EVOLUTION OF AUSTRALIAN BIOTA

Australia's past: part of a supercontinent

Evidence for the rearrangement of crustal plates and continental drift indicates that Australia was once part of an ancient supercontinent

Introduction

In the module 'Life on Earth' you studied the origin of living things on Earth, from 4500 million years ago until about 250 million years ago. The Earth's history is subdivided into time spans called eons, eras, periods and ages. There are three main eras: Paleozoic, Mesozoic and Cenozoic. These may seem difficult to remember at first, but they become simpler if we understand their meaning.

Paleo means ancient, *meso* means middle and *ceno* means recent. They end in *zoic,* coming from the word root for *zoology*, relating to animals—the eras are based on the type of animal life present at each time.

You have now studied events that took place prior to and during the Paleozoic era (see Table 2.2 on page 208 in 'Life on Earth'). In this module you will look at events that occurred in the late Paleozoic era, but mainly during the Mesozoic and Cenozoic eras, during which time Australia broke away from a large common land mass and became an island continent, separate from all other land masses. This isolation led to the evolution of Australia's unique flora and fauna of today.

1.1 From Gondwana to Australia—how our continent arose

- ***identify and describe evidence that supports the assertion that Australia was once part of a landmass called Gondwana, including:***
  —matching continental margins
  —position of mid-ocean ridges
  —spreading zones between continental plates
  —fossils in common on Gondwanan continents, including **Glossopteris** ***and*** **Gangamopteris** ***flora, and marsupials***
  —similarities between present-day organisms on Gondwanan continents

(This dot point addresses outcome P10.)

Wallace, Wegener and drifting continents

Alfred Wallace was a natural scientist in the mid 1800s. He is famous for his work on evolution, but during his travels he also studied how geography affected the distribution of species of plants and animals—something we refer to as **biogeography** today. He studied thousands of plants and animals and kept thorough records of where each was found. He recognised patterns in their distribution and this led to his proposal of two separate zoogeographical areas. The line separating these areas is called Wallace's line—a clear boundary that snakes between the Indonesian islands in the northwest and those in the southeast. He noticed that, despite having similar climate and terrain, the north-western islands (Sumatra, Java and Bali) had fauna, in particular bird species, more similar to those of the Asian mainland, whereas in the southeast, the birds in Lombok and New Guinea were more like those in Australia. Wallace's line divides the Asian and Australian regions. At that point in time, there was no explanation for this phenomenon but Wallace suggested that it reflected that groups of organisms that were isolated evolved to become different. It has only recently been discovered that Wallace's line coincides with a very deep mid-ocean ridge.

In 1915, Alfred Wegener, a German scientist, noticed that identical fossil plants and animals had been discovered on opposite sides of the Atlantic Ocean. Since the ocean was too large for the animals to have crossed it, Wegener proposed the theory of continental drift, suggesting that all the continents had once been connected together, forming a large single mass of land—which he called **Pangaea**—surrounded by one huge ocean. He proposed that the continents then split up into smaller units of land which drifted to their current positions around the Earth. A large amount of evidence to support this theory has been found over the ensuing years.

In this chapter, how the theory of continental drift could account for Australia becoming an island continent will be described, followed by current evidence to support this theory.

How Australia arose from Gondwana

Maps of the world showing the position of continents do not address the fact that the continents may not always have been in those positions. Scientific studies over the past 100 years have led us to believe that continents have indeed moved. It is believed that about 250 million years ago (mya), all the continents were joined together to from one huge land mass called Pangaea. Forces beneath the surface of the Earth caused it to begin to break apart about 225 mya. The sequence of diagrams in Figure 1.1 shows how Pangaea is thought to have eventually given rise to the continents as we know them today. The sequence of events:

- 225 mya: Pangaea, one huge continent made up of all the continents we know today, splits into two large land masses—Laurasia to the north and Gondwana to the south
- 180 mya: Gondwana begins breaking up, as does Laurasia. (Australia is thought to have been part of the southern land mass and so we will follow the breaking up of Gondwana)
- 135–100 mya: Gondwana breaks into three parts:
  —Africa and most of South America (the southern-most tip of South America retained a small land bridge with Antarctica until 60 mya)
  —Antarctica, Australia, New Zealand and New Guinea
  —India (India began drifting northwards, towards the part of Laurasia that would become Asia)
- 80 mya: New Zealand breaks away
- 65 mya: Australia begins to separate from Antarctica (it is still attached by Tasmania)
- 60 mya: final separation of tip of South America from Gondwana
- 45 mya: Australia becomes a separate continent and begins drifting northwards, and therefore becomes hotter and drier.

PFA P1

PFA P2

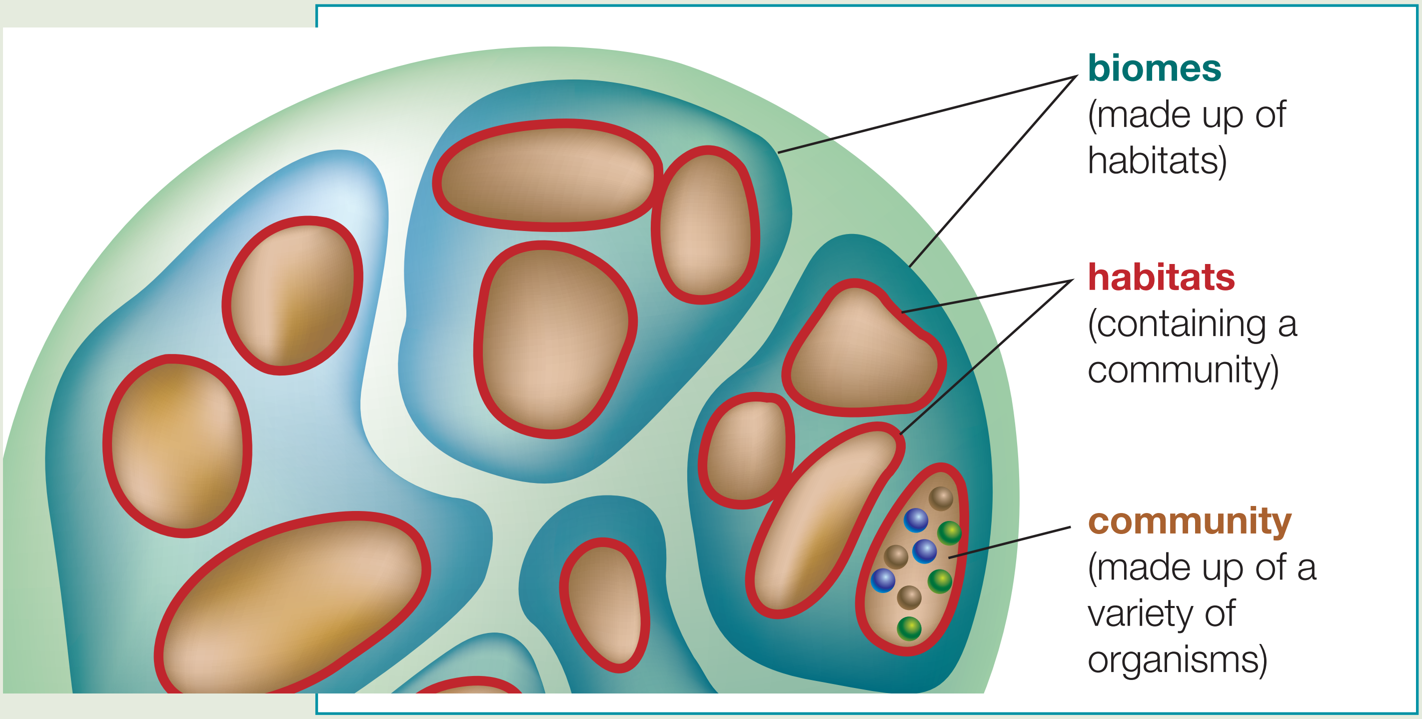


Figure 1.1 The breaking up of the supercontinent Pangaea to form the present-day continents

STUDENT ACTIVITY

Using the figure provided on the Student Resource CD colour the three parts of Pangaea in the following colours:

- India—red
- Australia—blue
- Antarctica—green.

