A charity fostering scientific research into the biology and cultivation of the Australian flora

Research Matters

Newsletter of the Australian Flora Foundation

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President's Report 2018

Delivered by Assoc. Prof. Charles Morris at the AGM, December 2018

This year saw the retirement of Peter Goodwin as President of the Foundation. Peter succeeded Richard Williams in 2006. Peter was always a conscientious custodian of the financial assets of the Foundation, accumulated from a number of bequests over the years. An innovation he introduced to regulate the expenditure on Research Grants was a funding formula which set a total amount to spend each year as a function of the net assets of the Research Fund. Prior to this, expenditure on Grants had oscillated somewhat from year to year. The aim of the formula was to ensure that the net assets of the Foundation grew in line with inflation, and it has been successful in doing so. It also gives an agreed budget to spend each year, and this sets an upper limit when making the final selection of grants in any given round. We all owe a debt of gratitude to Peter for his work for the Foundation. He is still managing the Research Grant business of the Foundation (traditionally the President's role) for the period when I hold the dual roles of President and Treasurer.

For the round of Grants commencing in 2019, the successful applicants were Nathan Emery of The Australian Botanic Garden Mt Annan, Bryn Funnekotter of Curtin University and Jodie Price of Charles Sturt University, Albury. Nathan Emery will investigate ways of establishing the rare plant *Persoonia hirsuta* subsp. 'Yengo NP' in cultivation, both to preserve it and foster its use in horticulture. Bryn Funnekotter aims to develop new cryopreservation protocols to conserve threatened Australian rainforest species, many of which are considered recalcitrant and thus are ineligible for storage in seed banks. Jodi Price will investigate barriers to recruitment in restoration plantings so that they become self-sustaining through time. Final Reports for earlier Grants were received from Mark Ooi and Berin Mackenzie (2014), Rebecca Jordan (2015), Noushka Reiter (2015), Michelle Leishman and Alexandra Carthey (2015) and David Mackay (2016).

Dr Jason Bragg of the Royal Botanic Gardens Sydney joined the Scientific Committee which evaluates grant applications each year, and thanks are due to Prof. Michelle Leishman and all the members of the Committee for undertaking that role. Thanks are also due to Assoc. Prof. Tina Bell for her excellent work with the Newsletter, which has received favourable comment from readers. Assoc. Prof. Jennifer Firn oversees the Foundation's web page, which is a valuable contact point with the wider community, and Mr Ian Cox as Secretary attends very ably to the administration of the Foundation. Thanks are due to Board members, ordinary members and our donors, all of whom allow the Foundation to function and support plant research.

A new development this year has been a donation from an Industry Partner (Bell Art Australia), with a request that a link to their website be shown on the Foundation's Home Page. This has been done, with Bell Art shown as a sponsor. The various Australian Native Plant societies continue to be another valuable source of donations, as are our members.

E. Charles Morris
President
3 December 2018

AFF Grants Awarded

Three grants were awarded for research to begin in 2019:

A determination of the taxonomy and horticultural potential of the endangered *Persoonia hirsuta*

Nathan Emery, The Royal Botanic Garden Sydney, NSW

Persoonia hirsuta (Hairy Geebung) occurs in small, scattered populations across the Greater Sydney Region. The species is listed as Endangered under the Australian Environment Protection and Biodiversity Conservation Act 1999 and the New South Wales (NSW) Threatened Species Conservation Act 1995 and is listed as a site-managed species under the current Office of Environment and Heritage Saving our Species program. *Persoonia hirsuta* was initially characterised into two sub-species: *P. hirsuta* subsp. *hirsuta* and *P. hirsuta* subsp. *evoluta* that occur on the eastern and western distribution extremes, respectively. Intergrades of the two sub-species occur clinally in an east-west direction. These sub-species are separated based on leaf morphology (narrow and broad-leaved populations).

Recently there has been uncertainty over the taxonomy of the *P. hirsuta* species complex, as the morphological variation has become more complex following the discovery of additional populations. Illustrating this, a formally unnamed third sub-species, *P. hirsuta* subsp. 'Yengo NP' occurs in the northern extent of the distribution in Yengo National Park, NSW. Plants in this population grow taller and more erect and have a distinctive weeping branching form with longer and less hirsute leaves on average than the other sub-species. A 2017 survey of the population recorded only nine adult plants and no recruitment.

Recognising the uniquely attractive weeping vegetative form of *P. hirsuta* subsp. 'Yengo NP', the overarching aim of this project is to investigate the potential for developing a propagation protocol to establish *P. hirsuta* subsp. 'Yengo NP' in cultivation. However, the taxonomic status of *P. hirsuta* subsp. 'Yengo NP' must also be resolved. It is vital that this work is undertaken given the restricted population size (nine plants).

Overcoming barriers to intergenerational recruitment in direct-seeded revegetation sites

Jodi Price, Charles Sturt University, NSW

Restoration of trees and shrubs contributes substantially to vegetation cover and habitat in degraded, fragmented landscapes and is particularly important for ecosystems that have experienced severe loss. Grassy ecosystems in south eastern Australia have experienced such loss (<10% of the pre-European extent remaining) and remaining remnants are often degraded. Incentives are provided to landholders to restore native vegetation to their property (e.g. augmenting native remnants, revegetation of corridors) and this private land restoration contributes substantially to native vegetation in heavily cleared regions and increases connectivity in highly fragmented landscapes.

Recent research suggests that landscape-scale recruitment failure may be occurring, leading to restoration collapse, once the life-span of these shrub species has been reached. This research aims to identify barriers to successful recruitment for key shrub species and identify simple management techniques that can promote regeneration of planted species. It is unknown if the main barriers to regeneration are based on reproductive output or microsite limitations or a combination of both. A series of field and lab methods are planned to be able to determine what barriers to successful recruitment are, and how they might be alleviated. Limited long-term success in restoration projects highlights the need to develop best practice management guidelines that encourage long-term regeneration in restored sites.

Is mitochondrial function the key to improving the cryopreservation of threatened Australian flora?

Bryn Funnekotter, Curtin University, WA

This project aims to advance the fundamental science of metabolic function that impacts the successful cryopreservation of threatened Australian plant species. Australia is host to an incredibly diverse and endemic range of species, many of which require conservation. The energy produced by the mitochondria is vital in almost all aspects of cell metabolism, and it is of particular importance for cryopreservation due to its role in providing energy for repairing damaged DNA, the production of new proteins and lipids, and the energy to resume normal cell division and growth after storage.

