The Banksia Garden
A Handbook for Volunteer Guides

The Banksia Garden handbook

Compiled by ANBG Volunteer Guides

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Cover: *Banksia baxteri,* ANBG (Baxter's or Bird's Nest Banksia)
Photo: Pam Rooney ©

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The Banksia Garden in the Australian National Botanic Gardens

In April 2020, the Australian National Botanic Gardens (ANBG) celebrates its 50th anniversary with a wonderful new offering to its visitors – a new Banksia Garden. The Garden presents an opportunity to learn more about this incredible group of plants, and wonder at their beauty and diversity. The Garden also showcases the adaptations banksias have developed over 60 million years.

The primary focus of the Banksia Garden is on members of the genus prior to the addition of *Dryandras.* The content of this Handbook reflects that focus.

Banksias and the name of our continent

The ANBG shares its 50th birthday in 2020 with the 250th anniversary of Lieutenant (later Captain) James Cook's landing in April 1770 on Dharawal country, at a place called 'Kundul' and later Botany Bay. This was an important event for Australian botany, as Joseph Banks and Daniel Solander with their 'botanical zeal' were on board Cook's vessel, HMB Endeavour. The confluence of these two anniversaries reminds us that, if Carl Linnaeus the Elder had had his way, the new Banksia Garden would be in the Banksian National Botanic Gardens, and we would all be 'Banksians'. At right is the extract from correspondence from Linnaeus to John Ellis, an English naturalist, in which he proposes that the continent then known as 'Terra Australis' should be renamed 'Banksia'. (Figure 1)

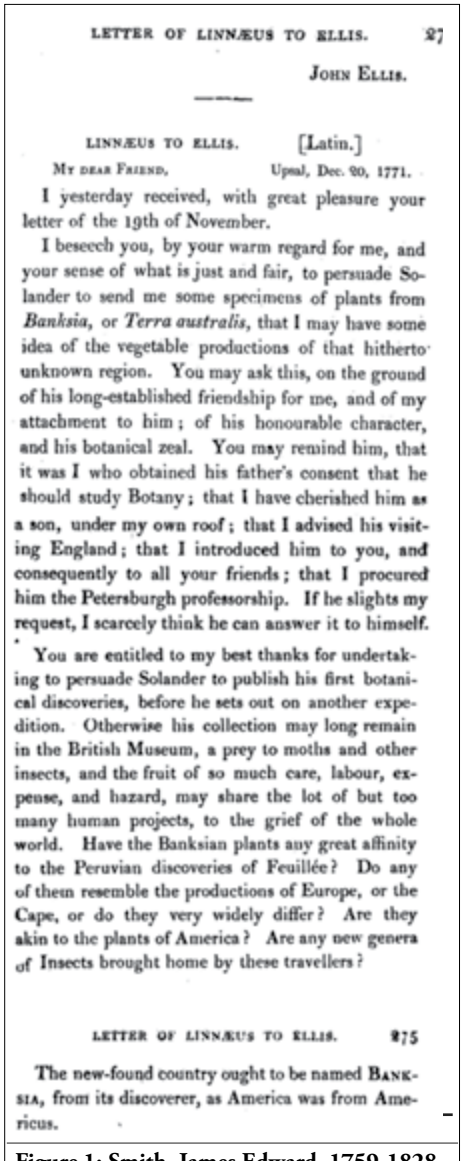
Banksias and the ANBG

Banksias have starred in the logo of the ANBG since 1978. The logo has changed three times and the current logo has been in place since 2011 and features a generic banksia flower. Banksias have been in the ANBG plant collection since the late 1940s.

AUSTRALIAN NATIONAL BOTANIC GARDENS

Of these early plantings, ANBG Plant Records has advised that two banksias have progeny still alive in the Gardens (Table 1).

At present, neither plant is readily accessible. Section 191c is at the top of the Sydney Basin and the plant is in the middle of the bed. Section 128 lies between the road behind Pollen (within the gated area) and the Bottom Depot.



LETTER OF LINNÆUS TO ELLIS. 27

JOHN ELLIS.

LINNÆUS TO ELLIS. [Latin.]

MY DEAR FRIEND, Upsal, Dec. 20, 1771.

I yesterday received, with great pleasure your letter of the 19th of November.

I beseech you, by your warm regard for me, and your sense of what is just and fair, to persuade Solander to send me some specimens of plants from *Banksia*, or *Terra australis*, that I may have some idea of the vegetable productions of that hitherto unknown region. You may ask this, on the ground of his long-established friendship for me, and of my attachment to him; of his honourable character, and his botanical zeal. You may remind him, that it was I who obtained his father's consent that he should study Botany; that I have cherished him as a son, under my own roof; that I advised his visiting England; that I introduced him to you, and consequently to all your friends; that I procured him the Petersburgh professorship. If he slights my request, I scarcely think he can answer it to himself.

You are entitled to my best thanks for undertaking to persuade Solander to publish his first botanical discoveries, before he sets out on another expedition. Otherwise his collection may long remain in the British Museum, a prey to moths and other insects, and the fruit of so much care, labour, expense, and hazard, may share the lot of but too many human projects, to the grief of the whole world. Have the Banksian plants any great affinity to the Peruvian discoveries of Feuillée? Do any of them resemble the productions of Europe, or the Cape, or do they very widely differ? Are they akin to the plants of America? Are any new genera of Insects brought home by these travellers?

LETTER OF LINNÆUS TO ELLIS. 275

The new-found country ought to be named BANKSIA, from its discoverer, as America was from Americus.

Figure 1: Smith, James Edward, 1759-1828 (compiler). A selection of the correspondence of Linnaeus, and other naturalists, from the original manuscripts. Volume 1 (pp 273-275), Cambridge University Press, 2014

New Wow Banksias Walk

To complement the younger plants in the new Banksia Garden, a new themed walk – the Wow Banksias Walk – has been prepared, to showcase some interesting mature specimens of banksias around the ANBG. The mature plants are wonderful in their own right, and give visitors an idea of the growth habits of different species and the full life-cycle of flower heads and adaptations to fire etc that will not be apparent in the younger plants for a few more years. The walk contrasts different species and highlights the diversity within the genus.

The notes for this walk can be found under Botanical Themes in the Special Walks part of the Guides Web.

These notes can be used as a whole walk route, or as part of a more general guided walk, perhaps taking visitors to the new Garden and some older plantings elsewhere in the ANBG.

The development of the Banksia Garden in the ANBG

The *Banksia* genus is already a very special year-round showy feature in the Gardens. The idea of having a dedicated site where all of the variability and drama of the genus could be brought together and displayed presented an irresistible challenge. The Garden provides opportunities to expand horticultural knowledge and to preserve threatened and endangered *Banksia* species.

The Banksia Garden displays around 90 banksias from all around our nation - the largest collection of banksias on the eastern side of Australia, noting that only one banksia occurs naturally in the ACT, *Banksia marginata.*

Table 1: Early Banksia plantings in ANBG

Species	Progeny accession	Section	Original parent (OPAR) accession	Year OPAR was propagated or collected
Banksia marginata	8100708.1	191c	ANBG 50686.2	1950
Banksia spinulosa	681149.1	128	ANBG 52609.1	1952

Eastern species and some Western Australian (WA) species have been successfully grown in the ANBG over many years. However, establishing so many different WA species presented special challenges since many are notoriously difficult to grow away from their natural habitat. Cutting-edge developments in grafting techniques and the preparation of growing media provided the knowhow to make the dream a reality.

The formation of the Banksia Garden has been a collaborative effort. A generous donation from the ANBG Friends made this project possible. Material for propagation of plants for the Garden has come from ANBG collections, specialist native plant growers such as Kevin and Kath Collins from the WA Banksia Farm, Phil Trickett and Catriona Bate on the south coast of NSW, specialist native seed suppliers such as the Seed Shed in WA and the Australian Seed Company in NSW.

The site

The ANBG team selected the old Banks Loop as the site for the Banksia Garden. The site was overdue for renewal and provided a readily accessible location for visitors. It had the potential to provide suitable growing conditions for banksias within the constraints of the Canberra climate. Its slope assists in supplying the groundwater requirements of different species of banksias, from those that prefer very good drainage to those that require damper conditions. Mature trees were removed to ensure that the plants would receive sufficient sunlight and air circulation.

The pre-existing circular pathway of the old Banks Loop provides the general structure of the new Garden. The gradient of the pathway is suitable for visitors using wheelchairs. The design incorporates sitting-height walls on which visitors may relax, surprise points where particular species are highlighted and opportunities where the special features of more subtle species can be appreciated at close quarters. There are also larger spaces for groups, including school children or special events and celebrations, such as weddings. Lighting has been installed for night-time usage.

Very large mounds are a feature of the higher side of the Garden. These provide exceptionally sharp drainage for some WA banksias, and also a vertical display canvas to showcase plants better. The soil composition in these mounds is designed to control groundwater levels. The lower side of the Garden has damper sites for those which require closer access to groundwater.

The relationship between fire and banksias is one of the key themes of the Garden. Other themes include the *B. spinulosa* complex, adaptations and variability within the genus, the relationship between animals and banksias and the Banks/Solander story. Interpretive signage throughout the Garden will focus on these themes.

The Garden includes a fire pit and seating area in the middle of a spiral inspired by the Periwinkle house design of Victorian architect, Alistair Knox. Gardens staff will use the fire pit to demonstrate that fire opens banksia follicles. Carrying on the story of the interaction between these plants and fire, a burnt banksia installation creates drama at the bottom of the Garden. It features twisted banksia skeletons left after fires in the Booderee National Park on the south coast of NSW. This installation creates a linkage to the fire theme illustrated in the neighbouring Treehouse.

A circular artwork forms the centrepiece of the main courtyard of the garden. It has the imprints of 498 leaves from thirteen different species of banksias. The leaves are arranged in a radiating pattern, based on the structure of a banksia inflorescence. This work highlights the variation in leaf shapes within species as well as between species in the genus.

Coping with Canberra's climate

To provide protection from Canberra's below-zero temperatures in winter, north-facing thermal walls of different heights have been built. These structures also provide protection from strong winds for more fragile species. Some frost-sensitive species will be grown in large movable pots, that can be placed under shelter when necessary.

WA *Banksia* species are adapted to Mediterranean rainfall patterns of wet winters and hot dry summers. Normal summer rainfall in south-west WA is only 25-100mm total, whereas Canberra's summer rainfall is usually much higher and thunderstorms can dump large amounts of moisture. There will be no overhead irrigation of plants, only drippers will be used to control soil moisture.

Propagation and selection of plants

In preparation for the final selection of plants to go into the new Garden, the horticultural team was busy for over two years propagating plants from cuttings and seeds. Many WA species (28) have been grafted onto eastern states rootstock so that they will be more adaptable to the conditions in Canberra. The grafted plants include some species at risk in the wild from threats including dieback, such as *B.brownii.*

In 2018/2019 around 25 species of these new plants were planted out into a special trial-site near the Main Path. The trial-site had high mounds of layered substrate.[1] The horticultural team tested whether particular species did best at the top of a mound, or half-way down or at the bottom. They also tested whether they grew better with a mulch of banksia leaves or not. The eighty per cent survival rate of these trial plantings was remarkably high, although the first winter in-ground in 2019 was comparatively mild for Canberra. Some of the plants that were lost showed strong root development, indicating that they were establishing well, even though they did not survive. The losses are thought to have been due to too much moisture in the soil in summer.

A year-round display of banksias

The final plant list was determined by the availability of planting material, the likelihood of success in the new Garden, the goal of maintaining displays throughout the year, and representation of different characteristics of banksias such as growth habit, colour, geographic and/or taxonomic spread and historical connections.

The planting plan was based on the particular horticultural requirements and growth habit of each species. The interpretive themes underpin the overall design of the Garden and highlight particularly showy or interesting species at various viewing points. Some parts of the Garden display only WA species, some only eastern states species, and other parts have both. Plants in pots will be able to be moved in and out of the Garden so that they can be displayed in peak condition.

Visitors to the Banksia Garden will come away with an understanding of the wide diversity within the *Banksia* genus, where they are found in the wild and how they have adapted to changing conditions over the last 60 million years. They will be able to appreciate different stages in the development of flower heads, fruiting bodies and follicles (the woody dry fruits that split open to release seeds). The Garden demonstrates the cutting-edge skills of ANBG team in creating a wonderful display and preserving these remarkable plants.

