



Summer 2017/18
Vol 29 No 233



\$6.50

Australian Plants





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Cover photo: Yellow Water Billabong, Kakadu. The billabong, which is also known by the local Aboriginal people as Ngurrungurrudjba, is part of the South Alligator River floodplain. The billabong is lined with Water Pandanus and towering silver-leaved paperbarks in the background, with large patches of floating *Nymphoides* species water lilies. The billabong is also renowned for its wildlife, including crocodiles. Photo: Ralph Cartwright

Australian Plants articles

Australian Plants is published quarterly to promote knowledge of Australian plants.

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Proofreading: Heather Miles and Rhonda Daniels

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Australian Plants No. 233 Issue of Volume 29, which comprises issues 230–237.

Published quarterly and available nationally in 2500 copies by the Australian Plants Society NSW Ltd

© Australian Plants Society NSW Ltd 2017 ABN 87002680408 ISSN 0005-0008

Printed by Elect Printing, Fyshwick, ACT Print post approved 100009857

Editorial and Introduction

John Aitken

This issue of *Australian Plants* contains a variety of articles. I am confident that you will find something stimulating, interesting and exciting which will expand your knowledge and understanding of our magnificent flora.

The first article, *Kakadu – a Walking Adventure*, explores some of the flora in the Kakadu National Park, Northern Territory. The author, Ralph Cartwright, spent a wonderful six-day walking experience in the Park where he encountered a variety of plants which he shares with us.

Many readers of *Australian Plants* live in areas that are subject to low temperatures, severe frosts and dryness. In their article, *Plants for a Cold Climate Garden*, Ben and Ros Walcott describe some of the plants in their magnificent garden in Canberra that have done well and have survived under such conditions.

South Australia has many beautiful gardens which feature Australian native plants. Max Jahn, shares his association with one such garden, Perroomba, Williamstown, north of Adelaide. The garden, designed and planted by Ruth and Colin Charlesworth, contains a large variety of plants which grow happily, in soil which is mainly sand.

When we think of Australian indigenous gardens, we normally associate them with having a 'natural' look' to recreate native bushland. In *The 'New' Formal Garden*, Kath Gadd explains how Australian native plants can be used in a variety of situations to create a formal garden.

In *Terra Australis Garden at the National Arboretum*, Canberra, Ben and Ros Walcott describe how the Australian Native Plants Society (Australia) (ANPSA) has secured a garden site at the National Arboretum, Canberra, and the Society's plans to create the *Terra Australis Garden*, which will be a wholly native plant garden featuring attractive modern cultivars and hybrids of Australian native plants.

Buzz pollination or sonication is a technique used by some bees to release pollen which is more or less firmly held by the anthers. In *Buzz pollination and 'Bee-purple'*, Jim Barrow, a regular contributor to *Australian Plants*, describes a number of Australian plants that rely on this fascinating method of pollination.

Most people are aware that life wouldn't exist on Earth without solar radiation. In *How the Growth of Vegetation is Powered by the Sun*, Doug Rickard explains why plants need solar radiation for more than just for photosynthesis.





Kakadu – a Walking Adventure

Ralph Cartwright

Ralph is a keen photographer who enjoys travel to new places. In mid 2016, he undertook a guided, six day, five-night bush walk venture in the Kakadu National Park, Northern Territory.

Kakadu is a World Heritage listed national park renowned for its extraordinary natural beauty, astonishing variety of wildlife and ancient cultural heritage. The park contains more than 2,000 plant species, around one third of all Australian bird species and about one-fifth of all Australian mammals.

The first location visited was Fogg Dam, which was built in 1956 as a water source for a failed rice growing project in 1956. It is located on the Adelaide River floodplain between Darwin and Kakadu covering over 1,500 hectares and is now known as the Fogg Dam Conservation Reserve. It features monsoon and eucalypt forest, open scrubland, melaleuca woodland, floodplain and open water which attract significant numbers of birds, reptiles, mammals and marsupials.

The dam has had a history of weed invasion and an aquatic weed harvester was brought to the dam by the local friends group. The aim was to control a floating invasive weed, *Eleocharis sphacelata* (a native species but considered a weed in this situation). The plan was to use low-risk prisoners trained to operate the machine with the expectation that they would work full time, five days a week, all year round to clear the weeds and re-open the waterways again. The removed biomass was to be used as a saleable item. Unfortunately, it didn't work very well. The resulting biomass was too low in nutrients to be viable so the scheme ran out of money to buy fuel. Also, the weeds proved too

tough for the machine, which, in the end, was used as more of a floating bulldozer to push the weeds to the edge where they could dry out and later be burned.



Weed harvester at work in Fogg Dam.

Plants observed in the area include *Nymphaea violacea* (Lotus Lily) and *Nymphoides indica* (Water Snowflake). The flowers of both species are mostly pink, white or blue-mauve with yellow centres. Both species are used by Aboriginal peoples for food – they use both the root-stock and the seeds, which are ground to make flour.

Another floating plant seen was *Nymphoides indica*, described as an aquatic herb. As well as being common in Kakadu's freshwater lagoons and billabongs, it is widespread in tropical areas around the world.

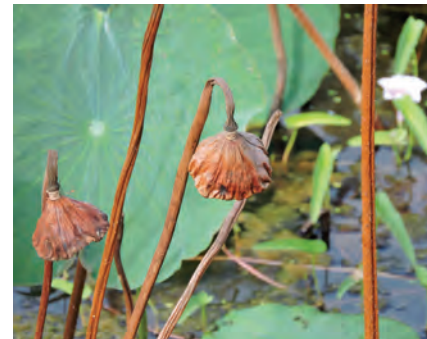
Clerodendrum costatum (bottom right) is a common small to medium shrub often found in monsoon vine forest margins. It has an attractive flower and is interesting when in fruit, with its prominent red calyx and green seed capsule



Nymphaea violacea



Nymphoides indica



Nymphaea violacea seed pods



Clerodendrum costatum





Bossiaea bossiaeoides is described as a leafless pea-flower and would make an unusual rockery plant in sunny gardens. The traditional owners use it as a calendar plant as it indicates the season that honey is available in bees' nests.



Bossiaea bossiaeoides, flower (left) and plant (right).

