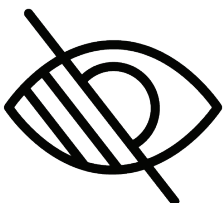


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Revealing Riversleigh Exhibition Guide

29 September 2025 – 13 March 2026



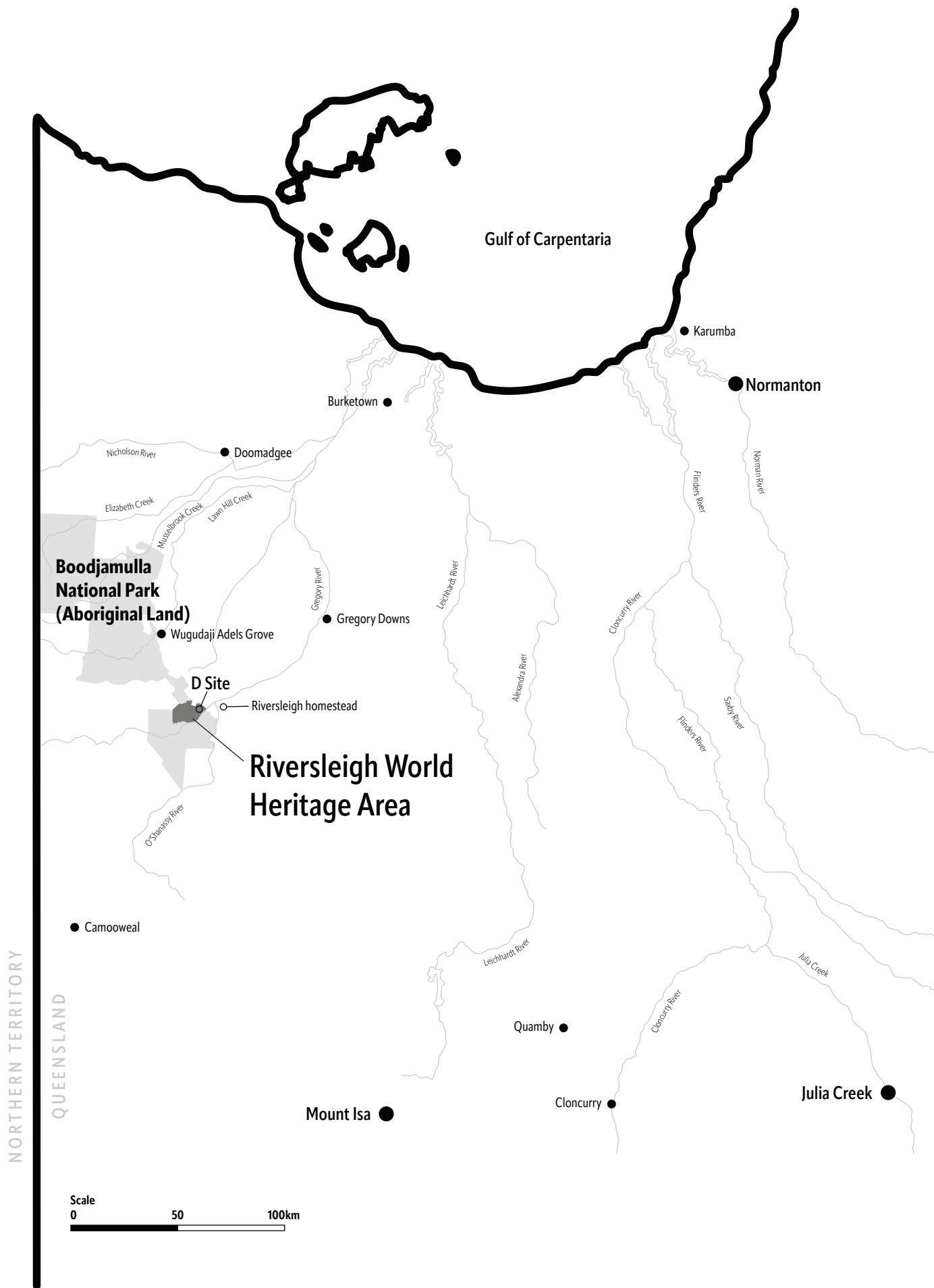
Introduction

Uncover the extraordinary story of Australia's ancient past through the fossil record of the Riversleigh World Heritage Area, located in Boodjamulla National Park on Waanyi Country in the lower Gulf region of Queensland. Renowned for its globally significant fossil discoveries, *Revealing Riversleigh* presents fossils etched out of limestone to reveal why they hold such vital clues to our continent's past.

Spanning the last 25 million years, Riversleigh's fossil record documents a period of dramatic transformation. Discoveries by teams of UNSW palaeontologists led by Professor Michael Archer and Professor Suzanne J Hand demonstrate how Australia's unique wildlife evolved adaptations to cope with the cycles of natural climate change that reshaped the continent's vast, ancient rainforests into the open forests, woodlands, and grasslands of today. The fossils include ancestors of familiar modern Australian marsupials such as kangaroos and koalas, as well as fascinating extinct groups such as marsupial lions, flesh-eating kangaroos, tree-climbing crocodiles, and creatures so strange they have names like 'Thingodonta'.

The fossils in *Revealing Riversleigh* provide unique insights into the processes that shaped Australia's present biodiversity. Understanding how life responded to ancient environmental shifts gives us powerful tools to anticipate and counter future challenges. This deep time perspective is now informing innovative conservation strategies, offering hope for critically endangered species like the Mountain Pygmy-possum facing the impacts of human-induced climate change. *Revealing Riversleigh* demonstrates how the past can help us understand the present in order to better protect the future.

We respectfully acknowledge the Waanyi peoples, on whose lands and waters the palaeontological fieldwork featured in this exhibition took place. UNSW Library stands on unceded lands of the Bedegal and Gadigal peoples.



