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

Research Matters

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President’s Report 2019

Delivered by Assoc. Prof. Charles Morris at the AGM, November 2019

A continuing development this year has been donations from Industry Partners who wish to support the work of the Foundation. Bell Art Australia started this trend with a donation in 2018, which they have continued in 2019. Source Separation is now the second Industry Partner sponsoring the Foundation, with a generous donation of $5,000. Other generous donors have been the Australian Plants Society (APS): APS Newcastle ($3,000), APS NSW ($3,000), APS Sutherland ($500) and SGAP Mackay ($467). And, of course, there are the amounts from our private donors.

In August, the Council was saddened to hear of the death of Dr Malcolm Reed, President of the Foundation from 1991 to 1998. The Foundation owes a debt of gratitude to Malcolm; the current healthy financial position of the Foundation has its roots in a series of large donations and bequests that came to the Foundation during his tenure. These monies were invested in a series of commercial investment funds, and have supplied a reliable stream of income, in conjunction with donations, to fund research each year.

For the round of AFF grants commencing in 2020, the successful applicants were Jenny Guerin (Botanic Gardens South Australia) for a project on the seed biology of sedges for restoration of wetlands; Borala Liyanage (Australian Botanic Gardens Mt Annan) for a project on understanding seed and reproductive biology of *Geijera parviflora* and the implications for conservation and restoration; Harry MacDermott (Charles Darwin University) for a project on the fire ecology of Northern Australian heath vegetation; and Jasmin Packer (University of Adelaide) for a project on fire versus mechanical disturbance in stimulating germination and establishment of the endangered Whibley Wattle. Final Reports for earlier AFF grants were received from Corey Bradshaw (2012), Edward Tsen (2013), Susanne Schmidt (2014), Monique Smith (2016) and Kerryn Chia (2017).

Thanks are also due to the hard working members of Council who keep the granting program and administration of the Foundation going. Ian Cox is a capable and competent Secretary; Peter Goodwin runs the administration for the granting program; Michelle Leishman heads the Scientific Committee, Tina Bell organises the excellent newsletter, and Jennifer Firn oversees the Foundation's web page. Thanks are due to Council members, ordinary members and our donors, all of whom allow the Foundation to function and support plant research.

E. Charles Morris
President
18 November 2019

AFF Grants Awarded

Four grants were awarded for research to begin in 2020:

Investigating seed development and germination requirements of sedges (Cyperaceae) for the purpose of restoration

Jenny Guerin, Botanic Gardens South Australia

The aim of this 2 year project is to develop effective methods of propagation through seed germination for four Australian native plant species within the plant family Cyperaceae. The target species are sedges from the Adelaide Mount Lofty Ranges region that are known to be difficult to propagate from seeds. The selected species are *Chorizandra enodis*, *Gahnia trifida*, *Lepidosperma laterale* and *Baumea gunnii*.

Sedges have important structural and ecological roles often dominating creek margins, damp woodlands and swamps. They are key species that contribute to retaining soil moisture, nutrient cycling, water filtration and soil stability and are important larval host plants for many species of butterflies, dragonflies and other insects. Many sedge species are not included in restoration programs due to a lack of understanding about propagation including seed viability assessment and germination requirements. One of the main limitations of propagating plants from seeds has been the inability to source collections of viable seeds from wild populations. In addition, little is known about the dormancy mechanisms, germination promoting treatments and practical nursery techniques to propagate species for large-scale restoration. It is possible to propagate some species vegetatively, but this often requires the harvesting of wild plants as source material. It is preferable to propagate from seeds for greater genetic diversity and to reduce harvesting wild plants, especially in the case of threatened species.

Understanding seed and reproductive biology of *Geijera parviflora* and its implications for conservation and restoration

Borala Liyanage, Australian Botanic Gardens Mt Annan, NSW

Geijera parviflora is an understorey species, found in both dryland open forests and dry rainforests. It is a key species in several Endangered and Critically Endangered Ecological Communities such as Yetman Dry Sclerophyll Forest, Hunter Valley Weeping Myall Woodland. It is a target species in restoration practices, as it enables spatial heterogeneity under the canopy and adds species richness and abundance. Occurrence of *G. parviflora* along a wide range of soil and habitat types indicates its drought tolerance and potential use as a shading plant in farmlands and urban streetscapes. However, knowledge of seed germination, seedling establishment and reproduction is still limited and impedes its use.

In this 2 year study we will investigate key aspects of seed and reproductive biology of *G. parviflora* to aid its use in ecological restoration, dry rainforest conservation, *ex situ* conservation in seed banking and as a shade plant. More specifically we will explore the conditions required for breaking dormancy, which will enable effective germination to test for *ex situ* seed banking and to produce seedlings for restoration. The pollination and seedling establishment experiments will reveal the limitations associated with low seed fill and natural recruitment that provide necessary understanding for conservation and restoration of *G. parviflora*.

Fire ecology and management of northern Australian sandstone heath

Harry MacDermott, Charles Darwin University, Northern Territory

The proposed collaborative research project aims to further ecological understanding of the northern Australian sandstone heath with a view to inform fire management. The project will focus on the Arnhem Plateau sandstone heath of the Northern Territory; a floristically diverse ecological community listed as Threatened by contemporary fire regimes according to the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This sandstone heath is characterised by a high proportion (ca. 50%) of fire sensitive (obligate-seeding) shrubs requiring 3-5 fire free years to reproduce. As such, the community is regarded as sensitive to extensive, intense and frequent fire. Therefore, this project aims to further investigate how fire at different times of year behave in this vegetation community and how the vegetation responds following these fires. The project may provide insights into how site fire history influences the capacity of sandstone heath to respond to fire events. Ultimately, the outcomes of this project will inform the development of an ecologically sustainable fire management strategy for this vegetation community, a system which includes a suite of flora species considered threatened at Territory and National levels. This 2 year project is part of a PhD study.

