

= Prosaurolophus =

Prosaurolophus (/ ˈproʊsəʊrəloʊfəs / ; meaning " before Saurolophus " , in comparison to the later dinosaur with a similar head crest) is a genus of hadrosaurid (or duck @-@ billed) dinosaur from the Late Cretaceous of North America . It is known from the remains of at least 25 individuals belonging to two species , including skulls and skeletons , but it remains obscure . Around 9 m (30 ft) , its fossils have been found in the late Campanian @-@ age Upper Cretaceous Dinosaur Park Formation in Alberta , and the roughly contemporaneous Two Medicine Formation in Montana , dating to around 75 @.@ 5 @-@ 74 @.@ 0 million years ago . Its most recognizable feature is a small solid crest formed by the nasal bones , sticking up in front of the eyes .

The type species is *P. maximus* , described by American paleontologist Barnum Brown of the American Museum of Natural History in 1916 . A second species , *P. blackfeetensis* , was described by Jack Horner of the Museum of the Rockies in 1992 . The two species were differentiated mainly by crest size and skull proportions .

= = Description = =

Prosaurolophus was a large @-@ headed duckbill ; the most complete described specimen has a skull around 0 @.@ 9 metres (3 @.@ 0 ft) long on a skeleton about 8 @.@ 5 metres (28 ft) long . It had a small , stout , triangular crest in front of the eyes ; the sides of this crest were concave , forming depressions . The upper arm was relatively short .

When originally described by Brown , Prosaurolophus maximus was known from a skull and jaw . Half of the skull was badly weathered at the time of examination , and the level of the parietal was distortedly crushed upwards to the side . The different bones of the skull could be easily defined , with the exception of the parietals and nasal bones . Brown found that the skull of the already described genus Saurolophus is very similar overall to , but also smaller than the skull of *P. maximus* . A unique feature of a shortened frontal in lambeosaurines is also found in Prosaurolophus , and the other horned hadrosaurines Brachylophosaurus , Maiasaura , and Saurolophus . Although they lack a shorter frontal , the genera Edmontosaurus and Shantungosaurus share with saurolophins an elongated dentary .

= = History of discovery = =

Well @-@ known paleontologist Barnum Brown recovered a duckbill skull in 1915 for the American Museum of Natural History (AMNH 5836) from the Red Deer River of Alberta , near Steepleville . He described the specimen in 1916 as a new genus , Prosaurolophus . Brown 's choice of name comes from a comparison to the genus Saurolophus , which he had described in 1912 . Saurolophus had a similar but longer and more spike @-@ like head crest . The skull had a damaged muzzle and was inadvertently reconstructed too long , but better remains were soon found that showed the true shape ; one is a nearly complete skeleton and skull , described by William Parks in 1924 . Twenty to twenty @-@ five individuals are known for this species , including seven skulls with at least some of the rest of the skeleton .

The second species , *P. blackfeetensis* , is based on a specimen in the Museum of the Rockies (MOR 454) , which was described by another notable paleontologist , Jack Horner . This specimen , and the remains of three or four other individuals , were found in Glacier County , Montana . In this case , the fossils were found in a bonebed of Prosaurolophus remains , which indicates that the animals lived together for at least some time . The bonebed is interpreted as reflecting a group of animals that congregated near a water source during a drought .

Horner differentiated the two species by details of the crest . He interpreted *P. blackfeetensis* as having a steeper , taller face than *P. maximus* , with the crest migrating backward toward the eyes during growth . More recent studies have regarded the differences as insufficient to support two species .

= = Classification = =

Because of its name , *Prosaurolophus* is often associated with *Saurolophus* . However , this is contentious ; some authors have found the animals to be closely related , whereas others have not , instead finding it closer to *Brachylophosaurus* , *Edmontosaurus* , *Gryposaurus* , and *Maiasaura* .