The project will increase our understanding of the stresses experienced by Australian plants during cryopreservation. Specifically, the characterisation of mitochondrial function and integrity in plant tissues will be pioneered as a novel approach to the development of species-specific cryopreservation protocols for some of Australia's endangered and critically threatened rainforest species. This knowledge will enable the development of effective cryopreservation protocols for problematic Australian species in future, an essential step for the successful conservation of Australian plant diversity and indeed the management of rare and endangered species.

Young Scientist Awards

The Australian Flora Foundation awards prizes annually to encourage young scientists to continue studying the flora of Australia.

At the annual conference of the Ecological Society of Australia (ESA) held in December 2018 the Foundation's prizes were presented to:

Outstanding student spoken paper on the biology or cultivation of an Australian plant

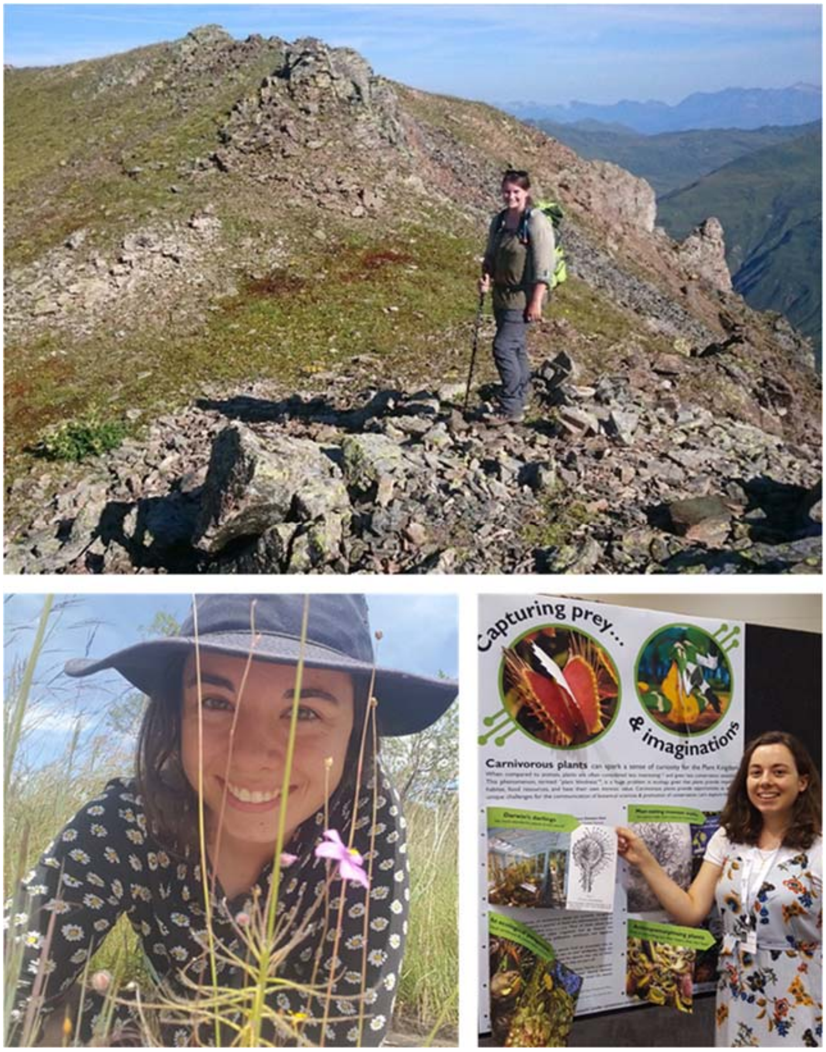
Sonya Geange, PhD candidate, Australian National University
Phenotypic plasticity in a changing climate: a multispecies, multi-site investigation into plant functional traits

Abstract: Current predictions of environmental change threaten to out-pace developmental, genetic and demographic capacities of plants. Phenotypic plasticity is a mechanism by which plants may persist under rapidly changing environments. However, many crucial questions remain, including: (1) what functional traits exhibit plasticity? (2) does the degree of plasticity differ within and between species? and, most importantly, (3) does phenotypic plasticity in plant functional traits correlate with plant fitness? To try to answer these questions, phenotypic plasticity in key functional traits was estimated for 36 species spanning semi-arid, alpine and coastal habitats. Each of the three habitats were represented within Australia, six species per habitat, and once within each of the overseas countries; Spain: semi-arid, Germany: alpine, and the United States: coastal, with six species each. Two years of observational data revealed

plasticity in traits such as specific leaf area (SLA) and leaf area to stem mass ratio varied highly among species, with substantial seasonal variation occurring within some species. Preliminary analysis also indicates that increased plasticity in traits such as SLA is associated with fitness, measured as higher growth rates.

Trait variation has important implications for current sampling efforts to build trait-based models to improve the predictive power of vegetation and bioclimatic models. We discuss these issues with regards to the contrasting patterns of variation in plasticity observed within and across species as a function of habitat, growth form, species and season and provide some guidance as to the approaches that can be taken in order to capture and understand this variation.

Sonya is a ‘multi-award winner’ as she was given the same award in 2014 for research on ‘Plasticity in water use traits within Australian alpine plants’? Well done on both accounts!



Top: Spoken paper award winner, Sonya Geange; bottom left and right: student poster award winner, Laura Skates. Photographs courtesy of S Geange and L Skates.

Outstanding student poster presentation on the biology or cultivation of an Australian plant

Laura Skates, PhD candidate, The University of Western Australia
Capturing imaginations and prey: using carnivorous plants to communicate botanical and ecological sciences

Abstract: Carnivorous plants are an ecologically defined group, characterised by their ability to capture and digest prey using specially modified leaf traps. Ever since Charles Darwin provided the first evidence of this unusual nutritional strategy, the carnivorous plants of the world have become a source of fascination for scientists, horticulturalists, gardeners, artists, and entertainers. In popular culture, carnivorous plants are often associated with both beauty and horror, portrayed either as wonders of the natural world or as man-eating monsters. In reality, they are an incredibly charismatic and diverse group of plants, found naturally all over the world, with significant ecological, socio-cultural, and economic value. Unfortunately, carnivorous plants are threatened by humans through the loss and disturbance of their natural habitat and through the illegal collection of wild plants. With people and the fate of carnivorous plants so intertwined, there is a clear need for open and effective communication between ecologists, conservationists, cultivators, collectors, and the wider public.

