[Template:Other uses](/wiki/Template:Other_uses" \o "Template:Other uses) [Template:Pp-semi-indef](/wiki/Template:Pp-semi-indef) [Template:Pp-move-indef](/wiki/Template:Pp-move-indef) [Template:Automatic taxobox](/wiki/Template:Automatic_taxobox) **Dinosaurs** are a diverse group of animals of the [clade](/wiki/Clade) **Dinosauria**. They first appeared during the [Triassic](/wiki/Triassic) period, 231.4 million years ago, and were the dominant terrestrial [vertebrates](/wiki/Vertebrate) for 135 million years, from the start of the [Jurassic](/wiki/Jurassic) (about 200 million years ago) until the end of the [Cretaceous](/wiki/Cretaceous) (66 million years ago),[[1]](#cite_note-1) when the [Cretaceous–Paleogene extinction event](/wiki/Cretaceous–Paleogene_extinction_event) led to the [extinction](/wiki/Extinction) of most dinosaur groups at the end of the [Mesozoic Era](/wiki/Mesozoic_Era).

Until the late 20th century, all groups of dinosaurs were believed to be extinct; however, the [fossil](/wiki/Fossil) record indicates that [birds](/wiki/Bird) are the modern descendants of [feathered dinosaurs](/wiki/Feathered_dinosaur), having evolved from [theropod](/wiki/Theropoda) ancestors during the Jurassic Period,[[2]](#cite_note-2) and are now termed "avian dinosaurs". As such, birds were the only dinosaur lineage to survive the mass extinction event.[[3]](#cite_note-3) Throughout the remainder of this article, the term "dinosaur" is sometimes used generically to refer to both the avian and non-avian dinosaurs combined, while at other times it is used to refer to the non-avian dinosaurs specifically, and the avian dinosaurs are sometimes simply referred to as "birds". This article deals primarily with non-avian dinosaurs.

Dinosaurs are a varied group of animals from [taxonomic](/wiki/Taxonomy_(biology)), [morphological](/wiki/Morphology_(biology)) and [ecological](/wiki/Ecology) standpoints. Birds, at over [Template:Gaps](/wiki/Template:Gaps) living species,[[4]](#cite_note-4) are the most diverse group of vertebrates besides [perciform](/wiki/Perciformes) fish.<ref name=Alfaroetal2009/> Using fossil evidence, [paleontologists](/wiki/Paleontology) have identified over 500 distinct [genera](/wiki/Genus)<ref name=Wang&Dodson/> and more than [Template:Gaps](/wiki/Template:Gaps) different species of non-avian dinosaurs.<ref name=AmosBBC/>

Dinosaurs are represented on every continent by both [extant](/wiki/Extant_taxon) species and fossil remains.<ref name=MacLeod/> Some are herbivorous, others carnivorous. While dinosaurs were ancestrally [bipedal](/wiki/Bipedalism), many extinct groups included [quadrupedal](/wiki/Quadrupedalism) species, and some were able to shift between these stances. Elaborate display structures such as horns or crests are common to all dinosaur groups, and some extinct groups developed skeletal modifications such as [bony armor](/wiki/Armour_(anatomy)) and [spines](/wiki/Spine_(zoology)). Evidence suggests that egg laying and nest building are additional traits shared by all dinosaurs.

While the modern-day surviving lineage of dinosaurs (birds) are generally small due to the constraints of flight, many prehistoric dinosaurs were large-bodied—the largest [sauropod](/wiki/Sauropod) dinosaurs are estimated to have reached lengths of [Template:Convert](/wiki/Template:Convert)[[5]](#cite_note-5) and heights of [Template:Convert](/wiki/Template:Convert)<ref name=KC06/> and were the largest land animals of all time. Still, the idea that non-avian dinosaurs were uniformly gigantic is a misconception based in part on preservation bias, as large, sturdy bones are more likely to last until they are fossilized. Many dinosaurs were quite small: [*Xixianykus*](/wiki/Xixianykus), for example, was only about [Template:Convert](/wiki/Template:Convert) long.

Although the word *dinosaur* literally means "terrible lizard", the name is something of an etymological misnomer; even though dinosaurs are [reptiles](/wiki/Reptiles), they are not [lizards](/wiki/Lizards), nor are they descended from them. Instead, dinosaurs, like many extinct forms of reptile sub-groups, did not exhibit characteristics which were traditionally regarded as reptilian, such as a [sprawling limb posture](/wiki/Terrestrial_locomotion#Posture) or [ectothermy](/wiki/Ectothermy) (colloquially referred to as "cold-bloodedness"). Additionally, many other prehistoric animals, including [mosasaurs](/wiki/Mosasaur), [ichthyosaurs](/wiki/Ichthyosaur), [pterosaurs](/wiki/Pterosaur), [plesiosaurs](/wiki/Plesiosaur), and [*Dimetrodon*](/wiki/Dimetrodon), while often popularly conceived of as dinosaurs, are not [taxonomically](/wiki/Taxonomy_(biology)) classified as dinosaurs.

Through the first half of the 20th century, before birds were recognized to be dinosaurs, most of the scientific community believed dinosaurs to have been sluggish and [cold-blooded](/wiki/Poikilotherm). Most [research conducted since the 1970s](/wiki/Dinosaur_renaissance), however, has indicated that all dinosaurs were active animals with elevated [metabolisms](/wiki/Metabolism) and numerous adaptations for social interaction.

Since the first dinosaur [fossils](/wiki/Fossil) were recognized in the early 19th century, mounted fossil dinosaur skeletons have been major attractions at museums around the world, and dinosaurs have become an enduring part of world culture. The large sizes of some dinosaur groups, as well as their seemingly monstrous and fantastic nature, have ensured dinosaurs' regular appearance in best-selling books and films, such as [*Jurassic Park*](/wiki/Jurassic_Park_(film)). Persistent public enthusiasm for the animals has resulted in significant funding for dinosaur science, and new discoveries are regularly covered by the media.

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## Etymology[[edit](/index.php?title=(none)&action=edit&section=1)]

The [taxon](/wiki/Taxon) **Dinosauria** was formally named in 1842 by [paleontologist](/wiki/Paleontology) [Sir Richard Owen](/wiki/Richard_Owen), who used it to refer to the "distinct tribe or sub-order of Saurian Reptiles" that were then being recognized in England and around the world.<ref name=Owen1842/> The term is derived from the [Greek](/wiki/Ancient_Greek) words [δεινός](/wiki/Wikt:δεινός) (*deinos*, meaning "terrible", "potent", or "fearfully great") and [σαῦρος](/wiki/Wikt:σαῦρος) (*sauros*, meaning "lizard" or "reptile").<ref name=Owen1842/><ref name=LSJ/> Though the taxonomic name has often been interpreted as a reference to dinosaurs' teeth, claws, and other fearsome characteristics, Owen intended it merely to evoke their size and majesty.<ref name=FBS97/>

## Definition[[edit](/index.php?title=(none)&action=edit&section=2)]

[thumb|left|150px|](/wiki/File:LA-Triceratops_mount-2.jpg)[*Triceratops horridus*](/wiki/Triceratops_horridus) skeleton, [Natural History Museum of Los Angeles County](/wiki/Natural_History_Museum_of_Los_Angeles_County) Under [phylogenetic nomenclature](/wiki/Phylogenetic_nomenclature), dinosaurs are usually defined as the group consisting of [*Triceratops*](/wiki/Triceratops), [Neornithes](/wiki/Modern_birds) [modern birds], their [most recent common ancestor](/wiki/Most_recent_common_ancestor) (MRCA), and all descendants.<ref name=MJB04dino/> It has also been suggested that Dinosauria be defined with respect to the MRCA of [*Megalosaurus*](/wiki/Megalosaurus) and [*Iguanodon*](/wiki/Iguanodon), because these were two of the three genera cited by Richard Owen when he recognized the Dinosauria.<ref name=olshevsky2000/> Both definitions result in the same set of animals being defined as dinosaurs: "Dinosauria = [Ornithischia](/wiki/Ornithischia) + [Saurischia](/wiki/Saurischia)", encompassing [theropods](/wiki/Theropoda) (mostly [bipedal](/wiki/Bipedalism) [carnivores](/wiki/Carnivore) and [birds](/wiki/Bird)), [ankylosaurians](/wiki/Ankylosauria) (armored herbivorous quadrupeds), [stegosaurians](/wiki/Stegosauria) (plated herbivorous quadrupeds), [ceratopsians](/wiki/Ceratopsia) (herbivorous quadrupeds with horns and frills), [ornithopods](/wiki/Ornithopod) (bipedal or quadrupedal herbivores including "duck-bills"), and [sauropodomorphs](/wiki/Sauropodomorpha) (mostly large [herbivorous](/wiki/Herbivore) [quadrupeds](/wiki/Quadruped) with long necks and tails).[[6]](#cite_note-6) Birds are now recognized as being the sole surviving lineage of theropod dinosaurs. In traditional taxonomy, birds were considered a separate [class](/wiki/Class_(biology)) that had evolved from dinosaurs, a distinct [superorder](/wiki/Superorder). However, a majority of contemporary paleontologists concerned with dinosaurs reject the traditional style of classification in favor of phylogenetic taxonomy; this approach requires that, for a group to be natural, all descendants of members of the group must be included in the group as well. Birds are thus considered to be dinosaurs and dinosaurs are, therefore, not extinct. Birds are classified as belonging to the subgroup [Maniraptora](/wiki/Maniraptora), which are [coelurosaurs](/wiki/Coelurosauria), which are theropods, which are [saurischians](/wiki/Saurischia), which are dinosaurs.<ref name=basalavialae>Padian, K. (2004). "Basal Avialae". In Weishampel, D.B.; Dodson, P.; Osmolska, H. (eds.). *The Dinosauria (Second ed.)*. Berkeley: University of California Press. pp. 210–231. ISBN 0-520-24209-2</ref>

### General description[[edit](/index.php?title=(none)&action=edit&section=3)]

[thumb|alt=montage of four birds|In phylogenetic taxonomy, birds are included in the group Dinosauria.](/wiki/File:Neognathae.jpg) Using one of the above definitions, dinosaurs can be generally described as [archosaurs](/wiki/Archosaur) with [hind limbs held erect beneath the body](/wiki/Terrestrial_locomotion#Posture).<ref name=DFG97/> Many prehistoric animal groups are popularly conceived of as dinosaurs, such as [ichthyosaurs](/wiki/Ichthyosaur), [mosasaurs](/wiki/Mosasaur), [plesiosaurs](/wiki/Plesiosaur), [pterosaurs](/wiki/Pterosaur), and [*Dimetrodon*](/wiki/Dimetrodon), but are not classified scientifically as dinosaurs, and none had the erect hind limb posture characteristic of true dinosaurs.<ref name=DL90/> Dinosaurs were the dominant terrestrial vertebrates of the Mesozoic, especially the [Jurassic](/wiki/Jurassic) and [Cretaceous](/wiki/Cretaceous) periods. Other groups of animals were restricted in size and niches; mammals, for example, rarely exceeded the size of a cat, and were generally rodent-sized carnivores of small prey.<ref name=MM97/>

Dinosaurs have always been an extremely varied group of animals; according to a 2006 study, over 500 non-avian dinosaur genera have been identified with certainty so far, and the total number of genera preserved in the fossil record has been estimated at around 1850, nearly 75% of which remain to be discovered.<ref name=Wang&Dodson/> An earlier study predicted that about 3400 dinosaur genera existed, including many that would not have been preserved in the fossil record.<ref name=russell1995/> By September 17, 2008, 1047 different species of dinosaurs had been named.<ref name=AmosBBC/> Some are herbivorous, others carnivorous, including seed-eaters, fish-eaters, insectivores, and omnivores. While dinosaurs were ancestrally bipedal (as are all modern birds), some prehistoric species were quadrupeds, and others, such as [*Ammosaurus*](/wiki/Ammosaurus) and [*Iguanodon*](/wiki/Iguanodon), could walk just as easily on two or four legs. Cranial modifications like horns and crests are common dinosaurian traits, and some extinct species had [bony armor](/wiki/Armour_(anatomy)). Although known for large size, many Mesozoic dinosaurs were human-sized or smaller, and modern birds are generally small in size. Dinosaurs today inhabit every continent, and fossils show that they had achieved global distribution by at least the early Jurassic period.<ref name=MacLeod/> Modern birds inhabit most available habitats, from terrestrial to marine, and there is evidence that some non-avian dinosaurs (such as [*Microraptor*](/wiki/Microraptor)) could fly or at least glide, and others, such as [spinosaurids](/wiki/Spinosauridae), had semi-aquatic habits.<ref name=RMetal10/>

### Distinguishing anatomical features[[edit](/index.php?title=(none)&action=edit&section=4)]

While recent discoveries have made it more difficult to present a universally agreed-upon list of dinosaurs' distinguishing features, nearly all dinosaurs discovered so far share certain modifications to the ancestral [archosaurian](/wiki/Archosaur) skeleton, or are clear descendants of older dinosaurs showing these modifications. Although some later groups of dinosaurs featured further modified versions of these traits, they are considered typical for Dinosauria; the earliest dinosaurs had them and passed them on to their descendants. Such modifications, originating in the [last common ancestor](/wiki/Last_common_ancestor) of a certain taxonomic group, are called the [synapomorphies](/wiki/Synapomorphy) of such a group.[[7]](#cite_note-7) A detailed assessment of archosaur interrelations by [Sterling Nesbitt](/wiki/Sterling_Nesbitt)<ref name=nesbitt2011/> confirmed or found the following twelve unambiguous synapomorphies, some previously known:

* in the skull, a supratemporal fossa (excavation) is present in front of the supratemporal [fenestra](/wiki/Temporal_fenestra#Temporal_fenestrae), the main opening in the rear skull roof
* [epipophyses](/wiki/Epipophyses), obliquely backward pointing processes on the rear top corners, present in the anterior (front) neck vertebrae behind the [atlas](/wiki/Atlas_(anatomy)) and [axis](/wiki/Axis_(anatomy)), the first two neck vertebrae
* apex of deltopectoral crest (a projection on which the [deltopectoral](/wiki/Clavipectoral_triangle) muscles attach) located at or more than 30% down the length of the [humerus](/wiki/Humerus) (upper arm bone)
* [radius](/wiki/Radius_(bone)), a lower arm bone, shorter than 80% of humerus length
* [fourth trochanter](/wiki/Fourth_trochanter) (projection where the [caudofemoralis](/wiki/Caudofemoralis) muscle attaches on the inner rear shaft) on the [femur](/wiki/Femur) (thighbone) is a sharp flange
* fourth trochanter asymmetrical, with distal, lower, margin forming a steeper angle to the shaft
* on the [astragalus](/wiki/Talus_bone) and [calcaneum](/wiki/Calcaneus), upper ankle bones, the proximal articular facet, the top connecting surface, for the [fibula](/wiki/Fibula) occupies less than 30% of the transverse width of the element
* exoccipitals (bones at the back of the skull) do not meet along the midline on the floor of the endocranial cavity, the inner space of the braincase
* in the pelvis, the proximal articular surfaces of the [ischium](/wiki/Ischium) with the [ilium](/wiki/Ilium_(bone)) and the [pubis](/wiki/Pubis_(bone)) are separated by a large concave surface (on the upper side of the ischium a part of the open hip joint is located between the contacts with the pubic bone and the ilium)
* [cnemial crest](/wiki/Cnemial_crest) on the [tibia](/wiki/Tibia) (protruding part of the top surface of the shinbone) arcs anterolaterally (curves to the front and the outer side)
* distinct proximodistally oriented (vertical) ridge present on the posterior face of the distal end of the tibia (the rear surface of the lower end of the shinbone)
* concave articular surface for the fibula of the calcaneum (the top surface of the calcaneum, where it touches the fibula, has a hollow profile)

Nesbitt found a number of further potential synapomorphies, and discounted a number of synapomorphies previously suggested. Some of these are also present in [silesaurids](/wiki/Silesauridae), which Nesbitt recovered as a sister group to Dinosauria, including a large anterior trochanter, metatarsals II and IV of subequal length, reduced contact between ischium and pubis, the presence of a cnemial crest on the tibia and of an ascending process on the astragalus, and many others.<ref name=MJB04dino/> [thumb|left|Diagram of a typical diapsid skull  
j:](/wiki/File:Skull_diapsida_1.svg) [jugal bone](/wiki/Jugal_bone), po: [postorbital bone](/wiki/Postorbital_bone), p: [parietal bone](/wiki/Parietal_bone), sq: [squamosal bone](/wiki/Squamosal_bone), q: [quadrate bone](/wiki/Quadrate_bone), qj: [quadratojugal bone](/wiki/Quadratojugal_bone) A variety of other skeletal features are shared by dinosaurs. However, because they are either common to other groups of [archosaurs](/wiki/Archosaurs) or were not present in all early dinosaurs, these features are not considered to be synapomorphies. For example, as [diapsids](/wiki/Diapsid), dinosaurs ancestrally had two pairs of [temporal fenestrae](/wiki/Temporal_fenestra) (openings in the skull behind the eyes), and as members of the diapsid group Archosauria, had additional openings in the [snout](/wiki/Antorbital_fenestra) and lower jaw.<ref name=TRHJ00/> Additionally, several characteristics once thought to be synapomorphies are now known to have appeared before dinosaurs, or were absent in the earliest dinosaurs and independently evolved by different dinosaur groups. These include an elongated [scapula](/wiki/Scapula), or shoulder blade; a [sacrum](/wiki/Sacrum) composed of three or more fused [vertebrae](/wiki/Spinal_vertebra) (three are found in some other archosaurs, but only two are found in [*Herrerasaurus*](/wiki/Herrerasaurus));<ref name=MJB04dino/> and a [perforate acetabulum](/wiki/Acetabulum#Perforate_Acetabulum), or hip socket, with a hole at the center of its inside surface (closed in [*Saturnalia*](/wiki/Saturnalia_(dinosaur)), for example).[[8]](#cite_note-8)<ref name=LARB99/> Another difficulty of determining distinctly dinosaurian features is that early dinosaurs and other archosaurs from the late Triassic are often poorly known and were similar in many ways; these animals have sometimes been misidentified in the literature.<ref name=NIP07/> [thumb|Hip joints and hindlimb postures of: (left to right) typical reptiles (sprawling), dinosaurs and mammals (erect), and](/wiki/File:Sprawling_and_erect_hip_joints_-_horizontal.svg) [rauisuchians](/wiki/Rauisuchia) (erect) Dinosaurs stand with their hind limbs erect in a manner similar to [most modern mammals](/wiki/Evolution_of_mammals#Erect_limbs), but distinct from most other reptiles, whose limbs sprawl out to either side.<ref name=Holland1909/> This posture is due to the development of a laterally facing recess in the pelvis (usually an open socket) and a corresponding inwardly facing distinct head on the femur.<ref name=MJB00/> Their erect posture enabled early dinosaurs to breathe easily while moving, which likely permitted stamina and activity levels that [surpassed those of "sprawling" reptiles](/wiki/Carrier's_constraint).<ref name=RC05/> Erect limbs probably also helped support the evolution of large size by reducing bending stresses on limbs.<ref name=TKMB07/> Some non-dinosaurian archosaurs, including [rauisuchians](/wiki/Rauisuchia), also had erect limbs but achieved this by a "pillar erect" configuration of the hip joint, where instead of having a projection from the femur insert on a socket on the hip, the [upper pelvic bone](/wiki/Ilium_(bone)) was rotated to form an overhanging shelf.<ref name=TKMB07/>

## Evolutionary history[[edit](/index.php?title=(none)&action=edit&section=5)]

[Template:Life timeline](/wiki/Template:Life_timeline) [Template:Main article](/wiki/Template:Main_article)

### Origins and early evolution[[edit](/index.php?title=(none)&action=edit&section=6)]

Dinosaurs diverged from their [archosaur](/wiki/Archosaur) ancestors during the middle to late [Triassic](/wiki/Triassic) period, roughly 20 million years after the [Permian–Triassic extinction event](/wiki/Permian–Triassic_extinction_event) wiped out an estimated 95% of all [life on Earth](/wiki/Life).<ref name=KPA/><ref name=TannerLucas/> [Radiometric dating](/wiki/Radiometric_dating) of the [rock formation](/wiki/Rock_formation) that contained fossils from the early dinosaur [genus](/wiki/Genus) [*Eoraptor*](/wiki/Eoraptor) at 231.4 million years old establishes its presence in the fossil record at this time.<ref name=OARM2010>[Template:Cite journal](/wiki/Template:Cite_journal) <http://www.pensoft.net/inc/journals/download.php?fileId=1401&fileTable=J_GALLEYS></ref> Paleontologists think that *Eoraptor* resembles the [common ancestor](/wiki/Common_descent) of all dinosaurs;<ref name=Sereno1999/> if this is true, its traits suggest that the first dinosaurs were small, bipedal [predators](/wiki/Predation).<ref name=SFRM93/> The discovery of primitive, dinosaur-like [ornithodirans](/wiki/Ornithodiran) such as [*Marasuchus*](/wiki/Marasuchus) and [*Lagerpeton*](/wiki/Lagerpeton) in [Argentinian](/wiki/Argentina) [Middle Triassic](/wiki/Middle_Triassic) strata supports this view; analysis of recovered fossils suggests that these animals were indeed small, bipedal predators. Dinosaurs may have appeared as early as 243 million years ago, as evidenced by remains of the genus [*Nyasasaurus*](/wiki/Nyasasaurus) from that period, though known fossils of these animals are too fragmentary to tell if they are dinosaurs or very close dinosaurian relatives.<ref name=nyasasaurus>Nesbitt, S. J., Barrett, P. M., Werning, S., Sidor, C. A., and A. J. Charig. (2012). "The oldest dinosaur? A Middle Triassic dinosauriform from Tanzania." *Biology Letters*.</ref>

When dinosaurs appeared, they were not the dominant terrestrial animals. The terrestrial habitats were occupied by various types of [archosauromorphs](/wiki/Archosauromorpha) and [therapsids](/wiki/Therapsida), like [cynodonts](/wiki/Cynodont) and [rhynchosaurs](/wiki/Rhynchosaur). Their main competitors were the [pseudosuchia](/wiki/Pseudosuchia), such as [aetosaurs](/wiki/Aetosaur), [ornithosuchids](/wiki/Ornithosuchidae) and [rauisuchians](/wiki/Rauisuchia), which were more successful than the dinosaurs.[[9]](#cite_note-9) Most of these other animals became extinct in the Triassic, in one of two events. First, at about 215 million years ago, a variety of basal [archosauromorphs](/wiki/Archosauromorpha), including the [protorosaurs](/wiki/Protorosauria), became extinct. This was followed by the [Triassic–Jurassic extinction event](/wiki/Triassic–Jurassic_extinction_event) (about 200 million years ago), that saw the end of most of the other groups of early archosaurs, like aetosaurs, ornithosuchids, [phytosaurs](/wiki/Phytosaur), and rauisuchians. Rhynchosaurs and [dicynodonts](/wiki/Dicynodont) survived (at least in some areas) at least as late as early-mid [Norian](/wiki/Norian) and early [Rhaetian](/wiki/Rhaetian), respectively,[[10]](#cite_note-10)<ref name=DSN08>[Template:Cite journal](/wiki/Template:Cite_journal)</ref> and the exact date of their extinction is uncertain. These losses left behind a land fauna of [crocodylomorphs](/wiki/Crocodylomorpha), dinosaurs, [mammals](/wiki/Mammal), [pterosaurians](/wiki/Pterosauria), and [turtles](/wiki/Turtle).<ref name=MJB04dino/> The first few lines of early dinosaurs [diversified](/wiki/Adaptive_radiation) through the [Carnian](/wiki/Carnian) and [Norian](/wiki/Norian) [stages](/wiki/Faunal_stage) of the Triassic, possibly by occupying the niches of the groups that became extinct.[[6]](#cite_note-6)

