Australian National Botanic Gardens

Teachers' Notes

Module 2

Plant Structure

We acknowledge the Traditional Owners of Country throughout Australia and recognise their continuing connection to land, waters and culture. We pay our respects to their Elders past, present and emerging.

Plant Science Learning Hub

Students need a space to learn that is fun and rewarding. The Australian National Botanic Gardens has developed a Plant Science Learning Hub that aims to inspire and engage students in plant science and the stories surrounding Australian flora. With clear links to the Australian Curriculum for school years four to six, the Plant Science Learning Hub will provide a valuable resource for students and educators.

1. Plant Life Cycles
2. **Plant Structure**
3. Pollination
4. Seeds

This series provides educators with authoritative plant science content that has a uniquely Australian perspective. The Gardens manages globally significant scientific collections of living plants and herbarium specimens of Australian native flora. We provide educational experiences for students from pre-primary to tertiary levels, leveraging our scientific collections, participation in national and international conservation projects and outreach programs to engage the community in valuing, conserving, and appreciating Australia's diverse plant heritage.

Document overview

This document provides educators with supporting notes for the **Plant Structure** module. It focusses specifically on flowering plants native to Australia.

- Flowers facilitate plant reproduction and provide pollinators with food.
- Flowers come in many shapes and sizes but they all have the same basic structures and functions.
- The female part of the flower is called the **pistil** (comprising the stigma, style, ovary and ovules) and the male part is called the **stamen** (comprising the filament and anther).
- Plant and flower structures vary according to environmental factors and pollinator interactions.
- Australia's native plants provide an insight into the variable nature of flower forms.

Module Learning Objectives

The following learning objectives apply to the Plant Structure Module.

1. Identify the basic structural elements of a generalised flowering plant.
2. Identify the structural elements of several specific Australian plants.
3. Understand the functions and parts of a flowering plant.
4. Explore links between plant structure and the physical environment.

Each lesson within the lesson plans and the field kits has individual learning intentions appropriate to the activity.

Contents

INTRODUCTION TO PLANTS

Plant morphology describes the physical features and appearance of a plant, also known as plant structure. Examining their morphology allows us to identify and **classify** plants according to the features they have in common, helping us to understand how plants are related in Australia and across the world. This material focuses on the features of Australian native flowering plants (**angiosperms**).

Classifying and naming plants

Plants are known to most people by their **common name**, such as Blue Gum or Waratah, but this can be confusing when different plants are known by the same name or when the same plant has different common names in different parts of the country. To avoid this confusion every plant has a unique **scientific name** that allows it to be identified. These names form part of the **hierarchy of classification** that all living things are grouped by, which includes a descending series of ranks known as Kingdom, Phylum, Class, Order, Family, Genus and Species. A scientific name describes a plant's genus and species classification. For example, the plant known commonly as Sticky Paper Daisy has:

- the genus name *Xerochrysum*, written with an upper-case X,
- the species epithet *viscosum*, written with a lower-case v and
- the species name *Xerochrysum viscosum*, which joins the genus name and species epithet together.

Scientific names allow people to make informed decisions about the plants used to make foods, medicines and tools, ensuring that they are safe and effective. Scientific names also allow people to make accurate decisions about plants, such as:

- farmers identifying and removing specific weeds in their crops,
- conservationists choosing native species to replant and regenerate an environment and
- scientists conducting research on environments, ecosystems, plants or animals.

Identifying plants

Identifying a plant using its structure is not always simple and can require observation of several of its physical features, including bark, leaves, roots, flowers, fruits, and seeds. To identify a plant you can look at books, compare it to illustrations, ask an expert, upload a photo to an identification app or use an **identification key**. Using a key involves answering questions or statements about the plant's features to progressively narrow down the species, such as:

- Leaf edges have teeth vs
- Leaf edges are smooth
- Bark is smooth vs
- Bark is rough

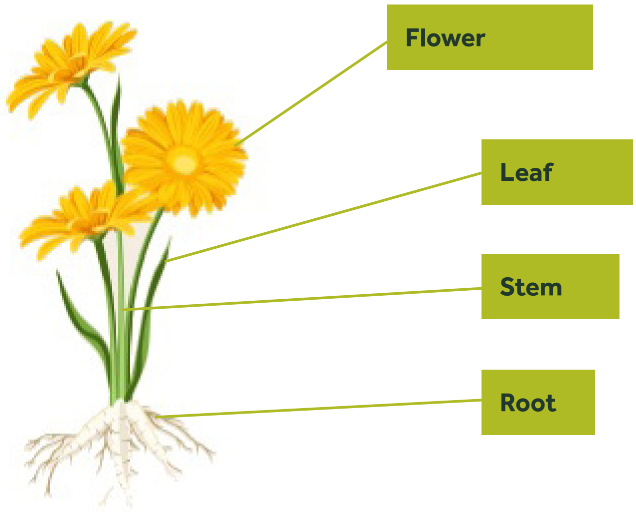
The structure of a generalised flowering plant

Different plant species look different but are structurally similar. Most flowering plants have the structural elements listed below.