Riversleigh Project

Riversleigh's fossils, in Waanyi country, were undoubtedly known to First Nations peoples for thousands of years. It was not until 1963 that mammal fossils were collected at Riversleigh by Dick Tedford (American Museum of Natural History). After Alan Bartholomai (Queensland Museum) spotted a new species in 1965, he informed Mike Archer (Queensland Museum, until joining UNSW in 1978), who then organised an expedition to Riversleigh in 1976. Completely 'hooked' by what he saw that year, Mike and his colleagues, including Sue Hand, Troy Myers, Anna Gillespie, Henk Godthelp, and Phil Creaser, have returned annually for the last 50 years, which makes the Riversleigh Project the longest continually running palaeontological project in Australia.

When palaeontologists find new Riversleigh fossil sites, they use a range of tools to quarry the bone bed, including hammers, chisels, and even light explosives to 'carve' the extremely hard limestone into portable blocks. After transporting the blocks to the laboratory at UNSW, they are processed using dilute acetic acid, which dissolves the limestone, leaving the chemically fortified fossils to emerge in the thousands.

With decades of discovery at more than 300 fossil sites spanning the last 25 million years, over 100 colleagues from 30 institutions and 11 countries, and more than 90 research students at UNSW have collaborated to interpret the extraordinary record preserved in this place. Hundreds of new species have been found, with many representing the first known fossil records for a wide range of living groups such as lyrebirds, striped possums, and extremely mysterious creatures like 'Thingodonta'.

In 1994, with Naracoorte Caves in South Australia, the global significance of the fossil record at Riversleigh was recognised through its inclusion on the World Heritage List. Sir David Attenborough described it as one of the four most important fossil deposits in the World.

Thylacines & Marsupial Lions

The thylacine or Tasmanian tiger (marsupial family Thylacinidae— ‘pouched dogs’) was Australia’s “King of Beasts” before the last one died in a Hobart Zoo on 7 September 1936. In Riversleigh’s wet forests, between about 25 and 15 million years ago, there were more than ten different kinds of thylacines, ranging from the small fox-sized *Nimbacinus dicksoni* to dog-sized species. Then, as climate change began to dry the continent, by eight million years ago, the number of species had dropped to just three kinds, one of which was the size of a wolf. By three million years ago, there was just one species left—the Tasmanian thylacine. After dingoes were introduced to Australia about 4,000 years ago, the thylacine species vanished from the mainland. It survived in dingo-free Tasmania until Europeans arrived on the island state with sheep, at which point the species was lost forever. Now, however, research teams are using ancient DNA from preserved specimens to revive the thylacine, hoping to bring it back to life to once again thrive in the forests and grasslands of Tasmania.

The marsupial lions (family Thylacoleonidae— ‘pouched lions’), distant cousins of wombats and koalas but with very different food interests, were extraordinary Australian flesh-eaters that lived and evolved alongside the early thylacines. Among the earliest known from Riversleigh was the cat-sized *Microleo attenboroughi*, named after the British naturalist Sir David Attenborough. It may have given rise to the small dog-sized *Lekaneleo roskellyae*, which in turn gave way to the leopard-sized species of *Wakaleo* that hunted in trees as well as on the forest floor. The largest marsupial lion (similar in size to a modern African lion), *Thylacoleo carnifex*, was also the world’s most specialised mammalian carnivore with gigantic meat-cutting premolars. It was still in existence when humans first arrived in Australia, before it went extinct about 35,000 years ago.

AL90 Site

In 1990, Alan Krikman was a UNSW Honours student researching the 25-million-year history of Australia's evolving wombats at Riversleigh. While on the 1990 Riversleigh Expedition, he spotted a bone in a lump of limestone that jutted up from the spinifex grass-covered ground. His discovery proved to be one of the most significant of the more than 300 fossil sites in the Riversleigh World Heritage Area. What Alan had found was the tip of a vast, completely filled-in cave that had itself become a fossil, and was named AL90 in his honour. In 1993, Dr Anna Gillespie began excavating the top of AL90, which had been marked on a map for future investigation. Although she was unsure if the effort would be worthwhile, the site ultimately revealed thousands of fossil bones from fascinating animals. Over the following decades, UNSW palaeontologists excavated about four cubic metres of AL90 cave fill.

We now know that 15 million years ago (the Middle Miocene), the jagged, narrow rooftop opening into the AL90 cave yawned invitingly up through the rainforest floor, beckoning the creatures of that species-rich rainforest to enter. Trees filled with a vast array of different animals leaned over the

cave entrance and, now and then, would fall into a shallow pool of water in the floor of the chamber. Limestone deposited by the water slowly but steadily filled the cave, sealing within its layers the skeletons of extinct sloth-like marsupials (*Nimbadon lavarackorum*), fox-sized thylacines, tusked kangaroos, bandicoots, possums, millions of bats, and many other species entirely new to science. This remarkable fossilised cave is a spectacular gift from the Middle Miocene, deepening our understanding of the diverse species of Riversleigh animals thanks to the incredible preservation of the fossils it contains.

Bats and Cave deposits

In the Riversleigh World Heritage Area, caves have formed over millions of years within the limestone karst landscape. Some of these are 'fossil' caves where the roof and walls have eroded, but the cave floor persists. These old cave floors are often rich in fossil remains, particularly those of bats. From the many fossil deposits at Riversleigh spanning the last 25 million years, palaeontologists have identified at least 44 species of previously unknown extinct fossil bats. It is not surprising that many of these have been discovered in Riversleigh's fossil cave deposits, since more than half of all 1,460 living bat species roost (and die) in caves, crevices, and other underground structures.

When first found, most of these bat fossils appear as rows of tiny teeth and cross sections of the fine, long, tubular bones of the wings. After dissolving limestone blocks with acetic acid, palaeontologists uncover spectacularly preserved, chemically inert fossils, including perfect skulls of many bat species and other animals. While some species are known from hundreds of specimens, others are, so far, only known from a single tooth.

