= Iguanodon =

Iguanodon (/ ???w??n?d?n / i @-@ GWAH @-@ n? @-@ don ; meaning " iguana @-@ tooth ") is a genus of ornithopod dinosaur that existed roughly halfway between the first of the swift bipedal hypsilophodontids of the mid @-@ Jurassic and the duck @-@ billed dinosaurs of the late Cretaceous . While many species have been classified in the genus Iguanodon , dating from the late Jurassic Period to the late Cretaceous Period of Asia , Europe , and North America , research in the first decade of the 21st century suggests that there is only one well @-@ substantiated species : I. bernissartensis , which lived from the late Barremian to the earliest Aptian ages (Early Cretaceous) in Belgium and possibly elsewhere in Europe , between about 126 and 125 million years ago . Iguanodon were large , bulky herbivores . Distinctive features include large thumb spikes , which were possibly used for defense against predators , combined with long prehensile fifth fingers able to forage for food .

The genus was named in 1825 by English geologist Gideon Mantell , based on fossil specimens that are now assigned to Therosaurus and Mantellodon . Iguanodon was the second type of dinosaur formally named based on fossil specimens , after Megalosaurus . Together with Megalosaurus and Hylaeosaurus , it was one of the three genera originally used to define Dinosauria . The genus Iguanodon belongs to the larger group Iguanodontia , along with the duck @-@ billed hadrosaurs . The taxonomy of this genus continues to be a topic of study as new species are named or long @-@ standing ones reassigned to other genera .

Scientific understanding of Iguanodon has evolved over time as new information has been obtained from fossils . The numerous specimens of this genus , including nearly complete skeletons from two well @-@ known bonebeds , have allowed researchers to make informed hypotheses regarding many aspects of the living animal , including feeding , movement , and social behaviour . As one of the first scientifically well @-@ known dinosaurs , Iguanodon has occupied a small but notable place in the public 's perception of dinosaurs , its artistic representation changing significantly in response to new interpretations of its remains .

= = Description = =

Iguanodon were bulky herbivores that could shift from bipedality to quadrupedality . The only well @-@ supported species , I. bernissartensis , is estimated to have weighed about 3 @.@ 08 tonnes (3 @.@ 4 tons) on average , and measured about 10 metres (33 feet) long as an adult , with some specimens possibly as long as 13 metres (43 feet) . These animals had large , tall but narrow skulls , with toothless beaks probably covered with keratin , and teeth like those of iguanas , but much larger and more closely packed .

The arms of I. bernissartensis were long (up to 75 % the length of the legs) and robust , with rather inflexible hands built so that the three central fingers could bear weight . The thumbs were conical spikes that stuck out away from the three main digits . In early restorations , the spike was placed on the animal 's nose . Later fossils revealed the true nature of the thumb spikes , although their exact function is still debated . They could have been used for defense , or for foraging for food . The little finger was elongated and dextrous , and could have been used to manipulate objects . The phalangeal formula is 2 @-@ 3 @-@ 3 @-@ 2 @-@ 4 , meaning that the innermost finger (phalange) has two bones , the next has three , etc . The legs were powerful , but not built for running , and each foot had three toes . The backbone and tail were supported and stiffened by ossified tendons , which were tendons that turned to bone during life (these rod @-@ like bones are usually omitted from skeletal mounts and drawings) .

Iguanodon teeth are , as the name suggests , like those of an iguana , but larger . Unlike hadrosaurids , which had columns of replacement teeth , Iguanodon only had one replacement tooth at a time for each position . The upper jaw held up to 29 teeth per side , with none at the front of the jaw , and the lower jaw 25 ; the numbers differ because teeth in the lower jaw are broader than those in the upper . Because the tooth rows are deeply inset from the outside of the jaws , and because of other anatomical details , it is believed that , as with most other ornithischians ,

Iguanodon had some sort of cheek @-@ like structure , muscular or non @-@ muscular , to retain food in the mouth .

= = Classification and origins = =

Iguanodon gives its name to the unranked clade Iguanodontia , a very populous group of ornithopods with many species known from the Middle Jurassic to the Late Cretaceous . Aside from Iguanodon , the best @-@ known members of the clade include Dryosaurus , Camptosaurus , Ouranosaurus , and the duck @-@ bills , or hadrosaurs . In older sources , Iguanodontidae was shown as a distinct family . This family traditionally has been something of a wastebasket taxon , including ornithopods that were neither hypsilophodontids or hadrosaurids . In practice , animals like Callovosaurus , Camptosaurus , Craspedodon , Kangnasaurus , Mochlodon , Muttaburrasaurus , Ouranosaurus , and Probactrosaurus were usually assigned to this family .