- A **root system** to stabilise the plant and absorb water and nutrients from the soil.
- A **stem** to support the branches, leaves, flowers and fruits and carry water and nutrients absorbed by the roots to all parts of the plant.

- **Leaves** to produce food for the plant. Leaves are structures that are often flat, but sometimes can be curled or folded, and are attached to the stem of the plant. Leaves allow the plant to **photosynthesise** to produce sugar to fuel the plant's growth.
- **Reproductive structures** such as flowers enable the plant to develop seeds and fruit in order to reproduce.

Flowering plants are also **vascular** plants, meaning they have a **vascular system** of internal tubules that run from their roots to their leaves. This system is made up of special tissues called **xylem** and **phloem** and carries water, nutrients, minerals and important chemicals around the plant's 'body'.



The basic structural elements of a flowering plant.

Root system

Roots anchor the plant and provide it with access to water, nutrients, minerals and fungi that are essential for their growth and survival. Root systems can be made up of a network of **fibrous roots** or based around one main **taproot**.

Taproot

A taproot is a dominant root that is typically straight, thick, points downwards and has a tapering shape (like a carrot), but they can grow into other shapes (like a radish). Roots grow from the sides of the taproot as well (**lateral roots**), but they are smaller than the taproot itself.

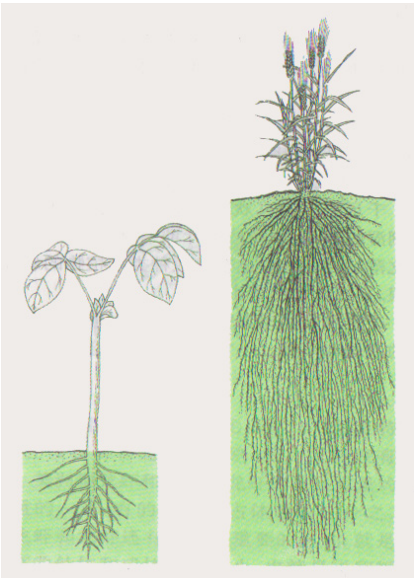
Scientists think that taproots evolved from fibrous roots to allow plants to live in drier environments. Because taproots grow downwards they can provide plants in dry areas access to water deeper in the soil profile, such as groundwater. Taproots can also store food and nutrients for the plant to access during tough conditions associated with dry environments.

Taproots are found in **gymnosperms** (like pine trees) and **dicotyledons** (dicots), plants that sprout with two cotyledon leaves instead of one. You can find plants with taproots in your garden or kitchen, such as dandelions, carrots, radishes or beetroot!

Fibrous roots

Fibrous root networks generally form dense mats made up of many thin roots. Unlike taproots, fibrous roots remain relatively shallow in the soil profile, so they do not provide plants with access to deeper water. As such, fibrous roots are better suited to wetter environments. The mat network can help to hold soil together and prevent erosion of the upper soil layers, which is especially beneficial in the wetter environments they are suited to.

Fibrous root systems occur in **monocotyledons** (monocots), plants that sprout with one cotyledon leaf. They are commonly found in grasses like rice and wheat, and other plants like bananas, asparagus and onions.



Left, a taproot with lateral roots.
Right, fibrous roots.

Image: CRCHF, CC BY-SA 4.0, via Wikimedia Commons

Stems

Stems provide support for leaves, flowers and fruits and allow nutrients, minerals and water to travel around the plant. Some stems are soft and **herbaceous** (e.g. in herbs) and others are hard and woody, like the stems in trees and shrubs. Stems can also be **unbranched** (single stem) or **branched** (divisions and side stems). Palm trees and cycads have unbranched stems, whereas tomato vines and pine trees have branched stems.

Stem types

Stems are categorised according to where they grow: **underground**, **aerial** or **subaerial**.

Underground stems remain under the ground, store food and nutrients and are often capable of **asexual reproduction** (genetic cloning). Rhizomes, tubers and corms are forms of underground stems and some that are commonly seen in the kitchen include potatoes (tubers) and ginger (rhizomes).