Today, bats are especially sensitive to current climate change, becoming globally recognised as bellwether species. The deep-time record of bats at Riversleigh provides an opportunity to study changes in bat diversity and abundance in northern Australian bat communities through three climate change cycles over the last 25 million years. The Riversleigh record indicates that individual bat families have responded quite differently to past changes in Australia's climate and environments, with those responses ranging from diversification to decline and extinction.

Palaeoconservation & Climate Change

As the study of ancient life, palaeontology helps us understand the origins of Earth's creatures by connecting the past and present. It also offers a compelling predictive tool, hinting at what the future holds as our world continues to change. Throughout the last 25 million years, cycles of climate change have constantly challenged Riversleigh's animals and plants to either evolve and adapt to the transition from rainforest to grasslands, retreat to more comfortable habitats, or face extinction. Palaeontologists have found evidence for all these responses in Riversleigh's fossil record. For example, 'Thingodonta' (species of *Yalkaparidon*) went extinct; musky rat-kangaroos, striped possums (species of *Dactylopsila*), and cuscuses retreated to rainforests in northeastern Queensland; while wombats and grazing kangaroos evolved dental adaptations to exploit the spread of the grassy woodlands that now dominate the Riversleigh region.

Among the most significant insights provided by Riversleigh's fossil record is the increased ability to predict what's likely to happen to Australia's animals as today's global temperatures

increase by 2°C. This is because many of Riversleigh's fossil deposits span previous cycles of climate change, providing us with a fossil record that documents what happened to Australia's animals 17 million years ago when global temperatures rose 2°C during the Middle Miocene Climatic Optimum (MMCO), held steady and then, by 14 million years ago, dropped by 2°C. Understanding the consequences of previous climatic events documented in Riversleigh's fossil record will improve scientists' ability to anticipate which of today's species are likely to need the most help to survive the climate challenges they are now beginning to face.

Burramys Project

Australia's devastatingly cute but critically endangered Mountain Pygmy-possum (*Burramys parvus*), which lives in the alpine zone of mountains in New South Wales and Victoria, is on the verge of extinction. Due to climate change, the winter snow cover these possums rely on for insulation is at risk of disappearing. The snow allows the small, golf ball-sized mammals to safely hibernate in nests deep within damp rock piles, protecting them from the lethal cold air of winter. Most ecologists have long since concluded they are about to become Australia's first mammalian extinction victims of this human-made environmental crisis.

Palaeontologists, however, believe that there may be a way to save this possum. By researching its 25-million-year evolutionary history, including three other *Burramys* species (one of which inhabited Riversleigh approximately 24 to 15 million years ago), they discovered that in every case, they thrived in lowland, wet rainforest habitats. This suggests that the Mountain Pygmy-possum was probably 'tricked' into following the rainforest up the flanks of the Blue Mountains during a wet phase in a previous climate cycle, only to become stranded in an increasingly hostile

environment when the climate changed again. To survive there, the possums had to evolve behavioural tricks to avoid the extremes of the alpine zone.

Working with Secret Creek Sanctuary, UNSW palaeontologists collaborated to establish a non-alpine breeding facility in Lithgow, NSW, where a colony of Mountain Pygmy-possums have lived since 2022. As palaeontologists predicted, the possums are thriving and breeding in these non-alpine conditions. The ultimate plan for the Burramys Project is to trial release and monitor captive-bred individuals into non-alpine wet forest habitats, giving them the chance to repopulate environments similar to those in which their ancestors once thrived.

Riversleigh Fossil Dreaming Tour

We, the Waanyi People, traditional owners and custodians of the Riversleigh World Heritage Area, invite you to immerse yourselves in stories from our Country, learn about our language and culture, and take a virtual tour of a 25-million-year-old fossil site.

We know the Riversleigh area as **Miyumba** - part of our sacred **Bujimala** (Rainbow Serpent) Country. We feel a deep responsibility for this place and we developed the Fossil Dreaming Tour to tell the story of its cultural significance.

Journey to Recognition

Our people have continuously occupied Riversleigh Country for over 35,000 years. The Gregory River is a particularly important area – along its running waters is where our ancestors camped and fished, lived in rockshelters, and made tools and rock art. The World Heritage Area was once part of Riversleigh Station, which also holds an important place in our history. Many of our family members were born or worked on the station, and some are buried there. It was

on this station that one of our Elders taught palaeontologist Professor Mike Archer in 1976 about the Waanyi language and the animals on this Country. Many of these language terms were used to name fossil animals only found at Riversleigh.

When the fossil deposits became part of Boodjamulla National Park, our people protested and helped start the Waanyi Ministerial Advisory Committee, which gave our people a greater say in the management of the area. Since those days, many Waanyi people have worked as cultural rangers to look after this Country. After a long fight, our Native Title rights were recognised in 2010 and in 2023 the park was handed back to us to be co-managed.

Dual Perspectives

Scientists see Riversleigh as a natural landscape shaped over millions of years, but to us it is a cultural landscape belonging to the **Wanggala** – the beginning of time, where all things originate - when the features of the physical and social world were created by our ancestral **Dreamings**. It can be hard for people with different worldviews to understand our beliefs about fossil animals that existed millions of years ago, but

through the Fossil Dreaming Project our people have started to think more about our cultural relationships with these animals.

The Riversleigh Fossil Dreaming Tour is delivered by the Waanyi Native Title Aboriginal Corporation with funding support from the Commonwealth Government.

Wall Contents (A-Z)

(A) UNSW palaeontologists working at Neville's Garden Site

Neville's Garden Site, D-Site Plateau, Riversleigh World Heritage Area, QLD
c. 2015

Credit: Photographed and supplied by Mike Archer

(B) UNSW PhD students and staff undertaking fieldwork at LD94 Site

LD94 Site, Gag Plateau, Riversleigh World Heritage Area, QLD
c. 2021

Credit: Photographed and supplied by Mike Archer

(C) UNSW palaeontologists searching for fossils in Riversleigh World Heritage Area

Gag Plateau, Riversleigh World Heritage Area, QLD
2005

Credit: Photograph by Harry Rosenthal.
Supplied by Mike Archer

- (D) Alan Rackham working at Rackham's Roost Site. He is using ropes and a bucket to haul up equipment approximately 100 metres from the Gregory River below.**

Rackham's Roost Site on top of cliffs adjacent to the Gregory River, Riversleigh World Heritage Area, QLD 1986

Credit: Photograph by Sue Hand.

