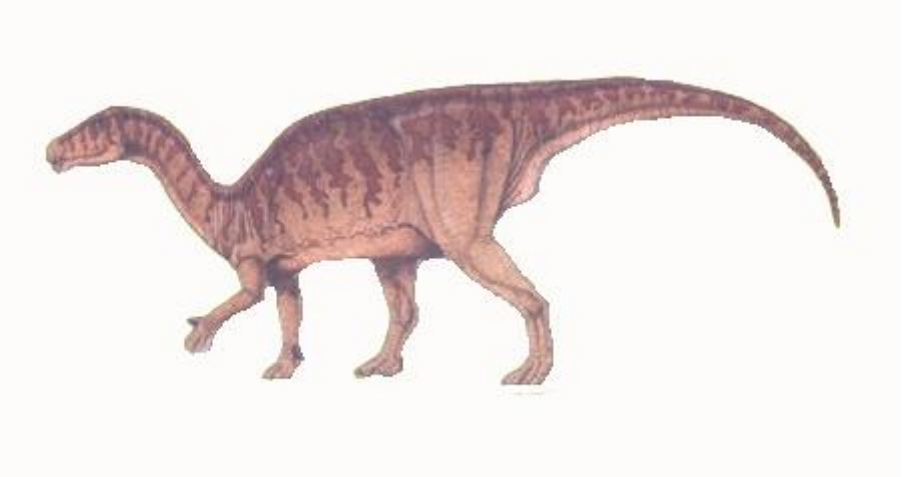
DINOSAUR BOOKLET No. 2

Iguanodon bernissartensis and *Mantellisaurus atherfieldensis*



Description

Iguanodon (pronounced 'Ig-wan-oh-don') was one of the first dinosaurs to be named. The name is derived from 'Iguana' - a type of modern reptile, and 'don' meaning tooth.

Iguanodon is the name of a small group of dinosaurs within the much larger group called Iguanodontids; they were large herbivores, with a long tail for balance, and hind legs that were longer than their fore limbs. There were three large hooved toes on each foot, and four fingers and a thumb spike on each hand. The mouth had a battery of chewing teeth, and a boney beak in place of front teeth. Since its initial discovery in the early nineteenth century, and more detailed reconstructions after complete skeletons were found in a Belgian mine in 1878, we have been forced to re-evaluate its posture, shape and movement; and to look again at how it fits in with other members of the Iguanodontids. Fossil remains from the group show they existed from the late Jurassic through to the late Cretaceous.

Here on the Isle of Wight it was once thought there were two basic species of Iguanodon; a larger form called *Iguanodon bernissartensis*, and a more graceful species called *Iguanodon atherfieldensis*. The first was named after the Belgian town where complete skeletons were found (Bernissart) and the latter from Atherfield on the south west coast of the Isle of Wight. However

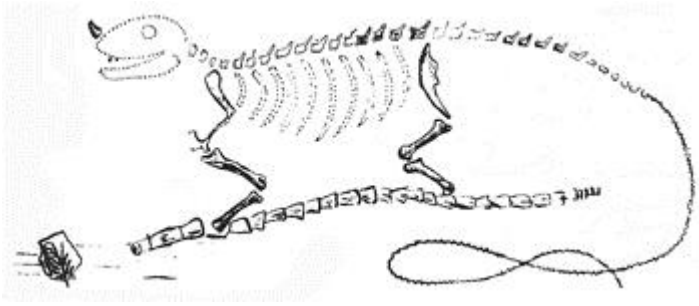
more recently palaeontologist Gregory Paul has moved our smaller variety to a new genera, leaving us with only one Iguanodon but a new genera of Iguanodontid called *Mantellisaurus atherfieldensis* (named after Gideon Mantell) in its place. It was initially very difficult to identify, name and group these animals from the fragmentary information that was first available in the Victorian era. As a result a number of species names have now been discarded.

