

Evolution of Australian Biota

Stage 6 Biology Resource



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Zoo Education is a partnership between:



Zoological Parks Board of New South Wales

Evolution of Australian Biota



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This resource is to be used as part of an excursion to Taronga Zoo – home to over 2,627 animals representing 315 species/sub-species. The resource and related workshop is linked to the NSW School Curriculum and has been developed in consultation with Department of Education and Training Curriculum Coordinators and NSW School Teachers. It is a comprehensive kit of information and activities designed to ensure maximum benefit to you during your excursion to Taronga Zoo.

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Introduction

Since finally breaking away from Antarctica and South America approximately 55 million years ago, Australia's animals have evolved in isolation under the influence of a number of major climatic changes. As a result of this, the Australian continent today contains a diverse and unique collection of fauna vastly different to that found elsewhere in the world.

Unfortunately, Australia's unique biodiversity today faces new and potential devastating threats, a consequence of a number of human-related activities.

The purpose of the Taronga Zoo excursion is to investigate the evolution of Australian fauna since its Gondwanian origin, with special reference to the evolution of Australia's kangaroos. Students will also be required to investigate the adaptations of a selection of living species, with particular reference to how they assist the animal to endure variations in temperature and water availability. Finally, students will also be required to identify examples of threats to biodiversity on this continent.

This involves:

- making first hand observations of different animals.
- recording observations in an appropriate format.
- investigating second-hand sources such as reading signs/boards and listening to Keeper and other Zoo personnel presentations.



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NSW School Curriculum Links

8.5 Preliminary HSC – Evolution of Australian Biota

Taronga Zoo exhibits a variety of unique Australian animals to help understand the past environmental conditions Australia's unique animals evolved in currently survive in.

The 45 minute to one hour presentation gives a brief history of the Australian continent, from its early position as part of the very large southern landmass, Gondwana, to its present global location. Further to this, students will learn about the following syllabus related information:

- a brief overview of the climatic changes that have occurred on the Australian continent in the last 50 million years.
- the effect these environmental changes had on the evolution of Australian animals, with particular reference to the evolution of kangaroos.
- examples of Australian animals which show variation within species and under what conditions these variations occurred.
- mechanisms employed by a selection of Australian fauna to ensure fertilisation and survival of the embryo and young after birth.
- threats to Australia's biodiversity and the Zoo's role in maintaining this biodiversity.

Students will also be required to collect primary and secondary data from within the zoo grounds. Through these activities, students will be required to:

- gather first-hand information by measuring, observing and recording results.
- process information to evaluate the relevance of first-hand and secondary information and data in relation to the area of investigation.
- justify positive values and attitudes towards both the living and non-living components of the environment, ethical behaviour and a desire for a critical evaluation of the consequences of the applications of science

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Pre-visit Activities

Syllabus Concepts

Students should be familiar with the following concepts prior to their visit to Taronga Zoo:

- evidence that supports the assertion that Australia was once part of Gondwana, including:
 - matching continental margins
 - position of mid-ocean ridges
 - spreading zones between continental plates
 - common fossils
 - similarities between present-day organisms on Gondwanan continents
- the theory of Evolution
- speciation
- observations and inferences

Unlocking Australia's History

Research Australia's rich fossil sites that assist in helping to understand the evolution of Australia's unique fauna.

In particular, students should research the following places:

- Riversleigh
- Naracoorte
- Lake Eyre and Lake Frome
- Murgon
- Lightning Ridge

In researching these sites, students should investigate the following:

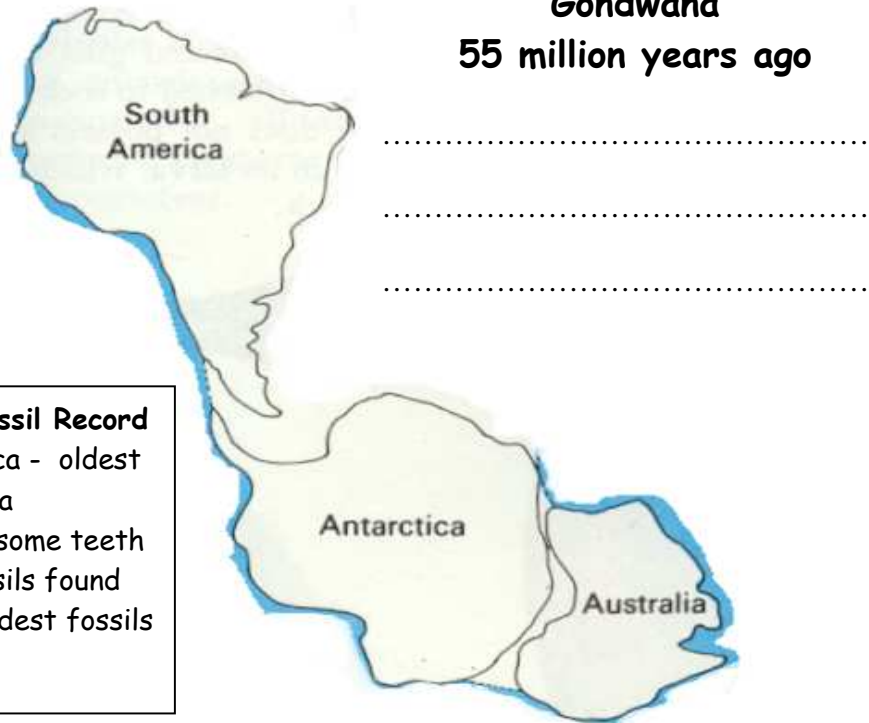
- the age of rocks at the site
- an overview of the environment (rainforest, desert etc) that the site represents
- a brief description of a selection of fossils that the site has revealed
- an in-depth discussion of at least one important fossil find from this site, with an explanation of how this fossil has contributed to the understanding of the evolution of this Australian animal group.

At the Zoo

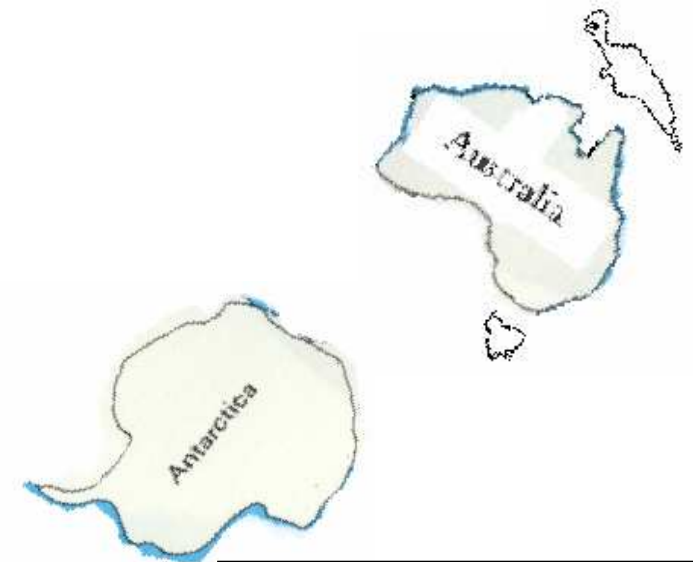
Part 1 - Presentation

The Changing Australian Continent

Gondwana
55 million years ago



Separated Continents
20mya to present



Marsupial Fossil Record

South America - oldest fossils 70 mya
Antarctica - some teeth and bone fossils found
Australia - oldest fossils 54 mya

Monotreme Fossil Record

Platypus-type animals to move across the whole of Gondwana.
The location of known Monotreme fossils are shown:

LR - Lightning Ridge

Steropodon - 110 mya

Kollikodon - 110 mya

(very different teeth to later platypus-type animals)

R - Riversleigh

Obdurodon - 65 mya

P - Patagonia

Monotrematum - 65 mya

(modern tooth types)

On the diagram-

Draw the circumpolar ocean current. It dried Australia because cooler water carries less moisture - thus less rainfall.