Soil disturbance trials to improve germination and seedling establishment for the Endangered Whibley Wattle (*Acacia whibleyana*)

Jasmin Packer (University of Adelaide), South Australia

Australia recognises urgent action is needed to protect 1319 threatened native flora. Our most threatened and cherished, including just two wattles, are prioritised under the Threatened Species Strategy 30 Priority Plants and EPBC Act. As one of these iconic species, Whibley Wattle (*Acacia whibleyana*), is an urgent conservation priority – and much loved by its local community. Our project responds to a call for help from the Tumby Bay community and builds on foundational, federally-funded research to protect *A. whibleyana* as a national priority.

Acacia whibleyana is endemic and restricted to Tumby Bay. The seeds require a germination trigger to break dormancy, and loss of disturbance is a key threat to long-term persistence. Once germinated, decreasing summer rainfall threatens the critical life-stage of seedling establishment.

To test the influence of disturbance and water availability on germination and seedling establishment of *A. whibleyana*, we will conduct mechanical soil disturbance trials with four treatments. We anticipate this approach will be more successful than previous ecological burn trials in terms of social licence and seedling survival. Our disturbance trials are a vital next step to designing and implementing larger-scale disturbance regimes essential for self-sustaining populations of *A. whibleyana*, and potentially other threatened, disturbance-dependent wattles. This research will be funded for 2 years by the Foundation.

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 November 2019 in Tasmania the Foundation's prizes were presented to the following students.

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

Variation and drivers of island-wide dieback in the sub-Antarctic Macquarie cushion plant

Catherine Dickson, School of Biological Sciences, Monash University, Victoria

Abstract: The dominant keystone species Macquarie cushion (*Azorella macquariensis*, Apiaceae) has undergone rapid, wide-spread dieback across the alpine plateau of Macquarie Island, potentially signalling the initiation of a regime shift. To date the pathogen/s have not been identified, however, a number of fungal, bacterial and oomycete taxa were found in association with cushion dieback. It was hypothesised that a decadal reduction in plant available water caused by change in regional climate, facilitated the secondary pathogenic infection of weakened cushions. This suggested that dieback would be greatest under high water-stress. While previous topographic modelling demonstrated a negative latitudinal gradient in dieback, terrain variables that influence water availability had no effect on the amount of dieback. Using fine-scale microclimate data we found that dieback was driven by microclimate extremes known to promote (humidity) or suppress (freezing) pathogen activity, in particular fungal or water-mould pathogens. While variables associated with water stress (vapour pressure deficit, wind exposure and soil gravel content) were unimportant. To improve future monitoring and understanding we developed refined condition classes. The classes revealed a latitudinal progression in dieback, where the healthiest cushions occurred in the south and the most advanced dieback in the north. The south of the island was significantly colder, while relative humidity was similar across regions, suggesting that freezing days drive the latitudinal gradient of dieback. Microclimate and refined condition classes provided valuable insights into the drivers and progression of cushion dieback on Macquarie Island, emphasising their importance for inclusion within future monitoring programs to assess ecosystem change.

Left and right: Catherine Dickson sampling *Azorella macquariensis* on Macquarie Island during the 2017/2018 sampling season. Photographs courtesy of R Hannaford and C Dickson.

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

Effect of multiple heatwaves on seed germination in plant species of the Cumberland Plain Woodland

Philippa Alvarez, School of Life Sciences, University of Technology Sydney, NSW

Abstract: Climate change has the capacity to increase the frequency, duration, and intensity of heatwaves around the world. Understanding the effects heatwave events can have on seed germination in plant species is critical for ensuring the effective conservation of native plant communities. The focus of my study is to understand the effects of heatwave intensity and frequency on the germination onset, duration, and the total proportion of seeds. A broad range of species were chosen as key representatives from the threatened ecological community, the Cumberland Plain Woodland (CPW). The native plant species from the CPW in Sydney's west are particularly vulnerable due to the small size of remnant land left untouched by urbanisation. In this study, I expand the knowledge base we currently have on these species' responses to

heatwave events, leading to a better understanding of which species may be susceptible to climatic change over the coming decades.

Left: Philippa Alvarez with her award winning poster at the Ecological Society of Australia conference in 2019. Right: a selection of seed from species from Cumberland Woodland featured in her research. Photographs courtesy of P Alvarez.

From Red Boxes to the World: the Digitisation Project of the National Herbarium of New South Wales

Dr Shelley A James and Andre Badiou*
National Herbarium of New South Wales, Royal Botanic Garden Sydney, NSW

The National Herbarium of New South Wales, currently based at the Royal Botanic Garden Sydney, houses a significant scientific, historical and cultural botanical collection of more than 1.4 million objects. The collection begins with specimens from 1769 sampled by Joseph Banks and Daniel Solander on James Cook's first voyage to the Pacific, contains specimens gathered by prominent botanist Robert Brown and from the expeditions of Major Mitchell and Ludwig Leichhardt, to significant discoveries and collections made by botanists and naturalists today. Established in 1853, the collection focusses on the documentation of the flora of New South Wales. However, as plants do not conform with political boundaries and with the strong biogeographical interest of humans, about half of the collection is from Australia and the remaining world collection has strengths in the regions of Melanesia, Asia and the Pacific. The scope of the collection is largely based on observation and estimation as a full inventory has never been completed – until now.