Through my PhD research on the nutrition and ecology of Australian carnivorous plants, I have taken several opportunities to communicate my research to a variety of audiences at scientific conferences, public events, schools, botanic gardens, in print, and online. At the recent Ecological Society of Australia conference held in Brisbane, Queensland, I presented on the benefits and challenges of using carnivorous plants to communicate botanical sciences and promote conservation, as part of the *Communicating Ecology in the Anthropocene* symposium. It was a fantastic opportunity to discuss these ideas with other ecologists, and I had a lot of fun putting together my 3D interactive poster, with paper doors opening up to provide more information and a pop-out Venus flytrap to play with! I've always found that carnivorous plants can spark a sense of curiosity for the Plant Kingdom, and open conversations up to broader discussions on botany, ecology, conservation, and the intrinsic value of our native species. I think this is particularly important here in Australia, where we are lucky to host the world's greatest diversity of native carnivorous plants, including sticky-leaved *Drosera* and *Byblis* species, suction-trapping *Utricularia* species, *Nepenthes* pitcher plants, the aquatic snap-trapping *Aldrovanda vesiculosa*, and the endemic pitcher plant, *Cephalotus follicularis*.

Laura's work was featured in the AFF newsletter in July 2018 with a project update on her AFF-funded research project. Laura is also a 'multi-award winner' so double congratulations to her as well!

Some of the carnivorous plants that Laura Skates works with. Top left: *Byblis* sp.; top right: *Drosera glanduligera*; bottom left: *Cephalotus follicularis*; bottom right: *Drosera zonaria*. Photographs courtesy of L Skates.

Ten years of forest restoration in the Upwey Corridor, Dandenong Ranges, Victoria

Bill Incoll and Alex Maisey*
Friends of Ferny Creek, Monbulk, VIC and La Trobe University, Bundoora, VIC

The problem

The Dandenong Ranges, 40 km east of Melbourne in Victoria, was first settled in the late 1890s. Dense Wet and Damp Forest vegetation communities were cleared by small holding settlers (about 4 ha), initially for subsistence agriculture. As access and economic conditions improved, land use changed to peri-urban settlement around the city of Melbourne based on weekend visitation and suburban living.

Throughout this period, exotic garden shrubs and trees were introduced by settlers and inevitably these species moved away from gardens into public land reservations and remaining remnant native vegetation on private property. The species involved included trees such as Sycamore Maple (*Acer pseudoplatanus*), Sweet Pittosporum (*Pittosporum undulatum*) and Holly (*Ilex acquifolium*), shrubs such as Tree Tobacco (*Solanum mauritianum*), Red Cestrum (*Cestrum elegans*) and Himalayan Honeysuckle (*Leycesteria formosa*), climbers such as English Ivy (*Hedera helix*) and Cape Ivy (*Delairea odorata*), and ground covers such as Periwinkle (*Vinca major*) and Trad (*Tradescantia fluminensis*). These weeds, either singly or together, are able to establish in native vegetation and eventually overtop and suppress that vegetation, substantially reducing biodiversity. The scale of this environmental weed problem became apparent during the 1970s and efforts to deal with it have been carried out since, by both State Government agencies and local community environment groups.

This study

The Upwey Corridor is an area of land (approximately 80 ha) connecting two sub-units of the Dandenong Ranges National Park (DRNP). It comprises public land bought back from private ownership (for conservation and fire safety objectives) and private property, some of which carries remnant native vegetation. The Upwey Corridor includes some sites of high environmental value as well as areas severely impacted by the problem described above.

In accordance with a management plan prepared for the DRNP in 1991, action was initiated in 2006 by Friends of Ferny Creek (FoFC), a local environment group, to deal with the problem in cooperation with Parks Victoria, the manager of the land.

Before any work on weeds was done, a Habitat Hectare survey was applied across 56 ha formed by a 100 m square grid across the Upwey Corridor. This survey was to serve as a baseline for monitoring and a guide for work priorities.

Environmental weeds were removed by contractors and by volunteers from FoFC and other local groups. The methods used included pulling small weeds, cut and paint and drill and fill, depending on weed size. Some broad area spraying was necessary to deal with dense ground layers of English Ivy. The primary herbicide used was Glyphosate, except for use on English Ivy, where mixture with other chemicals was necessary. A single treatment in any given area was usually not sufficient to deal with the weed problem, either because weeds were missed, or regrowth occurred from soil-stored seed or new weed inputs. Weed treatments were repeated as necessary with the objective of establishing native vegetation that was stable for the long term. Native understorey vegetation re-occupied the treated areas without the need for re-vegetation. Overstory eucalypts were re-established by planting.

Over the 10 years of the study, a total of $276,463 was obtained by FoFC from State and Federal Government agencies to fund the work by contractors. Over the same period, a total of 4695 hours was contributed by local environmental volunteers. Current conventions value this work at $30/hour and represents an in-kind contribution of $140,850.

Comparison of vegetation quality before and after treatment

After 10 years, the Habitat Hectare survey was repeated over the same 56 ha. The average score for the area assessed in 2006 was 57.6, which increased to 75.5 by 2016, an improvement of 31%.

Before and after pictures (below) show the success of the treatments.

Left: An extensive infestation of Red Cestrum (*Cestrum elegans*) before treatment in June 2007; right: the same site in October 2015. This area has been replanted with Manna Gum (*Eucalyptus viminalis*) (from Incoll *et al*. 2018).

Left: An extensive infestation of English Ivy (*Hedera helix*) on the ground and climbing trees in June 2007; right: the same site treated in November 2007 and photographed in October 2015.

Left: Dead English Ivy (*Hedera helix*) on the ground after treatment in November 2007; right: the same site in October 2015.

Statistical analysis of the Habitat Hectare survey indicated that the work done reduced weed cover ("lack of weeds" score +65%, t(55) = -5.96, p <0.001), as would be expected, but also beneficially improved understorey cover (+52% t(55) = -17.54, p <0.001) (excluding plantings), recruitment (+53%, t (55) = -11.55, p <0.001) and litter depth (+37%, t(55) = -5.38, p <0.001). There was some improvement in score for canopy cover during this time (+11%, t(55) = -2.81, p = 0.006). Statistical analysis also showed that two or more successive treatments significantly improved treatment scores, as would be expected.

Implications for management

The average Habitat Hectare score over 56 ha after 10 years showed a 31% improvement compared with the score before work started. Statistical analysis demonstrated that work on reducing weeds has strong and lasting effects on other aspects of stand structure as well. Fauna observations showed that the Upwey Corridor provided the threatened Greater Glider (*Petauroides volans*) and Superb Lyrebird (*Menura novaehollandiae*) with permanent habitat and for lyrebirds, a route between the two park units. The work demonstrates that significant improvement in biodiversity of weed-degraded areas is possible given adequate investment, continuous management and re-treatment of areas as necessary.