Use these colours to shade these three regions on the sequence of diagrams showing the separation of Australia over the previous 250 million years, to the present.

SR

Figure to use for this student activity

TR

Solutions to this student activity

Evidence for this theory

- Geological:
  —matching continental margins
  —position of **mid-ocean ridges** and spreading zones between continental plates
- Biological:
  —common fossils
  —similar present-day organisms.

Although the theory of continental drift was proposed over a hundred years ago and has been under discussion since then, finding sufficient evidence to support it has only come about fairly recently.

Background information—the theory of plate tectonics

It was only in the1960s that a theory was proposed that could account for how continents could drift. Harry Hess, a geologist, proposed the **theory of plate tectonics**, which provided a mechanism by means of which continents could move. He explained that continents were carried on large plates beneath the ocean. These plates were positioned on top of the semi-molten interior of the Earth. To understand this idea, picture a cracked eggshell surrounding the contents of a raw egg. The pieces of eggshell would be equivalent to the plates forming the ocean floor. The continents, which are made of lighter rock and are thicker, jut out above the ocean (equivalent to the thicker bits on the cracked eggshell that are sticking up). As the plates move, their boundaries may *collide*; *slide past each other*, so that one slides beneath the other (termed '**subduction**'); or *move apart* (see Fig. 1.2). Picturing the analogy of the egg once again, if two pieces of cracked eggshell move towards each other, they would converge on one side, but a gap would form on the opposite side of each piece, where they moved away from another plate of cracked eggshell.

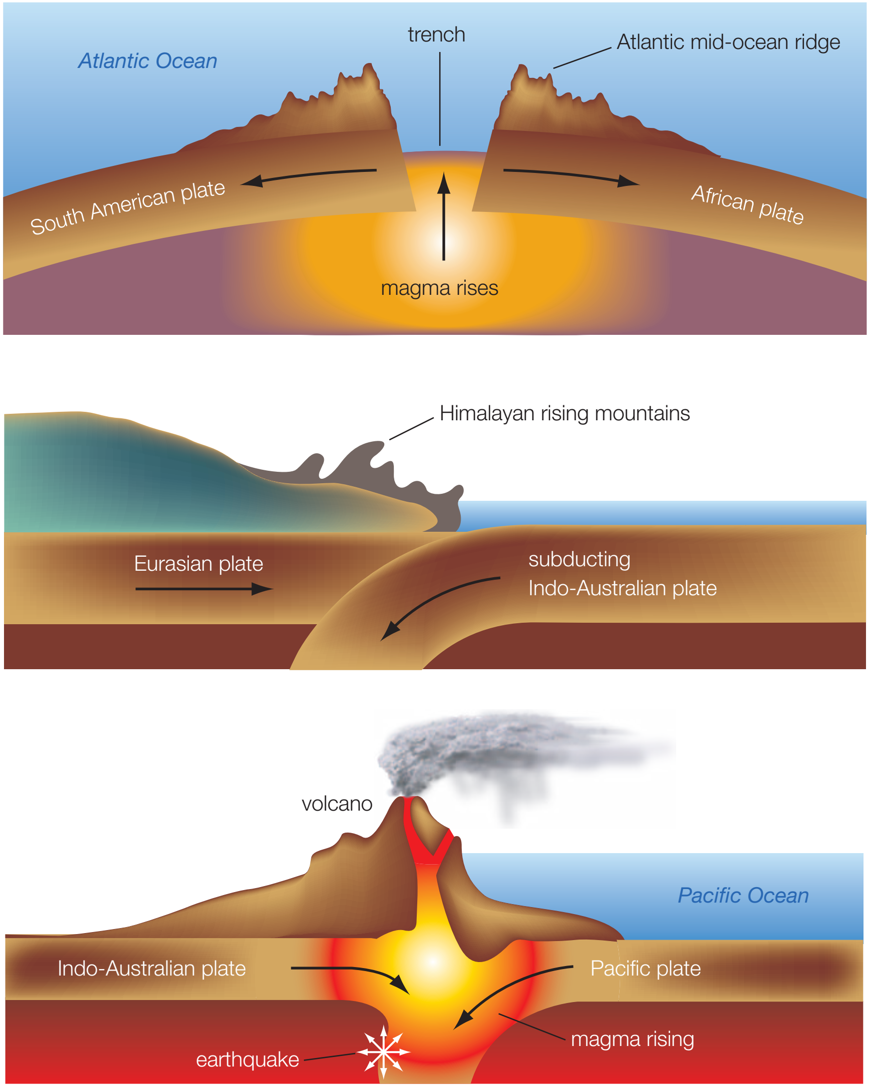


Figure 1.2
Movements of crustal plates: (a) spreading zone, with diverging plates forming a mid-ocean ridge in the Atlantic Ocean (b) converging plates form a subduction zone, with the formation of fold mountains; (c) converging plates forming a collision zone

Studies of the ocean floor have revealed evidence that there are in fact plate boundaries such as those described by Hess. Plates that are moving together are said to be **converging**. Those moving apart are said to be **diverging**. At points where plates collide, the sediments may be folded and distorted to form mountains (e.g. the Himalayan mountains of North India formed when the Indo-Australian plate collided with the Eurasian plate, about 50 million years ago).

Website which shows an animation of the process of the breaking up of Gondwana and subsequent continental drift: http://kartoweb.itc.nl/gondwana/gondwana_gif.html

Evidence for the existence of Gondwana—geological

Matching continental margins

Looking at the *shapes of the continents* today, it is easy to picture how they may have once fitted together to form one landmass. Scientific studies using computer-generated models of the continents show that they fit extremely well, particularly if the **continental shelf** margins, rather than the shorelines, are used.

Further geological evidence is provided by the similarity of *rock strata* (the layering of rocks) on matching continental margins. Matching layers of rock found on continental margins that fit together suggest that they were once adjoining.

(The student task on the Student Resource CD allows you to check this for yourself by matching current continental margins to build a model of Pangaea.)

SR

Extension activity—continental margins

Mid-ocean ridges, spreading zones and subduction zones

- *Mid-ocean ridges* are the sites where two crustal plates meet or move apart. The theory of continental drift suggests that as the continents drift apart magma wells up through the spreading floor and new crust is formed.
  —*Evidence*: There is scientific evidence using **radiometric dating** that the rocks towards the edges of these mid-ocean ridges are younger than those further in from the margins, supporting the idea that rock near the edges of spreading zones are newly laid down.
- Mid-ocean ridges where plates collide are the sites where most volcanoes and earthquakes occur (to illustrate this complete the problem-solving activity on page 243).
- At subduction zones, where plates collide and fold, or one plate slides beneath the other, the formation of mountains and the continued movement of present-day continents provides evidence to support the theory of plate tectonics.
  —*Evidence*: The Himalayan mountain range is at a subduction point where India is sliding under the Asian plate. Evidence is provided by the fact that the Himalayan mountains are still slowly rising, supporting the theory of continental drift.
  —*Prediction to validate the theory*: Australia is still moving northwards at a rate of approximately 7 cm per year, which means that it could collide with Southeast Asia in approximately 50 million years if the drifting continues at the current rate.