The National Herbarium of New South Wales engaged the Netherlands digitisation professionals, Picturae, to undertake the digitisation of the collection, and imaging began in April 2019. Only flat-sheet (pressed and dried) specimens (Figure 1, left) and those in packets (mosses, liverworts, hornworts and lichens) (Figure 1, right) are being imaged. In collaboration with Alembo, transcription specialists based in Suriname, the 700,000 specimens not yet databased are having their collection metadata (taxon name, collector, collection number, date, locality information) captured for incorporation into the Herbarium collections management database from the images. By the completion of the project in 2021, both the metadata and images, once linked and checked for quality, will be shared online, through open access biodiversity data portals such as the Australasian Virtual Herbarium.

Here are answers to some of the most common questions we have been asked about the project so far.

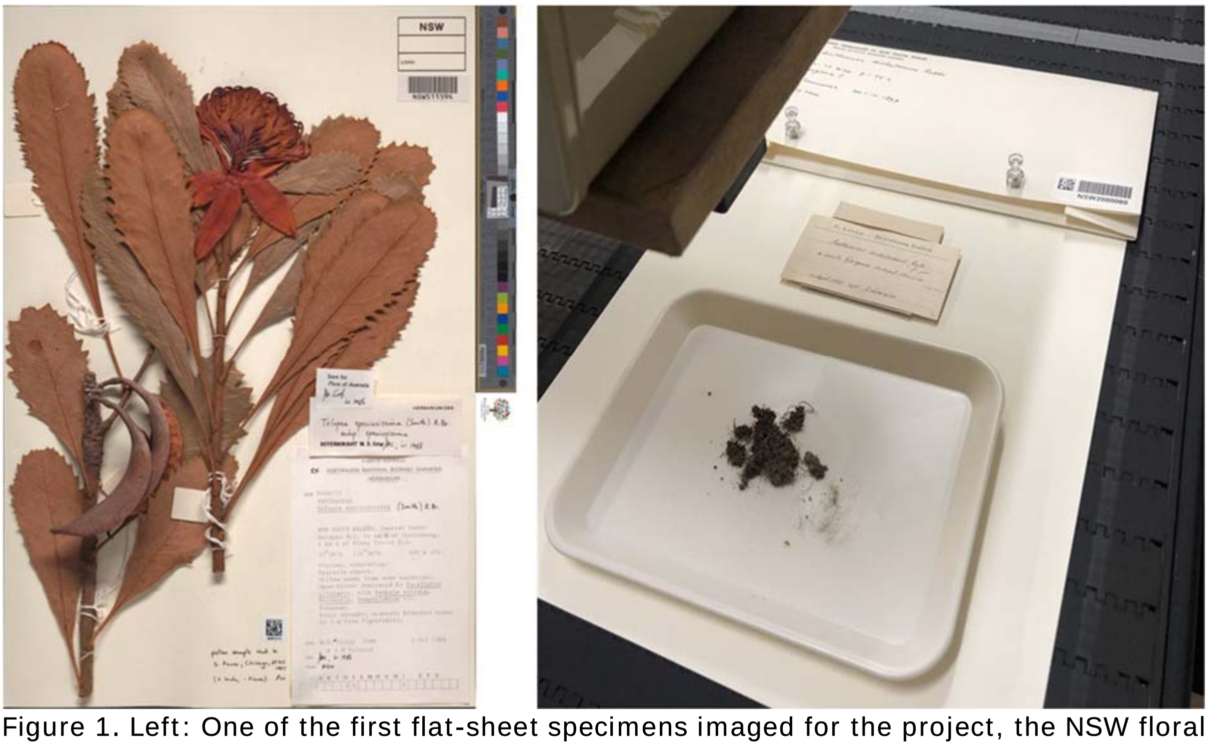

Figure 1. Left: One of the first flat-sheet specimens imaged for the project, the NSW floral emblem, *Telopea specioissima* (Smith) R.Br. This specimen, received from Australian National Herbarium, highlights the importance of specimen exchange between herbaria nationally and internationally. Right: The first packet specimen in the first box to be imaged on 30 April 2019: *Anthoceros dichotomus* Raddi, a hornwort collected on 1 April 1899 by S Sommier. While the resolution may not be adequate for many systematic studies, the metadata and overall appearance of the specimen are invaluable for collections management and researchers to explore the collection.

Why image the collection?

The National Herbarium of New South Wales will relocate to a new herbarium facility at the Australian Botanic Garden, Mount Annan in 2021. In the process of relocation, the collection will be rearranged to the most recent systematic organisation with collection management best practice in mind. Imaging and capture of collections metadata will facilitate this reorganisation and provide an inventory of the entire collection prior to the move. While a little over half the collection has already been databased through projects such as the Australasian Virtual Herbarium and daily collections operations, the current digitisation project will enable the Herbarium to share with researchers, students, the public, and policy makers, data and images of the collection. Our aim is to bring the specimens out of the more than 70,000 red boxes in which they are currently housed and expose them to the world, to advance botanical science and understanding of global floral diversity. It will also enable innovative collections management processes without the physical handling of the specimens, helping to protect and preserve them into the future.

Once you've created the digital collection, is there still a need for the physical collection?

This is a question often asked by administrators in museum and herbarium communities around the world, and the answer is a resounding "Yes!" We are creating a digital record of a specimen in the form of an archival image; the ultimate archive, however, is the physical specimen itself. The collection will inherently degrade through time, despite the care and conservation techniques applied to it, but this project provides an important step in documenting the collection as it is today. Digital files still require curation and preservation and are costly to manage and maintain through time – much like the physical collection. Digital technologies continue to improve through time, and archival standards will also change. Remember the first digital cameras, less than 10 years ago, at 4MP, considered to be the best technology of the time? Today we capture specimen images at 100MP. Tomorrow?

