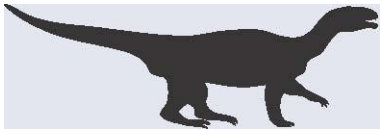

Azendohsaurus

(ah-ZEN-do-SAWR-us) “Azendoh Lizard”

Introduction

Originally thought to be one of the earliest dinosaurs, recent research has revealed that this species is not actually a dinosaur at all. In May 2010, a group of researchers from a collection of academic institutions, including the American Museum of Natural History, Columbia University, the University of Antananarivo, and the University of California, published their detailed research on new fossil finds of *Azendohsaurus* found in Madagascar, stating that this species was, in fact, not a primitive dinosaur but something even more interesting. Scientists now believe that this species was a **basal** archosauromorph, which is a diverse group of **diapsid** reptiles that lived from the late Permian (299–251 million years ago) to the Late Triassic (235–201.6 million years ago). It is believed that *Azendohsaurus* lived during the Late Triassic, although maybe as early as 237 million years ago.

Classification

All dinosaur species are classified based on their hip structure as either ornithischia (bird-hipped) or saurischia (lizard-hipped) dinosaurs. Despite the name, it is from the lizard-hipped dinosaurs that today’s avian dinosaurs (birds) descend. While this may seem illogical, scientifically it is known as **convergent evolution**, whereby the backward pointing pubis seen in ornithischian dinosaurs and birds actually evolved separately.

For more than ~~thirty~~ 30 years, *Azendohsaurus* was regarded as a primitive dinosaur based on dental and gnathic (jaw) characteristics. Originally, *Azendohsaurus* was described and classified as an ornithischian dinosaur based on the similarity of its teeth to *Fabrosaurus* and *Lycorhinus*, dinosaurs from the Late Jurassic in southern Africa. Palaeontologists later realized, however, that *Azendohsaurus*’s teeth more closely resembled that of basal sauropodomorph dinosaurs. Although this classification remained for many years, a non-dinosaurian plylogenetic position was suggested as early as 2002. It was not until 2010 that *Azendohsaurus* was described and assigned to the archosauromorph clade, which is a diverse group of diapsid reptiles that include the orders rhynchosauria, trilophosauridae, prolacertiformes, and archosauriformes. While it is from archosauromorphs that the lineages of crocodiles, dinosaurs, and birds descend, *Azendohsaurus* is now considered to be only distantly related to dinosaurs.

Because the process of changing taxonomy is complicated and determined by the International Commission on Zoological Nomenclature (ICZN), the classification for *Azendohsaurus* has not yet officially changed to recognize the 2010 study.

Anatomy

Fossil remains of *Azendohsaurus* collected so far are limited to a skull, several teeth, and mandible from Madagascar and a mandible from Morocco. It was initially thought that *Azendohsaurus* was a relative of the Bristol dinosaur *Thecodontosaurus*. However, as the latest research has demonstrated that *Azendohsaurus* is not a dinosaur but a more primitive diapsid reptile, definite ideas about its body form remain somewhat speculative. Like modern-day diapsid reptiles, which include all crocodiles, lizards, and snakes, extinct diapsid species were extremely diverse and were likely characterized by many different body forms. It is thought, however, that *Azendohsaurus* may have resembled another early lizard-like **archosaur** called *Trilophosaurus*.

Azendohsaurus was a relatively small animal, being only 1.8–2.0 meters (6–6.5 ft) long and weighing 35–55 kilograms (77–120 lbs). Current paleontologist theory states that this species was a quadrupedal herbivore, somewhat lizard-like in appearance, with its hind and forelimbs likely ending in four to five clawed digits.

Azendohsaurus had a strong skull, with leaf-shaped teeth not only found along its jaw, but also on the roof of its mouth. Like all diapsid reptiles, it possessed two temporal fenestrae, or openings, on either side of its skull.

Intelligence

The intelligence of animal species, both extinct and extant, is most often measured and compared using the **encephalization quotient** (EQ). This measure is a ratio between body and brain size and, with the exception of the Troodontids (EQ of 5.8) and the Dromaeosaurids (EQ of 5.8), all dinosaur species fall below 2.0. While this compares poorly with today's animals, new research on dinosaur cranial morphology has indicated that they may have been more intelligent than previously thought. Current EQ measures for *Azendohsaurus* have currently not been conducted. Fossil specimens are limited to just a skull and jaw, which makes it impossible to calculate a body-to-brain ratio. *Azendohsaurus*'s recent reclassification from dinosaur to archosauromorph also means it is difficult to determine its intelligence. It is likely, however, that this primitive species possessed an EQ in the lower to middle range compared to dinosaur species, as evidence suggests that herbivore species were less intelligent than carnivore species.

Reproduction & and Population

The paucity of fossils makes it very difficult for paleontologists to determine past populations. This is especially so for *Azendohsaurus*, as unearthed fossils are limited to finds of only a skull and several mandibles. From remains discovered so far, however, it appears that *Azendohsaurus* was at least distributed from what is now Morocco to Madagascar during the Late Triassic period, when Pangaea was still a supercontinent.

Like dinosaur species, it is assumed that extinct archosauromorph reptiles were **oviparous** and laid a number of eggs per clutch (number of eggs produced in a nest at a single time). Although it is considered unlikely that *Azendohsaurus* performed highly-developed or sophisticated parental care, to date, no eggs shell fossils of *Azendohsaurus* have been found, which limits current understanding of the reproductive behavior of these ancient reptiles. It is considered possible, however, that *Azendohsaurus* exhibited some form of brooding behavior, such as seen in modern-day crocodiles, which bury eggs underground to keep them warm.

