# The Art of Living Together

This walk was developed by Glenys Bishop, Pam Cooke, Jean Golding and Kaye Saunders as a Themed Rostered Walk in August 2023.

## Theme:

Generally, this walk is about the interactions between plants and animals, plants and fungi and also between different species of plants. Specifically, we want to show visitors:

- examples of two species interacting to their mutual benefit (mutualism or win-win);
- examples in which one species obtains food or other benefits from the other without either harming or benefiting the latter (commensalism or win-neutral);
- examples where one species benefits and the other is harmed (parasitism or win-lose);
- examples where one species is inhibited or completely obliterated and one is unaffected (amensalism or win-lose), including allelopathy and competition;
- how these interactions can occur between different species of plants or between plants and fungi, or plants and animals, including insects, birds and mammals.

By the end of this walk we want visitors to understand that ecological systems are complex.

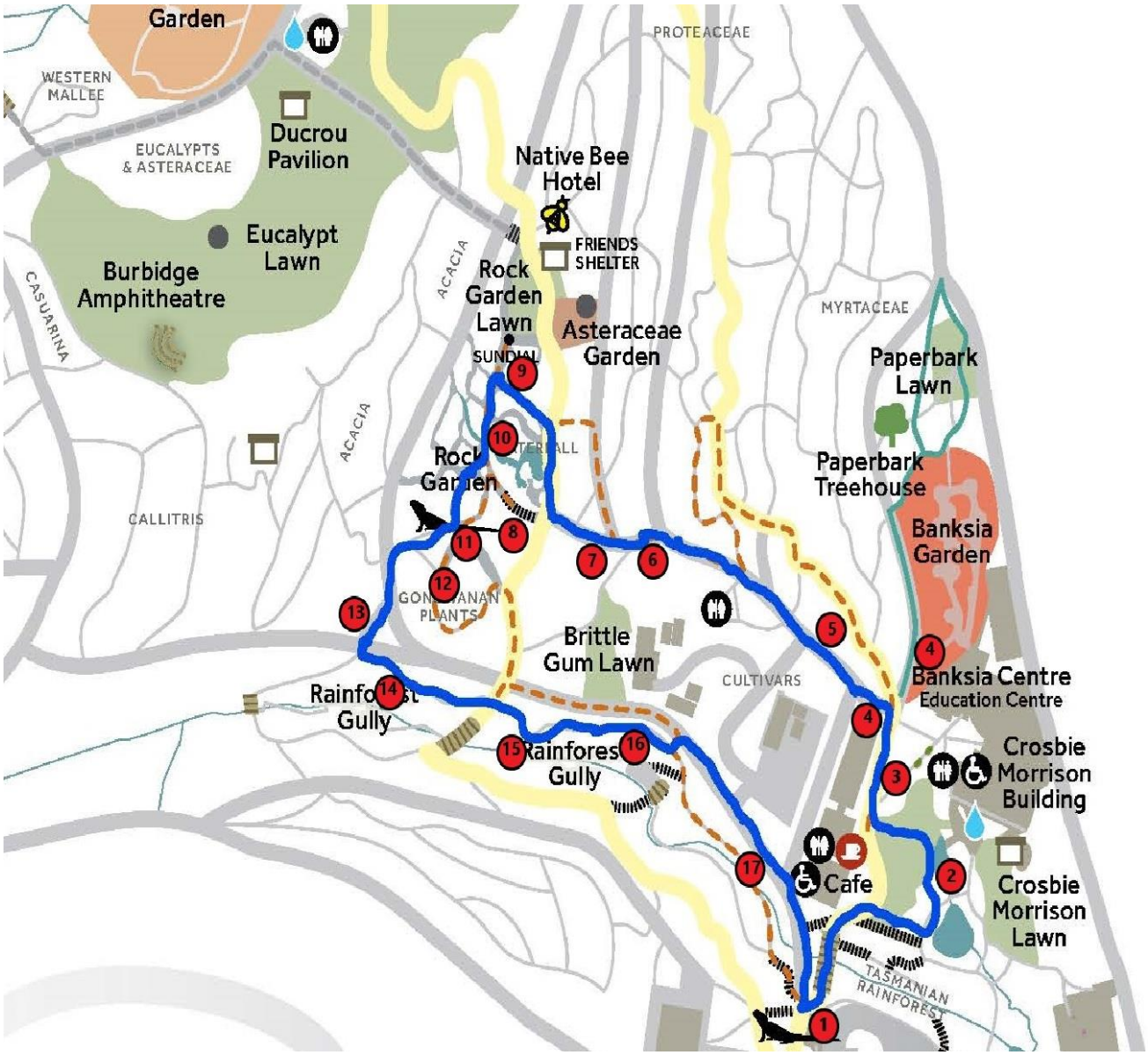
## Alternatives for Wheelchairs

Most of this walk is accessible. However, to get from stop 8 to stop 9, you will need to go along the bottom of the rock pool and make your way round the Rock Garden lawn rather than walk up the steps. Getting from stop 11 to stop 12 could be difficult with some wheelchairs. If this seems to be the case, omit stop 12, return to the main path through the gymnosperms and go up the road alongside the rainforest to stop 13.

## Stop List

| Stop | Plant | Theme point | Where |
|---|---|---|---|
| 1 | *Exocarpus cupressiformis* (Cherry Ballart) | Parasitism | Opposite clock |
| **2** | Vines | Competition | Path next Friends lawn |
| 3 | *Santalum Acuminatum* (Quandong) | Parasitism | Pot outside Ellis Rowan |
| 4 | *Banksia menziesii* (Firewood Banksia) | Mutualism | Entrance to Banksia garden |
| 5 | Lichen on *Melaleuca lanceolata* | Mutualism and Commensalism | Myrtaceae section next to road |
| **6** | *Eucalyptus mannifera* tree hollows | Commensalism | Edge of Brittle Gum lawn |
| **7** | *Callistemon citrinus* | Allelopathy | On left of bitumen road |
| **8** | *Grevillea lanigera* | Mutualism | Bottom of rock garden |
| **9** | *Acacia aneura* (Mulga) | Mutualism | Rock garden next to lawn |
| **10** | *Triodia (*spinifex) | Commensalism | Rock Garden |
| **11** | *Podocarpus elata* (Queensland plum pine) | Mutualism | Section 79 path away from Rock Garden |
| **12** | *Macrozamia* | Mutualism | |
| **13** | *Armillaria* | Parasitism | Opposite section 17 |
| **14** | Epiphytes | Commensalism | In rainforest |
| **15** | Bracket fungus | Parasitism and Mutualism | On tree stump in rainforest |
| **16** | *Cyathea australis, C. cooperi* (Tree ferns) | Commensalism | Rainforest |
| **17** | Orchid in flower | Mutualism | Rainforest verge section 125 |