Supplied by Mike Archer

- (E) Rick Arena coordinating a helicopter collection of limestone blocks containing fossils for transport back to the palaeontology lab at UNSW**

Gag Plateau, Riversleigh World Heritage Area, QLD 1999

Credit: Photograph by Arthur White.

Supplied by Rick Arena

- (F) Henk Godthelp (far left), David Joffe (centre), Mike Archer (right) working in the field at Riversleigh. This was the first year Archer's team visited Riversleigh**

D-Site, D-Site Plateau, Riversleigh World Heritage Area,
QLD

1976

Credit: Photograph by Rudy Kahout.

Supplied by Mike Archer

- (G) UNSW palaeontologists climbing Bitesantennary Valley**

Bitesantennary Valley, D-Site Plateau, Riversleigh
World Heritage Area, QLD

2005

Credit: Photograph by Harry Rosenthal.

Supplied by Mike Archer

(H) Miocene bandicoot skull in limestone

Camel Sputum Site, Godthelp Hill, D-Site Plateau,
Riversleigh World Heritage Area, QLD
2010

Credit: Photograph by Prof. Jon Woodhead.
Supplied by Mike Archer

**(I) Dr Anna Gillespie sorting fossils under a microscope
in the UNSW palaeontology lab**

UNSW palaeontology lab, Kensington, NSW
2015

Credit: Supplied by Mike Archer

**(J) Stephan Williams, one of the preparators who
worked in the UNSW palaeontology lab, with a
massively bone-rich block of Riversleigh limestone**

UNSW palaeontology lab, Kensington, NSW
2004

Credit: Photograph by Henk Godthelp.
Supplied by Mike Archer

- (K) Volunteer Elaine Clarke bagging blocks in the Riversleigh World Heritage Area. Her father, Mr Bruty, was the namesake of *Burramys brutyi***

Neville's Garden Site, D-Site Plateau, Riversleigh World Heritage Area, QLD

1990

Credit: Photograph by Ross Arnett.

Supplied by Mike Archer

- (L) Australian Fossil Mammal Sites (Riversleigh), date unknown**

Credit: Australian Heritage Council © Commonwealth of Australia, rt55784

- (M) Bandicoot skull inside limestone**

Camel Sputum Site, Godthelp Hill, D-Site Plateau, Riversleigh World Heritage Area, QLD

2010

Credit: Photograph by Karen Black.

Supplied by Mike Archer

(N) Fossil in limestone at Riversleigh

Australian Fossil Mammal Sites, Riversleigh, QLD
date unknown

Credit: Australian Heritage Council © Commonwealth
of Australia, rt56500

(O) Riversleigh Fossil Fields

Riversleigh, Boodjamulla National Park, QLD
22 August 2010

Credit: © Ian Beattie / Alamy

**(P) Recreation of Late Oligocene rainforest scene
at Riversleigh**

White Hunter Site, D-Site Plateau, Riversleigh World
Heritage Area, QLD
Late Oligocene, approximately 26–23 million
years ago

Credit: © Peter Schouten, 2012.

Published in *Prehistoric Australasia* (2023)

In a wet forest that once covered much of Australia,
an ancient fox-sized thylacine (*Badjcinus turnbulli*)

leaps up to catch a rail (*Australlus disneyi*).

At the same time, the much larger, herbivorous wynyardiid (*Namilamadeta albivenator*) strolls into the scene without worry. In the water, a nervous stork (*Ciconia louisebolesae*) prepares to make a quick exit.

(Q) Recreation of Late Oligocene rainforest scene at Riversleigh

Hiatus and White Hunter Sites, D-Site Plateau,
Riversleigh World Heritage Area, QLD

Late Oligocene, approximately 25 million years ago

Credit: © Peter Schouten, 2023

Two of the oldest known ancestors on the Tasmanian Tiger's family tree are picking their dinners. The one on the upper right (*Nimbacinus peterbridgei*) is assessing a sheep-sized, herbivorous ilariid marsupial (*Kuterintja ngama*). This ambitious thylacine is directly related to the recently extinct Tasmanian Tiger. The larger thylacine (*Ngamalacinus nigelmarveni*) is intent on the frightened kangaroo (*Gumardee springae*) pictured bottom left.

**(R) Recreation of *Ektopodon serratus* and
*Wakaleo oldfieldi***

Riversleigh World Heritage Area, QLD and the Leaf
Locality in the Tirari Desert, SA

Early to Middle Miocene, approximately 23–15 million
years ago

Credit: © Peter Schouten, 2014/2021.

Published in *Prehistoric Australasia* (2023)

In the rainforests of Riversleigh, as well as central
Australia during the Early to Middle Miocene,
confrontations may have happened between species.
The likely seed-eating mammal in the bird's-nest fern
(*Ektopodon serratus*) represents one of the strangest
groups of marsupials yet discovered, and is a member
of the family Ektopodontidae. The ferociously
predatory, leopard-sized marsupial lion (*Wakaleo
oldfieldi*) is eyeing it off as a snack.

(S) **Recreation of Early Miocene rainforest scene at Riversleigh**

Upper Site, Godthelp Hill, D-Site Plateau, Riversleigh
World Heritage Area, QLD

Early Miocene, approximately 20 million years ago

Credit: © Peter Schouten, 2011.

Published in *Prehistoric Australasia* (2023)

A 2.5-meter-tall, 250-kilogram flightless dromornithid bird (*Dromornis* sp.) feeds on fruits that have fallen from the rainforest trees overhead. Watching nearby is a curious, 2000-kilogram, leaf-eating diprotodontid (*Neohelos tirarensis*). Behind this leaf eater is a larger individual of the same species, perhaps a male.

