

VOLUME
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explore



discover

TYRANNOSAURS: MEET THE FAMILY

nature

SHARING SYDNEY HARBOUR

culture

COLLECTING INDIGENOUS LANGUAGES

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changing BELIEFS



As I write this the IPCC has just released its fifth report on climate change, and the evidence points overwhelmingly to human activity as the cause of current climate warming. Yet I perceive an entrenching of positions by those who do not accept human-caused global warming – a shrug of the shoulders and a ‘yes, the IPCC would say that, wouldn’t they?’

The opponents of climate change science in Australia seem to have become ideological, with entrenched beliefs and vested interests lined up against the evidence – the facts, models and projections – put forward by scientists. In this regard, their opposition is similar to the creationists’ position on evolution.

So where does this leave us? There is much evidence that no amount of fact-based argument will sway an entrenched belief, and this creates a very dangerous situation for the world when such beliefs unduly influence policies and actions.

INUNDATION

Only a few weeks ago the Museum hosted a visit from Tony de Brum, Vice President of the Marshall Islands. Much of that country is likely to be inundated before the end of this century from sea level rises related to global warming. Maps are routinely published showing which parts of the world’s coastlines are destined for inundation, including Australia’s, yet there seems to be a collective shrugging of the shoulders from key parts of the media and some of our political representatives: ‘Yes it is terrible, but it’s somebody else’s problem’ – somewhere else in the world, like China, or for someone in the future, like those who will have to live with the consequences.

We need a new way of talking about climate change and the beliefs that people hold, but I don’t yet know, nor have I seen, an effective way of doing this. Certainly trying to scare people or simply haranguing them does not work. It seems that only when the impacts on everyday lives and economies become severe will most people or governments actually do something. Until then, we need to try to keep the factual, science-based debate on climate change alive, notwithstanding the entrenched views of others.

PRIORITIES

We in the Museum have some key roles to play in this debate. Our new science strategy sets out four major research priorities for the Museum, and one of these is to better understand the impacts of climate change on biodiversity.

On the human cultures side, we are working with communities who stand to be directly impacted by climate change, be it from rising sea level or more extreme weather events, to record how they see the situation unfolding. And our learning programs will continue to communicate the science of climate change and the value of scientific thinking. We must continue to hope that a reasoned response to the greatest threat we have faced will eventually prevail.

FRANK HOWARTH PSM

Director of the Australian Museum

on the RECORD

GOING

Australian Museum Director Frank Howarth has announced that he will not seek re-appointment when his current term expires early next year. After almost 10 years at the helm of Australia's first museum, Frank will remain in the role until a new director is appointed in 2014.

Museum Trust President Catherine Livingstone said: 'Frank has built up the Museum to be dynamic, outward facing and successful. The recent announcement of the creation of the Australian Museum Research Institute reflects Frank's commitment to focusing the Museum's science to where it will make the most difference. On behalf of the Trustees of the Museum, I want to thank Frank for his dedication to the Museum and to the cultural scene in Sydney and Australia.'

ARRIVED

Long-time readers of *Explore* magazine, now in its eighth year, may recognise perhaps half of the 60 stories in the Museum's new publication *Feathers of the gods and other stories from the Australian Museum*. Here, these are retold in a smartly designed, beautifully produced volume, along with many new tales from staff about some of the Museum's iconic treasures. The book itself is a visual feast thanks to Amanda Lo Teer's Zen-like design; Stuart Humphreys' quirky photographs depicting storytellers and objects in behind-the-scenes settings; and rarely glimpsed prints and photos from the Museum Archives. It's an ideal gift, available exclusively through the Australian Museum Shop. To order, see inside back cover.

ABORIGINAL SYDNEY APP

Explore the history and culture of Aboriginal Sydney. Based on the book *Aboriginal Sydney* (Aboriginal Studies Press), this new app provides self-guided audio-supported tours of heritage areas, rock art sites and other significant Aboriginal places in the Sydney region. Available in iPhone, iPad and Android versions.

Details: visit aiatsis.gov.au/asp/welcome

GONE

With this edition of *Explore* we farewell some highly valued contributors to the magazine. Photo editor and rights coordinator Cate Lowe worked at the Museum for over 30 years in the photography and publishing departments and brought a great depth of knowledge and experience to the magazine. Carl Bento joined the Museum as a photographer in 1990 and managed the photography department since 1998, his distinctive work appearing regularly in these pages. We wish these and other departing colleagues all the best for the future.



Photo by Stuart Humphreys.

DIGGING FOR *dugongs*

WE KNOW WHY THESE GENTLEMEN ARE DIGGING IN THEIR THREE-PIECE SUITS, BUT THEIR IDENTITY HAS BEEN A MOOT POINT AMONG ARCHIVISTS, SAYS **PATRICIA EGAN**.



This famous photograph from the Museum Archives dates from 1896 and was taken at Shea's Creek, Alexandria, during the construction of Alexandra Canal.

Workers had uncovered numerous large bones, but further excavation of the site, near the Ricketty Street bridge, was delayed until the Museum's Curator, Robert Etheridge Jnr (second from left), and Government Palaeontologist William Dun (far left), could inspect it.

The bones, later identified as Dugong, were (and are) of great scientific interest. The Dugong is a warm-water tropical marine mammal, and this deposit was hundreds of kilometres south of its

range. Further the fossilised bones were 'confusedly heaped together' and revealed cut marks which the authors attributed to an Aboriginal stone tool.

So who are the men in the photograph? The handwritten registration of the glass-plate negative in the Museum photographic collection identifies the two standing men as Etheridge and Dun.

Etheridge presented a paper about the discovery to a meeting of the Royal Society of New South Wales on 5 August 1896 with co-authors JW Grimshaw (an engineer on the excavation and amateur scientist) and geologist TW Edgeworth David.

Below

Palaeontologist William Dun (left) and Australian Museum Curator Robert Etheridge Jnr stand watch as Dugong bones are excavated from Shea's Creek, Alexandria, Sydney. Photographer unknown. Australian Museum Archives. V9817

The paper noted that the bones were initially detected in the presence of 'one of us' (the engineer, Grimshaw) with the later excavation 'in the presence of two of us'. The next day's report of the meeting in the *Sydney Morning Herald* identified these two as Grimshaw and Etheridge.

The identity of the fourth man is not recorded, but if the article, photograph and newspaper report are correct, he could not have been Edgeworth David as some authors have erroneously inferred.

The scientists concluded that the occurrence of Dugong bones so far south indicated recent changes (in geological terms) in sea level and water temperature. It wasn't until 2004 that Dr Robert Haworth and colleagues at the University of New England carbon-dated the fossils to around 5500 years BP.

The human markings on the fossils also provided the first archaeological evidence of long-standing Aboriginal occupation of the area, which was reinforced by the recovery of a number of stone hatchets from the excavation. The fossil bones and one of the hatchet heads are still held in the Australian Museum collection.

As a footnote, the Alexandra Canal was originally envisaged as a grand waterway for transporting goods between Botany Bay and Port Jackson at Circular Quay, but the cost proved prohibitive and the plan was abandoned after the completion of just a few kilometres.

PATRICIA EGAN ARCHIVIST

ON THE TYRANNOSAURS

THE SEARCH FOR THE LATEST DISCOVERIES HAS TAKEN PALAEOLOGIST **ANNE MUSSER** AROUND THE WORLD.

A new exhibition at the Australian Museum is guaranteed to change your perception of the world's favourite dinosaur, *Tyrannosaurus rex*, and its bloodthirsty relatives.

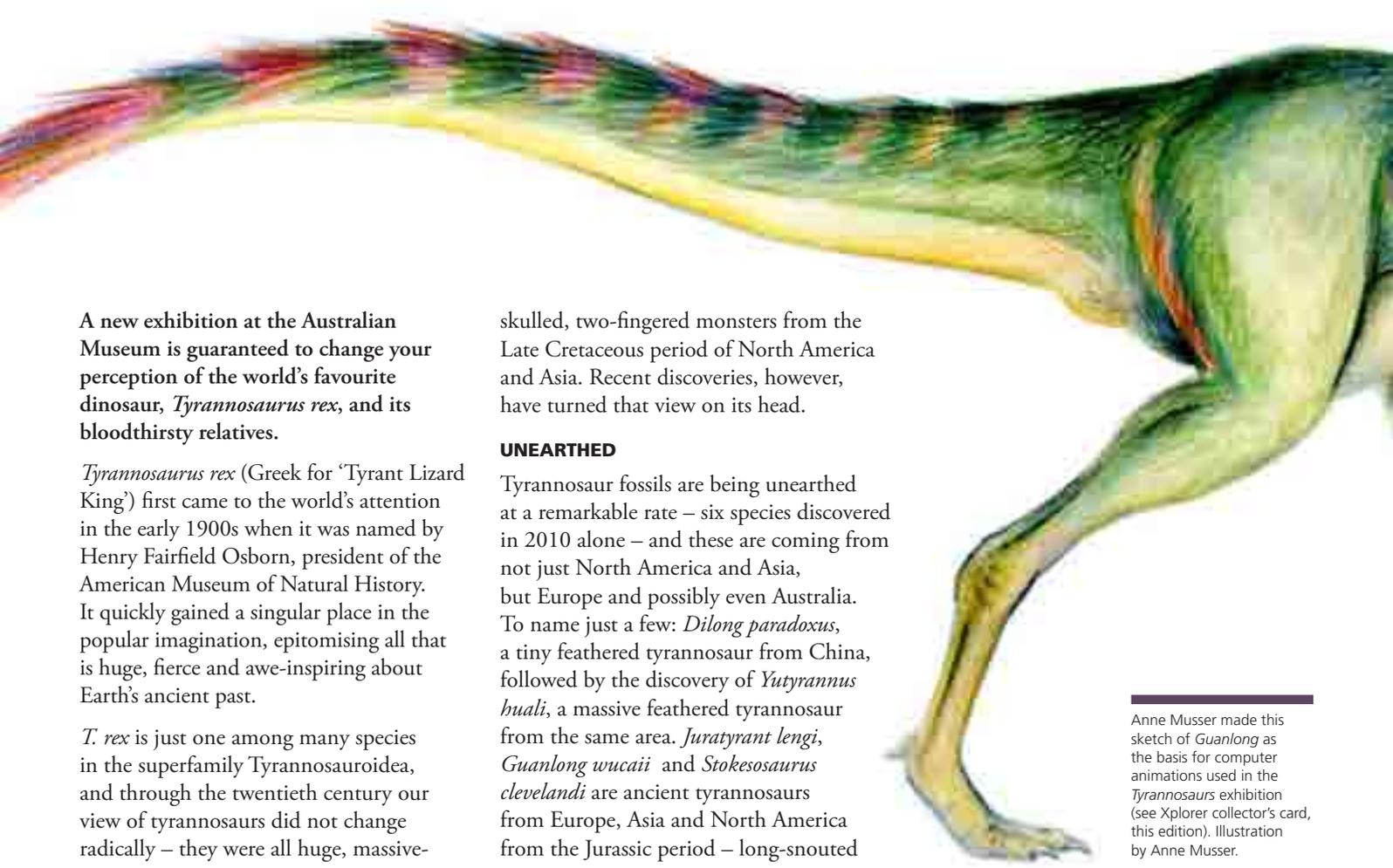
Tyrannosaurus rex (Greek for 'Tyrant Lizard King') first came to the world's attention in the early 1900s when it was named by Henry Fairfield Osborn, president of the American Museum of Natural History. It quickly gained a singular place in the popular imagination, epitomising all that is huge, fierce and awe-inspiring about Earth's ancient past.

T. rex is just one among many species in the superfamily Tyrannosauoidea, and through the twentieth century our view of tyrannosaurs did not change radically – they were all huge, massive-

skulled, two-fingered monsters from the Late Cretaceous period of North America and Asia. Recent discoveries, however, have turned that view on its head.

UNEARTHED

Tyrannosaur fossils are being unearthed at a remarkable rate – six species discovered in 2010 alone – and these are coming from not just North America and Asia, but Europe and possibly even Australia. To name just a few: *Dilong paradoxus*, a tiny feathered tyrannosaur from China, followed by the discovery of *Yutyranus huali*, a massive feathered tyrannosaur from the same area. *Juratyran lengi*, *Guanlong wucaii* and *Stokesosaurus clevelandi* are ancient tyrannosaurs from Europe, Asia and North America from the Jurassic period – long-snouted



Anne Musser made this sketch of *Guanlong* as the basis for computer animations used in the *Tyrannosaurs* exhibition (see Xplorer collector's card, this edition). Illustration by Anne Musser.

trail



tyrannosaurs that looked nothing like that tyrannosaur we all know and love, *T. rex*.