Evidence for the existence of Gondwana—biological

Fossil evidence

More than 180 mya, when Gondwana existed, the same type of organisms (both plant and animal) would have been distributed across the entire landmass. Many of the species that lived at that time are now extinct and so fossils provide the only record to show that they once existed and how they were distributed. Fossil evidence shows the common occurrence of certain extinct organisms across all of the continents that once formed Gondwana:

- *Glossopteris* and *Gangamopteris* were types of tree ferns that formed the dominant vegetation on Gondwana 280–225 mya, before it split into the continents that we know today (see Fig. 1.3). Fossils show that they had tongue-shaped leaves with a midrib and net venation, and were typically found in swampy habitats. They were the main type of vegetation involved in the formation of coal. *Glossopteris* leaf fossils have been found on all the continents that once formed Gondwana (see Fig. 1.4). In Antarctica, *Glossopteris* fossils were found embedded in coal seams and rocks that date back to 250 mya (these were collected by Captain Robert Scott and his team on their final and fatal voyage to Antarctica, found along with their frozen bodies). The fossils that they found were the same as those found in Australia, India, South Africa and South America and those found in South Africa were in rock of the same age.
- Labyrinthodonts were amphibians (now extinct) that resembled salamanders, but differed in that

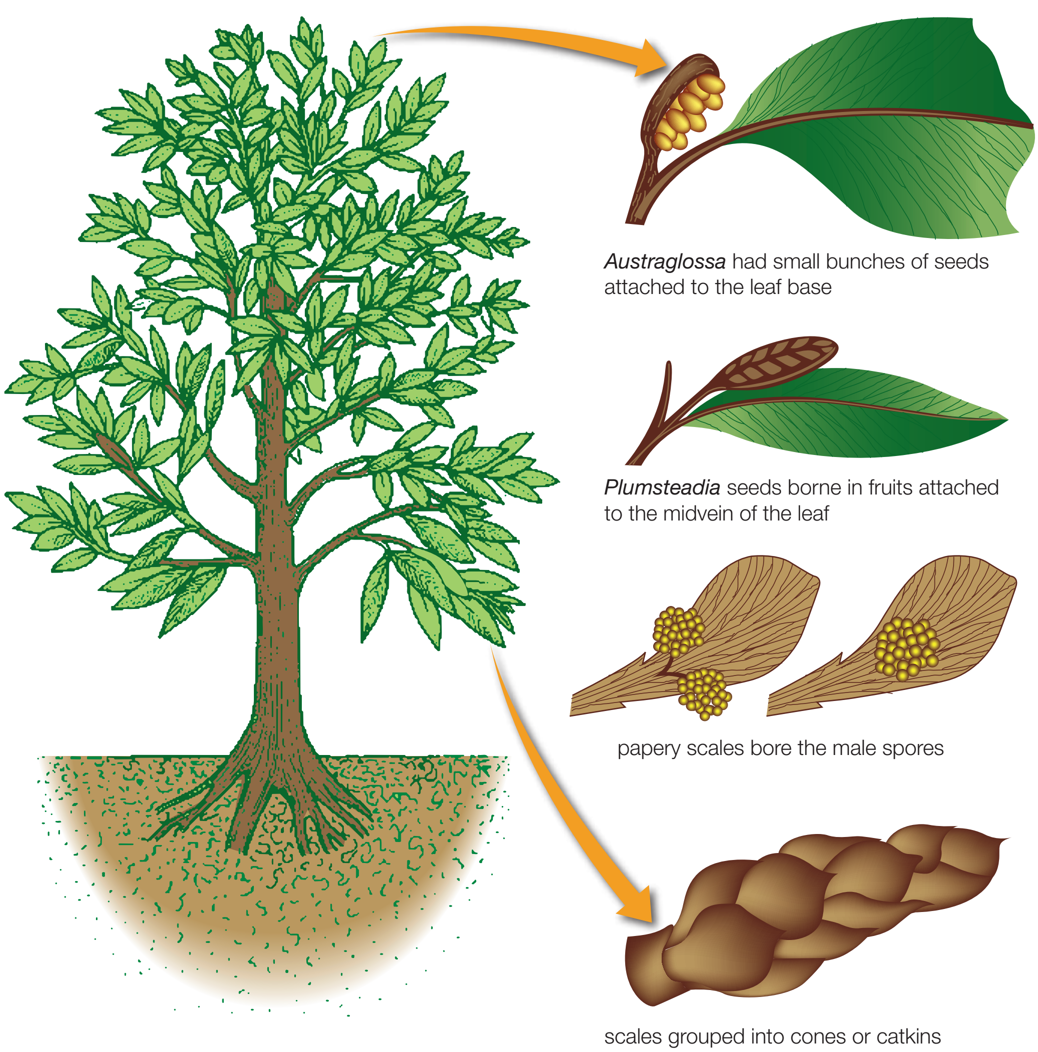


Figure 1.3
Glossopteris plant with leaves and seed-bearing structures

Figure 1.4 Fossils found in the Hunter Valley, NSW: *Glossopteris*

they had jaws full of teeth and grew to much larger sizes. They lived about 200 million years ago and provided the first evidence that land vertebrates had roamed Antarctica when its climate was warm. Labyrinthodonts of the same period are known to have lived in both Australia and South Africa, supporting the theory that these were once part of the supercontinent, Gondwana. Labyrinthodonts were thought to eat insects, the abundance of which at that time is supported by insect fossil remains, as well as evidence provided by the jagged holes present in many of the fossilised *Glossopteris* leaves, where insects probably ate them

- fossils of *Lystrosaurus*, a sheep-sized reptile that existed 200 mya, were found in South Africa, India and Antarctica (see Fig. 1.5).

It is highly unlikely that creatures like the labyrinthodonts and *Lystrosaurus* would have evolved separately on such isolated continents as Antarctica and Australia and they certainly had no way of crossing the oceans. So the similarities in the fossil records of these continents support the idea that they were once joined.