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Image 1: *Banksia solandri* is a key focus in the Banksia Garden due to the significance of its name which commemorates both Joseph Banks and Daniel Solander, who was a student of Carl Linnaeus, and accompanied Banks on the Endeavour. First collected by William Baxter in 1847, it was described by James Drummond as having 'leaves more than nine inches long, and about five wide, irregularly jagged and sinuated like those of an English Oak'. It is closely related to *B. grandis*.

The species is categorised as Priority Four – Rare, and is found only in the Stirling Ranges. It is killed by fire and takes more than 5 years to produce flowers, and longer to produce a good canopy of seeds, so is vulnerable to overly-frequent fires. It is also highly susceptible to *Phytophthora cinnamomi*. It can be grafted onto *B. integrifolia* and the plants in the Garden are grafted specimens. The flower heads smell strongly of coconut, cherry and musk and Kevin Collins of WA reports seeing them being covered in moths at night. http://anpsa.org.au/banksSG/banksiasg-9-1.pdf

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Image 1: Smith, James Edward, 1759-1828 (compiler). A selection of the correspondence of Linnaeus, and other naturalists, from the original manuscripts. Volume 1 (pp 273-275), Cambridge University Press, 2014

https://books.google.com.au/books/about/A_Selection_of_the_Correspondence_of_Lin.html?id=UNYMAAAAYAAJ&printsec=frontcover&source=kp_read_button&redir_esc=y#v=onepage&q&f=false

1 The mounds are capped with gravel, over a layer of ash, with a base of chunky sandstone G65 medium.

Naming of banksias

Fossil record

Banksias have been on the Australian continent for at least 60 million years. Fossils of the cones and leaves of extinct banksias have been found in deposits in many places in Australia. Some have been given names including *Banksia archeocarpa* (Image 2) which was found in the Kennedy Range in WA and is dated at around 45 million years old. Today, only *B. ashbyi* is found nearby, with the Kennedy Range being too far north for other WA banksias. Another fossil banksia cone found near Maree in South Australia has been named *B. longicarpa,* while cones found in brown coal in Victoria resemble *B. marginata*.

Older fossils of pollen and leaves resembling banksias have been found dating from 70 million years ago and have been named as *Banksieaidites, Banksieaephyllum* and *Banksieaeformis.*

Aboriginal names for banksias

When the first people arrived in Australia over 50,000 years ago, they would have encountered banksias in many parts of the continent. Banksias have different names in different languages. In the Canberra region, the Ngunnawal people call them *dhulwa.* The people of western Victoria call the banksia tree *wuuriwuuit*, which was also used as a woman's name. In southwest WA, Noongar names include *bool-galla* which means 'many fires' (*boola*, many or plenty + *galla* or *kalla,* fire) and refers to people using dead flower cones for carrying and making fire. In South Australia, *B. ornata* is called *yelakut* by the Ngarrindjeri people of the Coorong. *B.ericifolia,* which was one of the plants collected by Banks and Solander, is called *wadanggari* (pronounced 'wa-tang-gre') by the Eora and Darug inhabitants of the Sydney basin. In 1992, this banksia was named as the official plant for Sydney as part of the city's 150th anniversary celebrations. In Arnhem land, Aboriginal groups use a variety of names for *B. dentata,* now known locally as the Swamp Banksia. These include *guibu, rilirdili, enindurrkwa* and *gulpu*.

Kenneth J. McNamara ©

Image 2: The oldest fossil fruit of *Banksia archeocarpa,* found in the Kennedy Ranges. It has some of its follicles missing or broken, suggesting predation by some prehistoric cockatoo ancestor. https://www.wanaturalists.org.au/reports/fossil-plants-of-the-darling-range-and-beyond/

Kenneth J. McNamara ©

Image 3: Fossils of Nothofagus and Banksia leaves found together in Walebing in the Wheatbelt near Moora, WA. The rainforest has long disappeared from WA, leaving only species adapted to poor soils and the drying out of the continent that commenced 25MYA, such as those in Proteaceae family. http://www.wildflowersocietywa.org.au/news-and-views/western-australian-fossil-plants-and-climate/

Early European collecting of banksias

The first official collection of banksias by Europeans was made by the botanists Banks and Solander, who were on the HMB *Endeavour* with Lieutenant Cook. They sighted the east coast of Australia for the first time around the middle of April 1770 but sailed northwards for 10 days before landing. The trees of the Coast Banksia, *B. integrifolia* and the Saw Banksia *B. serrata* may have been visible through their telescopes as they sailed along close to the coast. As they were probably in bloom, they could have been impressed by the large flower spikes.

Prior to this the early Dutch explorers like Wilhelm de Vlamingh may have seen local banksias in southern WA.

Joseph Banks and Daniel Solander collected five species of banksias in 1770. The first four were collected at Botany Bay (Image 5). They were the Coast Banksia (*B. integrifolia),* the Heath Banksia (*B. ericifolia*), the Swamp Banksia (*B. robur*) and the Saw Banksia (*B. serrata*). Later, a fifth species, the Tropical Banksia (also known as the Swamp Banksia), *B. dentata*, was collected at Endeavour River in Queensland. They were new plants to Banks and Solander. Four of these specimens were officially described and named by Carl Linnaeus the Younger in 1782 who gave the genus the name *Banksia*. As *B. serrata* was the first one described, it is considered the type specimen for the genus.

Banksia robur was not officially named until 1800 by the Spanish taxonomist, Antonio Cavanilles, from a specimen collected by Thadeo Haenke and Luis Née on the Malaspina expedition in 1793. Cavanilles also named *B. marginata* and *B. oblongifolia* and the type specimens of these plants are in Madrid.

Further collections of banksias were made on the voyage of HMS *Discovery* led by the British naval commander George Vancouver circumnavigating the world in the 1790s. The name *B. menziesii* commemorates Archibald Menzies, surgeon-naturalist on this vessel, who collected plants at Joseph Banks' request, and turned specimens over to him on his return to England. Once British settlement was established in Australia, large numbers of botanical specimens including new banksia species, were sent back to Britain. French expeditions also collected banksias, with the botanist Jean de Labillardiere collecting the first of the prostrate species, *B. repens*.

Robert Brown, who sailed with Matthew Flinders, made substantial botanical collections which included the stunning Scarlet Banksia, *B. coccinea* (Image 4) and the Woolly Banksia, *B. baueri* both of which have been displayed at various times in pots near the Visitor Centre at the ANBG. Brown also named *B. solandri* which commemorates both Banks and Solander (Image 1, p6).

Pam Rooney ©

Image 4: *Banksia coccinea* - '… the beautiful scarlet stamina forming such regular and exact rows as to make it more desirable than any of the Genus yet discovered …' (note by Peter Good at King George Sound, Dec. 1801)

As the colonies expanded, more and more banksias were collected, particularly in Western Australia. By the time George Bentham published his *Flora Australiensis* in 1870, 51 species of *Banksias* were listed. In their 2008 book *Banksias*, authors Kevin and Kathy Collins and Alex George listed the tally of species at 78 with 9 subspecies and 11 varieties.

Joseph Banks

Banks was one of the most influential men of his time. He sponsored many naturalists on voyages of discovery to all parts of the globe, fostering an increased interest in the natural world.

Joseph Banks was born in 1743. On gaining his inheritance when his father died in 1761, he followed his lifelong interest in exploration, botany and natural history. In 1766 he travelled to Newfoundland and Labrador as an independent naturalist. Shortly after his return in 1767 he was elected a Fellow of the Royal Society.

In 1768, he obtained permission to accompany Captain James Cook on an expedition to Tahiti organised by the Royal Society to observe the Transit of Venus. This expedition on HMB *Endeavour* (1768-1771) was to become Cook's first voyage of discovery.

Banks joined the ship with a staff of eight: Daniel Solander and H. D. Spöring, naturalists; Alexander Buchan and Sydney Parkinson, landscape and natural history artists; James Roberts and Peter Briscoe, tenants from Revesby; Thomas Richmond and George Dorlton (Dollin), servants. Only four of this party survived the voyage; Banks himself, Solander and the two Revesby men. Banks probably contributed at least £10,000 towards the voyage. He took a large collection of reference books, as well as equipment for collecting, studying and preserving natural history specimens.

The expedition collected specimens from South America, Tahiti and New Zealand before reaching Australia in 1770. The first landing was at what was later named Botany Bay on the 28th April and from there, they proceeded

to explore the east coast of Australia up to the Torres Strait, making landfall 14 times. Six weeks were spent at Endeavour River, Cooktown, when the ship was being repaired. Extensive botanical collections were made. Some of the original botanical specimens collected by Banks and Solander are now preserved in the Australian National Herbarium in Canberra. These specimens were used by Parkinson to make his original sketches.

Banks maintained a lifelong interest in the Pacific, in particular Australia. He promoted the establishment of colonies on the east coast of Australia, and after the founding of the settlement at Port Jackson, he became, through his myriad of contacts, the acknowledged expert on matters relating to the colony of New South Wales. He encouraged further exploration of the area and corresponded with a wide range of people, including the first four governors of the colony.

Banks held many influential posts. He became President of the Royal Society from 1778 until his death in 1820. He was one of the founders of the Royal Horticultural Society, Superintendent of the Royal Botanical Gardens at Kew and a member of the Board of Longitude. He was a Trustee of the British Museum and his herbarium became one of the foundation collections of the museum's botanical department. Banks has become known as 'the Father of Australian Botany' acknowledging his important role over more than 40 years of his life in the collection and investigation of Australian plants. Over this time he commissioned David Burton, George Caley, Robert Brown, Allan Cunningham and George Suttor to collect Australian plants for addition to the Kew Gardens and his own collections.

Because of his keen interest in the colony, Banks has also been called 'the Father of Australia'. Bankstown and the Canberra suburb of Banks were named after him. There is a monument to his memory at Kurnell and the north headland of Botany Bay was named Cape Banks by Cook. His name has been commemorated in the plant genus, *Banksia,* and in the name of some Australian plant species, eg a red spider flower (*Grevillea banksia*), the seaweed known as 'Neptune's necklace' or 'Bubbleweed' (*Hormosira banksia*), a sundew (*Drosera banksia*,) a wild pepper (*Piper banksia*) and the Tenterfield Woollybutt (*Eucalyptus banksia*).

Image 5: Herbarium specimen sheet of Banksia Type specimen of *B. serrata* and also of *B. ericifolia,* collected by Joseph Banks and held in the National Herbarium of Victoria.

From a presentation at the International botanical congress 2011 Symposium 133 by Doug Benson. *The Banksian Legacy: Botany Bay and the plants collected by Banks & Solander: a benchmark for 18th century scientific collecting,*

***'Dr Solander and myself went a little way into the woods and found many plants.'* Extract from Banks diary, 29 April 1770.**

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Banksias, botanical features —what makes a banksia?

Proteaceae

The banksias sit in the family Proteaceae named after its type genus, *Protea* from South Africa. Many members of this genus are well known for their large and colourful flower heads. The genus *Protea* was named in 1735 by Carl Linnaeus after the Greek god Proteus, who could change his form at will, because the proteas have such a wide variety of forms. Later, in 1809, the name *Protea* was taken up by Robert Brown to typify the family. Of the 79 genera in the Proteaceae family, 46 occur in Australia. The remainder are mainly South African or South American. There is a great diversity of form within the family, but the floral structure is distinctive. (See diagram of *Banksia marginata* flower, figure 2)

Banksias

Taxonomy

By 2007 botanists had recognised 78 species of *Banksia*, the spectacular Australian wildflower genus named in honour of Sir Joseph Banks.

Until then, it was thought that *Banksias* and *Dryandras* had evolved separately. But, on February 26, 2007, Dr Kevin Thiele and Dr Austin Mast found evidence from DNA and other laboratory-based analyses to support the addition of the 93 members of the Western Australian endemic genus *Dryandra* to the *Banksia* genus giving 171 species. In other words, *Dryandras* and *Banksias* have a shared ancestor, and thus Dryandras are a subgroup of *Banksia* rather than a separate genus. This new understanding of the relationships between the two groups has been accepted by all Australian herbaria and the name *Dryandra* was replaced by *Banksia,* reflecting this new understanding.

The decision to incorporate *Dryandras* into the *Banksia* genus is still contentious. Many native plant enthusiasts and nurserymen have resisted the merging of the two genera and wait to see if the change of name becomes widely adopted.

Interestingly, the DNA analysis found some lineages previously within *Banksia* to be closer to *Dryandra* than to each other – for example, *Banksia serrata*, the type species in the genus found on the east coast from Queensland to New South Wales and Victoria and extending to Tasmania, is more closely related to the Western Australian *Dryandra* than to another widely distributed eastern Australian species, *B. integrifolia.* (An excellent explanation of this can be found on *Florabase*, the website of the Western Australian Herbarium, Department of Biodiversity.) The alternative response to the new evidence would have been to divide *Banksia* into a number of new genera, which probably would not have been easy to distinguish morphologically.