This ‘breaking story’ was gathering speed just as the Australian Museum was looking at ideas for an exciting new dinosaur exhibition. As a vertebrate palaeontologist with a longstanding connection to the Museum, I have been involved with *Tyrannosaurs: meet the family* since its inception several years back.

We realised that no major museum had yet put the tyrannosaur story together, since there were so many recent game-changing discoveries, and the Museum decided that the tyrannosaur story was the right exhibition at the right time. Little did I know how much I would learn about this incredible group of ancient reptiles, or what a personal journey it would be.

ON THE TRAIL

Planning for the exhibition began in earnest in 2010. I had plans to go overseas in 2011 and 2013, and it seemed like a great idea to include some key tyrannosaur sites in my itinerary. In 2011, I visited Montana in the United States (where many *T. rex* fossils have been found), the People’s Republic of China (home to several new, early tyrannosaurs), and Mongolia (where Asian tyrannosaurs like the huge *Tarbosaurus* and long-snouted *Alioramus* lived alongside an amazing array of other dinosaurs).

Earlier this year, during the northern summer of 2013, I visited the United Kingdom where some of the oldest tyrannosaur species have been found. I also had the opportunity to meet several tyrannosaur experts – an experience in itself!

Montana is ‘big sky country’: endless panoramas of mountains, wilderness and, well, sky. Bozeman, Montana is home to the Museum of the Rockies, which features the mighty *T. rex* (numerous fossils have been found in Montana and are the subject of much research at the University of Montana neighbouring the museum). The highlight of the museum was the sheer number of real *T. rex* specimens – young, old and at least one female (the bones of an animal with preserved medullary tissue showing it to be female). Also featured was the massive and equally stunning *Triceratops*, adversary and prey of *T. rex*. The specimen of *T. rex* featuring in the *Tyrannosaurs* exhibition, nicknamed ‘Scotty’, comes from the Canadian province of Saskatchewan north of Montana. Another spectacular tyrannosaur, *Albertosaurus*, is from the neighbouring province of Alberta.

CHINA

My trip to China was hosted by the Beijing Museum of Natural History (BMNH), whose staff took me touring around Liaoning Province where several



Above left

This specimen of *Dilong* is interesting because it shows the tyrannosaur in a bird-like sleeping position with forelimbs tucked. It was probably awoken by poisonous volcanic gases or asphyxiated in its sleep to become frozen in time. Photo courtesy Beijing Museum of Natural History.

Above right

The large volcanic (basalt) intrusion at this site was taken near the collection site for the *Dilong* specimen. It emphasises the key role volcanism played in the preservation of death assemblages. Photo © Anne Musser.



Above

Albertosaurus lived in western North America during the Late Cretaceous period, about 70 million years ago. Photo © Taylor Made Fossils.

early tyrannosaurs have been found in recent years – a delightful cross-cultural experience, complete with banquets at every opportunity! The Chinese people are very proud of their dinosaurian heritage, and there were regional museums in every town we visited.

A highlight was the Beipiao Museum of Natural History in Liaoning Province where numerous feathered dinosaurs and fossilised trees have been found. The museum is near the discovery site of the early tyrannosaur *Dilong paradoxus*. The exhibition features one of the BMNH *Dilong* specimens – the complete skeleton of a beautiful but deadly little predator just over a metre and a half long when grown. It was preserved as it died, in death position, giving us a tantalising glimpse of the lives and deaths of these fierce carnivores.

I went on to Mongolia as a solo traveller and spent two long days at the Museum of Natural History in Ulan Baatar, where original fossil material from the Late Cretaceous of Mongolia is displayed for the public. The massive Asian tyrannosaur *Tarbosaurus*, almost equal in size to *T. rex*, is centre stage in the hall of dinosaurs. Many other unique dinosaurs are exhibited, including the tiny, bird-like, one-fingered *Mononykus*. Several of the specimens were preserved after being buried alive by sandstorms. Particularly evocative is a specimen of the tiny ceratopsian *Psittacosaurus*, which was fossilised in death position, its head raised as if breathing its last.

FUSS

The UK trip brought me to the Isle of Wight in the south of England, to meet with Wight palaeontologists and visit the locality where the early tyrannosaur *Eotyrannus* was found. I also visited the Oxford Museum of Natural History, whose collection is famous for a very different and more recent extinct animal: the dodo, the only known specimen preserved with skin intact. There I was shown the partial skeleton of a Jurassic tyrannosaur from England, *Juratyrant*, just described as a new species in 2012.

As I travelled and read, I found myself constantly surprised at the long and dramatic history of this iconic dinosaur group. As a mammal palaeontologist, I must admit that before this project I could not quite understand what all the dinosaurian fuss was about. But I am now a convert – boy, they were cool! And tyrannosaurs? The coolest! I am astounded by their sheer scale – stand next to Scotty and you will see what I mean. I was charmed by the unexpected feathery coat on little *Dilong*.

There were so many different species, over twenty now known, and all of these feature in the *Tyrannosaurs* exhibition. Now we just need to keep pace with new discoveries, which are sure to continue!

DR ANNE MUSSER PALAEOLOGIST

Tyrannosaurs: meet the family *opens exclusively at the Australian Museum on 23 November. Beat the crowds – pre-book your tickets at ticketek.com.au/tyrannosaurs.*

musings

GET THE BIG PICTURE

Having a weekend away? Now you can easily find local museums, art galleries and cultural centres thanks to a new 'one stop shop' website from Museums & Galleries of NSW. The website brings together hundreds of cultural attractions from across New South Wales into one mobile-friendly online portal. You can discover local heritage and visual arts in remote places, follow trails or develop personalised itineraries.

Visit mgnsw.org.au to find a museum near you!



Above

Chief Jerry Taki in the Museum's Cultural Collection selects a barkcloth for *Made in Oceania*, December 2012. The barkcloth design has been disguised in this photo to protect traditional copyright. Photo by Yvonne Carrillo-Huffman.

PROJECTIONS

The 20-metre façade of the Museum's Parkes-Farmer Wing on William Street is set to be transformed this summer with a series of large images projected onto its blank sandstone wall.

The projections, showing Aboriginal women draped in cloth, are part of the City of Sydney's *Eora Journey* program which celebrates Sydney's Indigenous history and culture. Taken from an original film work by Sydney-based Wiradjuri artist Nicole Foreshew, the images explore the Aboriginal concept of place.

'The artwork responds to the Australian Museum site, because it holds a huge amount of Aboriginal archaeological collections and objects', Nicole said.

'And that massive building is windowless so you can't actually grasp the amazingness of what this building has and what it can offer artists, Aboriginal people and the broader public through its collections. Hopefully this artwork will draw people inside.'

The projections can be viewed after dark until February 2014.

MADE IN OCEANIA

A major international exhibition of Oceania barkcloth at the Rautenstrauch-Joest-Museum Kulturen der Welt in Cologne, Germany is the largest ever to be staged. *Made in Oceania: Tapa – Art and Social Landscapes* presents 250 outstanding examples of barkcloth from major world cultural institutions, including loans from the Australian Museum.

Barkcloth is a unique fabric made from the beaten inner bark of selected trees as part of a cultural tradition in many Pacific societies that extends back centuries. The technologies and designs used in its manufacture vary between cultures.

The Rautenstrauch-Joest-Museum supported cultural fieldworker Chief Jerry Taki to travel to Sydney from south Erromango, Vanuatu, to select examples from the Australian Museum's barkcloths for the exhibition. The loan includes old barkcloths collected by early missionaries more than a century ago and recent examples made during a revival of traditional culture on Erromango, acquired in 2008.

The exhibition also includes examples collected by James Cook in the 18th century, contemporary artworks from renowned Polynesian and Melanesian artists and a vibrant public program highlighting personal viewpoints and current developments.

Read more about cultural revival on Erromango at australianmuseum.net.au/Cultural-revival



WHAT MAKES SYDNEY'S HARBOUR THE MOST BIODIVERSE IN THE WORLD? PLUNGE BENEATH ITS MURKY WATERS WITH MUSEUM SCIENTISTS TO FIND OUT.

SHARING



the harbour



Sydney Harbour has always been central to the lives of Sydneysiders – from the first inhabitants, the Gadigal people, who had long occupied the area; to the first European settlers, arriving by ship; and today’s bustling crowds of residents, tourists and workers.

It’s hardly surprising that the Harbour (also known as Port Jackson) and its environs have seen dramatic changes, starting with the displacement of the original Aboriginal inhabitants, then a history of residential and commercial development, fisheries, shipping and trade, and all types of industry from salt production to whaling and chemical manufacture taking place on its shores.

Today, the iconic Harbour Bridge and Opera House dominate Australia’s recently declared 16th National Landscape, and 90% of the catchment foreshore has been fully developed.

Although it’s the busiest port in the country, what lies below the water’s surface is little known among Sydneysiders. We know Sydney Harbour has more species than any other harbour, but just how many is a question that intrigues marine scientists at the Australian Museum. So we decided to find out.

SPECIMENS

The first port of call for such a question is the Museum’s own collection database. It’s an invaluable scientific and historical baseline for investigating biodiversity, with records dating back to 1850. Each record relates to a specimen, and each specimen has a name with the date and location of its collection, among other useful information.

Using these data, we mapped the distributions of five major marine animal groups in the Harbour – fishes, crustaceans, polychaetes, molluscs and echinoderms – and examined the historical trends of their discovery.

SHARING

In total, we have documented an astonishing 3000 marine species in the Harbour, which is two to three times greater than neighbouring Botany Bay, Port Hacking or the Hawkesbury River. And of course this figure doesn’t include the many birds (including penguins), marine mammals (whales, seals and dolphins), turtles and some invertebrate groups (especially sponges and corals) that also inhabit or visit its waters.

Molluscs broadly include slugs and snails, mussels and clams, and squids and octopuses. They range in size from tiny micro-molluscs of just a millimetre or two in size to much larger creatures, like the common Sydney Octopus, up to 60 centimetres in length. Like crustaceans, some molluscs live in all kinds of habitats including fresh, brackish and salty water.

Left
Australian Museum scientists call for a systematic biodiversity survey of Sydney Harbour. (left to right) Mandy Reid, Mark McGrouther, Pat Hutchings, Shane Ahyong. Photo by Stuart Humphreys.



Numerically, molluscs comprise the greatest number of species in Sydney Harbour, with 1339 species from 224 families recorded since 1860. Many new mollusc species were first described from specimens collected in and around the Harbour, and diversity is greatest in the northern and eastern (seaward-most) areas.

We found 'peaks' over time in the number of species documented that correspond to the focused research and collection activities of various Museum curators, most recently Drs Bill Rudman and Winston Ponder, or to the acquisition of large donations of molluscs (mainly shells) by amateur and professional collectors.

Fishes are some of the most familiar and iconic animals of Sydney Harbour. Species such as the Common Sea-dragon and the Eastern Blue Groper (the fish emblem for New South Wales) are well known, but numerous cryptic species and vagrants such as tropical juveniles sometimes call the Harbour home.

Archaeological records show that people have fished the Harbour for thousands of years. In the two centuries since European settlement you might think that we would now know all about its fish fauna. As it turns out, we don't. New records are still found and sometimes new species discovered.

Sydney Harbour has a rich fish fauna, with 586 species of fishes from 160 families recorded – more than the 540 species known to occur in the entire Mediterranean Sea. We expect this number will continue to climb.

The Museum's earliest fish records date from 1878, when 15 specimens (representing 11 species) were collected. We have more than 4300 records of fishes in the Australian Museum database. Fishes are found in all areas of the Harbour but are most numerous in the eastern region.

Collecting has been spasmodic since 1878, with the occasional big jump in the number of species known, most recently in the 1970s and corresponding to the employment of two new Museum ichthyologists, Drs John Paxton and Doug Hoese. At this time, scuba diving became widely used and the newly employed researchers started programs of Harbour-focused research.

Crustaceans include the familiar Blue Swimmer, Mud Crab, Eastern Rock Lobster and School Prawn, as well as the less familiar but more numerous isopods and amphipods. So far, we've recorded 672 species of crustacean in 163 families in the Harbour. They live in all types of habitat – mangrove muds in the upper reaches, weedy wharf pilings, sandy beaches, and wave-washed boulders of the Harbour mouth. Overall, crustaceans can be very resilient in the face of changing water salinities. Most crustaceans live in the eastern Harbour where the water quality is best.