Banksia dentata, Tropical Banksia, (below) is the only *Banksia* species growing in the tropical north and up into southern New Guinea. A gnarled tree to 7 metres. and flowering over the cooler months, it attracts various species of honeyeaters. It was one of the four *Banksia* species collected by Joseph Banks in 1770. The local Aboriginal people used the old seed cones to transport fire as they would smoulder for up to two hours. This banksia re-sprouts after fire from a woody lignotuber.



Despite being well known in Australia, *Hibiscus sabdariffa*, Rosella, is actually a species of hibiscus native to West Africa and therefore a weed.

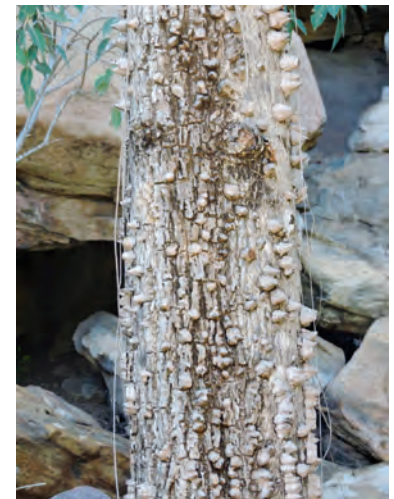
We found several plants in various locations, including around car parks and alongside tracks. Our guide suggested that they had germinated from seed discarded from jam sandwiches. The fruits are quite healthy, with high levels of calcium and Vitamin C, which these green ants also took a liking too.



The tropical savannas are well known for their termite mounds and we came across some enormous examples, including this one, which is reportedly the largest in mass, in Kakadu. It is still active and is known to be at least 40 years old, probably older, which means the queen has been alive for that time, continually pushing out eggs to keep the mound growing and healthy.



Boombax ceiba, the Kapok Tree or Silk Cottontree (right), is a large deciduous tree across the Top End and tropical Asia. It is easily recognized by the unusual trunk and branches, which bear numerous conical spines, particularly when young. In spring the tree is covered with large cup-shaped red flowers up to 20cm in diameter. Although each flower only lasts for one day, they are visited by numerous birds some of which have been observed to get drunk on the fermenting nectar. The Kapok tree normally grows between 10 to 20 metres, but can grow to 60 metres.





Boombax ceiba is widely planted for its flower display, particularly in India and Asia.



The flower display of *Boombax ceiba* forms a stunning canopy along this avenue.
Image: <http://jogindernursery.com>



This sticky/hairy herb, *Cleome cleomoides*, looks a very interesting plant, common across the Top End and into Western Australia (WA). One source states that it is a noctiflorous species, with flowers opening soon after sunset, but this picture was taken mid-afternoon and shows a couple of insects visiting the plant.



Also found among the steep and stony slopes at Maguk is this small, sticky, zig-zag stemmed shrub, *Goodenia cirrifica*. Although it is not threatened, it is restricted to Kakadu and Arnhem Land.

Calytrix exstipulata, Fringe Myrtle or Kimberley Heath, is very common across the Top End, WA and into Queensland. The leaves made a nice flavouring to a lamb roast cooked for us. The hard timber was used by Aboriginal people for spear heads, boomerangs and firewood.

On the other hand, *Calytrix achaeta*, a related plant with its white rather than pink flowers, has the local name of Kerosene Wood and is said to be good for starting fires in wet conditions.



Calytrix exstipulata



Calytrix achaeta



The *Pandanus spiralis*, Screw Pine, (left) is not a pine, or a palm, but one of the three *Pandanus* species found in Kakadu. It is a very important plant used extensively by Aboriginal people. The spiral arrangement of the leaves is meant to help water stay close to the roots where water can be found in dry periods. The leaves are used to weave mats, bags and ropes and the fruits were eaten raw or roasted.





Hypoestes floribunda, Gomphrena Weed, is a small annual herb that grows to 1 metre in height. It is a common plant and is widespread across the Top End, WA and Queensland.

Cycas lane-poolei, Zamia Palm, is a palm-like dioecious cycad. The male tree can be identified by the presence of nuts and the female by the spikey cones. It is an important food tree for the local peoples who have to prepare the nuts extensively before eating as they and the leaves are poisonous. The leaves have powerful antibiotic properties and were used to treat spear wounds when mixed with human urine.



Above: *Cycas lane-poolei*,
Left: *Hypoestes floribunda*

Xanthostemon paradoxus, Bridal Tree or Northern Penda (below), is a small tree of the Myrtaceae family. It is common across the Top End and Northern WA into tropical Asia. and is an epicormic re-sprouter after fire. It takes around six years for its first flower and is widely cultivated around the Darwin area for its shady habit and the large bunches of yellow flowers which attract birds and insects.



Haemodorum coccineum, Scarlet Bloodroot, is quite common in the north of NT and Queensland and is in the same family as Kangaroo Paws. The common name refers to the bulbous red root which the Aboriginal people chop or crush and boil in water to release red-brown dyes, with purple shades being made from the fruit. This plant has

been investigated for its horticultural potential as the orange to red flowers bloom from November to March, a time when red flowers are highly desired in global markets for Christmas, Chinese New Year and Valentine's Day.



Haemodorum coccineum



Baskets woven from pandanus leaves and dyed with the red-brown dye from the roots of *Haemodorum coccineum*

Eucalyptus phoenicea, Scarlet Gum, as shown below, is easily identified by its flaky orange bark and grows to about 10 metres. It has beautiful dense, globular umbels, which light up the tree and contrast beautifully against the blue tropical skies.





Pityrodia jamesii (left) is a small shrub with small, hairy and sticky leaves, and described as very aromatic, a mix of mint and tea tree oil to taste.

It is the host plant for the spectacular Leichhardt's Grass-hopper (*Petasida ephippigera*), which lives its entire life-cycle on this plant. The grasshopper was named after the explorer Ludwig Leichhardt, the first European to describe them in 1845,

They start their life as a grub living underground, feeding on the roots of this plant. As they emerge to feed on the leaves, they make their way further up the plant eventually to mate and then lay eggs at the base of the plant, starting the cycle all over again.



Leichhardt's Grasshopper on *Pityrodia jamesii*
Photo: Jutta Pryor, www.naturephotographeroftheyear.com.au

Plants for a Cold Climate Garden

Ben and Ros Walcott

Ben and Ros established a large Australian native garden in Canberra in 2003, which has featured on an Australian Post stamp and on Gardening Australia. Ben is currently the President of the Australian Native Plants Society (Australia).