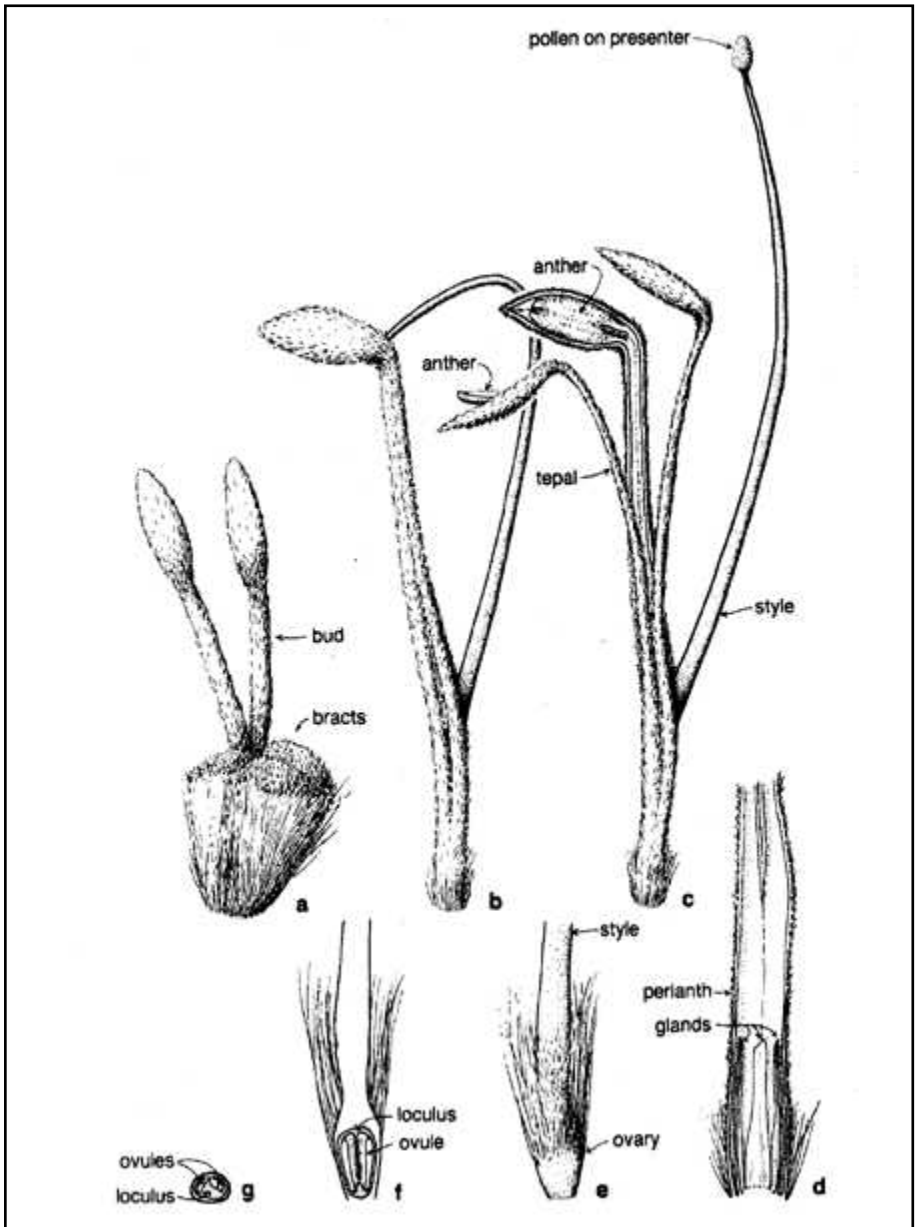

Figure 2: *Banksia marginata;* **a) two flower buds with subtending bracts; b) flower bud at anthesis, side view; c) flower, side view; d) base of perianth, internal view; e) ovary and base of style, side view; f) as in (c) but longitudinal section; g) Transverse section ovary. (Clarke & Lee)**

Distribution

Southwest WA contains the greatest diversity of banksias, with 60 species recorded (plus the 93 *Dryandras* which are found only in southwest Australia).

The tropical *B. dentata* is the only banksia to be found outside Australia. It is the most widely distributed and occurs across northern Australia, in Papua New Guinea, Irian Jaya and the Aru Islands, and is the only species common to both eastern and western Australia.

The remainder occur in eastern and southeastern Australia. Few banksias are found in arid regions or in the rainforests of the eastern coast.

Plant form

Banksias are usually woody shrubs or trees. Some have a prostrate form (eg *B. blechnifolia*). Others can be handsome trees up to 25m tall (*B. integrifolia* and *B. seminuda*).

There are also variations in form within species: for example, *B. integrifolia* may be upright or prostrate.

Leaves

The diversity of leaf shapes of banksias is remarkable (figure 3) and new leaves are often covered with colourful hairs usually rusty brown. Leaves may be small and thin (eg *B. ericifolia)* or thick and leathery (eg *B. serrata*). The leaf margins are often toothed and are always without stipules (small outgrowths at the base of a leafstalk).

The shape of the leaves may be a key identifying feature and is often reflected in the species name, eg *B. serrata* (from Latin, *serratus*, serrate or saw-edged; referring to the leaf margins); *B. integrifolia* (from Latin, *integer*, entire - having a smooth edge without any indentations; and *folium*, a leaf; refers to the entire margins of the mature leaves); *B. blechnifolia* (from *Blechnum*, a genus of fern and from the Latin *folium*, a leaf; the leaves resemble this fern); and, *B. praemorsa* (from Latin, *praemorsus*, as if bitten off; refers to the leaf tips). This diversity is beautifully demonstrated in the circle of leaves pressed into the courtyard paving.

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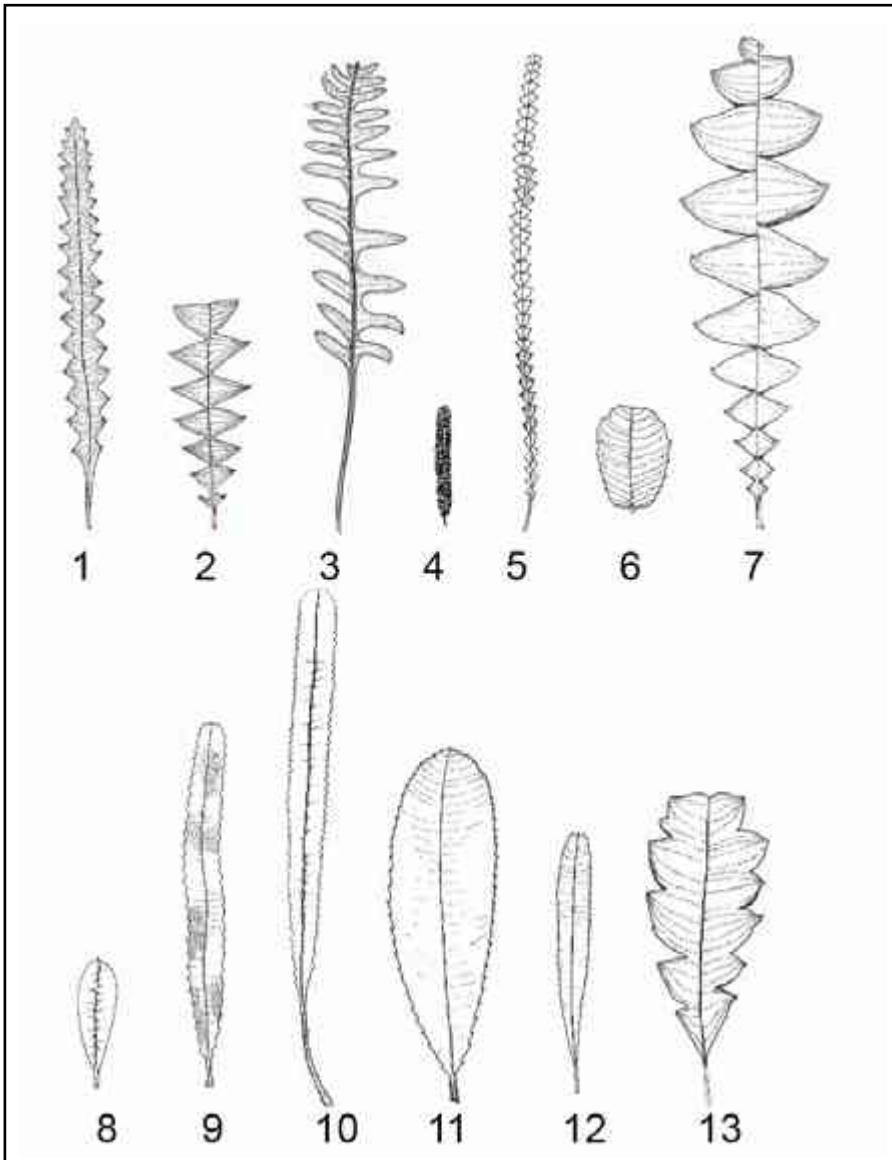


1.	***B. ashbyi***	*8.*	***B. integrifolia***
2.	***B. baxteri***	*9.*	***B. menziesii***
3.	***B. blechnifolia***	*10.*	***B. petiolaris***
4.	***B. brownii***	*11.*	***B. robur***
5.	***B. candolleana***	*12.*	***B. serrata***
6.	***B. coccinea***	*13.*	***B. solandri***
7.	***B. grandis***		

Figure 3. Diverse leaf shapes, *Banksia* leaves used in ANBG Banksia Garden courtyard circle[1]

1. Image modified from: Banksia Atlas, Instruction Booklet And Supplementary Field Guide, by Anne Taylor and Stephen D. Hopper pp 30-31

Flowers

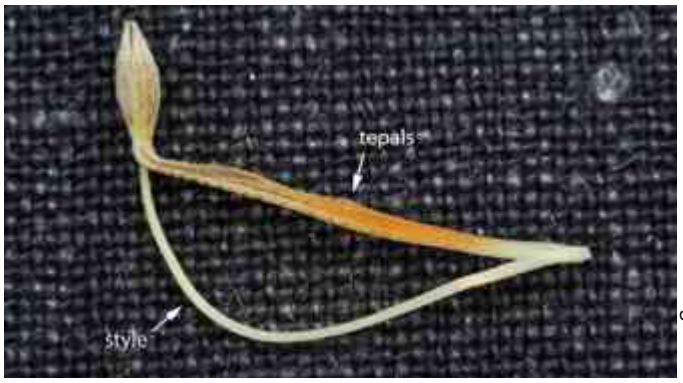
There is a great diversity of form of flower heads within the *Banksia* genus, and this expanded with the incorporation of *Dryandra*s into the genus.

In general terms the genus *Banksia* can be broadly characterised into three groups, based on the arrangement of the flower clusters:[2]

- Flowers arranged around a vertical axis, giving the familiar cylindrical inflorescence (previously classified as Banksia subgenus *Banksia).*
- Flowers are arranged in cone-shaped clusters without bracts (previously classified as *Banksia* subgenus *Isostylis*).
- Flowers are arranged in cone-shaped clusters surrounded by overlapping, scale-like bracts which often form a conspicuous part of the inflorescence (previously classified as genus *Dryandra)*

Flowers are produced in pairs in densely crowded flower heads. Some form massive cylindrical shapes eg *B. grandis* and may contain between 3000 and 6000 flowers. Most are erect although several WA species have pendulous flower heads eg *B. nutans.* Some banksias hold their flower heads conspicuously on the ends of branches, but others are held low to the ground to attract different pollinators. Some banksia flowers are arranged in a spherical or globular shape eg *B. sphaerocarpa* and B. *laevigata* (the Tennis ball Banksia), and some have a dome shape eg *B. illicifolia* (the Holly-leaved Banksia) and *B. cuneata* (the Matchstick Banksia). Individual flowers exhibit the typical Proteaceae structure.

2 http://anpsa.org.au/banksia1.html



Paul Whitington ©

Image 7. Individual flower dissected

Paul Whitington ©

Image 8. The stigma, covered in pollen it has picked up from the adjacent stamens, sitting in the cap formed by the tepals.

Paul Whitington ©

Image 9. Style and stigma pulled away to show the pair of stamens in this half of the flower more clearly. Pollen grains everywhere!

Paul Whitington ©

Image 6. Each flower consists of a bundle of tepals (four in a bundle) with a grey cap. The yellow stalk that projects from the base of the grey cap is a style.

