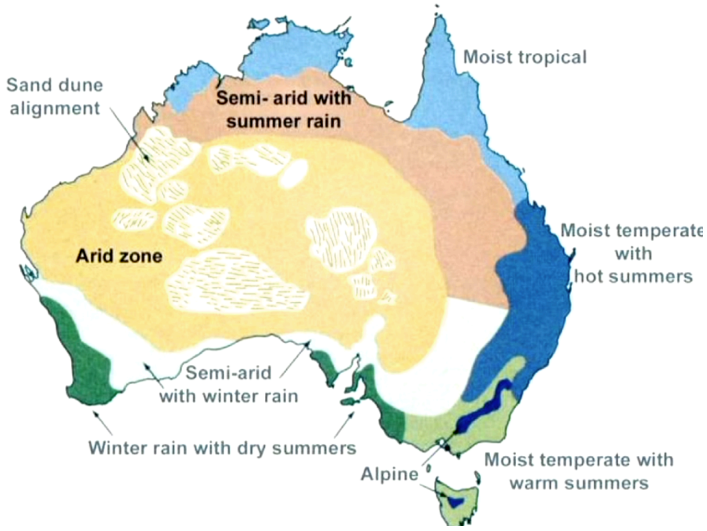
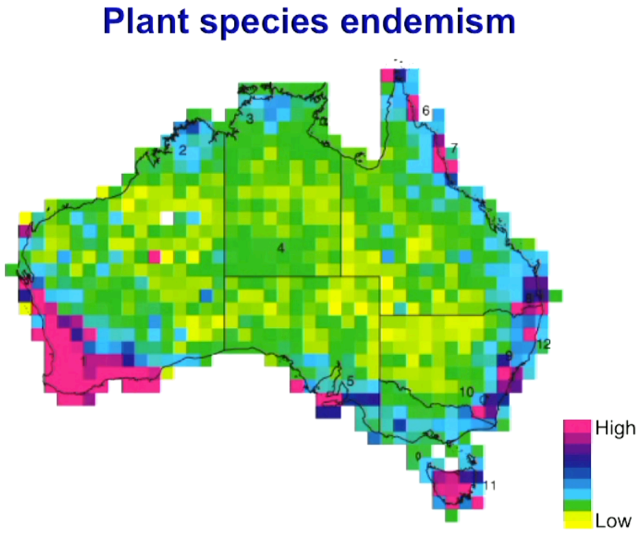
Gondwana & Changes Influencing Aridification

- Australia is an ancient landscape, with diverse biology and many unique plants and animals – **8% of the world's species, many endemic**





- The **largest variety** of **species** (and endemic species) are found along the **Eastern Seaboard**, in **Tasmania** and in **South-West WA**
- This is a result of:
  - **East Coast/Tasmania** – tropical or temperate rainforest climate, more nutrient rich soils, milder temperatures
  - **Southwest WA** – relatively mild and rainy climate – **endemism** is a result of **isolation**; very poor soil quality on the Nullabor plain (went **underwater 14 mya**, when the ocean receded it left a flat, **limestone plain poor in nutrients**), which meant that plants from the East could not spread across and species from the West did not spread to other parts of the continent
- Many **extant** (**living – opposite of extinct**) Australian species share common ancestors with those found on other **Gondwanan continents** – **species** in **same genus** or **family** found in **South America**, **Africa**, **India**, **Indonesia**, **PNG** & **NZ**
  - ***Osteoglossids*** – bony-tongued fish – South America, Africa, Australia, Indonesia
  - ***Ratites*** – flightless birds – South America, Africa, Australia, NZ, PNG
  - ***Nothofagus*** – Southern beech trees – South America, Eastern Australia, NZ, PNG
- Shared species also found in **fossil record** on **Gondwanan continents including Antarctica**

- ***Glossopteris*** – ancient fern, **dominant in Permian** (**280-260 mya**), **extinct 200 mya** but **seeds, stems,** and **pollen** identified

Breakup of Gondwana Timeline

- ***Africa & India* – 160 - 80 mya**
- ***NZ* – 80 mya**
- ***Australia* – 35 mya**
- ***South America* – 30 mya**

- The longer Australia has been separated from the other continent, the less species will be shared
- **Progression of climate in Australia**
  - **Pre-separation** – primarily **rainforest**, warm and wet
  - **Post-separation** – gradual contraction of rainforest areas, increasingly **arid** climate, hot and dry