= = History of classification = =

In 1918 , Lawrence Lambe revised the classifications of Hadrosauridae (then Trachodontidae) . He invalidated the family name and Trachodontinae , replacing them with Hadrosauridae and Hadrosaurinae . The other subfamily in Hadrosauridae then was Saurolophinae , which included *Stephanosaurus* (= *Lambeosaurus*) , *Cheneosaurus* , *Corythosaurus* , *Prosaurolophus* , and *Saurolophus* . Lambe , in 1920 , split Saurolophinae and found only two genera remaining in it , *Prosaurolophus* , and the type genus . The previous genera were then reclassified into Stephanosaurinae or Hadrosaurinae . In 1928 , *Prosaurolophus* was assigned to Saurolophinae by Franz Nopsca . The group contained hadrosaurids with a " males with median horn @-@ like protuberance on the skull " and " very numerous teeth " , found by Nopsca to be *Parasaurolophus* , *Saurolophus* , and *Prosaurolophus* .

In 1954 , Charles Sternberg reevaluated the genera in Hadrosauridae , invoking the probability that Saurolophinae should be sunk into Hadrosaurinae . This greatly changed the classifications of the family , as the " saurolophines " were kept separate because of their supposedly " footed " ischium . Sternberg identified that the " footed " ischium assigned to *Saurolophus* was not found with the holotype , and was only assigned to it because of the location of the find . Also , he noted that William Parks (1924) found a complete skeleton of *Prosaurolophus* clearly showing a " unfooted " ischium , which Sternberg realized meant that it was unlikely that *Saurolophus* possessed a " footed " ischium . Sternberg 's reevaluation led to the abandonment of Saurolophinae .

Young (1958) found that the subfamily Saurolophinae , however , was not to be abandoned , and in it placed his new genus *Tsintaosaurus* , as well as *Prosaurolophus* and *Saurolophus* , and also *Kritosaurus* (which included *Gryposaurus* and excluded *K. navajovius*) . Two years previous , Friedrich von Huene separated Saurolophinae from Hadrosauridae , naming Saurolophidae . Saurolophidae was a family in Huene 's Hadrosauria , including the genera *Prosaurolophus* , *Saurolophus* , and the probably unrelated *Bactrosaurus* . Another author to support the separation of Saurolophinae was John Ostrom (1961) . Ostrom found that the saurolophines *Brachylophosaurus* , *Prosaurolophus* , and *Saurolophus* all possessed a " pseudonarial crest " , a feature which united them , while distinguishing them from hollow @-@ crested lambeosaurines .

Hopson (1975) supported the division of Hadrosauridae into two subfamilies , Hadrosaurinae and Lambeosaurinae , and was first to suspect what modern analyses find . Hopson found that Hadrosaurinae could clearly be divided into groups , the " kritosaurs " , the " edmontosaurs " , and the " saurolophines " , including *Prosaurolophus* , *Saurolophus* , *Tsintaosaurus* and *Lophorhothon* , and intermediate between the " kritosaurs " and " saurolophines " . Brett @-@ Surman (1975) also followed Sternberg with sinking Saurolophinae into Hadrosaurinae , and like Hopson , he recognized three groups within the subfamily . Like Hopson , one group was called the *Edmontosaurus* lineage , the second the *Kritosaurus* group , and the third uniting *Prosaurolophus* and *Saurolophus* . Over a decade later in 1989 , Brett @-@ Surman scientifically named the groups of hadrosaurines , the first becoming Edmontosaurini , the second Kritosaurini , and the third Saurolophini .

= = Phylogeny = =

The first cladistic analysis to encompass the interrelationships of Hadrosauridae was conducted by Weishampel and Horner (1990) . They found Saurolophinae synonymous with Hadrosaurinae , but only separated the subfamily into two groups . The first group included *Gryposaurus* , *Aralosaurus* , *Maiasaura* , and *Brachylophosaurus* . The other contained *Edmontosaurus* , *Saurolophus* , *Prosaurolophus* , *Lophorhothon* , and *Shantungosaurus* .

A detailed cladogram of hadrosaurid relationships was published in 2013 by *Acta Palaeontologica Polonica*. The study was led by Alberto Prieto-Márquez, and recovered *Prosaurolophus* in a similar position as suggested by Brown in 1916. The below cladogram was the one recovered by their analysis:

In 2001, *Prosaurolophus* was studied with other hadrosaurids by Wagner. The genus, along with *Corythosaurus* and *Maiasaura*, were considered by Wagner to be synonymous with *Saurolophus*, *Hypacrosaurus* and *Brachylophosaurus* respectively. *Prosaurolophus maximus* was reassigned to *Saurolophus* as *S. maximus*. The same year however, *Prosaurolophus* was found to be distinct from *Saurolophus*, in an analysis of Hu et al.. Their analysis was unique from any of the time, and they recovered *Prosaurolophus* in *Saurolophinae*, with *Saurolophus*, *Lophorhothon*, *Tsintaosaurus*, *Jaxartosaurus*, and *Kritosaurus*. No other analysis has recovered this group of dinosaurs.

