The Evolution of Whales and the Evidence of their Evolution

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 In the history of evolution, biologists have concluded that the discovered fossils provide the evidence that is convincing that there has been an evolution as far as all the mammals are concerned. The fossil ancestors’ evidence shows the relationship between the ancestors and the modern creatures. The development of mammals dates back to the days that the dinosaurs were the dominant vertebrates. These vertebrates became lost a long time ago, millions of years and their extinction led to significant radiation of mammals. It was during these days that the first *cetaceans* evolved, which includes the whale. These first *cetaceans* didn’t look exactly as the whales that we nowadays know, but through the evidence that the biologists have discovered we can say that these earliest *cetacean* fossils are the ancestors of the modern whales. This paper, will focus on the evolution of whales as explained by Paleontologists. Also, it will discuss the evidence from biological research that shows that whales did originate from terrestrial mammals.

**Whales Ancestry**
 Many have done research that shows that the ancestors of whales are terrestrial mammals. This research indicates that, although modern whales are somehow different from the ancestor whales, they originate from mammals. For example, whales, just like the mammals, nurse their young ones and although they lack hairs or fur like the other mammals, their fetuses have whiskers (Thewissen and Cooper, 2009). These characteristics that whales have are the same as those of the mammals, suggesting that whales did originate from the terrestrial Mammals.
 According to Sutera (2000), many pre-Darwinian researchers realized that the whales had similar characteristics to the terrestrial mammals. He continues to state that according to Darwin, whales originated from bears, which are mammals (Sutera, 2000). This theory faced a lot of criticism forcing Darwin to withdraw it in his later research. Furthermore, there is evidence that confirms that whale originates from terrestrial mammals.
 Researchers like Van Valen stated that the whales did originate from the *mesonychid condylarths,* which is a group of extinct primitive carnivores ungulates, basing their argument on the dental characters of both creatures (Gingerich, 2012). These researchers’ evidence shows that the ancestors of whales are mammals. Although Van Valen hypothesis, also, faced criticism, it was supported by Boyden and Gemeroy’s who linked whale to have originated from *Artiodactyla.* The similarity between these researchers provided a perfect reconciliation with the known records of fossils (Gingerich, 2012).

 **Palaeontological Evolution of Whales**

 Many *palaeontologists* have tried their best in explaining the evolution of the whales. These explanations are trying to give a proof that the whales did originate from the terrestrial mammals, and through millions of years, they have evolved systematically to today’s whales that we know. Although these modern whales may not be looking the same way as their ancestors, there has been evidence that they evolved from these ancestors. Most *palaeontologists* have used the discovered fossils in explaining the evolution of whales. These fossils are in sequences starting from the first fossil. In this part, we will discuss these fossils in order beginning with the earliest fossil.

 To begin with, most of the *palaeontologists* have suggested that whales evolved from terrestrial mammals. These *palaeontologists* gathered their evidence from studying the sequence of fossils from terrestrial mammal to a modern whale (Sutera, 2000). The first fossil to be examined by these *Paleontologists Sinonyx.* The fossil was wolf-sized *mesonychid condylarths*, which is a group of extinct primitive carnivores ungulates. These *palaeontologists* based their evidence that link *Sinonyx* to whale on the dental characters, muzzle elongation, jugular foremen enlargement, and *basicranium* shortness (Sutera, 2000). The *Pakicetus* is the next fossil that the *palaeontologists* studied in their quest to connect the origin of whales to terrestrial mammals. This fossil is the oldest cetacean and is known only from the remains of the fragmented skull (Bajpai, 2009). Their dental characters are intermediate to that of the *Sinonyx,* although their premolars were triangularly consisting of a single cusp that was serrated on its back and front edge (Sutera, 2000). From its skull, the *palaeontologists f*ound out that this fossil couldn't hear well while underwater because the skull didn’t have sinuses or the dense tympanic bullae that isolate the left auditory area from the right auditory (Gingerich, 2012). This later became the adaptation of the following whales as it allowed them to hear underwater directionally, thus preventing sound transmission through the skull (Gingerich et al., 1983). Although *Pakicetus* fossil was found to be more of a terrestrial mammal than an aquatic due to its inability to hear while under water, its skull resembled that of a cetacean, where its teeth were between that of modern whale and its ancestors.

 In addition to that, *Ambulocetus* is another fossil that shows that whales originate from the terrestrial mammal. The fossil was referred to as a walking whale that could swim; thus it is a fantastic fossil. The fossil was a cetacean with functional legs, as it could use its hind limbs to walk. These hind limbs had toes that terminated into hooves, showing that ungulates were the ancestors of this animal. The walking indicates that the fossil might have as well been a terrestrial mammal beside its ability to swim while on water (Black, 2010). Both the structure and the function of forelimbs of this fossil were intermediate, and it had big elbow which was inclined rearward making it possible for this fossil to thrust its forearm to swim. Although this fossil lacked some traits that make a cetacean, its skull was similar to that of a cetacean, as it had an elongated muzzle, similar dental characters to those of *archaeocete*, and a poorly attached tympanic bulla. This fossil, therefore, can be described as a sea-lion–sized fish-eater which had not wholly evolved from its terrestrial ancestors.