## Map


Garden
WESTERN MALLEE
EUCALYPTS & ASTERACEAE
Ducrou Pavilion
Eucalypt Lawn
Burbidge Amphitheatre
CASUARINA
ACACIA
PROTEACEAE
Native Bee Hotel
FRIENDS SHELTER
Rock Garden Lawn
SUNDIAL
Asteraceae Garden
MYRTACEAE
Paperbark Lawn
Paperbark Treehouse
Banksia Garden
Rock Garden
CALLITRIS
GONDWANAN PLANTS
Brittle Gum Lawn
CULTIVARS
Banksia Centre
Education Centre
Rainforest Gully
Crosbie Morrison Building
Cafe
Crosbie Morrison Lawn
TASMANIAN RAINFOREST
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## Stop 1 *Exocarpus Cupressiformis* (Cherry Ballart, Native Cherry)

***Theme Point:*** An example of a hemi-parasitic plant, which means that the plant is part parasitic and needs host plants for water and soil nutrients, but it can photosynthesise.

**Location:** a very small one on Banks Walk, opposite the clock

**Main point:**

This little tree has probably attached itself to the roots of the large eucalyptus tree next to it. In the early stages of its development especially it is on the roots of other trees, particularly Eucalyptus. More mature plants are less reliant on this parasitism once photosynthesis in their stems is well established. Hence it is hemi parasitic. Photosynthesis occurs in the stems.

The small cream flowers are inconspicuous and are followed by the fruit which is a small nut about 0.5 cm in diameter. The nut is attached to a fleshy fruit-like structure which is actually an enlarged, succulent section of the flower stalk. As the fruit develops the stalk swells to 5-6mm in diameter and turns yellow or red, to form the edible "cherry" (which lacks the hard stone of a European cherry).

Larger specimens are frequently seen as sub-canopy trees in drier, rocky sites of eucalyptus woodlands. Their elegant form and drooping yellow-green foliage, distinguishes them from the surrounding sclerophyllous vegetation.

The name, *Exocarpos,* means outside fruit, referring to the fleshy false fruit and *cupressiformis* refers to the resemblance to cypress trees.

This species belongs to the Santalaceae family along with the Sandalwood and also the Quandong, which we will see later in this walk.

**Of interest:**

Because it stands out in a sclerophyll forest it is often used as a marker in the orienteering sport.

It used to be used as an attractive native Christmas tree, with its cypress foliage and red berries. Even in the 1950s my family was using these as Christmas trees on Yorke Peninsula in South Australia. *[personal reminiscence by Glenys Bishop, Volunteer Guide]*

**Distribution and habitat:**

Endemic to Australia, common to southeast Australia from Mackay to Port Lincoln and Tasmania, with a few outlier populations near Cairns. It is common locally , e.g. Mt Majura, Black Mountain and several examples in the ANBG along the road opposite the eastern mallee and Sydney Gully.

Exocarpos cupressiformis - Australian Native Plants Society (Australia) (anpsa.org.au)
Short Cuts (anpsa.org.au)
Cherry Ballart (Exocarpos cupressiformis) · iNaturalist Australia (ala.org.au)
Margaret Benson (1910) Root Parasitism in Exocarpus (with comparative Notes on the Haustoria of Thesium). [Annals of Botany, Vol. XXIV. No. XCVI. October, 1910.] pdf available.

## Stop 2 Vines and climbing plants *(Pandorea sp*)

***Theme Point:*** An example of **COMPETITION** which is a form of **AMENSALISM.**

**Location:** RHS of path next to the Friends Lawn, just past the second staircase, behind a light.

Vines and climbing plants compete for the same natural resources as their host trees and plants. This may block the process of photosynthesis if the vine covers the tree's leaves. The vines compete with the tree's roots for necessary elements, such as nitrogen.

**Description:** Two different vines are growing on the tree. The three plants are trying to acquire the same resource at the same time (location and nutrients). When organisms compete in this way, the dominating one will outgrow another. This is called the **Competitive exclusion principle**. It is difficult to say with certainty whether one of these three plants is inhibited or damaged by the presence of the other, which does not benefit. Perhaps over time one or more may die.

**Distribution and habitat:** *Pandorea* is an evergreen native climber with tubular or funnel-shaped flowers. Foliage is either dark green and glossy or bright green and growth is vigorous.

Flowering will occur mainly through spring and summer but will spot flower throughout the year. Flowers range from pink, to cream-white to bright-white to maroon-throated, burgundy or even yellow-orange, often with a delicate fragrance.

*Pandorea* is a tough climber and it's lush, bright green foliage will provide a great year-round cover for a fence, pergola, wall, or can be planted to cascade over a retaining wall or bank.

*Pandorea* will happily live amongst other climbers like **Bougainvillea** and deciduous climbers.

**Of Interest:** It is important to note that *Pandorea* species develop a strong and penetrating root system and should not be planted near underground pipelines.

**LINK:**

Pandorea | Flower Power
Pandorea jasminoides - Growing Native Plants (anbg.gov.au)
Competitive exclusion principle - Wikipedia

## Stop 3 *Santalum Acuminatum* (Quandong, Native Peach)

***Theme Point:*** Another example of a hemi-parasitic plant

**Location:** In a pot opposite the Ellis Rowan Building.

The Quandong relies on host plants for water and mineral nutrients (from the soil) but not for sugars, since with its green leaves it has the ability to photosynthesise and produce its own supply of carbohydrates. Hence it is a hemi-parasite.