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Part 1: Presentation Kangaroo Evolution: The Beginning

Ancestral Kangaroos: 25 millions years ago



Environment:

Movement:

Hind foot:

Tail:

Other:

Musky Rat Kangaroos: Living fossil

Environment:

Movement:

Hind foot:

Tail:

Other:

A Time of Kangaroo Diversity: 15 million years ago



Environment:

Movement:

Other:

.....

Illustrations - Australian Geographic

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Part 1: Presentation

Animals evolve in response to a changing climate.

The Australian Continent - a place for reptiles adapted to dry conditions

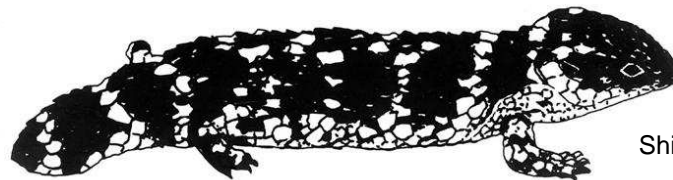
Observation: Scales
Inference: Protection and to prevent water loss

Observation:

Inference:

Observation:

Inference:



Shingleback Lizard

Observation:

Inference:

Observation:

Inference:

Arid Adaptations:

Reproduction:

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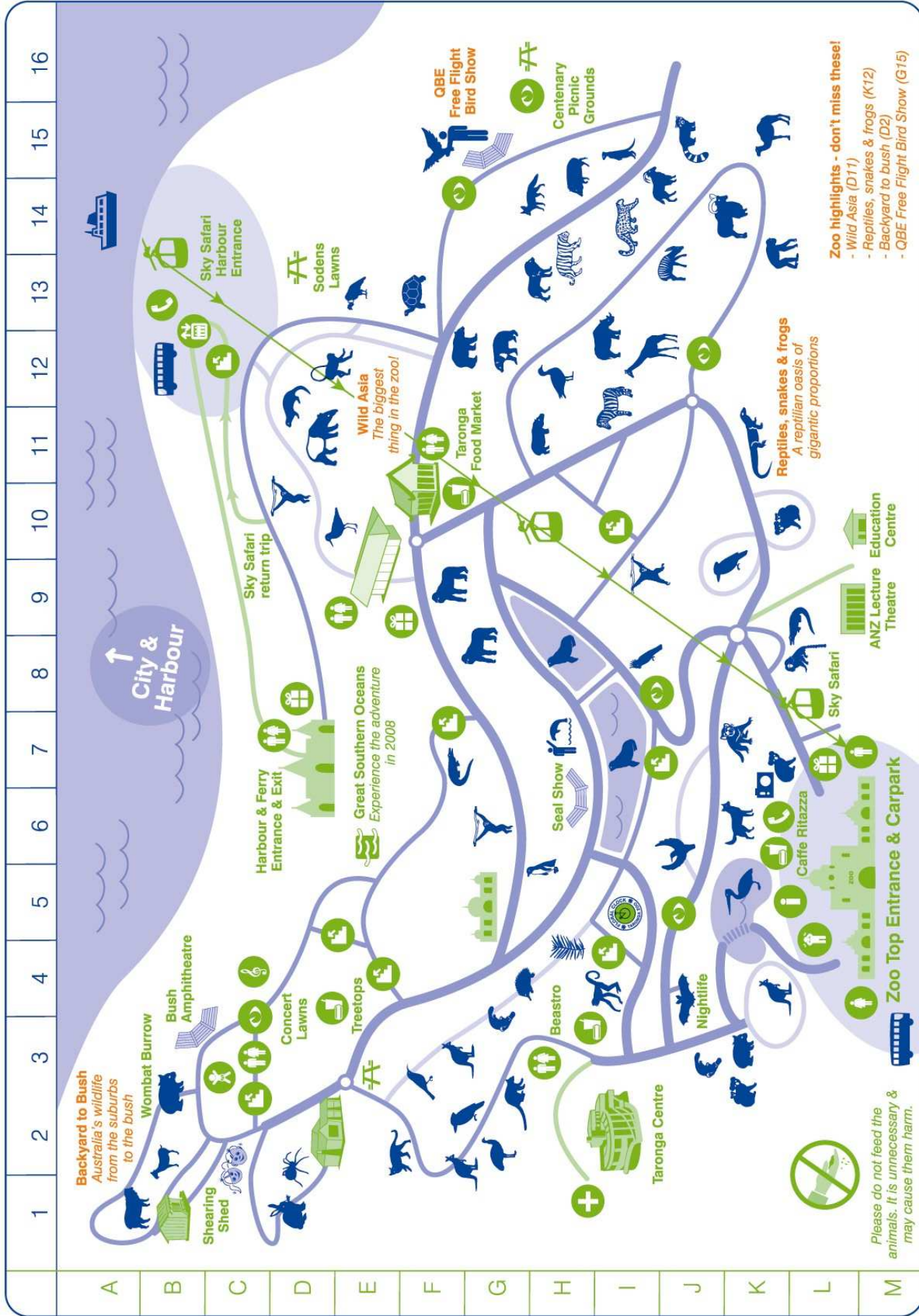
At the Zoo