Horner et al. (2004) also recovered a different phylogeny of *Saurolophinae*. *Prosaurolophus* was, for the first time, recovered separate from *Saurolophus*, in fact not even closely related. *Prosaurolophus* was found in a group with *Brachylophosaurus*, *Maiasaura*, *Gryposaurus*, and *Edmontosaurus*, while *Saurolophus* was grouped with *Naashoibitosaurus* (= *Kritosaurus*) and "*Kritosaurus*" *australis*.

The *Prosaurolophus*-*Saurolophus* clade has been a problematic grouping when trying to place among hadrosaurines. Many skull features are similar to *Edmontosaurus*, while other are closer to *Gryposaurus*, so the group has been classified as close to both. However, the clade might be closer to *Edmontosaurus*, as the features are more numerous uniting them.

= = Paleobiology = =

As a hadrosaurid, *Prosaurolophus* would have been a large herbivore, eating plants with a sophisticated skull that permitted a grinding motion analogous to chewing. Its teeth were continually replaced and packed into dental batteries that contained hundreds of teeth, only a relative handful of which were in use at any time. Plant material would have been cropped by its broad beak, and held in the jaws by a cheek-like structure. Feeding would have been from the ground up to around 4 meters (13 ft) above. Like other hadrosaurs, it could have moved both bipedally and quadrupedally. Comparisons between the scleral rings of *Prosaurolophus* and modern birds and reptiles suggest that it may have been cathemeral, active throughout the day at short intervals.

= = = Social behavior = = =

As noted, there is bonebed evidence that this genus lived in groups during at least part of the year. Additionally, it had several potential methods for display in a social setting. The bony facial crest is an obvious candidate, and nasal diverticula may also have been present. These postulated diverticula would have taken the form of inflatable soft tissue sacs housed in the deep excavations flanking the crest and elongate holes for the nostrils. Such sacs could be used for both visual and auditory signals.

= = Paleoecology = =

The Dinosaur Park Formation, home to *Prosaurolophus maximus*, is interpreted as a low-relief setting of rivers and floodplains that became more swampy and influenced by marine conditions over time as the Western Interior Seaway transgressed westward. The climate was warmer than present-day Alberta, without frost, but with wetter and drier seasons. Conifers were apparently the dominant canopy plants, with an understory of ferns, tree ferns, and flowering plants. In this well-studied formation, *P. maximus* is only known from the upper part, which had more of a marine influence than the lower section. It was the most common hadrosaurine of this section, which was deposited about 75 to 5 million years ago. The Dinosaur Park Formation was also home to well-known dinosaurs like the horned *Centrosaurus*, *Styracosaurus*, and *Chasmosaurus*, fellow duckbills *Gryposaurus*, *Corythosaurus*, *Lambeosaurus*, and

Parasaurolophus , tyrannosaurid Gorgosaurus , and armored Edmontonia and Euoplocephalus .

The roughly contemporaneous Two Medicine Formation , home to P. maximus , is well known for its fossils of dinosaur nests , eggs , and young , produced by the hadrosaurids Hypacrosaurus stebingeri and Maiasaura , and the troodontid Troodon . The tyrannosaurid Daspletosaurus , caenagnathid Chirostenotes , dromaeosaurids Bambiraptor and Saurornitholestes , armored dinosaurs Edmontonia and Euoplocephalus , hypsilophodont Orodromeus , and horned dinosaurs Achelousaurus , Brachyceratops , Einiosaurus , and Styracosaurus ovatus were also present . This formation was more distant from the Western Interior Seaway , and higher and drier than the Dinosaur Park Formation . The age of Parasaurolophus maximus remains from this formation is from approximately 75 @. @ 5 to 74 @. @ 0 million years ago .