Aerial stems grow above the ground, often vertically, and are the most familiar stem form. Modifications to aerial stems include **tendrils**, **thorns**, **bulbils** and **cladodes**. Thorns can be seen on rose bushes and tendrils on passionfruit vines. Bulbils are modified buds that can drop to the ground and grow into a new plant, such as those on agave succulents. Cladodes (or phylloclades) are specialised aerial stems that occur in some dry-adapted plants. To minimise water loss these plants have very small or absent leaves and the phylloclades undertake photosynthesis instead. Many cacti have cladodes ("pads") which can grow into a new plant if they become detached.

Subaerial stems grow just above the ground and include **runners**, **offsets**, **stolons** and **suckers**. Runners grow parallel to the ground and can help a plant to spread by putting down roots.

Offsets, stolons and suckers function similarly to runners but grow at different orientations to the main stem. These structures allow a plant to reproduce asexually.

Thorns on a *Vachellia nilotica* subsp. Indica. Note this is not a native Australian plant species.

Image: ©M.Fagg, 2013

Leaves

Leaves are attached directly to stems or via a 'leaf stem' called a **petiole**. Vascular tissues (**xylem** and **phloem**) run through the veins of the leaf, providing structural support and allowing nutrients and water to move through the leaf. The main functions of leaves include **photosynthesis**, **transpiration**, storage, **guttation** and plant defence.

Leaves are green due to a substance called **chlorophyll** which plays a vital part in photosynthesis. Chlorophyll allows leaves to combine energy from the sun, carbon dioxide and water to produce sugar and oxygen. This provides food for the plant, allowing it to grow and produce flowers and fruit.

When leaves open their stomata (pores) to acquire gases for photosynthesis a lot of water is lost to the atmosphere. This process is called transpiration, and a plant can lose up to 99% of the water taken up by their roots in this way. Dry-adapted plant species have developed ways of reducing water loss by transpiration, such as:

- having hairy, thick or waxy leaf **cuticles** (surfaces),
- being a lighter colour,
- having small leaves, and
- having no leaves and photosynthesising through specialised leaf or stem structures instead (e.g. cladodes).

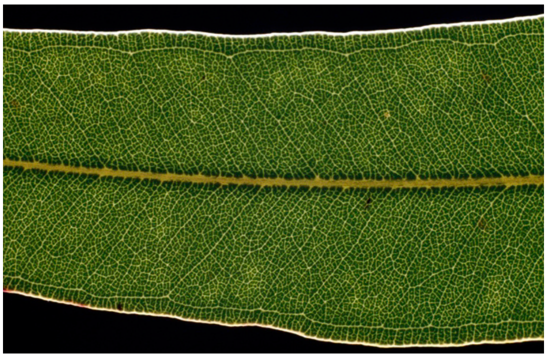
Leaves can be a storage site for sugars, minerals, nutrients and important chemicals.

Guttation describes the release of sap from leaf edges and tips. This occurs when leaves have an excess of fluid built up in their vascular system and need to release it.

Leaves are a target for herbivores looking for food, but a plant will have difficulty making food through photosynthesis if its leaves are damaged or absent. To reduce the risk of this, leaves can be poisonous, spiky, thorny, rough, tough or produce irritating hairs or chemicals to deter the animals trying to eat them.

Eucalyptus pauciflora leaves.

Image: M.I.H.Brooker©CANBR,1994



Close up of a *Eucalyptus* leaf.

Image: Brooker and Kleinig©ANBG

Flowers

The primary function of flowers is reproduction. Flowers also provide food to pollinators and seed dispersers in the form of nectar, pollen, seeds and fruit.

The flowers of monocots tend to have features occurring in multiples of three, and those of dicots tend to have features occurring in multiples of four or five.

This can be observed in the following images:

This Slender Wire Lily has three sepals (that look like petals), three petals and six stamens, indicating it is a monocot.

Image: ©M.Fagg, 2020

This *Leptospermum* 'Rudolph' has five petals and five groups of stamens indicating it is a dicot.

Image: ©M.Fagg, 2005

A more detailed overview of flower anatomy and function is provided below.

WHY DO PLANTS HAVE FLOWERS?

The primary purpose of flowers is for plant **reproduction**. After pollination, flowers develop into fruit to protect their seeds and aid in their dispersal. Many flowers rely on animal **pollinators** to facilitate reproduction, often using **visual cues** to attract them. Many of the relationships that have evolved between plants and pollinators are **symbiotic**, meaning that the two organisms work together for the benefit of each other.

Although flowers have the same basic parts and functions, they can look very different due to environmental conditions and their individual pollinator relationships. Some of the interactions between Australian flowers and their pollinators are outlined below.