It commonly attaches to nitrogen-fixing trees such as Acacias (wattles) and Casuarinas (she oaks), but also parasitises other legumes, shrubs (e.g., saltbush and bluebush) and grasses. The Quandong normally has more than one host. Like all parasitic plants it has a modified root structure called a **haustorium**, which penetrates the root tissues of the host plant and absorbs nutrients and water.

In this pot the host is an acacia.

**Distribution and habitat**: Endemic to Australia, the quandong is widely dispersed throughout most southern regions of Australia including the arid area of the central deserts. It is found north to Karratha in WA and east to Dubbo in NSW, in a wide variety of habitats characterised by nutrient poor, free draining soils. Its height can be from one to six metres in height.

Pale green to olive leaves that are classically eucalyptus shaped – elongated and often with a sickle-like curve. The bright red 2-2.5 cm long fruit contains one large nut, which is sometimes only marginally smaller than the fruit.

**Of interest:**

- **Game of Bully**: Game common among boys. A hole was drilled through a quandong nut so that a piece of string could be threaded through it and then knotted at one end. A 50cm to 75cm circle was drawn on the ground, a boy put his 'bully' in the middle, holding the string, and the other boy whacked it with his 'bully', trying to smash it. They take it in turns if they miss. Spare bullies are stored on another string. Newer bullies more prized as older ones too brittle. (*personal recollection of Wayne Hoy, ANBG Volunteer Guide*)
- It is prized by Aboriginal Australians as highly nutritious bush tucker and contains approximately twice the vitamin C of an orange. It is described as slightly sour and salty with its sweetness varying considerably between trees. Its aroma is likened to "dry lentils or beans with earthy fermented notes".

Haustorium | Definition, Description, & Facts | Britannica

Quandong Tree – Australian Native Growing Guide - AGT (aussiegreenthumb.com)

Santalum acuminatum - Growing Native Plants (anbg.gov.au)

Parasitic plant - Wikipedia

## Stop 4 *Banksia menziesii* (Firewood Banksia, Port Wine Banksia, Strawberry Banksia) and Banksia spinulosa (Hairpin banksia)

***Theme Point:*** Two examples of mutualism. The plant gets pollinated and the pollinators (birds and mammals in this case) get nectar which is a source of energy for them.

**Location:** Top of Banksia garden close to path and at the end of the Ellis Rowan building

In Australia, there are three main groups of pollinators: insects, birds and mammals. Here we have Banksia spinulosa from eastern Australia and *Banksia m*enziesii from SW WA. Each Banksia species (there are about 170 of them) has unique traits designed to improve pollination efficiency: the transfer of pollen to the stigma, the first step in fertilisation.

For instance, a honeyeater (bird) uses the *B. menziesii* flower head as a landing platform and feeds from the opening front, i.e. half way down the flower head, where most nectar and pollen are located and where pollination occurs. As the bird is feeding on the nectar, pollen is dusted onto its forehead, throat and beak. After the pollen has been transferred, the flower stigma becomes receptive to pollen from the head of another visiting bird. The colours of bird-pollinated flowers are usually bright red, orange, or green.

A study of B. spinulosa in the Barren Grounds Nature Reserve near Wollongong found that mammals and birds, including the sugar glider, the brown antechinus, the eastern pygmy possum and the eastern spinebill, were successful pollinators for this species. Moths and honeybees also visited flower heads, but moths carried very little pollen, and the foraging behaviour of other insects was unlikely to promote pollination. Pollination success was similar for nocturnal and diurnal visitors. However, nocturnal visitors were more effective at removing pollen from newly opened flowers.

Furthermore, the foraging behaviour of mammals was such that they would transfer copious amounts of pollen to inflorescences, and probably contact receptive stigmas more often. Overall, mammals were considered to be slightly more effective pollinators than the more obvious daytime visitors, eastern spinebills.

Banksia spinulosa "The pollination biology and breeding system of Banksia spinulosa" by Susan Mary Carthew (uow.edu.au)

Pollination of the South-Western Australian Flora | Western Australian Naturalists Club (wanaturalists.org.au)

**Of interest:**

- The prominent autumn and winter inflorescences of *B. menziesii* are often two coloured red or pink and yellow. Yellow blooms are rare. The flowering spikes have many hundreds of individual flowers, which usually open from the bottom up. In individual flowers the style and stigma initially act as a pollen presenter. **Dependent on fire to reproduce** because its follicles only open after being burnt.
- Birds pollinate 1000 Australian plant species. At equivalent latitudes in N America the number is 8, in Asia it is 2, in all of Europe and N. Africa the figure is zero.
- Named for botanic collector Archibald Menzies

**Distribution and habitat:**

- *Banksia menziesii* is found in WA, from the Perth region north to the Murchison River. *Banksia spinulosa* is from the eastern states, extending along the coast from Victoria to Cairns and distributed from the coastline into forest areas of the Great Dividing Range.

## Stop 5 Lichens on *Melaleuca lanceloata*

***Theme Point*: Commensalism and Mutualism**

**Location:** Section 10, on RHS of bitumen road heading up to the new Conservatory

Here we have two types of symbiosis.

Firstly, this Black Paperbark or Western Black Tea Tree is playing host to these lichens. The tree provides a place for the lichen to grow at no cost to itself. (Commensalism)

Secondly, the lichen itself is an example of symbiosis (Mutualism). Lichens are composed of a fungus and another organism that photosynthesises. That is usually an alga but it may be a cyanobacteria, or sometimes two of these. Together, they make a new organism, producing structures and compounds that are unique. If you try to separate the two, the fungus cannot live alone. And it is the same for most of the algae – although there are a few that may.

In the partnership, the alga provides the products of photosynthesis – the energy component, the carbohydrates. It uses some of this stored energy itself but also provides a lot to the fungus which cannot make these carbon compounds. The fungus, in return, provides the nutrients gathered by threadlike hyphae. Cyanobacteria can fix nitrogen and so when a lichen dies and decays in the soil, it contributes to soil fertility and therefore the growth of plants in the environment.

Lichens come in different forms. This one on the tree has a low three-dimensional structure while there are some on the rock below that are flat. There is a third form that is pendulous or erect. There are over 3,000 different lichen in Australia.