This winter has been the worst we have experienced since starting our Canberra garden in 2003 as it was so dry and cold. We had many nights of frost, some as low as -8°C , even though the daytime temperatures were often at record highs. Here we describe some plants that did well in our heavy clay soil and survived the persistent frosts and dryness.

Among the smaller plants, *Rhodanthe anthemoides* cultivars 'Paper Cascade', 'Paper Star' and 'Southern Stars', have done well, even those growing in very exposed positions. Generally, these plants thrive in semi-shade under the protection of taller plants. They are compact plants that form low mounds of grey foliage with spectacular floral displays of white flowers with yellow centres in spring. Their common name of everlasting daisy is very appropriate as the flowers and bracts last for several months.



Rhodanthe anthemoides



Brachyscome 'White Delight'

Another small plant that works well for us is *Brachyscome* 'White Delight', which flowers almost all year round and seems much more resistant to frost than other brachyscomes such as 'Amethyst'. This plant is very easy to propagate and we have spread it around our garden along the edges of paths.





Another excellent low growing plant is *Carpobrotus glaucescens* 'Aussie Rambler'. This plant is an enthusiastic grower that seems immune to frost and prefers to grow in the open in full sun. However, King Parrots and Crimson Rosellas love to chew the foliage and cut off the growing tips of the plants. In summer the rapid growth of the plants soon overcomes the bird pruning. The bright pink flowers are spectacular all spring and summer and the foliage makes a very attractive ground cover.



Carpobrotus glaucescens 'Aussie Rambler'

Another slightly taller compact plant is *Westringia* 'Deeppurple'. This plant was found growing near Wild River, NSW and its species is unknown. It is advertised as a small plant only 50cm or so high and wide, although it does get a bit larger in our garden. It flowers bright purple all year round with a burst of flowering in spring. It is a compact shrub with attractive foliage and seems to need very little care.



Westringia 'Deeppurple'

One would not think of eremophilas as being very hardy to frost but some are. While eremophilas will grow in poor sandy soil with little water, many will grow into very decorative plants in the garden with richer soil and some water. We do add sand to the plant hole and mix it with the soil to ensure good drainage, but eremophilas seem to do well in our heavy clay once established. We have had good success with *Eremophila* 'Fairy Floss' which is a hybrid between *Eremophila maculata* and *E. racemosa*. *Eremophila* 'Fairy Floss' grows to around 2 metres high by 1.5 metres wide and has bright green foliage and candy pink flowers. It seems to do well in full sun or light shade. Many of the *Eremophila maculata* selections perform well for us. For example, *Eremophila maculata* 'Compact Lemon' is a spectacular plant, growing to about 1 metre by 1 metre, with a profusion of soft yellow flowers. *Eremophila maculata brevifolia* is a small shrub with bright pink flowers which is very tolerant of frosts and dry conditions. Like most eremophilas, pruning makes the plants denser and seems to encourage flowering. *Eremophila maculata* x *E. viscida* is another successful 1 metre by 1 metre plant. We have tried many of the grey leaved eremophilas, even grafted ones, with little success. We have better luck with the *E. maculata*, *E. racemosa* and *E. glabra* plants.





Eremophila 'Compact Lemon'



Acacia 'Burgundy Cascade'

There are many larger shrubs that perform extremely well in our garden. Several acacias are amongst the best. *Acacia boormannii*, which we keep pruned 2 metres high, is tough and flowers densely in spring but forms a green backdrop the rest of the year. Small birds enjoy the fine foliage. *Acacia* 'Burgundy Cascade' is the one cultivar of *Acacia cognata* which copes with heavy frost. This plant grows to 3 metres x 4 metres in our garden, with attractive weeping foliage which turns burgundy in the cold. We would not be without the outstanding silver foliage of *Acacia covenyi* or Bluebush in our garden. This small tree, rare in the wild, from Deua National Park, NSW, grows to 6 metres high and puts on a magnificent display of gold ball flowers in the spring.

Another three wattles which provide a show for us are *Acacia* 'Lemon Glow', a cultivar of *Acacia howittii*, *Acacia spectabilis* or Mudgee Wattle and *Acacia subulata*.



Above and left: *Acacia covenyi*

Grevilleas form the backbone of our garden as they flower right through the winter, providing food and shelter for the birds. Ben's favourite plant is *Grevillea* 'Lady O', bred at nearby Bywong Nursery by Peter Ollerenshaw and named for Peter's mother. This plant is never out of bloom in our garden with cheerful red flowers all year. It is painful to prune, as you know you are cutting off many flowers.



Grevillea 'Lady O'

Grevillea 'Poorinda Queen' is a robust bush, 2 metres x 2.5 metres, which also blooms for a long period with apricot flowers. A variegated sport of *Grevillea* 'Poorinda Constance', *Grevillea* 'Waverley Ghost', arose in the nursery of the Victorian State Schools Horticultural Society in Glen Waverley, Victoria. This showy plant, 1 metre x 2 metres, has stable, light green variegated foliage and deep red flowers over a long period.

Among the smaller shrubs, a prostrate spreading *Grevillea lanigera* cultivar called 'Woolly Bear Hero' is a low growing (30cm) coastal selection that spreads to about one metre. It has very dark green dense foliage and seems impervious to frosts. It flowers profusely for much





Grevillea 'Waverley Ghost'

of the year and is very attractive and useful in a small space. Another excellent prostrate grevillea in our garden (2 metres wide) is *Grevillea 'Carol Ann'* with bright red flowers.

Myoporum floribundum is an unusual plant which grows to 3 metres x 4 metres, with long drooping aromatic fine leaves along the branches, with rows of white flowers along the top of the branches in spring. This plant gives a 'Japanese' effect in the garden.



Myoporum floribundum

Hakea macreana is a dependable plant in our garden, growing quite large, 4 metres x 4 metres, with soft weeping foliage and plenty of white flowers in spring. *Leptospermum scoparium 'Fantasia'* is the only leptospermum in our garden which flowers over a long period. We are not usually keen on double flowering plants, but will make an exception for 'Fantasia' with its light pink flowers which darken with age.



