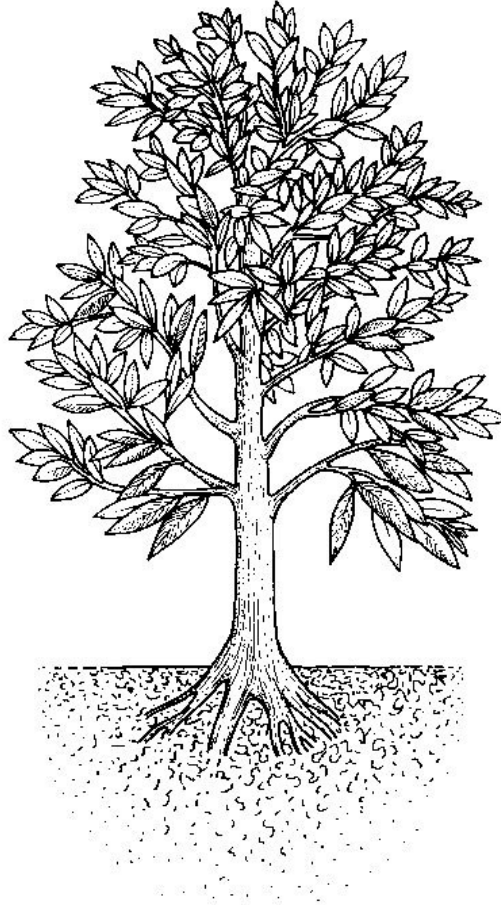


AUSBIOTA STUDY DAY 2011
Evolution of the Australian biota
Student worksheet.

The Botanic Gardens field presentation takes one hour.
This worksheet reinforces the key points of the field presentation. It may be completed at
the end of the presentation or back in the classroom.



***Glossopteris sp.* (Seed fern).**

This pack for the North Coast Regional Botanic Garden contains:
A set of activity sheets- to be copied for all students.

Section 1. The evolution of the plant kingdom.

Time line	Era	Evolutionary trend.
543-490	Cambrian flora.	Plants during this era were mostly algae. There were no land plants or plants with vascular tissue. Many species spread by asexual means or needed water to reproduce sexually.
490-443	Ordovician Flora:	A major milestone in plant evolutionary history; the first land plants are evolving with the fossil records show extensive appearances of spores (sexual reproduction). Liverworts, Hornworts and Mosses become prevalent. These early plants don't have conducting tissue and were tied to water. Spores are largely requiring water to be transported to spread the species, however a hard protective outer covering is evolving and the spore can survive in drier times.
385-290	Late Devonian Early Carboniferous	Plants had developed the ability to produce secondary wood through the development of a cambium layer. Hence, Vascular plants were no longer restricted to heights of less than 1 metre and tall treed forests developed. An ideal climate helped the spread of the flora of this era, creating the Great Coal Forests. It was during the late Devonian that seeds developed (to replace spores).
280-235	During the Permian	There was a rapid evolution of a range of plants including the Ginkgoales and Bennettites, as well as the dominant flora of the era; the Glossopterids. For the first time, seed plants became the dominant reproductive type. The cycads first appear in the fossil record dating back to 280 Ma. Water is no longer required for reproduction. The Glossopterids (none survive today), have been located in Australia, South America, Africa, India and Antarctica which indicates that they were a dominant feature of the Gondwanan flora
245-190	Triassic period	Witnessed the mass radiation of the conifers across the planet. The eight conifer families are still surviving today. Conifers have a pollen tube which delivers sperm cells directly to the eggs and this makes the Coniferales more advanced than the Cycadales and Ginkgoales. Wind pollination allows for wide dispersal of genetic material the conifers rarely reproduce asexually (Wollemi does).
190-140	Jurassic	<i>Agathis</i> was a genus of dominant conifers, which are sometimes referred to as "Kauri Pines". The Podocarps were derived from the Glossopterids. Like the <i>Agathis</i> species, this is a group that still survives today, but has lost the dominance it once had. In the Atherton Tableland (Queensland, Australia) remain some remnant rainforests from the Jurassic era. Growing together are Kauri Pines and Podocarps, as well as an arboreal cycad called <i>Lepidozamia hopei</i> .
135-66.4	Cretaceous	The gymnosperms are in decline making way for a new group the Angiosperms (flowering plants). These now carry out double fertilisation two sperms are produced one fertilising the egg the other fertilising the endosperm. This is greatly sought after as a food source by birds, mammals and other insects all of which allow for the species to be spread far and wide. However, asexual reproduction is still common. Insect pollination is developing and will in later periods become common.
6.4-2.5	Tertiary	The new climate regime suits angiosperms and they become the dominant plant forms. Late in the Tertiary grasses develop and spread over wide areas. These are dry climate adapted species. Grasslands tend to occur in regions of lesser rainfall. In addition, grasses are generally well adapted to survive grazing and fire, and an increase of these two phenomena may also have helped in the selection of grasses to dominate these ecosystems.

Mosses, Ferns and HorseTails (Devonian, Carboniferous):

Asexual reproduction:

What is asexual reproduction? In your answer use the terms: mitosis and meiosis?

What is a stolon and give an example of an Australian plant that uses this method of asexual reproduction?

Description; A sexual reproduction. Draw a Chicken and hen Fern.

Plant Name:

Scientific name:

Conifers and Gingko (Carboniferous):

Sexual Reproduction:

Description; Wind Pollination Draw a winged seed.