**Of Interest**
Some lichens are very effective sand and soil binders and can help in dune stabilization and erosion control. In arid and sub-arid areas, lichens, in association with bryophytes, can create extensive biological soil crusts on the soil and such crusts help maintain the underlying soil structure and prevent erosion. Lichens don't only grow on trees and rock. They have been found on living animals eg on the large Galapagos tortoises and some weevils.

Lichen colonies provide niches for numerous invertebrates, often the very tiny invertebrates, which are then eaten by larger invertebrates which, in turn, are eaten by other creatures. Such lichen colonies are thus indirectly important in various food chains. Lichens are a food source for mammals, birds and insects. Many birds also use them for nesting material. Did you know that one of the animals that eats lichen is the reindeer.

As well as having important ecological roles lichens have also been used by humans as food, medicine and for the dyeing of cloth. For example, traditionally lichens were used to produce the colours of Harris tweed.

Lichens are still used today in the manufacture of various perfumes. The major perfume lichens are *Evernia prunastri* (often called Oakmoss), which grows on oak trees, and *Pseudevernia furfuracea* (often called Treemoss), which grows on conifers. Lichen extracts act as fixatives and also give the so-called 'bass notes' (or base notes) in a perfume, with floral essences supplying the 'top notes'

https://www.anbg.gov.au/lichen/what-is-lichen.html

https://www.anbg.gov.au/lichen/lichens-people.html

## Stop 6 Nesting Tree Hollows

**Theme point**: Commensalism - birds and animals derive the benefit, the tree is not affected.

**Location**: Brittle gums opposite the construction site at the junction of bitumen roads.

Tree hollows occur naturally (often in eucalypts) and they are essential to the lives of many species that take advantage of the hollows for nesting sites as well as refuge from the weather and predators. Importantly, hollows must be within reach of suitable food sources to be of value. Here we are looking for tree hollows and can also see the start of some. Factors such as entrance size and shape, depth, degree of insulation and position on the tree affect how frequently, in what season and by what species a hollow is used.

The best tree hollows are found in older trees. Wildlife will also renovate or enlarge hollows using beaks, teeth or claws.

**Of Interest**

Hollow formation is dependent on a tree's history, its species and location. Hollows are formed by a variety of natural causes such as wind, heat, fire, lightning, rain and attack from insects such as termites and beetles, fungi, bacteria and so on. Whilst the external, living part of the tree may remain healthy, injuries to the protective inner bark may allow the entry of fungi (which can cause wood decay) and chewing insects such as termites. Termites usually enter trees at points where fungal wood decay has already started. Fire can contribute to the initial cause of injuries and the creation of hollows in trees. An intense fire or an area that has been subject to repeated burns can lead to a shortage of hollows for wildlife but can also assist in the process of hollow formation.

Most species of eucalypts and other long-lived Australian trees produce hollows. Eucalypts usually self-prune, shedding their lower branches as they grow exposing the point of branch attachment. Or branches may break in storms or high winds. These openings may eventually develop into hollows.

Valuable hollows for wildlife are generally found in mature and dead trees. Openings range from as small as 2 cm to as large as 75 cm, with depths ranging anywhere from 10 cm to 10 metres. In southeastern Australia 17 % of bird species, 42 % of mammals and 28 % of reptiles use tree hollows. Many of these species have been listed under the Threatened Species Conservation Act 1995.

Generally, small hollows with narrow entrances suitable for small birds and animals such as the brush-tailed phascogale and the eastern pygmy-possum take about 100 years to form. Hollows of a medium size and suitable for animals such as parrots will take around 200 years to form, and the larger and deeper hollows occupied by glossy black cockatoos and other larger animals such as masked owls can take a lot longer.

https://www.environment.nsw.gov.au/resources/nature/Factsheet5Treehollows.pdf

## Stop 7 *Callistemon species* – Crimson Bottlebrush

***Theme Point:*** Alellopathy, i.e. one plant inhibits the growth of another through the release of biochemicals, resulting in either replacement or modification of other species.

**Location:** LHS of the road approaching the Rock Garden before the junction with the main path

Most of us know the bottlebrush, like these on the side of the road. Many of us have them growing in our gardens. One of the more common ones is *Callistemon citrinus,* (now currently called *Melaleuca citrina*). It is the common red bottlebrush or crimson bottlebrush. It occurs naturally in eastern Australia. It is a hardy and adaptable species, common in its natural habitat. It is widely cultivated, not only in Australia. It was one of the first Australian plants to be grown outside the country, having been taken to England in 1770 by Joseph Banks. Its showy red flower spikes, present over most of the year in an ideal situation, account for its popularity. Now it is a popular plant grown in many places in the world.

However, its roots have a secret. They have a defence mechanism for the plant to prevent other plants growing nearby. In the case of this callistemon, a chemical is produced by the roots. It enters the soil and supresses the germination of many broad-leaved plants. Scientific investigation led to the development of a herbicide called Callisto.

**Background**

In 1977, a biologist working in California, noticed that very few plants were growing under the *Callistemon citrinus* bushes in his garden. The extent to which weeds were suppressed was out of proportion to what he expected from shading or leaf litter.

What he had observed was a phenomenon known as allelopathy. This is a process in which an organism produces one or more biochemicals that influence the germination, growth, survival, and/or reproduction of other organisms.

The scientist in the USA took samples of soil from the area immediately beneath the *Callistemon citrinus* and used a series of extractions in an attempt to isolate the allelopathic agent. As a result, he identified a compound called leptospermone, produced by the roots of the bottlebrush. Further investigations confirmed its herbicidal properties. Leptospermone did in fact kill certain other plants. That meant that under the bottlebrush, fewer plants germinated and so there was less competition for soil moisture and nutrients.

However, further investigations showed that it was unsuitable for development as a commercial herbicide. Using the structure of leptospermone as a lead, a more potent compound called mesotrione was formulated and this became the basis of a new herbicide called Callisto. This herbicide is now on the market to control of broadleaved weeds in cereal crops.

https://bie.ala.org.au/species/https://id.biodiversity.org.au/node/apni/2899547

https://en.wikipedia.org/wiki/Allelopathy

http://www.regional.org.au/au/allelopathy/2005/2/7/2636_cornesd.htm

## Stop 8 *Grevillea lanigera* Mt Tamboritha form (Woolly Grevillea)

***Theme Point:*** This is another example of mutualism where the plant gets pollinated and the pollinators (birds, insects and possibly mammals) get nectar which is a source of energy for them.