### Evolution and paleobiogeography[[edit](/index.php?title=(none)&action=edit&section=7)]

Dinosaur evolution after the Triassic follows changes in vegetation and the location of continents. In the late Triassic and early Jurassic, the continents were connected as the single landmass [Pangaea](/wiki/Pangaea), and there was a worldwide dinosaur fauna mostly composed of [coelophysoid](/wiki/Coelophysoidea) [carnivores](/wiki/Carnivore) and early [sauropodomorph](/wiki/Sauropodomorph) [herbivores](/wiki/Herbivore).<ref name=HCL04/> [Gymnosperm](/wiki/Gymnosperm) plants (particularly [conifers](/wiki/Conifer)), a potential food source, radiated in the late Triassic. Early sauropodomorphs did not have sophisticated mechanisms for processing food in the mouth, and so must have employed other means of breaking down food farther along the digestive tract.<ref name=FS04/> The general homogeneity of dinosaurian faunas continued into the middle and late Jurassic, where most localities had predators consisting of [ceratosaurians](/wiki/Ceratosauria), [spinosauroids](/wiki/Spinosauroidea), and [carnosaurians](/wiki/Carnosauria), and herbivores consisting of [stegosaurian](/wiki/Stegosauria) ornithischians and large sauropods. Examples of this include the [Morrison Formation](/wiki/Morrison_Formation) of North America and [Tendaguru Beds](/wiki/Tendaguru) of Tanzania. Dinosaurs in China show some differences, with specialized [sinraptorid](/wiki/Sinraptoridae) theropods and unusual, long-necked sauropods like [*Mamenchisaurus*](/wiki/Mamenchisaurus).<ref name=HCL04/> [Ankylosaurians](/wiki/Ankylosauria) and [ornithopods](/wiki/Ornithopoda) were also becoming more common, but [prosauropods](/wiki/Prosauropods) had become extinct. Conifers and [pteridophytes](/wiki/Pteridophyte) were the most common plants. Sauropods, like the earlier prosauropods, were not oral processors, but ornithischians were evolving various means of dealing with food in the mouth, including potential [cheek](/wiki/Cheek)-like organs to keep food in the mouth, and jaw motions to grind food.<ref name=FS04/> Another notable evolutionary event of the Jurassic was the appearance of true birds, descended from [maniraptoran](/wiki/Maniraptora) [coelurosaurians](/wiki/Coelurosauria).<ref name=KP04/> [thumb|Skeleton of *Marasuchus lilloensis*, a dinosaur-like](/wiki/File:Marasuchus.JPG) [ornithodiran](/wiki/Avemetatarsalia) By the early Cretaceous and the ongoing breakup of Pangaea, dinosaurs were becoming strongly differentiated by landmass. The earliest part of this time saw the spread of ankylosaurians, [iguanodontians](/wiki/Iguanodontia), and [brachiosaurids](/wiki/Brachiosauridae) through Europe, North America, and northern Africa. These were later supplemented or replaced in Africa by large [spinosaurid](/wiki/Spinosaurid) and [carcharodontosaurid](/wiki/Carcharodontosauridae) theropods, and [rebbachisaurid](/wiki/Rebbachisauridae) and [titanosaurian](/wiki/Titanosauria) sauropods, also found in South America. In Asia, maniraptoran coelurosaurians like [dromaeosaurids](/wiki/Dromaeosauridae), [troodontids](/wiki/Troodontidae), and [oviraptorosaurians](/wiki/Oviraptorosauria) became the common theropods, and [ankylosaurids](/wiki/Ankylosauridae) and early [ceratopsians](/wiki/Ceratopsia) like *Psittacosaurus* became important herbivores. Meanwhile, Australia was home to a fauna of basal ankylosaurians, [hypsilophodonts](/wiki/Hypsilophodont), and iguanodontians.<ref name=HCL04/> The stegosaurians appear to have gone extinct at some point in the late early Cretaceous or early late Cretaceous. A major change in the early Cretaceous, which would be amplified in the late Cretaceous, was the evolution of [flowering plants](/wiki/Angiosperm). At the same time, several groups of dinosaurian herbivores evolved more sophisticated ways to orally process food. Ceratopsians developed a method of slicing with teeth stacked on each other in batteries, and iguanodontians refined a method of grinding with tooth batteries, taken to its extreme in [hadrosaurids](/wiki/Hadrosaurid).<ref name=FS04/> Some sauropods also evolved tooth batteries, best exemplified by the rebbachisaurid [*Nigersaurus*](/wiki/Nigersaurus).<ref name=serenoetal07/> [thumb|alt=Full skeleton of an early carnivorous dinosaur, displayed in a glass case in a museum|The early forms](/wiki/File:Herrerasaurusskeleton.jpg) [*Herrerasaurus*](/wiki/Herrerasaurus) (large), [*Eoraptor*](/wiki/Eoraptor) (small) and a [*Plateosaurus*](/wiki/Plateosaurus) skull There were three general dinosaur faunas in the late Cretaceous. In the northern continents of North America and Asia, the major theropods were [tyrannosaurids](/wiki/Tyrannosauridae) and various types of smaller maniraptoran theropods, with a predominantly ornithischian herbivore assemblage of hadrosaurids, ceratopsians, ankylosaurids, and [pachycephalosaurians](/wiki/Pachycephalosauria). In the southern continents that had made up the now-splitting [Gondwana](/wiki/Gondwana), [abelisaurids](/wiki/Abelisauridae) were the common theropods, and titanosaurian sauropods the common herbivores. Finally, in Europe, dromaeosaurids, [rhabdodontid](/wiki/Rhabdodontidae) iguanodontians, [nodosaurid](/wiki/Nodosauridae) ankylosaurians, and titanosaurian sauropods were prevalent.<ref name=HCL04/> Flowering plants were greatly radiating,<ref name=FS04/> with the first grasses appearing by the end of the Cretaceous.<ref name=PSAS05/> Grinding hadrosaurids and shearing ceratopsians became extremely diverse across North America and Asia. Theropods were also radiating as herbivores or [omnivores](/wiki/Omnivore), with [therizinosaurians](/wiki/Therizinosaur) and [ornithomimosaurians](/wiki/Ornithomimosauria) becoming common.<ref name=FS04/>

The [Cretaceous–Paleogene extinction event](/wiki/Cretaceous–Paleogene_extinction_event), which occurred approximately 66 million years ago at the end of the Cretaceous period, caused the extinction of all dinosaur groups except for the [neornithine](/wiki/Neornithes) birds. Some other [diapsid](/wiki/Diapsid) groups, such as crocodilians, [sebecosuchians](/wiki/Sebecosuchia), [turtles](/wiki/Turtle), [lizards](/wiki/Lizard), [snakes](/wiki/Snake), [sphenodontians](/wiki/Sphenodontia), and [choristoderans](/wiki/Choristodera), also survived the event.<ref name=AF04/>

The surviving lineages of neornithine birds, including the ancestors of modern [ratites](/wiki/Ratite), [ducks and chickens](/wiki/Galloanserae), and a variety of [waterbirds](/wiki/Charadriiformes), diversified rapidly at the beginning of the [Paleogene](/wiki/Paleogene) period, entering ecological niches left vacant by the extinction of Mesozoic dinosaur groups such as the arboreal [enantiornithines](/wiki/Enantiornithine), aquatic [hesperornithines](/wiki/Hesperornithine), and even the larger terrestrial theropods (in the form of [*Gastornis*](/wiki/Gastornis), [eogruiids](/wiki/Eogruidae), [bathornithids](/wiki/Bathornithids), [ratites](/wiki/Ratites), [geranoidids](/wiki/Geranoididae), [mihirungs](/wiki/Mihirung), and "[terror birds](/wiki/Terror_bird)"). It is often cited that mammals out-competed the neornithines for dominance of most terrestrial niches but many of these groups co-existed with rich mammalian faunas for most of the Cenozoic.<ref name=lindow>Lindow, B.E.K. (2011). "Bird Evolution Across the K–Pg Boundary and the Basal Neornithine Diversification." In Dyke, G. and Kaiser, G. (eds.)*Living Dinosaurs: The Evolutionary History of Modern Birds*, John Wiley & Sons, Ltd, Chichester, UK. [Template:Doi](/wiki/Template:Doi)</ref> [Terror birds](/wiki/Terror_bird) and [bathornithids](/wiki/Bathornithids) occupied carnivorous guilds alongside predatory mammals,[[11]](#cite_note-11)[[12]](#cite_note-12) and ratites are still being fairly successful as mid-sized herbivores; eogruiids similarly lasted from the Eocene to [Pliocene](/wiki/Pliocene), only becoming extinct very recently after over 20 million years of co-existence with many mammal groups.[[13]](#cite_note-13)

## Classification[[edit](/index.php?title=(none)&action=edit&section=8)]

[Template:Main article](/wiki/Template:Main_article)

Dinosaurs are [archosaurs](/wiki/Archosaur), like modern [crocodilians](/wiki/Crocodilia). Within the archosaur group, dinosaurs are differentiated most noticeably by their gait. Dinosaur legs extend directly beneath the body, whereas the legs of lizards and crocodilians sprawl out to either side.[[7]](#cite_note-7) Collectively, dinosaurs as a [clade](/wiki/Clade) are divided into two primary branches, [Saurischia](/wiki/Saurischia) and [Ornithischia](/wiki/Ornithischia). Saurischia includes those taxa sharing a more recent common ancestor with birds than with [Ornithischia](/wiki/Ornithischia), while Ornithischia includes all [taxa](/wiki/Taxon) sharing a more recent common ancestor with [*Triceratops*](/wiki/Triceratops) than with Saurischia. Anatomically, these two groups can be distinguished most noticeably by their [pelvic](/wiki/Pelvis) structure. Early saurischians—"lizard-hipped", from the [Greek](/wiki/Ancient_Greek) *sauros* (σαῦρος) meaning "lizard" and *ischion* (ἰσχίον) meaning "hip joint"—retained the hip structure of their ancestors, with a [pubis](/wiki/Pubis_(bone)) bone directed [cranially](/wiki/Anatomical_terms_of_location), or forward.<ref name=MJB00/> This basic form was modified by rotating the pubis backward to varying degrees in several groups ([*Herrerasaurus*](/wiki/Herrerasaurus),<ref name=GSP88/> [therizinosauroids](/wiki/Therizinosaur),<ref name=clarketal2004/> [dromaeosaurids](/wiki/Dromaeosauridae),<ref name=MAPM04/> and [birds](/wiki/Bird)<ref name=KP04/>). Saurischia includes the [theropods](/wiki/Theropoda) (exclusively bipedal and with a wide variety of diets) and [sauropodomorphs](/wiki/Sauropodomorpha) (long-necked [herbivores](/wiki/Herbivore) which include advanced, quadrupedal groups).<ref name=theropods>[Template:Cite journal](/wiki/Template:Cite_journal)</ref><ref name=sauropodomorphs>[Template:Cite journal](/wiki/Template:Cite_journal)</ref>

By contrast, ornithischians—"bird-hipped", from the [Greek](/wiki/Ancient_Greek) *ornitheios* (ὀρνίθειος) meaning "of a bird" and *ischion* (ἰσχίον) meaning "hip joint"—had a pelvis that superficially resembled a bird's pelvis: the [pubis](/wiki/Pubis_(bone)) bone was oriented [caudally](/wiki/Anatomical_terms_of_location) (rear-pointing). Unlike birds, the ornithischian pubis also usually had an additional forward-pointing process. Ornithischia includes a variety of species which were primarily herbivores. (**NB:** the terms "lizard hip" and "bird hip" are misnomers – birds evolved from dinosaurs with "lizard hips".)[[7]](#cite_note-7) <gallery class="center" mode="packed" heights="170px"> Image:Saurischia pelvis.png|[Saurischian](/wiki/Saurischia) pelvis structure (left side) Image:Tyrannosaurus pelvis left.jpg|[*Tyrannosaurus*](/wiki/Tyrannosaurus) pelvis (showing saurischian structure – left side) Image:Ornithischia pelvis.png|[Ornithischian](/wiki/Ornithischia) pelvis structure (left side) Image:Edmontosaurus pelvis left.jpg|[*Edmontosaurus*](/wiki/Edmontosaurus) pelvis (showing ornithischian structure – left side) </gallery>

### Taxonomy[[edit](/index.php?title=(none)&action=edit&section=9)]

The following is a simplified classification of dinosaur groups based on their evolutionary relationships, and organized based on the list of Mesozoic dinosaur species provided by Holtz (2007).[[3]](#cite_note-3) A more detailed version can be found at [Dinosaur classification](/wiki/Dinosaur_classification). The dagger (†) is used to signify groups with no living members.

* **Dinosauria**
* [**Saurischia**](/wiki/Saurischia) ("lizard-hipped"; includes Theropoda and Sauropodomorpha)
* [**Theropoda**](/wiki/Theropoda) (all [bipedal](/wiki/Bipedalism); most were carnivorous)

[thumb|Artist's impression of six](/wiki/File:Dromaeosaurid_parade_by_durbed.jpg) [dromaeosaurid](/wiki/Dromaeosauridae) [theropods](/wiki/Theropoda): from left to right [*Microraptor*](/wiki/Microraptor), [*Dromaeosaurus*](/wiki/Dromaeosaurus), [*Austroraptor*](/wiki/Austroraptor), [*Velociraptor*](/wiki/Velociraptor), [*Utahraptor*](/wiki/Utahraptor), and [*Deinonychus*](/wiki/Deinonychus)

* †[Herrerasauria](/wiki/Herrerasauridae) (early bipedal carnivores)
* †[Coelophysoidea](/wiki/Coelophysoidea) (small, early theropods; includes [*Coelophysis*](/wiki/Coelophysis) and close relatives)
* †[Dilophosauridae](/wiki/Dilophosauridae) (early crested and carnivorous theropods)
* †[Ceratosauria](/wiki/Ceratosauria) (generally elaborately horned, the dominant southern carnivores of the Cretaceous)
* [Tetanurae](/wiki/Tetanurae) ("stiff tails"; includes most theropods)
* †[Megalosauroidea](/wiki/Megalosauroidea) (early group of large carnivores including the semi-aquatic spinosaurids)
* †[Carnosauria](/wiki/Carnosauria) ([*Allosaurus*](/wiki/Allosaurus) and close relatives, like [*Carcharodontosaurus*](/wiki/Carcharodontosaurus))
* [Coelurosauria](/wiki/Coelurosauria) (feathered theropods, with a range of body sizes and niches)
* †[Compsognathidae](/wiki/Compsognathidae) (common early coelurosaurs with reduced forelimbs)
* †[Tyrannosauridae](/wiki/Tyrannosauridae) ([*Tyrannosaurus*](/wiki/Tyrannosaurus) and close relatives; had reduced forelimbs)
* †[Ornithomimosauria](/wiki/Ornithomimosauria) ("[ostrich](/wiki/Ostrich)-mimics"; mostly toothless; carnivores to possible herbivores)
* †[Alvarezsauroidea](/wiki/Alvarezsaur) (small insectivores with reduced forelimbs each bearing one enlarged claw)
* [Maniraptora](/wiki/Maniraptora) ("hand snatchers"; had long, slender arms and fingers)
* †[Therizinosauria](/wiki/Therizinosaur) (bipedal herbivores with large hand claws and small heads)
* †[Oviraptorosauria](/wiki/Oviraptorosauria) (mostly toothless; their diet and lifestyle are uncertain)
* †[Archaeopterygidae](/wiki/Archaeopterygidae) (small, winged theropods or primitive birds)
* †[Deinonychosauria](/wiki/Dromaeosauridae#Deinonychosauria) (small- to medium-sized; bird-like, with a distinctive toe claw)
* [Avialae](/wiki/Avialae) (modern birds and extinct relatives)
* †[Scansoriopterygidae](/wiki/Scansoriopterygidae) (small primitive avialans with long third fingers)
* †[Omnivoropterygidae](/wiki/Omnivoropterygidae) (large, early short-tailed avialans)
* †[Confuciusornithidae](/wiki/Confuciusornithidae) (small toothless avialans)
* †[Enantiornithes](/wiki/Enantiornithes) (primitive tree-dwelling, flying avialans)
* [Euornithes](/wiki/Euornithes) (advanced flying birds)
* †[Yanornithiformes](/wiki/Yanornithiformes) (toothed Cretaceous Chinese birds)
* †[Hesperornithes](/wiki/Hesperornithes) (specialized aquatic diving birds)
* [**Aves**](/wiki/Bird) (modern, beaked birds and their extinct relatives)