With the advent of cladistic analyses , Iguanodontidae as traditionally construed was shown to be paraphyletic , and these animals are recognised to fall at different points in relation to hadrosaurs on a cladogram , instead of in a single distinct clade . Essentially , the modern concept of Iguanodontidae currently includes only Iguanodon . Groups like Iguanodontoidea are still used as unranked clades in the scientific literature , though many traditional iguanodontids are now included in the superfamily Hadrosauroidea . Iguanodon lies between Camptosaurus and Ouranosaurus in cladograms , and is probably descended from a camptosaur @-@ like animal . At one point , Jack Horner suggested , based mostly on skull features , that hadrosaurids actually formed two more distantly related groups , with Iguanodon on the line to the flat @-@ headed hadrosaurines , and Ouranosaurus on the line to the crested lambeosaurines , but his proposal has been rejected .

The cladogram below follows an analysis by Andrew McDonald , 2012 .

= = Palaeobiology = =

= = = Feeding = = =

One of the first details noted about Iguanodon was that it had the teeth of a herbivorous reptile , although there has not always been consensus on how it ate . As Mantell noted , the remains he was working with were unlike any modern reptile , especially in the toothless , scoop @-@ shaped form of the lower jaw symphysis , which he found best compared to that of the two @-@ toed sloth and the extinct ground sloth Mylodon . He also suggested that Iguanodon had a prehensile tongue which could be used to gather food , like a giraffe . More complete remains have shown this to be an error ; for example , the hyoid bones that supported the tongue are heavily built , implying a muscular , non @-@ prehensile tongue used for moving food around in the mouth . The giraffe @-@ tongue idea has also been incorrectly attributed to Dollo via a broken lower jaw .

The skull was structured in such a way that as it closed , the bones holding the teeth in the upper jaw would bow out . This would cause the lower surfaces of the upper jaw teeth to rub against the upper surface of the lower jaw 's teeth , grinding anything caught in between and providing an action that is the rough equivalent of mammalian chewing . Because the teeth were always replaced , the animal could have used this mechanism throughout its life , and could eat tough plant material . Additionally , the front ends of the animal 's jaws were toothless and tipped with bony nodes , both upper and lower , providing a rough margin that was likely covered and lengthened by a keratinous material to form a cropping beak for biting off twigs and shoots . Its food gathering would have been aided by its flexible little finger , which could have been used to manipulate objects , unlike the other fingers .

Exactly what Iguanodon ate with its well @-@ developed jaws is not known . The size of the larger species , such as I. bernissartensis , would have allowed them access to food from ground level to tree foliage at 4 ? 5 metres (13 ? 16 ft) high . A diet of horsetails , cycads , and conifers was suggested by David Norman , although iguanodonts in general have been tied to the advance of

angiosperm plants in the Cretaceous due to the dinosaurs ' inferred low browsing habits . Angiosperm growth , according to this hypothesis , would have been encouraged by iguanodont feeding because gymnosperms would be removed , allowing more space for the weed @-@ like early angiosperms to grow . The evidence is not conclusive , though . Whatever its exact diet , due to its size and abundance , Iguanodon is regarded as a dominant medium to large herbivore for its ecological communities . In England , this included the small predator Aristosuchus , larger predators Eotyrannus , Baryonyx , and Neovenator , low @-@ feeding herbivores Hypsilophodon and Valdosaurus , fellow " iguanodontid " Mantellisaurus , the armoured herbivore Polacanthus , and sauropods like Pelorosaurus .

= = = Posture and movement = = =

Early fossil remains were fragmentary , which led to much speculation on the posture and nature of Iguanodon . Iguanodon was initially portrayed as a quadrupedal horn @-@ nosed beast . However , as more bones were discovered , Mantell observed that the forelimbs were much smaller than the hindlimbs . His rival Owen was of the opinion it was a stumpy creature with four pillar @-@ like legs . The job of overseeing the first lifesize reconstruction of dinosaurs was initially offered to Mantell , who declined due to poor health , and Owen 's vision subsequently formed the basis on which the sculptures took shape . Its bipedal nature was revealed with the discovery of the Bernissart skeletons . However , it was depicted in an upright posture , with the tail dragging along the ground , acting as the third leg of a tripod .

During his re @-@ examination of Iguanodon , David Norman was able to show that this posture was unlikely , because the long tail was stiffened with ossified tendons . To get the tripodal pose , the tail would literally have to be broken . Putting the animal in a horizontal posture makes many aspects of the arms and pectoral girdle more understandable . For example , the hand is relatively immobile , with the three central fingers grouped together , bearing hoof @-@ like phalanges , and able to hyperextend . This would have allowed them to bear weight . The wrist is also relatively immobile , and the arms and shoulder bones robust . These features all suggest that the animal spent time on all fours .