Twenty years ago, we would not have imagined the global use of DNA and other molecular compounds in scientific research, the importance of collections for understanding genetic variation through time and across the original distribution before human impact, and being able to analyse now extinct species, for example. Discovery and documentation of new species requires a deposition of a physical specimen, and a vast number of new species have already been collected and are found in herbarium collections (and perhaps no longer in the wild). Many species still require the physical specimen for the study of defining features, both morphological and anatomical, which are not visible on herbarium specimens without further physical analysis, let alone from a digital representation. Each herbarium specimen is an ecosystem, with many species epiphytic, parasitic, or symbiotic on the living plant, which can now be studied (but not from a digital image). Other chemistries, such as toxicology, pesticide use, carbon-ratios, heavy metals, cannot be gleaned from digital images, but many interesting studies have used collections in this way. Who knows what questions might be asked of our specimens in the future? We can certainly not go back in time to recollect them.

Why not invest in three dimensional imaging?

Imaging the specimens and transcribing the collection data allows us to fulfil two main objectives: to inventory the collection prior to moving to the new herbarium facilities; and to share the collection across the globe for the advancement of science and knowledge of the flora of the world.

The full-sized images captured using the Picturae conveyor belt digitisation system “DigiStreet” (Figure 2, left) are of sufficient resolution for scientists to be able to study, in some cases, the hairs on the leaves. The 600 ppi TIFF images were determined as a standard for the Global Plants Initiative for the capture of type specimen images, and essentially provide 6x magnification when viewing the full-sized images. Most herbarium specimens are pressed and dried specimens, typically under 2 cm thickness. While there is still some dimensionality to the specimens, and particularly fruits, the need for three dimensional images is currently limited and extremely costly, both in terms of time to capture the images, the technology required, and the digital storage space needed. Given the primary goals of the project, images in two dimensions are sufficient at this time for the majority of scientific research needs – and certainly for other artistic and educational uses. Other parts of the National Herbarium of New South Wales collections may be more suitable for three dimensional digitisation, such as the carpologica (dried seeds, fruits and other plant parts not pressed), the wet or fluid collection which is specifically for studying the three dimensional characteristics of plant parts, and the xylarium (wood) collection, amongst others.

We are also only capturing a single image of each of the specimens. Where a fragment packet or label might be covering the specimen, or where a specimen might be too thick for the depth-of-focus settings of the equipment, secondary images, or auto-montage (multilayered) images may need to be utilised into the future – most likely at the request of a researcher for a specific project and as needed due to the exponential cost of such imaging. We are capturing the collection at a moment in time, and as technology changes, future images will continue to be captured.

How can I be involved? Can I see the process?

With only a little over half the collection mounted on archival quality materials, the first step in the imaging process is to secure unmounted specimens (Figure 2, right). This is to protect the specimens as they are transferred along conveyor belt used by Picturae to be imaged (at more than 3,500 specimens per day). However, this process is also important for the relocation of the specimens and their transfer from the red boxes into herbarium cabinets in the new facility at the Australian Botanic Garden, Mount Annan. Due to the volume of specimens requiring attaching, we have initiated a volunteer program where more than 150 staff, university students, and life-long-learners are assisting with the digitisation project by attaching the specimens to their backing sheets and barcoding the specimens. For many, getting up close and personal with the botanical specimens is a new experience, and they are gaining a new collections-based skill set and understanding of the importance of biological voucher collections.

Figure 2. Left: Prime Minister Mark Rutte of The Netherlands, one of the many visitors to the National Herbarium of New South Wales to see Picturae's conveyor “DigiStreet” system in action, assisted by applying a barcode to a flat sheet specimen. The system can be viewed in action during business hours through windows accessible via the Herbarium reception. Right: More than 100 enthusiastic volunteers are assisting by attaching of the specimens to their backing sheet using glue-backed tape and applying barcodes. About half the collection is not mounted.

The Picturae team are situated in the old Red Box Gallery of the National Herbarium of New South Wales. The Herbarium is closed for tours (as you can imagine, we're a little busy!), but if you are interested in seeing the digitisation project in action, we have viewing windows in place. Just ask to take a peek at the Herbarium Reception when you next visit the Royal Botanic Garden Sydney.

We look forward to being able to share the collection with you virtually in the near future!

For more information on the project, including videos, podcasts and blog posts, details outlining how to get involved, or to support the project, please visit our website: https://www.rbgsyd.nsw.gov.au/science/herbarium-digitisation-relocation

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Hibbertia (Dilleniaceae) aka Guinea Flowers

Adjunct Prof. Betsy R Jackes*
James Cook University, Townsville, Queensland

Hibbertia (the Guinea Flower genus) is a large Gondwanan genus in the family Dilleniaceae. Species occur throughout Australia as well as in Madagascar, Malesia, New Guinea, New Caledonia and Fiji. Although, widespread in Australia and reasonably well known in the southern states, they are poorly known and under collected in the Tropics. Some 300 taxa are currently recognised in Australia with the greatest concentration being in Western Australia. Although some species are widespread such as *H. scandens* and *H. dentata*, others are localised endemics, some are known only from the type locality. They form small shrubs and woody climbers with yellow, rarely orange flowers and they grow in a variety of habitats from rainforest to dry semi-arid environments and from sand dunes at sea level to over 1000 m altitude. All too often they occur in areas likely to be razed for urban sprawl or mining. The genus is easy to recognise but not at the species level. Their brilliant yellow flowers, rarely orange, have petals with a notch at the apex (two exceptions). Species acquired the common name of Guinea Flower because they were thought to resemble the appearance of the 18th century coin known as a Golden Guinea.