Just in front of the leg of the dromornithid is the only known ancestral, rainforest lyrebird (*Menura tyawanoides*). At the far right is a very strange kangaroo with long, dog-like canines, appropriately named the *Balbaroo fangaroo*. On the rock at the pool's edge is an ancestral dragon lizard (*Physignathus* sp.) ready to leap into the water at any sign of danger.

(T) **Recreation of Middle Miocene rainforest scene at Riversleigh**

Gag Site, Gag Plateau, Riversleigh World Heritage Area, QLD

Middle Miocene, approximately 15 million years ago

Credit: © Peter Schouten, 2012.

Published in *Prehistoric Australasia* (2023)

The Middle Miocene rainforests of Riversleigh were crowded with an extraordinarily diverse array of fascinating animals. In the upper left corner is an ancestral omnivorous cuscus (*Oniocuscus reidi*), a distant relative of brushtail possums. On the branch in the top centre is an ancestral koala (*Nimiokoala greystanesi*). On the top of the branch at the right, reaching for fruit, is the 70-kilogram Nimbadoron (*Nimbadoron lavarackorum*) with a juvenile next to the adult. Near the base of the same branch is an ancestral ghost bat (*Macroderma godthelpi*) carrying a small, yet unnamed, pygmy possum (*Cercartetus* sp.) as its prey. On the branch at the lower left is a small, yet unnamed, possibly moss-eating ringtail possum (*Pildra* sp.). Further away on the branch at

the middle left are two other possums, the most distant with the black stripe being another, larger kind of ringtail possum (*Marlu kutjamarpensis*), while the one it faces is a larger 2-kilogram brushtail possum (*Trichosurus dicksoni*).

(U) Recreation of Late Miocene rainforest scene at Riversleigh

Encore Site, Gag Plateau, Riversleigh World Heritage Area, QLD

Early Late Miocene, approximately 12 million years ago

Credit: © Peter Schouten, 2013.

Published in *Prehistoric Australasia* (2023)

Approximately 12 million years ago, in the early Late Miocene, the dense rainforests of Riversleigh began to thin out, gradually transitioning to drier forest environments. Two browsing kangaroos (*Ganguroo robustiter*) warily watch the approaching, herbivorous marsupial tapir (*Propalorchestes annulus*), which could use its powerful claws as lethal weapons. In the lower right, a small cat-sized carnivorous

marsupial (*Ganbulanyi djadjinguli*) is intent on catching and dining on a small primitive bandicoot (*Yarala burchfieldi*). A skink (*Tiliqua pusilla*) lounges out of sight on a rock at the lower left.

(V) **Recreation of *Whollydooleya tomnpatrichorum***

Whoolydooley Hill, 10 kilometres west of the
Riversleigh World Heritage Area, QLD
Late Miocene, approximately 10 million years ago

Credit: © Peter Schouten

One of the most mysterious of Riversleigh's carnivorous marsupials is the Late Miocene, small dog-sized *Whollydooleya* (*Whollydooleya tomnpatrichorum*). The two individuals shown here are squabbling over a dead kangaroo, much in the manner that the modern species of Tasmanian Devils bicker over kills today.

**(W) Aerial photograph of the Gregory River,
Riversleigh World Heritage Area**

Hunting for caves along the Gregory River, Riversleigh
World Heritage Area, QLD

July 2014

Credit: Photographed and supplied by Blake Dickson

The Gregory River is the vital heart of biodiversity in Riversleigh. The species found along the banks of the Gregory are the last remaining survivors of the rich rainforests preserved in the Riversleigh fossil record. In 2014, we searched in remote parts of Riversleigh by helicopter for new fossil sites and caves along the Gregory's limestone banks. Caves are a valuable source of vital scientific data in Riversleigh—they can preserve fossils and climate data spanning millions of years. Finding them, however, is no easy task. Some were spectacular, with flooded chambers filled with crystal blue water. Others were muddy holes with entrances barely large enough to squeeze into. All were worth exploring.

**(X) Australian Fossil Mammal Sites (Riversleigh),
date unknown**

Credit: Australian Heritage Council © Commonwealth
of Australia, rt56496

(Y) Gregory River, north Queensland, Australia

Credit: Adobe. Educational License
(File #: 440863058)

**(Z) Riversleigh Fossil Exploration: Riversleigh World
Heritage Area, QLD. 29 June 2021**

Credit: © Buddy Patrick

Display Case Contents (1-39)

(1) **Field equipment: Marsh pick and long-necked geology pick**

The chisel/point Marsh Pick is used to lever up loose slabs of limestone to examine the undersides for potential fossil bones. The long-necked steel geology pick is used to break open lumps of limestone to check whether they reveal enough fossil bone to merit collecting them into the specimen bags for transport back to our acid preparation lab at UNSW.

(2) **Field equipment: sledgehammer, glue and solvent, brushes, flagging tape, and assorted tools**

The standard collecting items used at Riversleigh include: a sledgehammer to reduce the size of limestone boulders that are too big to lift; a geology pick and chisel to remove parts of rocks that don't appear to contain fossils; jars of soluble plastic glue and its solvent acetone used to harden the surface of exposed fossils in preparation for transport to the lab in UNSW; brushes used remove dust from exposed surfaces to examine them carefully for

fossils; felt-marking pen to write the site name and any other details on the specimens themselves; striped, bright flagging tape to tie a conspicuous ribbon around a branch near a newly discovered site so it can be found again and examined more carefully; a tool box containing a range of items such as awls and different size brushes and chisels needed for specific tasks.

(3) Cast of *Obdurodon dicksoni* skull

Ringtail Site, Gag Plateau, Riversleigh World Heritage Area, QLD

Middle Miocene, approximately 15 million years ago

This fossil, the only known platypus skull, has been incredibly important in helping to document evolutionary changes in platypuses over the last 15 million years. It retains functional teeth, which the modern platypus lacks.