Hakea macreana



Leptospermum scoparium

Pimelia nivea has a marvellous compact shape, 1.5 metres x 1 metres, dark green shiny foliage with silver backs and numerous white flowers in spring and early summer as can be seen below.





Many of the banksias do very well in our garden, particularly *Banksia* 'Yellow Wing' which is a cross between *Banksia* 'Giant Candles' and *Banksia spinulosa* 'Birdwire'. This shrub is rather open in habit and has many very prominent large flower spikes.



Banksia 'Yellow Wing'

Another Banksia that does well is *Banksia* 'Bulli Baby' which is a cultivar of *Banksia ericifolia nana* which as the cultivar name implies was found in the Bulli area. It is a very upright plant that displays its flower spikes prominently.



Banksia 'Bulli Baby'

Of course, there are many other plants which perform well in our garden under frosty, dry conditions but those above are some of our favourites.



A Tribute to Ruth and Colin Charlesworth

Article and photos by Ruth and Colin Charlesworth and Max Jahn

Max has been a member of Australian Plants Society South Australia (formerly SGAP) since 1959 and his father, Vic Jahn, was the inaugural president of the Society. Max is also involved in assisting in conservation parks in Adelaide and the York peninsula.

Ruth and Charles have been members of the Australian Plants Society for 21 years, attending the Para Districts regional group, as well other environmental groups around Williamstown.

'Perroomba', Aboriginal for wattle, is the name of Ruth and Colin Charlesworth's property at Williamstown, in the hills 45 kilometres northeast of Adelaide, SA.

Their extensive, wholly Australian native plant garden, is the product of 20 years of loving, tender care and has been both challenging and rewarding. The garden is mainly the brain-child of Ruth, who selects



The view from Ruth and Colin's front patio.



and raises many of her own plants. Colin is an essential part of the garden structure, doing much of the harder work, but also enjoying his 'chooks'.

The five-acre (2 hectare) property is situated on a gently sloping hill, the soil of which is mainly sand, 'just like the beach'. The unusual shape of the block means they have a very large fence line which is very hard to keep repaired. It does not keep rabbits or foxes out, and large pine trees on the edge of neighbouring properties shade parts of the garden. Many variety of weeds need constant attention.



As soon as you arrive at Perroomba, a beautiful weeping *Acacia baileyana* 'Prostrate' greets you.

A big plus is the good drainage through the sandy soil, which is necessary for many Australian plants. However, the sandy soil lacks nourishment and is water repellent, requiring wetting agents. Many plants take longer than usual to establish, and constant watering is required during that time.

Williamstown has a Mediterranean climate which means hot and dry summers. Annual average rainfall is 690mm (27 inches).

In recent, extremely dry summers flowering has been erratic and unpredictable. Some plants die while others spring back in more moderate seasons.



Melaleuca filifolia



Acacia denticulosa



Rodanthe chlorocephala ssp. *rosea*





The choice of plants is very important as there are many that do well under these sandy conditions. Favourites are:

Banksias



Banksia ashbyi



Banksia spinulosa



Banksia attenuata

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Banksia repens

Dyandras



Above: *Dryandra quercifolia*
 Left: *Dryandra obtusa*



Verticordias



Verticordia mirabilis



Verticordia chrysantha



Some trees have been planted by grandchildren, and have plaques showing the youngsters' names.

Others have been planted by special visitors.

Ruth directs her visitors to look inside many of the bushes to find the flowers, but to take care of the prickly nature of some of the leaves. She tells the children small birds like it that way so they can escape from the larger birds.

The garden contains some native grasses, but not as many as Ruth would like. She has dedicated one area to local plants only.

Some local orchids grow naturally in the garden, as do some fungi.





Ruth and Colin have opened their garden over the years for various local charities mainly for the local Abbyfield Retirement Village, but also for Red Cross and Heart and Cancer Foundations. The garden was opened as part of the Australian Open Gardens Scheme in 2006 and 2008.

Ruth and Colin enjoy the rambling nature of their garden, with the textures, colours and shapes of the foliage as much as the beauty of the Australian native flowers.



Ruth and Colin enjoying one of the frequent 'cuppas' in their 'Rest Awhile' which Colin built.

Ruth enjoys picking bunches of flowers at any time of the year.



Ruth and Colin sold their beautiful property while this article was being compiled.

The 'New' Formal Native Garden

Kath Gadd

Kath is a Landscape Designer and Horticulturalist who specialises in creating Australian Native Gardens. She is based in the Illawarra Region, NSW, and is passionate about encouraging the use of native plants in the landscape. Please see her blog for further information – malleedesign.com.au

When most people think of a formal garden the first images that spring to mind are rows of neatly clipped *Buxus* borders with some *Robinia* topiary and maybe a screening camellia hedge. These are some of the easiest plants to use if you are copying the European template for creating a formal style garden. They are a throwback from our European heritage and they should, by no means, set the standard for a more structured garden style.

It is possible to choose any style or popular trend in gardening and substitute suitable Australian native species as an integral part of the design. In this article, I will discuss how to integrate some of the formal garden design elements into an Australian native garden.

To be honest, I don't like the term 'formal garden' as it connotes something prim and proper, reserved and even conservative – basically the opposite of relaxed. It is, however, a class of garden that has



Two hedges of *Acmena smithii* 'Allyn Magic', two lilly pilli topiaries and *Callistemon* 'Little John' create a beautiful formal garden. Zanthorrea Native Nursery, WA.





been around for centuries and relates well to some of Australia's older architecture and heritage. The simple, structural nature of the formal style beautifully complements both traditional and contemporary houses.



The Christina Kennedy Garden, Horse Island, NSW, is an excellent example of where a formal garden complements the traditional home. The garden beds mirrored on either side of the entrance steps create a harmonious balance. Two grafted standard *Grevillea* 'Royal Mantle' are the statement plants with other low-mounding natives like dwarf *Banksia spinulosa* and *Baeckea virgata* 'Dwarf'. The veranda is framed with the beautiful weeping habit of *Baeckea linifolia*.

There are elements of a formal garden style that can be incorporated into a native garden giving the garden a contemporary edge.

For example, the practice of topiary pruning on selected native species will give your garden overall shape and structure – try pruning some low to medium sized hedges into balls or spheres.