Factors Influencing Aridification & Sclerophyll Dominance

- **Circum-polar current** – when Australia detached from Antarctica, a new ocean current formed in the new gap between the continents. This changed the pattern of rainfall in Australia, leading to a decrease in precipitation
- **Northward drift** – as the continent drifted Northwards, **temperatures increased** and **rainfall** further **decreased**. Both of these climatic changes contributed to the **contraction** of **rainforests** and the **expansion** of **sclerophyll** dominance
- **Low-nutrient soils** – Australia is a very old land, even in geological terms. This is why our highest mountains are relatively low on a global scale. The longer soil has been exposed to weathering and erosion, the less nutrient-rich it will be, and as such much of **Australia's soil** is relatively **nutrient-poor**, especially in **phosphorus** (**essential to plant growth**). This is compounded by the **lack** of **volcanic activity** which has occurred in Australia's recent history, as volcanoes cycle nutrients back up to the surface – this has not really occurred in Australia
- **Increased fire frequency** – fires were infrequent in wetter periods, but as the climate dried out, they became more and more frequents. This has again contributed to the contraction of rainforests, and the expansion of more fire-resistant sclerophylls
- **'Ice Ages'** – between **2.5 mya – present** the world has gone through a number of **glacial** (**cooler and dryer**) and **interglacial** (**warmer and wetter**) phases – during interglacial periods rainforest areas did not contract as much as during glacials, even though Australia did not actually freeze over. However, the sea around the continent did freeze in parts, leading to sea levels around **130 m lower** than present around **18,000 years ago** –

this allowed for the **overland movement** of **animals**, **plants**, and **people** between **Australia** & **PNG** and **Australia** & **Tasmania**

- **Early human impacts** – Aboriginal people settled Australia between **50,000 – 60,000 years ago**. They had relatively minor impacts, but practices including **fire-stick farming** impacted on **flora** (**favouring sclerophylls**), and **hunting** impacted on **fauna** (**extinction** of **megafauna**)

Rainforest Plants

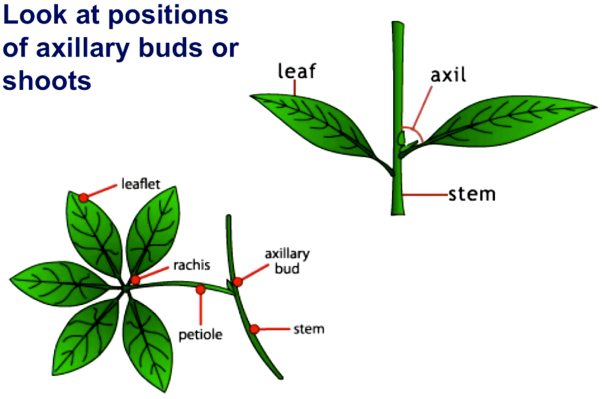
- The **structural classification** of **plants** is based on **height**:
  - **Forest** – medium/large trees – **10m – 30m+**
  - **Scrubland** – tall shrubs – **2m – 9m**
  - **Grassland/sedgeland** – grasses **- < 2m**

  And the **degree of foliage cover** at the **highest stratum** (**level of vegetation**):
  - **Closed - > 70%** cover
  - **Open** – **30 – 70%** cover
  - **N/A - < 30%** cover
- **Rainforests** are a type of **closed forest**, **> 70%** cover, usually **> 90%**
- Different types based on **climatic zones**:
  - **Monsoonal** – NT
  - **Tropical** – North QLD
  - **Sub-tropical/warm temperate** – South QLD & NSW
  - **Cool temperate** – VIC & TAS
- Rainforests are found from **sea level** to **high altitudes**, and are home to **huge diversity** in both **flora** and **fauna**.
- **Tropical Rainforests**
  - **Complex structure**
  - **> 100 – 200 tree species/ha**
  - **> 1,000 insect species/tree**
  - Plants typically have **large leaves - > 12.5cm long**
- **Temperate Rainforests**
  - **Less complex structure**
  - Often **one dominant species of trees**
  - **Smaller leaves** – **2.5cm – 7.5cm long**
- **Lowland tropical rainforests** are the **most diverse** areas, and occur worldwide between **latitudes 23°N-23°S** at **altitudes < 1,000m**