(4) **Recreation of Middle Miocene rainforest scene at Riversleigh**

Ringtail Site, Gag Plateau, Riversleigh World Heritage Area

Middle Miocene, approximately 15 million years ago

Credit: © Peter Schouten, 2011/2019.

Published in *Prehistoric Australasia* (2023)

A tension-riddled rainforest scene at Riversleigh 15 million years ago. The toothed Dickson's Platypus (*Obdurodon dicksoni*) is about to leap for safety into the rainforest below before it is grabbed by the very strange, terrestrial and possibly even arboreal 1.5 metre long Three-ridged Crocodile (*Trilophosuchus rackhami*). On the tree root above the platypus is a direct ancestor (*Burramys brutyi*) of the critically endangered living Mountain Pygmy-possum (*B. parvus*). Worried, in the water below, is a direct ancestor (*Pseudemydura* sp.) of the critically endangered Western Swamp Tortoise (*P. umbrina*).

(5) **Platypus (*Ornithorhynchus anatinus*)**

Eastern Australia

Modern species

Credit: © Adam Richardt, iNaturalist Australia 2020.

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(6) **Casts of adult and juvenile skulls of *Silvabestius johnnili***

Bitesantennary Site, Bitesantennary Valley, D-Site

Plateau, Riversleigh World Heritage Area, QLD

Early Miocene, approximately 17 million years ago

In Mount Isa, a fossilised mother and baby are known as the “Madonna and Child.” The mother had her baby in her pouch when they fell into a water-filled ancient cave in the rainforest floor. The position of their skulls suggests that in her final moments, the mother nuzzled her baby’s nose. They remained together in that position for 17 million years until they were discovered by UNSW palaeontologists.

(7) **Skull of Eastern Grey Kangaroo**
(*Macropus giganteus*)

Eastern Australia

Modern species

(8) **Eastern Grey Kangaroo (*Macropus giganteus*)**

Eastern Australia

Modern species

Credit: © Ron Greer, iNaturalist Australia 2019.

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(9) **Skull and lower jaw of *Balbaroo fangaroo***

MIM Site, D-Site Plateau, Riversleigh World Heritage Area, QLD

Early Miocene, approximately 19 million years ago

Credit: Photograph by Anna Gillespie.

Supplied by Rick Arena

Balbaroo fangaroo was a very strange rainforest kangaroo that had elongated, dog-like upper canines or 'fangs'. Because their cheek teeth indicate they were confirmed herbivores, they likely used

their canines for defence against the many carnivorous kangaroos, thylacines, and marsupial lions that hunted them.

(10) Kangaroo femur fossil in limestone

White Hunter Site, D-Site Plateau, Riversleigh World Heritage Area, QLD

Late Oligocene, approximately 24 million years ago

This is how fossils appear in the field after palaeontologists break open limestone boulders using hammers and chisels. After first hardening the surface of the bone with soluble plastic, scientists mark the block with a symbol to designate the site where it was found—WH refers to White Hunter Site.

(11) Cast of the skull of *Ekaltadeta ima*, the ‘Ripparoo’ of Riversleigh

Camel Sputum Site, Godthelp Hill, D-Site Plateau, Riversleigh World Heritage Area, QLD

Early Miocene, approximately 19 million years ago

The shape of the teeth and marks on the surface of the *Ekaltadeta ima* skull indicate that, although it was a kangaroo, it was a meat-eater. The omnivorous Musky Rat-kangaroo in the rainforests of northern Queensland is a very distant living relative.

(12) Fossil concentrate (unsorted)

AL90 Site, Gag Plateau, Riversleigh World Heritage Area, QLD

Middle Miocene, approximately 15 million years ago

When the limestone blocks from Riversleigh are processed using dilute acetic acid, everything that the acid can't dissolve, including all bones and teeth, is collected from the bottom of the vat.

Scientists meticulously wash and carefully sort the concentrate under the microscope, where they find thousands of potentially important teeth and bone fragments.

(13) Cast of a skull of *Thylacoleo carnifex*

Although from the Riversleigh area, this composite cast is based on specimens from VIC and NSW Pleistocene Epoch, approximately 2 million to 35,000 years ago.

The marsupial carnivore, *Thylacoleo carnifex*, which could reach 160 kilograms in weight, was the world's most specialised carnivorous mammal. It had uniquely powerful shearing premolars capable of severing large bones, dagger-like lower incisors and huge, tearing claws on each thumb.

(14) Reproduction of the plate *Skull of a large extinct Marsupial Carnivore (Thylacoleo carnifex), Pleistocene, Australia*

Credit: *Palaeontology: or a systematic summary of extinct animals and their geological relations* by Richard Owen, 1860. Published in Edinburgh by Adam and Charles Black.

K 560/34

(15) **Recreation of *Thylacoleo carnifex***

Known from fossils found in all states of Australia
Pleistocene Epoch, approximately 2.6 million–35,000
years ago

Credit: © Peter Schouten. Published in *Prehistoric
Animals of Australia* (1983)

The last surviving and largest of Australia's
carnivorous marsupials, comparable in size
to an African lioness, was the Pleistocene marsupial
lion (*Thylacoleo carnifex*), which ruled Australia until
approximately 35,000 years ago. With a long
line of earlier ancestors discovered at Riversleigh,
such as Attenborough's cat-sized marsupial lion
(*Microleo attenboroughi*), these remarkably
specialised flesh-eaters may well have hunted in trees
as well as on the ground with a lifestyle perhaps
similar to that of African leopards.

(16) Cast of a skull of *Wakaleo schouteni*

Hiatus Site, D-Site Plateau, Riversleigh World Heritage Area, QLD

Late Oligocene to Early Miocene, approximately 25–17 million years ago

The leopard-sized marsupial lion, *Wakaleo schouteni*, is estimated to have weighed approximately 23 kilograms. It was a ferocious carnivore that hunted in the rainforests of Riversleigh, competing with a range of slightly smaller thylacinids as well as many snakes and even carnivorous kangaroos.