This study also demonstrates the importance of volunteer effort in restoring biodiversity in the Victorian public land management context. Most of the grant funding obtained by FoFC was not available to Parks Victoria and the large volunteer in-kind input, valued at 34% of the total $417,313 investment, showed clearly how much biodiversity restoration in the Dandenong Ranges depends on volunteer effort. This restoration would not have happened without volunteer initiative and effort, and a willingness by Parks Victoria to work cooperatively with volunteers.

The volunteer group, FoFC, are doing similar work on several other project areas within the Ferny Creek locality in the Dandenong Ranges.

This article is a summary of a recent paper published in *Environmental Management and Restoration*:

Incoll B, Maisey A, Adam J (2018). Ten years of forest restoration in the Upwey Corridor, Dandenong Ranges, Victoria. *Ecological Management and Restoration* 19, 189–197.

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Dormancy and germination in West Australian Ericaceae

Michael Just*
Curtin University, Perth, WA

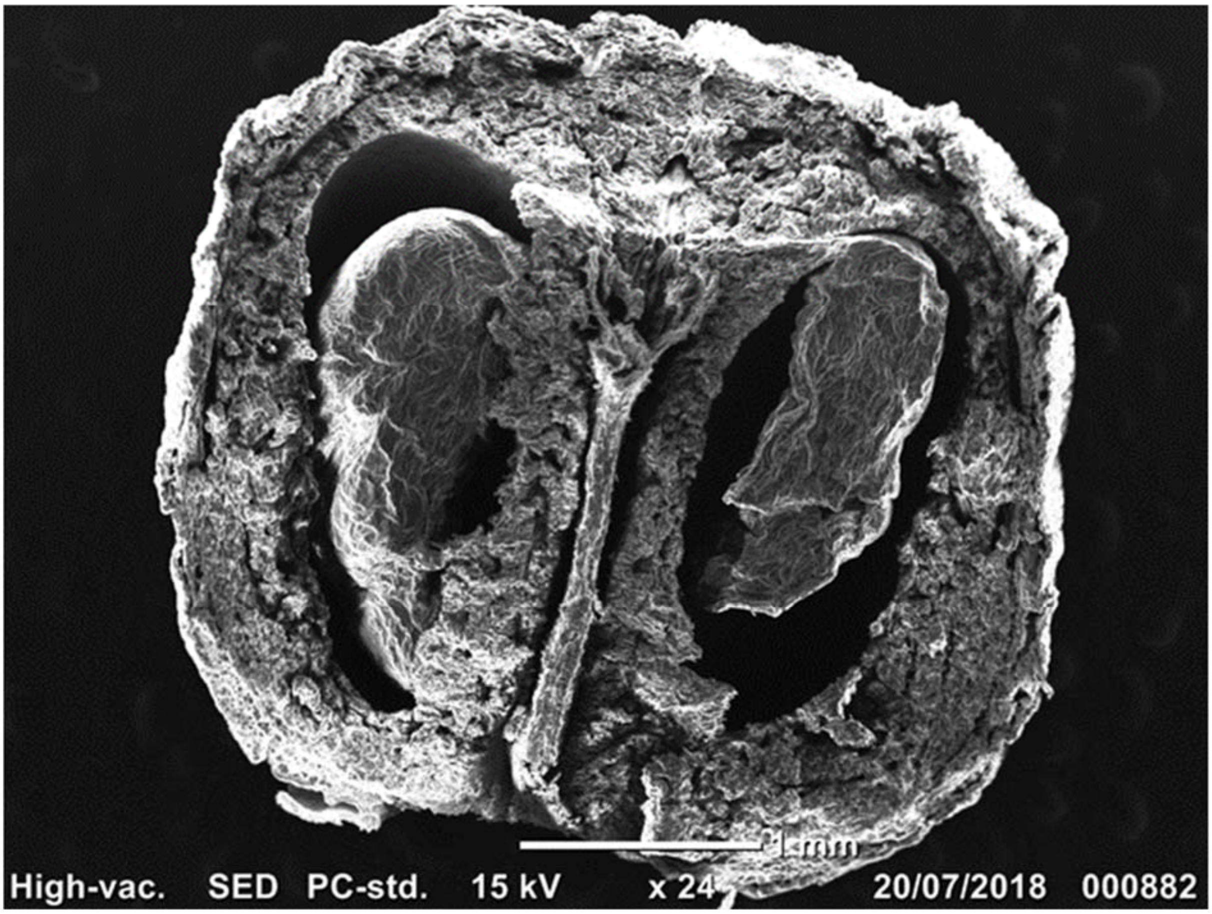
The Ericaceae are a stunning group of plants that can be found all over the world. In Australia there exists some of the most unique and complex Ericaceae species, all of which are classified in the sub-family Epacridoideae Am. (Ericaceae Juss.). In Western Australia, the Ericaceae are represented by 20 genera, cumulatively possessing 380 species; 135 of which are currently listed as rare, highly restricted, threatened or endangered. The family forms a dominant component of understory vegetation throughout the south west of WA which, when combined with the large number of threatened species, makes the Ericaceae a priority group for both conservation and restoration. Outside of native vegetation, Australian Ericaceae have significant horticultural potential as they are prolific producers of long-lived flowers that possess unique characteristics not seen in other native flora.

Conostephium pendulum in full flower on the Swan Coastal Plain. Photograph courtesy of M Just.

By all accounts, the Ericaceae are a group of plants that should take pride of place in nurseries and gardens across the country. However, their use in horticulture is limited by the lack of protocols able to reliably grow these species within suitable timeframes. Likewise, the representation of Ericaceae in restoration communities is lacking in projects that rely on direct seeding or tube stock. The underrepresentation of Ericaceae in restoration and horticulture both stem from the fact that many Australian Ericaceae produce seeds that are incredibly difficult to germinate.

Seed of the Ericaceae

One factor that sets Australian Ericaceae apart from foreign relatives and many other Australian flora is their ability to produce seeds within a woody, indehiscent endocarp that protects the seeds within from the harsh conditions of an arid environment. These endocarps remain intact for several seasons until seed dormancy is alleviated by conditions of temperature and moisture within the soil, allowing the seeds to overcome any mechanical or physiological constraint provided by the progressively degrading endocarp.



An image generated using a scanning electron microscope (SEM) of the transverse section of the endocarp of *Astroloma xerophyllum* showing a viable (left) and non-viable (right) seed. Photograph courtesy of M Just.