Discovery

The bones of Iguanodontid dinosaurs are amongst the most common to be found today on the Island. They may have been picked up as curiosities by local people, who worked along the coastline, for many centuries. Iguanodon was the first dinosaur to be named on the Isle of Wight.

William Smith had found isolated Iguanodon bones in a quarry at Cuckfield in Sussex during 1809, and now it is believed that Dean William Buckland had also discovered Iguanodon remains on the Island prior to 1822.

In the early 1800's Gideon Mantell had also acquired some Iguanodon teeth from Cuckfield (although there is some debate about how they came to him). William Conybeare advised using the name 'Iguanodon' after their similarity to modern Iguana teeth, and so Mantell published this in 1825. This made Iguanodon the second dinosaur to be named (after Megalosaurus).



In 1834 a significant amount of Iguanodontid material was found in a quarry near Maidstone in Kent, and this was purchased for Mantell. His subsequent reconstruction of the partial skeleton showed the creature perched on a tree branch, with its thumb spike on its nose. Today we believe the skeleton to be an example of a gracile form which has been renamed *Mantellisaurus atherfieldensis*.

Thus began a series of attempts to reconstruct the fleshed creature and establish its normal posture.

Mantell's original concept of a lightweight tree-climbing creature was changed in 1841 when the eminent scientist Sir Richard Owen explained his idea of Iguanodon as a heavy creature - with a head similar to that of a crocodile attached to a body like a scaly elephant or rhinoceros, all supported on short, heavy legs with big claws. This interpretation was re-inforced in the Great Exhibition at Crystal Palace during 1853-4 when sculptor Benjamin Waterhouse Hawkins built two large Iguanodon models under Owen's guidance. The thumb spike can still be seen mounted on its nose.

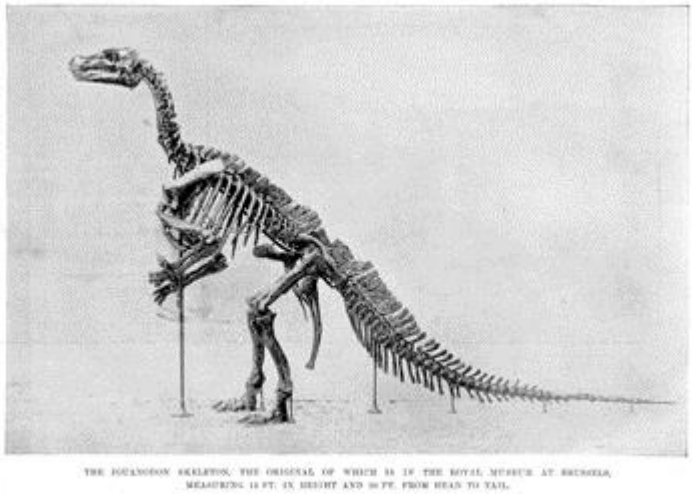
The first criticisms that this heavy posture may not be correct were voiced by American palaeontologist Joseph Leidy in 1858 when working on a similar creature called Hadrosaurus. He believed the front limbs were too short to support an animal walking on all fours; as was the case with the limb bones from Iguanodon.

Ten years later in 1868 Hawkins had been invited to New York to recreate the Great Exhibition display in Central Park. His reconstruction of the dinosaur was still firmly based on the older posture; and drawings of his lab show a fleshed dinosaur model sitting in a pose similar to that of a deer he had placed nearby. This practice of basing reconstructions on modern animals was to continue some years later.

The breakthough came in 1878 when a large number of near-complete, and articulated Iguanodon skeletons were found by miners excavating near Bernissart in southern Belgium. One of the first problems could now be resolved. The unusual spike found in the scattered bones of the English dinosaurs, and mistakenly placed on their noses was found to be part of the hand. The remains from the mine were originally laid on their sides, and many of the bones were in a poor state. Thus began the next attempt to stand the skeletons up and see what they would have looked like when the animals were alive.