Left: *Hibbertia nemorosa* with typical notched petals and numerous stamens; middle: *Hibbertia longifolia* (Arsenic Plant) with petals lacking a notch. Photograph courtesy of R Fryer. Right: *Hibbertia synandra* showing stamens only on one side of the two carpels. Photograph courtesy of R Jensen.

The genus *Hibbertia* was named by Henry Charles Andrews, after his friend George Hibbert (1757-1837), an English merchant and amateur botanist. Andrews was an artist and engraver as well as a botanist and the first species he named was based on a plant that had been collected around Port Jackson. Probably the most widespread species and one of the those cultivated is *Hibbertia scandens* (Climbing Guinea Flower) which can be grown readily from cuttings, but seed germination is slow.

Historically, the genus has been divided into up to seven sections based on the arrangement of the stamens with respect to the carpels. However, Horn (2009) recognised two subgenera based on molecular analyses; subgenus *Hemistemma*, in which all species with needle-like leaves occur, and subgenus *Hibbertia*, where the under surface of the leaves are exposed.

Habit

Most species form small bushy shrubs sometimes procumbent, semi-erect to erect, occasionally up to 3 m tall whilst a couple are climbers (*H. dentata* and *H. scandens*). The appearance varies with growing conditions, for example, vigorous resprouting or coppicing commonly occurs after fire and actively growing plants will have larger leaves and longer internodes than plants growing slowly or struggling. Short shoots are common.

Indumentum

A feature of most species, and often vital for identification, is the nature of the indumentum. This varies from simple erect hairs to stellate or star-shaped hairs and peltate scales, the latter may or may not have arms, or there may be various combinations. These scales are particularly common on the bracts and calyx. There are some excellent illustrations in Toelken (2010).

Leaves

Leaves are alternate, simple and range in shape from linear to lanceolate, oblanceolate, elliptical and obovate. The petiole is usually very short or even indistinct. Margins may be entire or toothed and are often revolute so much so that in linear leaves the entire under surface maybe almost hidden from view. The leaves of most species have some covering of hairs and/or scales and are useful in distinguishing between many species. An exception are leaves of *H. longifolia* which are glabrous on both surfaces.

Reproductive structures

Flowering occurs chiefly in spring and summer, but flowers of some species are frequently found at any stage of the year. The flowers are usually solitary but in some of the northern species they are in spikes (e.g. *Hibbertia banksii*) and up to 4-5 cm in diameter, however, in most species they are about 2 cm in width. The calyx consists of five sepals that surround five obovate petals. The flowers usually close at night, and reopen the next day, however, if touched the petals often fall off easily leaving the stamens and carpels remaining and surrounded by the sepals. These petals vary in shade from pale yellow to almost orange (*H. miniata* and *H. stellaris*) and typically have an obvious notch at the apex, although several species such as *H. longifolia* lack an obvious notch at the apex.

A distinctive feature is the arrangement of the stamens. They may be all on one side of the carpels (the structures containing the unfertilised seeds at the centre of the flower) or they may surround the carpels as in *H. nemorosa* (see figure above). The number of stamens varies between species from less than 10 to over 100, and there is even one species which appears to have only one stamen (*H. hirsuta*)! Sometimes sterile stamens or staminodes are also present.

In the centre of the flower are the carpels which are loosely adhering at the base. The number of carpels varies from two to five but may be more depending on the species. The style is usually attached at or near the apex of the ovary and extends beyond the length of the stamens. The number of ovules varies per ovary from two to six, again, depending on the species.

The persistent calyx enlarges around the developing fruit, which is capsule-like and consists of a number of loosely adhering follicles. Each follicle contains from two to four seeds and each seed is covered or almost covered by a reddish-brown to orange coloured aril. This nutritious tissue is a valuable food source for dispersers. The aril in *H. aspera* is white.

Pollination and dispersal

Pollination in the species that have been studied appears to be chiefly by native bees in the genera *Lasioglossum* and *Leioproctus*, as well as hover flies. Whether the pollen is shed from the anther through terminal pores or longitudinal slits or a combination of both varies with species. The larger the bee then the more likely it is that pollen is shed by vibration through the terminal pores of the anther. There does not appear to be a nectar reward for pollinators, but there are reports of a weak fragrance. Hence, pollinator reward is likely to be the pollen and, where present, the staminodes may also be a food source. Pollen dispersal is also aided by the present of pollenkitt, an oily yellow substance which helps the pollen adhere to potential pollinators. Ants appear to be the most common dispersers of seeds from species that grow in drier areas. Birds have been reported as dispersing seeds of *H. scandens*, a scrambling vine growing in moist areas.

Germination and growth

Initially, germination is slow as the embryo is immature, a 'tiny blob' when the seed is shed. This enforced dormancy means the embryo may take several years before all conditions are met and it is ready to germinate. It appears that seeds from plants adapted to dry habitats may require several wet-dry cycles. Smoke water increases the germination rate for some of the species that have been trialled. Fire triggered germination from the seed bank of *H. spanantha*, a species from the Sydney north shore area. Coppicing or suckering from a rootstock is also common for some species after fire. Good post-fire seedling growth for *H. aspera* and *H. dentata* has been noted.

Many species have been successfully grown from cuttings. The Society for Growing Australian Plants Study Group found that for species with fleshy leaves, such as *H. dentata* (Toothed Guinea Flower) and *H. scandens*, firm new growth gives the best results and woody material is the most difficult material for propagation, but results varied with the species trialled and the media used.