In their book, *Native: Art and Design with Australian Plants*, the authors, Kate Herd and Jela Ivankovic-Waters, state that:

Many native species can withstand more rigorous horticultural techniques, such as topiary shapes, pleached or hedged structures, espaliers, patterned displays and copse configurations. They offer refreshing expressions of formal design principles, as seen increasingly in contemporary landscape gardens and public spaces.



Myoporum parvifolium creates a lovely dense spill over and the *Baeckea imbricata* have been pruned into feature balls. Geilston Bay, Tasmania.



Layered hedges of *Hibiscus insularis* in the background with *Westringia fruticosa* clipped tightly in front. Mt Annan Botanic Gardens, NSW.





Another way to achieve formality in the landscape rather than by intensive pruning is by using mass planting of single species and creating layered heights in garden beds.

In Ben and Ros Walcott's garden in Canberra, ACT (below), *Rhagodia spinescens* has been mass planted and clipped to an undulating form to create a clean open space, simulating a body of water.



The strong forms of a grafted *Grevillea* standard combined with dwarf *Banksia spinulosa* species and grevillea groundcovers provide a feeling of symmetry and balance to the sculptures in Christina Kennedy's garden.



Melaleuca hypericifolia 'Ulladulla Beacon', Gynea lilies and *Baeckea virgata* 'Dwarf' complement the formal clean lines of the pond in Christina Kennedy's garden.





The use of Callistemon 'Great Balls of Fire' (background) combined with *Acacia baileyana prostrata* (foreground) at the Christina Kennedy garden shows how striking contrasting foliage can be.

A formal garden is also restricted in its choice of plants with flower colour as a secondary element in the design. This suits native plants well as they possess a vast range of foliage colour, shape and texture.

One of the biggest attractions of formal gardens is that they are designed to look good all year round. This is another reason native plants are perfect in formal gardens as they are mainly evergreen.

Formal gardens are often planned around 'features' that are strategically placed to bring a feeling of symmetry and balance, incorporating sculpture or art into the garden can both enhance the plants and add extra visual interest.

Water is often used as a feature in formal style gardens, which can be in the form of a water bowl, birdbath or pond. The beauty of water is that it adds an extra element to the design and helps to soften an area of sharp lines with its peaceful appearance and tranquil sounds. In formal gardens, water is best contained in a structure such as a pond with clean edges, a pot or even a pool staying central to the design with symmetrical edging

Reference: *Native: Art and Design with Australian Plants*, Herd, Kate and Ivankovic-Waters, Jela, 2017 Thames and Hudson, Australia.

Terra Australis Garden at the National Arboretum, Canberra

Ben and Ros Walcott

Ben is the President of the Australian Native Plants Society (Australia). We are both working with a team to provide local knowledge of plants that thrive in Canberra and help with the planting of the garden.

The National Arboretum in Canberra, opened in 2013, features 100 forests of rare, endangered and symbolic trees from around Australia and the world. It has become a national tourist destination even though many of the trees are still young. However two of the forests are nearly one hundred years old. More than 44,000 trees from over 100 countries are growing across the 250 hectare (618 acre) site, making it one of the world's largest living collections of rare, endangered and significant trees.



Sculpture of the handwritten title to the poem My Country by Dorothea Mackellar

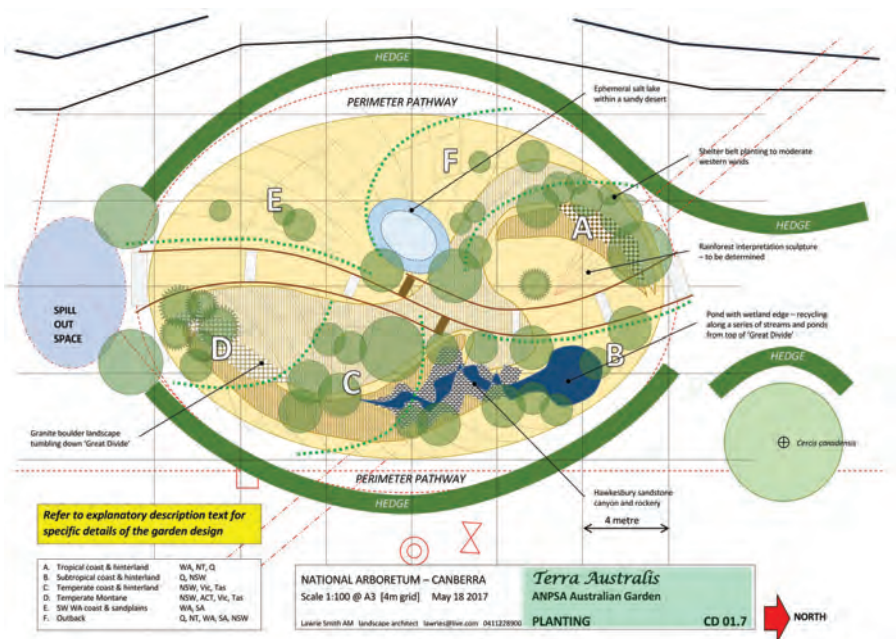
The National Arboretum is in the process of creating a 'Gallery of Gardens' which is a chain of seven gardens spread along a hillside from the main Visitors Centre. These gardens have been developed to raise awareness of, or pay tribute to, a range of Australian charities and community groups through a garden. The Australian Native Plants Society (Australia) (ANPSA) has secured one of these gardens, the *Terra Australis* Garden, as a wholly native plant garden featuring attractive modern cultivars and hybrids of Australian native plants.

The design for the garden is an oval shape 30 metres x 20 metres, surrounded by a hedge. Lawrie Smith, who designed the Roma Street Parklands among many other botanic gardens, is leading the design team. Australian native plant expert Angus Stewart is working with nurseries to encourage donation of the plants while we, and others, will provide local knowledge of what will grow in Canberra on that site. We think this is a wonderful opportunity to not only show the public how attractive native plants can be but to encourage more people to use them in their own gardens.