Large, showy flowers

Gymea Lily (*Doryanthes excelsa*) does not keep its flowers a secret! It produces flower spikes up to six metres tall that display flower heads up to 30 centimetres in diameter. Each individual flower is about 10 centimetres in diameter and stands out at a distance due to their showy pinky-red colouring. The Gymea Lily's impressive flowers attract nectar-seeking pollinators including birds and bees.

A *Doryanthes excelsa* flower spike can grow up to six metres tall!

Image: M.Plumley©ANBG,1996

A *Doryanthes excelsa* flower head contains multiple flowers and can reach up to 30 centimetres in diameter.

Image: ©M.Fagg, 2009

Alluring scents

We often associate flowers with pleasant aromas, but flower scents are not intended to attract people. Many species of thynnid wasps are routinely tricked by the scents produced by **sexually deceptive** orchids, such as the Brown-clubbed Spider Orchid (*Caladenia phaeoclavia*). By producing a scent that mimics the **pheromones** of a female wasp the orchid flowers deceive male wasps into attempting to mate with them, allowing the orchid to be pollinated in the process.

A male thynnid wasp (*Lophocheilus anilitatus*) attempts mating with a Brown-clubbed Spider Orchid (*Caladenia phaeoclavia*) flower.

©T.Hayashi

Flower shape

The shape of a flower can help or hinder certain pollinators in accessing its pollen and nectar. Some species of *Epacris* have brightly coloured, tubular flowers that encourage birds with thin, dexterous beaks such as honeyeaters and spinebills to visit and pollinate them.

The flowers of *Epacris impressa* are bright red-pink and tubular.

Image: ©M.Fagg, 2008

The tubular flowers of a Kangaroo Paw allows birds like this to pollinate them.

Image: ©B.Harvey, 2023

Buzz pollination

Some Australian plants require the specialised act of **buzz pollination** to release their pollen. This involves bees vibrating hundreds of times per second to shake pollen from a flower, allowing them to collect it and transport it to another flower. Buzz pollination cannot be performed by European European Honey Bees (*Apis mellifera*), instead being undertaken by native species including Blue Banded Bees (*Amegilla* species) and Carpenter Bees (*Xylocopa* species).

A native Blue Banded Bee 'buzz pollinating'

Image: ©S.B.Rogers, 2018

A native Blue Banded Bee can be seen on a plant stem.

Image: ©S.B.Rogers, 2022

Hidden colours

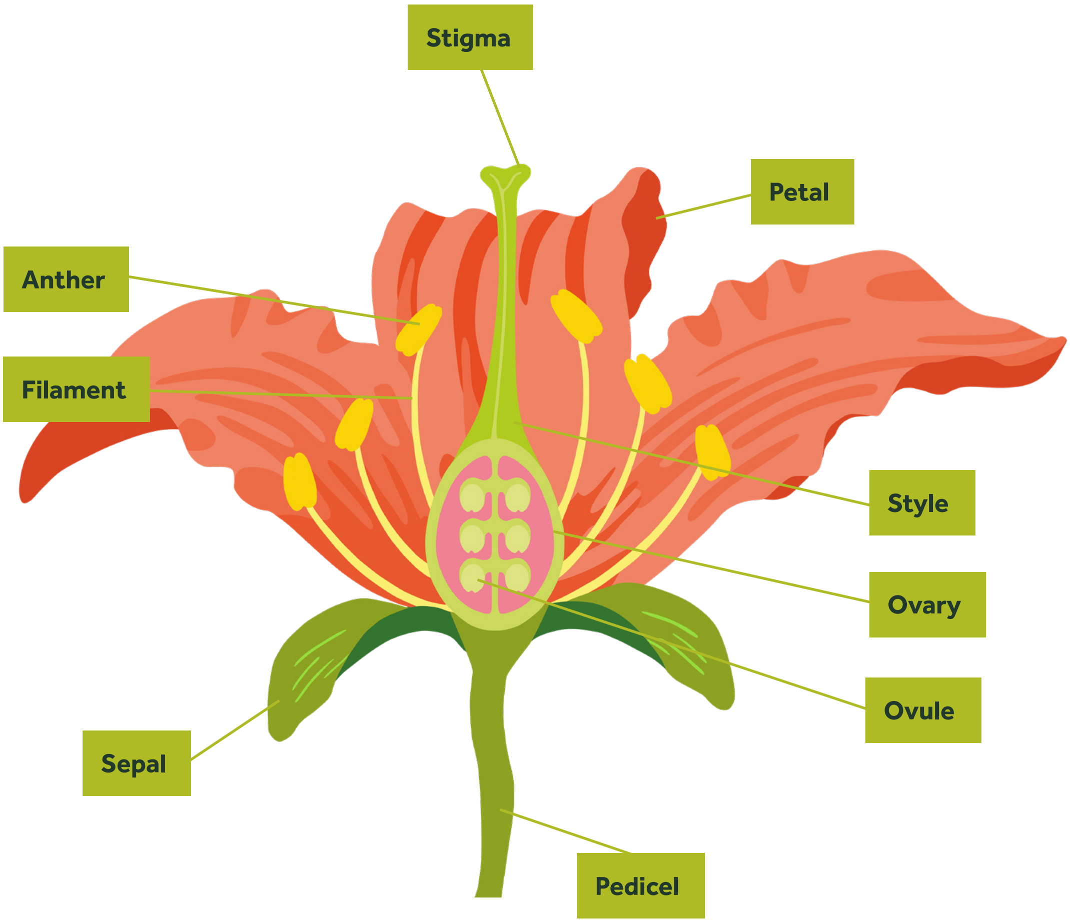
Pollinators do not see colours in the same way that humans do. Ultraviolet (UV) light is outside of the visible range for humans but within the visible range for many insect species. **Nectar guides** direct pollinators towards the flower's nectar and pollen but are often only visible under UV light. Bees and other pollinators often perceive nectar guides as dark 'pathways' towards the food, but they are hidden to humans.