Part 2 – Australian Biota Trail Activities

Use the map on the following page to navigate your way around the Zoo and locate animals and exhibits you need to observe to complete the activities that follow.

HINT: Take time before you begin this section to plan a trail that incorporates the animals and exhibits you are required to locate. The following list of animals and activities should help you.

Koala House	Map ref. L10	Activity 1 - Koala Focus
Tasmanian Devil	Map ref. K7	Activity 2 – Threats to Biodiversity
Dingo	Map ref. K6	Activity 2 – Threats to Biodiversity
Quokka	Map ref. K2	Activity 2 – Threats to Biodiversity
Goodfellows Tree Kangaroo	Map ref. G3	Activity 3 - Examining Kangaroo Evolution
Red Kangaroo	Map ref. G2	Activity 3 - Examining Kangaroo Evolution Activity 4 - Kangaroo Adaptations
Macropod Walk-through	Map ref. K4	Activity 4 - Kangaroo Adaptations
Echidna	Map ref. K3	Activity 5 - Echidna Focus



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Activity 1 – Koala Focus

Koala Walkabout map ref L10

1. Describe the current distribution of koalas in Australia.

.....
.....

2. The Koala Walk-about currently houses koala's from Queensland, NSW and Victoria. These koala's all belong to the same species, *Phascolarctos cinereus*. Provide possible explanations for the koala facts given below in relation to variation between populations of koala's.

Koala is an Aboriginal word meaning 'no drink'

Victorian population adults are larger than their northern relatives

.....
.....
.....

Queensland koalas are lighter in colouration than their southerly relatives.

.....
.....
.....
.....



Southern populations tend to have a thicker coat than their northern relatives

.....
.....
.....

3. Using the koala as an example, briefly describe marsupial reproduction (use illustrations provided in the exhibit to help explain your answer).

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Activity 2 – Threats to Biodiversity

Tasmanian Devil exhibit map ref K7, Dingo exhibit map ref K6
Quokka exhibit map ref K2

Tasmanian Devil

1. The Tasmanian Devil was once found across much of the Australian continent? What evidence assists in this theory of past distribution?

.....
.....

2. What reasons account for their current distribution?

.....
.....

Dingo

1. How did dingoes arrive in Australia?

.....
.....

2. Using two examples, what effect have dingoes had on Australian fauna since their introduction?

.....
.....

Quokka

1. Describe current quokka distribution?

.....
.....

2. What factor(s) account for quokka population success?

.....
.....