The plan for the garden should appeal to all regions of Australia as there will be representative plants from most areas. The garden design concept takes the basic form of the Australian continent – the oval garden represents the island coastline and the Great Dividing Range which sweeps across the continent from north to south, physically expressed in an appropriate landform. Within this geographic form, the design philosophy is to create and interpret our continent with plants known to be suitable to withstand the rigours of the Canberra climate. The intent is to invite the viewer to explore the flora of Australia by meandering along the central pathway from north to south (or vice versa) crossing the Great Divide to experience a representative selection of the flora from the regions traversed. The Great Divide is represented on the plan in dark yellow for the gentler slopes and brown where they are steeper. Similarly, the perimeter pathway recalls the voyage of discovery and exploration around the coastline by many mariners.



The design also incorporates three distinct geological formations of basalt, sandstone and granite, plus a waterway, shown in dark blue, of a coastal river system flowing down through a sandstone gorge to a pond that is suggestive of east coast bays and harbours. In the centre is an ephemeral dry lake shown as a light blue oval.



View from behind the *Terra Australis* Garden towards the Margaret Whitlam Pavilion with Black Mountain in the background.



View across *Terra Australis* Garden site toward Dairy Farmers Hill.

It will be difficult to create a palette of plants that represent the diverse climates and soil types of Australia using new cultivars and hybrids that are available in the nurseries. Canberra has significant frosts and can be very hot in summer. The site of the garden is very exposed to wind until the surrounding hedge grows up which will take some time.





Pimelia nivea

We know, however, that some plants such as *Acacia argyraea*, which is found only in the northern coastal regions, and *Pimelia nivea*, which comes from Tasmania, both do well in Canberra so we expect it will be possible to have representative plants from all regions.

The goal is to have a selection of plants that will appeal to the many visitors from around Australia and encourage them to use native plants in their gardens at home. The plants

will be pruned, fertilised and watered and thus be maintained as a formal garden. The Arboretum will hire a full-time gardener who will maintain the gallery of gardens as well as the event terrace gardens. Maintenance will be done initially in consultation with volunteers, but the appointment of a full-time gardener ensures that maintenance is ongoing and does not depend on volunteers in the future.

We are very grateful for the support, both financial and moral, that most of the regions of ANPSA have shown toward this project. We feel that it will be a lasting legacy for ANPSA and will show visitors and residents alike the beauty and usefulness of Australian native plants in their gardens.



A striking metal sculpture of an Australian wedgetail eagle on its nest, at the National Arboretum. The sculpture sits at the top of Dairy Farmers Hill, which provides a wonderful panoramic view of the Arboretum. Photo: John Aitken

Buzz pollination and 'Bee-purple'

Jim Barrow

Jim spent nearly 40 years working for CSIRO and 'retired' as a Chief Research Scientist in 1992. Post retirement he continued his scientific work but also devoted time to his wildflower interests. He is a past president of the Wildflower Society of Western Australia and recipient of the Wildflower Society Award.

Fans of David Attenborough (just about every wildflower enthusiast) will remember him talking about buzz pollination. To demonstrate it, he brings a tuning fork, tuned to the correct frequency, up to the flower in order to induce it to eject its pollen.

The tuning fork mimics the action of several species of bee that also vibrate their wing muscles at the appropriate frequency and this causes the anthers to shed their pollen. These flowers don't provide nectar; the pollen is the reward. About 400 species of plants on the south west WA, are buzz pollinated. Several species of native bee, such as the blue-banded bees, can do it. Honeybees cannot, but bumblebees can. The anthers of buzz pollinated flowers are typically long and thin and have a pore at the top end. This flower structure is common in *Solanaceae* species including tomato – and this is why growers of glasshouse tomatoes would rather like to import bumble bees into mainland Australia.

If you are to rely on buzz pollination, you need to attract the appropriate bees to your flower. It is therefore a good idea to adopt a common colour scheme and a similar structure. Many buzz pollinated flowers mimic the *Solanum* colour scheme, that is, blueish-mauve petals (and



Solanum symonii showing typical *Solanum* colour scheme.



Cheiranthra filifolia is an attractive member of the Pittosporum family. For obvious reasons, its common name is Finger Flower or Five Finger Flower. Not, as I read in one brochure 'Singer flower'.





Calcectasia narragara, Star of Bethlehem (left) is a member of the Dasypogon family. *Conostephium pendulum*, Pearl Flower, (right) is a member of the Erica family. Its flowers hang downwards in common with several other winter-flowering plants – an adaptation to keep the pollen dry in our wet winter.

sepals for monocots) and bright yellow anthers. These colours are used by plants in widely differing families. (Football fans will have noticed that these are the colours of the West Coast Eagles.) Buzz pollination also occurs in *Conostephium* (Pearl Flowers) and there the colour scheme is white and purple. (These colours are also used by that other WA football team. That must have some significance!)

However buzz pollination also occurs in yellow flowers such as *Hibbertia*, *Senna* and *Labichea*. And that poses a problem. Why are blue and yellow flowers used by many species but yellow flowers used by others?



Left *Hibbertia huegelii* and right *Labichea punctata*, These plants often grow near each other and probably use the same pollinators.

Before trying to answer this question, I had better tell you a little more about these three genera.

Hibbertia will be familiar to you. It is a genus with about 120 species in Australia and about 85 in Western Australia. The genus takes its name from George Hibbert (1757–1837) an eminent merchant and

amateur botanist. Here, in the south-west, there would be few patches of bushland without at least one species of *Hibbertia* present. For all but three species of *Hibbertia*, the flowers are yellow. For the three exceptions, they are shades of orange.

Senna and *Labichea* are both legumes. This just means that their fruit is a pod like that of a pea. This large family used to be called Leguminosae so that, in common with other large and important families such as the grass, the carrot, and the cabbage families, it broke the rule that families are to be named after the type genus but with the ending changed to 'aceae'. These errant families have now been brought into line. For the legumes, the type genus is *Faba* and so the family becomes Fabaceae.

The *Senna* genus has had a complex taxonomic history. For a long time, it was included in *Cassia*, and Australian species were thought to belong to that genus. That is why the common name of many of the species is as a *Cassia*. For example, *Senna artemisioides* is known as Silver Cassia.