Furthermore , it appears that Iguanodon became more quadrupedal as it got older and heavier ; juvenile I. bernissartensis have shorter arms than adults (60 % of hindlimb length versus 70 % for adults) . When walking as a quadruped , the animal 's hands would have been held so that the palms faced each other , as shown by iguanodontian trackways and the anatomy of this genus 's arms and hands . The three toed pes (foot) of Iguanodon was relatively long , and when walking , both the hand and the foot would have been used in a digitigrade fashion (walking on the fingers and toes) . The maximum speed of Iguanodon has been estimated at 24 km / h (15 mph) , which would have been as a biped ; it would not have been able to gallop as a quadruped .

Large three @-@ toed footprints are known in Early Cretaceous rocks of England , particularly Wealden beds on the Isle of Wight , and these trace fossils were originally difficult to interpret . Some authors associated them with dinosaurs early on . In 1846 , E. Tagert went so far as to assign them to an ichnogenus he named Iguanodon , and Samuel Beckles noted in 1854 that they looked like bird tracks , but might have come from dinosaurs . The identity of the trackmakers was greatly clarified upon the discovery in 1857 of the hind leg of a young Iguanodon , with distinctly three @-@ toed feet , showing that such dinosaurs could have made the tracks . Despite the lack of direct evidence , these tracks are often attributed to Iguanodon . A trackway in England shows what may be an Iguanodon moving on all fours , but the foot prints are poor , making a direct connection difficult . Tracks assigned to the ichnogenus Iguanodon are known from locations including places in Europe where the body fossil Iguanodon is known , to Spitsbergen , Svalbard , Norway .

= = = Thumb spike = = =

The thumb spike is one of the best @-@ known features of Iguanodon . Although it was originally placed on the animal 's nose by Mantell , the complete Bernissart specimens allowed Dollo to place

it correctly on the hand , as a modified thumb . (This would not be the last time a dinosaur 's modified thumb claw would be misinterpreted ; Noasaurus , Baryonyx , and Megaraptor are examples since the 1980s where an enlarged thumb claw was first put on the foot , as in dromaeosaurids .)

This thumb is typically interpreted as a close @-@ quarter stiletto @-@ like weapon against predators , although it could also have been used to break into seeds and fruits , or against other Iguanodon . One author has suggested that the spike was attached to a venom gland , but this has not been accepted , as the spike was not hollow , nor were there any grooves on the spike for conducting venom .

= = = Possible social behaviour = = =

Although sometimes interpreted as the result of a single catastrophe , the Bernissart finds instead are now interpreted as recording multiple events . According to this interpretation , at least three occasions of mortality are recorded , and though numerous individuals would have died in a geologically short time span (? 10 ? 100 years) , this does not necessarily mean these Iguanodon were herding animals .

An argument against herding is that juvenile remains are very uncommon at this site , unlike modern cases with herd mortality . They more likely were the periodic victims of flash floods whose carcasses accumulated in a lake or marshy setting . The Nehden find , however , with its greater span of individual ages , more even mix of Dollodon or Mantellisaurus to Iguanodon bernissartensis , and confined geographic nature , may record mortality of herding animals migrating through rivers .

Unlike other purported herding dinosaurs (especially hadrosaurs and ceratopsids) , there is no evidence that Iguanodon was sexually dimorphic , with one sex appreciably different from the other . At one time , it was suggested that the Bernissart I. " mantelli " , or I. atherfieldensis (Dollodon and Mantellisaurus , respectively) represented a sex , possibly female , of the larger and more robust , possibly male , I. bernissartensis . However , this is not supported today .

= = = Paleopathology = = =

Evidence of a fractured hip bone was found in a specimen of Iguanodon , which had an injury to its ischium . Two other individuals were observed with signs of osteoarthritis as evidenced by bone overgrowths in their anklebones which are called osteophytes .