The seeds themselves possess mechanisms which ensure germination does not occur into an environment detrimental to sustained growth of seedlings. Once shed from the mother plant, seeds of woody-fruited Ericaceae possess an immature embryo, which requires time to grow and mature within the seed. The growth of embryos, and the resulting germination, is further limited by internal hormonal concentrations which maintain the embryo in a dormant state. It is the concentrations of these hormones that fluctuate with ambient conditions of temperature and moisture to ensure germination potential is at its highest when soil conditions are most suited to sustain seedlings. To put it in technical terms, seeds of woody-fruited Ericaceae possess morphophysiological dormancy with either mechanical or chemical manifestations of physiological dormancy. To put it simply, seeds of woody-fruited Ericaceae employ complex mechanisms which ensure their persistence through time but make them incredibly difficult to germanite for even the most experienced horticulturalist.

Germination in the Ericaceae

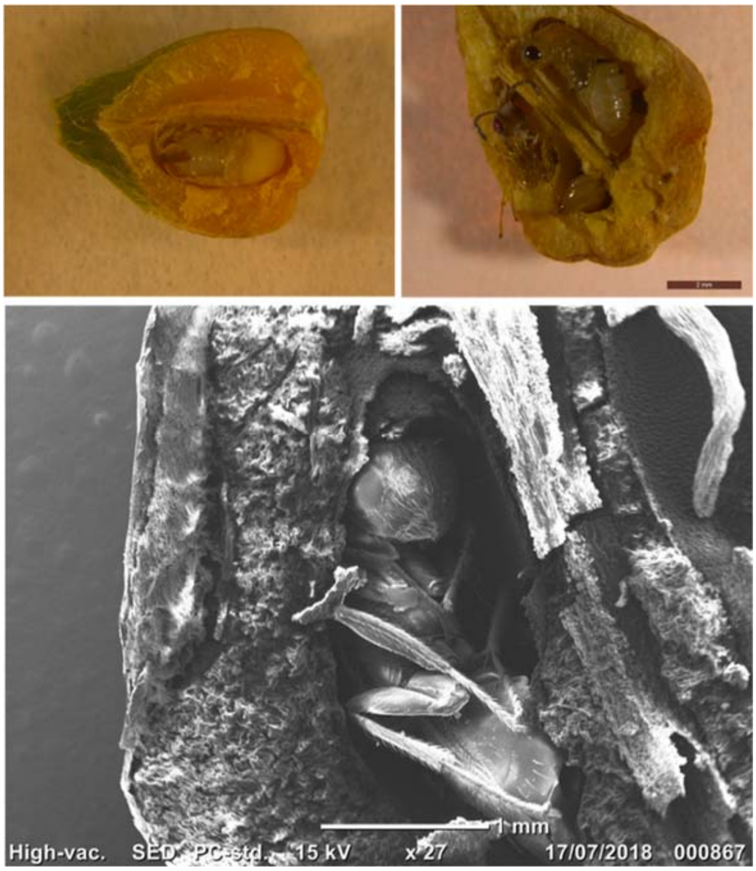
The Ericaceae in Australia have become very good at ensuring germination does not occur under conditions unsuitable for seedling growth. In nature, seeds may persist in the soil seed bank for several seasons before the perfect combination of conditions come together and allow them to germinate. This is often aided by soil disturbance or the passage of fire, which can remove overlying vegetation and alter diurnal temperature fluctuations while reducing direct competition and providing various germination stimulating compounds to the soil seed bank. Outside of nature, the combination of time in soil, specific temperature fluctuations, and the application of germination stimulants at just the right time combine to make germination of these species a difficult endeavour.

Initial attempts to germinate Western Australian Ericaceae were not promising. In a simple experiment, seeds of eight species of WA Ericaceae were treated with water (control), gibberellic acid or smoke water and left at incubation temperatures indicative of the yearly average *in situ*. Within 30 days, germination of the two species that did not possess a woody endocarp (*Andersonia heterophylla* and *Lysinema pentapetalum*) began, with both species responding to gibberellic acid, and neither responding to smoke. This result was concerning, as both species have previously been cited as smoke responsive and are somewhat easy to germinate. Upon further investigation it was found that certain compounds in a commercially-produced smoke solution were toxic when used at a 10% concentration. Using fresh collected and aged seed of *Lysinema pentapetalum* treated with a 10% solution of smoke water produced by the Kings Park Botanical Gardens, germination occurred, and it was found that seed aging had a significant positive impact on total germination.

While some success was had for *Andersonia heterophylla* and *Lysinema pentapetalum,* the woody-fruited Ericaceae used in my experiment did not respond, with no germination recorded across six species after 540 days. This result, as disheartening as it was, enforced the idea that these species have adapted to long periods in soil, and that within the environment of a laboratory incubator, the processes required to overcome seed dormancy were not provided.

By removing the endocarp from the six woody-fruited study species it was possible to achieve rapid germination in some, but not all, species. Endocarps form the dispersal unit and seeds can germinate from within the endocarp without its complete degradation or removal. However, removal of the endocarp provided evidence for a variable depth of physiological dormancy among woody-fruited Ericaceae and highlighted that in some cases physiological dormancy is imposed through mechanical or chemical mechanisms. In other species the physiological component of dormancy was not alleviated by removal of the woody fruit and it is likely that these species required cool temperatures prior to warm temperatures to alleviate physiological dormancy and stimulate germination. Further investigation is required if woody-fruited Ericaceae are to be sufficiently represented in horticulture. Optimum temperatures for the alleviation of dormancy and stimulation of germination should be a research priority, along with the mechanisation of endocarp removal.

One of the findings that came about from the dissection of many woody fruits was the role of *Conostephium pendulum* in the life cycle of a native Calcidoid wasp in the genus *Megatistigmus*. I observed the presence of larval wasps in around 50% of fruits collected and noted that predation of seeds by larvae reduces mean seed number per endocarp by 0.75. Contrary to my hypothesis at the time, recent observation of endocarps stored in the lab for 2 years indicates that wasps are unable to emerge from fruits stored *ex situ*. Not a single emergence event has been noted to date and dissection of endocarps reveals all contained wasps have perished. To my knowledge, this was the first documented case of *Conostephium pendulum*, or any Australian Ericaceae, acting as a larval host species to a native wasp. While this type of association is common in Australian flora it highlights just how little attention has been paid to the Ericaceae.



