

Dinosaurs in the Museum

The Museum has an impressive collection of dinosaurs, and the footprints that span the front lawn give the first time visitor an idea of what to expect on entry. Inside the building a spectacular display of dinosaurs includes four species from Oxfordshire, and dinosaurs from around the world.



The *Iguanodon* skeleton in the main court

The word dinosaur comes from the Greek *deinos* meaning 'terrible' and *sauros*, 'lizard'. Dinosaurs dominated life on land during the Mesozoic Era, more commonly known as the 'age of reptiles', 250-65 million years ago. A number of theories have been put forward to explain their extinction.

What is a dinosaur?

On first entering the Museum you are struck by the sight of the *Iguanodon* and *Tyrannosaurus* towering over you; most people recognise these as dinosaurs, but can get confused identifying other specimens.

Two simple facts will help you. Dinosaurs were reptiles that lived on land; they did not fly like the pterosaurs, or swim like the plesiosaurs and ichthyosaurs. Their legs were held directly underneath them; other reptiles, like crocodiles and lizards, walk with their legs held to the side of their body. Remember these facts when you visit the Museum and you shouldn't have any problems identifying a specimen again!

Dinosaur discoveries

Dinosaur bones have probably been found for millennia, but it was not until 1842 that the term 'dinosaur' was first coined. Oxford has played a major role in the history of dinosaur discoveries.

Prior to the 1800s scientists struggled to interpret early findings of large bones that were occasionally dug from quarries.



Early sketch of part of a *Megalosaurus* leg bone

In 1677 Robert Plot wondered if a bone, now recognised to be from a dinosaur, could have been evidence of an elephant brought to Britain by the Romans, but finally concluded it was the petrified bone of a giant!

The first dinosaur to be described and named was presented in 1824 as the '*Megalosaurus* or great Fossil Lizard of Stonesfield'. The author of the scientific paper was William Buckland, professor of Geology at Oxford. The bones he described came from the nearby village of Stonesfield, and most of these are on display in the Museum today.

Richard Owen invented the word 'dinosaur' in 1842. Owen was a distinguished professor of anatomy and based his new grouping on the shared features of the large land-living reptiles *Megalosaurus*, *Iguanodon* and *Hylaeosaurus*. He saw that they shared certain features (including hollow limb bones, and five fused vertebrae where the spine fastens to the pelvis) and recognised that they were more than just the overgrown lizards others had seen them to be.

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The dinosaur footprints

A sixty-metre long reconstruction of the trackway of the giant carnivorous dinosaur *Megalosaurus* is now permanently installed on the lawn in front of the Museum.

In the spring of 1997, Christopher Jackson, a Birmingham school teacher, learnt of the presence of dinosaur footprints on the floor of an old limestone quarry at Ardley, 20 kilometres northeast of the Museum. He contacted the Department of Earth Sciences in Oxford, and as a result, staff of the Department and the Museum described the site, casting parts of the better-preserved trackways. Between thirty and forty trackways are present and some are up to 200 m long.

In the field

Technicians from the Museum cast one of the better preserved trackways in the limestone floor of Ardley. The site exposes 168 million year old limestones, formed at a time when Britain lay in the tropics.



The footprint bed records a brief episode when this part of Oxfordshire was an area of mudflats, fringing a shallow-water area of sea and lagoons that extended north and west into what are now the Cotswolds. Two sorts of trackway are present, and these can be tentatively linked to the skeletal remains of dinosaurs known from the Jurassic rocks of Oxfordshire since the seventeenth century.



Working in the field

A technician from the Museum casts one of the three-toed *Megalosaurus* footprints at Ardley. All of the footprints were carefully cleaned and mapped; the best were cast in the field and brought back to the Museum.

What made the footprints?

The bipedal carnivorous dinosaur *Megalosaurus* probably produced the three-toed footprints. The prints are up to 80 cm long, 65 cm wide, and 2 metres apart, and in some, impressions of claws are preserved. Calculations based on stride length show that the *Megalosaurus* was moving at about 2 miles per hour, though one section shows a speedy 20 mph.

Installing the footprints on the Museum lawn

A 60 metre long trackway, made up of casts of the footprints of the giant carnivorous dinosaur *Megalosaurus* is displayed on the lawn in front of the Museum.