[thumb|Artist's impression of four](/wiki/File:Macronaria_scrubbed_enh.jpg) [macronarian](/wiki/Macronaria) [sauropods](/wiki/Sauropoda): from left to right [*Camarasaurus*](/wiki/Camarasaurus), [*Brachiosaurus*](/wiki/Brachiosaurus), [*Giraffatitan*](/wiki/Giraffatitan), and [*Euhelopus*](/wiki/Euhelopus)

* †[**Sauropodomorpha**](/wiki/Sauropodomorpha) (herbivores with small heads, long necks, long tails)
* †[Guaibasauridae](/wiki/Guaibasauridae) (small, primitive, omnivorous sauropodomorphs)
* †[Plateosauridae](/wiki/Plateosauridae) (primitive, strictly bipedal "prosauropods")
* †[Riojasauridae](/wiki/Riojasauridae) (small, primitive sauropodomorphs)
* †[Massospondylidae](/wiki/Massospondylidae) (small, primitive sauropodomorphs)
* †[Sauropoda](/wiki/Sauropoda) (very large and heavy, usually over [Template:Convert](/wiki/Template:Convert) long; quadrupedal)
* †[Vulcanodontidae](/wiki/Vulcanodontidae) (primitive sauropods with pillar-like limbs)
* †[Eusauropoda](/wiki/Eusauropoda) ("true sauropods")
* †[Cetiosauridae](/wiki/Cetiosauridae) ("whale reptiles")
* †[Turiasauria](/wiki/Turiasauria) (European group of Jurassic and Cretaceous sauropods)
* †[Neosauropoda](/wiki/Neosauropoda) ("new sauropods")
* †[Diplodocoidea](/wiki/Diplodocoidea) (skulls and tails elongated; teeth typically narrow and pencil-like)
* †[Macronaria](/wiki/Macronaria) (boxy skulls; spoon- or pencil-shaped teeth)
* †[Brachiosauridae](/wiki/Brachiosauridae) (long-necked, long-armed macronarians)
* †[Titanosauria](/wiki/Titanosaur) (diverse; stocky, with wide hips; most common in the late Cretaceous of southern continents)

[thumb|Artist's impression of six](/wiki/File:Ornithopods_jconway.jpg) [ornithopods](/wiki/Ornithopod) and one [heterodontosaurid](/wiki/Heterodontosauridae). Far left: [*Camptosaurus*](/wiki/Camptosaurus), left: [*Iguanodon*](/wiki/Iguanodon), center background: [*Shantungosaurus*](/wiki/Shantungosaurus), center foreground: [*Dryosaurus*](/wiki/Dryosaurus), right: [*Corythosaurus*](/wiki/Corythosaurus), far right (small): [*Heterodontosaurus*](/wiki/Heterodontosaurus), far right (large) [*Tenontosaurus*](/wiki/Tenontosaurus).

* †[**Ornithischia**](/wiki/Ornithischia) ("bird-hipped"; diverse bipedal and quadrupedal herbivores)
* †[Heterodontosauridae](/wiki/Heterodontosauridae) (small basal ornithopod herbivores/omnivores with prominent [canine-like teeth](/wiki/Canine_tooth))
* †[Thyreophora](/wiki/Thyreophora) (armored dinosaurs; mostly quadrupeds)
* †[**Ankylosauria**](/wiki/Ankylosauria) ([scutes](/wiki/Scute) as primary armor; some had club-like tails)
* †[**Stegosauria**](/wiki/Stegosauria) (spikes and plates as primary armor)
* †[Neornithischia](/wiki/Neornithischia) ("new ornithischians")
* †[**Ornithopoda**](/wiki/Ornithopod) (various sizes; bipeds and quadrupeds; evolved a method of chewing using skull flexibility and numerous teeth)
* †[Marginocephalia](/wiki/Marginocephalia) (characterized by a cranial growth)
* †[Pachycephalosauria](/wiki/Pachycephalosauria) (bipeds with domed or knobby growth on skulls)
* †[**Ceratopsia**](/wiki/Ceratopsia) (quadrupeds with frills; many also had horns)

## Biology[[edit](/index.php?title=(none)&action=edit&section=10)]

Knowledge about dinosaurs is derived from a variety of fossil and non-fossil records, including fossilized [bones](/wiki/Bone), [feces](/wiki/Feces), [trackways](/wiki/Trackway), [gastroliths](/wiki/Gastrolith), [feathers](/wiki/Feather), impressions of skin, [internal organs](/wiki/Viscus) and [soft tissues](/wiki/Soft_tissue).[[14]](#cite_note-14)[[15]](#cite_note-15) Many fields of study contribute to our understanding of dinosaurs, including [physics](/wiki/Physics) (especially [biomechanics](/wiki/Biomechanics)), [chemistry](/wiki/Chemistry), [biology](/wiki/Biology), and the [earth sciences](/wiki/Earth_sciences) (of which [paleontology](/wiki/Paleontology) is a sub-discipline).<ref name=dinobiomechanics>[Template:Cite journal](/wiki/Template:Cite_journal)</ref><ref name=dinobiology>[Template:Cite journal](/wiki/Template:Cite_journal)</ref> Two topics of particular interest and study have been dinosaur size and behavior.<ref name=thedinosauria90>Weishampel, D.B., Dodson, P., Oslmolska, H. (1990). "The Dinosauria". *University of California Press*. pp. 733. ISBN 0-520-06727-4</ref>

### Size[[edit](/index.php?title=(none)&action=edit&section=11)]

[Template:Main article](/wiki/Template:Main_article) [thumb|400px|Scale diagram comparing the average human to the largest known dinosaurs in five major](/wiki/File:Largestdinosaursbysuborder_scale.png) [clades](/wiki/Clade): [Sauropoda](/wiki/Sauropoda) ([*Argentinosaurus huinculensis*](/wiki/Argentinosaurus)), [Ornithopoda](/wiki/Ornithopod) ([*Shantungosaurus giganteus*](/wiki/Shantungosaurus)), [Theropoda](/wiki/Theropoda) ([*Spinosaurus aegyptiacus*](/wiki/Spinosaurus)), [Thyreophora](/wiki/Thyreophora) ([*Stegosaurus armatus*](/wiki/Stegosaurus)) and [Marginocephalia](/wiki/Marginocephalia) ([*Triceratops prorsus*](/wiki/Triceratops)) Current evidence suggests that dinosaur average size varied through the Triassic, early Jurassic, late Jurassic and Cretaceous periods.<ref name=Sereno1999/> Predatory theropod dinosaurs, which occupied most terrestrial carnivore niches during the Mesozoic, most often fall into the [Template:Convert](/wiki/Template:Convert) category when sorted by estimated weight into categories based on [order of magnitude](/wiki/Order_of_magnitude), whereas [recent](/wiki/Holocene) predatory [carnivoran](/wiki/Carnivora) mammals peak in the [Template:Convert](/wiki/Template:Convert) category.<ref name=JF93/> The [mode](/wiki/Mode_(statistics)) of Mesozoic dinosaur body masses is between one and ten metric tonnes.<ref name=Peczkis1994/> This contrasts sharply with the size of [Cenozoic](/wiki/Cenozoic) mammals, estimated by the [National Museum of Natural History](/wiki/National_Museum_of_Natural_History) as about [Template:Convert](/wiki/Template:Convert).<ref name=NMNH/>

The [sauropods](/wiki/Sauropoda) were the largest and heaviest dinosaurs. For much of the dinosaur era, the smallest sauropods were larger than anything else in their habitat, and the largest were an [order of magnitude](/wiki/Order_of_magnitude) more massive than anything else that has since walked the Earth. Giant prehistoric [mammals](/wiki/Mammal) such as [*Paraceratherium*](/wiki/Paraceratherium) (the largest land mammal ever) were dwarfed by the giant sauropods, and only modern whales approach or surpass them in size.[[16]](#cite_note-16) There are several proposed advantages for the large size of sauropods, including protection from predation, reduction of energy use, and longevity, but it may be that the most important advantage was dietary. Large animals are more efficient at digestion than small animals, because food spends more time in their digestive systems. This also permits them to subsist on food with lower nutritive value than smaller animals. Sauropod remains are mostly found in [rock formations](/wiki/Rock_formation) interpreted as dry or seasonally dry, and the ability to eat large quantities of low-nutrient browse would have been advantageous in such environments.<ref name=KC06/>

#### Largest and smallest[[edit](/index.php?title=(none)&action=edit&section=12)]

Scientists will probably never be certain of the [largest and smallest dinosaurs](/wiki/Largest_organism) to have ever existed. This is because only a tiny percentage of animals ever fossilize, and most of these remain buried in the earth. Few of the specimens that are recovered are complete skeletons, and impressions of skin and other soft tissues are rare. Rebuilding a complete skeleton by comparing the size and morphology of bones to those of similar, better-known species is an inexact art, and reconstructing the muscles and other organs of the living animal is, at best, a process of educated guesswork.<ref name=GSP10>[Template:Cite book](/wiki/Template:Cite_book)</ref>

[thumb|Comparative size of](/wiki/File:Giraffatitan_scale.png) [*Giraffatitan*](/wiki/Giraffatitan) to the average human The tallest and heaviest dinosaur known from good skeletons is [*Giraffatitan brancai*](/wiki/Giraffatitan) (previously classified as a species of [*Brachiosaurus*](/wiki/Brachiosaurus)). Its remains were discovered in [Tanzania](/wiki/Tanzania) between 1907 and 1912. Bones from several similar-sized individuals were incorporated into the skeleton now mounted and on display at the [Museum für Naturkunde Berlin](/wiki/Museum_für_Naturkunde);<ref name=EC68/> this mount is [Template:Convert](/wiki/Template:Convert) tall and [Template:Convert](/wiki/Template:Convert) long,[[17]](#cite_note-17)[[18]](#cite_note-18) and would have belonged to an animal that weighed between [Template:Gaps](/wiki/Template:Gaps) and [Template:Gaps](/wiki/Template:Gaps) kilograms ([Template:Gaps](/wiki/Template:Gaps) and [Template:Gaps](/wiki/Template:Gaps) lb). The longest complete dinosaur is the [Template:Convert](/wiki/Template:Convert) long [*Diplodocus*](/wiki/Diplodocus), which was discovered in [Wyoming](/wiki/Wyoming) in the [United States](/wiki/United_States) and displayed in [Pittsburgh's](/wiki/Pittsburgh,_Pennsylvania) [Carnegie Natural History Museum](/wiki/Carnegie_Natural_History_Museum) in 1907.<ref name=hecket04>[Template:Cite journal](/wiki/Template:Cite_journal)</ref> [thumb|left|Comparative size of](/wiki/File:Human-eoraptor_size_comparison(v2).png) [*Eoraptor*](/wiki/Eoraptor) to the average human There were larger dinosaurs, but knowledge of them is based entirely on a small number of fragmentary fossils. Most of the largest [herbivorous](/wiki/Herbivore) specimens on record were all discovered in the 1970s or later, and include the massive [*Argentinosaurus*](/wiki/Argentinosaurus), which may have weighed [Template:Gaps](/wiki/Template:Gaps) to [Template:Gaps](/wiki/Template:Gaps) kilograms (90 to 110 short tons); some of the longest were the [Template:Convert](/wiki/Template:Convert) long [*Diplodocus hallorum*](/wiki/Diplodocus)<ref name=KC06/> (formerly *Seismosaurus*) and the [Template:Convert](/wiki/Template:Convert) long [*Supersaurus*](/wiki/Supersaurus);<ref name=LHW07/> and the tallest, the [Template:Convert](/wiki/Template:Convert) tall [*Sauroposeidon*](/wiki/Sauroposeidon), which could have reached a sixth-floor window. The heaviest and longest dinosaur may have been [*Amphicoelias fragillimus*](/wiki/Amphicoelias), known only from a now lost partial vertebral [neural arch](/wiki/Neural_arch) described in 1878. Extrapolating from the illustration of this bone, the animal may have been [Template:Convert](/wiki/Template:Convert) long and weighed [Template:Gaps](/wiki/Template:Gaps) kg ([Template:Gaps](/wiki/Template:Gaps) lb).<ref name=KC06/> However, as no further evidence of sauropods of this size has been found, and the discoverer, Edward Cope, had made typographic errors before, it is likely to have been an extreme overestimation.[[19]](#cite_note-19) The largest known [carnivorous](/wiki/Carnivore) dinosaur was [*Spinosaurus*](/wiki/Spinosaurus), reaching a length of [Template:Convert](/wiki/Template:Convert), and weighing 7–20.9 tonnes (7.7–23 short tons).<ref name=SMBM06/><ref name=TH07/> Other large carnivorous theropods included [*Giganotosaurus*](/wiki/Giganotosaurus), [*Carcharodontosaurus*](/wiki/Carcharodontosaurus) and [*Tyrannosaurus*](/wiki/Tyrannosaurus).<ref name=TH07/> [*Therizinosaurus*](/wiki/Therizinosaurus) and [*Deinocheirus*](/wiki/Deinocheirus) were among the tallest of the theropods.