**Glossopteris, Angiosperms, (Permian, Triassic).
Sexual reproduction.**

Description Insect pollination: Draw a wasp pollinating an orchid.

Plant: Common name:

Scientific name:

What is Pseudocopulation pollination ?

Description: mammal / Bird pollination. Draw a lorikeet pollinating a Grevillea

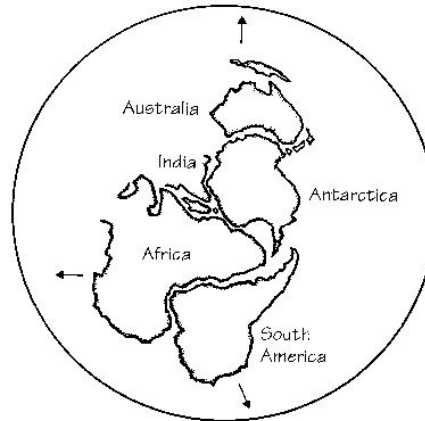
Plant: Common name:

Scientific name: family:

Show where the pollen is deposited

Section 2.

Gondwana, the fossil record and continental drift.



The future continents of the southern hemisphere were all joined together in a massive super continent known as Gondwana (Palaeozoic-early Mesozoic). But, after millions of years of unity, deep-seated tensions below the earth's crust began to split the giant land mass into separate pieces. These pieces were slowly moved apart by convection currents under the earth's crust at the rate of 5 to 10 cm a year. Over millions of years, this rate of drift caused a substantial separation of the once adjacent 'continents'. As the continental 'rafts' or plates drifted through varying latitudes they encountered different climatic conditions, induced by changes in global ocean and wind circulations.

The fossil plant record was assisted greatly in this theory of continental drift developing by showing that plants were common across distances that meant that they could not have migrated from one to another. Fossils of the seed fern *Glossopteris* (at 280 Million years old) are found on the separated continents of Antarctica, Africa, South America and Australia. This was confirmed by the abundance of Proteaceae pollen found in ice cores from Antarctica's continental shelf and the fossilised pollen found in Brazil and western Africa. In this era we can see that some plant species are still found across each continent, Thus, the Southern Beech genus (*Nothofagus*) occurs in Australia, New Guinea, New Zealand, New Caledonia, South America and, in fossil form, in Antarctica. Similarly, close relatives of Australia' Macadamia nut (Proteaceae) occur in South America and Southern Africa.

1) What is Gondwana?

2) How can the fossils *Glossopteris* be used as evidence that Gondwana existed?

3) Give 2 examples of plant families from modern times that could be used as evidence that Gondwana existed ?

Section 3.

The drying of the continent and its effects on the Australian flora.

80% of our plants are not found anywhere else in the world and have developed an amazing set of adaptations to enable them to survive in this harsh environment.



The current Australian landmass is a vastly different environment from of ancient past. At the time of the Gondwana division the continent was a moist forested, landscape dominated by zeromorphic plants. Around **45 Million Years ago** The drying out of Australia was largely the result of a global process known as continental drift. Around 45 million years ago, Australia finally broke away from Antarctica and began its separate drift northwards. At the time, rainforests covered large areas of the continent, since substantial rainfall penetrated well into inland areas. During the course of Australia's drift, the temperature of surrounding ocean currents changed, resulting in altered climatic patterns and lower rainfall over the land. Although there are no fossil records of eucalypts older than 38 million years, it is probable that the first hard-leaved plants made an appearance not long after Australia's separation from Antarctica. **15 Million Years ago** Australia's northward journey through 27 degrees of latitude slowed down when its leading edge rammed into the Asian continental plate. The once widespread rainforests had begun their long retreat, unable to survive the increasingly arid conditions for much of the lands surface. The drying out resulted from a combination of factors. These included the rain-shadow effect of the Great Dividing Range which caught the moisture-bearing winds travelling inland, Australia's movement towards the equator, and a worldwide change in atmospheric and oceanic circulation patterns. The new conditions placed stresses on the plant and animal species, including the rainforests.

The end result we have looked at the retreat of the rainforest as though it was a one-way process. However, there is plenty of evidence from the past two million years to suggest that the rainforests can reverse the trend and actually advance into neighbouring eucalypt woodlands if the conditions are suitable. In the recent past, large-scale fluctuations in Australia's rainforest distribution have been triggered by the onset and cessation of periods of glaciation.

Though Australian rainforests may seem to be diminishing today, the situation was even more critical 26,000 to 13,000 years ago on Queensland's Atherton Tableland. In this region, a picture of the past distribution of rainforests has been worked out from the proportion of fossil pollen grains of various plant species in soil profiles stretching back 120,000 years. The pollen record indicates that 26,000 to 13,000 years ago local rainforests all but disappeared because of periods of extreme aridity associated with ice ages. Once the aridity eased, the rainforest remnants were able to expand, perhaps with the assistance of seed-dispersing animals and birds that migrated between patches of local rainforest.

Why is wind dispersal of dry seeds more common than dispersal of succulent fruit in arid parts of Australia?

What method do Banksia cones use to protect them from fire? How are the seeds dispersed?

Why would dispersal of seed by succulent fruit be relatively uncommon in arid areas of Australia?

What are some of the Adaptations of Eucalyptus to the dry climate?

What is myrmecochory?

What are the advantages of seed dispersal by myrmecochory

Sketch, label and name a seed a from an Australian plant that uses myrmecochory:



Plant Species;
Scientific name:

The end