Diallagy

Diallagy is a term coined by Alex George to describe a physiological strategy to cope with extended periods of dry weather. It involves the withdrawal of nutrients marked by a change in colour under dry conditions but when adequate moisture is available then the colour returns to normal. At least one species, *H. ferox*, has been observed to exhibit diallagy. The leaves in this species normally spread from the stem at an angle of 75°, but under dry conditions this angle is reduced to less than 25°. The leaves closest to the roots are the last to change colour and the first to regain colour.

Above: Mature plant of *Hibbertia ferox* with good access to water. Image from The Conversation, theconversation.com/guinea-flowers-are-fierce-and-golden-109189. Below: *Hibbertia ferox* showing development of diallagy – a gradual change in colour as access to water by the plant is limited. Photograph courtesy of K Townsend.

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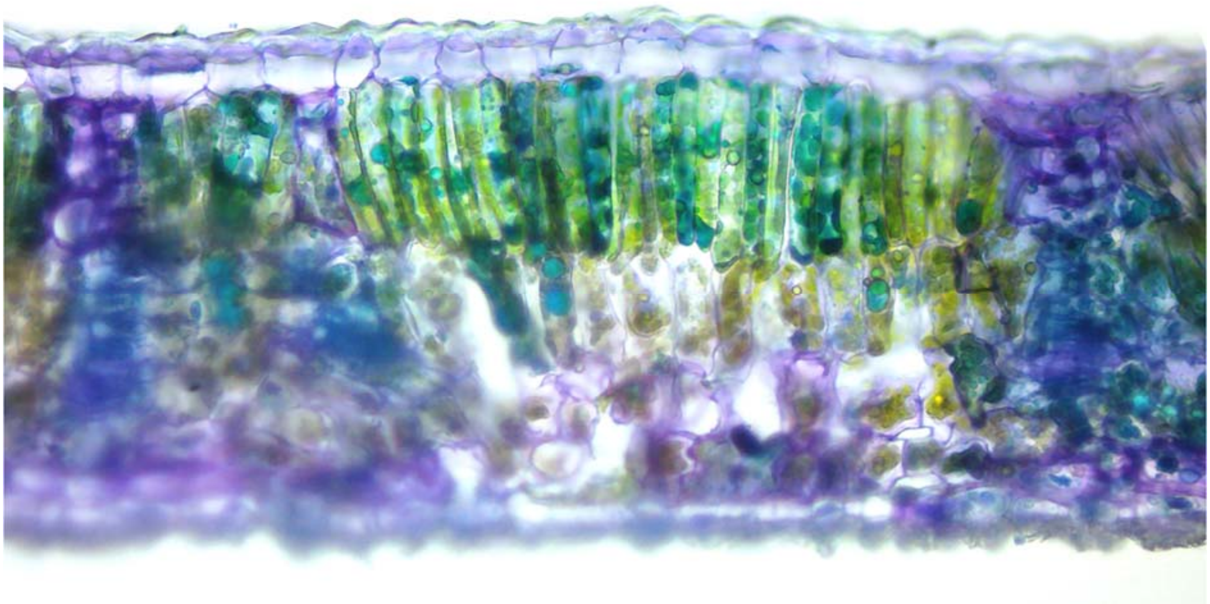
The Joy of Plants

Assoc. Prof. Rosanne Quinnell*
School of Life and Environmental Sciences, University of Sydney, NSW

I have taught botany for over two decades on topics ranging from plant ecology and diversity to plant anatomy and physiology. Much of my 25 years of teaching has been working with students generating micrographs. I have educated first year students through to honours and supervised higher research degree students. So, when invited to write this piece, my intent was to offer some background on botanical literacy but as I was writing I felt my usual scientific tone drift to include my musings in recent weeks. Global discussions about climate change, and the political situation in Australia, which for too long has focused on short term media cycles, accounting timelines, and 3-year political terms at the expense of our long term survival have rendered conversations about our environment an emotional space. I offer this piece as a homage to plants.

There is no doubt that phototrophs support all life on our planet, and this makes the care of our botanical environment critical for the survival of animal life. Plants, and other photosynthetic oxygenic organisms sequester carbon from the atmosphere. But they cannot keep up with the amounts of carbon dioxide for which we humans are responsible. Carbon emissions are able to cross international borders so this is collective 'we'.



Above: Transverse section of leaflet from *Jacaranda mimosifolia* taken from a historically significant tree in the south eastern corner of the Main Quadrangle, University of Sydney. Photograph courtesy of the author.

Our Great Southern Continent in unique and our plants and animals have adapted ways to survive here. These adaptations are being put to the ultimate test as fires increase in intensity and frequency and there is emerging evidence that tree survival is diminishing because of this (Fairman *et al*. 2019). The recent fires that have raged across millions of hectares have resulted in what ecologists would call a ‘natural experiment’, offering opportunities to assess diversity of biota of the scorched earth, to count the survival rates of vertebrates, and diversity of pollinators visiting the plants as they regenerate in comparison to unburnt areas. As a plant scientist, I found the focus on animals (mainly koalas) to be strange. With the notable exception of the Wollemi Pine, it was as if the trees, the things that were burning, were invisible. This invisibility of plants is referred to in the scholarly literature as ‘plant blindness’ (Wandersee and Schussler 1999), the antidote to which is ‘botanical literacy’ (e.g. Mathes 1983).

Throughout my career, I have deliberately shied away from the term 'plant blindness', as it is a deficit definition (the inability to see plants or to recognise differences between plant species), and have instead focussed on devising ways to improve engagement of both students and the broader campus community with the botanical world. One innovation has been a mobile app called CampusFlora (currently undergoing redevelopment) where the plants growing on the campuses of the University of Sydney are presented as learning objects making spaces outside of the classroom learning places for botany (e.g. Pettit *et al*. 2014; Cheung *et al*. 2015; Dimon *et al*. 2019). Alongside this initiative I have offer reminders via Yammer posts to the university community prompting us all to stop, look and learn about at the plants in our working environment, which in our campus context, is akin to a botanic garden.