**Location:** S15c – intersection of the main path at the bottom of the rock garden

Many animals and flowering plants have co-evolved to maximise cross-pollination success; in the plants this is most obviously seen in the shapes, coloration, marking and clustering of the flowers. Cross-pollinating species have also evolved various mechanisms to prevent self-pollination.

*G. lanigera* is a member of the Proteaceae family and, like many members of this family, is designed for fertilisation by birds. Grevillea flowers are especially well designed for this as their flowers occur in clusters or inflorescence. Each flower is an elongated narrow tube and has its anthers very close to the insides of the flower tube. The male anthers release the pollen which sticks to the stigma which then becomes the 'pollen presenter' protruding from the tube.

A honeyeater, accessing the nectar, brushes its head against the pollen presenter and flies away with pollen on its head to another flower that may already have a receptive stigma. Once the pollen has been removed from the stigma it changes from a pollen presenter to a pollen receptor. A number of Grevillea species rely on other methods of pollination, eg, beetles, moths, bees, ants, and even small marsupials.

**Distribution and habitat:**

*G. lanigera* occurs from Wilsons Promontory in SE Vic north to the south coast of NSW and nearby mountain ranges. The foliage can appear hairy – hence common name of woolly grevillea.

Two common forms of Grevillea inflorescences are toothbrush and spider, as this one is.

Grevillea lanigera 'Mt Tamboritha' - Wikipedia
Grevillea - Australian Native Plants Society (Australia) (anpsa.org.au)

**Of Interest**

Plants attract mutualistic animals by offering a reward of nectar. Specifically, floral nectar is produced to attract pollinators, whereas extrafloral nectar mediates indirect defences through the attraction of mutualist predatory insects to limit herbivory, e.g. Acacias. Nearly 90% of all plant species, including 75% of domesticated crops, benefit from animal-mediated pollination, which is largely facilitated by floral nectar. Moreover, extrafloral nectar represents one of the few defence mechanisms for which stable effects on plant health and fitness have been demonstrated in multiple systems, and thus plays a crucial role in the resistance phenotype of plants producing it. Review: Nectar biology: From molecules to ecosystems - ScienceDirect

## Stop 9 *Acacia aneura* (Mulga Wattle) and Australian Honey Pots Ants

***Theme Point:*** An example of **MUTUALISM.** The acacia trees produce specialised structures to shelter and feed the ant colony, and the ants, in turn, defend the tree against herbivores by stinging any animals that attempt to munch on the leaves. [I don't think this is correct. See for example Introduction to NSW Wattles which says that the ants which may be observed on Australian acacias are more likely to be associated with the taking of the honeydew excreted by some lerps, scale insects and larvae of butterflies (family Lycaenidae) than preying on insects and protecting the plant from being eaten. ]

**Location:** Rock Garden section 15r - next to the sundial

The Australian Honeypot Ant (*Camponotus inflatus*) is closely associated with Mulga (Acacia aneura) trees, which provide shelter from high temperatures, act as a nectar source, and attract insect prey. The worker ants tend to feed on sap-sucking hemipterans (aphids) living either on the phyllodes or roots of the Mulga trees.

Australian honeypot ants gather nectar from a range of floral sources, but they're thought to prefer a sticky, sweet substance called honeydew made by mulga trees and aphids. After aphids consume the trees' sweet sap, the ants use their antennae to stroke the bugs, which causes them to excrete the honeydew from their anuses.

Worker ants collect this liquid, then feed it to certain other worker ants called repletes, whose bellies swell and become semi-transparent as they fill with the substance. The ants become so stuffed with honey that they can barely move, and they hang from the roofs of their nests. If the colony's food stores run low, the repletes regurgitate what's in their bellies for other ants to feed on.

**Distribution and habitat:** *A. aneura* is widely distributed throughout all mainland states of Australia, with the exception of Victoria. In some arid and semi-arid inland areas, *A. aneura* is such a dominant and conspicuous element of the landscape it has given rise to the terms 'mulga country', or 'mulga lands'.

*A. aneura* grows up to 10 metres as single-stemmed tree in higher rainfall areas, but is a 2-3 m shrub in dry situations or on very shallow soils. Phyllodes are needle-like with very fine hairs giving the foliage an attractive silvery-grey appearance. Small bright-yellow flowers may occur at any time of the year following suitable rains, but the principle flowering time is between March and October. Unlike many acacias which are relatively short-lived, *A. aneura* has a lifespan of over 50 years. It has the capacity to withstand prolonged drought owing to its arrangement of phyllodes and branches which channel rainwater to the stem and onto the ground directly to its deep taproot. Seedlings of only 10 centimeters high have been found to have taproots reaching 3 meters into the ground, in addition to an extensive lateral root system in the top 30 centimeters of the soil.

**Uses:** Some Australian Aboriginal people also harvest honey ants as a sweet food and a medicine.

Honey Made by Ants Could Protect Against Bacteria and Fungi | Smart News| Smithsonian Magazine
Acacia aneura - Growing Native Plants (anbg.gov.au)

## Stop 10 *Triodia sp.* (Spinifex Grass)

***Theme Point:*** Protective habitat for small animals and birds with no particular advantage nor disadvantage for the spinifex, an example of **COMMENSALISM.**

**Location:** Rock Garden section 15e – on left of path, next to the Spinifex sign.

The genus Spinifex grows on coastal sand dunes. The grasses in Central Australia, widely referred to as Spinifex, are actually species of Plectrachne or Triodia. Triodia species are slow-growing perennial grasses endemic to Australia. They grow in tussocks or hummocks. As the plants age the centre of the hummock may collapse, and rings are formed with dead material surrounded by live leaves. It has recently been discovered that the dead interiors are caused by harmful soil pathogens (microbes) building up in the centre of the clumps.

Triodia species were originally called Porcupine Grasses because of their leaf blades, so strongly inrolled as to appear cylindrical. Spinifex Grass has sharply pointed leaves that are awl-shaped with a tapering point, making tussocks impossible for larger animals to enter and therefore providing protection for small animals and birds.