The 15 m long herbivorous dinosaur *Cetiosaurus*, probably made the second sort of trackway. It walked on all fours like the more familiar 'brontosaurus'. Where distinct, the front footprints are up to 40 cm long and kidney-shaped; those of the rear feet are larger, semicircular and up to 60 cm across. The great weight of the animals is indicated by the ridges of mud (now transformed into limestone), which form a rim at the front of the footprints. Again, calculations show that the animals were moving at less than 2 mph.

What is 'Learning more'?

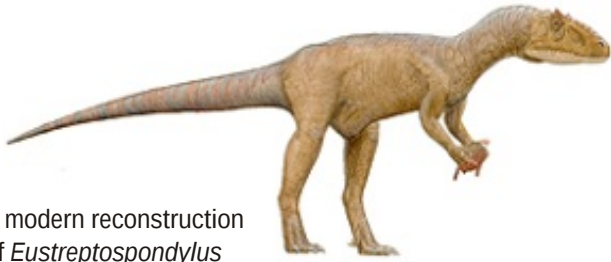
'Learning more' presents a series of articles about the Museum and its collections. It is designed for older students, teachers, researchers, and anyone who wants to find out more about particular aspects of the Museum's work and its history.

This article introduces the dinosaurs on display in the Museum, explaining what a dinosaur actually is, and giving a brief history of dinosaurs as a group.

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Eustreptospondylus oxoniensis

The skeleton of *Eustreptospondylus* on display in the main court is the most complete example of its kind anywhere in Europe, and was found just up the road from the Museum.



A modern reconstruction of *Eustreptospondylus*

The skeleton of *Eustreptospondylus* was found in the 155 million year old Oxford Clay. Like *Megalosaurus* and *Tyrannosaurus rex*, it is a typical theropod dinosaur; a carnivore, it walked on its hind legs, with a large head armed with sharp blade-like teeth, a short neck, reduced forelimbs, and a long tail to balance its body. The skeleton on display is that of an immature animal, about four and a half metres long. It is the most complete example of a 'carnosaur' in Western Europe, and the only specimen of the species.

The discovery of a dinosaur

In 1871, workmen in a brickpit in North Oxford discovered the skeleton of a dinosaur. It was acquired by an amateur geologist, given to the University, and described by John Phillips, the first curator of the Museum; it is now named *Eustreptospondylus oxoniensis*.



Workmen in the brickpit where the skeleton was found.

The history of the display

For the first time *Eustreptospondylus* has been mounted in a life-like pose, walking as it would have done, on its two hind legs with its tail held aloft. Previously it could be seen sitting like a kangaroo with its tail pressed to the ground, as the *Iguanodon* skeleton of the main court does today. Modern scientific thinking indicates that neither species of dinosaur could possibly have stood in that way.



The *Eustreptospondylus* as it appeared in the 1930s (left); fitting together the same skeleton in today's display (right).



Also displayed is the life-size reconstruction of an adult that figured prominently in the BBC series *Walking with Dinosaurs*.

The Oxfordshire dinosaurs

The dinosaur displays in the Museum include four species from Oxfordshire, and two of these, *Eustreptospondylus* and *Camptosaurus*, are that great rarity in geology - complete skeletons. The bones of *Megalosaurus*, the first dinosaur ever described, and the giant herbivore, *Cetiosaurus*, are also on show.

Camptosaurus prestwichii

The brickpits of the 1870s were very productive, and in 1879 another skeleton was unearthed - this time in Cumnor Hurst, five kilometres south west of Oxford.



A modern reconstruction of *Camptosaurus*

The skeleton of *Camptosaurus* was found in the 143 million year old Upper Jurassic Kimmeridge Clay and is the most complete skeleton of a camptosaur from Europe. Camptosaurs have a strong bony wrist and would probably have walked on all fours, but could also have raised themselves on their hind legs to browse on leaves and twigs. Their serrated teeth were well adapted for processing plant material, and were continually shed and replaced by newly erupted teeth throughout the animal's life.

Why is the Oxford specimen so special?

The Oxford specimen is the most complete member of the genus known from Europe, and is the earliest known representative of the large-bodied, quadrupedal, sometimes bipedal, herbivorous dinosaurs later represented by the iguanodontids.