Megatistigmus sp. within the endocarps of *Conostephium pendulum*. Top left: the larval stage within an immature endocarp; top right: mature, live specimens within a naturally dispersed endocarp; bottom: SEM of a deceased wasp within a 2-year-old endocarp. Photographs courtesy of M Just.

Not surprisingly, the association between *Conostephium pendulum* and *Megatistigmus* sp. was known to a range of practitioners who exist outside of academia. This embodies the issue that I faced when dealing with the Ericaceae; that most of the known information exists in that grey area between academia, industry and the observations of practitioners. Difficult to germinate seeds produce many null results which are unlikely to be published. Difficult-to-germinate seeds pose a barrier to industry, and any breakthroughs are unlikely to be made public. Propagation of seed that is difficult to germinate may be easy for the practitioner, but without controlled experiments their results and techniques are unlikely to be widely known.

*About the author
Michael holds a Master degree in Biological Science from Edith Cowan University, where his work with Ericaceae took place. He is currently undertaking a PhD with Centre for Mine Site Restoration (Curtin University) to investigate the dormancy and germination of Rutaceae, another difficult-to-germinate family. In addition, he is secretary to the Society of Ecological Restoration Australasia, works in terrestrial orchid conservation and helps manage a TERN Ozflux tower in Gingin, WA.

Planting Australian natives: are we bringing the bush to our backyards or our backyards to the bush?

Dr Matt Pye*

Introduction

Gardens are an important part of our existence in urban environments. They provide relief from the concrete and bricks that create the artificial environment that most Australians now inhabit – the urban landscape. Our gardens provide shelter and shade, a potential kaleidoscope of colour and, in many backyards, a small localised food source in the form of vegetable gardens. In cities, gardens and street trees also provide additional cooling mechanisms to the heat sinks of concrete structures.

Despite their ubiquitous presence, Australian backyard gardens have evolved over time and are far from static entities. The traditional English Gardens that were first established, presumably to trigger memories of the Mother Country, have morphed into a hybrid design which often includes representatives from the Australian flora. More recently, there has been a sustained trend towards preferentially planting native Australian species, deemed to be a better or more ‘natural’ alternative to the exotic imported species of the past. Many of these garden plants have gone on to achieve fame as invasive weed species. However, does the mere incorporation of native plants into one's garden warrant a horticultural 'pat on the back'? Do native plants actually do anything other than make us feel some misguided source of 'Aussie pride'? Can we actually increase the functionality of our backyards into something truly beneficial – for both our gardens and surrounding native ecosystems?

The use of Australian native plants

The dominance of native plants in many Australian horticultural contexts suggests that the practice of including indigenous flora in our backyard plant assemblages has long been established. However, it was only through the periodical '*Growing Native Plants*' published by the Canberra Botanic Gardens (now known as the Australian National Botanic Gardens) in the 1970s and early 1980s that any information was available on the topic of how to grow native plants. These booklets were published once a year for 14 years. The publication of '*Australian Native Plants*' by John Wrigley and Murray Fagg in 1979 and the '*Encyclopaedia of Australian Plants*' by Rodger Elliot and David Jones in the 1980s resulted in less demand for the booklets and the series was discontinued.

Nevertheless, the (native) seed had been planted. Australian native plants are now part of the Australian horticulture consciousness. Today, seeds and seedlings of many native species, along with established shrubs and trees, can be readily purchased from commercial suppliers (e.g. a well-known hardware chain lists the availability of 114 native species for sale as of September 2018).

There is also a substantial presence of Australian natives in the cut flower industry with many florists choosing to utilise the dramatic foliage and long-lived nature of many Australian species (e.g. flowers from *Banskia* spp., foliage from *Eucalyptus* spp.).

Growing natives is now a serious scientific, evidence-based business. For example, research on germination strategies of many members of the Australian flora has led to the inclusion of 'smoke water' when buying native seeds. Evolving in concert with fire, much of the Australian flora have developed a dependency on smoke, or rather the chemicals found in the smoke from bushfires. In an evolutionary sense this strategy assures the best prospects for germination and establishment in natural settings.

A preference for Australian native plants

This may explain how Australian native plants became available but how and why did they initially become the preferred selection for the informed gardener? Why does the use of native plants persist despite the reputation of being "scraggly", "untidy" and "difficult to grow" in an urban garden context? The answer possibly lies in a similar domain to Dick Smith and Aussie Mite – stay with me here.

Flowers from native plant species sit alongside their gaudy exotic counterparts, albeit with a higher price tag. Photographs courtesy of M Pye and T Bell.

In 1986, 3 years after Australia raised its profile on the international stage beginning with the America Cup win, and just after the first publications about Australian plants became available, the Australian Made logo was launched – an initiative to support locally-grown produce and locally-made products. Launched by Prime Minister Bob Hawke, this campaign strengthened Australian nationalism and pride for our Country was at an all-time high. Consumers are likely to have been making conscious choices about supporting Australian products, including the selection of plants for their backyards. The link to the backyard garden and the plants surrounding the ubiquitous Hills Hoist may well have been established right then and there in the suburban consciousness. The choice to incorporate more “Aussieness” in backyards and other local spaces would have been simple. Native plants offered a bold statement, given their differing and distinctive morphology and colour palette compared to more traditionally preferred species.

So, at this point in time, we began to incorporate native flora into everyday Australian life. A research study conducted in 2010 in the Melbourne metropolitan area, showed that 60% of gardens contained a mix of native and non-native species but only 10% of gardens contained mostly Australian native plants. Evidence can also be seen in street plantings which are generally species that local councils deem to be “non-offensive” in terms of fruit production and branch drop. An inquiry to local Sydney City Council governance was illumining in this respect. The selection of dry-fruited species is always promoted over any fleshy-fruited species due to trip hazards, “mess” and other undesirable features. Plants in the genera *Melaleuca* and *Waterhousea* seem to be favourites in the

Sydney landscape. Do we therefore have an assemblage bias in urban landscapes by promoting one species over another in our streets?

Left: *Syzygium* sp. planted as a street tree in Sydney; right: fallen fruits from this species ‘litter’ the footpath and road. Photographs courtesy of M Pye.

The potential horticultural bias can be further explored using the Gondwanan family, Myrtaceae. This family contains a fleshy-fruited group and a dry-fruited group, historically described as the subfamilies Myrtoideae and Leptospermoideae (Note: current molecular studies do not support this taxonomy, with fleshy-fruits appearing to evolve independently at least twice in the family, rendering Myrtoideae polyphyletic). In theory, that would mean we should only see approximately half of the diversity of this iconic Australian plant family in our urban landscapes. This means we would see more species in the genera *Eucalyptus*, *Corymbia* and *Angophora* than we would of *Syzygium*. However, the ‘widow maker’ status (i.e. tendency to drop large branches) of the *Eucalyptus*/*Corymbia*/*Angophora* group adds complexity and has probably resulted in fewer street plantings that we would otherwise see, except in some rare exceptions. Public safety is paramount and trumps any effort to restore our urban environments to their former plant community structure.