When the history of their discovery is considered, it is clear that the number of new species has grown in steps following the appointment of each new crustacean researcher. The current research scientists are Drs Shane Ahyong and Jim Lowry.

Echinoderms, which include sea urchins, sea-stars and sea cucumbers, can be very common on rocky reefs and among seaweeds. At least 118 species in 45 families of echinoderms live in the Harbour. Unlike the crustaceans, most echinoderms cannot cope with fluctuating salinity, so almost all records are from the eastern Harbour.

As with the Crustacea, the rate of discovery follows a stepwise pattern, with the largest jump in the late 1960s to 1970s following expansion of the Museum's research staff, among them echinoderm specialist Dr Frank Rowe.

Polychaetes, or marine worms, range in size from less than one millimetre to a metre or more in length. Over 300 species are found in the Harbour, with the area east of the Harbour Bridge home to the greatest diversity. Like echinoderms, polychaetes prefer the more stable oceanic salinity of the eastern part of the Harbour. In addition, a greater number have been recorded from this region because it has been subjected to intensive sampling.

Worms occur in all of the Harbour's numerous habitat types, but they specifically live within deep crevices and holes or as encrusting species on coral, rocks, pylons and boats. One of these, *Hydroides elegans*, is a common encrusting species that is a pest in many areas around the world, but we don't yet know precisely where it originated. It might have been introduced accidentally to the Harbour, or it may have originated here and been carried to other parts of the world on the hulls of ships.

“Sydney Harbour has more species of fishes than the entire Mediterranean Sea”

Left to right

The Blue Swimmer, *Portunus armatus*, is common on soft sediments, especially in the eastern Harbour. Photo © Shane Ahyong.

This high-domed sea urchin, *Temnopleurus alexandri*, lives on rocky reefs in the eastern Harbour among seaweeds. Photo © Ashley Miskelly.

Sepia mestus, known as the Red Cuttle or Reaper Cuttlefish, is common in shallow rocky reefs sheltering beneath ledges. Photo © Becca Saunders.

Despite its name, the Eastern Blue Groper, *Achoerodus viridis*, is not a grouper but a wrasse. Photo © David Harasti.



TAXONOMY

It's the highly specialised job of Museum scientists to place species into groupings of genus, family, order, class and phylum to reflect evolutionary relationships.

This crucial step links the physical specimens in the collection with useful knowledge for managing natural areas. Without it, we simply wouldn't know what is what!

Our knowledge of this group has increased considerably since the appointment of Pat Hutchings in 1970. An intensive survey of the Harbour around the commercial shipping areas in 2001 to look for introduced species greatly increased our knowledge of worms and some other groups.

DISCOVERY

The history of discovery for each of the major groups reveals some interesting features. First, our knowledge of Harbour species has not grown evenly and gradually but in distinct jumps that happen whenever marine scientists join the Museum staff.

Second, after more than two centuries, we are still discovering new species in the Harbour, yet many areas of the Harbour have not been scientifically surveyed.

Third, the largest proportion of species occurs in the eastern region of the Harbour, probably because of the wider variety of habitats there as well as more stable salinities and better water quality due to massive tidal flushing.

We are now seeing that Sydney Harbour is remarkable, not only above the water line, but also below. Of the major city-ports around the world, Sydney's is the most biologically diverse. As part of our natural heritage, we have a responsibility to ensure that this valuable legacy remains.

The reasons for such diversity are many, but primarily Nature has been good to us by providing relatively good water quality, thanks to the high volume of tidal flushing (the entire volume of the main Harbour is replaced every 20 days). Without this, the Harbour's health would have been far more seriously impacted by all the changes that have occurred along its shores and in its catchments.

Related to water quality is the combination of many different habitat types, each supporting different animal communities in seagrass beds, mangrove swamps, high-energy exposed rocky reefs, sandy beaches, intertidal areas and sheltered bays. Other habitats are out of sight below the surface

Below

Idanthyrus australiensis is a gregarious polychaete in the Sabellariidae family. Originally described from Sydney Harbour, it lives in sandy tubes cemented to rocky surfaces. Photo © Maria Capa.



SYDNEY HARBOUR FACT FILE

Water depth at the Heads: 30 metres

Deepest water: 50 metres, near Taronga Zoo

Length: 30 kilometres

Surface area: about 50 square kilometres

Total catchment: 500 square kilometres

Tributaries: the Parramatta and Lane Cove rivers to the west, and Middle Harbour to the north.

Most of the harbour (49.7 square kilometres) is tidal, with a 2.1-metre tidal range and change of tide every 6 hours.

Tidal flows: up to 6000 cubic metres per second between the Heads.

“To best manage the asset that the Harbour is, we need to know more about it”

– unless you’re one of the many snorkellers and scuba divers who take to the Harbour each year to enjoy sights such as fluorescent corals, rare lobsters and, each summer, the many tropical reef fishes carried south by the East Australian Current.

SURVIVAL

Harbour health has improved significantly over the last three decades. Offshore deep ocean outfalls built in the late 1980s divert sewage away from the Harbour, and heavy industry along the foreshore has been removed, reducing the inflow of toxic wastes. But there is no room for complacency. The signature of past industrial pollution remains in the sediments in some parts of the upper Harbour such as Homebush Bay and Parramatta River and is found in the biota through the process of bioaccumulation, which is why fishing is still banned in these areas. Also, significant amounts of untreated urban runoff, loaded with sediment, pollutants and rubbish, continue to enter the Harbour, and the regular shipping traffic poses a constant threat of more invasive species arriving.

How do we ensure the Harbour survives and continues to flourish as a significant part of our natural heritage?

Despite the impressive results from the Museum’s database, no comprehensive marine survey of the Harbour has ever been undertaken, and many parts remain unexplored, including its darkest depths.

We need a sound knowledge of what species live in the Harbour, where they live and how they interact with each other. In this way, we can understand how the Harbour ecosystem works, and what affects the fauna, positively or negatively.

We also need to document how the fauna is changing. For example, are those tropical fishes and crustaceans coming into the Harbour in summer more likely to survive the winter if sea temperatures continue to rise, and what effect will this have?

We need to understand how our use or misuse of the Harbour affects the marine life. We also need to be far more careful about what is still finding its way into the Harbour, such as stormwater pollution and waste, and the potentially invasive species brought here by shipping.

Finally, we need to prevent the loss of the remaining natural shorelines and develop artificial walls and marinas that are more fauna friendly. To best manage the asset that the Harbour is, we need to know more about it.

Just as the Museum database has provided these insights into what we know, it also highlights the gaps that we believe should be the target of further investigation.

Imagine what we might find in a major, planned survey of the Harbour ...

DR SHANE AHYONG SENIOR RESEARCH SCIENTIST
DR PAT HUTCHINGS SENIOR PRINCIPAL RESEARCH SCIENTIST
DR MICK ASHCROFT SPATIAL ANALYST
MARK MCGROUTHER COLLECTION MANAGER (FISH)
DR AMANDA REID COLLECTION MANAGER (MOLLUSCS)

WEBLINK >

See more amazing photos of Sydney Harbour fauna at australianmsuem.net.au/explore-magazine

Further reading

PA Hutchings, ST Ah Yong, MB Ashcroft, MA McGrouther and AL Reid, 2013. Sydney Harbour: its diverse biodiversity. *Australian Zoologist* 36(3): 255–320, dx.doi.org/10.7882/AZ.2012.031



AUSTRALIAN MUSEUM
HIGHLIGHTS & SNAPSHOTS
2012–13

Special
report to
Members



PRESIDENT'S REPORT

A VIBRANT MUSEUM

At the end of my first full year as President of this internationally renowned Museum, the vibrancy of its programs, rigor of its research and diversity of its collections continue to surprise and delight me.

Some of the exhibition highlights and successes of the past year include *Alexander the Great: 2000 years of treasures*, the *Menagerie* exhibit of contemporary Indigenous sculpture in our newly refurbished *Indigenous Australians* gallery, the internationally acclaimed *Wildlife Photographer of the Year*, and our touring exhibitions showing in cities and regional galleries around the country.

With the establishment of Life Long Learning, a new branch within the Science & Learning Division, the Museum now acknowledges that education for all is a cornerstone of its role, from pre-schoolers through to senior high school, postgraduate students and 'students' of all ages.

Every member of staff contributes to the quality of what the Australian Museum has on offer. I commend staff, in all their diverse roles, for their commitment to the future of the Museum.

Director Frank Howarth will want to join me in thanking staff, Australian Museum Members, volunteers, chairmen and trustees of the Australian Museum Foundation and the Lizard Island Reef Research Station Foundation, and the Board of Trustees of the Australian Museum.

CATHERINE LIVINGSTONE AO
PRESIDENT
AUSTRALIAN MUSEUM TRUST



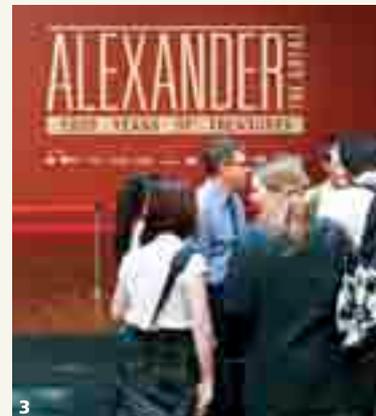
438,454

onsite visitors enjoyed the Museum in 2012–13 – a record



160+

new species described



161,145

visitors experienced *Alexander the Great: 2000 years of treasures*

front cover: A taxidermied Koala from the Museum collection keeps silent watch in the DNA laboratory. Photo by Stuart Humphreys.

from left: 1 The Museum experienced record visitation in 2012–13. Photo by Carl Bento.

2 The Australian Centre for Wildlife Genomics establishes the Museum as an Australian leader in wildlife genetics research. Photo by Stuart Humphreys.

3 *Alexander the Great: 2000 years of treasures* drove record attendance and raised the Museum's profile internationally. Photo by Carl Bento.

NATURE

- Research scientists and science technical staff completed the second, marine, stage of the Museum's expedition to Timor-Leste – one of the largest biological surveys undertaken by the Museum. The results will provide a basis for the design of a protected area network in Timor-Leste.
- The Koala Genome Project was launched with consortium partner QUT in April 2013. It is one of the first Australian-led projects to sequence a mammalian genome, and the results will be crucial for Koala conservation.
- The Rapid Digitisation Project and Virtual Volunteer Portal have resulted in the creation of 142,000 digital images, the transcription of 31,500 items (labels, notes and archival material) from hardcopy, and the importation of 41,500 records to our database, making vast amounts of data accessible to stakeholders.
- Museum scientists, Senior Fellows and Research Associates described more than 160 new species in 2012–13, including 73 marine invertebrates, 53 insects, 19 snails and 10 fishes.
- The Australian Museum Science Festival (formerly Science in the City) in August 2012 saw more than 5000 students participate in 212 workshops.

Science on Saturday, open to the general public, attracted more than 1800 people, while another 1100 students attended regional events.

- Streamwatch, a citizen science initiative promoting the importance of water quality in ecosystems, has more than 50 community groups monitoring water quality and providing data for catchment management purposes.

CULTURE

- Alexander the Great: 2000 years of treasures* was the first time the State Hermitage (St Petersburg) allowed such a significant part of its collection to visit Australia, and it contributed to a new high in visitor numbers for the Museum.
- In January, the Hon. George Souris, Minister for the Arts, opened the *Menagerie* exhibit of contemporary Indigenous sculpture in the newly refurbished *Indigenous Australians* gallery.
- The Australian Museum Foundation disbursed grants totalling \$626,166 to the Museum for projects including the Timor-Leste expedition, the Pacific Youth Reconnection Project, 'ghost net' sculptures from Erub (Darnley Island in Torres Strait) and several other projects.
- The Museum reached thousands of people by participating in major Pacific

community events across Sydney, including Waitangi Day (February, Merrylands), Fiji Independence Day (October, Lidcombe) and the Pacific Unity Festival (November, Lidcombe).