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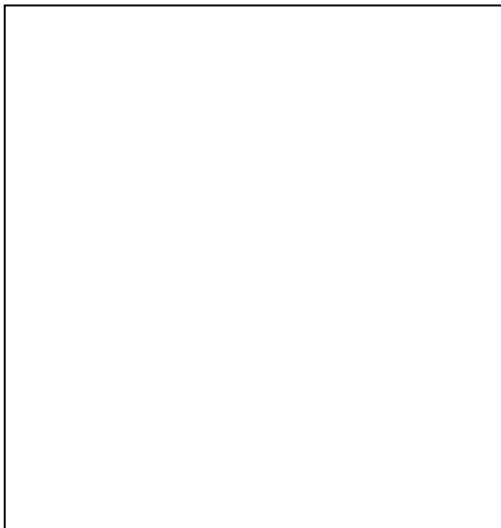
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Activity 3 – Kangaroo Evolution

Goodfellows Tree Kangaroo exhibit map ref G3

Tree Kangaroos: 5 millions years ago to present

1. In the space provided, complete observations of the tree kangaroo.



Environment:

Movement:

Hind foot:

Tail:

Other:

Draw a diagram of the tree kangaroo in the space provided

2. It is believed that tree kangaroos evolved about 5 to 3 million years ago.

a. From you observations of the tree kangaroo, what evidence is there to support the idea that tree kangaroos had ancestors that were terrestrial?

.....
.....

b. Describe three adaptations tree kangaroos have evolved for an arboreal existence.

.....
.....
.....

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Activity 3 –Kangaroo Evolution (cont.)

Red Kangaroo map ref G2

Red Kangaroos: 2 millions years ago to present

1. In the space provided, complete observations of the red kangaroo.



Environment:

Movement:

Hind foot:

Tail:

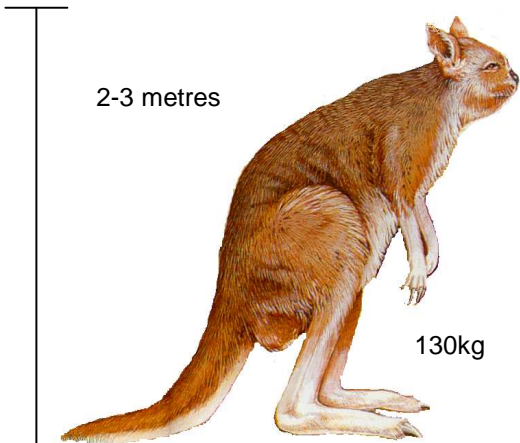
Other:

.....

Illustrations - Australian Geographic

Procoptodon *goliath*: 3.4 millions years ago to 46,000 years ago

2. Below is a diagram of, Procoptodon *goliath*, the largest kangaroo ever known. Compare three features of this extinct kangaroo with the male red kangaroo.



Skull Shape:
Procoptodon:

Red kangaroo:

Size:
Procoptodon:

Red kangaroo:

Foot Structure:
Procoptodon:

Red kangaroo:

Front limbs:
Procoptodon:

Red kangaroo:

Illustrations - Australian Geographic

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Activity 3 –Summarising Kangaroo Evolution

In the space provided below, draw a timeline of the major events in kangaroo evolution, using information from the lesson and previous activities. Include in your timeline the following:

- ancestral kangaroos
- kangaroo diversity 15 mya
- tree kangaroos
- musky rat kangaroo
- *Procoptodon goliath*
- red kangaroos