The iconic avenue of Lemon-scented Gums (*Corymbia citriodora*) lining the Avenue of Honour, May Drive, Kings Park and Botanic Garden, WA. These trees were planted in 1938, despite their tendency to drop branches, to replace the original avenue of Red-flowering Gums (*Corymbia ficifolia*), many of which succumbed to canker. Photograph courtesy of T Bell.

The role of native plants in urban environments

An example I can draw from personal connection is the Bunya Pine, *Araucaria bidwillii* – a majestic Australian conifer which is almost demonised when planted in urban areas. I spent a good few years thinking about little else while studying this species for my PhD. This magnificent tree, one deeply embedded within Indigenous knowledge along the eastern seaboard of Australia, has long suffered the reputation of being the bad guy. “Attack of the Killer cones” is a frequently encountered headline for this species due to the production of female cones which can weigh up to 20 kg each. Some basic physics calculations shows that they have the potential to kill or at least do some serious damage to a person. Most commonly they damage property such as parked cars, so they generally are roped off and given a wide berth during their coning period, as if they were some infectious entity worth avoiding at all costs. In reality, they mostly drop their cones at night, thereby avoiding the humans who are seen as the target of their reproductive strategies.

Left: The stately silhouette of the Bunya Pine (*Araucaria bidwillii*); right: a warning to the unwary. Photographs courtesy of M Pye.

What benefit other than an aesthetic one could Bunya Pines possibly provide? Urban specimens in Brisbane are at least 100 km from their nearest population in the Bunya Mountains and nearby Noosa Hinterland, and 1000 km away from their northern population counterparts at Cannabullen Falls and Mount Lewis in Far North Queensland. I suggest that these urban plantings offer little to biodiversity as they are too far away to reproduce with their naturally-occurring conspecifics. If, however, they were planted closer to their forebears the potential benefits to the genetic diversity of the species, and biodiversity itself, could be massive and ongoing.

The question here is what function do we want our gardens and urban landscapes to serve? Do we merely want an aesthetic reprieve from the concrete and bricks (similar to the initial colonised gardening practices of re-creating the English garden), or is there a deeper function that we could tap into whilst also retaining their visual benefit?

The deeper function that I am referring to here is the maintenance of gene flow within the Australian landscape – between our urban landscapes and the natural vegetation that these islands of concrete are situated within. Gene flow refers to the movement of genetic material (e.g. seeds, pollen) from one population to another. When gene flow rates are high, two geographically distinct populations may be considered to be one as they share a significant proportion of genetic diversity. Low gene flow can lead to speciation events (i.e. the creation of distinct species) as random mutations and/or selection for certain traits driven by environmental and/or other factors create two distinct genetic populations. Eventually these distinct populations may become different enough that the two populations can no longer interbreed – leading to the creation of two new species.

I believe that our goal, as an environmentally-conscious society, should be to decrease the manipulation of our natural environments as much as possible, and, ideally, to minimise our genetic impact on these environments. The question for our society is, do we want isolated urban vegetation pockets containing a mishmash of aesthetic, non-messy plant species (native or otherwise) or do we have an ethical responsibility to reconnect these urban landscapes to the vegetation and surrounding habitats that they have replaced?

Climate change, and all of the environmental uncertainties that it brings, adds more support to the planting of locally-occurring species – plants of local provenance. On one hand we have the question of the capability of garden species to withstand local environmental conditions and fluctuations, and on the other we have the water demands of those species alongside any need for fertilisers and other inputs. If plant species are sourced from the native vegetation that surrounds our urban fragments, then they are more likely to be locally adapted, in an evolutionary sense, to available nutrient and water regimes. This is a win/win situation in terms of reducing added nutrient loads to soil and any runoff that may occur, while also minimising the use of additional water to keep gardens alive. Such a garden would have zero net needs – the perfect environmental model for a climatically uncertain world.

We need only look to the history of the colonisation of Australia for a chilling lesson – one which we are yet to fully adopt and one which I echo in the sentiments of this article. Upon arriving in Sydney, the First Fleet established a food garden at Farm Cove where the Royal Botanic Garden Sydney is now situated. A lack of understanding of the differences in soil types, climatic regimes and local pest species proved to be a significant barrier to the establishment of core crops:

"*Very little of the English wheat had vegetated and a very considerable quantity of the barley and many seeds had rotten in the ground ... all the barley and wheat likewise destroyed by the weevil*".

28 September 1788, Governor Phillip reporting to Lord Sydney.

It was the use of Warrigal Greens (*Tetragonia tetragonioides*) that saved the first settlers and helped them avoid scurvy, a common condition resulting from diets low in Vitamin C. It would appear that over 200 years later we have learned little of the importance of planting local species that are adapted to local conditions.

Australian plants for nationalist pride? We can do better than that

While the presence of Kangaroo Paws (*Anizoganthos* spp.) in Sydney may make us well up with nationalistic pride and perhaps fond memories of the incredibly diverse flora of Western Australia, they do little to contribute to gene flow along the eastern seaboard. Their contribution is quite definitely confined to the aesthetic.


Left: Kangaroo Paws (*Anigozanthos* sp.) planted adjacent to an artwork at the University of Sydney, NSW; right: Kangaroos Paws in a mass planting in Kings Park and Botanic Garden, WA, a location closer to their area of origin. Photographs courtesy of M Pye.

I am not arguing against the use of native flora in our gardens and streets. I am, however, ardently pointing out that we could do better with what we have – plant what is adapted to local environments and, where possible, use local council nurseries to source plants and/or seeds of local provenance. We can still plant native plants, with all of their "scraggly" beauty, while also doing our bit for remediation of habitats. Such plants will attract pollinators (another win for the zoologically-inclined) that then pollinate neighbouring plants within the surrounding vegetation. Gene flow in action. Our backyards will be connected to the bush and each planting will increase exponentially in its utility – albeit on a timescale that may not be evident in a human lifespan. Rest assured, your contribution to biodiversity will be imprinted in the genetic makeup of these populations for years to come.