DISCOVER

- The Museum received 438,454 visitors in 2012–13, the highest visitation since the introduction of admission charges in the early 1990s.
- Two new grant-funded Indigenous cadetships have been established in the Museum's Cultural Collections, part of an initiative to boost Indigenous employment.
- Jurassic Lounge, an after-hours program showcasing emerging artists, attracted an audience of 19,562 people in two ten-week seasons to experience music, science presentations, galleries, displays, live animals, burlesque acts and Winny the *Muttaborrasaurus* puppet.
- The 2012 Australian Museum Eureka Prizes recognised excellence in science with 18 prizes in four categories: Research & Innovation, Leadership & Commercialisation, School Science, and Science Communication & Journalism. The Awards dinner was attended by 700 guests, and publicity reached an estimated global audience of 12.5 million.



tens

of thousands enjoyed Pacific events

two

new grant-funded Indigenous cadetships created

\$626k

in grants received from the Australian Museum Foundation

new

Life Long Learning branch established

19,562

people experienced Jurassic Lounge

4 Dancers in traditional costume inspect the Museum's stand at Fiji Independence Day, October 2012. Photo by Yvonne Carrillo-Huffman.

5 The results of a biological survey to Timor-Leste will provide a basis for conservation planning in this developing nation. Photo by Jim Lowry.

6 Jurassic Lounge attracted a young adult audience to the Museum for an after-hours Museum experience. Photo by Diabolique Photography.



DIRECTOR'S REPORT

A YEAR OF CHANGE

The Museum has had a very positive year, with some outstanding achievements on top of a major organisation review.

We continue to make significant impact through social justice and inclusion with a dedicated, grant-funded youth worker appointed to the Pacific Youth Reconnection Project to work collaboratively with juvenile justice centres; two new grant-funded Indigenous cadetships working in the Museum's Cultural Collections; and reduced fees and charges across a range of activities for economically disadvantaged schools.

Of our other achievements during one of the Museum's best years ever, the positive impact of *Alexander the Great* on our image and brand should not be underestimated. It drove our record attendance but also raised the Museum's profile internationally as a major cultural player with capacity to deliver a new and more diverse program to all our stakeholders.

Succeeding in a climate of reducing government funding is a reality we must manage. We will ensure it drives innovation as we continue to work on our e-programs and interactions and develop revenue-raising initiatives.

These themes contribute to the New Museum Project, for which we now have a comprehensive business case. It includes developing the Museum site, but also aims to expand digital literacy across the Museum to participate in and effectively utilise the digital revolution – in our management, marketing, exhibitions, collection access and outreach.

FRANK HOWARTH PSM
DIRECTOR
AUSTRALIAN MUSEUM



18

Eureka prizes awarded to scientists

1100

students attended regional Science Festival events

142k

digital images created

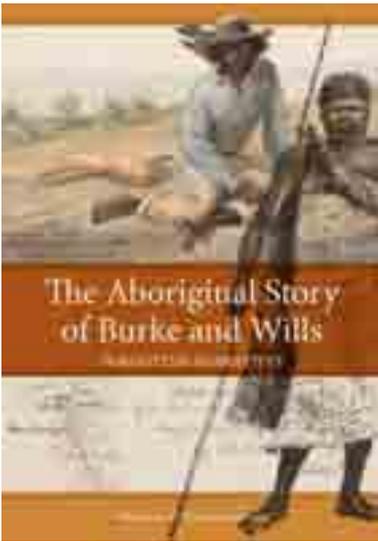
from left: 1 Dr Marie-Liesse Asselin-Labat, winner of the 2012 Macquarie University Eureka Prize for Outstanding Young Researcher. Photo by Daniel O'Doherty.

2 The Australian Museum Science Festival showcased leading science organisations to more than 5000 students and 1800 general visitors. Photo by Carl Bento.

3 Artists from Darnley Island pose with sculptures commissioned by the Museum and made from abandoned fishing nets ('ghost nets').

Photo by Louisa Anson, courtesy Erub Erwer Meta art centre.

reVIEW



THE ABORIGINAL STORY OF BURKE AND WILLS: FORGOTTEN NARRATIVES

Edited by Ian D Clark and Fred Cahir
CSIRO Publishing, 2013

There are many ironies at the heart of the Burke and Wills story. It was ironic (and tragic) that Robert O'Hara Bourke, with no prior experience as a bushman, surveyor or navigator, was chosen to lead one of Australia's most ambitious and challenging overland explorations.

It was ironic that the 'ghastly blank white man's grave' of Central Australia was yet so intimately familiar to its Aboriginal residents, full of life-giving plants and animals and charged with spiritual significance.

It was ironic too that when the starving explorers eventually did learn to gather an Aboriginal food – the seedlike sporocarps of nardoo, an arid zone fern – they did not learn to prepare it properly, such that its toxins may have actually contributed to their deaths.

But perhaps the most surprising irony to emerge from this new book is the way that Aboriginal people disappeared from the Burke and Wills story as its narrative became a 'national myth of heroic endeavour'. *The Aboriginal story of Burke and Wills: forgotten narratives* represents a deliberate attempt to challenge this literary *terra nullius*.

The book is the first major study of the cross-cultural exchanges that took place on the Burke and Wills expedition and subsequent rescue attempts. The seventeen chapters by a multi-disciplinary team of academics, Aboriginal elders and artists explore how expedition members interacted with Aboriginal people.

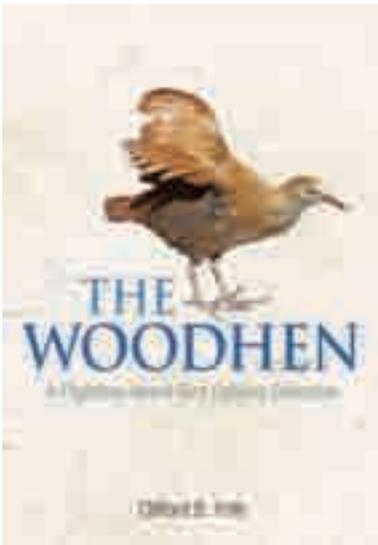
The authors delve into the cultural background of Aboriginal people living in the Coopers Creek region and explore Aboriginal oral history accounts of the expedition, drawing on a rich source of archival documents, anthropological and linguistic research, visual art and historical photographs.

At its best the book draws on Indigenous perspectives to shed a whole new light on this seemingly familiar story. For example Darrell Lewis describes an intriguing oral history that challenges the standard narrative that Burke died of deprivation and exhaustion. Phillip Clarke, by documenting the explorers' use (and misuse) of Aboriginal ecological knowledge, shows just how narrow the margin between life and death may have been for the ill-fated pair. Fred Cahir explores the 'terrible bind' of the Yandruwandha people, caught between their cultural obligations to assist strangers in need and the equally compelling need to repel culturally insensitive intruders.

Ultimately in this book, it is the Yandruwandha who step from the shadows to the centre of the Burke and Wills story. It is sure to be enjoyed by anyone with an interest in the history of Australian exploration or in the development of our Australian national identity.

DR SCOTT MITCHELL

reVIEW



**THE WOODHEN:
A FLIGHTLESS ISLAND BIRD
DEFYING EXTINCTION**

by Clifford Frith
CSIRO Publishing, 2013

A paradox for ecologists and evolutionary biologists is that they are driven by a desire to understand diversity, yet some of the most influential discoveries have been made in the most species-poor ecosystems.

Because island faunas usually arise from the occasional and somewhat unpredictable arrivals of immigrants, they tend to have fewer species than comparable mainland areas – a feature that has stimulated major breakthroughs in evolutionary ecology by legends like Darwin, Wilson and Diamond.

Some immigrant species are able to establish and prosper, while others become extinct because they are unable to establish or co-exist with other hapless arrivals on the island zoo. But if a species is able to withstand this juggling act of immigration and extinction for long enough, it can evolve within its new environment and differentiate from its mainland ancestors.

The flightless Woodhen of Lord Howe Island, like many other island rails, evolved from a free-flying immigrant ancestor. Given the physiological cost of developing and servicing the powerful musculature required for flight, selection against flight should be great in environments which are naturally free of mammalian predators, such as Lord Howe.

Once flight is lost, dispersal between islands becomes extremely infrequent and island rails are free to evolve into distinct species without immigrants polluting their gene pools. It's truly remarkable (to me at least!) that

flightlessness has evolved multiple times, with perhaps 1500 species of island rail in existence before humans moved across Oceania and extinguished them.

The Woodhen of Lord Howe Island was unwary and easily captured by new mammalian immigrants, providing fresh meat and eggs to sailors and their accompanying dogs, cats, pigs and rats. By 1887 an Australian Museum scientist reported that woodhens '... were soon to become extinct unless protected', but their decline continued, perhaps assisted by an overzealous 1915 collector (82 skins!), and their population eventually dropped to 30 individuals by the 1970s.

They were then saved from extinction by a dedicated team (including Australian Museum scientists, I'm relieved to say) who implemented a captive breeding program and eliminated the bird's main predators. The Woodhen's population has now stabilised at around 250 – a heartening 'back from the brink' story fully documented in this useful volume.

There are two audiences for this book: conservation managers, for whom this book is a handy, comprehensive manual, and lay readers, for whom the extraordinary level of detail may sometimes make for frustrating reading.

However it is worth persevering with because the content is so rich, and the setting so compelling, that the story ultimately provides an inspirational tale of conservation in action.

DR RICHARD MAJOR

Summer December 2013 to March 2014



xplorer

experiment discover create



liftout for young scientists

-  **ACTIVITIES**
make your own dinosaur
meet the neighbours
-  **INTERVIEW**
animator matt drummond
-  **COLLECTOR'S CARD**
guanlong, the crown
dragon
-  **INFO**
carla's blog
meet the family

TYRANNOSAUR TIME!



ZOOM IN TO THE MUSEUM

to see our latest dinosaurs exhibition, *Tyrannosaurs: meet the family*. And don't forget to see our regular *Dinosaurs* exhibit while you're here!



FUN FACT



The first Australian dinosaur bones ever found were collected from Cape York by the crew of HMS *Fly* in 1844 and taken back to England. It was 50 years later that they were named *Agrosaurus* and placed with the prosauropods.

FUN FACTS



Tyrannosaurus rex (*T. rex*) was known as the king of the dinosaurs. Its name translates to Tyrant Lizard King.

T. rex was over 12 metres long, 3.5 metres tall at the hips, towering to 7 metres, and weighed up to 8 tonnes. That means it was longer than a bus, tall enough to look into an upstairs window and heavier than an African bull elephant.

CARLA'S BLOG



Hi, I'm Carla and I work at the Australian Museum.

I love nature and science and I'm here to tell you stories and share interesting facts.

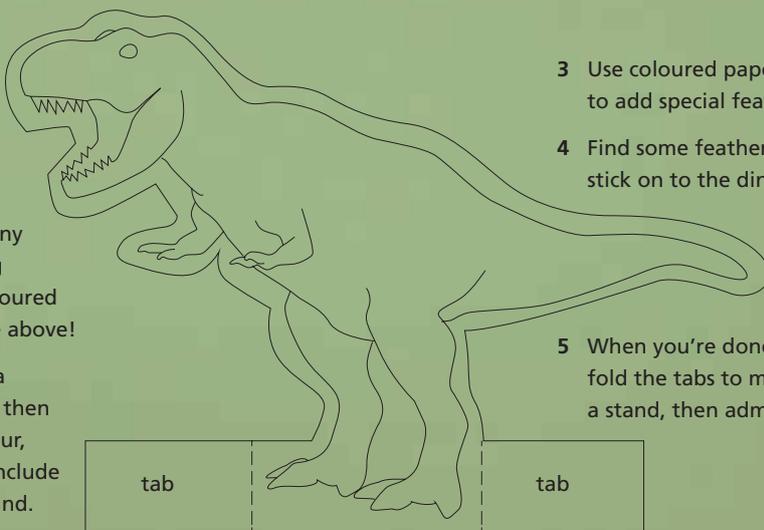
Just this morning, I was digging a burrow in the bush and came across a big dinosaur bone. So I brought it into the Museum and asked one of the scientists what it belonged to. After a close look they said it was from a *Muttaburrasaurus* – a large plant-eating dinosaur that lived in Australia more than 100 million years ago. Cool!

Did you know that the king of dinosaurs, *T. rex*, was born with feathers, just like a cuddly bird? Maybe they aren't so scary after all.

MAKE YOUR OWN DINOSAUR MODEL



- 1 Draw and colour in your dinosaur any way you like using crayons, paint, coloured pencil or all of the above!
- 2 Glue the page to a piece of stiff card, then cut out the dinosaur, remembering to include tabs to act as a stand.



- 3 Use coloured paper to add special features.
- 4 Find some feathers to stick on to the dinosaur
- 5 When you're done, fold the tabs to make a stand, then admire!