Goodenia alba flower as seen by human eyes on the left and under UV light on the right.
The UV light shows nectar guides that only insects can see.

Image: ©D.Oldfield

THE STRUCTURAL ELEMENTS AND FUNCTIONS OF A FLOWER

Before a flower opens it is called a **bud**. The outside of the bud is made up of **sepals** which protect the inner parts of the flower. When the flower begins to open the sepals usually remain in place below the **petals**. Once the bud opens and a flower forms you will be able to identify its main parts (as seen in the diagram below).



Sepal - Sepals are usually green and protect the inner parts of the flower in the bud. The sepals open with the petals and usually remain at the base of the flower.

Petal - Petals help to attract pollinators to the flower. The colour and markings of the petals will attract specific pollinator types. Petals also help to protect the inner reproductive parts of the flower.

Tepal - Tepal is a term used instead of sepal and petal when it is not possible to distinguish them from each other, such as when the sepals are enlarged and coloured (not shown on diagram).

Pedicel - This is also known as the flower stem. The purpose of the pedicel is to support the flower. It also helps to elevate the flower and make it attractive to pollinators.

The male parts of a flower:

Stamen - The stamen is the male reproductive organ of the flower. It has two main parts, the pollen-producing anther and the supporting filament.

Anther – The anthers are the pollen-producing organ of the flower. Pollen contains the male gametes, or reproductive cells of a flowering plant.

Filament – The filament is the usually slender stalk that supports the pollen-producing anthers. The filament makes the anthers more accessible to pollinators. Depending on the flower filaments can be short, long or not present.

The female parts of a flower:

Pistil - The pistil is the female reproductive part of a flower. It is usually made up of the stigma, which is at the top and receives pollen; the ovary, which is at the bottom and contains ovules (future seeds); and the style, a stalk-like structure that connects the stigma and ovary.

Stigma - Depending on the plant's pollination strategy, stigmas receive pollen from air, water, insects or other animals. Pollen is tiny and difficult to catch so stigmas have different adaptations to improve their chance of retaining pollen. Some stigmas are hairy or lobed, some have flaps and some are specifically shaped to help catch and trap the pollen.

Style - The style is a stalk that connects the stigma and the ovary, providing a pathway for the male gametes. Once the pollen has been caught by the stigma a pollen tube may grow from the pollen grain, through the style into the ovary, allowing fertilisation to occur.

Ovary and ovules – The ovaries house the ovules, which contain the female gametes. When fertilisation is successful the ovules grow into seeds and the ovary wall often expands into a fruit that encloses the seeds.

PLANT STRUCTURE AND THE PHYSICAL ENVIRONMENT

Plant growth and form is influenced by the environment and over time plants adapt to suit the conditions and geography of their environment.

For example, only plants that have adapted to survive with limited water supply can live in the desert or arid areas. These plants have adapted to these conditions by developing very deep root systems to access deep aquifers, a vascular system that is able to store water, shiny leaves that can reflect excess sunlight, small leaves to reduce their surface area and thick leaf cuticles to further reduce water loss.

Temperature, water, light and air can all influence plant growth and development.

Trees, shrubs and herbs

Plants can grow in different forms, or **growth habits**, depending on the type of plant and its environment. Growth habits can be broadly categorised into **herbaceous plants**, **shrubs** and **trees**.