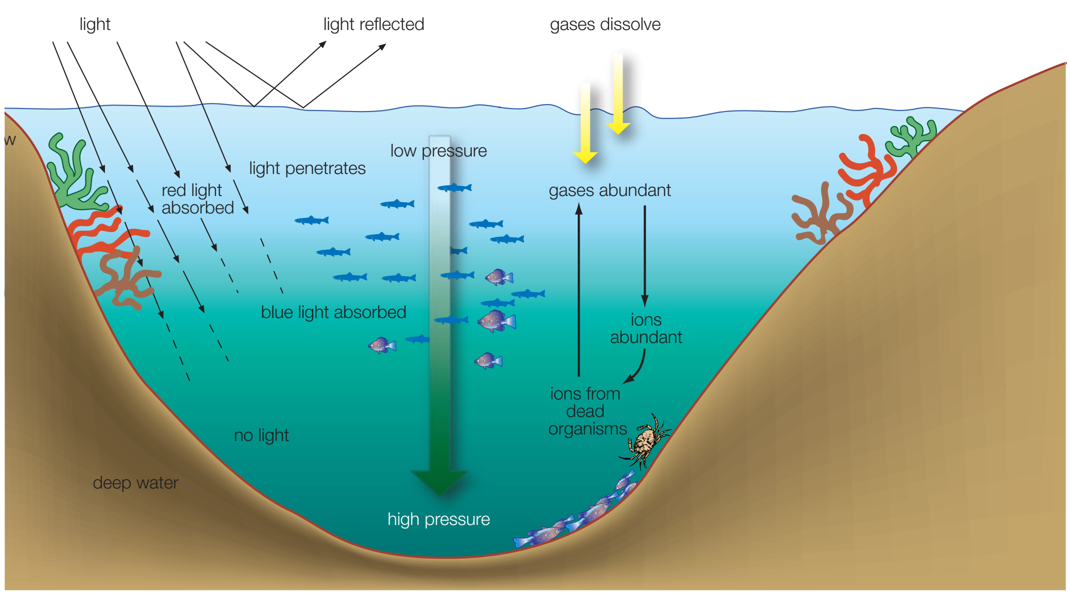


Figure 1.5 Map of the distribution of fossils on Gondwanan continents

Evidence provided by the distribution of present-day organisms

Biogeography is the study of the geographical distribution of species, both present-day and extinct. It has long been recognised that Australia and other lands in the southern hemisphere share many similar plants and animals, but it was an English botanist Joseph Hooke (1853), who first pointed out similarities between *southern hemisphere lands* and *rainforest* vegetation *in India*. He also described alpine plant groups in south-eastern mainland Australia and Tasmania as being similar to those found in New Zealand.

Similarities in present-day fauna on Gondwanan continents show that *living marsupials* are found in Australia and South America, suggesting that these continents once were joined.

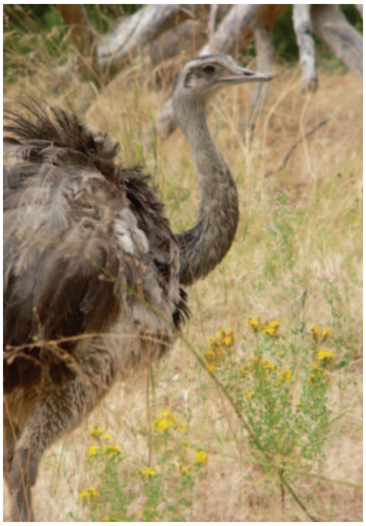
Flightless birds

The *ratitaes* are an ancient group of flightless birds that are believed to have evolved from a common ancestor on Gondwana. Their present-day southern-hemisphere distribution can be explained as a result of the separation of the southern continents. Each continent except Antarctica is represented by at least one living species: the emu in Australia, the kiwi in New Zealand, the rhea in South America and the ostrich in Africa. The cassowary is found in both Australia and New Guinea, perhaps suggesting that their separation occurred later. Two extinct forms of flightless birds have also been found—the elephant bird in Madagascar (an Indian ocean island off the west coast of Africa) and the moa in New Zealand.

(a)

(b)

(c)



(d)

(e)

Figure 1.6 Flightless birds: (a) emu; (b) kiwi; (c) rhea; (d) ostrich; (e) cassowary

Marsupials

At the time that South America was separating from the Antarctica–Australia landmass 65 mya, marsupials are believed to have been moving from North America into South America. Living marsupials today are found only in South America and Australia. The present-day distribution reflects continental drift if we take the following into account:

- the tip of South America was still very close to Antarctica (60 mya) and so marsupials could cross the land bridge that still existed
- Africa had already split from Antarctica (135 mya) and this could explain the absence of marsupials from that continent
- Antarctica later split from Australia and drifted southwards, becoming too cold for the survival of its marsupials
- Australia became a 'drifting ark' with many marsupials which thrived as it drifted northwards where it was warmer.

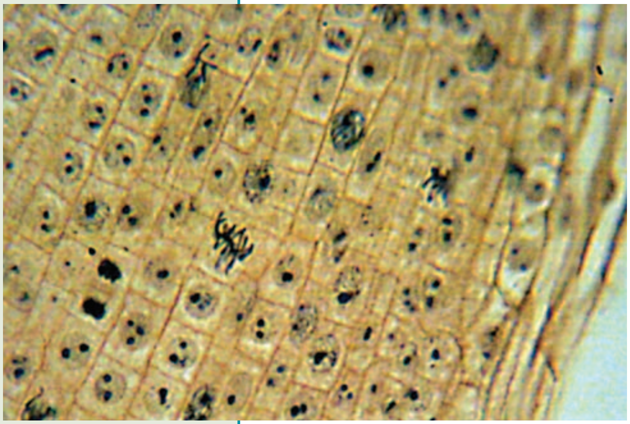
(*Note*: Theories such as this are still being investigated by biologists who constantly seek evidence to support their explanation of how the present-day biogeography came about.)

Plants

Southern beech trees, *Nothofagus,* are represented in Australia, Antarctica, South America, New Guinea and New Caledonia in both living and fossil forms, further supporting the idea that these continents once were joined and arrived in their present locations as a result of continental drift.

Figure 1.7
Marsupials:
(a) American opossum;
(b) Australian grey kangaroos

(a)



(b)

STUDENT ACTIVITY

Internet virtual tour of the Australian continental shelf:
Visit this website for a virtual tour of the Australian continental shelf, showing the hidden vista of the ocean floor: www.environment.gov.au/coasts/discovery/flythrough/index.html
Geoscience Australia and the National Oceans Office have produced a virtual tour, showing rugged undersea ridges formed long ago when Australia tore away from Antarctica. A modern technology called a *swath mapper*, installed on a CSIRO marine research ship, was used.

SR
Map to cut and paste

TR
Solutions to this student activity

Problem solving to infer a moving Australian continent

SECONDARY SOURCE INVESTIGATION

BIOLOGY SKILLS

P14

■ ***solve problems to identify the positions of mid-ocean ridges and spreading zones that infer a moving Australian continent***

Aim

1. To solve problems.
2. To identify the positions of mid-ocean ridges and spreading zones that infer a moving Australian continent.

Maps showing age of sea floor: http://zephyr.rice.edu/plateboundary/TGpart2.ppt#297,27,slide27

Animation of different types of plate boundaries: www.classzone.com/books/earth_science/terc/content//visualizations/es0804/es0804page01.cfm?chapter_no=visualization

Background information

The Earth's structure consists of three parts: the core, mantle and crust. The crust is made up of a number of plates sitting on the mantle and any movement is determined by the mantle's convection currents. Both oceanic and continental plates float on the Earth's mantle. The theory of plate tectonics has helped to understand the mechanism for the movement of continents and the formation of mountains and oceans. This theory has led to the discovery of Earth's plate boundaries (see Fig. 1.8) through methods such as the plotting of earthquakes and volcanoes around the world. Using seismic equipment scientists are able to collect information on the occurrence of earthquakes and volcanoes around the world.

Scientists use the position of earthquakes (see Fig. 1.9) and volcanoes (see Fig. 1.10) to determine plate boundaries and the movement occurring at the edges of different plate boundaries. Hence, they are able to determine effect of the shifting plates on the movement of entire continents.

There are three different types of plate boundaries (see Fig. 1.11):

- *converging boundary* where two plates are moving towards each other and collide
- *diverging boundary* where two plates are moving away from each other
- **transform boundary** where two plates are sliding past each other.