The skeleton represents an individual about 3.5 metres long; the incomplete fusion of its vertebrae and skull, giving it its 'flexibility', suggest that it could be a juvenile.

Discovering *Camptosaurus*

The skeleton of *Camptosaurus* was discovered in 1879 by workmen in a brickpit on Cumnor Hurst. The bones were dug out and cast aside, until a workman took a bag of them to George Rolleston, the Professor of Anatomy and Physiology at Oxford. Recognising their importance, he secured them for the University.

Joseph Prestwich
Professor of Geology at
Oxford, who announced the
discovery of the dinosaur
that bears his name.



Naming a dinosaur

Camptosaurus prestwichii gets its name from the Greek *kamptos* meaning 'flexible', and *sauros*, 'lizard'; the 'flexibility' came from the incomplete fusion of its vertebrae and skull, and suggest it could have been a juvenile. Its species name, *prestwichii*, was given for Joseph Prestwich, a professor of geology at Oxford.



Vertebrae of *Camptosaurus*

A lithograph from the original description of this dinosaur showing its vertebrae (left), and the actual specimens held at the Museum (right).



Other specimens in the collection include the toe-bones (left), jaw (right) and bones which make up an almost complete skeleton.

Megalosaurus bucklandi

The first described dinosaur, A modern reconstruction of *Megalosaurus*

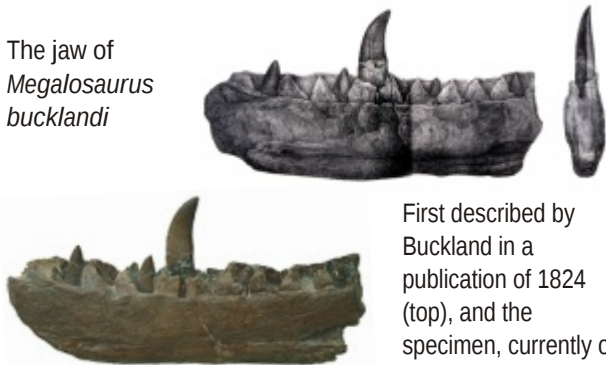
from anywhere in the world, was found in Oxfordshire.

It was a nine metre long carnivore that stood on its hind legs; we now call it *Megalosaurus bucklandi*, or 'Buckland's giant-lizard', and its remains are now on display in the central aisle of the main court.



When William Buckland acquired some bones from Stonesfield, north west of Oxford, he was unsure of their significance. However, with the end of the Napoleonic Wars, contact between English and French scientists was renewed, and in 1818 the great French comparative anatomist Georges Cuvier visited Oxford.

The jaw of *Megalosaurus bucklandi*



First described by Buckland in a publication of 1824 (top), and the specimen, currently on display (below).

Cuvier examined the Stonesfield bones and realised that they belonged to a giant animal resembling a lizard. Following Cuvier's visit, Buckland started describing the fossils in earnest, and he published an account of them in 1824.

William Buckland

Buckland was a man of enormous energy, being both a member of the clergy and a brilliant scientist. His account of *Megalosaurus* bones from Stonesfield in Oxfordshire was the first scientific description of a dinosaur.



Misconceptions

The first published record of a dinosaur bone was in Dr Robert Plot's 1677 book *The Natural History of Oxfordshire*.

Recognisable today as part of a single thigh bone of *Megalosaurus*, Plot wondered if it could have come from an elephant brought to Britain by the Romans, but concluded it was the petrified bone of a giant.



An early reconstruction of *Megalosaurus* on display (above), and in the grounds of Crystal Palace at Sydenham in Kent (right); we now know it as a bipedal dinosaur, similar to *T. rex*.



The display in the main court

The *Megalosaurus* display includes most of the specimens from Buckland's description. A complete skeleton has never been found, but comparison of the bones with those of better known dinosaurs such as *Allosaurus* from North America suggests that *Megalosaurus* was a typical bipedal carnivore, seven or eight metres long and probably weighing around a tonne.



The *Megalosaurus* display

The display includes most of the specimens from 1824 - lower jaw with teeth, sacrum and two other vertebrae, pelvic bones and femur - as well as important later material - upper jaw with teeth and tibia.

