

= Vulcanodon =

Vulcanodon (meaning " volcano tooth ") is an extinct genus of sauropod dinosaur from the Early Jurassic of southern Africa . The only known species is *V. karibaensis* . Discovered in 1969 in Rhodesia (now known as Zimbabwe) , it was regarded as the earliest known sauropod for decades , and is still one of the most primitive sauropods that has been discovered . As a quadrupedal , ground @-@ dwelling herbivore , Vulcanodon already showed the typical sauropod body plan with column @-@ like legs and a long neck and tail . It was much smaller than most other sauropods , measuring approximately 6 @.@ 5 metres (20 ft) in length . Vulcanodon is known from a fragmentary skeleton including much of the pelvic girdle , hind limbs , forearms , and tail , but lacking the trunk and neck vertebrae as well as the skull .

Originally , this genus was believed to be a prosauropod because of the knife @-@ shaped teeth found near its fossils , which fit in with the idea that prosauropods were omnivorous . Scientists now know that the teeth belonged to an unidentified theropod that may have scavenged on the Vulcanodon carcass . Vulcanodon is now known to be a true sauropod . Upon the discovery of the related Tazoudasaurus , both animals were unified in the family Vulcanodontidae , though this has not been universally accepted .

= = Etymology = =

Vulcanodon (lat . Vulcanus ? Roman god of fire ; gr. odon ? " tooth ") was named by Michael Raath in 1972 . The name points to the fact that the skeleton was found in a small body of sandstone that is sandwiched between two lava flows , and emphasizes the peculiar knife @-@ shaped teeth that are now known to belong to a theropod . The species name , *karibaensis* , refers to the place of discovery on a small island in Lake Kariba .

= = Description = =

Vulcanodon was a small sauropod , measuring approximately 6 @.@ 5 m (21 ft) in length . As one of the earliest and basalmost sauropods , it is important for understanding the early evolution of this group . Sauropods descend from basal sauropodomorphs (informally called " prosauropods ") , which were primitively bipedal (two legged) . While Vulcanodon already was fully quadrupedal (four legged) , its limb proportions were intermediate between those of its prosauropod ancestors and those of later , more derived sauropods . Its forelimbs were much more similar to later sauropods than basal sauropodomorphs because they are straight , much more gracile , and the proximal end of the ulna is v @-@ shaped . Unfortunately , no skull or neck of Vulcanodon is known , although it is otherwise very well @-@ known .

= = = Hindlimbs and pelvis = = =

Vulcanodons limbs were sturdy and column @-@ like , and its forelimbs were already proportionally long , reaching 76 % of hindlimb length . Its lower leg , metatarsus , and toes were shortened in comparison to its bipedal ancestors , but still not as short as in later sauropods . The sacrum was made out of four fused sacral vertebrae ; " prosauropods " possessed only three sacra . The tail vertebra bodies already showed an incipient excavation of their lateral sides , saving weight and giving them a waisted appearance when viewed from below . In later sauropods , this excavations were enlarged to form extensive pockets called pleurocoels . Contrasting the many sauropod @-@ like features of the skeleton , the pelvis was relatively primitive , reminiscent of its " prosauropod " ancestors . One such feature is that the brevis shelf of the ilium has a fossa , which is not found in any more derived sauropods .

The hallux (the first toe of the foot) showed a large claw that was flattened laterally , as seen in " prosauropods " . However , the claws of the second and third toe were unusual in being nail @-@ like and broader than deep . This feature was also found in the probably closely related

Tazoudasaurus , but is absent in all other sauropods . The feet of Vulcanodon were semiplantigrade as in later sauropods (where both the digits and part of the metatarsals contact the ground) , a derived feature not found in more basal sauropods like Isanosaurus . However , they also retained primitive features , like the fact that the phalanges were not reduced .

Many of the features found in sauropods that basal sauropodomorphs lack are related to the change in body size . The greatest regions affected by this are the hind limbs and pelvis . For example , an elongating of the ilium , size reduction of the lesser trochanter shelf , and semiplantigrade posture are some features that indicate the amount and positioning of leg muscles being modified . Vulcanodon possessed these features , the latter of which is seen earliest in it . However , Vulcanodon does not have reduced distal phalanges , which are seen in Shunosaurus and all more derived sauropods . This means that while the muscle positioning of its legs were changing , they had not yet reduced in the distal region of the limb .

= = Classification = =

Originally , Michael Raath (1972) described Vulcanodon not as a sauropod but as an advanced , specialized prosauropod , possibly of the family Melanorosauridae . According to Raath , the sauropod @-@ like limb proportions have been independently evolved in Vulcanodon and sauropods (convergent evolution) . He argued that primitive features of the pelvis as well as the knife @-@ shaped teeth preclude a classification within the Sauropoda . The teeth , however , are now known to belong to a theropod . Arthur Cruickshank (1975) was the first to show that Vulcanodon was indeed a sauropod , arguing that the fifth metatarsal bone was equally long as the remaining metatarsals , a condition seen in other sauropods but not in prosauropods . Today , Vulcanodon is universally accepted to be one of the most basal (primitive) members of Sauropoda .