Paul Whitington ©

Image 10. As the style continues to lengthen, it eventually pulls right away from the flower cap becoming the pollen presenter.

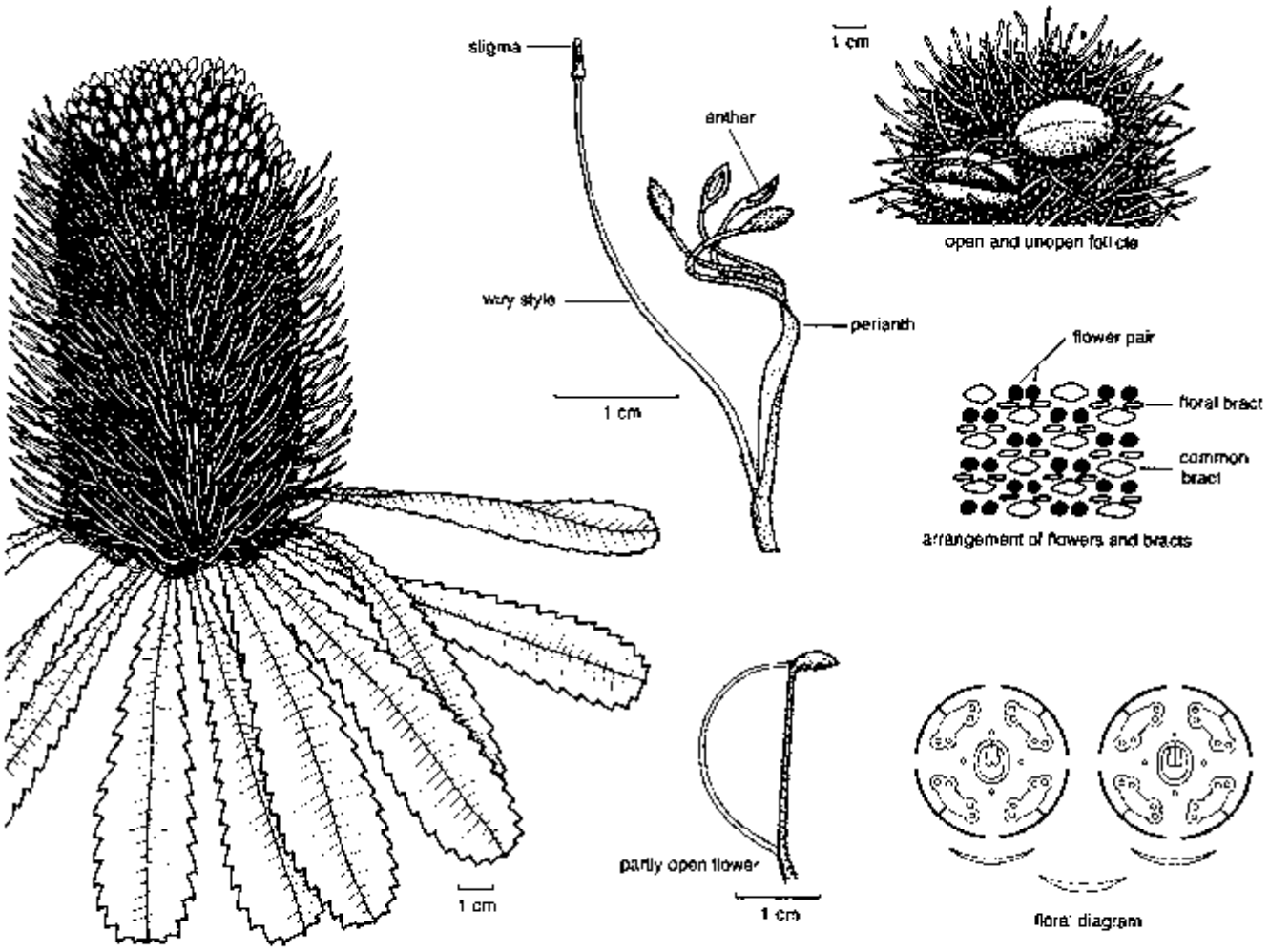


Figure 4: ***Banksia serrata***

Artist: © Murray Fagg

The perianth tube consists of 4 segments (tepals) which split to reveal the style. The tip of each segment contains an anther and pollen is transferred from the anther to the stigma just before the flower opens. The style grows longer than the perianth and is initially trapped by the upper perianth parts. These are gradually released over a period of days, either from top to bottom or from bottom to top. At this stage the stigma is not receptive which avoids self-pollination. As the flower opens, the stigma is released and pollen is presented to pollinators (honeyeaters, insects or small mammals). Once the pollen is removed the stigma becomes receptive. (Figure 4: *B. serrata* by M. Fagg)

The set of images of *B. serrata* (Images 6 - 10, p.12) are reproduced with kind permission of by Paul Whitington of Wonboyn, and can be found with further explanation on his website, *Southern Forest Life*. https://southernforestlife.net/happenings/2018/1/11/flowering-of-two-species-in-the-proteaceae-an-iconic-gondwanan-family

Banksia flowers are most often a shade of yellow, but orange, red, pink and violet flowers also occur. The colour

Pam Rooney

Banksia buds showing the paired arrangement of flowers

of the flowers is determined by the colour of the perianth parts and often the style. When the styles and perianth parts are different colours, the visual effect is of a colour change sweeping along the spike as flowers open. This is spectacular in *B. prionotes* (Acorn Banksia) as the white flower head in bud becomes a brilliant orange.

Pollination

European honeybees and also Australian honeyeaters are frequently seen visiting banksia flower heads. Visits by mammals, including marsupials, are less often observed as these are usually nocturnal.

Karlo Taliana ©

***Banksia menziesii* and Western Spinebill**

Pam Rooney ©

New Holland Honeyeater on *Banksia* Giant Candles, ANBG, showing pollen dusted onto the top of the beak and around the face

Pollination by birds

Bird pollinated flowers like banksias are often brightly coloured, are not usually perfumed, produce abundant nectar and the pollen presenter is remote from the nectar. The flowers are closely grouped. When the bird visits the flower in search of nectar from the base of the flower, pollen is dusted onto its forehead, throat and beak. After the pollen has been transferred the flower becomes receptive to accept pollen from the head of another visiting bird.

Pollination by mammals

Banksias flowers pollinated by mammals also produce copious nectar, many have a strong perfume and the flower head may be close to the ground and often concealed in the foliage. Marsupials and some rodents are known to pollinate banksias.

In WA researchers set up a covert wildlife watching operation in a patch of banksia woodland north of Perth, focused on flowering heads of *B. ilicifolia* (Holly-leaved Banksia) and *B. menziesii* (Firewood Banksia). The camera caught a variety of daytime honeyeaters, spinebills and wattlebirds and night time images showed that it was honey possums (*Tarsipes rostratus*) that worked the pollination night shift. At only 7-10 grams in weight, they are the only marsupial in the world with a diet entirely made up of pollen and nectar. They have a pointy nose and long, brush tipped tongue that function like the beak and tongue of honeyeater birds.

Pollination by insects

In NSW, at Barren Grounds Nature Reserve, pollination of *B. Spinulosa* was studied. The main pollinators were mammals and birds and included the sugar glider, brown antechinus, eastern pygmy possum and eastern spinebill. Although insects including moths and honeybees visited the flowers, they were found to be less effective pollinators than the vertebrates.

Some have distinctive smells

Most banksias have a spicy or sweet scent. For example, *B. solandri* has been described as having a 'sweet and musky' odour, smelling of 'coconut, cherry and musk'. Others smell less sweet: Alex George is reported as describing *B. nutans* as having a 'pungent onion smell' and saying that several species smell like rodents.

Boronia Halstead ©

Distinctive follicles of *B. candolleana* or Propeller Banksia

Boronia Halstead ©

***Banksia nutans* is one of small group of banksias with pendulous flowers (others are *B.aculeata, B.caleyi, B.lemanniana, B.rosserae*). This Banksia is mammal-pollinated – its flower heads are close to the ground, and it has a very interesting smell.**

Some observers have noted that some banksias have a stronger odour at night, possibly to attract nocturnal mammalian pollinators.

Fruiting structures

Usually only a small number of flowers on a flower head set fruit. The fruits are a distinctive two-valved dry and woody follicle, embedded in and often protruding from the woody axis.

Seeds: these take one to two years to mature depending on the species. Each follicle contains two winged seeds and a separator. The wing assists the seed to drift a short distance from the parent plant and the separator serves to prevent the seed falling immediately after a fire. After rain, the wings of the separator close thereby releasing the seed into optimum conditions for germination.

Inside the follicles, banksia seeds can remain viable for many years (up to 17 years in some species). The hard, woody structures are designed to protect seeds from seed eaters, like cockatoos, agents of decay and fire. Serotinous banksias accumulate a bank of seeds inside follicles until fire triggers them to open and release seed. The follicles keep seeds safe from seed eaters, while preserving their viability for a long period. The withered flowers and leaves held by some banksias are fire-enhancing, but the design of the follicles protects the seed inside from the fire. They are held at the back of the follicle furthest away from the heat. The follicles and seed separators inside are made of insulating material and there is a small insulating airgap inside each follicle. The cones have an inner velvety layer of fire-retardant material surrounding the base of the follicles. The follicles are made of three layers of tissue which expand in different ways in response to fire, and the tension between the expanding layers opens the follicle (a bit like a bimetal strip).

Figure 5, *Protecting Offspring against fire* shows follicles and the arrangement of their contents for three different banksias: in the diagrams on the right, follicle valves are blue, seed separator is grey, seeds in white - wings are not displayed, embedment in the cone in dark grey). The orange area indicates areas with direct exposure to flames. Sometimes only one (as in *B. candolleana* here) or no seed is developed.[3]

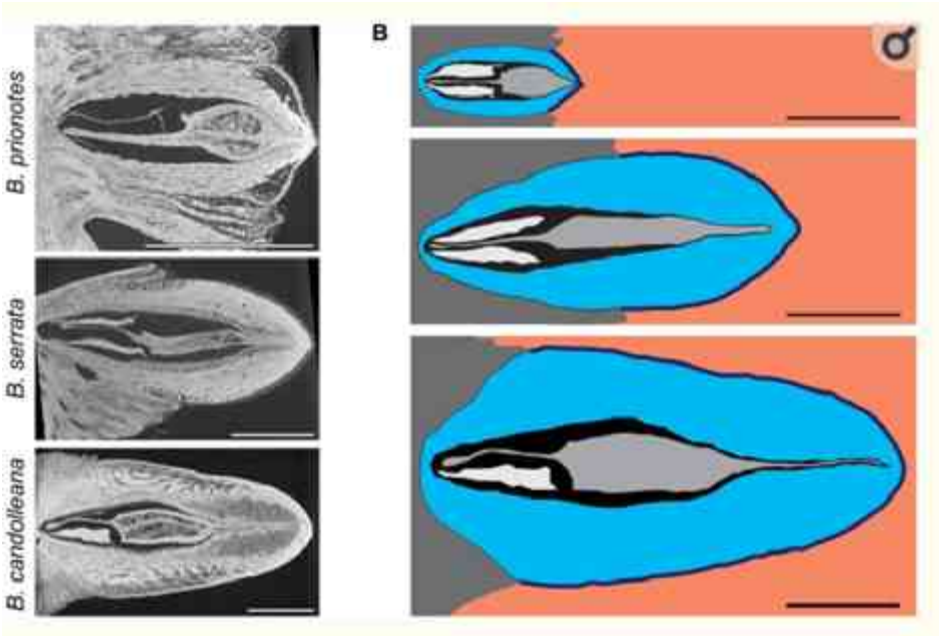


Figure 5: Protecting Offspring Against Fire

Recent research on *B. attenuata*, *B. serrata* and *B. candolleana* follicles reveals that they also have a self-healing wax that melts in hot weather, and mends fissures and nicks that arise over the long life of the follicle, preserving the seed inside. Banksias and other Proteaceae with large follicles may allocate up to 150 times more biomass to these defensive structures than to the seeds inside. Nevertheless, the structures are not totally unassailable: cockatoos time their raids on banksia seeds when the follicles have not yet hardened but the seeds are fat and nutritious.

Another distinguishing feature of the fruiting cone is the retention or shedding of the old flowers. In some the perianth and styles fall off after the flowers fade leaving the axis with its bracts and developing follicles. In other species the perianth and styles persist, often for many years although they may wear away with time.

Response to fire

Banksias respond to fire in a variety of ways as do many other vascular plants. They are often categorised as resprouters or reseeders.

