously dependent on oil supplies and deeply alarmed by the effects of global warming.' That's very scary indeed.

Climate change will result in dramatic changes to the vegetation that we are familiar with. The composition and abundance of plant species will change to the extent that the plant communities we recognize, and currently try to conserve, may not be recognizable to our children. It is likely that vegetation will be dominated by short-lived weedy species and that species diversity will be much reduced. This may seem like the 'black armband' view of climate change, but it is critically important that we understand the implications of climate change if we hope to mitigate against it and its effects on our planet.

What can we at a local level do? We can try to foster understanding of these issues among land managers such as our local council and the National Parks and Wildlife Service. We can encourage the conservation of north-south vegetation corridors to allow species to migrate. We can consider using seeds from a provenance 100 km or so north rather than locally for longer-lived species in bush regeneration projects, and sourcing seeds from a variety of populations to maximize genetic diversity and the opportunities for plants to adapt to climate change. We can even consider planting particularly vulnerable species into their new predicted range rather than leaving them isolated in a patch of land that will not suit them climatically in 20-30 years. We can also keep our eye out for warmer-climate species that appear to be increasing their range so that we can control them before they become a problem. For example the extensively planted hedge *Murraya* is invasive in the Brisbane region – how long before it finds Sydney's climate suitable to allow it to become invasive in our bushland?

** Associate Professor Michelle Leishman, Department of Biological Sciences, Macquarie University. Michelle was appointed a Councillor of the Australian Flora Foundation at our AGM in December 2011.*

Summaries of Final Reports

Each year the Australian Flora Foundation funds a number of grants for research into the biology and cultivation of the Australian flora. While the grants are not usually large, they are often vital in enabling such projects to be undertaken. Many of the projects are conducted by honours or postgraduate students, hopefully stimulating their interest in researching Australia's unique and diverse plants. This work is only made possible by the generous support of donors and benefactors.

Presented here are brief summaries of completed projects. Full reports of these and other projects can be viewed on the Foundation's website www.aff.org.au

Germination of Australian alpine species and implications in a changing climate

Amelia J. Martyn, Karen D. Sommerville and Catherine A. Offord, The Australian Botanic Garden, Mount Annan, NSW

Euphrasia Sp. (above) and Aciphylla glacialis (right)

Note: This project was funded jointly by the Foundation and by a special grant from the Australian Native Plants Society (Canberra Region).

While the distribution and general ecology of Australian high-altitude species is increasingly well-studied, little is known about the seed biology of individual herbs. It is not known, for example, which species require low temperatures and/or cold stratification for germination and dormancy break, and whether these requirements would be fulfilled in a warmer climate. In this study, we investigated optimum temperatures for germination, and response to dormancy alleviating treatments of cold stratification and gibberellic acid (GA_3), for 20 species collected from high altitudes (860-1960m elevation) in Kosciuszko National Park, south-eastern Australia. While many of these species occur generally only at relatively high altitude (e.g. *Coronidiium waddelliae* 1170-1500m), a number have wider distributions (e.g. *C. scorpiodes* 1-1300m).

Germination response to temperature was highly variable among species. Temperature ranges and optima with and without periods of stratification (4, 8, 12 weeks) were determined for each species. For example, without stratification, low temperatures (5-19°C) were optimal for germination of *Aciphylla glacialis, Oreomyrrhis eriopoda* and *Arthropodium* sp. B. Moderate temperatures were favoured by *Brachyscome* sp. 1 sensu P.S.Short (1999) and *Epilobium gunnianum*, while *Wahlenbergia* had a higher temperature optimum (25°C). The endemic, high altitude species *Euphrasia collina* ssp. *diversicolor* exhibited poor germination at all temperatures. Two species (*Epilobium gunnianum* and *Oreomyrrhis eriopoda*) germinated to some extent at all temperatures (10, 15, 20, 25°C, 20/5°C and 20/10°C). Cold moist stratification response was positive for seven species, while GA_3 substituted for or improved upon cold stratification for *Derwentia* and *Wahlenbergia*. In general, the seven *Asteraceae* species germinated well at a wide range of temperature responses and showed little or no response to stratification or GA_3, with the exception of *C. waddelliae* which had faster germination after stratification.

This information was synthesized to determine the dormancy status of the species collections. Ten species appeared to be non-dormant, although there were indications of a degree of physiological dormancy in several. One species had deep physiological dormancy (*Viola betonicifolia*) and another had physical dormancy (*Acacia pravissima*). The type and depth of morphophysiological dormancy varied for the other seven species (*Aciphylla glacialis, A. simplicifolia, Oreomyrrhis eriopoda, Wahlenbergia ceracea, W. gloriosa, Derwentia perfoliata*) including one which was deeply dormant (*Euphrasia collina ssp. diversicolor*).

Understanding the germination response to temperature has the potential to improve models of species' response to pressures such as climate change and improve seed utilisation for rehabilitation, as well as clarify seed germination requirements for conservation seed banks and restoration.