Spinifex is home to a lot of fauna. It provides shelter to insects, small marsupials to skinks, snakes and small birds. The huge variety of insect life that lives within a clump means that it is a well-stocked larder for any species that can forage within it. The Striated and Carpentarian grass wrens spend most of their time in and around Triodia tussocks, feeding on insects and seeds. When predators appear, they dart inside the tussocks for protection. Even emus nest in the centre of spinifex rings, which offer their chicks protection from foxes and other predators. The spiny rings also protect many small delicate plants from grazing animals.

**Uses:** Spinifex has had many traditional uses for Aboriginal Australians. Several species were (and are) used extensively as materials for basket weaving. The seeds were collected and ground to make seedcakes. Spinifex resin was an important adhesive used in spear-making. Burning spinifex produces a strong black smoke, and smoke signals made in this way were an effective means of communication with families and groups over substantial distances.

The species *Triodia wiseana* is used for building shelters; bunched together it is used for trapping fish against creek beds.

Triodia (plant) - Wikipedia
Hard spinifex or lobed spinifex - Alice Springs Desert Park
Mysterious spinifex grass rings of the Australian outback may be caused by microbes - ABC News
RCG_Handbook_v26May19_1.docx (live.com)

## Stop 11 *Podocarpus elatus* - plum pine, brown pine, Illawarra plum

***Theme point:*** An example of mutualism where birds eat the fruit and spread the plant seeds.

**Location:** After the spinifex, leave Rock Garden passing the seat. This plant is straight ahead at the edge of the Rock Garden in section 79.

Many rainforest birds will feast on the fruit, including Green Catbirds, Wompoo Fruit-Doves and pigeons, helping the plant in seed dispersal and providing a boost of fertiliser as they pass the seeds. Many parrots will also feed on the seeds. Here in the gardens, currawongs are known to consume the fruit and seed of the *podocarpus.* However, rather than the seed passing through the bird's digestive tract, the currawong stores the seed in its crop and heads to water for a drink after feeding. It then empties its crop and while some of the crop contents may fall in the water, some seeds will fall on soil and may germinate which is why a small forest of *podocarpus* seedlings may be found near water.

**Description:** *Podocarpus elatus* is a medium to tall tree with brown fissured bark and shiny dark green leaves. It generally produces single seeds attached to branches by swollen, fleshy, plum-like, stalks (receptacles). The fruiting receptacles form a blue-black, fleshy, "plum", while the seed sits outside on the end of the receptacle.

**Of interest:** When we hear the word conifer, we immediately think of trees that produce seeds in cones. The *Podocarpus* genus is a striking exception, where two to five fused cone scales form the fleshy, berry-like coloured receptacles. There are more than 100 species of *podocarpus* in the world today. The genus first appeared in the fossil record in the Early Triassic, 250 million years ago, prior to the break-up of Pangaea. Podocarpus plants are fire tolerant (unlike most other conifers).

*P. elatus* is dioecious, with male (pollen) cones on male trees, and single (rarely double) ovules produced on female trees.

**Distribution and habitat:** It grows in littoral, dry and sub-tropical rainforests, often on enriched soils but can also be found in sandstone environments, from Jervis Bay in NSW north to Gladstone in Qld with disjunct patches between Rockhampton and Coen on Cape York Peninsula.

**Uses:** The fleshy receptacles ("plums") were eaten by Aboriginal people. The fruit can be eaten raw or made into a jam or jelly. They're often used as a compliment for chilli, garlic, sauces and marinades, and are especially popular in sauces, preserves, muffins, cheesecakes and fruit compotes. When cooking with Illawarra Plums, stainless steel utensils are recommended over aluminium to prevent bitterness.

Andy Rawlinson, personal communication.

https://www.mq.edu.au › arboretum › Plants
PDF
Podocarpus elatus (brown pine) description (conifers.org)
Australian Conifers (anbg.gov.au)
Illawarra Plum - Podocarpus elatus - Tucker Bush
The Temperamentally Fruiting Plume Pine: Podocarpus elatus – Mallee Design

## Stop 12 *Macrozamia communis* - Burrawang

***Theme point:*** An example of Mutualism. The plant provides thrips or weevils with a food source and safe haven and they, in turn, enable pollination of the plants.

**Location:** After stop 11, move to the left towards the Section 105 sign and then take the path to the right – on the left next to a large stump.

Macrozamias are dioecious, i.e. male and female plants are separate. On the male plant, the strobili, often called cones, are home to generations of weevils or thrips. When a female cycad is ready to be fertilised, it emits a pheromone.

The male cycads in the vicinity detect the smell and an interesting process occurs. The male cones heat up through a process called thermogenesis. The temperature increase can be up to 16°C. This makes the male cone very unpleasant for the weevils and thrips. So they leave, carrying a load of pollen stuck to their hairs. They also detect the female pheromone and visit the female cone and the pollen they are carrying fertilises the female ovules.

Once fertilised, the female plant ceases to emit the pheromone and the nearby male plants begin to reduce the heat in their cones. However, the female plant now increases the temperature of its cones to deter the insects so that they do not remain to eat the developing seeds. The insects leave the female plant and return to the males.

Some *Macrozamia* species are pollinated only by thrips from the genus *Cycadothrips* and some are pollinated by both thrips and weevils.

**More Detail:**

In a 2001 study of this cycad, it was observed that larvae of both Cycadothrips and Tranes weevil developed in male cones. Cycadothrips adults and larvae fed on pollen, while Tranes weevil adults fed mainly on the tissue of the male cones but some pollen and weevil larvae fed on cone stem tissue.

- Ancient plant – fossil record to Permian, 280ma. Jurassic period common. Changed very little since then. 2020 study suggests that a push-pull pollination mutualism strategy is ancestral in this ancient, dioecious plant group of cycads.
- Gymnosperm (naked seeded) i.e. unfertilized ovules are open to the air to be directly fertilized by pollinators. (Flowering plants have enclosed ovules) Grow very slowly – some specimens over 1000 years old.
- Cylindrical trunk. Leaves grow directly from trunk, fall when older leaving a crown of leaves at top. Leaves large in proportion to trunk. Wide variety of leaf shapes, cones and seeds. Similar in appearance to palms and ferns but only distantly related to either.