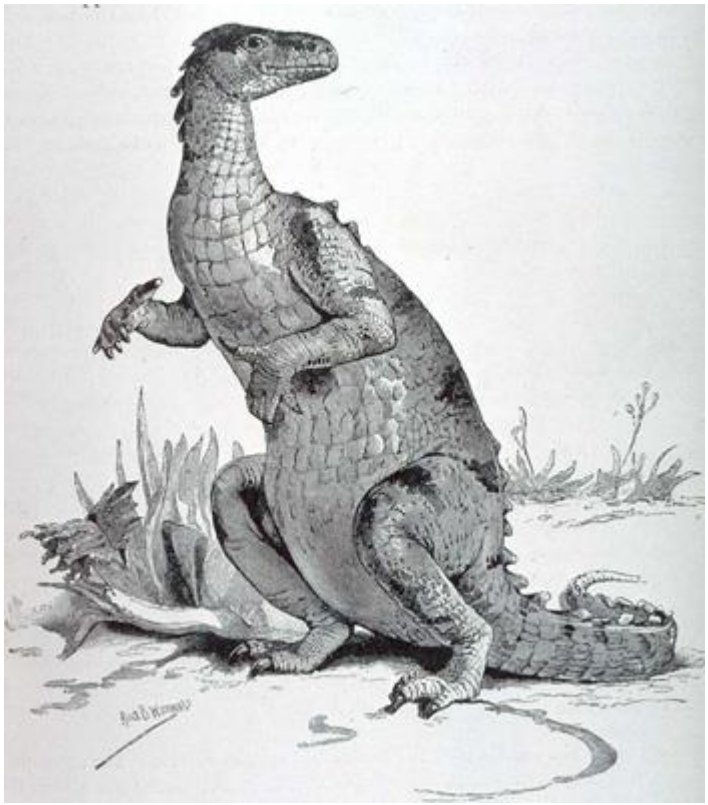
Shortly after, the palaeontologist Louis Dollo began his work on determining the form.

The specimens from Belgium were good enough to formally describe a new species, and *Iguanodon bernissartenis* was named by Boulenger in 1881 ('bernissartensis' means 'from Bernissart').



THE IGUANODON SKELETON, THE ORIGINAL OF WHICH IS IN THE ROYAL MUSEUM AT BRUSSELS, MEASURING 15 FT. IN HEIGHT AND 30 FT. FROM HEAD TO TAIL.

By 1883 Louis Dollo had discarded a number of provisional postures (some based on large birds). With a mounted kangaroo skeleton for reference he recreated a skeleton for the Institut Royal des Sciences Naturelles de Belgique in Brussels.



In 1895 Alice Woodward drew a fleshed Iguanodon based on Dollo's mounted skeleton. This pose remained in vogue for decades, inspiring the postures of Tyrannosaurus rex, Allosaurus and 'Godzilla' in various B-movies of the 20th Century.

Later research was to show that the fossil bones in the tail had been broken to allow the reconstructed skeleton to sit up. In reality the animal's tail would not have been able to flex in this manner and it is now obvious that the reconstructed skeleton created by Dollo was made to fit the idea of a kangaroo rather than following the anatomical evidence preserved in the articulated remains from the mine.

During 1917 Reginald Hooley discovered a partial skeleton of an Iguanodon at Atherfield on the Isle of Wight. His subsequent research enabled him to determine that this skeleton was different from the other more robust forms found on the Island and in Belgium (it is lighter and smaller - more 'gracile'). He named it *Iguanodon atherfieldensis* in 1925 (in this case 'atherfieldensis' means 'from Atherfield').

A number of new bones continued to be found over the following decades, including much of a large *Iguanodon bernissartensis* (MIWG.5126) we call 'Pink Iggy'; found in 1976 by Steve Hutt. The fossil bones have a pink colouration due to the minerals in the rocks they were excavated from.