On the cover Tyrannosaurs have arrived at the Australian Museum! Styling by Jeremy Austen. Photo by Stuart Humphreys.

MEET THE FAMILY



Tyrannosaurs: meet the family is the Museum's latest exhibition to feature real dinosaur fossils as well as casts used by scientists to make copies of fossils for further study. The most spectacular is *Dilong*, a recently discovered tyrannosaur from China that became fossilised in volcanic ash. Others on display include:

Tyrannosaurus – a real tooth, bone, claw and coprolite (fossil poo!)

Yangchuanosaurus – a real articulated skeleton

Gorgosaurus – a real half-skeleton fossil in matrix

Albertosaurus – a real partial jaw fossil

plus skull casts of *Teratophoneus*, *Alioramus*, *Tarbosaurus*, *Appalachiosaurus*, fossil eggs and more.



MEET THE NEIGHBOURS



This map shows where people have found dinosaurs in Australia. So far, there are no *confirmed* sightings of a tyrannosaur fossil in Australia.

Check the map above to find the following Australian dinosaurs, then find their names in the word puzzle, below.

LEPTOCERATOPS MUTTABURRASAUROS FULGUROTHERIUM
RHOETOSAURUS STEGOSAUR MINMI ALLOSAURUS

B R R H O E T O S A U R U S E N
D A N E X P E W Y U M I N M I D
I R A L L O S A U R U S T Y R A
T B F U L G U R O T H E R I U M
M U T T A B U R R A S A U R U S
J L E P T O C E R A T O P S O U
E L T I M S T E G O S A U R U S

SCIENTIST FOR A DAY

15 & 16 January Tyrannosaurs: rise and fall of the tyrant kings

22 & 23 January DNA detectives

Have you ever wanted to unearth the secrets of the Tyrannosaurs? Or maybe you're a DNA detective in the making? Find out in these fun, one-day workshops.

Ages 8–12 years

Time 9 am – 3 pm

Cost Members \$110, non-Members \$135

Bookings

t 02 9320 6389

e scicom@austmus.gov.au

For the complete school holiday program, visit australianmuseum.net.au/whatson

DREAMING OF DINOSAURS



Describe what your dream dinosaur would look like, what it would eat and how big it would be. Is it small and fast, or big and slow? Does it run, swim or fly? Email your entry to scicom@austmus.gov.au or post it online at australianmuseum.net.au/blog/dream-dinosaur.



Each issue of Xplorer includes a collector's card for you to cut out and keep!

xplorer
collector's card

28



Guanlong wucaii





LIVING THE DREAM

Helping to bring science to life is all part of a day's work for animator Matt Drummond. He took time out to chat with the Museum's Bliss Jensen, exhibition project manager for *Tyrannosaurs*.

BLISS: So Matt, you're a director, animator and visual FX artist – what did you work on before *Tyrannosaurs*?

MATT: I wrote and directed a feature film called *Dinosaur Island*, which is due for worldwide release in early 2014. It involved re-creating many dinosaurs and other prehistoric creatures. It's a lot of fun.

BLISS: What has been the most exciting part of working on the *Tyrannosaurs* exhibition?

MATT: Visually bridging the gap between birds and dinosaurs! *Guanlong* and *Dilong* are small, feathered tyrannosaurs and it was great to be able to give them very bird-like qualities in their motion and behaviour.

BLISS: So how do you create an animation of dinosaurs?

MATT: I usually start with pencil and paper and roughly sketch the animal based on the scientific research at hand. I then build a rough form in the computer. Once the dimensions of the animal are correct, I sculpt and paint the animal's details until I have a final creature. I then create a skeleton and rigging in the computer to be able to move the animal around.

THIS EDITION OF XPLORER COMPILED BY TIM MALL

Guanlong wucaii

Guanlong wucaii was a small/medium-sized early tyrannosaur, about 4 metres long. Its name means 'crowned dragon', so called because of its large but fragile head crest along the midline of the skull – one of the most elaborate crests of any non-avian dinosaur. It could raise the crest much like a peacock raises its tail, and possibly for the same reason – to attract a mate. It ate meat, capturing prey in its long, three-fingered forelimbs.

At around 160 million years old, *Guanlong* is 95 million years older than *T. rex*. It's not an ancestor but a specialised lineage with no known descendants.

Scientists in China discovered two skeletons of *Guanlong*, one lying on top of the other. They were entombed in the fossilised giant footprint of a massive sauropod, *Mamenchisaurus*.



Illustration by Matt Drummond.

BLISS: And finally, and most importantly, if you were stranded in Jurassic Park, which dinosaur would you be most nervous about meeting?

MATT: *Velociraptor* – though actually the animals in the Jurassic Park movie weren't Velociraptors. They were based upon *Deinonychus* but given the size of a 7-metre long *Utahraptor*. Velociraptor was actually the size of a turkey – not a 6-foot turkey as the kid in the movie states, but a tiny half-metre feathered theropod!

WEBLINK >

Check out one of Matt's videos at youtu.be/VX8pB7H9dyw

Film director, animator and visual FX artist Matt Drummond. Photo courtesy Matt Drummond.



FUN FACT

The earliest animated film to feature a dinosaur was *Gertie the Dinosaur*, made in 1914 by American cartoonist and animator Winsor McCay. This silent film in black and white ran for just 12 minutes!



Send your query to the Search & Discover team, email sand@austmus.gov.au

search > DISCOVER



Q. *I saw a Swamp Wallaby in my backyard in St Ives. Who can I report it to?*

That's a great sighting! The Swamp Wallaby, *Wallabia bicolor*, is not as common in Sydney as it once was, but can still be found in a few places in its preferred habitat of thick forest undergrowth or sandstone heath.

You can upload this and any other sightings to the Atlas of Living Australia (ALA) at the URL shown below. The ALA is the same network that museums, herbaria and other scientific institutions use to share information and create a picture of the organisms that inhabit Australia. The ALA produces maps based on museum specimens and sighting data.

This is a great resource if you've ever wondered about the animals that have been recorded in an area, such as your own neighbourhood.

CHRIS HOSKING

WEBLINK >

Try out the Atlas of Living Australia for yourself at ala.org.au/get-involved

Swamp Wallaby, *Wallabia bicolor*.
Photo by Stuart Humphreys.



Q. *My dad and I were debating the difference between a turtle and a tortoise. Can you help?*

What a great debate! The terms turtle and tortoise are often used interchangeably and can cause some confusion. It all comes down to their habitat. In the past, all freshwater turtles were called tortoises, and marine (salty water) turtles were called turtles. Now, the term 'turtle' is used for those that live in water, while tortoises are those that live exclusively on land. As such, there are no tortoises in Australia. However, Australia is home to 23 species of freshwater turtle, and six species of marine turtle.

If you really want to impress your dad with your knowledge, tell him about the terrapin – this term is sometimes used overseas for turtles that are semi-aquatic and live near brackish waters or swampy regions. They're like a mix between a turtle and a tortoise as they spend their time divided between water and land.

MELISSA SLARP

Editor's note: The fossils discussed on page 32 have retained their historical common name of horned turtles, despite suggestions they were terrestrial when extant.

Eastern Snake-necked Turtle, *Chelodina rugosa*.
Photo by John Cann.



Q. *I have photographed rock formations like these at various locations in the upper Blue Mountains. What are they called and how were they formed?*

Your photo shows outcrops of sedimentary rocks from the Narrabeen Group sandstones. They have concentric ironstone and ironstone pipe concretions, and differential weathering (from wind, rain, heat and cold) has resulted in alternating prominent and recessed layers. It also shows honeycomb weathering, which adds to the patterns with stone filigree of weather-resistant iron-rich sandstone layers and less-resistant pure sandstone.

The iron-rich sandstone has formed from iron oxides moving in solution through the porous sandstone. The concretions have formed from minerals such as quartz and iron oxides either precipitating as successive layers around a nucleus (such as a mineral fragment, shell or pebble) or occupying the pore spaces in a layer of sandstone, shale or other sedimentary rock.

MELISSA MURRAY

Rock formations in the Blue Mountains.
Photo © Derek Finter.

THE MORE MOVING PARTS THE BETTER...

One of the interesting differences between human-designed systems and natural ones is the inverse effect of increasing complexity.

With human systems, tools and machines, the more complex they are, the more likely they are to break down. One tiny factor or faulty component can cause an entire system to grind to a halt, and fixing the problem usually calls for replacement of parts rather than repair.

Similarly the more refinement, or work, needed to produce the device, the more quickly it will fail or need maintenance.

Each component of a system depends on the others, rather than functioning in isolation – and there is often very little ‘give’ in the more complex systems. A hammer is less likely to fail than a hand drill, which is less likely to fail than an electric drill, and so on. In a complex machine like a computer, one tiny fault can (and often does) stop work until a specialist can come to adjust an electronic feature, reinstall software or replace some component. Yet the home handyman can hammer away for weeks or months until the head falls off the hammer!

In natural systems too, each component depends on others, rather than functioning in isolation. Simple systems are prone to failing as too few components are involved, and there is little ‘give’ or resilience. Consider, say, a temporary puddle consisting of five species – one plant, three herbivores and a carnivore. If the plant should go, the herbivores starve and die out, shortly followed by the carnivore.



Left
Rainforests are among the most diverse habitats on Earth. Photo by Stuart Humphreys.

If we compare the puddle to a more complex system – say, a river or lake – there are many more species, niches and diets involved. If one species of plant disappears, the herbivores can turn to others. Similarly, the predators can prey on the herbivores or on other carnivores, and the diversity and populations ensure they won't eat out their food supply completely. The system is far more stable if it has developed all together in a natural system over a long time.

So why then are so many natural systems in trouble right around the world? The answer is, predictably, us in most cases. We now have inputs into most, which tends to make them ‘smaller’

(think of land clearing and swamp draining) or less complex by reducing key species and populations (overfishing, clear-felling trees etc).

With fewer species, systems become less stable. When we add other decidedly unnatural inputs, like pollution, pest species and climate change, it is not surprising that many natural areas are struggling to survive.

Left to their own devices, some natural systems have run, and may continue to run, more or less unchanged for thousands of years. Will any human-made systems last as long?

JUST ADD WATER

MARTYN ROBINSON
IS THE MUSEUM'S
RESIDENT NATURALIST

As a child, I was fond of the 'Bugs Bunny' cartoon shows. Although I always felt sorry for him, my favourite character was Wile E Coyote. I particularly liked his various Acme instant products – just add water and a tiny dehydrated 'pill' would transform into a grand piano or something equally improbable.

I was always a little disappointed that real life wasn't quite the same – until I discovered that, for some species, it is like that. Almost.

Australia is renowned as one of the driest continents, with droughts lasting decades affecting the arid interior. So it might come as a surprise to learn that these dry areas are home to a wealth of unusual animals, particularly some invertebrates, that live and grow only after rain or flooding.

The secret of success for most of these animals is the egg stage, which can withstand years of drought, extreme heat and cold, and abrasion from wind and sand and yet still hatch when rain or floodwaters eventually come.

The water, of course, causes the eggs to rehydrate and hatch, but then the race is on and the animals must grow, mature into adults and breed before the temporary water body, whether a puddle or a lake, dries up again.

So rapid is their growth that, within days of heavy rains, roadside ditches will be teeming with life, leading many observers to conclude (incorrectly) that the animals must have come down in the rainstorm itself (though we know the eggs are distributed by wind, birds or floodwater).



Perhaps the most famous of these 'temporary puddle' animals – most of which are crustaceans – are the two species of tadpole shrimp, *Triops australiensis* and *Lepidurus apus*. These strange and quite large crustaceans resemble the horseshoe crabs of America and Asia, except that 'tadpole shrimp' eyes are concentrated in a cluster at the front rather than at the sides.

I used to think they were called 'tadpole shrimp' because of their appearance but having seen them shred and eat some real tadpoles inhabiting the same temporary puddles out west I am not so sure!

There are other, gentler, crustaceans which have this abbreviated life cycle, such as the various brine shrimps

(sold as 'sea monkeys', although they never live in the sea!) which hatch in salt lakes such as Lake Eyre. In freshwater puddles you can find feather shrimp and clam shrimp, and their names give a good guide to their appearance. There's another whole world of amoeba and other microscopic life forms that are similarly adapted.

So there you go – (almost) instant life – just add water! Wile E Coyote would have been proud!