Cetiosaurus oxoniensis

Cetiosaurus was a herbivorous dinosaur with a long neck and tail, and four massive legs; it is estimated that it reached lengths of 15-25 metres. The Museum houses limb bones and vertebrae of this giant, which were collected in the 1860s near Oxford.



In 1935 a life-size paper model of *Cetiosaurus* was installed on the Museum lawn. It was a prop for the lecture on 'Prehistoric monsters' given as part of the Christmas lecture series. Modern reconstructions look quite similar to this model.

In the 1860s a series of bones were discovered in 163 million year old limestone in quarries near Bletchington Station, just north of Oxford. The huge bones in this collection probably belonged to several individuals, some of them juveniles. To date no skull has been found, but a few teeth that are thought to belong to this species have been discovered.

How did this dinosaur live?

Cetiosaurus was a typical sauropod dinosaur, with a small head on a long neck, a long tail, and elephant-like limbs. Footprints and tracks show that sauropods lived in herds. Although they usually walked very slowly, they could probably reach a speed of around 15 km per hour.



Scientists once thought that large dinosaurs like *Cetiosaurus* would not have been able to support their bodies on land, and believed that they must have spent their lives in water. Evidence from trackways like those in Ardley (left) show that they were quite capable of life on land.

Discovering a dinosaur

Most of the specimens on display were found in the 1860s by Mr Chapman, a watchmaker who 'discovered and rescued the monster *Cetiosaurus* at [Enslow Bridge]. He was on a botanising expedition with his son, and had just got off the train as the first fragment was disclosed by the pickaxe. He found the foreman, stopped the digging, and telegraphed to John Phillips, Professor of Geology and the first Curator of the University Museum, who super-intended the removal of the enormous bones to the Museum. The credit went to Phillips, no one remembered Chapman'.

Bones of *Cetiosaurus* have also been found at Woodeaton a few miles north east of Oxford as recently as the 1980s.

Cetiosaurus at the Museum

The bones of *Cetiosaurus* have been on display since their discovery. Like all the major dinosaur exhibits they have undergone many facelifts as new scientific discoveries change our views on the life of the dinosaurs.

The *Cetiosaurus* display

On display in the 1800s (right) and today (below). When the specimens were redisplayed in the summer of 2000, it took two men to manoeuvre the huge leg bones into place.



Other dinosaurs in the Museum

The dinosaur displays include species other than those found in Oxfordshire. They include *Iguanodon bernissartensis*, and the *Tyrannosaurus rex* of the central aisle of the Museum, and many other species in the geology section of the court.

Triceratops horridus

The name *Triceratops* means three-horned face, referring to the one small and two large horns on the skull, which can be seen on the cast on display in the Museum.

A modern reconstruction
of *Triceratops*



Triceratops was 7.3 metres long, and weighed more than 6 tonnes. It was a herbivore, and its jaws were equipped with a constantly replaced battery of teeth specially adapted for cutting up tough plant material.

Why did *Triceratops* have horns?

The horn and frill of *Triceratops* have attracted much speculation, but it is likely that they were used for display and fighting to maintain social dominance, and to defend territory and mates. Functional analysis suggests that *Triceratops* locked horns in pushing and twisting fights between individuals, the massive frill at the back of the skull acting as a shield to deflect the horns of opponents and protect the vulnerable neck and shoulder muscles.



The Museum has a cast of a skull of *Triceratops horridus* from the 65 million year old Upper Cretaceous Hell Creek Formation of Harding County, South Dakota, USA.

Edmontosaurus annectens

The Museum has a cast of a skeleton of *Edmontosaurus annectens*, the duck-billed dinosaur.

A modern reconstruction
of *Edmontosaurus*



Edmontosaurus belongs to the group of herbivorous dinosaurs known as the duck-bills, because of their distinctive toothless, beak-like snout. The teeth and jointed skull of the animal show that it had evolved a complex grinding mechanism that allowed it to chew plant material efficiently prior to swallowing.

The life of *Edmontosaurus*

The original skeleton came from a bone bed containing thousands of skeletons and remains of the same species. The duck-bills were social animals, migrating in vast herds along the western shore of the great seaway that extended from the North Slope of Alaska to Mexico during the late Cretaceous. Bones of *Edmontosaurus* have been found in droppings of *Tyrannosaurus rex*, which probably followed the migrating herds, feeding on the young, weak, dying and dead.

