= Alioramus =

Alioramus (/ ?ælio??re?m?s / ; meaning ' different branch ') is a genus of tyrannosaurid theropod dinosaurs from the Late Cretaceous period of Asia . The type species , A. remotus , is known from a partial skull and three foot bones recovered from Mongolian sediments which were deposited in a humid floodplain about 70 million years ago . These remains were named and described by Soviet paleontologist Sergei Kurzanov in 1976 . A second species , A. altai , known from a much more complete skeleton , was named and described by Stephen L. Brusatte and colleagues in 2009 . Its relationships to other tyrannosaurid genera are unclear , with some evidence supporting a hypothesis that Alioramus is closely related to the contemporary species Tarbosaurus bataar .

Alioramus were bipedal like all known theropods , and their sharp teeth indicate that they were carnivores . Known specimens were smaller than other tyrannosaurids like Tarbosaurus bataar and Tyrannosaurus rex , but their adult size is difficult to estimate since both species are known only from juvenile or sub @-@ adult remains . The recent discovery of Qianzhousaurus indicates that it belongs to a distinct branch of tyrannosaur . The genus Alioramus is characterized by a row of five bony crests along the top of the snout , a greater number of teeth than any other genus of tyrannosaurid , and a lower skull than other tyrannosaurids .

= = Description = =

Alioramus remotus was estimated at 5 to 6 metres (16 to 20 ft) in length when originally described by Sergei Kurzanov in 1976 . Kurzanov , however , did not correct for lengthening of the skull by deformation during fossilization , which may indicate a shorter overall body length for this individual . If this specimen is a juvenile , then adult Alioramus would have reached greater lengths , but no confirmed adult specimens are known .

The skull of A. remotus was approximately 45 centimetres (18 in) long . In general , it is long and low , a shape typical of more basal tyrannosauroids and juveniles of larger tyrannosaurids . The premaxillary bones at the tip of the snout in Alioramus remotus have not been found , but are taller than wide in all tyrannosauroids for which they are known . The nasal bones are fused and ornamented with a row of five irregular bony crests that protrude upwards from the midline , where the nasal bones are sutured together . These crests all measure more than 1 centimetre (0 @.@ 39 in) tall .

At the back of the skull there is a protrusion , called the nuchal crest , arising from the fused parietal bones , a feature shared with all tyrannosaurids . In Alioramus , the nuchal crest is greatly thickened , similarly to Tarbosaurus and Tyrannosaurus . Like the rest of the skull , the lower jaw of Alioramus was long and slender , another possible juvenile characteristic . As in Tarbosaurus , a ridge on the outer surface of the angular bone of the lower jaw articulated with the rear of the dentary bone , locking the two bones together and removing much of the flexibility seen in other tyrannosaurids . Other tyrannosaurids had four premaxillary teeth , D @-@ shaped in cross section , on each side . Including 16 or 17 in each maxilla , and 18 in each dentary , Alioramus had 76 or 78 teeth , more than any other tyrannosaurid . The braincase of A. altai was intermediate between the basal theropod and avialan conditions .

The rest of the skeleton of Alioramus remotus is completely unknown except for three metatarsals (bones of the upper foot) , but the discovery of A. altai , which is known from substantially more complete remains , has shed light on the anatomy of the genus .

= = Classification and systematics = =

Paleontologists have long classified Alioramus within the superfamily Tyrannosauroidea , but because its remains were for many years poorly known , a more precise classification had remained elusive until the discovery of A. altai . A cladistic analysis published in 2003 found Alioramus could be further classified into the family Tyrannosauridae and the subfamily Tyrannosaurinae , alongside Tyrannosaurus , Tarbosaurus and Daspletosaurus . A 2004 study supported this result but

suggested it was equally probable that Alioramus belonged outside the family Tyrannosauridae entirely , with its supposed juvenile characters actually reflecting a more basal position within Tyrannosauroidea . Another study omitted Alioramus altogether due to the only specimen 's fragmentary nature . The discovery of A. altai in 2009 confirmed the placement of the genus within the Tyrannosaurinae .

Tarbosaurus and Alioramus shared several skull features , including a locking mechanism in the lower jaw between the dentary and angular bones , and both lacked the prong of the nasal bones which connected to the lacrimal bones in all other tyrannosaurids except adult Daspletosaurus . The two genera may be closely related , representing an Asian branch of the Tyrannosauridae . Some specimens of Tarbosaurus have a row of bumps on the nasal bones like those of Alioramus , although much lower . The long and low shape of the only known Alioramus remotus skull indicated that it was immature when it died and might even have been a juvenile Tarbosaurus , which lived in the same time and place . The more prominent nasal crests and much higher tooth count of Alioramus , however , suggested it was a separate taxon , even if it is known only from juvenile remains , confirmed by the discovery of A. altai . Specimens identified as immature Tarbosaurus have the same tooth count as adults .

Recently a cladogram has been published finding Alioramus just outside Tyrannosauridae . Below is the cladogram by Loewen (2013) .

= = Discovery and naming = =

The holotype (PIN 3141 / 1) of Alioramus is a partial skull associated with three metatarsals . A joint Soviet @-@ Mongolian expedition to the Gobi Desert in the early 1970s found these remains at a locality known as Nogon @-@ Tsav in the Mongolian province of Bayankhongor . Alioramus was named and described by Russian paleontologist Sergei Kurzanov in 1976 . Its crests and low skull profile looked so different from other tyrannosaurids that Kurzanov believed his find was far removed from other members of the family . Accordingly , he gave it the generic name Alioramus , derived from the Latin alius (' other ') and ramus (' branch ') , and the specific name A. remotus , which means ' removed ' in Latin . Alioramus is known from the holotypes of A. remotus and A. altai .

= = Paleoecology = =

The Beds of Nogon @-@ Tsav are considered to be the same age as the Nemegt Formation . This geologic formation has never been dated radiometrically , but the fauna present in the fossil record indicate it was probably deposited during the Maastrichtian stage , at the end of the Late Cretaceous .

The Maastrichtian stage in Mongolia , as preserved in the Nemegt Formation and at Nogon @-@ Tsav , was characterized by a wetter and more humid climate compared with the semi @-@ arid environment preserved in the earlier , underlying Barun Goyot and Djadochta Formations . Nemegt sediments preserve floodplains , large river channels and soil deposits , but caliche deposits indicate periodic droughts . This environment supported a more diverse and generally larger dinosaur fauna than in earlier times . Kurzanov reported that other theropods , including Tarbosaurus , ornithomimosaurs and therizinosaurs were discovered at the same locality , but these remains have never been reported in detail . If the Nogon Tsav fauna was similar to that of the Nemegt Formation , troodontid theropods , as well as pachycephalosaurs , ankylosaurids and hadrosaurs would also have been present . Titanosaurian sauropods were also potential prey for predators in the Nemegt .