SECONDARY

Teacher Resource and Curriculum links

Exhibition Producer and Tour Manager

MU SEA UM | AUSTRALIAN NATIONAL MARITIME MUSEUM

Queensland Museum Network Exhibition Partner

PROJECT DIG | BHP

Exhibition Development Partner

QUEENSLAND MUSEUM NETWORK

Queensland Government

Introducing the Exhibition

Sea Monsters: Prehistoric Ocean Predators was developed by the Australian National Maritime Museum in partnership with Queensland Museum.

The exhibition showcases the mighty ancient marine reptiles that hunted the oceans at the same time dinosaurs walked the land: these were the plesiosaurs, ichthyosaurs and mosasaurs.

Through a range of interpretative panels, life size models, fossils, and engaging interactive experiences you and your students will have a terrifyingly great time!

Key themes:

- **Palaeontology** – history, study of fossils, impact of technologies
- **Adaptations to life in the ocean** – movement, sensory information, reproduction, diet and salt excretion, camouflage
- **Ocean predators today** – extinct and extant (living) animal groups, convergent evolution, human impacts, conservation

Complementary messages:

- Our knowledge and understanding of ancient animals can change! Human eyes have never seen a living plesiosaur or dinosaur, so we interpret fossils for evidence of how they looked and behaved. New fossils and or new technologies may reveal additional information.
- The largest known animal to have ever lived, is the Blue Whale, *Balaenoptera musculus*.
- Marine reptiles which are alive today (extant as opposed to extinct groups) are the sea turtles, sea snakes, marine iguanas and crocodiles.
- It is scientifically incorrect to call ancient marine reptiles and flying reptiles “dinosaurs”. Dinosaurs are their own taxonomic group, evolving from separate common ancestors. You could think of dinosaurs as ‘ancient land reptiles’, occurring at the same time as other flying and swimming reptile groups.
- Megalodon is an extinct shark (fish) species, the largest that we know of so far. It lived approximately 23 to 3.6 million years ago, a long time after the ancient marine reptiles went extinct and before humans had evolved.

Stimulus Questions for students visiting the exhibition

How has the study of palaeontology changed from Mary Anning's time to today?

Compare and contrast (identify the similarities and differences) the three types of Mesozoic marine reptile groups: plesiosaurs, ichthyosaurs and mosasaurs.

How are these ancient animals similar to marine fauna alive today?

Describe some of the processes of locating, excavating and interpreting fossils.

What did the exhibition make you curious about (did anything make you think deeply, connect known/partly known information or want to find out more)?

Nominate some of your favourite animals (represented in the exhibition as fossils, fossil casts, or models) in the exhibition and explain why you chose them.



Meet the Curator:

Q & A with Dr Espen Knutsen

Dr Espen Knutsen is Senior Curator Palaeontology at the Queensland Museum Network, based at the Museum of Tropical Queensland campus in Townsville. His position is co-appointed with the College of Science and Engineering at James Cook University.

Espen is a vertebrate palaeontologist, who over the past 12 years has conducted pioneering fieldwork and excavations in Australia, the Arctic, The Netherlands and USA. He has described five new species of Jurassic marine reptiles, and was part of an international multidisciplinary research team studying a newly discovered Jurassic marine ecosystem from the High Arctic archipelago of Svalbard, Norway.

He has a special interest in the diversity, evolution and ecology of Mesozoic reptiles, such as ichthyosaurs, plesiosaurs and dinosaurs. Current projects, involving fieldwork throughout Australia for the Australian Mesozoic Tetrapod Project, aim to fill significant gaps in our knowledge and understanding of the Triassic, Jurassic and Cretaceous vertebrate fauna of the southern hemisphere.

Find out more about Espen's research including links and short videos, here.
https://www.qm.qld.gov.au/Research/People/People/Profile/K/Espen+Knutsen

What did you study to become a palaeontologist? Did you always want to be one?

I didn't always want to become a palaeontologist, but I was always interested in natural sciences. So when I started at university, I enrolled in topics I found interesting, such as biology, chemistry, physics and astronomy. Eventually I decided that I really liked the biology path, which led me to working on their long dead relatives. I also had to learn a whole lot of geology to understand what the different rock types fossils are found in can tell us about their death and the environment they lived in.

Where have you travelled for work? What was the most exciting place?

Working in palaeontology often allows you to work with colleagues in other places of the world. This has allowed me to dig for 250 million year-old lizard tracks in the Netherlands, for 70 million year-old dinosaurs in southern USA, 150 million year-old marine reptiles in the Arctic, and of course dinosaurs and marine reptiles here in Australia. All of these places are very different and exciting in their own way, but having to watch your back for polar bears in the Arctic takes things to another level!

How many species have you described so far in your career? Do you have a favourite?

Describing a new species is something that doesn't happen very often. A lot of the time palaeontologists spend time studying new fossils of species that we already know existed, but don't necessarily know very much about. Every now and then we find new fossil localities around the world that preserve whole new ecosystems. It is often at these places that new species are discovered. I was part of the discovery of such a place in the Arctic, where we found an incredible nine new species of marine reptiles (plesiosaurs and ichthyosaurs)! My favourites are the really long-necked plesiosaur varieties we found. Two-thirds of their body-length is only neck, with a tiny head right at the end.

What is something about being a palaeontologist that people might not know?

Even though when you see palaeontologists on TV they are often in the field digging for bones, most of our time is actually spent in the lab extracting bones from the rock, or in the office trying to unravel the stories fossils can tell us and planning next year's fieldwork.

What are you currently working on?