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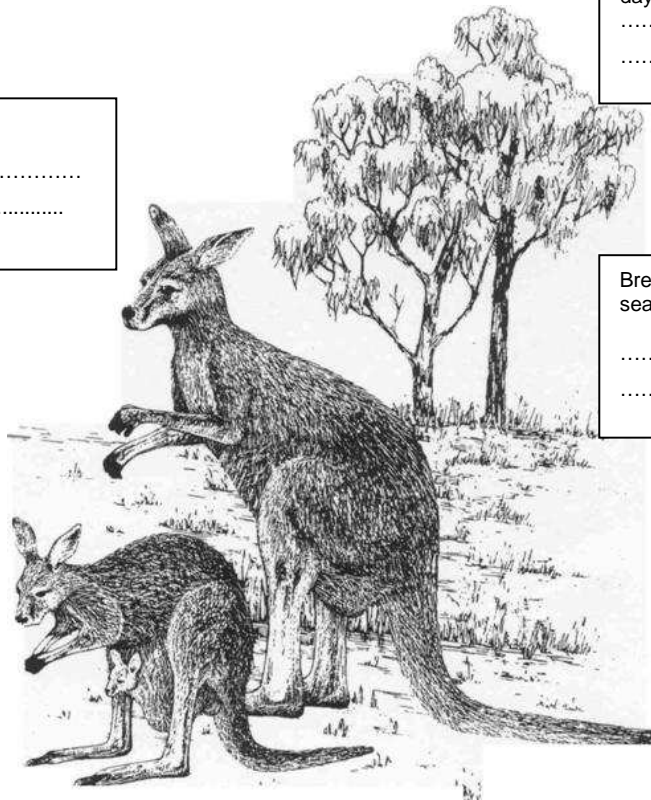
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Activity 4 – Kangaroo Adaptations

Red Kangaroo map ref G2
Macropod walk-through map ref K4

The red kangaroo is very well adapted to the harsh, drought-prone areas of arid Australia.

In the space provided, infer the reason for each of the adaptations stated.



Activity – rests in shade during middle of the day
.....
.....

Migrate over large distances
.....
.....

Breeding not restricted to a set breeding season (opportunistic breeders)
.....
.....

No sweat glands, lick paws
.....
.....

Faeces – dry pellets
Urine – highly concentrated urea
.....
.....

Embryonic diapause is an amazing adaptation used by many species of kangaroo, including the Red Kangaroo. Briefly describe embryonic diapause, including in your answer the advantage of this reproductive adaptation in the harsh Australian environment.

.....
.....

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Activity 5 – Echidna Focus

Echidna exhibit map ref K3

Echidnas have evolved a fantastic array of adaptations to survive in a variety of Australian conditions.

1. Observe the echidna in it's exhibit and in the space provided, write five adaptations you have observed. These observations can be structural features or behavioural features. Once completed, infer the reasons for the feature (the first one is done for you).

Observation: Spines that cover the back and sides

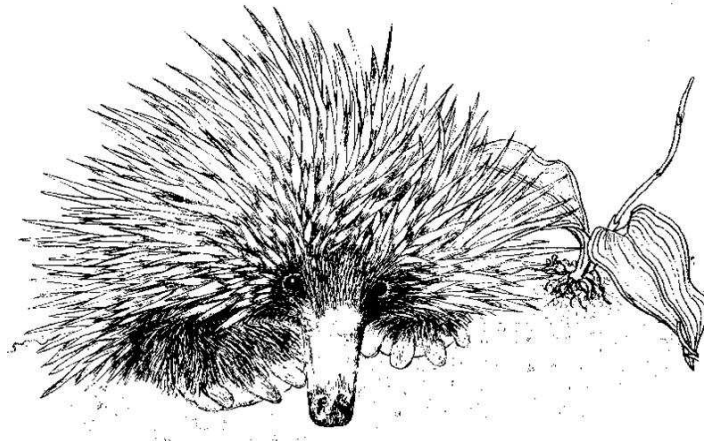
Inference: Spines are used to protect the echidna from predators

Observation:

Inference:

Observation:

Inference:



Observation:

Inference:

Observation:

Inference:

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2. Initial observations by Europeans about the echidna included the following pieces of information.

'An animal shot at Adventure Bay. It had a Beak like a Duck – a thick brown coat of Hair, through which the points of numerous Quills of an Inch long projected these very sharp – It was 14 inches long & walked about on 2 legs. Has very small Eyes & five claws on each foot – Its mouth has a small opening at the end of the Bill & had a very small tongue. – W.B.'

Captain Bligh's log of the ship Bounty
9 February 1792



The above is one of the first European illustrations of an echidna.