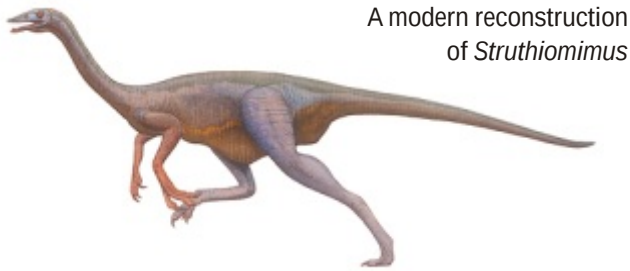


The duck-billed dinosaur

The Museum has a cast of a skeleton of *Edmontosaurus annectens* from the 65 million year old Upper Cretaceous Hell Creek Formation of Harding County, South Dakota, USA.

Struthiomimus sedens

The Museum has a cast of a skeleton of *Struthiomimus sedens* from the 65 million year old Lance Formation of Wyoming, USA. Its name means 'ostrich-mimic', and it shares some adaptive features in common with the ostrich and other large flightless birds.



A modern reconstruction
of *Struthiomimus*

Struthiomimus was a lightly built, agile dinosaur. Like the ostrich, it could run very fast, and some calculations suggest it would have reached speeds of up to 50 kilometres an hour - even faster than Usain Bolt running the Olympic 100 metres!

There is confusing evidence concerning *Struthiomimus*' diet. It lacked teeth, and one specimen was found with gizzard stones, which were used to grind food, and suggest a plant diet; however, the sharp claws on its hands may have been used to catch and hold prey, or were perhaps used to strip tender shoots and fruit from bushes and low trees.

Bambiraptor feinbergum

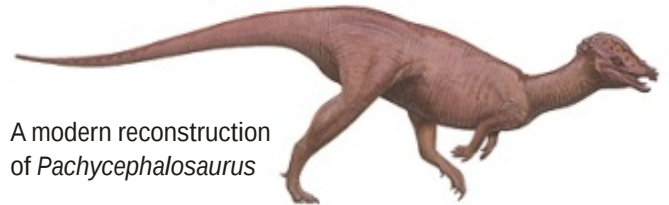
Bambiraptor is a theropod, and a member of the same dinosaur group as *Tyrannosaurus rex*. The adult animal would have been about the size of a turkey and is similar to the more familiar *Velociraptor*. A comparison with the head of *T. rex* that is also on display, illustrates the huge size range of the theropods.



A modern reconstruction of *Bambiraptor feinbergum*, previously known as *Velociraptor feinbergi*

Pachycephalosaurus wyomingensis

The Museum has a cast of a skull of *Pachycephalosaurus wyomingensis*, the 'thick-headed lizard'.



A modern reconstruction
of *Pachycephalosaurus*

These animals were bipedal. They grew up to 4.6 metres long, and probably fed on a mixed diet of leaves, seeds, fruits, and insects. Their most distinctive feature is the massive domed braincase with a row of bony knobs at the rear, and a short, spiky snout.

The massively reinforced skull suggests that *Pachycephalosaurus* was goat-like, and fought with 'battering-ram' collisions to establish mating rights and social dominance. This interpretation is supported by the structure of the vertebrae, which are designed to interlock and dissipate the shock of head-to-head impacts.

The specimen in the Museum

The Museum has a cast of a specimen of *Pachycephalosaurus wyomingensis* from the 65 million year old Upper Cretaceous Lance Formation of Wyoming, USA.



The cast of the skull of *Pachycephalosaurus*

The reinforced skull of the animal probably provided it with the necessary armour to fight in 'head-to-head' combat.

Utahraptor ostrommaysorum

The Museum has a reconstruction of *Utahraptor ostrommaysorum* based on partial skeletal remains found in Utah, USA.



A modern reconstruction of *Utahraptor*

Utahraptor was a close relative of the famous 'raptors' (properly called dromaeosaurs) such as *Deinonychus* and *Velociraptor*. Its hind foot was equipped with a large, retractable slashing claw. This was the main weapon of attack and would have been employed to deliver powerful kicks to the belly of unfortunate prey animals, quickly disembowelling them.