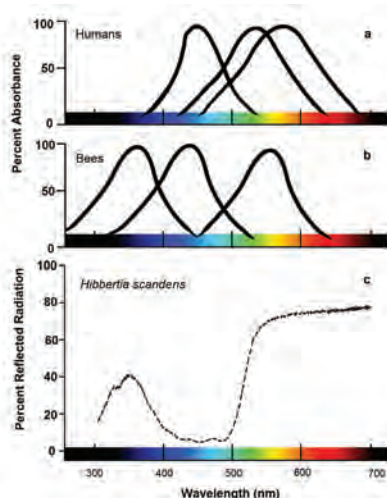


As currently recognised, *Senna* has about 350 species with about 80% of them occurring in America. WA has about 40 species, mostly occurring outside the better-watered areas of the south-west. The 'standard' number of stamens is 10. However, in many species, three of them are infertile and the remaining seven may be modified so that two deposit their pollen on the back of the bee and the others provide her with the reward.

Labichea is a much smaller genus with about 14 species nine of which occur in Western Australia with the remainder in Queensland and the Northern Territory. It is named for Jean Jacques Labiche, second lieutenant of Uranie on Freycenet's voyage. It differs from *Senna* in that there are only two stamens. Of our nine species, only two are common in the south-west. These are *L. punctata* (with anthers of similar size) and *L. lanceolata* (with one anther bigger).

You may not have noticed these plants. It is easy to walk past them thinking the flowers are 'just' another *Hibbertia*. And that is worth thinking about. Why the similarity? To have produced such similarity, there must have been a very strong selection pressure and considerable advantage to the plant. This selection pressure was exerted by bees who also recognise the *Solanum* colour pattern. The answer to this question may be in the way that bees and humans perceive colour.





Left: Comparison of human vision with bee vision and with the colour spectrum of *Hibbertia scandens*.

Parts a and b redrawn from: www.cals.ncsu.edu/course/ent425/tutorial/colorvision.html.

Part c redrawn from: Parallel evolution of angiosperm colour signals: common evolutionary pressures linked to hymenopteran vision. Dyer et al. (2012).

Bees and humans both have three-colour vision. However, we see different parts of the spectrum. Bee vision is shifted to shorter wavelengths; they do not see red and for them the longest visible wavelength is yellow, but they see well into the ultraviolet down to wavelengths that are invisible to us. When we see a mixture of the long wavelength red, and the short wavelength blue, we interpret the resulting colour as purple. When bees see a mixture of their long wavelength, which is yellow, and their short wavelength ultraviolet, they also interpret it as a different colour which is sometimes referred to as 'bee-purple'.

How many of these 'yellow' flowers are really bee-purple? We don't know. We do know that the few that have been tested all qualify. Dyer



We see the flower on the right but bees see something like the flower on the left (*Hibbertia scandens*).



Hibbertia scandens (also previous page) is widely grown in Perth, both in gardens and as amenity planting. It is well adapted to sandy soils where it grows vigorously. It has been imported without its natural pests and one seldom sees a chewed leaf, but neither does one ever see fruit. Perhaps this is due to absence of pollinators or perhaps the plants are all one clone so there is no cross pollination. In contrast, in its home range north of Newcastle, NSW, (left) it fruits, but has badly chewed leaves. Right: close-up of the tips of the anthers of *Hibbertia scandens* showing the tiny pores.

(1996) included 6 species of *Hibbertia* and one *Cassia* (Now referred to as a *Senna*). All reflected UV light from their petals but not from their anthers and would therefore appear to bees something like the picture above. For them, the colour scheme is 'supersolanum'.

Vicki Powys is well known as an expert in recording bird song. She has recently turned her attention to recording the pitch of bees buzzing pollinating flowers of *Hibbertia obtusifolia*. Because pollen can be released in response to a tuning fork it is sometimes thought that release only occurs within a narrow frequency range. In fact she found that some bees released pollen by buzzing at about 200 Hz; others buzzed at about 300 Hz. To put you on the scale (!), the frequency of 'middle C' is 261 Hz. The seven species of bees that visited the flowers ranged in size from 5 mm to 18 mm. One might think that the bigger the bee the lower the pitch but in fact the biggest bee buzzed at the highest frequency.

Further reading

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Dyer, AG, Boyd-Gerny S, McLoughlin, S, Rosa, MGP, Simonov, V, Wong BBM (2012) Parallel evolution of angiosperm colour signals: Common evolutionary pressures linked to hymenopteran vision, *Proceedings of the Royal Society B: Biological Sciences* 279(1742):3606-3615

Powys, V (2016) Buzz-pollination of *Hibbertia obtusifolia* by Australian native bees – a comparative study of bee buzzing behaviour in Capertee Valley, New South Wales. caperteebirder.com/web_documents/powys_australian_bees_090117.pdf





How the Growth of Vegetation is Powered by the Sun

Doug Rickard

Doug admits his knowledge of plants is limited. However, he understands heat and temperature as he spent his working life in industrial and scientific measurement and control, writing technical papers and conducting training on measurement, including measurement of temperature and heat.

Without solar radiation there would be no life on earth

Solar radiation provides the light, heat and energy essential for all life on earth. Without solar radiation this planet would be a cold, bleak, lifeless place. We are the right distance from the sun to receive just the right amount of solar radiation to allow life as we know it to exist. The part of the solar radiation essential for life is in the infrared, visible light and ultraviolet regions of the spectrum. Infrared radiation (heat) makes up 49.4% of the solar radiation that reaches the surface of the earth, visible light 42.3% and ultraviolet just over 8%. Although dry air is virtually transparent to this solar radiation, not all of it gets through the atmosphere to reach the earth's surface. Some of it is absorbed, reflected or scattered by particles in the atmosphere while more is reflected back into space by clouds. Infrared radiation is also readily absorbed by the water molecules and the small amount of CO₂ in the atmosphere. This converts some of the infrared radiation to heat before it reaches the surface. The amount that this radiation heats the surface depends on its colour – the darker it is, the warmer it will get. However, some of the infrared that reaches the surface is reflected back through the atmosphere and is lost into space. The more CO₂ in the atmosphere the greater this heating effect – this is the greenhouse effect and global warming.

At the other end of the spectrum, much of the ultraviolet radiation from the sun is absorbed by the ozone layer and very little of it reaches the earth's surface. This absorption is of critical importance to all life on earth. Without it, the high-energy ultraviolet radiation would cause a lethal dose of sunburn, and also severely damage the cellular structures of our bodies and all other living things – including plants.