= = Discovery and history = =

= = = Gideon Mantell , Sir Richard Owen , and the discovery of dinosaurs = = =

The discovery of Iguanodon has long been accompanied by a popular legend . The story goes that Gideon Mantell 's wife , Mary Ann , discovered the first teeth of an Iguanodon in the strata of Tilgate Forest in Whitemans Green , Cuckfield , Sussex , England , in 1822 while her husband was visiting a patient . However , there is no evidence that Mantell took his wife with him while seeing patients . Furthermore , he admitted in 1851 that he himself had found the teeth . Not everyone agrees that the story is false , though . It is known from his notebooks that Mantell first acquired large fossil bones from the quarry at Whitemans Green in 1820 . Because also theropod teeth were found , thus belonging to carnivores , he at first interpreted these bones , which he tried to combine into a partial skeleton , as those of a giant crocodile . In 1821 Mantell mentioned the find of herbivorous teeth and began to consider the possibility that a large herbivorous reptile was present in the strata . However , in his 1822 publication Fossils of the South Downs he as yet did not dare to suggest a connection between the teeth and his very incomplete skeleton , presuming that his finds presented two large forms , one carnivorous (" an animal of the Lizard Tribe of enormous magnitude ") , the other

herbivorous . In May 1822 he first presented the herbivorous teeth to the Royal Society of London but the members , among them William Buckland , dismissed them as fish teeth or the incisors of a rhinoceros from a Tertiary stratum . On 23 June 1823 Charles Lyell showed some to Georges Cuvier , during a soiree in Paris , but the famous French naturalist at once dismissed them as those of a rhinoceros . Though the very next day Cuvier retracted , Lyell reported only the dismissal to Mantell , who became rather diffident about the issue . In 1824 Buckland described Megalosaurus and was on that occasion invited to visit Mantell 's collection . Seeing the bones on 6 March he agreed that these were of some giant saurian ? though still denying it was a herbivore . Emboldened nevertheless , Mantell again sent some teeth to Cuvier , who answered on 22 June 1824 that he had determined that they were reptilian and quite possibly belonged to a giant herbivore . In a new edition that year of his Recherches sur les Ossemens Fossiles Cuvier admitted his earlier mistake , leading to an immediate acceptance of Mantell , and his new saurian , in scientific circles . Mantell tried to corroborate his theory further by finding a modern @-@ day parallel among extant reptiles . In September 1824 he visited the Royal College of Surgeons but at first failed to find comparable teeth . However , assistant @-@ curator Samuel Stutchbury recognised that they resembled those of an iguana he had recently prepared , albeit twenty times longer .

In recognition of the resemblance of the teeth to those of the iguana , Mantell decided to name his new animal Iguanodon or " iguana @-@ tooth " , from iguana and the Greek word ???? (odon , odontos or " tooth ") . Based on isometric scaling , he estimated that the creature might have been up to 18 metres (59 feet) long , more than the 12 metres (39 feet) length of Megalosaurus . His initial idea for a name was Iguana @-@ saurus (" Iguana lizard ") , but his friend William Daniel Conybeare suggested that that name was more applicable to the iguana itself , so a better name would be Iguanoides (" Iguana @-@ like ") or Iguanodon . He neglected to add a specific name to form a proper binomial , but one was supplied in 1829 by Friedrich Holl : I. anglicum , which was later amended to I. anglicus .

Mantell sent a letter detailing his discovery to the local Portsmouth Philosophical Society in December 1824 , several weeks after settling on a name for the fossil creature . The letter was read to members of the Society at a meeting on 17 December , and a report was published in the Hampshire Telegraph the following Monday , 20 December , which announced the name , mis @-@ spelt as " Iguanadon " . Mantell formally published his findings on 10 February 1825 , when he presented a paper on the remains to the Royal Society of London .

A more complete specimen of similar animal was discovered in a quarry in Maidstone , Kent , in 1834 (lower Lower Greensand Formation) , which Mantell soon acquired . He was led to identify it as an Iguanodon based on its distinctive teeth . The Maidstone slab was utilized in the first skeletal reconstructions and artistic renderings of Iguanodon , but due to its incompleteness , Mantell made some mistakes , the most famous of which was the placement of what he thought was a horn on the nose . The discovery of much better specimens in later years revealed that the horn was actually a modified thumb . Still encased in rock , the Maidstone skeleton is currently displayed at the Natural History Museum in London . The borough of Maidstone commemorated this find by adding an Iguanodon as a supporter to their coat of arms in 1949 . This specimen has become linked with the name I. mantelli , a species named in 1832 by Christian Erich Hermann von Meyer in place of I. anglicus , but it actually comes from a different formation than the original I. mantelli / I. anglicus material . The Maidstone specimen , also known as Gideon Mantell 's " Mantel @-@ piece " , and formally labelled NHMUK 3741 was subsequently excluded from Iguanodon . It is classified as cf . Mantellisaurus by McDonald (2012) ; as cf . Mantellisaurus atherfieldensis by Norman (2012) ; and made the holotype of a separate species Mantellodon carpenteri by Paul (2012) .