At diverging boundaries, mid-ocean ridges and **sea floor spreading zones** occur due to continents drifting apart and magma welling up from the Earth's mantle to the surface, solidifying to form new crust (see Fig. 1.12). This sea floor spreading creates new oceanic crust. Subduction zones, however, lose part of the oceanic crust at converging plate boundaries. A continental plate collides with an oceanic plate forcing the oceanic plate underneath the continental plate and entering

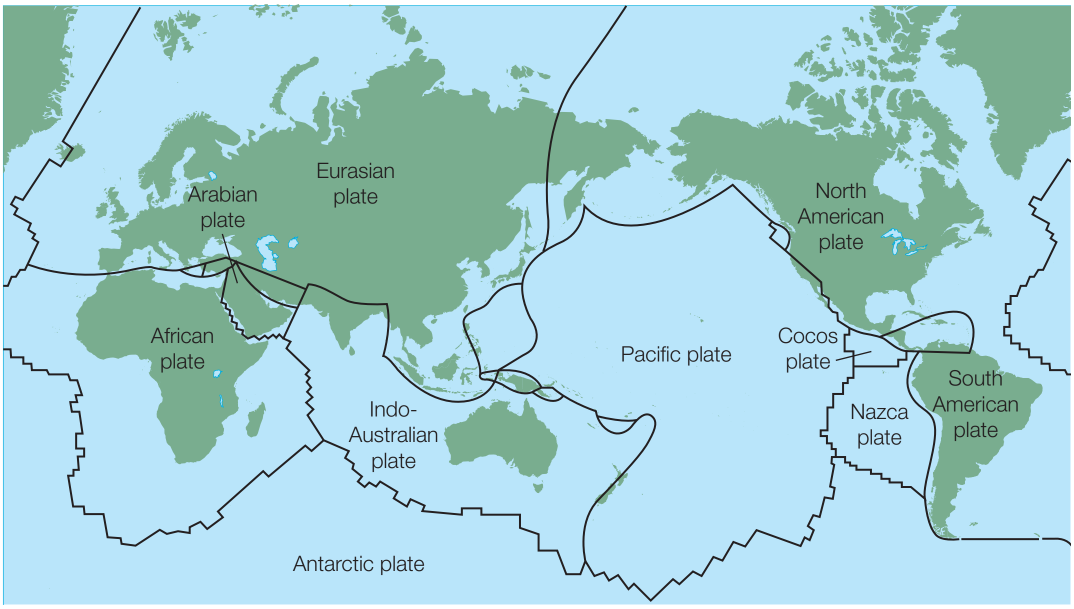


Figure 1.8 World map showing labelled tectonic plates and boundaries

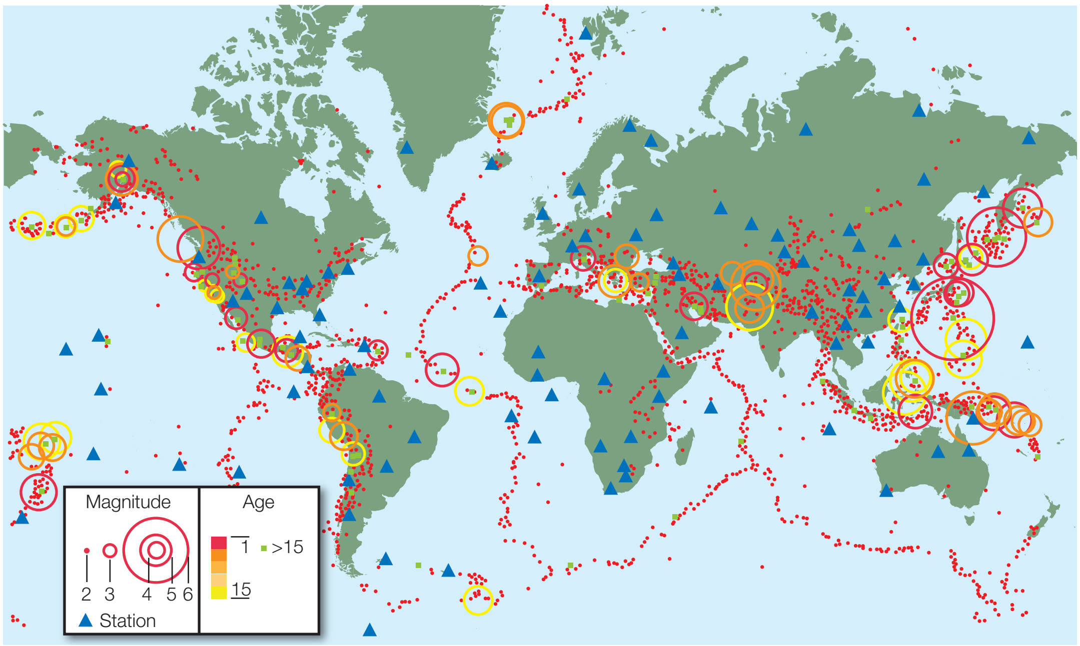


Figure 1.9 World map showing earthquakes that have occurred mainly in the last five years—ranging in magnitude from 2 to 6 on the Richter scale

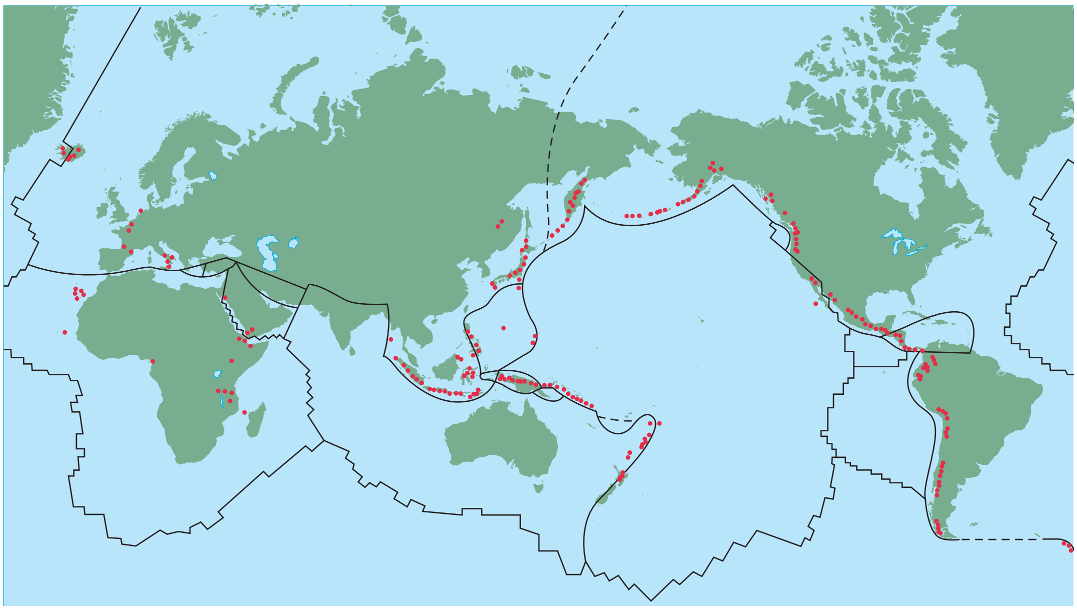


Figure 1.10 World map showing currently active volcanoes

the mantle where it is broken down. This results in forming a **deep ocean trench** (see Fig. 1.12).