With nearly 3 billion years of history almost at our doorstep here in Queensland, I have the opportunity to work on a variety of things. Right now, most of my time is spent collecting and studying the remains of animals and plants from the Triassic (252-201 million years ago) and Jurassic (201-145 million years ago) periods here in Queensland. The Triassic fossils can teach us about what happens to ecosystems during and right after mass extinction events, such as the largest in Earth's history at the end of the Permian period 252 million years ago. The Jurassic fossils are also very important as there aren't many of these in all of Australia, and we therefore know very little about life on the continent during these 50 million years.

What kind of technologies are you working with?

A lot of new technologies have been made available to palaeontologists in the past two decades, including 3D scanning, which allows us to more easily document and analyse fossil specimens. X-rays and computed tomography (CT) allow us to not only look inside fossils, but also to digitally prepare fossils out of the rock using computer software. We can also look at the chemistry of fossil animals' bone and teeth to learn about what they ate, in what kind of habitat they lived, and what happened to them after they died and were buried in sand and mud.

What is your favourite part of the exhibition and why?

My favourite part of the Sea Monsters exhibition has to be the life-sized skeleton mounts. They are really imposing and show the true scale of these ancient creatures.
It is one thing seeing them digitally animated on a TV or reconstructions in a magazine, it is a completely different feeling seeing them up close like this.

What is the hardest thing about curating an exhibition like this?

The hardest thing about curating an exhibition is often to restrict the narrative to something that is achievable within the space you have available. Also, choosing which fossils to include takes a lot of time.

Why shouldn't we call ancient marine reptiles dinosaurs?

"Marine reptiles" is kind of a waste-basket term for any reptile, be it crocodile, turtle or plesiosaur, whose land-living ancestors over time evolved to live in the ocean. All these groups evolved from different ancestors and are therefore only distantly related, like humans and cats. Similarly, dinosaurs are just another group of reptiles, although as far as we know, none of these ever evolved to a life in the ocean. Pterosaurs are another group of reptiles, which also are not dinosaurs.

How does palaeontology help the world today?

Fossils are the only clues to the history of life on Earth, how it originated, evolved, went extinct, and recovered. As such, palaeontology can provide clues to the answers for many fundamental questions, such as where did we come from? What did the world look like in the past? What happens to ecosystems during a global crisis, such as global warming, and how do they recover? Answers to these questions are really important to give us humans a broader perspective on our own place in this world, and guide us to make decisions about the future of our planet and the life that depends on it.

Secondary and Senior Secondary Australian Curriculum Links

The exhibition contains excellent information on the external and internal structures and adaptations of ancient marine reptiles - how they moved, breathed, ate, reproduced, and sensed their environment; and how they are classified and scientifically named. The exhibition also supports *Science as a Human Endeavour* content by examining how palaeontology as a scientific discipline has changed over time and refers to the individual contributions of past and contemporary palaeontologists.

Secondary Science	
Strand: Science Understanding	
Sub-strand: Biological Sciences	
Year 7	Classification helps organise the diverse group of organisms (ACSSU111)
Year 10	The theory of evolution by natural selection explains the diversity of living things and is supported by a range of scientific evidence (ACSSU185)
Sub-strand: Earth and space sciences	
Year 9	The theory of plate tectonics explains global patterns of geological activity and continental movement (ACSSU180)
Strand: Science as a Human Endeavour	
Sub-strand: Nature and development of science	
Year 7-8	Scientific knowledge has changed peoples' understanding of the world and is refined as new evidence becomes available (ACSHE119) & (ACSHE134) Science knowledge can develop through collaboration across the disciplines of science and the contributions of people from a range of cultures (ACSHE223) & (ACSHE226)
Year 9-10	Scientific understanding, including models and theories, is contestable and is refined over time through a process of review by the scientific community (ACSHE157) & (ACSHE191) Advances in scientific understanding often rely on technological advances and are often linked to scientific discoveries (ACSHE158) & (ACSHE192)

Senior Secondary Science – Biology
Unit 1: Biodiversity and the interconnectedness of life
Strand: Science Understanding
Biodiversity includes the diversity of species and ecosystems; measures of biodiversity rely on classification and are used to make comparisons across spatial and temporal scales (ACSBL015)
Biological classification is hierarchical and based on different levels of similarity of physical features, methods of reproduction and molecular sequences (ACSBL016)
Biological classification systems reflect evolutionary relatedness between groups of organisms (ACSBL017)
Relationships and interactions between species in ecosystems include predation, competition, symbiosis and disease (ACSBL020)
Ecosystems can change dramatically over time; the fossil record and sedimentary rock characteristics provide evidence of past ecosystems and changes in biotic and abiotic components (ACSBL027)
Strand: Science as a Human Endeavour
Science is a global enterprise that relies on clear communication, international conventions, peer review and reproducibility (ACSBL008)
Development of complex models and/or theories often requires a wide range of evidence from multiple individuals and across disciplines (ACSBL009)

Senior Secondary Science – Earth and Environmental Science
Unit 1: Introduction to Earth systems
Strand: Science Understanding
The characteristics of past environments and communities (for example, presence of water, nature of the substrate, organism assemblages) can be inferred from the sequence and internal textures of sedimentary rocks and enclosed fossils (ACSES028)
The diversification and proliferation of living organisms over time (for example, increases in marine animals in the Cambrian), and the catastrophic collapse of ecosystems (for example, the mass extinction event at the end of the Cretaceous) can be inferred from the fossil record (ACSES029)
Strand: Science as a Human Endeavour
Science is a global enterprise that relies on clear communication, international conventions, peer review and reproducibility (ACSES008)
Development of complex models and/or theories often requires a wide range of evidence from multiple individuals and across disciplines (ACSES009)