Research in the last few decades, supported by the use of computer graphics, biodynamics and a greater understanding of the articulation of the joint surfaces has enabled us to determine that these large dinosaurs walked with their spines almost horizontally and their tails held out behind them for balance. Thus the posture has changed again. Debate continues as to whether they were able to walk on all fours; the evidence on the Island supports walking on their hind legs for much of the time because most of the preserved footcasts are tridactyl from the hind feet.

In 2006 Gregory Paul suggested that the smaller of the two Iguanodons was different enough to justify giving it a new genus name. This was backed up the following year by his more detailed explanation placing it in context with a number of other Iguanodontids.

Fossils

Many thousands of bones and teeth, and even more fragments of rolled partial bones have been discovered on the beaches of the Isle of Wight. A few are complete, but the majority are damaged - with pieces having gone missing either before the bone was fossilised, or afterwards due to the effects of cliff-falls and the action of the sea. There are far too many bones of

Iguanodon in the museum's collection to put pictures of all of them on the museum's website; but a selection of some of them may begin to show the diversity of what can be found on the Island.

In many cases the bones that come into the museum are isolated objects. However once in a while something larger turns up; and when it does it is rarely in one piece. On this kitchen floor are the remains of a large Iguanodon pelvis. Each piece has to be matched together using evidence in the rock that covers the bone to find joining surfaces. Then begins the task of removing the sandy coating before the next task begins of putting it back together.

The finder is Nick Chase, one of the museum's long standing supporters.

Once the object has been identified (in this case part of a large dorsal vertebra from an *Iguanodon bernissartensis*) the object can be assessed and any conservation or preparation can begin. Here a power tool is being used to remove the softer grey mudstone from around the bone. A number of vertebrae from the same dinosaur were donated by local collector Nick Chase.

Dinosaur Isle houses a full-size reconstructed model of an Iguanodon; and displays a number of bones and teeth from both species.

All skeletons must stand on something! Feet are one of the most important parts of any animal, and in this case the weight of an adult Iguanodon is of the order of a few tons, so they must be strong and healthy for the dinosaur to continue to survive. Perhaps surprisingly the bones of the feet are not commonly found as fossils, and the relatively small bone that sits inside the claw at the end of each toe is quite rare. This 'ungual phalange' sits flat on the ground - at 20 centimetres long (without the horny sheath) this particular specimen in Dinosaur Isle's collection demonstrates just how big these animals could grow.

This single vertebra with its long neural spine was originally identified as from *Iguanodon atherfieldensis*, but along with a number of other bones in the collection from this dinosaur we now recognise it as a distinct new genus called *Mantellisaurus atherfieldensis*.
This vertebra is unusual in that it is reasonably complete.

The round portion on the left hand side of the vertebra in the image above is called the centrum, the hole in the middle provides protection for the spinal cord, and the projecting spines provide anchorage points for tendons which support the animals back and ribs.

Many years ago Steve Hutt and Kieth Simmonds excavated a partial skeleton of an Iguanodon that was associated with the remains of another dinosaur that was later to be named as a new Island theropod called Neovenator.

This specimen of Iguanodon (now thought to be *Mantellisaurus*) was interesting because as it was cleaned the bones revealed some strange features. The picture here is of one of the bones from its tail (a caudal vertebra). The bone has been stood on an end face in order to take the picture.

This image of the top of a neural spine from the *Mantellisaurus* is of a cut and polished cross-section. The bone was cut to try and find out more about the interior. (The neural spine is the vertical blade of bone that protrudes from the top of a vertebra, and to which are attached the tendons that support the dinosaur's back).

It displays the typical growth of metallic iron sulphide crystals we find within dinosaur fossil bone structures after the animals died and were buried.

However the hook on the side is not typical. It is a bony growth that should not be there. A number of the vertebrae in the dinosaur's back have been affected like this. This animal suffered some real problems in its life - it must have been painful to move and perhaps there were even open sores on its skin.