Earthquakes and volcanoes commonly occur along plate boundaries due to the pressure and resulting plate movement. Volcanic eruptions occur progressively along the rifts of the mid-ocean ridges.

The occurrence of earthquakes and volcanoes provide evidence for the existence of mid-ocean ridges and spreading zones. The position of the earthquakes and volcanoes pinpoints the area where these are situated deep under the ocean. In Australia, earthquake occurrences have been recorded at different magnitudes (or sizes) ranging from 4 to more than 6 (see Fig. 1.13). Although the Australian continent does not fall on a plate boundary, small shallow earthquakes occur due to pressure at fault lines. The Australian plate has many north–south concentrations of earthquakes, so this may suggest that it is adjusting to the activity of plate movement in that direction. In eastern Australia, earthquakes occur at a depth of 20 km. Earthquakes less than 5 km are considered as shallow, while those at depths greater than 15 km are deep. Shallow earthquakes cause much damage, but deep earthquakes rarely cause damage. An earthquake exceeding magnitude 7 occurs somewhere in Australia every 100 years.

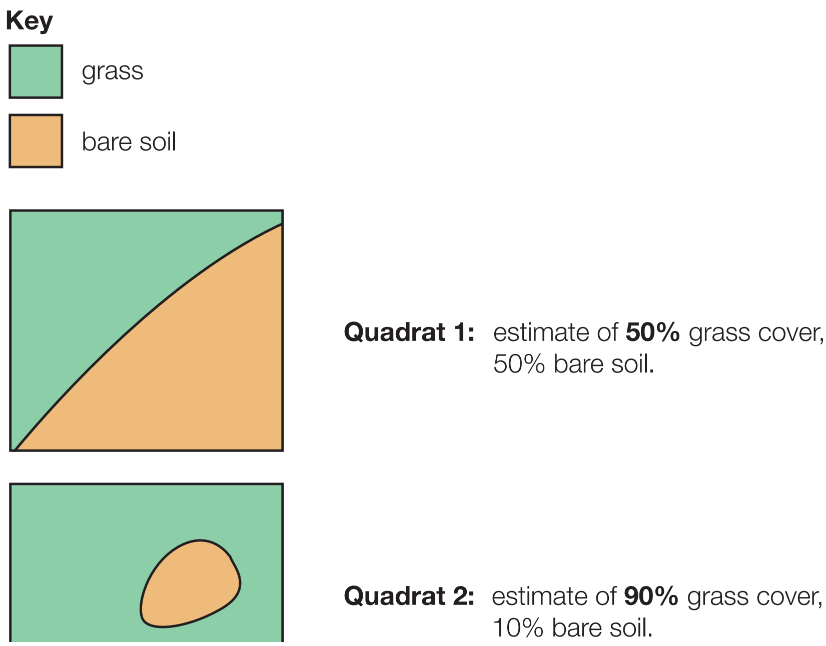


Figure 1.11 World map showing the plate boundaries and their different types of movements—diverging, converging and transform plates

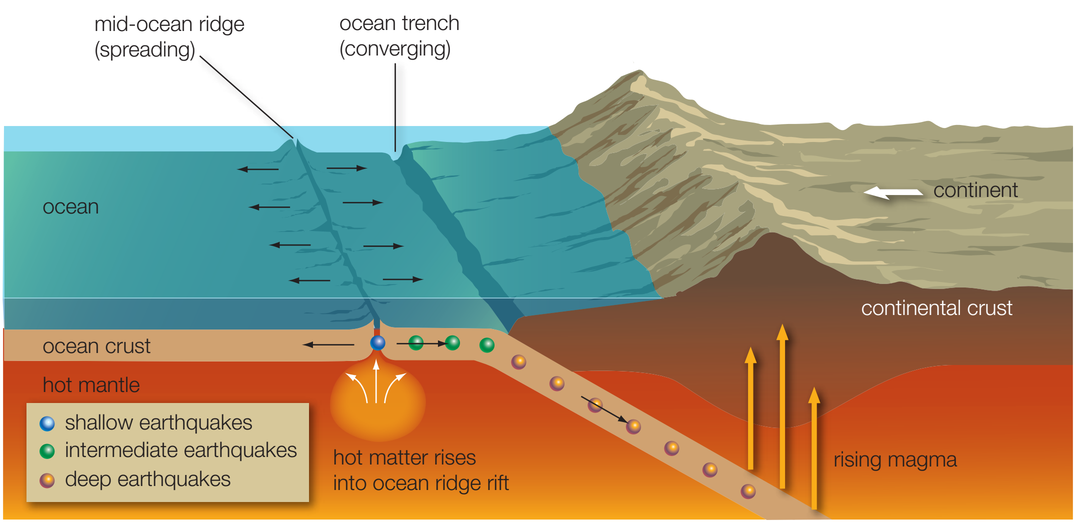


Figure 1.12 Formation of a mid-ocean ridge and sea floor spreading

Earthquakes of magnitude 8 and larger normally only occur at plate boundaries. The most disastrous Australian earthquake in the last 200 years was the Newcastle earthquake of 28 December 1989 which had a magnitude of 5.6 and caused $1.2 billion worth of damage.

Australia is far from the edges of the Indo-Australian plate yet volcanoes have been erupting along the eastern part of the continent for the last 33 million years. Australia's volcanoes are not related to the subduction zones that produce volcanoes in New Zealand, Tonga, Samoa and Indonesia. Although there is much evidence for previous existence of active volcanoes in the continent of Australia, at present all volcanoes are dormant or extinct. Active volcanoes are rare in Australia because there are no plate boundaries on the continent. However, there are two active volcanoes in the Australian territory located 4000 km southwest of Perth on Heard Island and the nearby McDonald Islands. A volcano on the largest of the McDonald Islands erupted some time after 1980 filling some of the island's bays with volcanic material and extending the coastline. Figure 1.14 illustrates the change in size of the island from before the eruption after 1980 to 2001.

When plotting volcanoes of the Australian continent onto a map, we can see that there are several chains with increasingly younger volcanoes to the south (see Fig. 1.15). The age progressions suggest that the hot spot beneath eastern Australia is broad and may take advantage of weak places on the plate to feed magma to the surface. The younger volcanoes

Figure 1.13 Map of Australia showing positions of earthquake occurrences at different magnitudes