The smallest dinosaur known is the [bee hummingbird](/wiki/Bee_hummingbird),<ref name=discovering\_dinosaurs>Norell, M., Gaffney, E.S., and Dingus, L. (2000). *Discovering dinosaurs: Evolution, extinction, and the lessons of prehistory*. University of California Press.</ref> with a length of only [Template:Convert](/wiki/Template:Convert) and mass of around [Template:Convert](/wiki/Template:Convert).[[20]](#cite_note-20)

### Physiology[[edit](/index.php?title=(none)&action=edit&section=16)]

[Template:Main article](/wiki/Template:Main_article) Because both modern [crocodilians](/wiki/Crocodilia) and [birds](/wiki/Bird) have four-chambered hearts (albeit modified in crocodilians), it is likely that this is a trait shared by all archosaurs, including all dinosaurs.<ref name=CH04/> While all modern birds have high metabolisms and are "warm blooded" (endothermic), a vigorous debate has been ongoing since the 1960s regarding how far back in the dinosaur lineage this trait extends. Scientists disagree as to whether non-avian dinosaurs were endothermic, ectothermic, or some combination of both.[[26]](#cite_note-26) After non-avian dinosaurs were discovered, paleontologists first posited that they were [ectothermic](/wiki/Ectotherm). This supposed "cold-bloodedness" was used to imply that the ancient dinosaurs were relatively slow, sluggish organisms, even though many modern reptiles are fast and light-footed despite relying on external sources of heat to regulate their body temperature. The idea of dinosaurs as ectothermic and sluggish remained a prevalent view until [Robert T. "Bob" Bakker](/wiki/Robert_T._Bakker), an early proponent of dinosaur endothermy, published an influential paper on the topic in 1968.[[27]](#cite_note-27) Modern evidence indicates that even non-avian dinosaurs and birds thrived in cooler temperate climates, and that at least some early species must have regulated their body temperature by internal biological means (aided by the animals' bulk in large species and feathers or other body coverings in smaller species). Evidence of [endothermy](/wiki/Warm-blooded) in Mesozoic dinosaurs includes the discovery of [polar dinosaurs in Australia](/wiki/Polar_dinosaurs_in_Australia) and [Antarctica](/wiki/Antarctica) as well as analysis of blood-vessel structures within fossil bones that are typical of endotherms. Scientific debate continues regarding the specific ways in which dinosaur temperature regulation evolved.[[28]](#cite_note-28) [thumb|Comparison between the](/wiki/File:Dino_bird_h.jpg) [air sacs](/wiki/Air_sacs) of an [abelisaur](/wiki/Abelisaur) and a bird

In [saurischian](/wiki/Saurischia) dinosaurs, higher metabolisms were supported by the evolution of the avian respiratory system, characterized by an extensive system of air sacs that extended the lungs and invaded many of the bones in the skeleton, making them hollow.[[29]](#cite_note-29) Early avian-style respiratory systems with air sacs may have been capable of sustaining higher activity levels than mammals of similar size and build could sustain. In addition to providing a very efficient supply of oxygen, the rapid airflow would have been an effective cooling mechanism, which is essential for animals that are active but too large to get rid of all the excess heat through their skin.[[30]](#cite_note-30) Like other [reptiles](/wiki/Reptile), dinosaurs are primarily [uricotelic](/wiki/Uricotelic), that is, their [kidneys](/wiki/Kidney) extract nitrogenous wastes from their bloodstream and excrete it as [uric acid](/wiki/Uric_acid) instead of [urea](/wiki/Urea) or [ammonia](/wiki/Ammonia) via the ureters into the intestine. In most living species, uric acid is excreted along with feces as a semisolid waste.[[31]](#cite_note-31)[[32]](#cite_note-32)<ref name=coprodeum>[Template:Cite journal](/wiki/Template:Cite_journal)</ref> However, at least some modern birds (such as [hummingbirds](/wiki/Hummingbird)) can be facultatively [ammonotelic](/wiki/Ammonotelic), excreting most of the nitrogenous wastes as ammonia.[[33]](#cite_note-33) They also excrete [creatine](/wiki/Creatine), rather than [creatinine](/wiki/Creatinine) like mammals.[[34]](#cite_note-34) This material, as well as the output of the intestines, emerges from the [cloaca](/wiki/Cloaca).[[35]](#cite_note-35)[[36]](#cite_note-36) In addition, many species regurgitate [pellets](/wiki/Pellet_(ornithology)), and fossil pellets that may have come from dinosaurs are known from as long ago as the Cretaceous period.[[37]](#cite_note-37)

### Number of Species[[edit](/index.php?title=(none)&action=edit&section=17)]

As of March 2016 the estimated number of dinosaur species that existed in the Mesozoic era is 1,543–2,468 species.[[38]](#cite_note-38)[[39]](#cite_note-39)

## Origin of birds[[edit](/index.php?title=(none)&action=edit&section=18)]

[Template:Main article](/wiki/Template:Main_article)

The possibility that dinosaurs were the ancestors of birds was first suggested in 1868 by [Thomas Henry Huxley](/wiki/Thomas_Henry_Huxley).<ref name=huxley1868/> After the work of [Gerhard Heilmann](/wiki/Gerhard_Heilmann) in the early 20th century, the theory of birds as dinosaur descendants was abandoned in favor of the idea of their being descendants of generalized [thecodonts](/wiki/Thecodontia), with the key piece of evidence being the supposed lack of [clavicles](/wiki/Clavicle) in dinosaurs.<ref name=heilmann/> However, as later discoveries showed, clavicles (or a single fused [wishbone](/wiki/Furcula), which derived from separate clavicles) were not actually absent;<ref name=KP04/> they had been found as early as 1924 in *Oviraptor*, but misidentified as an [interclavicle](/wiki/Interclavicle).<ref name=HO24/> In the 1970s, [John Ostrom](/wiki/John_Ostrom) revived the dinosaur–bird theory,<ref name=ostrom1973/> which gained momentum in the coming decades with the advent of cladistic analysis,<ref name=gauthier1986/> and a great increase in the discovery of small theropods and early birds.<ref name=TRHJ00/> Of particular note have been the fossils of the [Yixian Formation](/wiki/Yixian_Formation), where a variety of theropods and early birds have been found, often with feathers of some type.<ref name=KP04/> Birds share over a hundred distinct anatomical features with theropod dinosaurs, which are now generally accepted to have been their closest ancient relatives.<ref name=Mayretal2005/> They are most closely allied with [maniraptoran](/wiki/Maniraptora) coelurosaurs.<ref name=KP04/> A minority of scientists, most notably [Alan Feduccia](/wiki/Alan_Feduccia) and [Larry Martin](/wiki/Larry_Martin), have proposed other evolutionary paths, including revised versions of Heilmann's basal archosaur proposal,<ref name=martin2004/> or that maniraptoran theropods are the ancestors of birds but themselves are not dinosaurs, only [convergent](/wiki/Convergent_evolution) with dinosaurs.<ref name=AF02/>

### Feathers[[edit](/index.php?title=(none)&action=edit&section=19)]

[Template:Main article](/wiki/Template:Main_article) [thumb|Various feathered non-avian dinosaurs, including](/wiki/File:Feathered_non-avian_Maniraptora.jpg) [*Archaeopteryx*](/wiki/Archaeopteryx), [*Anchiornis*](/wiki/Anchiornis), [*Microraptor*](/wiki/Microraptor) and [*Zhenyuanlong*](/wiki/Zhenyuanlong) [Feathers](/wiki/Feather) are one of the most recognizable characteristics of modern birds, and a trait that was shared by all other dinosaur groups. Based on the current distribution of fossil evidence, it appears that feathers were an ancestral dinosaurian trait, though one that may have been selectively lost in some species.<ref name=switeknature>[Template:Cite journal](/wiki/Template:Cite_journal)</ref> Direct fossil evidence of feathers or feather-like structures has been discovered in a diverse array of species in many non-avian dinosaur groups, both among saurischians and ornithischians. Simple, branched, feather-like structures are known from [heterodontosaurids](/wiki/Heterodontosauridae), primitive [neornithischians](/wiki/Neornithischia)<ref name=svp2013abs>Godefroit, P., Sinitsa, S., Dhouailly, D., Bolotsky, Y., and Sizov, A. "Feather-like structures and scales in a Jurassic neornithischian dinosaur from Siberia." [Program and Abstracts of the 73rd Meeting of the Society of Vertebrate Paleontology](http://vertpaleo.org/PDFS/71/71353d57-1619-409e-9777-1f7c797d2ec6.pdf), October 2013.</ref> and [theropods](/wiki/Theropoda),<ref name=Xuetal2004/> and primitive [ceratopsians](/wiki/Ceratopsia). Evidence for true, vaned feathers similar to the flight feathers of modern birds has been found only in the theropod subgroup [Maniraptora](/wiki/Maniraptora), which includes oviraptorosaurs, troodontids, dromaeosaurids, and birds.<ref name=KP04/><ref name=GC06/> Feather-like structures known as pycnofibres have also been found in [pterosaurs](/wiki/Pterosaur),<ref name=kellneretal2009>Kellner, A.W.A., Wang, X., Tischlinger, H., Campos, D., Hone, D.W.E. and Meng, X. (2009). "The soft tissue of *Jeholopterus* (Pterosauria, Anurognathidae, Batrachognathinae) and the structure of the pterosaur wing membrane." *Proceedings of the Royal Society B*, published online before print August 5, 2009, [Template:Doi](/wiki/Template:Doi)</ref> suggesting the possibility that feather-like filaments may have been common in the [bird lineage](/wiki/Avemetatarsalia) and evolved before the appearance of dinosaurs themselves.<ref name=switeknature/> Research into the genetics of [American alligators](/wiki/American_alligator) has also revealed that crocodylian [scutes](/wiki/Scute) do possess feather-keratins during embryonic development, but these keratins are not expressed by the animals before hatching.<ref name=AlibL2006>Alibardi, L., Knapp, L.W., Sawyer, R.H. (2006). "Beta-keratin localization in developing alligator scales and feathers in relation to the development and evolution of feathers."

[US National Library of Medicine](http://www.ncbi.nlm.nih.gov/pubmed/17784647), June 2006</ref>

[*Archaeopteryx*](/wiki/Archaeopteryx) was the first fossil found that revealed a potential connection between dinosaurs and birds. It is considered a [transitional fossil](/wiki/Transitional_fossil), in that it displays features of both groups. Brought to light just two years after Darwin's seminal [*The Origin of Species*](/wiki/On_the_Origin_of_Species), its discovery spurred the nascent debate between proponents of [evolutionary biology](/wiki/Evolutionary_biology) and [creationism](/wiki/Creationism). This early bird is so dinosaur-like that, without a clear impression of feathers in the surrounding rock, at least one specimen was mistaken for [*Compsognathus*](/wiki/Compsognathus).<ref name=PW88/> Since the 1990s, a number of additional [feathered dinosaurs](/wiki/Feathered_dinosaurs) have been found, providing even stronger evidence of the close relationship between dinosaurs and modern birds. Most of these specimens were unearthed in the [lagerstätte](/wiki/Lagerstätten) of the Yixian Formation, [Liaoning](/wiki/Liaoning), northeastern China, which was part of an island continent during the Cretaceous. Though feathers have been found in only a few locations, it is possible that non-avian dinosaurs elsewhere in the world were also feathered. The lack of widespread fossil evidence for feathered non-avian dinosaurs may be because delicate features like skin and feathers are not often preserved by fossilization and thus are absent from the fossil record.[[40]](#cite_note-40) The description of feathered dinosaurs has not been without controversy; perhaps the most vocal critics have been Alan Feduccia and Theagarten Lingham-Soliar, who have proposed that some purported feather-like fossils are the result of the decomposition of collagenous fiber that underlaid the dinosaurs' skin,<ref name=TLS03/><ref name=FLH05/><ref name=LSFX07/> and that maniraptoran dinosaurs with vaned feathers were not actually dinosaurs, but [convergent](/wiki/Convergent_evolution) with dinosaurs.<ref name=AF02/><ref name=FLH05/> However, their views have for the most part not been accepted by other researchers, to the point that the scientific nature of Feduccia's proposals has been questioned.<ref name=Prum2003/>

### Skeleton[[edit](/index.php?title=(none)&action=edit&section=20)]

Because feathers are often associated with birds, feathered dinosaurs are often touted as the [missing link](/wiki/Transitional_fossil) between birds and dinosaurs. However, the multiple skeletal features also shared by the two groups represent another important line of evidence for paleontologists. Areas of the skeleton with important similarities include the neck, [pubis](/wiki/Pubis_(bone)), [wrist](/wiki/Wrist) (semi-lunate [carpal](/wiki/Carpal)), arm and [pectoral girdle](/wiki/Pectoral_girdle), furcula (wishbone), and [breast bone](/wiki/Keel_(bird)). Comparison of bird and dinosaur skeletons through cladistic analysis strengthens the case for the link.<ref name=archaeopteryxucmp>[Archaeopteryx: a missing link](http://www.ucmp.berkeley.edu/diapsids/birds/archaeopteryx.html). Berkeley: University of California. Museum of Paleontology.</ref>