At the same time , tension began to build between Mantell and Richard Owen , an ambitious scientist with much better funding and society connections in the turbulent worlds of Reform Act ? era British politics and science . Owen , a firm creationist , opposed the early versions of evolutionary science (" transmutationism ") then being debated and used what he would soon coin as dinosaurs as a weapon in this conflict . With the paper describing Dinosauria , he scaled down dinosaurs from lengths of over 61 metres (200 feet) , determined that they were not simply giant lizards , and put forward that they were advanced and mammal @-@ like , characteristics given to

them by God ; according to the understanding of the time , they could not have been " transmuted " from reptiles to mammal @-@ like creatures .

In 1849 , a few years before his death in 1852 , Mantell realised that iguanodonts were not heavy , pachyderm @-@ like animals , as Owen was putting forward , but had slender forelimbs ; however , his passing left him unable to participate in the creation of the Crystal Palace dinosaur sculptures , and so Owen 's vision of the dinosaurs became that seen by the public for decades . With Benjamin Waterhouse Hawkins , he had nearly two dozen lifesize sculptures of various prehistoric animals built out of concrete sculpted over a steel and brick framework ; two iguanodonts (based on the Mantellodon specimen) , one standing and one resting on its belly , were included . Before the sculpture of the standing iguanodont was completed , he held a banquet for twenty inside it .

= = = Bernissart = = =

The largest find of Iguanodon remains to that date occurred on 28 February 1878 in a coal mine at Bernissart in Belgium , at a depth of 322 m (1 @,@ 056 ft) , when two mineworkers , Jules Créteur and Alphonse Blanchard , accidentally hit on a skeleton that they initially took for petrified wood . With the encouragement of Alphonse Briart , supervisor of mines at nearby Morlanwelz , Louis de Pauw on 15 May 1878 started to excavate the skeletons and in 1882 Louis Dollo reconstructed them . At least 38 Iguanodon individuals were uncovered , most of which were adults . In 1882 , the holotype specimen of I. bernissartensis became one of the first ever dinosaur skeletons mounted for display . It was put together in a chapel at the Palace of Charles of Lorraine using a series of adjustable ropes attached to scaffolding so that a lifelike pose could be achieved during the mounting process . This specimen , along with several others , first opened for public viewing in an inner courtyard of the palace in July 1883 . In 1891 they were moved to the Royal Museum of Natural History , where they are still on display ; nine are displayed as standing mounts , and nineteen more are still in the Museum 's basement . The exhibit makes an impressive display in the Royal Belgian Institute of Natural Sciences , in Brussels . A replica of one of these is on display at the Oxford University Museum of Natural History and at the Sedgwick Museum in Cambridge . Most of the remains were referred to a new species , I. bernissartensis , a larger and much more robust animal than the English remains had yet revealed , but one specimen was referred to the nebulous , gracile I. mantelli (now Dollodon bampingi) . The skeletons were some of the first complete dinosaur skeletons known . Found with the dinosaur skeletons were the remains of plants , fish , and other reptiles , including the crocodyliform Bernissartia .

The science of conserving fossil remains was in its infancy , and new techniques had to be improvised to deal with what soon became known as " pyrite disease " . Crystalline pyrite in the bones was being oxidized to iron sulphate , accompanied by an increase in volume that caused the remains to crack and crumble . When in the ground , the bones were isolated by anoxic moist clay that prevented this from happening , but when removed into the drier open air , the natural chemical conversion began to occur . To limit this effect , De Pauw immediately , in the mine @-@ gallery , re @-@ covered the dug @-@ out fossils with wet clay , sealing them with paper and plaster reinforced by iron rings , forming in total about six hundred transportable blocks with a combined weight of a hundred and thirty tons . In Brussels after opening the plaster he impregnated the bones with boiling gelatine mixed with oil of cloves as a preservative . Removing most of the visible pyrite he then hardened them with hide glue , finishing with a final layer of tin foil . Damage was repaired with papier @-@ mâché . This treatment had the unintended effect of sealing in moisture and extending the period of damage . In 1932 museum director Victor van Straelen decided that the specimens had to be completely restored again to safeguard their preservation . From December 1935 to August 1936 the staff at the museum in Brussels treated the problem with a combination of alcohol , arsenic , and 390 kilograms of shellac . This combination was intended to simultaneously penetrate the fossils (with alcohol) , prevent the development of mold (with arsenic) , and harden them (with shellac) . The fossils entered a third round of conservation from 2003 until May 2007 , when the shellac , hide glue and gelatine were removed and impregnated with polyvinyl acetate and cyanoacrylate and epoxy glues . Modern treatments of this problem typically involve either

monitoring the humidity of fossil storage , or , for fresh specimens , preparing a special coating of polyethylene glycol that is then heated in a vacuum pump , so that moisture is immediately removed and pore spaces are infiltrated with polyethelene glycol to seal and strengthen the fossil .