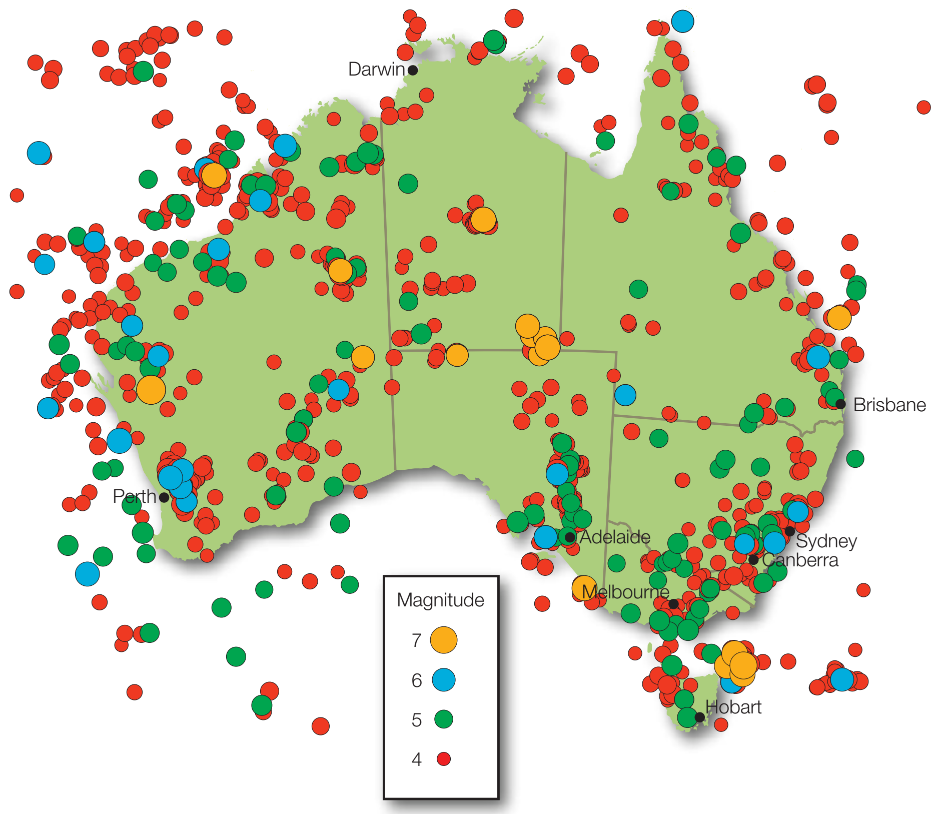
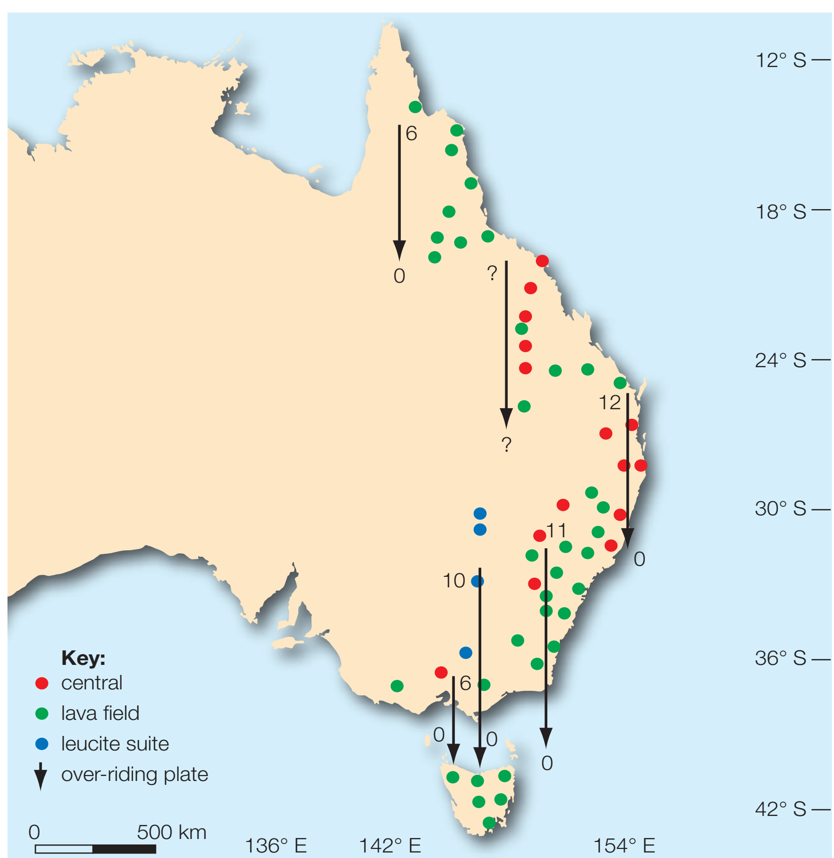


Figure 1.14 Satellite photographs: (a) McDonald islands before eruption in 1980; (b) McDonald islands in 2001, increasing over 1 km in width as the eruption continued

(a)

(b)

Figure 1.15 Volcanoes of Australia vary in age particularly between the northern and southern volcanoes (ages are shown in millions of years)



suggest more recent activity regarding the plate movement. In February 2002 an earthquake measuring a magnitude of 4.5 occurred between Victoria and the northwest coast of Tasmania. Scientists believe this region is a hot spot (a place where magma rises to Earth's surface) for the birth of a new active Australian volcano. Although, nothing has formed at present, it may occur sometime in the next 1000 years.

Other than making inferences about continent movement using the position of earthquakes and volcanoes, scientists may also combine other technologies such as geochronology (plotting the ages of the sea floor) (see website listed on page 243) and satellites with the global positioning system (GPS) for determining rates and directions of plate movement.

Method

Read the Background information and observe Figures 1.8 to 1.15 to solve the following problems surrounding the plate tectonics and inferences about a moving Australian continent.

Results—problem solving questions

1. Identify two types of evidence that are used for demonstrating the existence and position of mid-ocean ridges and sea floor spreading.
2. (a) Describe any patterns or trends in the position of earthquakes in Australia in Figure 1.13.
   (b) Explain reasons for the above.
3. Why does Australia not have any active volcanoes on the continent? Explain possible reasons why the two active volcanoes are positioned 4000 km southwest of Australia, towards Antarctica?
4. Identify any pattern or trend in the position of plate boundaries, earthquakes and volcanoes around the world using Figures 1.8, 1.9 and 1.10.
5. Describe the relationship between volcanoes and earthquakes and the position of mid-ocean ridges and sea floor spreading.
6. Discuss what the position of mid-ocean ridges and sea floor spreading may infer about the movement of continental plates, with particular reference to Australia.
7. Using Figure 1.14, determine the possible movement direction that this information suggests about the Australian plate and therefore the Australian continent.
8. Scientists are able to determine the direction and speed of movement of Australia using technology to produce the information in Figure 1.15. Based on the information on the map, which direction is Australia moving?
9. Scientists have suggested that the mid-ocean ridge south of the Australian continent has created 75 km of sea floor over the past one million years. How much should we see created per year from the mid-ocean ridge?

Analysis questions

1. Describe the scientific information that provides evidence towards the movement of crustal plates and therefore movement of continents.
2. Describe how solving problems surrounding the position of mid-ocean ridges and sea floor spreading has assisted in the understanding of continental plate movement.
3. Discuss how determining trends in earthquake and volcano positions can lead to inferences for the direction of movement of the Australian continent.

TR

Extension question

Changing ideas in science—the platypus enigma

SECONDARY SOURCE INVESTIGATION

PFAs

P3
P5

- ***identify data sources, gather, process and analyse information from secondary sources and use available evidence to illustrate the changing ideas of scientists in the last 200 years about individual species such as the platypus as new information and technologies became available***

Introduction

In the late 1700s, expeditions of natural scientists (as biologists were called back then) to distant lands were common. Voyages to Australia resulted in preserved specimens of the platypus being sent back to England, where scientists of the time were working on refining the classification of living organisms. The first specimen of a platypus was sent

PFA
P3

PFA
P5

SR TR

Scaffolds for breaking down the question

from NSW to Britain in 1798 by Governor John Hunter, who had an interest in natural history. As more specimens of this 'amphibious mole' began arriving in Britain, they were the cause of much puzzled speculation—an 'enigma' to the scientists of the time. The specimens of this strange, unnamed creature—a mixture of an animal with fur like a mammal, but webbed feet and a bill like a duck—were regarded as a hoax. Scientists at the time thought that perhaps someone had cleverly stitched together the body parts of more than one creature, and sold it to sailors who knew no better!