Michael Cooper (1984) erected a new family , the Vulcanodontidae , which he regarded as the " rootstock " for later sauropod families . Originally , the Vulcanodontidae included Vulcanodon and the Indian Barapasaurus , but subsequent studies attributed a number of other , much more fragmentary early sauropod genera to this family , including Ohmdenosaurus and Zizhongosaurus . Paul Upchurch (1995) showed that Barapasaurus was more closely related to later , more advanced sauropods than to Vulcanodon , rendering the Vulcanodontidae polyphyletic and therefore invalid .

The exact relationships with other basal sauropod genera remain unclear . Ronan Allain and colleagues (2004 , 2008) found that Vulcanodon is most closely related to Tazoudasaurus , a newly discovered sauropod genus from Morocco . These researchers suggested reintroducing the name Vulcanodontidae to name the clade containing Vulcanodon and Tazoudasaurus . However , this sibling relationship between Tazoudasaurus and Vulcanodon could not be confirmed by other analyses .

Adam Yates (2004) described a single sauropod tail vertebra from the Upper Elliot Formation of South Africa that may belong to a genus closely related to Vulcanodon . The Upper Elliot Formation is famous for its abundant fossils of the prosauropod Massospondylus .

= = Discovery = =

Vulcanodon is known only from a single locality on an island in Lake Kariba , the largest artificial lake in the world , in northern Zimbabwe (formerly Rhodesia) . The island , located west of Bumi Hills , is called " Island 126 / 127 " , after early , unpublished lake charts , but has no formal name . The first bone was found by B. A. Gibson of the town of Kariba in July 1969 , and an excavation team collected the specimen in October 1969 , March 1970 and May 1970 . In the later half of 1970 , the new find was presented at a scientific symposium in Cape Town and a brief note was published . The find was formally described in July 1972 by palaeontologist Michael Raath . It was one of the first dinosaurs found in Zimbabwe .

The skeleton (catalogue number QG24) has been found weathering out of a hill slope and was

partially eroded by surface exfoliation and plant roots . It includes the pelvis and sacrum , most of the left hind limb and foot , a right thigh bone , and 12 anterior tail vertebrae . These remains pertain to a single individual as they were all found articulated (still connected together) . Additionally , several disarticulated bones were found , including the right forearm and some metacarpalia and phalanges from both the right and left forefeet , probably also pertaining to this individual . Later , the site was revisited by the scientists G. Bond and Michael Cooper , who were able to collect additional remains including a scapula (shoulder blade) and a fragment of a neck vertebra . These remains show that more than one individual was present , and it is possible that they do not pertain to *Vulcanodon* at all . Today , the *Vulcanodon* remains are stored in the Natural History Museum of Zimbabwe in Bulawayo .

Raath (1972) noted the discovery of nine fragmentary carnivorous teeth near the pelvic region of the skeleton . He argued that the *Vulcanodon* carcass might have been embedded with the head and neck bended backwards above the pelvis , a posture called death pose that is frequently seen in dinosaur skeletons . The teeth would have been the only preserved elements of the skull . However , as shown by Cooper (1984) , these teeth do not pertain to *Vulcanodon* but to a theropod dinosaur that may have scavenged on the *Vulcanodon* carcass .

= = Paleoecology = =

During the later part of the Lower Jurassic , southern Africa was the scene of massive volcanism , resulting in extensive lava flows (so called flood basalts) that covered much of southern Africa and Antarctica . These basalt formations are known as the Karoo @-@ Ferrar large igneous province . *Vulcanodon* comes from the " *Vulcanodon* beds " , a fossil @-@ bearing sediment unit within the Batoka Formation , which is composed primarily of flood basalts . The skeleton was found near the top of a 30 m (98 @.@ 5 ft) thick bedded layer of sand- and siltstone that is over- and underlain by flood basalts .

It was long assumed that *Vulcanodon* lived during the lowermost (earliest) part of the Jurassic (the Hettangian stage) or at the Triassic @-@ Jurassic boundary , approximately 200 million years ago . Therefore , it was regarded the earliest sauropod known , until the discovery of the even older Late Triassic *Isanosaurus* was announced in 2000 . Adam Yates (2004) has recently shown that *Vulcanodon* is actually much younger than previously thought , dating to the uppermost (latest) part of the Lower Jurassic during the Toarcian stage , approximately 175 ? 183 million years ago . ? thus , it is contemporary to the closely related *Tazoudasaurus* . Although the locality of *Vulcanodon* itself cannot be dated radiometrically because of weathering of the lavas , it would roughly be a contemporary to Karoo lavas from other localities , as the entire sequence of volcanic eruptions was finished within one million years .

Vulcanodon is the only named dinosaur from the *Vulcanodon* beds . Cooper (1984) noted that the habitat was desert @-@ like , as indicated by aeolian (wind @-@ blown) sands of the Forest Sandstone Formation , which underlies the " *Vulcanodon* beds " . The sediments in which *Vulcanodon* was found may represent distal alluvial fan deposits which levelled off into a desert landscape , which may have contained lakes during the wet season . The individual may have roamed the shores of wadis that cut into the alluvial fan deposits , unless the carcass was transported to the locality it was found by flooding .

Initially , sauropods were thought to be mainly aquatic , inhabiting lush peat swamps and being captive to the buoyancy of water to support their giant body weights . In 1984 , Cooper pointed out that *Vulcanodon* , the most primitive sauropod known at that time , lived in a desert like environment and therefore must have been terrestrial . This indicated that the large body size of sauropods , as already seen in *Vulcanodon* , had not evolved as an adaptation to an aquatic life style .