**Uses:**

- A food source eaten by some indigenous tribes. It poses a health risk, as the seeds have to be ground and soaked to remove toxins. Eating bush animals that have eaten cycad seeds is also risky.
- Used as decoration during festivals and celebrations

Macrozamia and their Pollinators - Land for Wildlife (lfwseq.org.au)
Thrips and Weevils as Dual, Specialist Pollinators of the Australian Cycad Macrozamia communis (Zamiaceae) | Request PDF (researchgate.net)
An ancient push-pull pollination mechanism in cycads | Science Advances
Macrozamia communis - Wikipedia
Coralloid root | plant anatomy | Britannica

## Stop 13 *Armillaria luteobubalina* (Honey Mushroom)

***Theme point:*** An example of parasitism, where the fungus gets its energy from the plant and may eventually kill it.

**Location**: In section 123 above section 17 (triangular bed)

Armillaria is a fungus. As such, it cannot photosynthesise and so needs to form a relationship with a plant to get energy. In most cases, this relationship between fungus and plant can be mutually beneficial with the fungus giving the plant access to nutrients. However, sometimes this relationship becomes sinister.

*Armillaria luteobubalina* is such a fungus. It is one of the main fungal diseases present in the Gardens. It is spread by root-to-root contact. It causes dieback or death in most woody shrubs and trees that it infects. It destroys the plant roots in the cooler months, and, in the warmer months, the plants fail due to a compromised root system. Annuals are not so susceptible, as they are planted with their pre-existing soil and die naturally before the *Armillaria* can reach their roots.

*Armillaria luteobubalina* occurred naturally on the ANBG site before the Gardens' development. It would have maintained a stable population in Black Mountain vegetation without having the ability to increase in size and therefore kill off surrounding vegetation. Changes to soil composition including fertility, water regimes and increased food source (more plants) have enabled it to become a problem in the ANBG. It is a real "Botanic Gardens disease".

The fruiting bodies of the fungus appear in colonies of honey-coloured mushrooms on dead stump, old wood or large woody roots. They drop white spores.

This bed was infected with the fungus and has undergone remedial treatment. The treatment in this bed involved removal of all plants for several years, removal of fruiting bodies, trenching along the rainforest road to prevent spread and non-movement of soil. Now, the bed has been rehabilitated. This part has been planted with *Prostanthera cineolifera or Singleton* mint bush, in February 2021.

New treatments for Armillaria no longer involved clear felling of an area. In a recent treatment, a trench of 3-4 metres was dug, a plastic root barrier applied at the bottom and treatments of the herbicide Casuron applied as layers were filled in. Other treatments include inoculating tree stumps with Brown Rot fungus which may out-compete Armillaria and the use of Trichoderma, another fungus, to kill the Armillaria.

Armillaria is a genus of fungi. There are about 10 species worldwide. *Armillarias* are long-lived and form the largest living fungi in the world. The largest known organism (of the species *Armillaria ostoyae*) covers more than 3.4 square miles (8.8 $km^2$) in Oregon's Malheur National Forest and is estimated to be 2,500 years old. Some species of *Armillaria* display bioluminescence.

https://www.anbg.gov.au/gardens/about/management/policy-docs/Armillaria-Strategy-2003-2013.pdf

https://www.anbg.gov.au/gardens/living/horticulture/disease.html#arm

https://en.wikipedia.org/wiki/Armillaria

## Stop 14 Epiphytes

**Theme Point:** An example of commensalism, where the epiphyte benefits from the extra sunlight it gets when high up in a tree, but the tree is not affected in any way.

**Location:** Rainforest track

On many of the tree trunks in the rainforest, there are plants growing on the sides of the tree trunks. On this tree trunk, you can see several. There are different types of ferns and an orchid.

These plants are epiphytes. An epiphyte is a plant that grows on the surface of another plant but that derives its moisture and nutrients from the air, rain or from debris accumulating around it. It takes nothing from the other plant. The tree trunk only provides a place, a location for the epiphyte. It is not harmed in any way at all. The epiphytic plant, on the other hand, gets the benefit of being able to access more sunlight than if it was on the forest floor.

Epiphytes are not connected to the soil, and consequently must get water from other sources, such as fog, dew, rain and mist. They get nutrients from decomposing plant material. Epiphytic plants attached to their hosts high in the canopy have several advantages over plants restricted to the ground. Besides being able to get more sunlight for photosynthesis, they are not subject to grazing by ground dwelling herbivores. In Australia, 80% of epiphytes are ferns or orchids.

Epiphytic plants, in their turn, are also important to certain animals that may live in their water reservoirs, such as some types of frogs and insects.

**Of Interest**
Christopher Columbus was the first European credited to have talked about epiphytic plants when he wrote in his log in 1492 that many of the tropical trees 'have a great variety of branches and leaves, all of them growing from a single root'.

In the 17$^{th}$ century, most of the plants transported from the tropics to Europe were epiphytic species of orchids, bromeliads, aroids, ferns and others. Not only were they attractive, with highly ornamental foliage, inflorescences and flowers but they were a small and manageable size at maturity. Also they were often strongly drought tolerant with minimal nutrient needs and thus thrived on neglect, an important necessity of indoor plants for people who appreciate their beauty without appreciating cultural requirements, or are forgetful or neglectful.

https://en.wikipedia.org/wiki/Epiphyte

https://rune.une.edu.au/web/bitstream/1959.11/23348/4/open/SOURCE03.pdf

https://rune.une.edu.au/web/handle/1959.11/23348

## Stop 15 Bracket Fungus

**Theme point:** An example of parasitism where the fungus benefits from a living host, which is damaged by the presence of the fungus. However, if the fungus is on a dead tree, it can have beneficial effects by returning nutrients to the soil.

**Location:** On the right, walking down the rainforest path on an S-bend, just before the seat, there is a tree stump with bracket fungi on it.

The part of a fungus we see, the bracket, is the reproductive structure. The bracket has many pores lined with spore-producing cells called basidia, instead of the gills that you see in a mushroom. But the reproductive structure is only a fraction of the total fungus. The main body of the fungus is made up of many fine threads called hyphae that group together to form a vast network called a mycelium. Mycelium exists behind the scenes in dead organic matter and in plants. Mycelium travels through the wood via the vertical vascular system, breaking down fibres and causing them to rot.