Above
The shield shrimp, *Triops australiensis*, can appear in large numbers after flooding in desert wetlands. Photo by Stuart Humphreys.

INSECT SOUP *anyone?*

A PROTOTYPE CITIZEN SCIENCE PROJECT PROMISES TO UNLOCK VALUABLE INFORMATION FROM MUSEUM COLLECTIONS.

Many natural history museums hold unsorted jars of insects collected incidentally during field work and stored for future reference.

These bulk collections, known as insect soups, form a snapshot of biodiversity at a given time and place. They form a valuable resource for researchers, such as the ecologist who needs to know how diversity has changed over time at a location or the entomologist looking for specimens of one group of insects from several locations.

Traditionally, a researcher would need to come to the Museum and sort through each jar to see if it holds what they're looking for.

Now, thanks to a grant from the Australian Museum Foundation, the Museum is creating a searchable library of tagged insect images so that anyone can access such collections online via the internet.

Paul Flemons, Manager of Collection Informatics at the Museum, believes that, once developed, this technique will be a model for other museums.

'In this prototype project, we're looking at how best to make these collections widely available and accessible', Paul said.

'It has the potential to become a terrific citizen science project, like the DigiVol project where onsite volunteers take and upload photos of specimens and labels for transcription by online virtual volunteers.

'The aim is to help more researchers make better use of these largely untapped samples.'

JULIET GAUCHAT DEVELOPMENT OFFICER

Right

A typical insect soup with its label. Volunteers photograph and 'tag' the images so that researchers can more readily locate the specimens they seek. Photo by Paul Flemons.

MAKING A DIFFERENCE

Make a donation to the Australian Museum Foundation and you'll be directly supporting the Museum's science and cultural programs. For further information, please contact the Development Branch, phone 02 9320 6216 or email development@austmus.gov.au.





Australian Museum
K378047

NSW, Deniah Aboriginal Area,
20.9km E of Narrabri, stand of
Ooline, -30 368 S, 149 991 E,
11 to 19 Nov 2009, 340m, D R
Britton, J. Recsel,
SEVT2009014 [Malaise]

HYMENOPTERA



10mm

learner and



GREENER

CLIMATE CONTROL WITHIN THE MUSEUM IS ESSENTIAL FOR COLLECTION CARE AND VISITOR COMFORT, BUT NEW APPROACHES ARE REDUCING ENVIRONMENTAL IMPACT AND ENERGY COSTS, SAYS MATERIALS CONSERVATION MANAGER **COLIN MACGREGOR**.

Ensuring the Museum's collections remain in good condition deep into the future is one of our key goals. Climate control in storage areas is essential, but the environmental impact, and rising cost, of energy has led us to rethink the way we manage our airconditioning systems – with promising results.

The environmental efficiency of a building starts at the design stage, and the Museum's Collections & Research Building, completed in 2008, adopted a more passive approach to climate control, with an outer glass 'skin' to trap hot air, and collection storage areas located in the cooler heart of the building.

Humidity in particular can damage collections by encouraging mould, corrosion and increased pest activity, but extracting moisture from the air, especially in Sydney's humid climate, is the most energy-hungry part of airconditioning.

Until recently, international standards for collection care in museums and galleries mandated a relative humidity range of between 45 and 55 per cent, but running air-conditioning 24/7 to achieve this narrow range is extremely expensive.

SAVINGS

For the past two years we have trialled shutting down the airconditioning overnight and at weekends. We've found that a solid, well-sealed building can maintain stable conditions for long periods

without constant airconditioning or compromising collection care.

As a safety net, the computer-controlled airconditioners automatically restart should conditions start to drift too far in response to changes in the weather.

So far, these measures have resulted in energy savings of 1.6 MWh per day for the Museum, which is equivalent to taking 53 Sydney houses off the grid.

Most of the energy for airconditioning is used to process unconditioned air from outside. Our Building Services team is currently installing a new type of dehumidifier, allowing some moisture to be removed from incoming air before it reaches the airconditioning plant, further reducing energy consumption.

Additionally, the fitting of carbon dioxide sensors in the galleries allows the building management computer to control the amount of outside air brought in by the system. On quieter days, less outside air is required to maintain the balance between oxygen and carbon dioxide.

PEOPLE POWER

While very high or low humidity levels can damage collections, temperature is less critical. A mid-range and stable humidity level is ideal for collection care, but temperature standards are usually dictated more by human comfort and can be allowed to drift somewhat.



Opposite

Dr Mark Eldridge at work in the mammals collection area of the Museum's Research & Collections building. Photo by Stuart Humphreys.

This was brought home to me while visiting the National Museum of Science in Japan shortly after the 2011 earthquake and tsunami that killed tens of thousands and crippled the country's energy supply. In the hot summer weather, notices informed the public that the airconditioning was set at 28°C to help reduce energy usage.

Given the changing economic and environmental landscape in which we live, is the enormous energy cost of maintaining precise conditions through summer and winter acceptable?

The Director of the Tate Gallery in London, Sir Nicholas Serota, has stated that visitors to the Tate may have to dress appropriately for a varying climate in future as temperatures are allowed to drift in order to balance collection care with the energetic and economic costs of environmental control.

In a warming climate, perhaps we'll all need to develop greater tolerance of higher temperatures. The lessons we've learned at the Museum could readily be applied to other situations, such as office buildings and even homes.

Together we can make a difference. As the saying goes: think global and act local!

COLIN MACGREGOR MANAGER, MATERIALS CONSERVATION



collecting INDIGENOUS LANGUAGES

ARCHIVIST **VANESSA FINNEY** UNCOVERS AN ABORIGINAL WORD LIST COLLECTED BY NATURALIST RICHARD HELMS IN NORTHERN AUSTRALIA IN THE 1890S.

Nineteenth-century naturalists, collectors and explorers did not just make maps and collect objects and specimens. The best of them were just as busy recording the sights, sounds and experiences of the landscapes they journeyed through.

Their field notes, sketches and photography are important resources for contemporary researchers and historians. Their observations are sometimes the best evidence for changes in biodiversity and culture not recorded anywhere else. The Australian Museum Archives holds a small but significant collection of these field diaries and notebooks.

COLLECTING EVERYTHING

Richard Helms, naturalist and collector on the 1891 Elder Expedition to northwest Western Australia, collected as much new fauna and flora as he could carry. But he was not just busy with jars, spirits and field taxidermy. Where expedition leader David Lindsay saw geography and maps, Helms saw a landscape full of natural and human detail.

Collecting over 1000 specimens of plants and animals, Helms also recorded almost daily descriptive natural history notes

about the country the expedition travelled through and populated his entries with the Aboriginal people he met on his journey.

No wonder Lindsay complained that Helms was often many miles behind the main group, busy with his multi-faceted collecting activities and slowing the 'progress' of the main group on the expedition's mapping quest.

A GERMAN NATURALIST

A self-taught, German-born naturalist, Helms had arrived in NSW in 1858, aged 16. Of humble origins but exceptional talent, over his career he worked as a tobacconist, dentist, watchmaker, museum curator, collector, entomologist, fruit inspector and bacteriologist.

He was interested in, and had an encyclopaedic knowledge of all fields in nineteenth-century natural history – collecting, researching and writing about botany, zoology, geology and ethnology.

From 1888, Helms worked as a collector at the Australian Museum for three years. Hired by Edward Ramsay at a time when the Museum was keen to replenish its collections after the Garden Palace fire of 1882, Helms made extended collecting

Above
Richard Helms, 1858–1914.
Photo by Falk Studios.
State Library of NSW.
gpo1_15766

Opposite left
The Elder Scientific Expedition mapped over 80,000 square miles (207,000 square kilometres).

Opposite right
Setting off from Cootanoorina, 7 May 1891. Photo by FJ Elliot. South Australian Museum Archives. AA85



trips to the Snowy Mountains and Darling and Richmond rivers, describing, collecting and writing about natural and Aboriginal histories.

A SCIENTIFIC EXPLORATION

By 1891, Helms had left the Australian Museum and was invited to join the Elder Scientific Exploring Expedition as naturalist and collector. For eleven months, 14 men (including 3 scientists and 5 Afghan cameleers) and 44 camels travelled 4279 miles (6886 kilometres) through Western Australia, mapping and exploring for the Royal Geographic Society. The official goal for what was intended to be a two-year trip was to fill in the 'blank spaces between latitudes 15°S and 30°S' and make an 'exhaustive Scientific Exploration' of this enormous area.

The expedition was the most ambitious of its time and was based on scientific principles – organised, well equipped and guided in all things by a detailed Expedition Handbook which prescribed goals, procedures and scientific methods. The Handbook contained special instructions that all scientific staff were to keep 'daily and accurate' journals, with templates for the information and observations they should contain.

In its own terms, the expedition was a failure. It was undone by drought, fearsome heat, erratic water supplies and an epic, acrimonious 868-kilometre trek without water. The camels survived the distance on only 36 litres of water each. In December 1892, the group reached the Murchison River district. Here dissent over leadership and the expedition's route boiled over and all the scientific staff resigned. The Royal Society withdrew its support, the expedition was abandoned and the members and collections dispersed.

For Helms, however, the expedition proved extraordinarily rich. He collected 150 new species of insect, 700 plant specimens, with 19 new plant species, and 116 specimens of shells, lichen, fungi, birds, nests, eggs, reptiles and mammals, and around 35 cultural objects. He sent these collections to the South Australian Museum.

COLLECTING WORDS AND THINGS

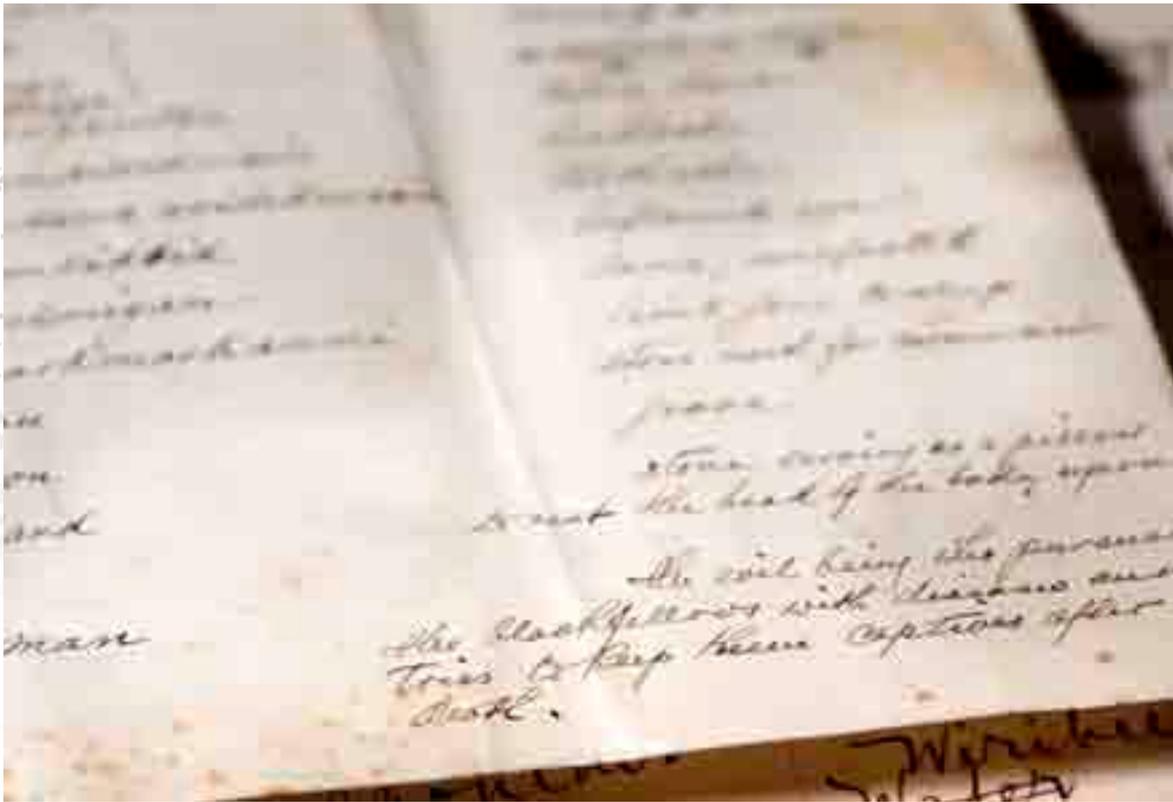
Lindsay reported that 'little need be said' of the 'natives', leaving this to the team's medical officer. Helms had a different view. He was fascinated by the people he met. Although thwarted by language barriers, he made almost daily notes in his diary of his observations and interactions with local Aboriginals.