(17) Cast of a skull of *Lekaneleo roskellyae*

Upper Site, Godthelp Hill, D-Site Plateau, Riversleigh World Heritage Area, QLD

Early Miocene, approximately 19 million years ago

The cat-sized marsupial lion, *Lekaneleo roskellyae*, was probably a hunter in rainforest trees, which may have limited its competition with the leopard-sized species of *Wakaleo* that also inhabited Riversleigh at the same time. This particular group of marsupial

lions is known only from Riversleigh, where the diversity of these carnivores was exceptionally high.

(18) Cast of a skull of *Nimbacinus dicksoni*

AL90 Site, Gag Plateau, Riversleigh World Heritage Area, QLD

Middle Miocene, approximately 15 million years ago

Nimbacinus dicksoni is a fox-sized distant ancestor of the recently extinct Tasmanian Thylacine and is the only known ancestral thylacine from a nearly complete skeleton. It fell into the AL90 cave and, resigned to its fate, rested its head on its folded arms and waited for immortality to catch up.

(19) Cast of skull and lower jaw of a modern Thylacine

Tasmania, Australia

Modern species

Unlike the Thylacine, which was driven to extinction by humans, many of the other species once plentiful in Riversleigh's fossil deposits were wiped out by climate change.

(20) The underside of the skull of *Wakaleo schouteni*

Hiatus Site, D-Site Plateau, Riversleigh World Heritage Area, QLD

Late Oligocene to Early Miocene, approximately 25–17 million years ago

Credit: Photograph by Anna Gillespie.

Supplied by Mike Archer

Even though its meat-cutting premolar was much smaller than that of the Pleistocene-era species *Thylacoleo carnifex*, the leopard-sized *Wakaleo schouteni* could still cut through the bones of many of the other animals found in the Riversleigh rainforests.

(21) Recreation of *Badjcinus timfaulkneri*

Hiatus Site, the D-Site Plateau, Riversleigh World Heritage Area, QLD

Late Oligocene, approximately 25 million years ago

Credit: © Peter Schouten, 2023

One of the oldest known ancestors of the Tasmanian Tiger, this Late Oligocene Thylacine (*Badjcinus*

timfaulkneri) has just brought down a 70-kilogram arboreal herbivorous diprotodontid that was named *Silvabestius michaelbirti* in honour of former UNSW Vice-Chancellor Professor Michael Birt, who helped to collect the only known specimen.

(22) Skull of *Nimbadon lavarackorum*

AL90 Site, Gag Plateau, Riversleigh World Heritage Area, QLD

Middle Miocene, approximately 15 million years ago

A dangerous and unusual scene must have unfolded at the AL90 Site during the Middle Miocene. Over 26 skulls of the 70-kilogram marsupial *Nimbadon lavarackorum* have been recovered, suggesting that these ancient 'drop bears' regularly fell from the trees overhead and into the open mouth of the cave below. This particular skull was likely damaged during such a fall. The individual was a young adult with all its teeth erupted, and palaeontologists are carefully reassembling its skull from the loose pieces recovered from the cave like a biological jigsaw puzzle.

(23) Cast of a lower jaw of *Nimbadon lavarackorum*

AL90 Site, Gag Plateau, Riversleigh World Heritage Area, QLD

Middle Miocene, approximately 15 million years ago

Like other members of the marsupial family Diprotodontidae, *Nimbadon lavarackorum* had a distinctive dental structure that marked it as a plant-eater. Its teeth included two sharp incisors for piercing or nipping, followed by a single premolar and four molars. The wear marks on these teeth suggest it was a specialised fruit eater.

(24) Cast of a skull of *Nimbadon lavarackorum*

AL90 Site, Gag Plateau, Riversleigh World Heritage Area, QLD

Middle Miocene, approximately 15 million years ago

The skulls of *Nimbadon lavarackorum* recovered from the AL90 Site represent a wide range of ages, from tiny pouch young with just-erupting teeth to old adults like this one. This adult skull features a wide snout and high ridges at the back, which supported massive chewing muscles.

(25) Isolated fossil stalagmite

Riversleigh World Heritage Area, QLD

Probably Early Miocene, approximately 19 million years ago

Among the most significant finds at the Riversleigh fossil deposits are ancient stalagmites that formed millions of years ago on the floors of caves. By using radiometric dating, researchers at the University of Melbourne have been able to determine the precise age of these formations, which in some cases grew directly on top of the bones of animals that had fallen into the caves.

(26) Miscellaneous vertebrae of a *Nimbadon lavarackorum*

AL90 Site, Gag Plateau, Riversleigh World Heritage Area, QLD

Middle Miocene, approximately 15 million years ago

While two nearly complete and fully articulated skeletons were found, the AL90 deposit also contained many isolated bones. These may be from

carcasses scavenged by carnivorous marsupials, which had also fallen into the cave but survived the fall.

(27) Limb bones of a *Nimbadon lavarackorum*

AL90 Site, Gag Plateau, Riversleigh World Heritage Area, QLD

Middle Miocene, approximately 15 million years ago

Some of the fossilised bones found in the AL90 Site show damage, possibly caused by the fall into the cave. Animals that survived the fall might have caused additional damage when they trampled the bones while stumbling on the dark cave floor, looking for a way out.

(28) Fossil concentrate (unsorted)

AL90 Site, Gag Plateau, Riversleigh World Heritage Area, QLD

Middle Miocene, approximately 15 million years ago

When palaeontologists dissolve large blocks of Riversleigh limestone in vats of dilute acetic acid,

undissolved material collects at the bottom. They then carefully examine this residue under a microscope to find small pieces that may fit with other recovered bones.