*About the author

Dr Matt Pye is an Academic Fellow in the School of Life and Environmental Sciences, Faculty of Science at the University of New South Wales. He has an interest in plant systematics and investigates the impacts of historical fragmentation on genetic diversity within and among plant populations.

What Research Were We Funding 30 Years Ago?

Note: See http://aff.org.au/results/grant-summaries/ for further details of these and other research projects funded by the AFF.

Microbial symbionts of Sturt's Desert Pea

Dr Greg Kirby, School of Biological Sciences, Flinders University of South Australia, SA; funded in 1990 for $1,738

This study investigated the effects of soil type and heat sterilisation of soil on the levels of microbial infection and growth of seedlings of Sturt's Desert Pea. Dr Kirby found that seedlings of Sturt's Desert Pea could withstand low levels of nutrient solution and still produce nodules and vesicular arbuscular mycorrhizal associations. When different types of soil were tested it was found that the shape and size of nodules varied suggesting that each soil had different strains of *Rhizobia*.

The research represents the start of a lifelong association that Dr Kirby has had with Sturt's Desert Pea and the commercialisation of this species. He outlined how versatile this plant could be when sold as a pot plant and for hanging baskets and as cut peduncles and runners (Kirby 2015). In this paper, Dr Kirby generously acknowledged other researchers working with this species at the time including Richard Williams (e.g. Williams 1996), Acram Taji and Manfred Jusaitis (e.g. Jusaitis 1994).

The natural variation of this native species proved to be a double-edged sword because, while it not only provided a huge variety of potential cultivars, the differences among populations needed to be thoroughly understood before it could be exploited. New plants were not only generated from seed, but investigations were also made by Dr Kirby and others into grafting stems of Sturt's Desert Pea onto wilt-resistant rootstocks from other closely related species and propagation by cuttings and tissue culture (Williams and Taji 1987; Taji and Williams 1989; Jusaitis 1997).

According to his website, Dr Kirby retired in 2011 but has continued to do research including contributing to a breeding program for commercial varieties of Sturt's Desert Peas. The 'Flinders Flame' cultivar was successfully trialled for sale in 2013 and larger scale production was initiated in 2014 along with the application for plant breeding rights.

A commercially available variety of Sturt's Desert pea (*Swainsona formosa*) called Flinders Flame (image from https://www.benaranurseries.com/plants/swainsona-form-flinders-flame).

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Propagation of *Conospermum* species (Smoke Bushes) by seed, cuttings and tissue culture

Dr Acram Taji, Department of Botany, The University of New England, Armidale, NSW; funded in 1990 for $2,234

Another project funded in 1990 was for investigation of propagation techniques suitable for *Conospermum*, a genus considered to have great horticultural potential. Seed from several species proved to be difficult to germinate and cuttings did not produce roots readily despite testing a range of aseptic techniques and hormonal additives, respectively.

This topic was further explored with an AFF-funded grant awarded to Fiona Perry and Dr Steven Trueman from La Trobe University in 1997 ("Development of reliable techniques for the propagation of *Persoonia* and *Conospermum*"; and see another AFF-funded project awarded to Dr Tony Slater from Institute for Horticultural Development Knoxfield, Department of Agriculture, VIC, in the same year for "Selection and evaluation of eastern Australian *Conospermum* species as cut flowers"). Successful propagation of *Conospermum mitchellii* was reported in Perry and Trueman (1999). Yet another AFF-funded grant was used to investigate micropropagation of this recalcitrant genus to Dr Eric Bunn from Kings Park and Botanic Garden, Perth, WA in 1993 ("*In vitro* propagation of Australian Proteaceae (*Conospermum* spp.)").

Other research on this genus at the time concentrated on the effectiveness of geographical and reproductive barriers to gene flow between *Conospermum taxifolium*, *C. ericifolium*, *C. ellipticum* and *C. longifolium* (Morrison *et al*. 1994) and genetic variation within a single species, *C. triplinervium* (Sinclair *et al*. 2008). More recently, the complex nature of the reproductive biology of species in this genus has been reported by Stone *et al*. (2006) along with additional attempts to germinate seed (*C. capitatum* and *C. petiolare*; Zhao and Ladd 2014).

The genus *Conospermum* remains an enigmatic and largely unknown species but is still highly prized as a cut flower. The Department of Primary Industries and Regional Development, WA Government reports that current supplies are still mostly harvested from natural populations and exported fresh or dried to Japan, Europe and the United States (https://www.agric.wa.gov.au/nursery-cutflowers/smokebush-cutflower-production). The sustainability of this practice needs to be thoroughly examined.

A striking bouquet of *Conospermum* and *Grevillea*. Image from https://www.agric.wa.gov.au/nursery-cutflowers/smokebush-cutflower-production.

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Financial Report

These statements are summarised from the Foundation's audited accounts for the year ending 30 June 2018.

Income	**$**
Donations	7,360
Administration contributions	756
Grant administration fees	1,017
Membership subscriptions	1,737
Interest	6,137
Managed fund distributions	32,498
Increase in market value of investments	72,345
Imputation credits refunded	6,950
Total income	128,800

Expenses	**$**
Grants	53,965
Decrease in market value of investments	-
Accounting and audit fees	2,250
Website costs	131
Bank charges	-
Postage and printing	51
Young Scientist awards	500
Administration	379
Total expenses	57,276
Surplus for the year	**71,524**

Assets	**$**
Investments and bank accounts	987,082
Debtors	19,365
Imputation credits receivable	6,950
GST receivable	6,270
Total assets	1,019,667

Liabilities	**$**
GST payable	275
Grant commitments	65,542
Total liabilities	65,817
Net assets	**953,850**

Accumulated funds	**$**
Accumulated funds from last year	882,326
Current year surplus	71,524
Total accumulated funds	953,850

About the Australian Flora Foundation

The Australian Flora Foundation is an Australian not-for-profit charity dedicated to fostering scientific research into Australia's flora. It is totally independent. All members of the Council and the Scientific Committee give their time freely as volunteers.

Each year the Australian Flora Foundation provides funding for 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 researchers are honours or postgraduate students, and their success with an Australian Flora Foundation grant hopefully stimulates their interest in researching Australia's unique and diverse plants throughout their careers.

This work is only made possible by the generous support of donors and benefactors.

The Foundation is currently calling for applications for projects to commence in December 2020. The Foundation expects to support between two and four projects funded for $5,000–$15,000 each in 2020 with the possibility of extension into 2021. See the AFF website for application details (http://aff.org.au/grants/grant-criteria/).

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- Dr Jason Bragg of the Royal Botanic Gardens Sydney, NSW

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