Resprouters may have epicormic shoots under thick and corky bark (eg *B. serrata)* and/or a lignotuber (eg *B. oblongifolia*) from which they sprout after fire. Resprouters can release seed at maturity (eg *B. dentata, B. integrifolia, B. marginata).*

3 Figure 5, *Protecting offspring against fire,* is reproduced with kind permission from Jessica Huss from: Huss JC, Fratzl P, Dunlop JWC, Merritt DJ, Miller BP and Eder M (2019) Protecting Offspring Against Fire: Lessons From Banksia Seed Pods. Front. Plant Sci. 10:283. doi: 10.3389/fpls.2019.00283 https://www.frontiersin.org/articles/10.3389/fpls.2019.00283/full

Reseeders have fire-sensitive stems (*B. coccinea*) with thin bark, often shiny or patterned: these are killed by fire and regenerate from seed. Reseeders hold the mature seed until a fire destroys the plant or dies from other causes. *B. marginata*, *B. ericifolia* and *B. coccinea* are examples of reseeders.

M Fagg, ANBG, APII, ©

B. serrata, **cut section through mature trunk showing thick, corky bark and epicormic shoots, characteristic of resprouters.**

Karlo Taliana ©

Bark of *B. ericifolia* showing thin bark, characteristic of reseeders.

Banksias are phosphorus wizards

Most banksias have evolved to thrive in very nutrient-poor soils, especially those found in southwest WA where soils have been described as among the worst in the world.

Banksias have adapted to Australia's low phosphorus soils by developing proteoid or cluster roots in addition to the main taproot. These cluster roots occur in most Proteaceae and also in other plant families, e.g. some members of the Casuarinaceae family. Species with cluster roots can grow in soils with poorly available nutrients, and most do not form mycorrhizal symbioses. These roots commonly form in the organic matter close to the soil surface. They release bursts of carboxylates to mobilise tiny amounts of bound nutrients in the soil, such as phosphorus, for uptake by the plant.

Phosphorus is a key plant nutrient for altering cluster-root formation: the amount of phosphorus available in the soil directly affects the formation of cluster roots, with their growth suppressed by high levels of this key plant nutrient.

Importantly, banksias have a very poor control over their phosphate uptake and take up far too much when they are supplied with more phosphate. Hence in cultivation it is important to use low phosphate fertilisers (or preferably no phosphate at all) on banksias in order not to poison them and not to suppress the formation of their cluster roots which may lead to micronutrient deprivation, stunted growth, yellowing of leaves and sometimes death of the plant.

Hans Lambers ©

When the winter rains arrive in southwest WA, *Banksia attenuata* will start producing its short-lived cluster roots, seen here just under the leaf litter. These roots are non-mycorrhizal, but release vast amounts of phosphate-mobilising compounds (carboxylates, phosphatases). That is why banksias do so well on dirt-poor soils such as those in southwest WA, where mycorrhizal plants have great difficulty acquiring phosphorus. They likely depend on their cluster-rooted neighbours to make ends meet. — at Alison Baird reserve, Yule Brook, Kwongan Foundation · October 29, 2016 ·

Delayed greening of new leaves – efficient use of small amounts of phosphorus

Many plants can grow new leaves and install the equipment necessary for photosynthesis (chloroplasts) at the same time. This uses a large amount of phosphorus. Banksias and some other plants perform these two steps separately, first building new leaves without the chloroplasts necessary for photosynthesis, then building the chloroplasts in the developed leaves thus achieving both steps using the small amount of available phosphorus. This results in red, rust-coloured or yellow new growth, rather than green. Other members of the Proteaceae family use this strategy, and proteaceae-rich landscapes can look rather autumnal at times as a result.

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Pam Rooney ©

Banksia baxteri: **delayed greening of new leaves, rust-coloured new growth, ANBG**

Threats to banksias

The fossil record shows that banksias have evolved over 61 million years. They came on the scene about 5 million years after the major extinction event that wiped out the dinosaurs. Over this time, banksias have been able to adapt to dramatic changes in climate, sea levels, fire regimes and CO_2 levels.

Different species of *Banksia* occupy particular environmental niches. The distribution and abundance are determined primarily by their ability to tolerate water stress and extreme temperatures in the summer, and to re-establish themselves after disturbance, usually from fire. As the location of their niche environments moved during interglacial/glacial periods, species were generally able to expand and contract their range to adapt.

Banksia populations are now facing a range of human-induced threats around Australia, from land-clearing, disease, changing fire regimes, the removal of groundwater, weed infestation and climate change. The rate of change of many of these threats may well be faster than the rate that would allow many species to adapt and thrive. Some threats are instantaneous and some are enduring, and some are both, such as land-clearing and dieback infection. With encroachment from agriculture and urbanisation and contamination from disease, banksias are much less able to change their range to adapt to threats.

Banksia woodlands provide essential habitats for many other species of animals and plants, some of which are already threatened or endangered. When banksia habitats are lost or at risk, the homes and food of these species go, along with the banksias.

Fire – not too much and not too little

Banksias have evolved to cope with fire but it is important to note that banksias and other plants are adapted not to fire *per se*, but to specific regimes of fire frequency and intensity. Adaptations can be fire tolerant (such as the capacity to resprout), or fire dependant (such as the need for fire to open follicles and release seeds) or fire enhancing (such as the retention of withered flowers and leaves).

Optimal fire regimes

The optimal fire regime varies between *Banksia* species, depending on the length of time it takes to recover (either by resprouting or growing replacement plants from seed) and reach maximum seed production. If the fire interval is shorter than the time it takes the species to reach full maturity, the population will decline. If the fire interval is too long, this can also be a threat to a local population that relies on fire to release canopy-stored seeds for new generations of plants. Generally, longer-lived woody species have longer juvenile periods.

The pattern of fire coverage is also important. Generally, a mosaic pattern of fire is preferred to maintain healthy populations.

The timing of post-fire rainfall is also critical for seed germination and survival of seedlings. For those banksias that depend on fires for seed release, fires need to reach a certain intensity to open follicles.

Resprouters survive fire and regrow from epicormic and/or lignotuberous buds after the passage of fire, as well as regenerating from seeds. Some can be extremely long-lived (*B. candolleana* can live for up to 1,000 years).

The length of the fire interval for resprouters is important. The development of lignotubers takes time and most resprouters do not develop a lignotuber until they are old enough to produce fruit. Resprouters can take up to 4 years to be able to produce viable seed after a fire.

Reseeders: *Banksia ericifolia* is a reseeder. It is killed by fire, has no lignotuber and does not resprout. It regenerates from seed released by the fire's heat. If the fire interval is shorter than the 7-8 years it takes from germination to setting seed, the local *B. ericifolia* population may be eliminated. For *B. spinulosa* var *cunninghamii* (also a reseeder) maximum seed production occurs 15-25 years after fire. Below 10 years, these plants produce almost no seed.

For reseeders, because of the hazards faced through the years from seed release and germination to maturity, a minimum number of viable seeds is required for replacement of a single parent plant. Plants need to have reached a certain age to be able to produce this number of viable seeds. For example, for *B. hookeriana*, up to 200 viable seeds are required to ensure full replacement of the parent plant when conditions are poor (eg low post-fire rainfall). It can take up to 12 years for a plant to achieve this size of seed bank.

Generally, reseeders are more vulnerable to decline and/or extinction from fire and other threats than resprouters. As a result, the mix of *Banksia* species in a location can change over time, depending on the fire regime experienced.

Climate change

Climate change is amplifying the extent of fluctuations in rainfall, temperature and groundwater levels significantly. In southwest WA, since the mid-1970s, annual rainfall has decreased by 30 per cent, and mean maximum temperatures have in-

creased by 0.15 to 0.2 degrees Celsius per decade. It is predicted that temperatures will increase further by 1 to 3 degrees across all seasons and rainfall will decrease by a further 10 to 20 per cent, with more frequent extreme weather events. The *Banksia* genus cannot tolerate drought conditions corresponding to a rainfall of less than 250 mm pa. Some researchers predict that between 5 and 25 per cent of *Banksia* species in southwest WA could become extinct by 2080, depending on climate scenarios.

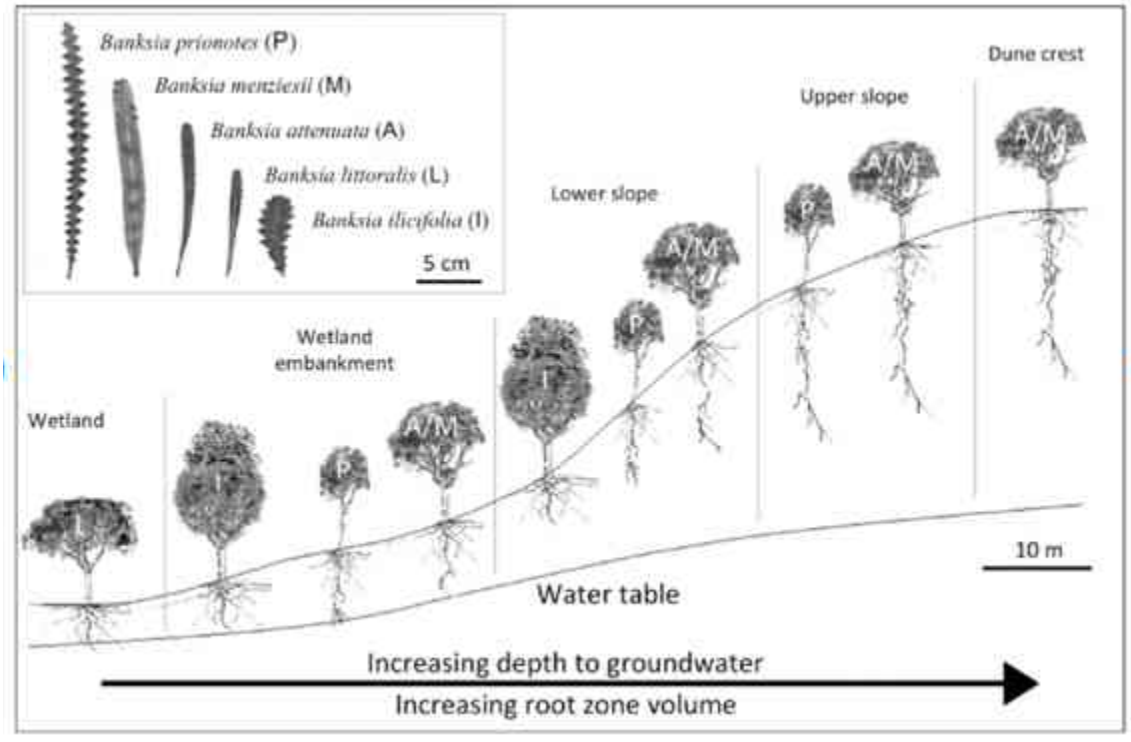
With climate change and associated higher temperatures and reduced rainfall, some regions are becoming more fire-prone and fire frequency is likely to increase. Some banksia habitats are close to urban areas, and the fire interval can be shortened from prescribed burns intended to preserve property and achieve other land management objectives. The catastrophic fires in the summer of 2019-20 may be a foretaste of the dramatic impact of climate change on Australia's flora, including banksias.

Climate change is happening at the time banksias are facing other threats, including the spread of dieback, land-clearing and fragmentation of populations, weed-infestation and the lowering of groundwater. All of these factors reduce the scope of a species to adapt by changing its range.

Changes in groundwater levels

Banksias have naturally adapted to seasonal fluctuations in rainfall, temperature and groundwater levels. Generally, mature plants tolerate the normal seasonal cycle of connection and disconnection of their roots to groundwater supplies. But species vary in how long they can tolerate disconnection and in the depth of their root penetration. *Banksia ilicifolia*, for example, is found on wetland embankments and seems to be more susceptible to stress from atypical lowering of groundwater levels.

Banksia seedlings in southwest WA rely on winter rains and need to get their roots down to reliable supplies



This diagram shows where particular Banksia species are found in different hydrological habitats in one location. Some species (*B. littoralis* - L) have much more restricted ranges than others in relation to groundwater levels. In this case, *B. prionotes* (P), *B. attenuata* (A) and *B. menzeisii* (M) have much broader ranges.

In recognition of this, the Banksia Garden provides mounded sites for species which prefer greater depth of groundwater, and damper sites for those which require closer access to groundwater. The soil composition in the Banksia Garden is also designed to control goundwater levels.

of groundwater as quickly as possible before the dry hot summer arrives. They invest large amounts of phosphorus in seed formation to enable germinating plants to establish and grow deep roots quickly. If the soil dries out before they can establish, they die. *Banksia attenuata* seedlings' roots grow at the rate of 3.5cms a day in the right conditions.