In the picture of the thin-section below we can see what the internal structure of dinosaur bone should look like. The walls of the cells are complete in the thin-section, however in the damaged neural spine above the walls can be seen to be fractured and disordered - this damage to the bone structure most likely occurred during the animals life.

This image shows a thin slice of vertebra (or to be more accurate part of the centrum from a caudal vertebra), cut and mounted so that it can be viewed under a microscope. The typical features of bone can clearly be seen in this photograph, demonstrating the remarkable processes that have preserved the shape and structure of this bone during 125 million years of burial.

The Science

Systematic palaeontology

Dinosauria Owen, 1842
Ornithischia Seeley, 1888
Ornithopoda Marsh, 1881
Iguanodontia Dollo, 1888
Dryomorpha Sereno, 1986
Ankylopollexia Sereno, 1986
Iguanodontidae Cope, 1869
Iguanodon Mantell, 1825
Iguanodon bernissartensis Boulenger, *in* Beneden, 1881 ***Mantellisaurus atherfieldensis*** (Hooley, 1925) - Paul, 2007

Research

It would not be possible to list every research paper that has ever been produced on the Iguanodontids so the selection below will hopefully provide an introduction. Iguanodon is still being researched; many bones have been found and as more are discovered it has become

obvious that there is considerable variation even amongst Island fossils. In addition to this variation there is also the historical problem generated due to the early definition of the group. Some dinosaur remains that have been described as 'Iguanodon' are now being suggested as belonging to other dinosaurs, perhaps even new ones. At the moment the most significant change for our Island dinosaurs is the move of *Iguanodon atherfieldensis* to a new genera called *Mantellisaurus atherfieldensis,* first proposed by American palaeontologist Gregory Paul in 2006. The following year he published a proposed change (in *Cretaceous Research*) to the inter-relationship of a number of Iguanodonts, which then also included *M. atherfieldensis*.

References

Buckland, W. 1829. On the discovery of the bones of the *Iguanodon* and other large reptiles in the Isle of Wight and Isle of Purbeck. *Proceedings of the Geological Society of London.* **1**. 159-160.

Martill, D.M. & Naish, D. 2001. Dinosaurs of the Isle of Wight. Field Guides to Fossils: Number 10. Palaeontological Association. p119-132.

Norman, D.B. 1980. On the ornithischian dinosaur *Iguanodon bernissartensis* from the Lower Cretaceous of Bernissart (Belgium). *Memoires de l'Insitut Royal des Sciences Naturelles de Belgique*, 178, 105pp.

Paul, G. 2006. Turning the old into the new: a separate genus for the gracile iguanodont from the Wealden of England. *In:* Carpenter, K. (*Ed*.), Horns and Beaks: Ceratopsian and Ornithopod Dinosaurs. Indiana University Press, Bloomington, pp. 69-77.

Paul, G.S. 2007. A revised taxonomy of the iguanodont dinosaur genera and species. Cretaceous Research. doi 10.1016/j.cretres.2007.04.009

Some facts and figures

Size

Iguanodon bernissartensis typically grew to a length of 9 to 10 metres, however some much larger bones have been found which Martill and Naish (2001) suggest meant that specimens may have reached upto 13 metres long. Heights may have reached 3.5 to 4 metres tall.

The smaller *Iguanodon atherfieldensis* (now renamed *Mantellisaurus atherfieldensis*) grew to about 6 to 7 metres long.

Weight

4 to 5 tons for an adult *Iguanodon bernissartensis*, less for an adult *Mantellisaurus atherfieldensis*.

Eats
Tough plants (comparable to today's cycad leaves, horse tails and tree fern leaves).

The geology and age
Lower Cretaceous
Wealden Group
mainly Wessex Formation
(but some rarer bones and teeth are found in the Vectis Formation).