The status of the Waddi Tree (*Acacia peuce*) in Queensland

Jon Luly[1], Joe Holtum[2] and Michelle Waycott[3]
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The juvenile growth form of the waddi tree produces abundant fuel (left and centre), unlike the mature form (right)

The waddi tree stand at Boulia is the most numerous of the three known localities in which the tree grows. The stand comprises somewhere around 100,000 individuals and has extended geographically and in density since the 1970s. The stand maintains a high genetic diversity and is actively recruiting. We believe it to be in good health.

Waddi trees recruit opportunistically and depend on canopy seed storage to supply seeds, most of which die unless there has been above average rainfall. Seedlings send down a rapidly growing tap root in order to keep up with subsidence of the soil wetting front. They establish best on sandy sites which allow rapid root penetration and extraction of water at low soil water potentials but do not persist on source bordering dunes. There are indications that waddi trees can reproduce by suckering from shallow horizontal roots. The extent of asexual reproduction in the stand has yet to be fully evaluated. The horizontal roots probably play a water storage function in addition to acting as reservoirs for buds. The anatomy and function of shallow roots is under active investigation. Grazing activity is not presently affecting the health of the stand. Cattle, kangaroos and camels browse foliage, devour seedlings and trample roots however they also reduce the significant risks to the stand posed by uncontrolled fire. Waddi trees exhibit structural adaptations to browsing by vertebrates and we believe this to contribute to their resilience to grazing in this the wettest part

of their range.
Waddi trees do not appear to be extremely long lived. Radiocarbon dating suggests that the majority of large trees are approximately 200 years old. Some exceptional individuals may live longer but the beginning of senescence in trees of the sizes dated suggests that the majority would die inside 300 years.
Water use studies suggest that waddi trees are strongly drought adapted and their scarcity at a landscape scale does not reflect confinement to refugial habitat by water stress. There are indications that waddi trees use water differently from potential competitors such as *Grevillea striata* and this will be one of the areas of focus for continuing research on the species.

Plasma discharge treatment for improved germination of seeds and killing of fungal spores on seed coats

Stefani S. Griesser, Shakti Prakash and Hans J. Griesser
Ian Wark Research Institute, University of South Australia

A gas plasma inside a glass chamber. The seeds are placed on the round table (diameter 90 mm).

A significant number of Australian plant species have adapted to an ecology in which periodic bush fires play a key role. Some species, particularly in the Fabaceae family, have evolved hard protective seed coats. Such hard seed coats, however, present challenges for the germination of such species. While a number of methods for their germination have been used, all have some disadvantage, which affect the use of such species in habitat restoration, *ex-situ* conservation, and horticulture. In this project, we have investigated a novel physico-chemical method for the treatment of seeds of Australian plants. The treatment may have two benefits: improved germination of seeds that do not germinate well without treatment (e.g., Fabaceae), as well as enhanced survival of seedlings via the effective killing of fungal spores on seed coats during treatment. Improved germination rates and decreased rates of fungal attacks will benefit the cultivation and conservation of various Australian native plant species, in particular those that traditionally have resisted high-yield germination by other methods and those whose seed numbers are so limited that effective usage of available seeds is essential. The approach we have used employs a gas plasma analogous to the etching of synthetic polymers in the semiconductor industry. Low pressure oxygen plasma exposure was used to treat seeds of a number of Australian plant species. Changes in the seed coat were investigated using swelling, measurement of seed coat thickness, and germination experiments.

The treatment was effective for the germination of seeds of species such as *Kennedia rubicunda,* whereas seeds of species such as *Banksia speciosa* germinated equally with and without treatment. Microscopy showed no measurable changes in seed coat thickness; the effect of the treatment thus probably is an enhancement of water permeability through the seed coat. With the limited number of seeds, no effect could be observed of the treatment on possible destruction of damping-off fungal spores. A small number of plants were grown on in order to test for possible effects of the treatment on genes; no differences were observed in the morphology of the plants nor in their growth rates.

Conclusions: The oxygen plasma treatment technique applied to hard-coated seeds has shown encouraging results with some Fabaceae seeds. With *Grevillea* and *Banksia* seeds, it made no difference, but the apparently old seeds of both *Grevillea* species may have prevented meaningful study. With the *Banksia* seeds and growing on several plants, it was shown that the plasma treatment does not cause any adverse genetic effects.
Study of the seed coat thicknesses showed that the plasma did not remove large fractions of the seed coat. The enhanced water uptake by (some) plasma-treated seeds is probably due to a combination of factors: first, the plasma removes effectively the very thin lipid layer that makes seeds water-repellent, as shown by much better wetting of seeds after treatment, and secondly the plasma probably reduces the length (and average molecular weight) of the biopolymer chains that make up the seed coat, thus enabling better water transport through the seed coat for swelling the embryo.
A key advantage of the plasma treatment is that it is a “dry” process. Seeds come out looking the same and can be stored until sowing is to be done. This may be a useful feature for use in large-scale revegetation projects.
It might be useful to extend this plasma approach to seeds that contain germination inhibitors in their seed coat. Perhaps the plasma could deactivate such inhibitors.

The Australian Flora Foundation is a not-for-profit organization with the sole objective of fostering scientific research into Australia’s flora. We are totally independent, and all office bearers are volunteers.

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