(29) Skull of *Nimbadon lavarackorum*

AL90 Site, Gag Plateau, Riversleigh World Heritage Area, QLD

Middle Miocene, approximately 15 million years ago

Credit: Photographed and supplied by Karen Black, 2010

The 26 *Nimbadon lavarackorum* skulls recovered from the AL90 Site gave palaeontologists a unique opportunity to study how the skulls of these herbivorous marsupials evolved from pouch young to adult. This particular skull, from a young individual, has a relatively short head and teeth that are still erupting in the lower jaw, suggesting it had a very cute face in life.

(30) Cast of juvenile jaw of *Nimbadon lavarackorum*

AL90 Site, Gag Plateau, Riversleigh World Heritage Area, QLD

Middle Miocene, approximately 15 million years ago

The left and right lower jaw of a young *Nimbadon lavarackorum* whose teeth were still erupting.

(31) Diagram of ancient rainforest cave and modern fossil deposit

When palaeontologists excavate Riversleigh's fossil deposits, they look for clues in the rocks and in the condition and distribution of the bones. By studying these factors, they can reconstruct how the deposit originally formed. The AL90 Site, for example, clearly accumulated in a cave on an ancient rainforest floor.

Animals entered the cave in various ways: bats flew in and out, while others stumbled in and were unable to escape. Some fell from the overhanging vegetation at the cave entrance. Over time, the cave filled with limestone and animal remains. Eventually, the rainforest gave way to the drier vegetation that now covers much of the Riversleigh area.

Today, palaeontologists carefully examine exposed rocks for bones protruding from the surface. Finding a fossil this way can signal an important deposit that is worth excavating.

Credit: Supplied by Mike Archer

(32) Bat fossils in limestone

Bitesantennary Site, D-Site Plateau, Riversleigh World Heritage Area, QLD

Early Miocene, approximately 17 million years ago

An ancient cave floor at Riversleigh's Bitesantennary Site contains the fossil remains of many thousands of small bats, belonging to at least nine species. In these limestone blocks from that cave floor, the outlines of skulls, rows of tiny teeth and cross sections of the fine, tubular long bones of bat wings can be seen. After the limestone blocks are acid-processed in the lab, the bat fossils reveal themselves to be exceptionally well-preserved, complete, and numerous.

(33) Skulls and jaws of trident bats

Bitesantennary Site, D-Site Plateau, Riversleigh World Heritage Area, QLD

Early Miocene, approximately 17 million years ago

Delicate skulls and jaws of small, trident bats recovered by acid-processing of Riversleigh limestones. These bats lived in Riversleigh's Miocene forests, roosting in limestone caves during the day and spreading out into the forest after dark to hunt for night-flying insects such as moths, beetles, and mosquitoes. Many Riversleigh bat species are known from near-perfect skulls, while others are as yet known only from single teeth.

(34) Cast of a skull of a trident bat (enlarged 15 times)

AL90 Site, Gag Plateau, Riversleigh World Heritage Area, QLD

Middle Miocene, approximately 15 million years ago

All of the bats known from Riversleigh are echolocating species. By emitting high-frequency echolocation calls and interpreting the returning

echoes, these bats can navigate and hunt insects in the dark. Trident bat skulls have enlarged ear bones that can detect high-frequency sound, and many also have inflated nasal cavities through which they emit their echolocation calls.

(35) Bat bones in limestone

AL90 Site, Gag Plateau, Riversleigh World Heritage Area, QLD

Middle Miocene, approximately 15 million years ago

This partly acid-processed limestone block bristles with tiny bat skulls, jaws, and limb bones. Millions of bat bones belonging to more than 40 bat species have been recovered from Riversleigh fossil deposits.

(36) Bat fossils emerging from partially dissolved limestone

AL90 Site, Gag Plateau, Riversleigh World Heritage Area, QLD

Middle Miocene, approximately 15 million years

Credit: Photograph by Karen Black, 2010.

Supplied by Mike Archer

Further acid processing of the limestone block exposes more of the delicate bat skulls, jaws, wing bones, ribs, and other parts of the skeleton encased within. These exceptionally well-preserved bat remains emerge perfectly intact after being protected in the AL90 Site limestone for the last 15 million years.

(37) Trident bat skulls

AL90 Site, Gag Plateau, Riversleigh World Heritage Area, QLD

Middle Miocene, approximately 15 million years

Credit: Photograph by Karen Black.

Supplied by Sue Hand

A group of Riversleigh trident bat skulls shown here in comparison to the size of a match. Most of Riversleigh's Miocene bats are small in size, ranging in skull length from less than one centimetre (trident bats) to nearly three centimetres in the largest species (ghost bats).

(38) Bat skulls

AL90 Site, Gag Plateau, Riversleigh World Heritage Area, QLD

Middle Miocene, approximately 15 million years

Credit: Photograph by Karen Black.

Supplied by Sue Hand

Bat fossils are small and delicate but very abundant in the Riversleigh World Heritage Area, found in nearly all of Riversleigh's 300-plus individual fossil sites. The 40-plus bat species recognised in the Riversleigh deposits range in age from 25 million years ago until the present day.

**(39) Orange Diamond-faced Trident Bat
(*Rhinonictoris aurantia*)**

Top end of Australia, from the Kimberley to north-west Queensland

Modern species

Credit: © Isaac Clarey, iNaturalist Australia.

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A living relative of Riversleigh's Miocene fossil bats is northern Australia's endangered Orange Diamond-faced Trident Bat (*Rhinonictoris aurantia*), which still inhabits the Riversleigh area today. These insect-eating bats emit their echolocation calls through their inflated nasal cavities and have complex flaps and folds of skin surrounding their nostrils; their common names refer to their trident- or diamond-shaped nose leaves. The majority of Riversleigh's 40-plus fossil bat species belong to the trident bat family (*Rhinonycteridae*). Trident bats were once widespread in the tropics, but only nine species survive, in eastern and southern Africa, Madagascar, the Seychelles, and northern Australia. Today, trident bats inhabit tropical and subtropical monsoonal forests, open savanna woodlands, shrublands and grasslands, and roost in caves, mines, buildings, and tree hollows.

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