Herbaceous plants, also called **herbs**, are plants that do not have a woody stem above the ground. Herbs can be annuals, biennials or perennials and will usually die back after flowering in cold climates, but roots, bulbs and other underground structures may remain. The non-woody stems of herbaceous plants are more flexible than woody ones and often remain green. Many ferns, grasses and soft-stemmed plants are herbs, but not all herbs are small: Australian Hollyhock, *Malva preissiana*, is a native herb that grows up to three metres tall!

Herbs evolved more recently than woody plants, appearing within the past 65 million years. The herbaceous habit is beneficial in colder climates, as perennial species can die back above ground and resprout from underground structures after winter. This ability can increase the distribution of a species, as they can grow in cold areas without being adapted to the winter conditions.

Shrubs are plants that are woody and have branches that arise at or near ground level. A shrub's stems and branches are woody because they are made of a hard tissue called **secondary xylem**. Shrubs are mostly perennials, meaning they do not die after one or two flowering seasons, and are often larger than herbs but smaller than trees. Australian native shrubs come in all shapes and sizes, including waxflowers (*Crowea* species) and emu bushes (*Eremophila* species).

In Australia's dry and arid environments shrubs tend to be the dominant growth habit as nutrients and water are limited. The Nullarbor Plain is a famously treeless area stretching from Western Australia to South Australia, in which the poor soils support a limited community of arid-adapted shrub and grass species, including saltbush (*Atriplex* species) and bluebush (*Maireana* species).

Australian Hollyhock, *Malva preissiana*, is an herbaceous plant that can grow up to three metres tall.

Image: ©M.Fagg, 2020

Atriplex vesicaria is one of the arid-adapted species of saltbush that grows across the Nullarbor Plain.

Image: ©M.Fagg, 2013

The Nullarbor Plain is dominated by shrublands.

Image: Bahnfrend, CC BY-SA 4.0, via Wikimedia Commons

Trees are plants that have a single woody stem with branches forming a crown above ground level. Like shrubs, they are perennials and have **secondary xylem** that makes their stems and branches woody. The tallest and oldest plants in the world are trees, and some species grow less than one centimetre per year. The incredible Huon Pine, *Lagarostrobos franklinii*, grows in Tasmania and a plant of this species is Australia's oldest tree. A stand of genetically identical Huon Pine clones on Mt Reed has been growing for 10,500 years and the oldest individual tree is 2,000 years old!,

A Huon Pine (*Lagarostrobos franklinii*) growing in Tasmania is 2,000 years old, making it the oldest tree in Australia!

Note – this is not the 2,000-year-old tree.

Image: ©M.Fagg, 2015

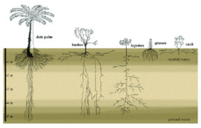
Responding to climatic changes

Being woody may be an advantage in terms of physical stability and strength, but in the past woody plants have taken up to 10 times longer to adapt to changes in climate than herbaceous plants. Scientists believe this could be due to the shorter generation time of herbs, as being able to reproduce faster allows them to respond more quickly to changing rainfall and temperature pattens. The longer generation time of trees and shrubs also means that genetic mutations required for evolution to occur accumulate more slowly in these populations.

While herbs adapted faster than woody plants to historical changes in climate, both groups were eventually successful in adapting to changing conditions. **Anthropogenic climate change** is occurring so rapidly, however, that scientists are unsure if the 'slow and steady' approach of woody plants will be successful under future conditions. This could result in the faster-adapting herbaceous species filling more niches and having greater distributions in the future.

Environment	Environmental features	Roots	Leaves	Stem	Flowers
Rainforest  Image: ©M.Fagg, 2007	High rainfall Low light level at ground Humid Low evaporation rate Little variation in temperature across day/night Little variation in temperature across seasons High density of plants Nutrient-rich soil	Buttress roots spread to stabilise tree and access nutrients (concentrated near the surface)  Image: ©M.Fagg, 2013	Large, flat, waxy, flexible, dark green  Image: ©M.Fagg, 2016	Canopy trees tallest (emergent)  Image: ©M.Fagg, 2012	Large, prominent, often white to be seen in darker environments, strong-smelling, sometimes open at night, sometimes grow on tree trunk (cauliflory)  Image: ©B.Gray, 1987

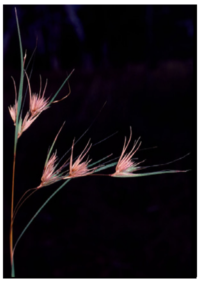
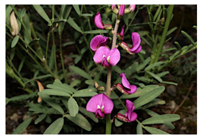
Plant Structure