### Soft anatomy[[edit](/index.php?title=(none)&action=edit&section=21)]

[thumb|Pneumatopores on the left](/wiki/File:Pneumatopores_on_the_left_ilium_of_the_theropod_Aerosteon_riocoloradensis.jpg) [ilium](/wiki/Ilium_(bone)) of [*Aerosteon riocoloradensis*](/wiki/Aerosteon) Large meat-eating dinosaurs had a complex system of air sacs similar to those found in modern birds, according to a 2005 investigation led by Patrick M. O'Connor. The lungs of theropod dinosaurs (carnivores that walked on two legs and had bird-like feet) likely pumped air into hollow sacs in their [skeletons](/wiki/Skeleton), as is the case in birds. "What was once formally considered unique to birds was present in some form in the ancestors of birds", O'Connor said.<ref name=OConnorClaessens2005/> In 2008, scientists described [*Aerosteon riocoloradensis*](/wiki/Aerosteon), the skeleton of which supplies the strongest evidence to date of a dinosaur with a bird-like breathing system. [CT-scanning](/wiki/Computed_tomography) of *Aerosteon****s fossil bones revealed evidence for the existence of air sacs within the animal's body cavity.<ref name=Sereno2008/><ref name=newswise2/>***

### Behavioral evidence[[edit](/index.php?title=(none)&action=edit&section=22)]

Fossils of the [troodonts](/wiki/Troodontidae) [*Mei*](/wiki/Mei_(dinosaur)) and [*Sinornithoides*](/wiki/Sinornithoides) demonstrate that some dinosaurs slept with their heads tucked under their arms.<ref name=XUNorell2004/> This behavior, which may have helped to keep the head warm, is also characteristic of modern birds. Several [deinonychosaur](/wiki/Dromaeosauridae#Deinonychosauria) and [oviraptorosaur](/wiki/Oviraptorosauria) specimens have also been found preserved on top of their nests, likely brooding in a bird-like manner.[[41]](#cite_note-41) The ratio between egg volume and body mass of adults among these dinosaurs suggest that the eggs were primarily brooded by the male, and that the young were highly [precocial](/wiki/Precocial), similar to many modern ground-dwelling birds.<ref name=Varricchioetal2008>[Template:Cite journal](/wiki/Template:Cite_journal)</ref>

Some dinosaurs are known to have used [gizzard](/wiki/Gizzard) stones like modern birds. These stones are swallowed by animals to aid digestion and break down food and hard fibers once they enter the stomach. When found in association with fossils, gizzard stones are called [gastroliths](/wiki/Gastrolith).<ref name=wings2007/>

## Extinction of major groups[[edit](/index.php?title=(none)&action=edit&section=23)]

[Template:Main article](/wiki/Template:Main_article)

The discovery that birds are a type of dinosaur showed that dinosaurs in general are not, in fact, [extinct](/wiki/Extinct) as is commonly stated.<ref name=mistaken>Dingus, L. and Rowe, T. (1998). *The Mistaken Extinction – Dinosaur Evolution and the Origin of Birds*. New York: W. H. Freeman.</ref> However, all non-avian dinosaurs as well as many groups of birds did suddenly become [extinct](/wiki/Extinct) approximately 66 million years ago. It has been suggested that because small mammals, [squamata](/wiki/Squamata) and birds occupied the ecological niches suited for small body size, non-avian dinosaurs never evolved a diverse fauna of small-bodied species, which led to their downfall when large-bodied terrestrial tetrapods were hit by the mass extinction event.[[42]](#cite_note-42) Many other groups of animals also became extinct at this time, including [ammonites](/wiki/Ammonite) ([nautilus](/wiki/Nautilus)-like [mollusks](/wiki/Mollusk)), [mosasaurs](/wiki/Mosasaur), [plesiosaurs](/wiki/Plesiosaur), [pterosaurs](/wiki/Pterosaur), and many groups of [mammals](/wiki/Mammal).<ref name=MacLeod/> Significantly, the insects suffered no discernible population loss, which left them available as food for other survivors. This [mass extinction](/wiki/Mass_extinction) is known as the [Cretaceous–Paleogene extinction event](/wiki/Cretaceous–Paleogene_extinction_event). The nature of the event that caused this mass extinction has been extensively studied since the 1970s; at present, several related theories are supported by paleontologists. Though the consensus is that an impact event was the primary cause of dinosaur extinction, some scientists cite other possible causes, or support the idea that a confluence of several factors was responsible for the sudden disappearance of dinosaurs from the fossil record.<ref name=ktextinction>[Template:Cite journal](/wiki/Template:Cite_journal)</ref><ref name=multimpacts>Mullen, L. (2004). "[Multiple Impacts](http://www.astrobio.net/exclusive/1253/multiple-impacts)". *Astrobiology Magazine*.</ref><ref name=dinoextinction>[Template:Cite journal](/wiki/Template:Cite_journal)</ref>

At the peak of the Mesozoic, there were no [polar ice caps](/wiki/Polar_ice_cap), and sea levels are estimated to have been from [Template:Convert](/wiki/Template:Convert) higher than they are today. The planet's temperature was also much more uniform, with only [Template:Convert](/wiki/Template:Convert) separating average polar temperatures from those at the equator. On average, atmospheric temperatures were also much higher; the poles, for example, were [Template:Convert](/wiki/Template:Convert) warmer than today.<ref name=pmid16311326/><ref name=McAetal2007/>

The atmosphere's composition during the Mesozoic is a matter for debate. While some academics argue that oxygen levels were much higher than today, others argue that biological adaptations seen in birds and dinosaurs indicate that respiratory systems evolved beyond what would be necessary if oxygen levels were high.[[43]](#cite_note-43) By the late Cretaceous, the environment was changing dramatically. Volcanic activity was decreasing, which led to a cooling trend as levels of atmospheric carbon dioxide dropped. Oxygen levels in the atmosphere also started to fluctuate and would ultimately fall considerably. Some scientists hypothesize that climate change, combined with lower oxygen levels, might have led directly to the demise of many species.<ref name=ktclimate>[Template:Cite journal](/wiki/Template:Cite_journal)</ref>

### Impact event[[edit](/index.php?title=(none)&action=edit&section=24)]

[Template:Main article](/wiki/Template:Main_article) [thumb|The](/wiki/File:Chicxulub_radar_topography.jpg) [Chicxulub Crater](/wiki/Chicxulub_Crater) at the tip of the [Yucatán Peninsula](/wiki/Yucatán_Peninsula); the impactor that formed this crater may have caused the dinosaur extinction. The asteroid collision theory, which was brought to wide attention in 1980 by [Walter Alvarez](/wiki/Walter_Alvarez) and colleagues, links the [extinction event](/wiki/Extinction_event) at the end of the Cretaceous period to a [bolide](/wiki/Bolide) impact approximately 66 million years ago.[Template:Sfn](/wiki/Template:Sfn) Alvarez *et al.* proposed that a sudden increase in [iridium](/wiki/Iridium) levels, recorded around the world in the period's rock stratum, was direct evidence of the impact.<ref name=Alvarezetal80/> The bulk of the evidence now suggests that a [bolide](/wiki/Bolide) [Template:Convert](/wiki/Template:Convert) wide hit in the vicinity of the [Yucatán Peninsula](/wiki/Yucatán_Peninsula) (in southeastern [Mexico](/wiki/Mexico)), creating the approximately [Template:Convert](/wiki/Template:Convert) [Chicxulub Crater](/wiki/Chicxulub_Crater) and triggering the [mass extinction](/wiki/Mass_extinction).<ref name=ARHetal91/><ref name=KPetal96/> Scientists are not certain whether dinosaurs were thriving or declining before the [impact event](/wiki/Impact_event). Some scientists propose that the meteorite caused a long and unnatural drop in Earth's atmospheric temperature, while others claim that it would have instead created an unusual heat wave. The consensus among scientists who support this theory is that the impact caused extinctions both directly (by heat from the meteorite impact) and also indirectly (via a worldwide cooling brought about when matter ejected from the impact crater reflected thermal radiation from the sun). Although the speed of extinction cannot be deduced from the fossil record alone, various models suggest that the extinction was extremely rapid, being down to hours rather than years.[[44]](#cite_note-44)

### Deccan Traps[[edit](/index.php?title=(none)&action=edit&section=25)]

[Template:Main article](/wiki/Template:Main_article)

Before 2000, arguments that the [Deccan Traps](/wiki/Deccan_Traps) [flood basalts](/wiki/Flood_basalt) caused the [extinction](/wiki/Extinction) were usually linked to the view that the extinction was gradual, as the flood basalt events were thought to have started around 68 [million years ago](/wiki/Annum) and lasted for over 2 million years. However, there is evidence that two thirds of the Deccan Traps were created in only 1 million years about 66 million years ago, and so these eruptions would have caused a fairly rapid extinction, possibly over a period of thousands of years, but still longer than would be expected from a single impact event.<ref name=wwnjsd/><ref name=Duncan/>

The Deccan Traps could have caused extinction through several mechanisms, including the release into the air of dust and sulfuric aerosols, which might have blocked sunlight and thereby reduced photosynthesis in plants. In addition, Deccan Trap volcanism might have resulted in carbon dioxide emissions, which would have increased the [greenhouse effect](/wiki/Greenhouse_effect) when the dust and aerosols cleared from the atmosphere.<ref name=Duncan/> Before the mass extinction of the dinosaurs, the release of [volcanic gases](/wiki/Volcanic_gas) during the formation of the [Deccan Traps](/wiki/Deccan_Traps) "contributed to an apparently massive global warming. Some data point to an average rise in temperature of [Template:Convert](/wiki/Template:Convert) in the last half million years before the [impact [at Chicxulub](/wiki/Chicxulub_Crater)]."<ref name=wwnjsd/><ref name=Duncan/>

In the years when the Deccan Traps theory was linked to a slower extinction, [Luis Alvarez](/wiki/Luis_Walter_Alvarez) (who died in 1988) replied that [paleontologists](/wiki/Paleontologists) were being misled by [sparse data](/wiki/Signor–Lipps_effect). While his assertion was not initially well-received, later intensive field studies of fossil beds lent weight to his claim. Eventually, most paleontologists began to accept the idea that the mass extinctions at the end of the Cretaceous were largely or at least partly due to a massive Earth impact. However, even [Walter Alvarez](/wiki/Walter_Alvarez) has acknowledged that there were other major changes on Earth even before the impact, such as a drop in [sea level](/wiki/Sea_level) and massive volcanic eruptions that produced the Indian Deccan Traps, and these may have contributed to the extinctions.<ref name=Alvarez1997/>

### Possible Paleocene survivors[[edit](/index.php?title=(none)&action=edit&section=26)]

[Template:Main article](/wiki/Template:Main_article) Non-avian dinosaur remains are occasionally found above the [Cretaceous–Paleogene boundary](/wiki/Cretaceous–Paleogene_boundary). In 2001, paleontologists Zielinski and Budahn reported the discovery of a single [hadrosaur](/wiki/Hadrosauridae) leg-bone fossil in the San Juan Basin, New Mexico, and described it as evidence of [Paleocene dinosaurs](/wiki/Paleocene_dinosaurs). The formation in which the bone was discovered has been dated to the early [Paleocene](/wiki/Paleocene) epoch, approximately 64.5 million years ago. If the bone was not re-deposited into that [stratum](/wiki/Stratum) by weathering action, it would provide evidence that some dinosaur populations may have survived at least a half million years into the Cenozoic Era.<ref name=Fassett/> Other evidence includes the finding of dinosaur remains in the [Hell Creek Formation](/wiki/Hell_Creek_Formation) up to [Template:Convert](/wiki/Template:Convert) above the Cretaceous–Paleogene boundary, representing [Template:Gaps](/wiki/Template:Gaps) years of elapsed time. Similar reports have come from other parts of the world, including China.<ref name=Sloan/> Many scientists, however, dismissed the supposed Paleocene dinosaurs as re-worked, that is, washed out of their original locations and then re-buried in much later sediments.<ref name=FS05/><ref name=Sullivan/> Direct dating of the bones themselves has supported the later date, with U–Pb dating methods resulting in a precise age of 64.8 ± 0.9 million years ago.<ref name=fassettetall2011/> If correct, the presence of a handful of dinosaurs in the early Paleocene would not change the underlying facts of the extinction.<ref name=FS05/>