Dollo 's specimens allowed him to show that Owen 's prehistoric pachyderms were not correct for Iguanodon . He instead modelled the skeletal mounts after the cassowary and wallaby , and put the spike that had been on the nose firmly on the thumb . He was not completely correct , but he also had the disadvantage of being faced with some of the first complete dinosaur remains . A problem that was later recognised was the bend he introduced into the tail . This organ was more or less straight , as shown by the skeletons he was excavating , and the presence of ossified tendons . In fact , to get the bend in the tail for a more wallaby or kangaroo @-@ like posture , the tail would have had to be broken . With its correct , straight tail and back , the animal would have walked with its body held horizontal to the ground , arms in place to support the body if needed .

Excavations at the quarry were stopped in 1881 , although it was not exhausted of fossils , as recent drilling operations have shown . During World War I , when the town was occupied by German forces , preparations were made to reopen the mine for palaeontology , and Otto Jaekel was sent from Berlin to supervise . The Allies recaptured Bernissart just as the first fossiliferous layer was about to be uncovered . Further attempts to reopen the mine were hindered by financial problems and were stopped altogether in 1921 when the mine flooded .

= = = Current research = = =

Research on Iguanodon decreased during the early part of the 20th century as World Wars and the Great Depression enveloped Europe . A new species that would become the subject of much study and taxonomic controversy , I. atherfieldensis , was named in 1925 by R. W. Hooley , for a specimen collected at Atherfield Point on the Isle of Wight .

Iguanodon was recorded from Africa based on teeth from Tunisia and elsewhere in the Sahara , but the description of Lurdusaurus and Ouranosaurus cast doubt on African records of Iguanodon . The genus was also recorded from Mongolia based on the description of I. orientalis , and in North America based on I. ottingeri from Utah . Another North American species , from South Dakota , once assigned to Iguanodon as I. lakotaensis , has since been reclassified as the genus Dakotadon .

Iguanodon was not part of the initial work of the dinosaur renaissance that began with the description of Deinonychus in 1969 , but it was not neglected for long . David B. Weishampel 's work on ornithopod feeding mechanisms provided a better understanding of how it fed , and David B. Norman 's work on numerous aspects of the genus has made it one of the best @-@ known dinosaurs . In addition , a further find of numerous Iguanodon skeletons , in Nehden , Nordrhein @-@ Westphalen , Germany , has provided evidence for gregariousness in this genus , as the animals in this areally restricted find appear to have been killed by flash floods . At least 15 individuals , from 2 to 8 metres (6 @.@ 6 to 26 @.@ 2 ft) long , have been found here , although at least some of them are gracile iguanodontians and belong to the related Mantellisaurus or Dollodon (described as I. atherfieldensis , at that time believed to be another species of Iguanodon) .

Iguanodon material has also been used in the search for dinosaur DNA and other biomolecules . In research by Graham Embery et al . , Iguanodon bones were processed to look for remnant proteins . In this research , identifiable remains of typical bone proteins , such as phosphoproteins and proteoglycans , were found in a rib .

= = Species = =

Because Iguanodon is one of the first dinosaur genera to have been named , numerous species have been assigned to it . While never becoming the wastebasket taxon several other early genera of dinosaurs became (such as Megalosaurus) , Iguanodon has had a complicated history , and its taxonomy continues to undergo revisions . Although Gregory Paul recommended restricting I. bernissartensis to the famous sample from Bernissart , ornithopod workers like Norman and

McDonald have disagreed with Paul 's recommendations , except exercising caution when accepting records of Iguanodon from France and Spain as valid .

I. anglicus was the original type species , but the holotype was based on a single tooth and only partial remains of the species have been recovered since . In March 2000 , the International Commission on Zoological Nomenclature changed the type species to the much better known I. bernissartensis , with the new holotype being IRSNB 1534 . The original Iguanodon tooth is held at Te Papa Tongarewa , the national museum of New Zealand in Wellington , although it is not on display . The fossil arrived in New Zealand following the move of Gideon Mantell 's son Walter there ; after the elder Mantell 's death , his fossils went to Walter .

= = = Species currently accepted as valid = = =

Only two species assigned to Iguanodon are still considered to be valid .

I. bernissartensis , described by George Albert Boulenger in 1881 , is the type species for the genus . This species is best known for the many skeletons discovered in Bernissart , but is also known from remains across Europe . David Norman suggested that it includes the dubious Mongolian I. orientalis , but this has not been followed by other researchers .