Environment	Environmental features	Roots	Leaves	Stem	Flowers
Desert  Image: ©M.Fagg, 2009	Low rainfall High light level at ground Dry High evaporation rate High variation in temperatures across day/night Little variation in temperature across seasons Extreme temperatures (high daytime, low nighttime) Low density of plants Low-nutrient soil Rocky Sandy Salty	Taproots, deep roots, many roots  ©Kirschner, Gwendolyn & Xiao, Ting & Blilou, Ikram. (2021). Rooting in the Desert: A Developmental Overview on Desert Plants. Genes. 12. 709. 10.3390/ genes12050709.	Small, pale green or grey, hairy, thick, scaly, powdery, sometimes absent  Image: ©R.W.Purdie, 2016	Pale green, grey or brown, hairy, thick, scaly, powdery, sometimes perform photosynthesis  Image: ©M.Fagg, 2011	Small, often wind-pollinated, sometimes open at night  Image: R.Hotchkiss@ ANBG, 1984

Environment	**Environmental features**	**Roots**	**Leaves**	**Stem**	**Flowers**
Woodland  Image: ©M.Fagg, 2009	Variable rainfall (250-800mm/year) Medium light level at ground Medium density of plants Can be humid or dry Fire-prone High variation in temperature across day/night High variation in temperature across seasons Can be rocky or boggy	Shallow and spreading in moist soil, deep in dry soil, can have a lignotuber for resprouting after fire  Image: Briggsy66, CC BY-SA 4.0, via Wikimedia Commons	Pale green or grey, thick, aromatic, tough, hang down  Image: J.R.Connors@CANBR, 1999	Thick bark to protect from heat and bushfires  Image: A.V.Slee@CANBR, 1996	Sweet-smelling flowers, produce a lot of pollen  Image: ©M.Fagg, 1999

Plant Structure

Environment	Environmental features	Roots	Leaves	Stem	Flowers
Alpine/montane  Image: ©A.J.Fagg, 1963	High rainfall High light level at ground Medium-low density of plants Becomes 'dry' when water stored as snow Moist, deep, nutrient-rich soils at higher elevations Drier, shallow, nutrient-poor soils at lower elevations Fire-prone High variation in temperature across day/night Extreme variation in temperature across seasons Snow/frost throughout the year Rocky Windy Parts are boggy	Store nutrients below-ground (away from snow/frost), can have tubers/ bulbs  Image: ©M.Fagg, 2013	Small tough, hairy, scaly, thick to conserve heat and water, often grow in dense tussocks or cushions to reduce airflow and increase temperature around leaves and stems  Image: ©M.Fagg, 1988	Slow growing, protected from cold by dense leaves, can be soft herbaceous stems or flexible woody stems to prevent breakage from snow accumulation  Image: ©M.Fagg, 2020	Small, can be high above the plant to attract pollinators, often yellow, purple, pink or white Buds can be produced in autumn and left dormant until snows begin to melt and flowering follows immediately  Image: ©M.Fagg, 2007

Environment	Environmental features	Roots	Leaves	Stem	Flowers
Grassland  Image: ©M.Fagg, 2011	Variable rainfall (500-1000mm/ year) High light level at ground Medium-low density of plants High variation in temperature across day/night High variation in temperature across seasons Low nutrient soils Fire-prone Can be moist or dry Can be rocky, windy, boggy	Can have tubers/bulbs for regeneration after winter die-back, can be fibrous and spreading  Image: ©M.Fagg, 1986	Can be soft, hairy, broad, narrow  Image: ©M.Fagg, 2005	Soft herbaceous stems  Image: ©M.Fagg, 2019	Small, diverse, brightly coloured  Image: ©M.Fagg, 2019

CASE STUDIES – AUSTRALIAN PLANTS

Daisy (Asteraceae family)

- The Asteraceae family is the largest family of flowering plants in the world.
- Well-known members of the Asteraceae native to Australia include the genera *Xerochrysum*, *Brachyscome* and *Coronidium*.
- Plants in the Asteraceae are commonly known as daisies.
- What is generally thought of as a single daisy 'flower' is a cluster of much smaller flowers. This cluster is called a head.
    - Within a typical daisy head, each of the outermost flowers has one ligule or 'ray' attached. These outer flowers are known as 'ray flowers' or 'ray florets'. The ligule or ray resembles and serves the same function as a petal.
    - The inner flowers in the typical daisy head have no ligule and are called 'disc flowers' or 'disc florets'.
    - Some daisies have only ray florets, such as yam daisies (*Microseris* species), and some have only disc florets, such as billy buttons (*Craspedia* species).
- The clustering of ray and/or disc florets into a head acts to attract pollinators in the same way that a single flower does in other plant groups.