Utahraptor in the movies

The discovery of *Utahraptor* coincided with the period during which the movie 'Jurassic Park' was filmed. Scientists were concerned that the *Velociraptor* models used in the film had been made too large, but *Utahraptor* provided evidence of raptors reaching the required 'cinematic' size.



The Museum has a reconstruction of *Utahraptor* based on partial skeletal remains from the 125 million year old Yellow Cap Member of the Cedar Mountain Formation, Utah, USA.

Iguanodon bernissartensis

As you enter the Museum you are greeted by the sight of a cast of a huge *Iguanodon* skeleton towering over the court.

A modern reconstruction of *Iguanodon*



In 1878 a group of thirty or so fully articulated dinosaur skeletons were found in a coal mine at Bernissart, Belgium. They were the most complete finds of their kind, and confirmed the new ideas emerging about dinosaurs, which were beginning to replace the prevailing view that dinosaurs were rhinoceros-like creatures. The Museum's *Iguanodon* is a cast of one of these specimens.

The *Iguanodon* skeleton

Although exhibited in a kangaroo-like posture, this stance is incorrect, and based on early ideas of how *Iguanodon* lived; looking closely you can see that its tail has actually been broken to pose it in this way. In fact, its strong hind limbs suggest it normally walked on two legs with its tail held aloft.



*Iguanodon*s appeared in late Jurassic times and persisted until the end of the Cretaceous. *Iguanodon bernissartensis* lived about 115 million years ago, when the group was flourishing. It fed on plant material which it cropped with its horny beak and minced with a long battery of cheek teeth.

Other specimens in the Museum

The Museum also has a cast of the skull, and a reconstruction of the head of an original specimen from Belgium. The skull is exhibited in its true colour, black, and not the sandy colour of the skeleton in the central aisle of the Museum.



A reconstruction of the head of *Iguanodon*

Last but not least...

Tyrannosaurus rex

It was one of the largest carnivorous animals to have walked the earth, and a cast of a complete skeleton of *T. rex* is on display in the central aisle of the court.



A modern reconstruction of *T. rex*

T. rex is probably the most famous of all the dinosaurs. It was a theropod, and is known from about 20 specimens from the Upper Cretaceous of the North Western Interior of the USA. Its name comes from the Greek *tyrannos*, meaning 'tyrant', *sauros*, or 'lizard', and the Latin *rex*, 'king'; so, tyrant lizard king.



A cast of the skeleton of 'Stan', an adult *T. rex* in the central aisle of the main court. The skeleton was found in the 65 million year old Hell Creek Formation, South Dakota, USA. The skeleton shows signs of repaired wounds to both the limbs and head, the result of fights with other dinosaurs, in all probability, other *T. rex*.

The animal was up to 12 metres long, 4 metres high at the hip and weighed more than 6 tonnes. It had a skull up to 1.5 metres long, containing teeth, some up to 30 cm long. It walked on its large back legs and its small forearms were probably used to grasp prey. Its large, forward-directed eyes indicate that *T. rex* probably had three-dimensional vision.

A reconstruction of *T. rex*



The models of *T. rex* and *Utahraptor* on display are based on real skeletal remains, but details like their colour can never be confirmed.

Other prehistoric reptiles in the Museum

Dinosaurs may be the most famous animals from the 'age of reptiles', but the Museum also has displays of the other reptiles that lived during the Mesozoic.



Ophthalmosaurus

Model of a juvenile ichthyosaurus. This species was one of many 'dolphin-like' reptiles that once dominated Jurassic seas.

The southern area of the main court is devoted to the geological collections of the Museum; exhibits include casts and models of the dinosaurs described here, and four cases devoted to ichthyosaurs, plesiosaurs, pterosaurs and crocodiles. Although perhaps less famous, these animals dominated the seas and skies of the prehistoric world.



Tapejara

Model of the head of *Tapejara*, one of the Lower Cretaceous pterosaurs that flew in prehistoric skies. This model is one of several in the Museum that was featured in the BBC series *Walking with Dinosaurs*.



The southern area of the main court (left) where much of the Museum's dinosaur collection is exhibited, including the cast of *Struthiomimus* (right). The cases containing other Mesozoic reptiles are also in this area.