Groundwater decline arises from reduced rainfall and/or groundwater extraction. Lower levels of rainfall as a result of climate change will mean less recharge of and more extraction from groundwater supplies, lowering groundwater levels. Long term lowering of groundwater levels will lead to changes in the species mix, with plants better adapted to very dry conditions replacing those that are more dependent on access to groundwater.

Dieback is a silent bulldozer

Dieback is caused by the spread of a micro-organism called *Phytophthora cinnamomi*. While it is often referred to as a fungus, it is in fact more closely related to algae, and has been described as a 'water mould'. Dieback infection is most likely in moist conditions. It moves downhill rapidly in water and along watercourses, but reproductive structures can survive dormant for long periods in dry conditions.

Phytophthora cinnamomi is parasitic and gets its nutrients from the roots of other plants. It lives in the soil and plant tissue. Its mycelia primarily infest plants' roots and cause them to rot. Water uptake is first affected. Plants can die very quickly or take some years to die.

Phytophthora cinnamomi is present in all Australian states and territories except the Northern Territory, where conditions do not favour its existence. It can establish in areas with average annual rainfall above 600mm pa.

Dieback infection has been around for 50 years in southwest WA (ie it is a relatively recent occurrence) and many species have not developed resistance. It is present in wide areas, including some national parks – over one million hectares are already infected. It is estimated that up to 80 per cent of the Stirling Ranges National Park is infected.

Human activity spreads dieback through the movement of infected plant material, soil and water on vehicle tyres, machinery and footwear, or through movement of contaminated soil, sand and gravel in roadbuilding, earthworks, forestry operations etc.

Management practices to prevent the spread of *P. cinnamomi* into uninfected areas include strict hygiene measures such as:

- cleaning footwear and washing down vehicles and equipment
- use of dieback-free construction materials
- seasonal and permanent road and trail closures, and
- information signs and education.

Banksia communities are particularly susceptible to dieback. Some species are more vulnerable than others, including *B. brownii*, *B. cuneata, B. goodii, B. oligantha* and *B. verticillata*. *Banksia grandis* is one indicator species for the presence of infection as it dies quickly once infected and is a large and conspicuous plant.

Dieback alters habitat structure with flow-on effects on other animal and plant species. It can turn a banksia woodland into a sparse sedgeland with disastrous effects on animals that rely on this habitat and the pollen and nectar produced by susceptible plants for food, such as dibblers, western ground parrots and honey possums.

Land-clearing

Land-clearing for urban development and agriculture has dramatically reduced the area of banksia woodland. It is considered to have had the greatest impact on the conservation status of banksias in southwest WA. Now only 40 per cent of the original woodlands remain. In Victoria, around 25 to 30 per cent of banksia woodland has been cleared for urban development or agriculture.

Banksia habitat often coincides with high population density. The Perth Metropolitan Area is in the middle of the natural range of banksia woodlands in WA and continues to expand from its current long sprawl of 123kms along the coast. As it spreads, more banksia woodland is cleared for housing and infrastructure and the remnants are broken into less viable fragments. Similarly a large part of the original landscape of the Sydney basin would once have been banksia scrub and now only remnants remain.

Banksia survival is dependent upon a healthy ecological community, supporting other plants and animals. These include pollinators such as birds, insects and the iconic honey possum in southwest WA. While there were previously 132 patches of a median size of 10 hectares of banksia woodland on the Swan Coastal Plain, there are now 12,000 patches, whose median size is now only 1.6 hectares. Where banksia habitats are fragmented as a result of land-clearing, pollinators need a connected network of woodland remnants to enable them to move throughout this habitat and perform their function. Plants in fragmented populations produce less seed. Connected populations are also better able to recover from fires and other threats.

The need to protect the banksia woodland ecological community in south-

west WA was recognised when it was listed by the Australian Government as Endangered under the *Environment Protection and Biodiversity Conservation Act 1999 (EPBCA Act)* in 2016. Unfortunately, clearing of woodlands continues despite this listing.

Banksia vincentia – a species under threat

Banksia vincentia is probably Australia's rarest banksia. It belongs to the *B. spinulosa* complex of banksia plants and is related to *B. neoangelica,* found in New England in northern NSW. It has a lignotuber and is a resprouter. It was discovered near Vincentia on the south coast of NSW in 2008 by Jacki Koppman and Suellen Harris who suspected that they had found something very unusual and sent a cutting to the Royal Botanic Gardens for identification. It was formally described in 2014. At the time of its discovery, 14 plants were found in the wild. But that number is now reduced to four, as a result of fire and soil-borne pathogens. Its habitat is also under threat from urban development. It has been identified as a priority species under the Commonwealth's Threatened Species Strategy.

Pam Rooney

***B. vincentia*, ANBG**

To preserve this rare species, a three-point insurance plan has been adopted, including protection of the remaining wild plants, propagating insurance populations of 600 plants from cuttings in botanic gardens around Australia, and storing seeds in seed-banks. The Booderie National Park has propagated 520 plants, to be planted out into an 'orchard' in the Park. Over time, it is planned that more and more of these cultivated plants will be reintroduced into their natural habitat, boosting wild populations.

The ANBG is working in partnership with other organisations to secure *B. vincentia's* future. It has had a key role in the insurance plan through propagating plants and preserving the seeds of this rare species. The horticultural team has been sharing its knowledge and techniques for growing the plant with other partners, such as the Wollongong Botanic Gardens and Booderie National Park. They are trialling grafts of *B. vincentia* onto disease-resistant rootstock, to improve the chances of survival if wild populations are found to be particularly prone to soil-borne pathogens.

Pam Rooney

***Banksia vincentia* nursery under construction, ANBG**

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Growing banksias in the home garden

Banksias in early home gardens

Banksias have been a feature in the home garden for a very long time. In 1775, Lee and Kennedy offered *Banksia oblongifolia* and *B. serrata* in their Vineyard Nursery in Hammersmith, then just outside London. James Lee was a Scottish-born Quaker who became a friend of Sir Joseph Banks. He was responsible for propagating the first seeds brought back by Joseph Banks from Botany Bay on HMB *Endeavour*. The first plant he propagated was *B. serrata*. His daughter, Ann Lee, became a renowned botanical artist.

Empress Josephine, the wife of Napoleon Bonaparte, was one of the earliest gardeners to attempt to grow banksias in a 'home' garden, even if 'home' was the modest digs at Chateau Malmaison just outside Paris. These plants were among the 200 species of Australian flora in her garden. She wrote to Sir Joseph Banks in 1803 thanking him for his help in enriching her garden.

Many of the plants at Malmaison were grown in an enormous hot-house on the property. Some of the plants were sourced from the voyages of Nicolas Baudin and Antoine Bruni d'Entrecasteaux. The botanist Labillardiere sailed with d'Entrecasteaux and was later employed as Chief Botanist at Malmaison. Such was the love of Australian plants shared by Napoleon and Josephine, that when Napoleon was exiled to St Helena, he took a collection of Australian plants with him, to remind him of Josephine, though they had divorced some years earlier.

Why grow banksias?

Banksias can provide a dramatic and long-flowering feature in the home garden. They are very variable in their size, leaf shape and growth habit as well as the colour and shape of their flowers and cones. Each species changes continually throughout the year, offering interest through all seasons: the flower heads go through dramatic changes in texture and colour as they mature and form follicles; the leaves also change in colour and texture as they mature, sometimes looking like flowers themselves in the earliest stages of their development. Even without new flowers, they have a lot to offer. Here is a wonderful description of what's happening in banksia 'downtime' from Karlo Taliano, a NSW banksia enthusiast:

> *This [downtime] period becomes what could be described as a 'consolidation phase' where they're planning ahead and investing in their own future.*
>
> *Some species are pushing out huge amounts of new growth while others are putting energy into developing fruiting bodies. These efforts will ultimately allow them to reproduce when the next bushfire comes along.*

While eastern states species generally flower in autumn, WA species flower at different times but mostly in spring, providing a year-long supply of nectar for pollinators.

New cultivars are coming into the market all the time. In the wild, observers have noted wide variability of form, leaf and flower colour within specific *Banksia* species. For example, low-growing forms of otherwise large *Banksia* species have been found in exposed seaside locations and the progeny of these plants remains true to type when grown away from exposed sites. This variability presents great opportunities for plant breeders. Now gardeners can buy a prostrate form of Old Man Banksia (*B. serrata*) known as *B. serrata* 'Pygmy Possum' which grows to 2 to 3m wide, but only up to 60cms tall.

As grafting techniques improve, some WA species are being grafted onto eastern states rootstock, often *B. integrifolia*, providing the opportunity to grow these in a wider variety of conditions. These techniques are still being refined, and grafted plants are not yet widely available to the home gardener.

Phil Trickett ©

B. hookeriana* grafted onto *B. serrata

Phil Trickett ©

B. aculeata* grafted onto *B. serrata

What do banksias need to thrive?

Some species tolerate a wider range of conditions than others and once established, they are generally quite hardy in the right conditions. Eastern states species are less fussy. Most banksias prefer well-drained soils in a sunny position with good air-circulation although some species such

as *B. grandis* and *B. blechnifolia* can tolerate semi-shaded environments. Many banksias, along with other Proteaceae, grow on extremely poor soils in the wild and cannot tolerate high levels of phosphorus. If fertilisers are used at all, it is important to choose one which has no or only low levels of phosphorus. Banksias do best if mulched with banksia matter.

Some banksias may require extra water during hot dry periods. Young plants will need watering until their roots reach the water table, which can take up to two years. Some WA species do not like high humidity or summer rainfall. Species with very hairy foliage and woolly flower heads can be more vulnerable to fungal problems and require very good air-circulation. Most WA species do not cope with wet feet although a few, such as *B. meisneri* and *B. occidentalis*, can tolerate seasonally water-logged conditions. Eastern species are generally not fussy regarding drainage, with *B. integrifolia*, *B. serrata*, *B. oblongifolia*, *B. robur* and *B. spinulosa* all tolerant of less than perfect drainage.

Most WA species are extremely difficult to grow away from regions which receive predominantly winter rainfall such as southwest WA, southern South Australia and Victoria. WA species are highly susceptible to *Phytophthora* whereas eastern species are more resistant. *Banksias,* a book by Kevin & Kathy Collins and Alex George, has a great chart on p. 49 showing the susceptibility of all species to *Phytophthora*.

Some banksias are lignotuberous, and some are not. Those with a lignotuber can cope with hard pruning, but those without should only be pruned lightly, after flowering has finished.

Doing a little research into the type of soil and other growing media in your garden and the natural habitats of different banksia species will help find a good match between a potential new home and the right species of *Banksia*. Gardeners may be able to modify the conditions in their garden to enhance the chances of success, for example, by improving soil drainage through mounding, and/or adding organic matter or gypsum, especially in clay soils. Some WA species

Information	**Links**
Species suitable for the home garden in temperate areas of Australia, that have been grown successfully in the ANBG	https://www.anbg.gov.au/banksia/
Recently released smaller-sized banksias suitable for the home garden:	https://gardendrum.com/2016/04/26/glorious-banksias-perfectly-sized-for-your-garden/
The newsletters and reports of the ANPSA Banksia Study Group document the experiences of many banksia growers since the 1970s	http://www.anpsa.org.au/banksSG/BSG-reps.html
Experience growing eastern states and WA banksias in a particular Victorian location: lists the climatic zones and soils where some specific banksia species are found in the wild, and their flowering times and growth habits	http://anpsa.org.au/APOL30/jun03-4.html
Frost tolerant banksias	https://www.malleenativeplants.com.au/frost-tolerant-banksias/
Banksias tolerant of alkaline soils	https://www.malleenativeplants.com.au/hardy-banksias-for-alkaline-areas/
Soil and growing media that are suited to growing phosphorus-sensitive Australian plants, such as banksias	https://www.rhs.org.uk/about-the-rhs/publications/the-plant-review/2017-issues/september-2017/phosphorus-toxicity-and-australian-plants.pdf
Propagation of banksias	http://anpsa.org.au/APOL24/dec01-1.html
Growing banksias as cut-flowers: advice to commercial growers, including soil preparation, planting times, irrigation etc, as well as enterprise management	https://www.agric.wa.gov.au/nursery-cutflowers/banksias-cutflower-production http://researchlibrary.agric.wa.gov.au/cgi/viewcontent.cgi?article=1165&context=bulletins

will only be able to be grown in a well-drained, low-nutrient growing medium in a pot. Growers suggest that commercially available native plant potting mixes might need additional sand or perlite to ensure adequate drainage.