DID YOU KNOW?

The word 'aster' means 'star' in Greek. Some daisy heads look like a star, with the ray florets resembling rays of light.

Microseris lanceolata is a species of daisy that has only ray florets.

Image: A.N.Schmidt-Lebuhn©CANBR, 2010

Craspedia aurantia var. *jamesii* is a daisy species that has only disc florets.

Image: ©M.Fagg, 2007

Wattle (Mimosaceae family)

- The most common genus in the family Fabaceae native to Australia is *Acacia*, or wattles.
- Wattle (*Acacia* species) flowers are clustered together in groups that can look quite different from each other. Some are cylindrical, like a pipe-cleaner, and some are globular, like a ball.
- Each cluster contains between 3 and 130 or more individual flowers.
- Each flower has five tiny petals at the base of very long stamens. The stamens make the wattle flower look fluffy.

Cylindrical wattle flowering heads resemble a pipe-cleaner.

Image: ©M.Fagg, 2007

Globular wattle flowering heads resemble fluffy balls.

Image: ©M.Fagg, 2011

Grevillea (Proteaceae family)

- Well-known members of the family Proteaceae native to Australia include the genera *Grevillea*, *Banksia* and *Hakea*.
- *Grevillea* flowers look very different from typical flowers. Several individual flowers are grouped together in clusters that are named for their perceived shape, including 'spider' clusters and 'toothbrush' clusters.
- *Grevillea* flowers have 'tepals', a term used when the petals and sepals of a flower cannot be easily distinguished from one another. The tepals of a *Grevillea* flower are fused together into a tube.
- Each flower has four stamens (male parts) and a long style (female part) that extends far beyond the rest of the flower.
- The stamens are found towards the base of the flower and have no filaments.
- Before the flower opens completely, the stigma is held between the pollen-producing anthers, forming a loop. This means that the stigma gets covered in pollen before it springs outwards. A pollinator such as a bird or insect may then perch on the plant and brush against the stigma, getting covered in pollen.

A *Grevillea* flower with one stigma clearly visible and one stigma being held between the pollen-producing anthers before springing out.

Image: ©M.Fagg, 2012

Orchid (Orchidaceae family)

- The Orchidaceae is the second-largest family of flowering plants in the world.
- There are over 1,400 species of orchid native to Australia and well-known members of the family include the genera *Caladenia*, *Thelymitra* and *Diuris*.
- Orchids have all the parts of a typical flower but they are highly modified so look quite different.
- Orchids tend to have sepals and petals in sets of three.
- The central of the three petals is modified into a lip-like structure called the labellum. It is usually very colourful and acts as a landing platform for insects to aid in pollination.
- Unlike in most other flowers, the female and male parts of an orchid flower are united into one structure called the column.

Orchid flowers can appear very different from each other but still contain the same structural elements, as seen in this comparison of *Glossodia major* (left) and *Caleana major* (right) flowers.

Glossodia major image: ©M.Fagg, 1998

Caleana major image: ©M.Fagg, 2012

SUSTAINABLE DEVELOPMENT GOALS

Our education materials support the following Sustainable Development Goals:

- ensure inclusive and quality education for all and promote lifelong learning (SDG 4)
- demonstrate actions that work towards making cities inclusive, safe, resilient and sustainable (SDG 11)
- inform and empower students to preserve our forests and halt biodiversity loss (SDG 15)

CURRICULUM LINKS

Biological Sciences

AC9S4U01 Explain the roles and interactions of consumers, producers and decomposers within a habitat and how food chains represent feeding relationships (Year 4)

AC9S5U01 Examine how particular structural features and behaviours of living things enable their survival in specific habitats (Year 5)

AC9S6U01 Investigate the physical conditions of a habitat and analyse how the growth and survival of living things is affected by changing physical conditions (Year 6)

Science as a Human Endeavour

AC9S4H01 Examine how people use data to develop scientific explanations (Year 4)

AC9S4H02 Consider how people use scientific explanations to meet a need or solve a problem (Year 4)

AC9S5H01 Examine why advances in science are often the result of collaboration or build on the work of others (Year 5)

AC9S5H02 Investigate how scientific knowledge is used by individuals and communities to identify problems, consider responses and make decisions (Year 5)

AC9S6H01 Examine why advances in science are often the result of collaboration or build on the work of others (Year 6)

AC9S6H02 Investigate how scientific knowledge is used by individuals and communities to identify problems, consider responses and make decisions (Year 6)

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