Helms made connections wherever he could between the landscapes the expedition travelled through, the flora and fauna he was collecting and the lifestyle and habits of the people he met and sometimes travelled with. He noted each local group's language, their physical appearance and lifestyles, habits and customs. He made copies of art sites and lamented his own inability to decipher their symbolic meanings. Helms also talked with any English-speaking Aboriginals he met, asking them about their customs, lifestyle and recent histories and recording their language where he could. Unusually for a man of his time, Helms writes that collecting this important information from still-living Aboriginal people is a 'duty we owe to the previous owners of this continent, as well as to our descendants'.

As a naturalist with an ecological eye to the landscape, Helms was particularly interested in the ability of Aboriginals to live off the land. His own expedition lumbered through the landscape, rationally organised and scientifically equipped but with no common purpose and at times oblivious to the food and water within easy reach. Helms complained that his zoological observations could not be



“man: the evil being who pursues the blackfellow with disease and tries to keep them captive after death”



Indigenous word lists collected by Richard Helms in northern Australia in the 1890s. Photo by Stuart Humphreys.

considered anything like exhaustive, since ‘passing over ground on a march [means] ... the greatest part of animal life must escape the observer’s eye’.

LANGUAGE LISTS

The Australian Museum Archives holds an intriguing manuscript list of more than 250 Aboriginal words said to have been recorded by Helms in northern Australia. Long overlooked and little studied, it is not yet certain the lists are from the Elder Expedition, as Helms worked again in northern Australia from 1896 to 1898 and continued to record, collect and write about cultural and natural history for the rest of his life.

In all his lists, Helms was a man ahead of his time. In this list, like his Elder Expedition lists, he seems to understand that to learn about language is to learn about culture. His lists include notes on language use and the cultural and material practices the words describe.

He understands that early explorers and collectors by their very presence were bringing change to the landscapes they moved through and described.

The manuscript held in the Archives includes this startling entry for the Aboriginal word ‘man’: ‘the evil being who pursues the blackfellow with disease and tries to keep them captive after death’.

With digital scans now available, we can bring Helms’ word lists to the attention of communities and interested specialist researchers. The vocabularies can be compared with other language lists and with contemporary language use.

The lists so diligently compiled by Helms may be among the earliest recorded language for these communities and stand as important resources for the ongoing project of Indigenous language revitalisation.

VANESSA FINNEY MANAGER, ARCHIVES AND RECORDS

WEBLINK >

australianmuseum.net.au/Archives-and-Records

OPENING *up*

AS THIS EDITION OF *EXPLORE* GOES TO PRINT, A NEW ANNUAL FESTIVAL OF INDIGENOUS CULTURE – *CORROBOREE SYDNEY* – IS GETTING UNDERWAY, HERALDING A RESURGENT INTEREST IN AUSTRALIA'S FIRST PEOPLES.



‘Aboriginality isn’t necessarily about race – it’s more about culture.’ So says Laura McBride, the Australian Museum’s first Indigenous creative producer.

Laura and her team are working to create new ways of presenting Indigenous Australian culture to Museum audiences, both local and international.

‘*Corroboree Sydney* is a great start for some of the things we’d like to do’, Laura said. ‘It’s a new annual festival for everyone, Indigenous and non-Indigenous alike.’

NETWORKS

The festival was initiated by a group of Indigenous arts workers from some of Sydney’s cultural institutions who came together over the last three years to develop the event.

‘By partnering with other Sydney cultural institutions, we’ve been able to develop wider, more meaningful programs with new connections, right here in the area where colonisation began’, Laura said.

‘As a museum of natural history and culture, we needed to base our contribution around natural history. The whole philosophy is to relate what we do to living culture, to bring the objects alive.’

‘For example, we have a lot of woven objects in the Museum, and the Boorlang Nangamai weavers from Gerringong will be showing how the objects might have been made, baskets or hats, how they sourced the material, this is how you can weave, and so on. We call them our “grass-roots fibre network”!’

‘Another example is the cabinet of didgeridoos in the *Indigenous Australians* gallery. We’ll have a musician, Jahmarley Dawson, playing his didj and talking about how the sound’s created, how he learnt to play, its importance to him.’

‘It’s a personal story that visitors don’t get just from looking at object labels.’

Laura stressed that the festival is for Indigenous audiences too.

‘It shows how the spaces and objects that are kept here can be used to maintain and preserve culture.’

‘New South Wales has the highest Indigenous population in Australia and also the highest density (in Western Sydney). That’s why we wanted a festival like *Corroboree* right here in Sydney.’

‘We’re also planning to work on some of the social issues around Aboriginal people, who are overrepresented in the justice system. So, following on from the Museums’ successful Pacific Youth program, we want to bring Aboriginal kids [from the justice system] to the Museum to see what attracts them, to reconnect them with their cultures and maybe help them stay out of trouble.’

DIRECTIONS

‘We’re moving in a new direction, opening up the collection and using more of that for our programming.’

‘We need to have Indigenous culture programmed across the board, not just in NAIDOC and Reconciliation weeks,

which are mainly political events. And now we have *Corroboree Sydney*, which is all about our culture.’

‘That’s the direction we want to try and take across the whole Museum – to include an Indigenous perspective.’

‘The future for Indigenous culture at the Museum is looking really positive. The 70s and 80s were about self-determination, with a need to acknowledge a past that wasn’t recognised – it was denied.’

Attitudes began to change with Kevin Rudd’s apology to Australia’s Indigenous peoples in 2008.

‘Many people have come out of that period now and it isn’t about “this is what happened”; it’s “this is what we need to do to help make a change”.’

LAURA MCBRIDE CREATIVE PRODUCER,
SPOKE TO BRENDAN ATKINS

Corroboree Sydney is a partnership between the Australian Museum, Bangarra Dance Theatre, the City of Sydney, the Museum of Contemporary Art, Blackfella Films, Sydney Opera House, Royal Botanic Gardens, Koori Radio 93.7 FM, the State Library and the Art Gallery of NSW.

Above

A Common Pain (2013) by Karla Dickens. The artist created the work from a prayer book, echidna quills, snakeskin and raffia. It responds to her research with another Aboriginal artist,

Leanne Tobin, into the Native Institute, established in Blacktown in 1823 to ‘educate’ and ‘reform’ Aboriginal children as part of Australia’s assimilation agenda. Photo © Michael Shapter.

getting into **DEEP WATER**

MARINE ZOOLOGIST **TORBEN RIEHL** GRAPPLES WITH BIG SCIENTIFIC QUESTIONS AS HE EXPLORES THE OCEAN DEPTHS FROM THE DECK OF A RESEARCH VESSEL.

Torben Riehl aboard the German research vessel *Sonne* during the KuramBio cruise 2012. On the slopes of the Kuril-Kamchatka Trench in more than 6000 metres the sampling device has become entangled in a ghost net (lost and forgotten fishing nets). These not only hinder deep-sea exploration but threaten fauna such as whales and fish which become entangled and drown. Photo © N Brenke.





Left

The German research vessel *Meteor* seeking protection from a hurricane in the Westfjords of Iceland during the IceAGE expedition 2011. This ship is among Germany's most famous vessels, built in 1986, 100 metres long; up 10 kilometres cable length allows sampling in the greatest depths of the Atlantic Ocean. Photo © Torben Riehl.

Right

This scanning electron micrograph shows an adult male isopod, *Macrostylys papillata*, (length 1.3 mm) in the family Macrostyliidae. These deep-sea isopods have no eyes. The males bear a bunch of sensillae on the small antenna which they use to find females. Scanning electron micrograph by Sue Lindsay and Torben Riehl.

Aquatic environments have deeply fascinated me from a very young age, so I'm astounded to be able to study organisms from the abyssal zone of the deep ocean that no one has ever encountered before.

The group of animals I'm interested in are isopods – microscopic crustaceans related to the pill bugs and slaters found in your back yard.

I am conducting my PhD studies at the University of Hamburg in Germany, focusing on deep-sea fauna, its evolution and its links with shallow-water biota.

COLLECTING

Lured by the great scientific expertise and collections at the Australian Museum, I was lucky enough to receive funding from the Geddes Visiting Research Fellowship and the German National Academic Foundation to visit several times over the last three years.

The Museum's collection holds many samples, some collected decades ago, waiting for specialists to come along and study them. While these collections are important for my studies, I also need freshly collected specimens for the extraction of DNA. The genetic information is used to infer the evolutionary history of a species (closely related species have similar DNA) and check morphological results (to see whether differences in body form and shape can reliably distinguish one species from another).

Deep-sea isopods are less than one centimetre in length. They are best collected with ship-based gear such

as an epibenthic sledge, which is dragged just above the sea bed to collect whatever lives there. Research vessels need to be equipped with specialised winches that can reach the very deepest parts of the ocean, up to 11 kilometres below the surface. Very few ships can fulfil such requirements, but I have been lucky to collect new material on several German and Russian research vessels. Participating in such deep-sea voyages is a privilege that I sincerely enjoy.

CONNECTING

While at the Museum, I became interested in three species of isopod from the collection that had been independently collected over the last 40 years but remained unclassified because they were so different to anything else known.

I have been able to place these oddities into a new family that sheds light on the evolution of the more common deep-sea isopod families found in all the world's oceans. As with most deep-sea organisms, knowledge about their general behaviour and ecology is scarce.

Moreover, I am describing the first Australian representatives of a group of isopods known primarily from the deep but which, surprisingly, were collected from shallower waters off Western Australia.

Their phylogenies (family histories) will reveal whether their closest relatives are found in abyssal depths or shallow Antarctic waters. From this we will know whether current distributions date to a time before the continents separated, or whether they colonised the Australian shelf independently, from Antarctica.

DEEP KNOWLEDGE

Compared to our collective knowledge of terrestrial and freshwater ecosystems, we have only scratched the surface of the biodiversity hidden in the great ocean depths. It is not only new species that await our attention, but even higher-level taxa, such as genera and families, up to hundreds of millions of years old – and many of them extremely rare.

We can justifiably claim that remarkable discoveries will continue to be made that will pose profound challenges for current scientific concepts. Many of these will provide new insights about how life on our planet has evolved.

The Australian Museum has offered me a great working environment and I wish to acknowledge the wonderful opportunity of working with Dr Buz Wilson and other Museum staff.

I sincerely hope for a chance to return to continue working on the Museum's rich and unique collections and on Australia's fascinating fauna.

TORBEN RIEHL GEDDES VISITING RESEARCH FELLOW

Since 2010, the generous support of Kel and Anne Geddes has brought 21 researchers to the Museum to work across a diversity of disciplines, collections and projects.

Further reading

T Riehl, GDF Wilson & RR Hessler, 2012. New Macrostyliidae Hansen, 1916 (Crustacea: Isopoda) from the Gay Head-Bermuda transect with special consideration of sexual dimorphism. *Zootaxa*, 3277, 1–26.

The defining feature of a turtle is its shell. This bony or cartilaginous protection accounts for around 40 per cent of the body mass and may be the most efficient form of armour ever to appear in an animal. Turtles make up the order Testudines, a group of reptiles that has existed nearly unchanged for at least 210 million years. Fossil turtle records, rich with many well-preserved hard shells, have played a crucial role in the study of vertebrate evolution. One of the best-known types of fossil turtle is the horned turtle family (Meiolaniidae), a now-extinct group that lived in the Southern Hemisphere from 110 million to a few thousand years ago, spanning the Cretaceous to the Holocene periods.

The horned turtle genus *Meiolania* is known only from mainland Australia and Lord Howe Island, New Caledonia and other islands of the south-west Pacific region. The last relict populations on Lord Howe Island, New Caledonia, and Efate Island of Vanuatu survived until early human settlement occurred around 3000 years ago. Their bizarre appearance featured a hefty body, large horns and spikes sprouting from an unusually shaped skull, and a long tail with thorn-like spikes at the end. With a body length reaching 2.5 metres, *Meiolania* species are the second largest of the known non-marine turtles. Their general body shape suggests that they were terrestrial (mainly living in the rainforests) and herbivorous.