Finding more information

Much information is available online and it should be possible to find at least one species of *Banksia* that is suitable for the home garden is most parts of Australia, apart from very arid areas. The table below sets out some useful links.

Home growers of banksias can seek advice and also celebrate their successes on some online forums, such as the Banksia Lovers Group on Facebook. Members post images of struggling plants and receive helpful hints on remedies from expert growers. They may ask for help with IDs both in gardens and in the wild. Sometimes there are posts from people overseas about their experience growing banksias around the world.

Key points for success

- Become familiar with information sources on growing banksias in your area, such as the local Australian Native Plant Society or reliable nursery
- Choose a species that is more adaptable to a variety of conditions
- Choose a banksia that thrives in similar growing conditions to that available in a particular location (eg. frost protection, pH, available sun and water including rainfall patterns, drainage, humidity)
- Modify the soil if necessary – if fertiliser is used, ensure it is low in phosphorus
- Don't overwater and ensure that drainage suits the particular species
- Make sure the growth habit is suitable for the available site/landscaping requirement
- If necessary, grow the plant in a pot with appropriate growing medium if otherwise available conditions do not match the requirements of the species

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Banksias in art

Early artists

From the first sightings of banksias by Europeans, as early as 1788, many artists have represented these plants in different contexts; in a scientific style, in children's stories and as a decorative image.

In the absence of photography in these early times, sketching the plant was the only possible method to record its image, other than presenting it as a pressed specimen. Artists' images captured the colour that fades from pressed specimens.

A large number of men, from an array of European countries, co-operated freely in the interests of their science. Linnaeus (the younger) was a Swede, as was Solander, Labillardière was French, Mueller was German, Cavanilles was Spanish and Ferdinand Bauer was Austrian while Sydney Parkinson was Scottish.

Sydney Parkinson (c.1745-71)

The first European artist to draw banksias was Sydney Parkinson. He was employed by Joseph Banks to accompany him on HMB *Endeavour* under Lieutenant James Cook, together with Daniel Solander, the Swedish botanist. Parkinson drew and partly painted in watercolour, three species discovered at Botany Bay in 1770 – *Banksia serrata, B. integrifolia and B. ericifolia* adding the tropical *B. dentata* at Endeavour River, in Queensland.

Unfortunately, Parkinson became ill in Batavia and died from dysentery and malaria, never completing these paintings. It was not until the 1980s that all 738 paintings from the *Endeavour* voyage were finally published in the *Joseph Banks' Florilegium*, including those commenced by Parkinson and completed by others contracted afterwards.

By the early 1800s, banksias were being grown in European glasshouses, and as they flowered, coloured drawings were often made directly from these specimens.

Banksia serrata, Botany Bay 28 April - 6 May 1770
Sydney Parkinson - artist,
Gabriel Smith engraver, 1724 - 1783
Peter Macinnis, *Curious Minds, The Discoveries of Australian Naturalists*, NLA, 2012, p36.

Banksia speciosa, collected at Lucky Bay WA, January 1802
Ferdinand Bauer - artist

Watts P, Pomfrett JA, Mabberly D, *An Exquisite Eye, The Australian Flora & Fauna Drawings 1801-1820 of Ferdinand Bauer*. Historic houses Trust of NSW, 1997

Ferdinand Bauer (1760-1826)

One of the greatest botanical artists was Austrian-born Ferdinand Bauer, who painted the flora of New South Wales during his voyage (1801-03) on HMS *Investigator* captained by Matthew Flinders. Bernard Smith in *European Vision and the South Pacific* says that Bauer 'sought in his drawings to reveal both the beauty of the plant and its scientific structure. Although he labored with infinite care upon detail, he never lost sight of the plant as a unified whole, so that he avoided both the dryness of science and the sweetness of sentiment.'

Besides having artistic skills of the highest order, Bauer benefitted from his association with Robert Brown, possibly the greatest botanist of the period. He was also fortunate to have access to a high-quality microscope, which had only just been developed at that time. His paintings of banksias included *B. coccinea, B. speciosa* and *B. pulchella.* Ferdinand Bauer was exceptional in that he undertook the entire process himself, whereas other artists sometimes had their work completed by others.

There were two Bauer artists in the family - Ferdinand's elder brother, Francis Bauer (1758-1840) was equally skilled and spent the last forty years of his life painting plants grown at the Royal Gardens, Kew, which also included banksias.

William Baxter (1787-1836)

One of the first privately financed plant collector to be sent to Australia was William Baxter, a Scottish Highlander. As a gardener to the Comtesse de Vandes, he raised many plants that were illustrated in early volumes of Curtis's *Botanical Magazine.* He made his first trips to southern Australia in a whaler boat when sealing and whaling were major industries. Later, he explored Western Australia. Australian plants were at the height of their popularity when Baxter produced his images of plants. *Banksia baxteri* is named in his honour. In 1823 he gathered the type specimen of *B. dryandroides* on the south coast of Western Australia near King George Sound.

Marianne North (1830-90)

In the late 1800s, some independently-minded women began to undertake adventurous journeys across the world in the hunt for spectacular plants to paint. Marianne North was one of these. She painted plants in their natural state using oils. Some of her locations included Chile, Borneo and the Seychelles. In 1880-81, while in Australia, she painted fine portraits showing buds, flowers fruit and new leaves of *B. attenuata, B. grandis* and *B. robur*.

Her work, including several hundred oil paintings, now hangs in a specially built gallery at the Royal Botanic Gardens, Kew.

Marian Ellis Rowan (1874-1922)

Marian Ellis Rowan was born in Victoria, the daughter of Charles Ryan, who created the garden at *Derriweit*, in Mount Macedon. In 1873, she married Frederick Charles Rowan who became a Melbourne businessman. She was a great admirer of Marianne North whom she met in Albany, Western Australia in 1880. Ellis Rowan emulated North's style of pursuing an independent career involving much travel. She was a petite, strong-willed yet fascinating woman, who forged her way through life, captivating others while pursuing her goal which was to find and paint wildflowers, birds, insects and butterflies from many different countries, often for the first time. Many of her finds were classified and named by the Victorian government botanist, Baron Sir Ferdinand Mueller.

Banksia littoralis, Swamp banksia, 1880s
Watercolour
Ellis Rowan - artist,
Leonie Norton, *Women of Flowers, Botanical Art in Australia from the 1830s to the 1960s*, NLA 2009

Initially, she travelled within Australia but following her husband's death, she went to the USA for several years and then to New Guinea, funding her travels through the sale of her work. She wrote for newspapers, had many exhibitions and was a knowledgeable botanist in her own right.

In 1879-93, Ellis Rowan exhibited her work in a range of exhibitions, not only in Australia but also in India, England, Europe and the United States. In that time she was awarded ten gold, fifteen silver and four bronze medals. In 1888, at Melbourne's Centennial International Exhibition, she was awarded the highest honours, with resulting controversy from fellow artists who considered her 'flower painting' to be inferior art.

Amongst her better-known banksia paintings are *Banksia robur*, named by Cavanilles (1800) and *Banksia menziesii* named by R. Brown (1830). More than 900 of her works were acquired by the National Library of Australia in 1923, including seven images of banksias.

Margaret Preston (1875-1963)

Margaret Preston was an Australian painter and printmaker who is regarded as one of Australia's leading modernists of the early 20th century.

Preston studied art at the National Gallery of Victoria Art School from 1889-1894 under Frederick McCubbin and later transferred to Adelaide's School of Design to study under H.P. Gill and Hans Heysen. From there she travelled to Europe, visiting Italy, Paris, Spain and Holland, and then Africa. She was also influenced by Japanese art.

Even more than her paintings, Prestons' woodcuts, linocuts and monotypes show her capacity for modernist innovation. The great majority of her surviving prints feature Australian native flora as their subjects, a result of her desire to make uniquely Australian images. The use of woodcuts in her botanical illustrations captures the strong lines and robust character of banksias.

May Gibbs (1877-1969)

May Gibbs is one of Australia's most treasured illustrators, artists and children's authors.

She moved from the United Kingdom with her family in 1877 at the age of four, living initially in South Australia. After two years the family moved to Western Australia.

As a child growing up in Perth, she had a great deal of exposure to the Australian bush surrounding her home. Hers was a creative family, and May demonstrated artistic ability from an early age. She excelled at botanical drawings and in 1892, when aged fifteen years of age, won the First Prize at the Perth Wild Flower Show, the first of many prizes throughout the 1890s.

May wrote many stories using the fairy-like characters of *Snugglepot and Cuddlepie*, and for her villain, she used the Big Bad Banksia Man, based on the fruiting cone of *B. ameula.*

Her bush fantasy world has captured the imaginations of Australians for over a century, creating a uniquely Australian folklore. World War One soldiers found the arrival of a May Gibbs' bookmark, shaped like a gum-leaf surrounded with little gum-blossom fairies, to be a powerful link to home. Her art proved to be a means of creating an Australian identity, turning early settlers' thoughts of 'home' to Australia, rather than being the 'old country' of England.

In early 1900, May went to England to study art in London. Returning to Perth in 1905, she embarked on a successful career as an illustrator for a leading Western Australian newspaper and later became the first woman cartoonist in Australia. May Gibbs moved to Sydney (Neutral Bay) in 1913 to a home she called 'Nutcote'. This is now a museum in her memory and can be visited today.

Margaret Stones (1920-2018)

Elsie Margaret Stones was born in Colac, Victoria in 1920. In 1951-8, she travelled to England where she became the principle contributing artist to *Curtis Botanical Magazine,* working at the Royal Botanic Gardens in Kew. This magazine became the longest running botanical periodical in the world.

In 1961, she was commissioned by Lord Talbot to paint the endemic plants of Tasmania. The resulting publication, *The Endemic Flora of Tasmania* (1967-78) was published in six volumes. Her work approached the quality of Ferdinand Bauer and Celia Rosser. She received two honorary doctorates: one from Louisiana State University (1986) and one from the University of Melbourne (1989).

Celia Rosser (1930-)

Celia Rosser was born in Victoria in 1930 and trained at Royal Melbourne Institute of Technology. She began painting Australian wildflowers early in her artistic career. She first painted a banksia after seeing a *B. serrata* near her home. Her first exhibition, in 1965 at Leveson Gallery in Melbourne, included three watercolours of *Banksia* species. Two years later she published *Wildflowers of Victoria.*

In 1970, Celia Rosser was appointed Science Faculty Artist at Monash University. It was there that 'The Banksia Project' was established in 1974. Through this project, Rosser painted 76 species of *Banksias* in three volumes, producing the most comprehensive set of botanical drawings of banksias. The volumes were titled *The Banksias* (1981-2000). Renowned Banksia expert, Alex George, wrote the accompanying text. The volumes represent a major publishing event for Australia. It was the first time a genus of such a size has been illustrated in a single set of volumes anywhere.

The Australian Government, as a gift from the Australian people, presented each volume of *The Banksias* to Queen Elizabeth. Celia Rosser was awarded a Medal of the Order of Australia in 1995 for her contribution to botanical art. This work is outstanding for both its quality and completeness, covering the entire genus at the time. In tribute, the recently discovered arid shrublands plant *Banksia rosserae* was named in her honour.

http://www.celiarossergallery.com.au/celia-rosser-the-banksia-s.html

Art in recent times

Botanical art is flourishing today with many people pursuing this art form.

Cathy Franzi

Dr Cathy Franzi is a Canberra-based ceramic artist. She uses Australian plants as her focus and spends time collecting seeds for seed-banks and gathering data through fieldwork. From 2011 to 2015, while a PhD student at the ANU School of Art, she undertook research into the representation of Australian flora on the ceramic vessel and how botanical and environmental knowledge might be expressed. Inspired by her research, her ceramics showcase many species of banksias, capturing beautiful detail. (http://www.cathyfranzi.com/)

Friends of the ANBG

The Friends of the ANBG has its own Botanical Art Groups who meet to paint botanical specimens, of which banksias are a regular subject. Their botanic art exhibitions sell well and draw many visitors.

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Banksias and animals

As banksias are heavy producers of nectar, they attract many honeyeaters whose brush-tipped tongues are adapted to extracting nectar from banksia flowers. In return, the visiting birds are dusted with pollen that they transfer to other flowers. Typical birds seeking nectar from banksias are Wattlebirds, New Holland Honeyeaters, Eastern Spinebills, Silvereyes and Lorikeets. Many banksias form a dense bush and provide nesting habitats for honeyeaters and a safe refuge for other small birds. Banksias also provide an important source of food for other animals such as insects, rodents, antechinus, honey possums, gliders and bats who consume nectar. These animals are also important pollinators of banksias.