I. galvensis , described in 2015 , is based on adult and juvenile remains found in Barremian @-@ age deposits in Teruel , Spain .

= = = Reassigned species = = =

I. hoggi (also spelled I. boggii or hoggii) , named by Owen for a lower jaw from the Tithonian ? Berriasian @-@ age Upper Jurassic ? Lower Cretaceous Purbeck Beds of Dorset in 1874 , has been reassigned to its own genus , Owenodon .

Iguanodon albinus (or Albisaurus scutifer) , described by Czech palaeontologist Antonin Fritsch in 1893 , is a dubious nondinosaurian reptile now known as Albisaurus albinus .

I. atherfieldensis , described by R.W. Hooley in 1925 , was smaller and less robust than I. bernissartensis , with longer neural spines . It was renamed Mantellisaurus atherfieldensis in 2007 . The Bernissart specimen RBINS 1551 was described as Dollodon bampingi in 2008 , but McDonald and Norman returned Dollodon to synonymy with Mantellisaurus .

I. exogyrarum was described by Fritsch in 1878 . It is a nomen dubium based on very poor material and was renamed Ponerosteus in 2000 .

I. prestwichii (also spelled I. prestwichi) , described by John Hulke in 1880 , has been reassigned to Camptosaurus prestwichii or to its own genus Cumnoria .

Two species described by Richard Lydekker in the late 19th century have been reassigned to different genera .

I. dawsoni , described by Lydekker in 1888 , is known from two partial skeletons found in East Sussex , England , from the middle Valanginian @-@ age Lower Cretaceous Wadhurst Clay . It is now the type species of Barilium .

I. fittoni was described by Lydekker in 1889 . Like I. dawsoni , this species was described from the Wadhurst Clay of East Sussex . It is now the type species of Hypselospinus .

I. hollingtoniensis (also spelled I. hollingtonensis) , described by Lydekker in 1889 has variously been considered a synonym of Hypselospinus fittoni or a distinct species assigned to the genus Huxleysaurus . A specimen from the Valanginian Wadhurst Clay Formation , variously assigned to I. hollingtoniensis and I. mantelli over the years , has an unusual combination of hadrosaurid @-@ like lower jaw and very robust forelimb ; Norman (2010) assigned this specimen to the species Hypselospinus fittoni , while Paul (2012) made it the holotype of a separate species Darwinsaurus evolutionis .

I. seelyi (also incorrectly spelled I. seeleyi) , described by Hulke two years after I. prestwichii , has been synonymised with Iguanodon bernissartensis , though this is controversial .

I. suessii , described by Emanuel Bunzel in 1871 , has been reassigned to Mochlodon suessi .

I. lakotaensis was described by David B. Weishampel and Philip R. Bjork in 1989 . The only well

@-@ accepted North American species of Iguanodon , I. lakotaensis was described from a partial skull from the Barremian @-@ age Lower Cretaceous Lakota Formation of South Dakota . Its assignment has been controversial . Some researchers suggest that it was more basal than I. bernissartensis , and related to Theiophytalia , but David Norman has suggested that it was a synonym of I. bernissartensis . Gregory S. Paul has since given the species its own genus , Dakotadon .

Iguanodon mantelli described by Christian Erich Hermann von Meyer in 1832 , was based on the same material as I. anglicus and is an objective junior synonym of the latter . Several taxa , including the holotype of Dollodon and Mantellodon , but also the dubious hadrosauroid Trachodon cantabrigiensis the hypsilophodont Hypsilophodon , and Valdosaurus , were previously mis @-@ assigned to I. mantelli .

I. hilli , coined by Edwin Tully Newton in 1892 for a tooth from the early Cenomanian Upper Cretaceous Lower Chalk of Hertfordshire , has been considered an early hadrosaurid of some sort . However , recent work places it as indeterminate beyond Hadrosauroidea outside Hadrosauridae .

I. orientalis , described by A. K. Rozhdestvensky in 1952 , was based on poor material , but a skull with a distinctive arched snout that had been assigned to it was renamed Altirhinus kurzanovi in 1998 . At the same time , I. orientalis was considered to be a nomen dubium because it cannot be compared to I. bernissartensis .

Harry Seeley described I. phillipsi in 1869 , but later reassigned it to Priodontognathus .

I. praecursor (also spelled I. precursor) , described by E. Sauvage in 1876 from teeth from an unnamed Kimmeridgian (Late Jurassic) formation in Pas @-@ de @-@ Calais , France , is actually a sauropod , sometimes assigned to Neosodon , although the two come from different formations .

" I. mongolensis " (Whitfield , 1992) is a nomen nudum from a photo caption in a book , of remains that would later be named Altirhinus .