Because fungi have no chlorophyll, they cannot source their energy from the sun via photosynthesis. Instead, fungi release enzymes that digest organic matter and then absorb it as sugars directly through their mycelium. Fungi store their food reserves as glycogen, while plants store them as starch.

Bracket or shelf fungi grow on live trees, fallen tree trunks or dead stumps, feeding on the host, helping break down rotting material to return as nutrient to the soil. Bracket fungi play an important ecological role in decomposing wood by breaking down cellulose. However, in live trees, the fungus can cause heart rot, so-called because the mycelium feeds on the heartwood.

A bracket fungus like this on a tree has probably been at work inside the tree for a number of years before it has developed enough energy to create a fungal bracket or the fruiting body.

**Of interest:** Whereas plant cell walls are made of cellulose, most fungi have cell walls that are made up of chitin, the same substance that is found in the external skeleton (exoskeleton) of insects and shells of crabs.

**Distiribution:** Bracket fungi occur in forests worldwide.

**Uses:** The bracket fungus *Laetiporus* portentosus, also known as white punk fungus, was burnt by indigenous people and used to repel insects such as mosquitoes. Dried, it has been used traditionally as a fire-starter or tinder and to carry fire by Indigenous Australians and by New Zealand Māori people

https://www.kew.org/read-and-watch/the-wonderful-world-of-fungi#:~:text=Unlike%20plants%2C%20fungi%20are%20unable,matter%20and%20then%20absorb%20it.

https://treeamigosvictoria.com.au/bracket-fungi-arborists-melbourne/

Fuher, Bruce, A field guide to Australian fungi, Bloomings Books, 2016

Ngunnawal plant use: a traditional plant use guide for the ACT, ACT Government, p 87

## Stop 16 Tree Ferns: *Cyathea australis, Cyathea cooperi*

***Theme point:*** In another example of commensalism in the wild, lyrebirds sometimes use tree ferns as a nesting site, giving no benefit to the plant, but providing a useful nesting site to the birds.

**Location:** Continue down the path, opposite the next exit is an Aboriginal Plant Trail sign on right. Ferns are behind this.

***Description:*** Here we are looking at *Cyathea australis* (Rough tree fern) on the left and *Cyathea cooperi* (Lacy tree fern) on the right. Another common tree fern species of south eastern Australia is *Dicksonia antarctica.* Lyrebirds sometimes use tree ferns as a nesting site. The female builds a dome-shaped nest of sticks, which can be on the ground, on rocks, within tree stumps, in tree ferns or even in caves. The nest is lined with ferns, feathers, moss and rootlets, including the fine roots you can see on the trunks in front of us.

In contrast, not all birds have a commensal relationship with tree ferns and the crimson rosella is a common predator, including the sori, spores and frond pith in its diet. They can often be seen feeding in the tops of the tree ferns below the bridge near the café.

**Distribution:** *C. australis* and *D. anatarctica* are found along much of the east coast of Australia, extending right down into Tasmania. *C. australis* prefers moist mountain areas and can grow on dryer slopes then most other tree ferns. *C. cooperi* is naturally found in tropical lowlands, along the coast of Qld and NSW. *D. antarctica* lives in wet sclerophyll forests, along creek beds, in gullies and occasionally at high altitudes in cloud forests.

**Challenge:** The strong fibrous stems of the tree ferns retain moisture well (one of the reasons they don't burn easily in bushfires) and they are often host to a range of smaller epiphytic ferns and mosses - another commensal relationship.

See if you can find some of these mini ecosystems on the *Dicksonia antarctica* along the road near the café.

**Of interest:** When the Great Flight Aviary in the Melbourne Zoo was first opened, it had a lot of Tree-ferns. They lost the lot - because all the parrot species thought they were ideal as nest-sites. The birds burrowed down from the centre of the top, effectively destroying the growth centre of the fern.

Magrath and Lill (1983) The use of time and energy by the CR in a temperate wet forest in winter. Australian Journal of Zoology 31: 903-12.

Tree Ferns (unsw.edu.au)

Tree ferns are older than dinosaurs. And that's not even the most interesting thing about them (theconversation.com)

Lyrebirds | NSW Environment and Heritage

## Stop 17 Orchids

***Theme point:*** An example of mutualism involving fungi and orchids.

**Location:** On the rainforest verge, just up from the café, opposite the 'No Vehicles Beyond This Point' sign.

While many of us think of orchid flowers as large and colourful, here, you can see an orchid with delicate flowers. Orchids have some of the smallest seeds in the plant world.

Orchids and mycorrhizal fungi have a complex symbiotic association where each stage of the orchid's life is dependent at some level on specific fungi. In the earliest stages, orchids rely entirely on their mycorrhizal fungi for all nutrients, including carbon.

Most plants produce seeds that have a 'packed lunch' on board, a cache of nutrients to feed the seed as it germinates. It is called endosperm, food that the germinating seed can use as it sprouts. Orchid seeds do not have this.

So when an orchid seed germinates, it needs some help. An orchid seed does not have enough nutritional support to grow on its own. Instead, it gets nutrients needed for germination from fungal elements in natural habitats. The young orchid is so reliant on the fungus that it must wait for the fungus to invade its seeds before the orchid begins to germinate. This relationship between the orchid plant and the fungus is complex and the process is unique to orchids. It is a partnership, a symbiotic process, where the juvenile orchids rely on special fungal organisms to supply them with carbohydrates and in exchange, the fungi receive moisture and access to organic matter.

Many orchid species keep up a partnership with a fungus for their whole life and do not develop any green parts that can photosynthesize. Others, like these plants, do

Orchids continue to rely on the fungus as they begin to grow but as they mature, many produce their own food source.

**Of interest**
Visitors may like to compare pumpkin seeds which include endosperm with the tiny dust-like seeds in vanilla pods, which are the seed pods of an orchid.

Orchids, Fungi & Symbioses | Smithsonian Environmental Research Center (si.edu)
Orchid mycorrhiza - Wikipedia
Orchid seeds: Nature's tiny treasures | Kew
(PDF) New Insights into the Symbiotic Relationship between Orchids and Fungi (researchgate.net)
The Proper Relationship Between Orchids and Fungus - The Orchid Resource