In the space provided below, compare your observations of the Short-beaked Echidna with the above early observations.

.....

.....

.....

3. There are five subspecies of Short-beaked Echidnas. Three of these are listed in the table below.

Name	Distribution	Distinguishing Characters
<i>T.a. acanthion</i>	Northern Territory, northern QLD, inland Australia and Western Australia	Hairs, usually black, are bristle-like, sparse on the back and often absent on the ventral surface. Spines long and stout
<i>T.a. aculeatus</i>	Eastern NSW and Victoria; southern QLD	Spines overshadow fur, which is relatively short.
<i>T.a. setosus</i>	Tasmania	

a. Based on the information provided in the above table, what do you predict the distinguishing characters of the Tasmanian subspecies would be (write your answer in the table)?

b. What subspecies do the Zoo's echidnas belong to? Provide evidence for your answer.

.....

.....

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Activity 6 – Taronga Zoo and Biodiversity

What role does Taronga Zoo play in assisting to maintain diversity of Australian animals?

In the space provided below, answer the above question in a suitable format. Identify in your answer any evidence that you have collected during your zoo visit.

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Post- visit Activities

Questions

1. Briefly describe two pieces of evidence that supports the assertion that Australia was once part of Gondwana.
2. Briefly describe how the Australian continent has changed over the past 55 million years.
3. How does the musky rat kangaroo contribute to our understanding of kangaroo evolution?
4. Describe three reproductive adaptations of red kangaroos.
5. Discuss Australian examples of variation between members of a species.
6. Assess the effectiveness of Taronga Zoo in helping to maintain biodiversity, using first hand information to support your answer.

Self Evaluation

Complete the following self evaluation.

Learning

(increased understanding of concepts and developed investigation and communication skills)



satisfactory



Good



excellent

Participation

(degree to which you engaged in activities, asked and answered questions, motivation)



satisfactory



Good



excellent

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Useful Resources

The Free Dictionary

A reference for terms and definitions

www.encyclopedia.thefreedictionary.com

Fauna of Australia

A complete guide to all aspects of the Short-beaked Echidna

<http://www.deh.gov.au/biodiversity/abrs/publications/fauna-of-australia/pubs/volume1b/15-ind.pdf>

Short-beaked Echidnas

Further information on Short-beaked Echidnas

<http://abc.net.au/science/scribblygum/June2000/default.htm>

Australia's Megafauna

A web-based activity exploring the diversity of the Australian megafauna and its extinction

<http://science.uniserve.edu.au/school/quests/mgfauna.html>

Tropical Tropics Newsletter

Contains information on the Tree Kangaroos and Musky-rat Kangaroo that live in Queensland Rainforests

<http://www.epa.qld.gov.au/register/p00820bm.pdf>

Uniserve Science

Reference websites are listed relating to the Evolution of Australian Biota course

<http://science.uniserve.edu.au/school/curric/stage6/biol/ozbiota.html>

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Glossary

Adaptation	the adjustment of an organism to its environment or the process by which it enhances such fitness.
Arboreal	of, living in, connected with trees.
Biodiversity	the number and variety of organisms found within a specified geographic region.
Bipedalism	an upright posture or form of locomotion that relies on the use of the legs without any assistance from the limbs.
Embryo	an organism in its early stages of development, especially before it has reached a distinctively recognizable form.
Gondwana	the large southern landmass of which the Australian continent was once apart of.
Megafauna	large or relatively large animals, as of a particular region or period, considered as a group.
Opposability	one digit of the hand or foot is able to cross over the palm to form a grip which uses force to oppose the other digits.
Prehensile tail	a tail capable of grasping. The tail can be used for extra support when in a tree while feeding, playing or resting. When not in use the tip of the tail is curled. A non-prehensile tail is only used for balancing purposes.
Quadrupedal	an animal having four limbs specialized for walking.
Species	a fundamental category of taxonomic classification, ranking below a genus or subgenus and consisting of related organisms capable of interbreeding.
Terrestrial	of, connected with the ground.