Delapparentia turolensis was named in 2011 based on a specimen previously assigned to Iguanodon bernissartensis .

= = = Species referred to Iguanodon that were originally named as nominal species of other genera = = =

I. valdensis , a renaming of Vectisaurus valdensis by Ernst van den Broeck in 1900 . Originally named Vectisaurus valdensis by Hulke in 1879 based on vertebral and pelvic remains , it was from the Barremian stage of the Isle of Wight . It was considered a juvenile specimen of Mantellisaurus atherfieldensis , or an undetermined species of Mantellisaurus , but is indeterminate beyond Iguanodontia .

I. foxii (also spelled I. foxi) was originally described by Thomas Henry Huxley in 1869 as the type species of Hypsilophodon ; Owen (1873 or 1874) reassigned it to Iguanodon , but his assignment was soon overturned .

I. gracilis , named by Lydekker in 1888 as the type species of Sphenospondylus and assigned to Iguanodon in 1969 by Rodney Steel , has been tossed of as a synonym of Mantellisaurus atherfieldensis , but is dubious nowadays .

I. major , a species named by Justin Delair in 1966 , based on vertebrae from the Isle of Wight and Sussex originally described by Owen in 1842 as a species of Streptospondylus , S. major , is a nomen dubium which is now thought to be a synonym of I. anglicus , although it may be its own species .

The nomen nudum " Proiguanodon " (van den Broeck , 1900) also belongs here .

= = = Dubious species = = =

Two Iguanodon species are currently considered to be nomina dubia :

I. anglicus , described by Friedrich Holl in 1829 , is the original type species of Iguanodon , but , as discussed above , was replaced by I. bernissartensis . In the past , it has been spelled as I. angelicus (Lessem and Glut , 1993) and I. anglicum (Holl , 1829 emend . Bronn , 1850) . It is

known from teeth from the middle Valanginian @-@ age Lower Cretaceous Grinstead Clay Formation) of Cuckfield , West Sussex , England . It is currently classified in the genus Therosaurus as T. anglicus .

I. ottingeri , described by Peter Galton and James A. Jensen in 1979 , is a nomen dubium based on teeth from the possibly Aptian @-@ age lower Cedar Mountain Formation of Utah .

The genera Iguanosaurus (Ritgen , 1828) , Hikanodon (Keferstein , 1834) , and Therosaurus (Fitzinger , 1840) , are simply junior objective synonyms , later names for the material of I. anglicus .

= = In popular culture = =

Since its description in 1825 , Iguanodon has been a feature of worldwide popular culture . Two lifesize reconstructions of Mantellodon (considered Iguanodon at the time) built at the Crystal Palace in London in 1852 greatly contributed to the popularity of the genus . Their thumb spikes were mistaken for horns , and they were depicted as elephant @-@ like quadrupeds , yet this was the first time an attempt was made at constructing full @-@ size dinosaur models . In 1910 Heinrich Harder portrayed a group of Iguanodon in the classic German collecting cards about extinct and prehistoric animals " Tiere der Urwelt " .

Several motion pictures have featured Iguanodon . In the Disney film Dinosaur , an Iguanodon named Aladar served as the protagonist with three other iguanodonts as other main characters ; a loosely related ride of the same name at Disney 's Animal Kingdom is based around bringing an Iguanodon back to the present . Iguanodon is one of the three dinosaur genera that inspired Godzilla ; the other two were Tyrannosaurus and Stegosaurus . Iguanodon has also made appearances in some of the many Land Before Time films , as well as episodes of the television series .

Aside from appearances in movies , Iguanodon has also been featured on the television documentary miniseries Walking with Dinosaurs (1999) produced by the BBC , and played a starring role in Sir Arthur Conan Doyle 's book , The Lost World as well as featuring in an episode of the Discovery Channel documentary , Dinosaur Planet (incorrectly portrayed being able to run on all fours and living in the Late Cretaceous) . It also was present in Bob Bakker 's Raptor Red (1995) , as a Utahraptor prey item . A main belt asteroid , 1989 CB3 , has been named 9941 Iguanodon in honour of the genus .

Because it is both one of the first dinosaurs described and one of the best @-@ known dinosaurs , Iguanodon has been well @-@ placed as a barometer of changing public and scientific perceptions on dinosaurs . Its reconstructions have gone through three stages : the elephantine quadrupedal horn @-@ snouted reptile satisfied the Victorians , then a bipedal but still fundamentally reptilian animal using its tail to prop itself up dominated the early 20th century , but was slowly overturned during the 1960s by its current , more agile and dynamic representation , able to shift from two legs to all fours .