Solar radiation provides the energy that drives all plant growth

Solar power is a potential solution to producing power with no global warming emissions. However, plants have been using solar power for hundreds of millions of years. Powered by the light and heat of the sun, plants produce about 100,000 tonnes of new vegetation every minute. But what mechanism drives this phenomenal growth?

Plants absorb water and nutrients through their roots and have to convert them into the substances they need to make new growth, fight diseases and make repairs. The plant roots suck in moisture from the soil. The plant then transports it up to the leaves where photosynthesis in the chlorophyll molecules produces glucose for the plant's energy. Both of these processes are powered by sunlight.

In sun-loving plants these processes are more efficient at higher levels of solar radiation while in shade-loving plants they are more efficient at lower levels. In general the leaves of sun-loving plants are small and thick, while the leaves of shade-loving plants tend to be thinner and longer and have a larger surface area to absorb more of the available solar radiation which makes it easier for photosynthesis to occur in low light.

Solar radiation and its role in getting water to the leaves

There is still much scientific debate on exactly how plants manage to get water from their roots up to their leaves. The ability of plants to suck water, sometimes to heights over a hundred metres, is remarkable. The Cohesion-Tension theory is generally accepted as the theory that best explains how plants do this. The theory relies on the exceptional cohesive and adhesive properties of water, the structural properties of plants and the role of evaporation (transpiration) from leaves – and the driving force is solar radiation. The warming of the leaves results in the opening of the stomata (pores) in their surfaces allowing the transpiration of the water in the leaves. This triggers the process that sucks more water into the roots which then moves up to the leaves through the xylem of the plant. This explains why plant growth is greater in the warmer summer than it is in cold weather or when the conditions are cloudy when the stomata are closed or only partly open. Globally the amount of water transpired by plants is roughly double that which flows in all the planet's rivers. In very hot weather the stomata close to reduce water loss, an essential attribute for survival in hot, drought conditions.

Solar radiation and its role in photosynthesis

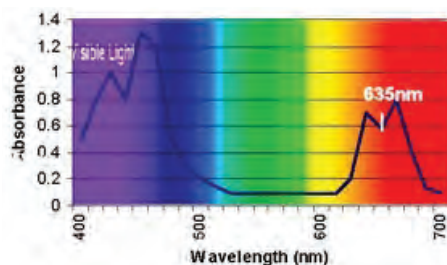
The chlorophyll molecules in the leaves require heat for the process of photosynthesis to start. As the leaves warm up air enters through the open stomata. The active chlorophyll molecules then convert the carbon dioxide (CO₂) in the air and the water (H₂O) in the leaves to glucose (C₆H₁₂O₆). The waste products of this process are oxygen (O₂) and water (H₂O) – which both escape back into the atmosphere through the stomata. Release of the glucose by the chlorophyll molecules triggers a complex sequence of chemical reactions that produce all the plant's building blocks. Although increased temperatures speed





up photosynthesis, too much heat can be detrimental. Above a certain temperature photosynthesis slows down and the stomata may close.

At night and on cold or sunless days the stomata close because not enough heat energy from the sun is being received to continue photosynthesis.



The absorption of visible light by chlorophyll molecules

The main driver of photosynthesis is visible light in the high-energy blue/violet end of the spectrum and to a lesser extent light in the lower energy orange/red end. Very little of the green part of the spectrum is used and it is simply reflected by the chlorophyll molecules which is why both chlorophyll and plant leaves appear green.

Solar radiation and air temperature

As air is virtually transparent to all wavelengths of light it is only indirectly heated by solar radiation. While dry air does not get heated by the infrared radiation, the surface of the earth does. Air is a poor conductor of heat so only the cooler layer of air in contact with the warm surface of the earth heats up and this is by conduction rather than radiation. This layer of air, now warmer and less dense, rises and cooler more dense air sinks to the surface where it too gets heated and rises. This means it takes time for all the air to warm up. Although the temperature of the surface of the earth is at a maximum about midday when the sun is directly overhead, it takes about 2 to 2½ hours for the temperature of the air above to reach a maximum.

Solar radiation and soil temperature

The temperature of the surface of the topsoil can vary greatly during the day. In Sydney in the middle of a summer's day the bare surface of dry soil can get to over 65°C. In early February during Daylight Saving Time when the sun was highest at about 1pm I measured the surface and air temperatures in my garden and the maxima where:

Shade air temperature	33.4°C at 3.25pm
Bare soil surface temperature	58.9°C at 1.13pm
Soil surface temperature under 5cm of mulch	27.3°C at 1.11pm
Bare rock surface temperature	60.1°C at 1.08pm

However, the soil temperature about 50cm below the surface was 17.3°C. It remained steady throughout the night although the air and soil surface temperatures had dropped significantly.

Soil temperature is key to plant growth

Plant root growth is a maximum when the soil temperature is between 25 and 28°C. The root growth of plants from temperate areas virtually ceases when the soil temperature drops below 7°C (12 to 16°C for plants from tropical areas). But soil temperatures above 35°C are lethal to plant roots as well as to all the creepy crawlies in the soil.

As the feeder roots of plants are searching for moisture in the topsoil and as temperatures above 35°C are lethal to them, it is important they are kept away from the hot surface of the soil. Make sure that any watering gets the water down deep into the soil. Light watering will encourage the roots to grow near the surface where they could be exposed to lethal high temperatures on the next hot day. A 5cm layer of mulch will help to suppress weed growth and significantly reduce the surface temperature of the soil (see figures above).

Don't cook your pot plants

In hot weather, infrared radiation can rapidly heat up a pot, particularly a black plastic pot. The soil and the roots also get hot which can cause plant death. Put the pot in the shade or put it inside another larger pot. Put some stones in the bottom of the pot to encourage air flow under the inner pot. Raising the outer pot on pot feet lets cooler air enter as the air in the space between the pots heats up and rises. Cover the surface with mulch to stop the sun heating the soil. White gravel reflects the most heat.



Solar radiation and bushfires

Bushfires occur when high levels of infrared radiation result in high air temperatures and low relative humidities, the drying out of leaf litter and reduced moisture content of plants. As soil is a good thermal insulator, bushfires rarely heat more than just the top few centimetres of the surface layer. The seeds of many native plants have evolved to need a bushfire to germinate and the ash from bushfires contains about 4% potash which is largely responsible for many native plants flowering profusely after a bushfire.