Colour on the campus at the University of Sydney. Left: *Brachychiton acerifolius*, commonly known as the Illawarra Flame Tree. Photograph courtesy of T Bell. Right: The iconic Kangaroo Paw, *Anigozanthus* sp. with the Madsen Building in the background. Photograph courtesy of the author.

Although I have taught botany for a long time, I feel obliged to share my knowledge, noting that I learn something new every year. I feel a bit sad knowing that I will never completely satisfy my botanical curiosity. As a case in point, on a recent field excursion to the Kimberley, it was such a treat to be able to see and touch Boab trees. Their mode of arrival to the Australian landscape remains a mystery to western science (see Baum *et al*. 1998). It is all so interesting to me.

I often ask myself the question: when did it become normal to not be able to recognise and appreciate plants? Does it start when we are young? I ask this because when I have looked at flash cards that are used to teach children to speak, I feel myself getting cross when, for example, the picture of the African savanna with a lion in it is only labelled as ‘lion’. I recall seeing images spruiking national tree day where the inclusion of a bird in the tree branches seemed to be obligatory. Is it true that most people will only pay attention when an animal is present? A study out of the US provides some evidence to confirm that our (human) attention is skewed to animals rather than plants (Balas and Momsen 2014).

Left: First real-life encounter with a Boab (*Adansonia gregorii*) in the Kimberley region of Western Australia; right: an image of East coast bush with which the author is so familiar featuring Sydney Red Gum (*Angophora costata*). Photographs courtesy of the author.

I wonder if there is a cultural element at play. Over the past 5 or so years I have been privileged to have been invited onto Country and, on every occasion, have been introduced first and foremost to the plants, considered as brothers and sisters (Martin and Mirrboopa, 2003). As a plant-lover, I can’t tell you how much it pleases me that plants are in the forefront of these introductions. Maybe it is worth noting that my background is Celtic with forebears coming to Australia only about 150 years ago. It should also be noted that here I am relying on a fuzzy memory of things my mother told me years ago.

My mother, too, was a lover of plants. She would be moved to tears (literally) if she found an off-cut of a plant (a sprig) on the footpath. She would take it home and coax it to grow, usually with success. When my sister passed away, my mother grew one of the white roses from my sister's wreath into a healthy plant. I recognise that some might view this as dark. But beyond our very existence being contingent on plants (calories, nutrients, oxygen, medicine, shelter) our emotional and cultural wellness is connected with plants. In our celebrations we include plants, roses on Valentine's day, the bride's bouquet, chrysanthemums on Mothers' day. And plants are integral to our commemorations – lilies for death, rosemary for remembrance, trees planted as memory waypoints. More explicitly, the Australian War Memorial offers an opportunity to purchase one of progeny of Gallipoli's Lone Pine; sunflower seeds from the field in the Ukraine where MH17 was shot down were sent back to Australia to respectfully commemorate those who were not able to come home. There are many more examples. I find it acutely interesting that plants, particularly their flowers, offer us ways to express what our words cannot. Gently and with beauty.

Sometimes when I look at our Southern landscape, I edit out the buildings, the roads, the poles and wires, the dams, so that I can imagine what our country was pre-contact, pre-colonisation, pre-invasion. That humans are still able to survive and thrive in remote areas speaks to the remarkable sophistication of Indigenous Knowledge Systems and the resilience of a culture derived from and integrated with the land and the sea. I like to think of the time when we will reintegrate with the land. When we die, we decompose. Our molecules disassembled and become available for use by the macro and micro soil biota. Carbon released into the atmosphere is refixed via photosynthesis; our nitrogenous waste is taken up by root systems. Even those who are the loudest climate change deniers will realise their full environmental potential when their bodily chemicals contribute to nutrient cycles to be incorporated into lignin, cellulose, botanical genomes. Incorporated into branches and leaves, I like to think of us dancing joyfully in the treetops together.

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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.

Micropropagation of threatened species of *Persoonia*

Janet Gorst, Department of Plant Science, University of Tasmania, Tasmania; funded in 1992 for $2,540

This research aimed to identify impediments to seed germination and tissue culture of *Persoonia*. The most significant problem was found to be the production of phenolics which led to rapid blackening and death of explants. This phenomenon could not be inhibited by standard anti-phenolic treatments. Embryo culture of *Persoonia* proved to be much less successful than for other members of the Proteaceae but it was concluded that, with further experimentation, it may prove to be a feasible way of overcoming difficulties associated with seed germination. From the research it was concluded that dormancy is probably linked with inhibitors produced within the seed as embryos showed precocious germination when removed from the seed.

Given the potential for domestication of species in this genus for the floriculture industry, it is not surprising that the Foundation continued to fund research related to *Persoonia*. In 1995, Jayne Balmer was funded to investigate the micropropagation of *Persoonia muelleri* ($5,000). This species is endemic to Tasmania where it forms a shrub in open areas of wet forests in the west and north east of the state. Dr Balmer had some success in establishing plantlets derived from embryos removed aseptically from seeds.