Diet

Azendohsaurus was an herbivorous species that fed on the plants found within its frequently arid environment. Vegetation across the giant supercontinent of Pangaea demonstrated geographic variation, but primarily consisted of **gymnosperms**, including palm-like cycads, ferns, and conifers, as angiosperms, or flowering vascular seed plants, had not yet evolved. *Azendohsaurus* was a relatively small species, especially in comparison to many species of dinosaur, and it was likely restricted to feeding on low-lying vegetation such as ferns, horsetails, cycads, and mosses, for which its leaf-shaped teeth were well adapted.

The revelation that this species was a basal archosauromorph is again an example of convergent evolution, in which a number of features found in both *Azendohsaurus* and later herbivores, such the gigantic sauropods, evolved separately. This discovery is particularly meaningful, as it proves that plant-eating, particularly the craniodental characteristics connected with herbivory, evolved independently on at least six to eight different occasions, and was more common within archosauromorphs than previously thought.

Behavior

Given the scarcity of fossil remains, very little is known about the behavior of *Azendohsaurus*, particularly in regards to social and defensive behavior. Without the discovery of full skeletal specimens, paleontologists can only speculate on the activity of these extraordinarily ancient reptiles.

From dentition and jaw morphology, it is known that *Azendohsaurus* was an herbivore and was also likely a quadruped. While it is not known if they formed herds, many species of ancient and modern-day plant-eaters exhibit this behavior. The discovery of a second species of *Azendohsaurus* in Madagascar in a "red bed" (red-colored sedimentary layers of sandstone, siltstone, and shale), in which several individuals died together, does provide tentative evidence of herd behavior. Given the small stature of *Azendohsaurus*, herd-living would have offered a measure of protection to offspring.

Habitat ~~&~~ and Other Life Forms

During the Triassic period, all land masses on earth were joined together in one supercontinent called Pangaea. At the end of the Triassic and the beginning of the Jurassic period, this super landmass began to develop rifts, and by the end

of the Jurassic period 145.5 million years ago, it had separated into the two distinct continents of Gondwana and Laurasia.

The prevailing climate during the Late Triassic period was generally very hot and dry, although some regions experienced wet monsoonal climate phases, and was characterized by warm temperate conditions at the southern and northern poles, as there was no polar ice. Late Triassic fauna in Africa, including what is now present-day Morocco and Madagascar, was similar to many regions of Pangaea. Dinosaur populations consisted primarily of carnivorous theropods and beaked, herbivorous ornithischians. The Late Triassic was also the time period in which the first primitive mammals appeared.

Most significantly in regards to species evolution and distribution, however, was the dramatic extinction event that occurred at the boundary between the end of the Late Triassic and the start the Early Jurassic 200 million years ago. This event wiped out 35 percent of all animal species, including many primitive dinosaurs. Although there is continued conjecture as to the cause of this extinction event, current theories center on volcanic activity, possible meteoric impact, and climate change.

Research

Named for the Moroccan village of Azendoh, which is located close to the fossil deposit in the Atlas Mountains, *Azendohsaurus laaroussi* was unearthed in 1972 by paleontologist J. M. Dutuit in the Argana Formation, a geological formation found in continental Africa. Several other species have been located within this formation, which is dated to the Late Triassic. From this, it is estimated that *Azendohsaurus* lived between 228 and 216.5 million years ago. *Azendohsaurus laaroussi* is known from very limited remains—to date from only two dentaries, a maxilla, and isolated teeth. In the late 1990s, however, a second species was discovered in the Makay Formation of Madagascar. The remains were a complete skull, mandible, and associated vertebrae. Although this species was described and named *Azendohsaurus madagaskarensis* ~~over~~more than a decade ago by a team of American and Malagasy scientists, it was only in 2010 that new research revealed that this species was not a dinosaur, but a basal archosauromorph. Such an interesting revelation highlights the difficulty of classifying animals from only a few fossilized remains.

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VOCABULARY

Archosaurs: Meaning "ruling reptiles," a type of diapsid reptiles that were the direct ancestors of the dinosaurs, evolving from more primitive reptiles in the Triassic period.

Basal: Used to describe a primitive or early form. In the case of *Azendohsaurus*, it is considered a basal archosauromorph reptile.

Convergent Evolution: When two or more distinct and unrelated species (~~that is~~i.e., possessing different ancestries) evolve similar biologically characteristics to fulfill a specific function, such as flight exhibited, for example, in flying reptiles, bats, and birds.

Diapsid: A form of reptile in which the skull possesses two temporal fenestrae (openings) on either side of the skull, and includes lizards, snakes, crocodiles, dinosaurs, and pterosaurs.

Encephalization Quotient (EQ): Is a measure of an organism's intelligence, based on a ratio of brain size to body size. For dinosaurs, this measure falls somewhere between 0.1 and 5.8.

Gymnosperms: The first seed plants to evolve, differing from angiosperms in regards to flowers and seed encasement, and first evolving in the upper Devonian (about 385 to 359 million years ago). Species include conifers and cycads.

Oviparous: Organisms that lay eggs instead of live young, such that most embryonic development occurs outside of the female's body.