- **Tropical rainforests** have **warm, wet climates** in which **rainfall > 1,800 mm**
- Soil is extremely **nutrient-rich**, however most tied up in **above-ground biomass**, which means that the **rate of decomposition** has to be **extremely fast**
- Most rainforests look very similar, but **species composition** varies significantly by **region**
- **Wallace's Line**:
  - Separates the **faunal regions** of **Indo-Malaya** (Western Indonesia, Philippines, etc.) and **Austro-Malaya** (Eastern Indonesia, PNG, Australia, etc.)
  - These regions are **geographically close**, but have **distinctly different species**
  - This is a result of **plate movements**

Plant Adaptations in Tropical Rainforests

- **Large leaves**
  - **Greater surface area**, means **greater ability** to **trap light** for photosynthesis
  - This is important in rainforests, as **competition** for **light** is **fierce**
  - Leaves typically have **smooth surfaces** and **'drip tips'**, which angle downwards to aid **water runoff** and prevent **moisture accumulation** and **fungal growth**
- **Guttation**
  - **Pores** around the **edges** of **leaves** which **drip water** to aid **transpiration**
  - The rate of **transpiration** is determined by **atmospheric demand** for **water** – the **less humid** the **air**, the **higher** the **rate of transpiration** will be
  - In **rainforests**, the **air** is **very humid**, and as such plants often **do not transpire enough** of their own accord
  - As such, they need other ways to remove water so they don't drown, which is where **guttation** comes in handy
- **Compound leaves**
  - Leaves are divided into a series of **smaller leaflets** – aids **light capture**, does not **obscure lower strata** as much as full leaves, and does not take as much **energy** to produce as a **new branch**



- **Leaves** and **leaflets** can be differentiated based on the **location** of **axillary buds**

- **Buttresses & prop roots**
  - Large and strong roots which hold up the tree and allow it to grow taller
  - Spread out from the tree and sprout **feeder roots** which draw nutrients from a wider area and help the tree compete
- **Cauliflory**
  - **Flowering** on the **trunk** or on **stems** lower down the tree, rather than at the tips of high branches
  - Allows more pollinators to reach fruit more easily
  - **Common** in **figs**
- **Fleshy fruits**
  - **> 80%** of rainforest fruits are **fleshy**, and most are **brightly-coloured**
  - This makes them **more attractive** to **animals**, which are **major seed-spreaders**
  - Most fruits have **small seeds** (**< 2cm diameter**) which are distributed by **small birds** – **97%** of **Australian fruiting species**
  - Plants with **larger seeds** (**> 2cm diameter**) are distributed by **mammals** and **large birds** such as **cassowaries** – **3%** of **fruiting species**
  - Globally, rainforests typically have **primates** which distribute a higher proportion of seeds, but Australian rainforests do not have these species
- **Large seeds**
  - **Advantages** – resistant to predation, capable of storing energy reserves which help the seedling establish
  - **Disadvantages** – take more energy to produce, less total seeds produced, restrictive in terms of which animals can distribute seeds
- **Insectivorism**
  - Some plants supplement their nutrient intake by consuming insects
  - Particularly important to **nitrogen** intake
  - **E.g.** – ***nepenthes*** (pitcher plant) – traps insects in a modified leaf, which forms a flask which fills with water – **85 species** found in **SE Asia** & **North QLD**, often in **nutrient-poor** soil

Symbiotic Relationships

- **Commensalism – one organism benefits, the other is not harmed**
  - ***Epiphytes***
    - plants which grow on other plants
    - **e.g. – orchids, ferns, lichens, vines**
    - no roots in the ground, rely on runoff from the host plant for water and nutrients
    - better access to sunlight than if it grew on the ground
  - ***Hemi-epiphytes***
    - Starts out as an *epiphyte*, eventually becomes a parasite
    - **E.g. – strangler fig**
    - Starts out as an epiphytic vine, sends roots down the trunk of the host tree, and eventually encircles and crushes the host once it is established of its own accord
- **Parasitism – one organism benefits, the other is harmed**
  - Overcome the need to compete for nutrients, water, and light by attaching to a host plant and leeching off them
  - **E.g.** – *balanophora* – fungus-like flowering plant, which attaches itself to the roots of a host and siphons off nutrients and water
- **Mutualism – both organisms benefit**
  - **E.g.** – ***myrmechotrophic*** (**ant-feeding**) plants – adapted to allow ant colonies to live inside them, plants in return derive nutrients from ant excrement
  - **E.g.** – ***ryparosa javanica*** (**Javan Ash**) and *cassowary* – seeds are **large** and extremely **toxic** (**highest cyanide content** ever recorded) – cassowaries somehow are resistant to this toxicity, and in fact, are essential to the germination process of *ryparosa* seeds – cannot germinate unless first eaten by a cassowary