Thomas Bewick, the first scientist to examine the platypus specimen, wrote that he had resisted any attempt 'to arrange it in any useful mode of classification' and Dr George Shaw, a respected naturalist at the British Museum, suspected that the specimen he had received in 1799 was a 'hoax'. Close and detailed examination showed, of course, that this was indeed a real animal and Shaw went on to name it *Platypus anatinus* in 1799. The original name was derived from Greek (*platypous* = flat-footed) and Latin (*anatinus* = duck-like). The name was later changed to *Ornithorhyncus anatinus,* after the discovery that the name *platypus* had already been given to a beetle (*ornitho* = bird-like, *rhyncus* = snout in Greek). The classification of the platypus continued to confound and interest biologists across the world for nearly 90 years.

Recent discoveries of platypus-like fossils have led to a whole new area of research. In the past, the modern-day platypus was thought of as a 'primitive' species that had survived, but current research and discoveries have led to the suggestion that it is a highly evolved form of an ancestor.

Figure 1.16
The platypus, with its strange mixture of characteristics

In 1985, a fossil jaw bone and three molar teeth of an early platypus ancestor (*Steropodon galmani*) were found in NSW. The main surprise came when its age was discovered to be 110 million years, making it the oldest mammal fossil found in Australia so far. Another possible ancestor of the platypus, *Obduron,* was discovered in 1991 in South America. It has been dated at about 62 million years old. Three species of *Obduron* have been found in Australia. Another convincing piece of evidence that supports the idea that the southern continents once were joined?

A current area of contention amongst biologists is that of the evolutionary relatedness of the platypus to other mammals. Studies of DNA sequences are being carried out to determine if it is more closely related to marsupial mammals or placental mammals, but there seems to be disagreement about a definite answer. And so the platypus enigma continues!

You will be given two introductory tasks to assist you in researching this complex topic. They will help you answer the third task which directly addresses the topic.

Background information to help get you started

Scientific work and ideas at the time (1798 onwards)

- During the late 18th and early 19th centuries, zoologists, botanists and other natural scientists were tackling the ongoing task of refining the classification systems of the animal and plant kingdoms.
- Evolution—that organisms change over time and came from a common ancestor—was not commonly accepted by scientists in the 1800s; the Darwin–Wallace theory of evolution was put forward and still being argued in the late 1800s.
- Amphibians, Reptiles, Birds and Mammals were all considered to be unrelated groups: their classification was based on evidence obtained from their external structure and their type of reproduction (in particular, whether they laid eggs, or their young were born alive).

Task 1 Structures in the platypus also observed in mammals and other vertebrate groups at that time.

Table 1.2 Features accepted as common to mammals and other vertebrate groups at that time

	Non-mammals	Mammals
Mouth	Bill or beak, no teeth: birds (bill: duck)	Mouth with lips and teeth
Feet	Webbed feet: Amphibians (which were classified as part of the reptile class back then) and some birds (ducks)	Free digits, not webbed
Reproduction	Internal fertilisation, but egg-laying (oviparous): Reptiles and Birds Internal fertilisation, young develop in soft eggs inside the female's body (ovo-viviparous): some Reptiles	Internal fertilisation, young born alive
Parental care—feeding young:	Young are not suckled—no mammary glands	Mammary glands for milk production; young are suckled
Regulation of body temperature	Ectotherms—body temperature regulated by external sources of heat (e.g. in the environment). Body temperature tends to fluctuate more—Fish, Amphibians and Reptiles Birds are endothermic (see Mammals)	Endotherms—body heat is generated from internal sources. Body temperature is constant and hardly fluctuates with that of the external environment.

Analysing this information

Using the information in Table 1.2 as a guide, research which of the features the platypus shares with mammals or non-mammalian organisms. Using the table on the Student Resource CD list the features evident in the platypus and identify the *class of vertebrates* in which this feature commonly occurs.

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See table: Features common to mammals, non-mammals and the platypus

Task 2 Platypus hypotheses that have been investigated

Use the details recorded in Task 1 and the statements below to guide your Internet searches, while attempting to do Task 3.
As you do your research for Task 3 you should come across information that will help you to determine whether each of the following statements is true or false:

- The platypus gives birth to live young.
- The body temperature falls rapidly when a platypus swims and it has to return to its burrow to warm up. (Radiotelemetry is used to measure platypus temperature and data loggers are used to measure burrow and water temperatures.)
- The platypus is a rare species (studies used tagging, monitoring, radio-tracking and reporting on platypus sightings).
- The platypus has more sets of chromosomes than mammals; its chromosomes may be more similar to those of birds or reptiles (microscopic examination of chromosomes—research at Monash University).
- The platypus does not rely on vision, but on specialised sensory perception to locate food underwater. (Website search hint: type 'electroreception in monotremes' into your search engine.)
- The platypus as we know it is not a 'primitive' animal, it has evolved from an ancestral form.
- Platypus fossil ancestors such as *Obduron* lived before Gondwana split.
- Fossilised platypus ancestors may occur in southern continents other than Australia.
- Studies of evolutionary relatedness show that monotremes (such as the platypus) are more closely related to marsupials than to placental mammals. (Research involves analysis of nuclear DNA and mitochondrial DNA.)

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'Then and now' table

Task 3 Information that you should gather, process and analyse

Use the 'Then and now' table on the Student Resource CD to record the information that you gather, as outlined below.

1. Outline ideas held 200 years ago about the platypus and its relationship to other individual species.
   (a) Use the background information above and the information in Tasks 1 and 2 to answer this question relating to the platypus specifically.
   (b) Also research the knowledge that the Aboriginal people had about the platypus at that time.
2. State the main difficulty involved in trying to classify the platypus.
3. Research the work of scientists in trying to solve the problem of platypus classification and evolution:
   (a) hypotheses posed (see hypotheses listed in Task 2)
   (b) evidence collected and technology used (research each hypothesis and briefly outline the technology used and the scientific findings for each)
   (c) conclusions drawn.
4. Outline the 'new idea' in science—how the platypus is classified today compared with the confusion of 200 years ago.
5. Putting it all together: explain how the ideas of scientists changed and how technology helped scientists to gather evidence to support their current conclusion.

REVISION QUESTIONS

1. List the present-day continents that made up Gondwana in the order in which they separated from the supercontinent.
2. State:
   (a) how long ago Australia is believed to have broken away from Antarctica
   (b) where predictions say Australia will be in 50 million years' time.
3. Explain how the fact that the Himalayan mountains are slowly rising supports the theory of continental drift.
4. Outline two examples of geographical evidence to support the theory that Australia was once connected to the supercontinent called Gondwana.
5. Name two *fossil groups* that are common to Gondwanan continents and identify on which present-day continents each of these fossil groups have been found.
6. Name two *present-day organisms*, one plant and one animal, that are common to Gondwanan continents and identify on which present-day continents each of these fossil groups have been found.
7. Describe ways in which scientists can identify the positions of mid-ocean ridges and spreading zones.
8. Describe how information about the position of mid-ocean ridges and evidence of sea floor spreading can infer that the Australian continent is moving.

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Answers to revision questions

(*Note*: The final dot point has been moved from Chapter 1 to a more suitable placement in Chapter 2, page 275.)