Meiolania platyceps, the type species of the genus, has been reported only from Lord Howe Island. The Australian Museum's earliest catalogued *Meiolania* fossil specimens were collected by palaeontologist Robert Etheridge Jnr in 1887 (Etheridge would later end up as Curator of the Museum, a position he held from 1895 to 1920). Through subsequent expeditions and extensive

THE MUSEUM'S NEW BOOK, *FEATHERS OF THE GODS*, TAKES YOU BEHIND THE SCENES TO MEET STAFF AND READ ABOUT THE MUSEUM'S TREASURES. HERE IS JUST A TASTE OF WHAT YOU'LL FIND.

CONFUSING HORNED TURTLE FOSSILS

collecting, the Museum now holds the world's largest collection of this species, represented by hundreds of well-preserved specimens, including nests of eggs, nearly complete skulls, shells and almost every part of the skeleton.

Some amusing stories behind the discovery and identification of *Meiolania* show how confused early British palaeontologists were as they endeavoured to identify the fossil remains found in Australia, and how easily a mistake could be made even by a world expert.

The first meiolaniid material collected in Australia was found in 1879 at King's Creek in the eastern Darling Downs area of Queensland and included a nearly complete skull of the horned turtle *Ninjemys oweni*. Like many vertebrate fossils discovered in 19th century Australia, the specimens were sent to Sir Richard Owen, one of the most eminent British palaeontologists of the time. In 1880 Owen grouped the turtle skull elements with the vertebrae of a large monitor lizard from the same area and various other sites in Queensland and Victoria under the name *Megalia prisca* and claimed them to be the remains of a 'gigantic land-lizard'.

Owen later even assigned the foot bones of a Diprotodon (a giant wombat-like marsupial) found in the Darling Downs area to *Megalia prisca*. In 1886 he named *Meiolania platyceps* based on the well-preserved material from Lord Howe Island, but he still considered both species to be lizards.

Two years later, Arthur Smith Woodward re-examined Owen's original material of *Megalia* and *Meiolania* housed at the British Museum and recognised the taxonomic confusions made by Owen. He then separated the meiolaniid material originally ascribed to *Megalia prisca* by Owen as a new species of *Meiolania* (*M. oweni*), which is now considered as the type species of a separate meiolaniid genus, *Ninjemys*.

DR YONG YI ZHEN TECHNICAL OFFICER, GEOSCIENCE

For further details about Feathers of the Gods, see review, page 2, and inside back cover.

A man with glasses, wearing a blue and white checkered button-down shirt and khaki pants, stands in a hallway. He is holding a large, light-colored fossilized skull with both hands in front of his chest. The hallway has a dark door in the background and a rack of black equipment on the left. The text "the scientists" is overlaid in a large, white, cursive font across the middle of the image.

the scientists

Yong Yi Zhen is holding a skull of the horned turtle *Meiolania platyceps*, a species that became extinct a few thousand years ago. Damaged after it was mistaken for a shoulder girdle during excavation, the skull is nicknamed 'Hole in the Head'. Photo by Stuart Humphreys.



TOURS

After our wonderful trip to the NSW Outback in August, we've decided to venture a little further afield this time, to take in the best of the Western Australian Pilbara and wildflowers. It's sure to be a real treat. We have also joined with our wine partner, Charles Sturt University Wines, and are taking a short sojourn to Orange as part of Food Week. We have thrown in some all-important astronomy and a museum visit too to keep the weekend full of fun and learning!

NIGHT TALKS: WE HEAR YOU!

After overwhelming demand we've changed the start time for Night Talks back to 6.30 pm. This gives everyone extra time to get here after their day's activities. Our Night Talk series this time ties in with the new *Tyrannosaurs: meet the family* exhibition and the topics cover the beginnings of the universe through to dinosaurs. We hope you can join us for this diverse program. Book the full series for a generous discount, and in the first of the series hear from the exhibition team, enjoy light refreshments and be among the first to see the exhibition.

From all of us here at the Museum, have a wonderful holiday period and summer!

SERENA TODD

Members Events Coordinator

Serena Todd's photo by Carl Bento.



Orange, New South Wales: FOOD, Wine, Stars

WHEN 4–6 April

Join us on this 3-day autumnal tour of the beautiful Orange Region to partake in the annual FOOD (Food of Orange District) festival. We'll begin with a special lecture by Nobel Laureate Brian Schmidt about his quest to find the meaning of life, then we're off to the Age of Fishes Museum in Canowindra, the famous 'Dish' in Parkes and more. Sip on fabulous wines from our partner CSU Winery and gaze at the stars with our special astronomy guest hosts.

For more information contact Marnie on 1300 729 183 or info@fredwatson.com.au

Blossoming Astronomy of Western Australia

WHEN 18–28 August

Explore breathtaking national parks, dramatic Pilbara landscapes and stunning coastlines as you travel from Perth to Port Hedland. This 11-day tour features the Pinnacles, Monkey Mia and the Kennedy Ranges and includes all main meals, accommodation and ground transport. Some time will also be spent on this tour in the company of Professor Fred Watson as he takes us on a journey exploring first-hand the hybrid science of astrobiology during the spectacular wildflower season.

For more information please call 1300 729 183 or email info@fredwatson.com.au



Scan this code to your mobile device to find all **Members travel**, or visit our website.

Above Join our special FOOD tour to the Orange district. Photo courtesy Justin Byrne, CSU Winery.

Night talk lecture series – deep time: earth, evolution and the dinosaurs

Enhance your experience of our new *Tyrannosaurs: meet the family* exhibition with these fascinating lectures from leading authorities.

TIME All lectures start promptly at 6.30 pm and finish by 7.45 pm, except Lecture 1 which includes exhibition viewing (from 5.15 pm) and drinks (from 6.30 pm), with lecture from 7 pm.

COST Single lecture (Lecture 1): Members \$35, non-Members \$50 (includes exhibition viewing and refreshments)
Single lecture (Lectures 2–8): Members \$20, non-Members \$30
Full Series (Lectures 1–8): Members \$155, non-Members \$245

BOOKING Phone 02 9320 6225 or visit australianmuseum.net.au/whatson

Lecture 1 Tyrannosaur tales: backstage at the best show in town

Glenn Ferguson and Bliss Jensen, Australian Museum

WHEN Wednesday 29 January

Meet the team behind the *Tyrannosaurs* exhibition and find out how an extraordinary show like this all comes together. On this special night, you'll also have the opportunity to view *Tyrannosaurs* after hours, enjoy a glass of wine and a nibble, and shop at our dedicated *Tyrannosaurs* store.

Lecture 2 The universe: the dark side

Dr Tamara Davis, University of Queensland

WHEN Wednesday 5 February

In recent times we've come to realise that the expanding universe is only part of the story. In fact, everything we thought we knew about matter accounts for just 5 per cent of the universe, with the rest composed of mysterious dark matter and dark energy. Seems ludicrous? Let Tamara Davis explain what we know and what we stand to learn in the search for explanations.

Lecture 3 Earth evolution: from go to now!

Dr Lin Sutherland, Australian Museum

WHEN Wednesday 12 February

Earth has experienced 4.6 billion years of constant change! Come and hear how core, mantle and surface events have added life and atmosphere, created continents and altered climates, leading to the geo-bio-diverse Earth that we depend on. Explore the history of the planet with Dr Lin Sutherland, and take this opportunity to see specimens from the Museum collection.

Lecture 4 Origin and early history of life on Earth

Professor Simon George, Macquarie University

WHEN Wednesday 26 February

Join Professor Simon George as he tackles the mysteries of how, when and where life began on Earth. He will take you through some of the earliest evidence, the first animals and how living organisms influenced the climate and ocean chemistry. Is it possible that there was once life on Mars too? Come along and hear an expert perspective on this ever-popular question.

Lecture 5 Spores, roots, shoots and leaves: how plants invaded then dominated dry land

Dr Peter Weston, Royal Botanic Gardens and Domain Trust

WHEN Wednesday 5 March

Dr Weston will talk us through the fascinating evolutionary history of land plants, from the first invaders to the highly diverse, more complex, and sometimes massive, flowering plants. What were the changes that gave some groups the evolutionary edge? And were they victims of their own success? Don't miss this salutary tale.

Lecture 6 Our deep, distant origins – how the human body plan was built from early fish evolution

Professor John Long, Flinders University

WHEN Wednesday 12 March

What does the early evolution of fishes tell us about modern-day vertebrates? For the past 26 years Professor Long has been collecting from the Gogo formation in northern Western Australia, including perfectly preserved three-dimensional fish fossils that ultimately reveal the stories of our own bodies. Don't miss this fascinating lecture from a global expert.

Lecture 7 Fierce creatures: tyrannosaurs and their meat-eating kin

Dr Anne Musser, Australian Museum

WHEN Wednesday 26 March

Meet the extended family as Dr Anne Musser takes you on a tour of the tyrannosaurs and other theropods. The group includes many weird and wonderful meat-eaters, from the bizarre, pot-bellied therizinosaurs to the bird-like alvarezsaur and the tiny, feathered *Microraptor*. Explore their world and new discoveries of theropods in Australia, including what may be the Southern Hemisphere's first tyrannosaur.

Lecture 8 Fate of the dinosaurs: a perfect storm

Dr Andrew Glikson, Australian National University

WHEN Wednesday 2 April

The discovery of the K-T boundary (a thin, distinctive layer found in geological sediments worldwide), and the realisation that it coincided with mass extinctions 65 million years ago, heralded a major shift in the long-running debate about the demise of the dinosaurs. Join Andrew Glikson as he presents the evidence for our theories of the events that wiped out so many, yet allowed others to survive.

adventurouswalks

TIME 9.30 am – 3.30 pm approximately

COST Members \$15, non-Members \$20

BOOKING Phone 02 9320 6225 or
australianmuseum.net.au/whatson

Navigating Northbridge

WHEN Wednesday 5 March

Discover Northbridge with walk leader Keith Robinson. Journey to Northbridge Plaza, Sailors Bay Road, the Aboriginal Heritage Centre, and much more. Visit Hallstrom Close, where Sir Edward Hallstrom once lived and even kept his very own small zoo!

The Mittagong Colliery Walk

WHEN Sunday 15 April

Explore the old Mittagong Colliery Walk in Box Vale with popular walk leader Ross Pearson OAM. Meander through caves, cuttings and old railway lines.

specialevents



Shopping weekend!

Once again Members can stock up at the Museum Shop and receive a special 20% discount, only from Saturday 30 November to Sunday 1 December, on all merchandise (including *Feathers of the Gods*!).

Friends around the Domain

WHEN Sunday 2 February

TIME From 8 am at the Art Gallery of NSW

VENUES Art Gallery, Royal Botanic Gardens, State Library, Sydney Living Museums, Lucy Osburn Nightingale Foundation Museum, John Passmore Museum of Art, Australian Museum

INFORMATION See individual venue websites

Be part of the inaugural Friends around the Domain event! Join members of Sydney's leading, and some lesser-known, cultural institutions to view exhibitions, listen to talks and visit special events – all in a special free day of discovery with like-minded culture lovers.

COST Members \$15, non-Members \$20

BOOKING Phone 02 9320 6225 or visit
australianmuseum.net.au/whatson

Above Photo by Jeremy Austen.



TYRANNOSNORE

WHEN Friday 7 February, Friday 21 February,
Friday 21 March, Friday 11 April

TIME 6.30 pm – 7.30 am

COST Members: adults \$120, children \$150
non-Members: \$140, children \$180

AGES 5–12 years

BOOKING Phone 02 9320 6225 or visit
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How would you like to spend the night sleeping in the brand new *Tyrannosaurs* exhibition at the Australian Museum?

Come to the Museum at night for a special pizza dinner, join in a fun *T. rex* craft activity, tour the Museum by torchlight, watch some DVDs with friends and then catch some zzz's in the *Tyrannosaurs* exhibition, surrounded by the dinosaurs!

Make sure you bring your camera to capture every moment of this larger-than-life experience.



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NEW BOOK! FEATHERS OF THE GODS AND OTHER TALES FROM THE AUSTRALIAN MUSEUM

Available only from the Museum Shop,
phone 02 9320 6150, email shop@austmus.gov.au

RRP \$50, Members price \$45.

Above

Dr Frank Talbot AM with specimen of Red Bass, *Lutjanus bohar*, from *Feathers of the Gods*. Photo by Stuart Humphreys.



Exhibition preparator Mike Smith assembles a cast model of *Albertosaurus* for the *Tyrannosaurs: meet the family* exhibition. Photo by Stuart Humphreys.

EXPLORE

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Email the Editor at explore@austmus.gov.au

Frank Howarth's photo by Carl Bento

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