Banksia seeds are food for birds and insects. Cockatoos target developing follicles when the seeds are maturing but the follicle is still soft enough to break open. The larvae of invertebrates, such as moths and weevils, burrow into the cones to eat the seeds and pupate in the follicles. Some burrow into the bark. Birds such as cockatoos break off the cones to eat both the seeds and the insect larvae. They can also break into the bark to find grubs. Seeds that fall to the ground after fire or are released at maturity are eaten by birds. Seedlings can be eaten by grasshoppers, mites, kangaroos and bandicoots.

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Pam Rooney ©

Pollinators: New Holland Honeyeater on B. aemula

Pam Rooney ©

Banksias* as food source: Yellow-tailed Black Cockatoo eating developing follicles of *B. integrifolia.

Photo: Sophie Xiang with kind permission ©

***Banksias* as food source: A chewing *Catacarcus* snout beetle on the new leaves of *Banksia menziesii*. A range of insects eat banksia. Some moths lay eggs on immature flowers and the larvae hatch and burrow into the central spike of the flower head, eating the soft tissue. Others burrow into banksia seeds. The larvae are food for birds such as cockatoos.**

Uses of banksias

Indigenous usage

Food and drink

Aboriginal people use the nectar from banksia flowers as a delicious bush food. It is best harvested in the early morning before birds and evaporation reduce the supply. Nectar-laden flowers can feel sticky when squeezed. Aboriginal people from Groote Eylandt and the Top End suck the nectar from the flowers from *B. dentata* (Swamp Banksia), or mix the flowers with water to make a sweet, energy-boosting drink.

The Noongar people from southwest WA referred to nectar as *mangite*. They had prohibitions regarding the time that the nectar could be gathered, possibly to ensure it was fully ripe and fit for consumption. It is recorded that they also made a form of mildly intoxicating drink by allowing the sugary drink to ferment. Aboriginal people chewed the sticky protective bracts of the emerging buds of *B. attenuata* as a long-lasting chewing gum. Banksia seed was collected and crushed as a food from some species of *Banksia* in southwest WA. Lightly roasted *B. baxteri* seed is said to be delicious, tasting like macadamias or peanuts. *B. grandis* cones were traded for food with inland tribes living where this species did not occur.

Banksia ericifolia has been described as 'the winter life blood of the Wadi Wadi people of the Illawarra' region of New South Wales. In winter they would migrate to the escarpment, and use the nectar from the flowers as an important source of food. The nectar also attracted large flocks of Wattle Birds, which were caught for food. The old cones provided a fuel source, which was reported to burn very cleanly.

In the Grampians, banksia flowers were used to filter muddy water while old flower heads were similarly used to strain water.

Lighting and carrying fire

Dry banksia cones were smeared with animal fat then set alight to use as torches or to transport fire. Young flower spikes of *B. dentata* were used to carry fire. The flower spike could smoulder for hours, burning from one end to the other end without flaring or producing a flame. When one spike burnt through, another could be lit from its stub. It is also reported that cones were wrapped in melaleuca bark and carried in kangaroo skin bags. In WA, the large cones of *B. grandis* were favoured as they smouldered for many hours. When ready to ignite, fine grass and twigs were placed on the smouldering cone and blown over to facilitate ignition.

Medicinal uses

Aboriginal people had many medicinal uses for *B. dentata*. Squatting over the smoke of burning cones was believed to ease diarrhoea. Heated flower spikes were used to cauterize leprosy sores. The heated central stem of an old flower spike was used to treat toothache by holding it near the skin on the face, outside the area causing the pain

Infusions of the flowers of some species were made by steeping them in water, to make a drink to relieve coughs and sore throats.

Other uses

Old cones were used as hairbrushes. Fresh, single flowers could be used as paintbrushes for ceremonial make-up and painting. The inner core from young flower heads was used as a pierced-nose ornament. The axis of *B. dentata* flower heads was used to apply body paint.

Warmed cones were used as body warmers when placed under clothing.

B. marginata, (Silver Banksia) had many uses in Ngunnawal culture. Its curved branches could be used to make boomerangs. Large *B. grandis* cones on strong branches were reportedly used as clubs or *Nulla Nullas* in southwest WA.

As banksia flowers open in response to sunlight and heat, banksia flower heads can be used as a compass, as the flowers on the north-facing side open first.

Boronia Halstead ©

***B. menziesii*, commonly known as the Firewood Banksia because it burns quickly. It has more colour variants than any other species of banksia, ranging through pinks, yellows and greens. The flower heads take around 8 months to develop, but very few flowers develop into follicles – sometimes as low as one in a thousand. It is closely related to *B. baxteri* and slightly more distantly to *B. serrata* found on the east coast.**

The Beeloo Whadjuk Noongar people of the Perth region know it as *Mungyt* and make a drink from its nectar. This was drunk at sweet water festivals. Its flowers and seeds provide an important food source for the threatened Short-billed Black Cockatoo.

Early European use

Early settlers in south-eastern areas made bullock yokes from the timber of *B. integrifolia* (Coastal Banksia). Banksia wood was used for boat building. The wood of certain species, such as *B. serrata* was used for boat parts such as keels. The timbers for a cutter that Matthew Flinders had built at Sydney in May-June 1802 ...'were cut from the largest kind of banksia which had been found more durable than mangrove and the planking of cedar.' The boat was constructed under the superintendence of Mr Thomas Moore, master builder to the colony; and proved ... 'to be excellent at sea, as well for rowing and sailing in smooth water' (Flinders, May 1802), cited in *Banksias* by K. and K. Collins.

Timber and fruiting cones were used for firewood, especially in Western Australia where a common species, *B. menziesii,* is known as the Firewood Banksia.

Pioneer women removed the bracts from non-pollinated flower spikes to use as kapok to stuff small pillows.

Current use

Banksia wood is reddish in colour with an attractive grain and it is occasionally used for ornamental purposes in woodturning and cabinet panelling. It has a spotted pattern and is light to work with. Banksia timber is scarce now and is used largely as a feature wood in marquetry or jewellery boxes.

The large cones of *B. grandis* are used for woodturning projects. Bungendore Woodworks has items such as coasters, tea-lights, vases and wine-stoppers for sale, made from banksia cones. The Botanical Bookshop at the Australian National Botanic Gardens sells Christmas decorations and fragrance pots made from cones.

Children like to use the soft velvet rods from non-pollinated flower spikes as toys. The velvet rods can attach to one another, like Velcro. In this way they can be used in play for Lego-like construction. Banksia inflorescences with hooked styles could be used in a throwing game from one person to another, as they will stick together on contact.

Pam Rooney

Banksia cone used for pepper grinder

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Appendix 1: Banksias held in ANBG nursery, ready for planting as at January 2020

List of banksias available for the Banksia Garden as on January 2020.
Plants have been grown from seed, cuttings or are grafted.

Stocktake of banksias available for the Banksia Garden, January 2020.					
Genus	**Species**	**Rank**	**Infraspecies name**	**Common name**	**Particular form**
EASTERN SPECIES					
Banksia	*aemula*				
Banksia	*aquilonia*				Usual form
Banksia	*canei*				Typical form
					Low Mt. Tamboritha (Vic) form
Banksia	*collina*				
Banksia	*dentata*				
Banksia	*ericifolia*				
Banksia	*integrifolia*	subsp.	*integrifolia*		Typical tree form
					Prostrate form (ex-Burrendong)
					Prostrate form
		subsp.	*compar*		
		subsp.	*monticola*		Usual form
Banksia	*marginata*				Typical form
Banksia	*neoanglica*				
Banksia	*oblongifolia*				
Banksia	*ornata*				Typical form
Banksia	*paludosa*	subsp.	*paludosa*		Usual form
Banksia	*penicillata*				
Banksia	*plagiocarpa*			Dallachy's/Blue Banksia	
Banksia	*robur*				Usual green form
					Purple leaf form
Banksia	*serrata*			Saw Banksia	Usual form
Banksia	*spinulosa*				Usual form
					Dwarf form
					Low form, Snapper Point
Banksia	*vincentia*				
WESTERN SPECIES					
Banksia	*ashbyi*	subsp.	*ashbyi*	Ashby's Banksia	
		subsp.	*boreoscaia*		Dwarf form
Banksia	*attenuata*			Slender Banksia	
Banksia	*baueri*			Woolly Banksia	
Banksia	*baxteri*			Baxter's Banksia	
Banksia	*blechnifolia*				
Banksia	*brownii*			Feather-leaved Banksia	Usual tree form
					Mountain shrub form
					Waychinicup form
Banksia	*burdettii*			Burdett's Banksia	

Stocktake of banksias available for the Banksia Garden, January 2020.					
Genus	**Species**	**Rank**	**Infraspecies name**	**Common name**	**Particular form**
Banksia	*caleyi*			Caley's Banksia	
Banksia	*candolleana*			Propeller Banksia	
Banksia	*coccinea*			Scarlet Banksia	
Banksia	*cuneata*			Quairading Banksia	
Banksia	*dryandroides*				
Banksia	*epica*				Typical form
					Very large flowers - Banksia Farm
Banksia	*grandis*			Bull Banksia	Typical form
					Coastal, small form
					Small form - from Peter Olde
Banksia	*grossa*				
Banksia	*hookeriana*			Hooker's Banksia	
Banksia	*laevigata*	subsp.	*laevigata*	Tennis Ball Banksia	
Banksia	*lanata*				
Banksia	*laricina*			Rose Banksia	
Banksia	*lemanniana*			Lemann's Banksia	
Banksia	*lindleyana*			Porcupine Banksia	
Banksia	*media*			Southern Plains Banksia	Typical form
					Compact South coast form
Banksia	*meisneri*	subsp.	*ascendens*	Scott River Banksia	
Banksia	*menziesii*			Firewood Banksia	Typical form
Banksia	*micrantha*				
Banksia	*nutans*	var.	*nutans*		
			cernuella	Nodding Banksia	
Banksia	*occidentalis*			Red Swamp Banksia	Typical form
					Compact, mini form
Banksia	*petiolaris*				
Banksia	*pilostylis*				
Banksia	*praemorsa*			Cut-leaf banksia	Typical yellow flower form
					Burgundy-flowered form
Banksia	*prionotes*			Acorn Banksia	
Banksia	*quercifolia*			Oak-leafed Banksia	
Banksia	*repens*			Creeping Banksia	
Banksia	*rosserae*				
Banksia	*sceptrum*			Sceptre Banksia	
Banksia	*seminuda*			River banksia	
Banksia	*solandri*			Stirling Range Banksia	

Stocktake of banksias available for the Banksia Garden, January 2020.					
Genus	**Species**	**Rank**	**Infraspecies name**	**Common name**	**Particular form**
Banksia	*speciosa*			Showy Banksia	
Banksia	*sphaerocarpa*	var.	*caesia*		
			dolichostyla	Ironcap Banksia	
			sphaerocarpa	Fox Banksia	
Banksia	*tricuspis*				
Banksia	*verticillata*			Albany Banksia / Granite Banksia	
Banksia	*victoriae*			Woolly Orange Banksia	
Banksia	*violacea*			Violet Banksia	
Dryandras					
Banksia	*formosa*				
Banksia	*fraseri*				
Banksia	*nivea*				
CULTIVARS AND SELECTIONS:					
Banksia	*spinulosa*	'Coastal cushion'			From Snapper Point, similar to 'Birthday Candles' with larger flowers
Banksia	*spinulosa*	'Coastal Gold'			From Snapper Point golden flowers
Banksia	*spinulosa*	'Birthday Candles'			low, compact to 80cm, very floriferous
Banksia	*spinulosa*	'Black Magic'			1 1.5m, chunky habit, black styles
Banksia	*spinulosa*	'Carnarvon Gold'			slender upright habit
Banksia	*spinulosa*	'Cherry Candles'			cherry red flowered low form from Snapper Point as per B. 'Birthday Candles'
Banksia	*spinulosa*	'Stumpy Gold'			1.5m, hardy
Banksia	*marginata*	'Mini Marg'			1 m
Banksia	*marginata*	'Portland Dwarf'			1.2m
Banksia	*oblongifolia*	prostrate low SW Rocks NSW			prostrate low
Banksia	*paludosa*	prostrate SW Rocks			prostrate
Banksia	*ericifolia*	'Little Eric'			2m
Banksia	*ericifolia*	Crowdy Bay			red cream flowers
Banksia	*ericifolia*	'Bulli Baby'			60 cm
Banksia	*integrifolia*	'Green Cape Dwarf'			2m
Banksia	*integrifolia*	'Roller Coaster'			semi prostrate
Banksia	*serrata*	'Pygmy Possum'			60cm x 1.2m