Iguanodon remains are found throughout the the Wessex Formation rocks on the Island, which range from approximately 122 to 126 million years old; however some rare Iguanodon material is found in the younger lagoonal and estuarine rocks of the Vectis Formation, from about 122 to 120 Million years ago. Exceptionally rare bones have been found in the offshore sands of the Ferruginous Sands, presumably after their bodies had floated out to sea from land lying to the north. Since these sands range in age from about 116 to 113 million years ago it demonstrates the long period of time in which these plant-eating dinosaurs were roaming the local area.

Where was it found?
Cuckfield in Sussex (1809), somewhere on the Isle of Wight before 1822. Today the remains can be found in the Wealden rocks of the Isle of Wight - in coastal exposures from Compton Bay to Atherfield Point, and at Yaverland. Rare bones have been found in the marine Ferruginous Sands at Shanklin (where carcases may have floated out to sea, with bones preserved as fossils in nodules on the sea floor).

When was it first found?
1809.

Something different or unusual?
As members of the Ankylopollexia they had fused bones in the wrists and a sharp thumb spike. Although this was once proposed as a defence mechanism against other dinosaurs some researchers now believe it may have had very little impact on a carnivorous dinosaur of the same size.

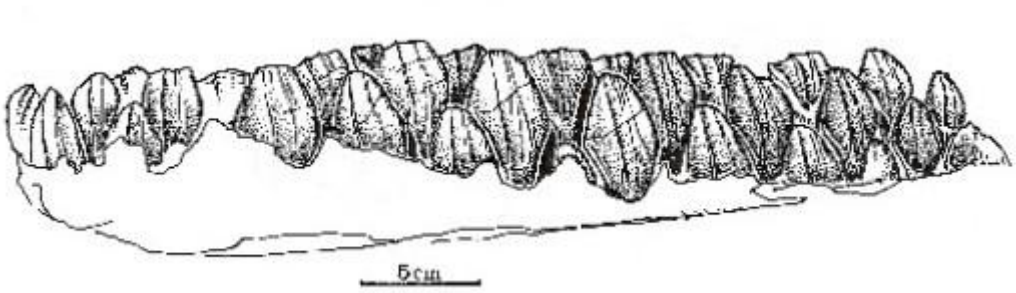
Environment and adaptation

I. bernissartensis is now believed to have been bipedal, walking for most of the time only on its hind feet. The evidence of the preserved footprints and footcasts shows that most of them are tridactyl (three-toed); and there are very few hand prints from this larger species.

With a higher shoulder than *M. atherfieldensis* and sharp serrated teeth adapted to chopping harder vegetation it is thought this meant that fully grown *I. bernissartensis* adults browsed about 4 metres high. *M. atherfieldensis* had lower shoulders and appears to have walked on all fours for

most of the time, suggesting it ate plants that were closer to the ground. Both species had teeth that were constantly growing and being replaced, suggesting a hard diet (with some dinosaurs of the type replacing teeth in less than a year). Iguanodonts had cheeks that enabled them to hold plant material in their mouths so that they could chew it up.

Many of the preserved footcasts are found near former river channels indicating that they may have congregated here for drinking in herds, or that they were using river banks as natural paths. Fossils from the group of dinosaurs called Iguanodontia have been found on all of the continents except for Antarctica (and that may only be because there is very little rock exposed there in which to find remains). Parallel trackways with footcasts of various sizes suggest they travelled in large mixed herds, most likely for defence. Like other ornithopods (meaning 'bird feet') they became more prolific at the time of the appearance of the first flowering plants.



The human story

A number of eminent scientists have been involved in the researches into this dinosaur. If you wish to read more about some of the people mentioned on this page then visit the webpage http://www.dinosaurisle.com/paleontologists.aspx

The future

Iguanodontids are the subject of continuing research, and feature in the work of many undergraduate and post-graduate students' work. The many bones that have been found tell us that there was more diversity than perhaps once thought. Re-appraisal of existing literature, and fossils held in museums like Dinosaur Isle, are a rich resource that will help us learn not just about the individual dinosaurs, but along with other new environmental evidence and records of trackways may lead us to a greater understanding of the animals social interactions.

Produced by

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