## History of study[[edit](/index.php?title=(none)&action=edit&section=27)]

[Template:Further](/wiki/Template:Further) Dinosaur fossils have been known for millennia, although their true nature was not recognized. The Chinese, whose modern word for dinosaur is *kǒnglóng* (恐龍, or "terrible dragon"), considered them to be [dragon](/wiki/Chinese_dragon) [bones](/wiki/Bone) and documented them as such. For example, [*Hua Yang Guo Zhi*](/wiki/Hua_Yang_Guo_Zhi), a book written by [Chang Qu](/wiki/Chang_Qu) during the [Western Jin Dynasty](/wiki/Western_Jin_Dynasty) (265–316), reported the discovery of dragon bones at Wucheng in [Sichuan](/wiki/Sichuan) Province.<ref name=dong1992/> Villagers in central China have long unearthed fossilized "dragon bones" for use in [traditional medicines](/wiki/Traditional_Chinese_medicine), a practice that continues today.<ref name=BBCdinobonemed/> In Europe, dinosaur fossils were generally believed to be the remains of [giants](/wiki/Giant_(mythology)) and other biblical creatures.<ref name=benton2000>Benton, M.J. (2000). "A brief history of dinosaur paleontology". pp. 10–44, In Paul, G.S. (ed.). *The Scientific American book of dinosaurs*. St. Martin's Press, New York.</ref>

Scholarly descriptions of what would now be recognized as dinosaur bones first appeared in the late 17th century in [England](/wiki/England). Part of a bone, now known to have been the [femur](/wiki/Femur) of a [*Megalosaurus*](/wiki/Megalosaurus),<ref name=WAS97/> was recovered from a limestone quarry at Cornwell near [Chipping Norton](/wiki/Chipping_Norton), [Oxfordshire](/wiki/Oxfordshire), in 1676. The fragment was sent to [Robert Plot](/wiki/Robert_Plot), Professor of Chemistry at the [University of Oxford](/wiki/University_of_Oxford) and first curator of the [Ashmolean Museum](/wiki/Ashmolean_Museum), who published a description in his *Natural History of Oxfordshire* in 1677. He correctly identified the bone as the lower extremity of the [femur](/wiki/Femur) of a large animal, and recognized that it was too large to belong to any known species. He therefore concluded it to be the thigh bone of a giant human similar to those mentioned in the [Bible](/wiki/Bible). In 1699, [Edward Lhuyd](/wiki/Edward_Lhuyd), a friend of [Sir Isaac Newton](/wiki/Sir_Isaac_Newton), was responsible for the first published scientific treatment of what would now be recognized as a dinosaur when he described and named a [sauropod](/wiki/Sauropod) [tooth](/wiki/Tooth), "[Rutellum implicatum](/wiki/Rutellum)",<ref name=L99/><ref name=DS02/> that had been found in Caswell, near Witney, Oxfordshire.<ref name=G45/>

[thumb|left|](/wiki/File:William_Buckland_detail.png)[William Buckland](/wiki/William_Buckland) Between 1815 and 1824, the Rev [William Buckland](/wiki/William_Buckland), a professor of [geology](/wiki/Geology) at Oxford, collected more fossilized bones of *Megalosaurus* and became the first person to describe a dinosaur in a [scientific journal](/wiki/Scientific_journal).<ref name=WAS97/><ref name=buckland1824/> The second dinosaur genus to be identified, [*Iguanodon*](/wiki/Iguanodon), was discovered in 1822 by [Mary Ann Mantell](/wiki/Mary_Ann_Mantell) – the wife of English geologist [Gideon Mantell](/wiki/Gideon_Mantell). Gideon Mantell recognized similarities between his fossils and the bones of modern [iguanas](/wiki/Iguana). He published his findings in 1825.<ref name=GM25/><ref name=HDS97/>

The study of these "great fossil lizards" soon became of great interest to European and American scientists, and in 1842 the English paleontologist [Richard Owen](/wiki/Richard_Owen) coined the term "dinosaur". He recognized that the remains that had been found so far, *Iguanodon*, *Megalosaurus* and [*Hylaeosaurus*](/wiki/Hylaeosaurus), shared a number of distinctive features, and so decided to present them as a distinct taxonomic group. With the backing of [Prince Albert](/wiki/Prince_Albert), the husband of [Queen Victoria](/wiki/Queen_Victoria), Owen established the [Natural History Museum, London](/wiki/Natural_History_Museum,_London), to display the national collection of dinosaur fossils and other biological and geological exhibits.<ref name=owen94>Rupke, N. (1994). *Richard Owen: A Victorian Naturalist*. New Haven: Yale University Press.</ref>

In 1858, [William Parker Foulke](/wiki/William_Parker_Foulke) discovered the first known American dinosaur, in [marl](/wiki/Marl) pits in the small town of [Haddonfield, New Jersey](/wiki/Haddonfield,_New_Jersey). (Although fossils had been found before, their nature had not been correctly discerned.) The creature was named [*Hadrosaurus foulkii*](/wiki/Hadrosaurus). It was an extremely important find: *Hadrosaurus* was one of the first nearly complete dinosaur skeletons found ([the first](/wiki/Iguanodon#Gideon_Mantell,_Sir_Richard_Owen,_and_the_discovery_of_dinosaurs) was in 1834, in Maidstone, England), and it was clearly a [bipedal](/wiki/Bipedal) creature. This was a revolutionary discovery as, until that point, most scientists had believed dinosaurs walked on four feet, like other lizards. Foulke's discoveries sparked a wave of dinosaur mania in the [United States](/wiki/United_States).<ref name=weishampel06>[Template:Cite journal](/wiki/Template:Cite_journal)</ref>

[Template:Multiple image](/wiki/Template:Multiple_image) [thumb|Marsh's 1896 illustration of the bones of](/wiki/File:Stego-marsh-1896-US_geological_survey.png) [*Stegosaurus*](/wiki/Stegosaurus), a dinosaur he described and named in 1877 Dinosaur mania was exemplified by the fierce rivalry between [Edward Drinker Cope](/wiki/Edward_Drinker_Cope) and [Othniel Charles Marsh](/wiki/Othniel_Charles_Marsh), both of whom raced to be the first to find new dinosaurs in what came to be known as the [Bone Wars](/wiki/Bone_Wars). The feud probably originated when Marsh publicly pointed out that Cope's reconstruction of an [*Elasmosaurus*](/wiki/Elasmosaurus) skeleton was flawed: Cope had inadvertently placed the [plesiosaur's](/wiki/Plesiosaur) head at what should have been the animal's tail end. The fight between the two scientists lasted for over 30 years, ending in 1897 when Cope died after spending his entire fortune on the dinosaur hunt. Marsh 'won' the contest primarily because he was better funded through a relationship with the [US Geological Survey](/wiki/US_Geological_Survey). Unfortunately, many valuable dinosaur specimens were damaged or destroyed due to the pair's rough methods: for example, their diggers often used [dynamite](/wiki/Dynamite) to unearth bones (a method modern paleontologists would find appalling). Despite their unrefined methods, the contributions of Cope and Marsh to paleontology were vast: Marsh unearthed 86 new species of dinosaur and Cope discovered 56, a total of 142 new species. Cope's collection is now at the [American Museum of Natural History](/wiki/American_Museum_of_Natural_History) in [New York](/wiki/New_York_City), while Marsh's is on display at the [Peabody Museum of Natural History](/wiki/Peabody_Museum_of_Natural_History) at [Yale University](/wiki/Yale_University).<ref name=Holmes/>

After 1897, the search for dinosaur fossils extended to every continent, including [Antarctica](/wiki/Antarctica). The first [Antarctic dinosaur](/wiki/South_Polar_dinosaurs) to be discovered, the [ankylosaurid](/wiki/Ankylosaur) [*Antarctopelta oliveroi*](/wiki/Antarctopelta), was found on [James Ross Island](/wiki/James_Ross_Island) in 1986,<ref name=antarctopelta>[Template:Cite journal](/wiki/Template:Cite_journal)</ref> although it was 1994 before an Antarctic species, the theropod [*Cryolophosaurus ellioti*](/wiki/Cryolophosaurus_ellioti), was formally named and described in a scientific journal.<ref name=cryolophosaurus>[Template:Cite journal](/wiki/Template:Cite_journal)</ref>

Current dinosaur "hot spots" include southern South America (especially [Argentina](/wiki/Argentina)) and China. China in particular has produced many exceptional [feathered dinosaur](/wiki/Feathered_dinosaur) specimens due to the unique geology of its dinosaur beds, as well as an ancient arid climate particularly conducive to fossilization.<ref name=Schweitzeretal1999/>

### "Dinosaur renaissance"[[edit](/index.php?title=(none)&action=edit&section=28)]

[Template:Main article](/wiki/Template:Main_article) [thumb|Paleontologist](/wiki/File:Dr._Bob_Bakker_with_Dino.jpg) [Robert T. Bakker](/wiki/Robert_T._Bakker) with mounted skeleton of a tyrannosaurid ([*Gorgosaurus libratus*](/wiki/Gorgosaurus)) The field of dinosaur research has enjoyed a surge in activity that began in the 1970s and is ongoing. This was triggered, in part, by [John Ostrom's](/wiki/John_Ostrom) discovery of [*Deinonychus*](/wiki/Deinonychus), an active predator that may have been [warm-blooded](/wiki/Warm-blooded), in marked contrast to the then-prevailing image of dinosaurs as sluggish and [cold-blooded](/wiki/Poikilotherm). [Vertebrate paleontology](/wiki/Vertebrate_paleontology) has become a global [science](/wiki/Science). Major new dinosaur discoveries have been made by paleontologists working in previously unexploited regions, including [India](/wiki/India), South America, [Madagascar](/wiki/Madagascar), [Antarctica](/wiki/Antarctica), and most significantly China (the amazingly well-preserved [feathered dinosaurs](/wiki/Feathered_dinosaurs) in China have further consolidated the link between dinosaurs and their living descendants, modern birds). The widespread application of [cladistics](/wiki/Cladistics), which rigorously analyzes the relationships between biological organisms, has also proved tremendously useful in [classifying](/wiki/Scientific_classification) dinosaurs. Cladistic analysis, among other modern techniques, helps to compensate for an often incomplete and fragmentary fossil record.<ref name=bakker86>Bakker, R.T. (1986). *The Dinosaur Heresies*. New York: William Morrow. ISBN 0-8217-5608-7 OCLC 363439291</ref>

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| **Timeline of notable dinosaur taxonomic descriptions** |
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at:2013 mark:(line,black) text:[Aurornis](/wiki/Aurornis)  color:1900s bar:NAM14 at:2014 mark:(line,black) text:[Changyuraptor](/wiki/Changyuraptor)  color:1900s bar:NAM15 at:2015 mark:(line,black) text:[Yi](/wiki/Yi_(dinosaur))  PlotData=  align:center textcolor:black fontsize:M mark:(line,black) width:25  bar:period  from: 1820 till: 1830 color:1800syears text:[20s](/wiki/1820s_in_paleontology)  from: 1830 till: 1840 color:1800syears text:[30s](/wiki/1830s_in_paleontology)  from: 1840 till: 1850 color:1800syears text:[40s](/wiki/1840s_in_paleontology)  from: 1850 till: 1860 color:1800syears text:[50s](/wiki/1850s_in_paleontology)  from: 1860 till: 1870 color:1800syears text:[60s](/wiki/1860s_in_paleontology)  from: 1870 till: 1880 color:1800syears text:[70s](/wiki/1870s_in_paleontology)  from: 1880 till: 1890 color:1800syears text:[80s](/wiki/1880s_in_paleontology)  from: 1890 till: 1900 color:1800syears text:[90s](/wiki/1890s_in_paleontology)  from: 1900 till: 1910 color:1900syears text:[00s](/wiki/1900s_in_paleontology)  from: 1910 till: 1920 color:1900syears text:[10s](/wiki/1910s_in_paleontology)  from: 1920 till: 1930 color:1900syears text:[20s](/wiki/1920s_in_paleontology)  from: 1930 till: 1940 color:1900syears text:[30s](/wiki/1930s_in_paleontology)  from: 1940 till: 1950 color:1900syears text:[40s](/wiki/1940s_in_paleontology)  from: 1950 till: 1960 color:1900syears text:[50s](/wiki/1950s_in_paleontology)  from: 1960 till: 1970 color:1900syears text:[60s](/wiki/1960s_in_paleontology)  from: 1970 till: 1980 color:1900syears text:[70s](/wiki/1970s_in_paleontology)  from: 1980 till: 1990 color:1900syears text:[80s](/wiki/1980s_in_paleontology)  from: 1990 till: 2000 color:1900syears text:[90s](/wiki/1990s_in_paleontology)  from: 2000 till: 2010 color:2000syears text:[00s](/wiki/2000s_in_paleontology)  from: 2010 till: 2020 color:2000syears text:[10s](/wiki/2010s_in_paleontology)  from: 2020 till: 2030 color:2000syears text:[20s](/wiki/2020s_in_paleontology)  from: 2030 till: 2040 color:2000syears text:[30s](/wiki/2030s_in_paleontology)  from: 2040 till: 2050 color:2000syears text:[40s](/wiki/2040s_in_paleontology)  bar:era  from: 1820 till: 1900 color:1800s text:[19th](/wiki/19th_century_in_paleontology)  from: 1900 till: 2000 color:1900s text:[20th](/wiki/20th_century_in_paleontology)  from: 2000 till: 2050 color:2000s text:[21st](/wiki/21st_century_in_paleontology)  </timeline> |
|  |