In 1995-1996, Margaret Johnston and Lynda Ketelhohn (Bauer) were also funded to develop propagation techniques of *Persoonia virgata* for the development of a new export crop ($7,500). This species is native to New South Wales and Queensland and has an attractive yellow flower which, at the time, was harvested from wild populations. These researchers had success in cultivating this species from cuttings of juvenile (non-woody) material and from seed when at least half of the endocarp was removed. Several publications (e.g. Ketelhohn *et al*. 1994; 1996; Bauer *et al*. 1999) and a number of conference proceedings resulted from this research. In 1997 Steven Trueman and Fiona Perry were funded ($5,900) to continue investigation of the propagation of *Persoonia*, this time for *P. pinifolia* (Pine-leaved Geebung). Indole-butyric acid was found to be the most effective auxin for stimulating root formation on cuttings of this species.

In recognition of the increasing importance of understanding distribution patterns of threatened species, in 1999 Chris Nancarrow from the University of Wollongong was funded by the Foundation for an investigation of *Persoonia* ($4,000). His research aimed to determine hybridisation patterns in three sympatric species of *Persoonia*; *P. chaemaepitys*, *P. myrtilloides* and *P. levis*. These three species grow together in the Blue Mountains region in eastern Australia. It was found that there was considerable potential for hybridisation between *P. myrtilloides* and *P. levis* and, at some sites, adult plants had morphological characteristics that were intermediate between plants of either species in pure stands. Hand pollination studies confirmed that these two species were self-incompatible and therefore require pollinators to transfer pollen between plants.

Most recently, in 2017-2018, the Foundation funded Kerryn Chia from the Biodiversity Conservation Centre, Kings Park, Western Australia for research on the germination of *Persoonia* ($19,324). The aim of this study was to determine if novel techniques such as simulations of wetting and drying cycles could be used to germinate a number of species *Persoonia* (*P. elliptica*, *P. quinquenervis* and *P. saccata*) as had been found previously for *P. longifolia.* The results of this research are described in detail in the final AFF report: http://aff.org.au/wp-content/uploads/AFF-Final-report-Chia.pdf and the study is featured in the July 2019 AFF Newsletter.

Top left: *Persoonia muelleri* (Mueller's Geebung). Image from www.flickr.com/photos/ 111339831@N02/16866618709. Top middle: Flowers of *P. virgata* (Geebung). Image from noosasnativeplants.com.au/plants/379/persoonia-virgata. Bottom left: Distinctive flowers of *P. hirsuta* (Hairy Geebung). Image from en.wikipedia.org/wiki/File:Boree_Trk_ 18.tif_Persoonia_ hirsuta.jpg. Bottom middle: Flowers and developing fruits of *P. levis* (Broad-leaved Geebung). Image from en.wikipedia.org/wiki/Persoonia_levis#/media/File: Persoonia_levis_fruit_2.jpg. Far right: Flowers and fruits of *P. pinifolia* (Pine-leaved Geebung). Image from www.anbg.gov.au/gnp/interns-2009/persoonia- pinifolia .html.

The Foundation has also lately funded Nathan Emery and Cathy Offord from The Royal Botanical Garden, Sydney to investigate the taxonomy of *P. hirsuta* (Hairy Geebung) ($10,000; 2019-2020). This is a species listed as Endangered under the EPBC Act and the *New South Wales Threatened Species Act 1995*. *Persoonia hirsuta* occurs as a species complex in NSW with two subspecies (based on leaf morphology – narrow (*P. hirsuta* subsp. *hirsuta*) and broad-leaved (*P. hirsuta* subsp. *evoluta*) occurring in the eastern and western extremes of the distribution of the species with intergrading forms where the populations are in contact. An additional population found in 2017 in the northern part of the distribution of this species, *P. hirsuta* subsp. '*Yengo*' requires the taxonomy of the complex to be confirmed. This research is ongoing and will be reported in future reports and newsletters.

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Left: *Persoonia longifolia* (Snottygobble). Image from florabase.dpaw.wa.gov.au/potm/?y=2015&m=1. Right: Flowers of *P. elliptica* (Snottygobble). Image from:en.wikipedia.org/wiki/Persoonia_elliptica.

Financial Report

This statement is summarised from the Foundation's audited accounts for the year ended 30 June 2019.

	2019	2018
Income	**$**	**$**
Donations	17,563	7,360
Administration Contributions	520	756
Grant Administration Fees	305	1,017
Membership Subscriptions	1530	1,737
Interest	7,534	6,137
Managed Fund Distributions	46,978	32,498
Increase in Market Value of Investments	-	72,345
Imputation Credits Refunded	8,158	6,950
Total Income	**82,588**	**128,800**
Expenses		
Grants	45,716	53,965
Decrease in Market Value of Investments	45,322	-
Accounting and Audit Fees	2,245	2,250
Website Costs	87	131
Postage and Printing	177	51
Young Scientist Awards	500	500
Australian Network for Plant Conservation	100	-
Administration	(25)	379
Total Expenses	**94,122**	**57,276**
Surplus (Deficit) for the Year	**(11,534)**	**71,524**
Assets		
Investments and bank accounts	970,632	987,082
Debtors	29,287	19,365
Imputation Credits Receivable	8,158	6,950
GST Receivable	4,378	6,270
Total Assets	**1,012,455**	**1,019,667**
Liabilities		
GST Payable	166	275
Grant Commitments	69,973	65,542
Total Liabilities	**70,139**	**65,817**
Net Assets	**942,316**	**953,850**
Accumulated Funds		
Accumulated Funds from last year	953,850	882,326
Current Year Surplus (Deficit)	(11,534)	71,524
Total Accumulated Funds	**942,316**	**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 2021. The Foundation expects to support between two and four projects funded for $5,000–$15,000/year each in 2021 with possible extension into 2022. Typically, projects are funded up to $10,000 per annum for two years or up to $15,000 for one year. See the AFF website for application details (http://aff.org.au/grants/grant-criteria/).

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