### Soft tissue and DNA[[edit](/index.php?title=(none)&action=edit&section=29)]

One of the best examples of soft-tissue impressions in a fossil dinosaur was discovered in [Pietraroia, Italy](/wiki/Pietraroja). The discovery was reported in 1998, and described the specimen of a small, very young [coelurosaur](/wiki/Coelurosaur), [*Scipionyx samniticus*](/wiki/Scipionyx_samniticus). The fossil includes portions of the intestines, colon, liver, muscles, and windpipe of this immature dinosaur.[[14]](#cite_note-14) In the March 2005 issue of [*Science*](/wiki/Science_(journal)), the paleontologist [Mary Higby Schweitzer](/wiki/Mary_Higby_Schweitzer) and her team announced the discovery of flexible material resembling actual soft tissue inside a 68-million-year-old [*Tyrannosaurus rex*](/wiki/Tyrannosaurus) leg bone from the [Hell Creek Formation](/wiki/Hell_Creek_Formation) in [Montana](/wiki/Montana). After recovery, the tissue was rehydrated by the science team.<ref name=Schweitzer2005/> When the fossilized bone was treated over several weeks to remove mineral content from the fossilized bone-marrow cavity (a process called demineralization), Schweitzer found evidence of intact structures such as [blood vessels](/wiki/Blood_vessel), [bone matrix](/wiki/Bone_matrix), and connective tissue (bone fibers). Scrutiny under the microscope further revealed that the putative dinosaur soft tissue had retained fine structures (microstructures) even at the cellular level. The exact nature and composition of this material, and the implications of Schweitzer's discovery, are not yet clear.<ref name=Schweitzer2005/>

In 2009, a team including Schweitzer announced that, using even more careful methodology, they had duplicated their results by finding similar soft tissue in a [duck-billed dinosaur](/wiki/Hadrosaurid), [*Brachylophosaurus canadensis*](/wiki/Brachylophosaurus_canadensis), found in the [Judith River Formation](/wiki/Judith_River_Formation) of [Montana](/wiki/Montana). This included even more detailed tissue, down to preserved bone cells that seem even to have visible remnants of nuclei and what seem to be red blood cells. Among other materials found in the bone was [collagen](/wiki/Collagen), as in the *Tyrannosaurus* bone. The type of collagen an animal has in its bones varies according to its DNA and, in both cases, this collagen was of the same type found in modern chickens and ostriches.[[45]](#cite_note-45) The extraction of ancient DNA from dinosaur fossils has been reported on two separate occasions;<ref name=bone>[Template:Cite journal](/wiki/Template:Cite_journal)</ref> upon further inspection and [peer review](/wiki/Peer_review), however, neither of these reports could be confirmed.<ref name=Wangetal1997/> However, a functional [peptide](/wiki/Peptide) involved in the vision of a theoretical dinosaur has been inferred using analytical phylogenetic reconstruction methods on gene sequences of related modern species such as reptiles and birds.<ref name=changetal2002/> In addition, several [proteins](/wiki/Protein), including [hemoglobin](/wiki/Hemoglobin),<ref name=Schweitzeretal1997/> have putatively been detected in dinosaur fossils.<ref name=Emberyatal2003/>[[46]](#cite_note-46) In 2015, researchers reported finding structures similar to blood cells and collagen fibers, preserved in the bone fossils of six Cretaceous dinosaur specimens, which are approximately 75 million years old.[[47]](#cite_note-47)[[48]](#cite_note-48)

## Cultural depictions[[edit](/index.php?title=(none)&action=edit&section=30)]

[Template:Main article](/wiki/Template:Main_article) [thumb|Outdated](/wiki/File:Iguanodon_Crystal_Palace.jpg) [*Iguanodon*](/wiki/Iguanodon) statues created by [Benjamin Waterhouse Hawkins](/wiki/Benjamin_Waterhouse_Hawkins) for the Crystal Palace Park in 1853 [thumb|The battles that may have occurred between](/wiki/File:Triceratops-vs-T-Rex001.jpg) [*Tyrannosaurus rex*](/wiki/Tyrannosaurus) and [*Triceratops*](/wiki/Triceratops) are a recurring theme in [popular science](/wiki/Popular_science) and dinosaurs' depiction in culture. By human standards, dinosaurs were creatures of fantastic appearance and often enormous size. As such, they have captured the popular imagination and become an enduring part of human culture. Entry of the word "dinosaur" into the common [vernacular](/wiki/Vernacular) reflects the animals' cultural importance: in English, "dinosaur" is commonly used to describe anything that is impractically large, obsolete, or bound for extinction.<ref name=m-w/>

Public enthusiasm for dinosaurs first developed in [Victorian](/wiki/Victorian_era) England, where in 1854, three decades after the first scientific descriptions of dinosaur remains, a menagerie of lifelike [dinosaur sculptures](/wiki/Crystal_Palace_dinosaurs) were unveiled in [London's](/wiki/London) [Crystal Palace Park](/wiki/Crystal_Palace_Park). The Crystal Palace dinosaurs proved so popular that a strong market in smaller replicas soon developed. In subsequent decades, dinosaur exhibits opened at parks and [museums](/wiki/Museum#Natural_history_museums) around the world, ensuring that successive generations would be introduced to the animals in an immersive and exciting way.<ref name=torrens1993/> Dinosaurs' enduring popularity, in its turn, has resulted in significant public funding for dinosaur science, and has frequently spurred new discoveries. In the United States, for example, the competition between museums for public attention led directly to the [Bone Wars](/wiki/Bone_Wars) of the 1880s and 1890s, during which a pair of feuding paleontologists made enormous scientific contributions.<ref name=breithaupt1997/>

The popular preoccupation with dinosaurs has ensured their appearance in [literature](/wiki/Literature), [film](/wiki/Film), and other [media](/wiki/Media_(communication)). Beginning in 1852 with a passing mention in [Charles Dickens](/wiki/Charles_Dickens)[Template:'](/wiki/Template:') [*Bleak House*](/wiki/Bleak_House),<ref name=bleakhouse/> dinosaurs have been featured in large numbers of [fictional](/wiki/Fiction) works. [Jules Verne's](/wiki/Jules_Verne) 1864 novel [*Journey to the Center of the Earth*](/wiki/Journey_to_the_Center_of_the_Earth), [Sir Arthur Conan Doyle's](/wiki/Sir_Arthur_Conan_Doyle) 1912 book [*The Lost World*](/wiki/The_Lost_World_(Conan_Doyle_novel)), the iconic 1933 [film](/wiki/Motion_picture) [*King Kong*](/wiki/King_Kong_(1933_film)), the 1954 [*Godzilla*](/wiki/Godzilla_(1954_film)) and its many sequels, the best-selling 1990 novel [*Jurassic Park*](/wiki/Jurassic_Park_(novel)) by [Michael Crichton](/wiki/Michael_Crichton) and its 1993 [film adaptation](/wiki/Jurassic_Park_(film)) are just a few notable examples of dinosaur appearances in fiction. Authors of general-interest [non-fiction](/wiki/Non-fiction) works about dinosaurs, including some prominent paleontologists, have often sought to use the animals as a way to educate readers about science in general. Dinosaurs are ubiquitous in [advertising](/wiki/Advertising); numerous [companies](/wiki/Company_(law)) have referenced dinosaurs in printed or televised advertisements, either in order to sell their own products or in order to characterize their rivals as slow-moving, dim-witted, or obsolete.<ref name=DFGlut1997/>

## See also[[edit](/index.php?title=(none)&action=edit&section=31)]

[Template:Portal](/wiki/Template:Portal)

* [Animal track](/wiki/Animal_track)
* [Dinosaur diet and feeding](/wiki/Dinosaur_diet_and_feeding)
* [Evolutionary history of life](/wiki/Evolutionary_history_of_life)
* [Lists of dinosaur-bearing stratigraphic units](/wiki/Lists_of_dinosaur-bearing_stratigraphic_units)
* [List of dinosaur genera](/wiki/List_of_dinosaur_genera)
* [Living dinosaur](/wiki/Living_dinosaur)

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## Notes and references[[edit](/index.php?title=(none)&action=edit&section=32)]

[Template:Reflist](/wiki/Template:Reflist)

## Further reading[[edit](/index.php?title=(none)&action=edit&section=33)]

[Template:Library resources box](/wiki/Template:Library_resources_box)

* Bakker, Robert T. (1986). [*The Dinosaur Heresies: New Theories Unlocking the Mystery of the Dinosaurs and Their Extinction*](/wiki/The_Dinosaur_Heresies). New York: Morrow. ISBN 0-688-04287-2.
* [Holtz, Thomas R. Jr.](/wiki/Thomas_R._Holtz_Jr.) (2007). [*Dinosaurs: The Most Complete, Up-to-Date Encyclopedia for Dinosaur Lovers of All Ages*](/wiki/Dinosaurs:_The_Most_Complete,_Up-to-Date_Encyclopedia_for_Dinosaur_Lovers_of_All_Ages). New York: Random House. ISBN 978-0-375-82419-7.
* [Paul, Gregory S.](/wiki/Gregory_S._Paul) (2000). *The Scientific American Book of Dinosaurs*. New York: St. Martin's Press. ISBN 0-312-26226-4.
* Paul, Gregory S. (2002). *Dinosaurs of the Air: The Evolution and Loss of Flight in Dinosaurs and Birds*. Baltimore: The Johns Hopkins University Press. ISBN 0-8018-6763-0.
* [Template:Citation](/wiki/Template:Citation)
* Sternberg, C. M. (1966). *Canadian Dinosaurs*, in *Geological Series*, no. 54. Second ed. [Ottawa]: National Museum of Canada. 28 p., amply ill.
* [Template:Cite web](/wiki/Template:Cite_web) ISBN 1-55670-596-4 (Article: [The Humongous Book of Dinosaurs](/wiki/The_Humongous_Book_of_Dinosaurs))
* [Template:Cite journal](/wiki/Template:Cite_journal)

## External links[[edit](/index.php?title=(none)&action=edit&section=34)]

[Template:Commons category](/wiki/Template:Commons_category) [Template:Wikiquote](/wiki/Template:Wikiquote) [Template:Wikisource portal](/wiki/Template:Wikisource_portal) [Template:Wikispecies](/wiki/Template:Wikispecies) [Template:Wiktionary](/wiki/Template:Wiktionary)

[Template:Spoken Wikipedia](/wiki/Template:Spoken_Wikipedia)

General

* [DinoDatabase.com | Hundreds of dinosaurs and dinosaur related topics](http://www.dinodatabase.com/)

Images

* [The Science and Art of Gregory S. Paul](http://www.gspauldino.com/) Influential paleontologist's anatomy art and paintings
* [Skeletal Drawing](http://skeletaldrawing.com/) Professional restorations of numerous dinosaurs, and discussions of dinosaur anatomy.
* ["Dinosaur Discovery"](http://lhldigital.lindahall.org/cdm/landingpage/collection/dino), a collection of images from early works on dinosaurs at the [Linda Hall Library](/wiki/Linda_Hall_Library), in support of the exhibition, [*Paper Dinosaurs, 1824–1969*](http://dino.lindahall.org/).

Video

* BBC Nature: [Dinosaur reconstructions and expert interpretations, including *Walking with Dinosaurs*](http://www.bbc.co.uk/nature/life/dinosaur)
* BBC Explainer – [Dinosaurs – a complete history in 4 minutes, animation](http://vimeo.com/74636204)
* [Origin, evolution and extinction of the dinosaurs](http://www.scientificamerican.com/article/how-dinosaurs-got-their-start-and-met-their-end-video/) [Stephen Brusatte](/wiki/Stephen_L._Brusatte) video lecture April 15, 2014

Popular

* [Dinosaurs & other extinct creatures](http://www.nhm.ac.uk/nature-online/life/dinosaurs-other-extinct-creatures/index.html): From the [Natural History Museum](/wiki/Natural_History_Museum,_London), a well illustrated dinosaur directory.
* [Dinosaurnews](http://www.dinosaurnews.org/) Dinosaur-related headlines from around the world, including finds and discoveries, and many links.
* [Dinosauria](http://www.ucmp.berkeley.edu/diapsids/dinosaur.html) From UC Berkeley Museum of Paleontology.
* [LiveScience.com](http://www.livescience.com/dinosaurs/) Dinosaur pages
* [Zoom Dinosaurs](http://www.enchantedlearning.com/subjects/dinosaurs/) From Enchanted Learning. Kids' site, info pages and stats, theories, history.
* [Dinosaur genus list](http://www.geol.umd.edu/~tholtz/dinoappendix/HoltzappendixWinter2010.pdf) contains data tables on nearly every published Mesozoic dinosaur genus as of January 2011.

Technical

* [*Palaeontologia Electronica*](http://palaeo-electronica.org/) From Coquina Press. Online technical journal.

[Template:Featured article](/wiki/Template:Featured_article)

[Template:Ornithodira](/wiki/Template:Ornithodira)

[Template:Authority control](/wiki/Template:Authority_control) [Template:Taxon bar](/wiki/Template:Taxon_bar)

[Template:DEFAULTSORT:Dinosaur](/wiki/Template:DEFAULTSORT:Dinosaur) [Category:Dinosaurs](/wiki/Category:Dinosaurs) [Category:Fossil taxa described in 1842](/wiki/Category:Fossil_taxa_described_in_1842) [Category:Carnian first appearances](/wiki/Category:Carnian_first_appearances) [Category:Extant Late Triassic first appearances](/wiki/Category:Extant_Late_Triassic_first_appearances) [Category:Taxa named by Richard Owen](/wiki/Category:Taxa_named_by_Richard_Owen)