 Moreover, the fossil that followed was *Rodhocetus*. Although this fossil contains more changes than its predecessors, it still had physical characteristics (Gingerich et al., 1994). It had higher neural spines compared to the whales, and its tail was very powerful for swimming (Bajpai, 2009). The traits that linked it to the modern whale were its cervical vertebrae that were short, strong and heavy tail vertebrae, a dorsal spine that was large and was attached to lumbar vertebrae. These traits show that this fossil must have been able to swim because of its tail which suited swimming. Although *Rodhocetus* pelvis was smaller compared to that of its predecessors, it was still attached to sacral vertebrae, showing that this fossil might have the ability to walk. This trait indicates that *Rodhocetus* could probably get around the land, just like its predecessors (Gingerich, 2012). On dental formula, the lower molars of the fossil were higher and that differentiation of the teeth was reduced. Its nostrils had moved back unlike those of its predecessors. The characteristics that made it more cetacean were that its auditory bullae were massive and it was made of dense bone but lacked sinuses which are the adaptation of later whales, making it difficult to know if the fossil possesses the ability to directional hearing underwater.

 Furthermore, the next fossil that the paleontologists did study was *Basilosaurus*. This fossil was long, thin, and twisted making it be seen as the remains of the serpent that used to live in the sea. The vertebrae of this fossil were very long compared to those of other whales (Black, 2010). It is contained an almost complete pelvic girdle with a set of hind limb bones. These hind limbs were tiny to be used for walking. The fossil, also, could not bear its weight as its pelvic girdle was not attached to the spine. *Basilosaurus* tail and cervical vertebrae were shorter, evidence that the fossil might have a tail fluke.
 On top of that, this fossil had single nostril that was large and was located nearer the top of the head. These traits show that this fossil was spending most of its time on water rather than on the land. In addition to that, the fossil that was a successor of *Basilosaurus* was *Dorudon* (Uhen, 2010). The fossil, unlike *Basilosaurus*, lacked the elongated vertebrae. Their vertebrae were smaller while on their dental characters, they shared similarities with those of *Basilosaurus*. The hind limbs of this fossil were tiny and were slightly projected beyond the walls of the body (Black, 2010). This trait shows that the fossil could not walk on land and that it always spend its entire time on the water. The short limbs and their small body size shows that this fossil was an aquatic mammal.

 Generally, these evidence from the paleontologists suggests that evolution of the whales from the terrestrial mammals followed a systematic sequence that proves that the whales originated from the mammals. The changes at each stage of development affect the shape of the skull, teeth, nostrils position, the way and the size of the tail, the middle ear structure, and the size and structure of the forelimbs and hind limbs. This evidence shows that the evolution of the whales was increasing their adaptation on water than on land.

 **Whales Evolution Evidence**

Apart from the evidence provided by the paleontologists, there is other evidence that proves that whales evolved from the terrestrial mammals. This evidence includes *Morphological* evidence, and *vestigial* evidence. *Morphological* evidence shows that certain characteristics link modern whales to their ancestral terrestrial mammals (Sutera, 2000). For example, the similarity in the foot anatomy of *Basilosaurus* and *artiodacty* shows that these fossils might have shared one terrestrial mammal ancestor. The similarity between the incus of *Pakicetus* and those of the modern whales is another example that shows that both of them might have shared the same ancestor (Thewissen and Hussain, 1993). These characteristics prove that the whales evolved from the terrestrial mammals. In addition to that, vestigial features that whales have are evidence that they did evolve from terrestrial mammals. Such evidence shows that whales carried their past pieces through their evolutionary life, proving their terrestrial ancestry (Sutera, 2000). Modern whales have rod-like vestiges of tibiae and pelvic bones, which are more pronounced by the earlier fossils. For example, modern whales have retained most of the vestigial structures that *Basilosaurus* fossil had (Sutera, 2000). Such features show that Modern whales and *Basilosaurus* could have shared the same terrestrial ancestor.

 Furthermore, *geochemical* evidence shows that whales originated from mammals. According to Thewissen (1996), modern whales from freshwater can adapt to salt water, whose isotopic ratio of oxygen is different from that of fresh water. This shows that the whales might have recorded the trait on their skeletal remains like teeth, throughout their evolutionary life because the isotopic ratio of oxygen from the fossil teeth of earlier whales suggests that some of them might have been drinking fresh water while others might have been drinking salt water (Thewissen et al., 1996). Therefore, suggesting that modern whales might have adapted to salt water from terrestrial habitats through the habitat of freshwater.

Lastly, the *embryological* feature provides evidence that modern whales originate from terrestrial mammals. Most of the whales while in the womb develop hairs around their bodies, which they don't retain when growing into adulthood (Sutera, 2000). The presence of body hairs on the whales that are in womb suggests that their ancestors might have been with body hairs, and since the creatures with body hairs are mammals, it means the whales originated from terrestrial mammals. Moreover, whales while in the womb have visible hind limbs which disappear as the well grows larger and larger. The nostrils that are located on top of the whales’ head starts growing on the usual place as that of the mammals while the whales are in the womb but later moves to the top of their heads as they grow (Sutera, 2000). Also, rudimentary ear pinnae, which disappears before the whales are born, are visible while the whales are still in the womb. These features provide evidence that these whales did evolve from the terrestrial mammals.

**Conclusion**

In conclusion, the paleontologists' explanation on the evolution of the fossils suggests that development of the whales from the terrestrial mammals followed a systematic sequence that proves that the whales originated from mammals. The changes at each stage of evolution affect the shape of the skull, teeth, nostrils position, the way and the size of the tail, the middle ear structure, and the size and structure of the forelimbs and hind limbs. This evidence shows that the evolution of the whales was increasing their adaptation on water than on land. Furthermore, the evidence explain above provides enough proof that the whales originated from terrestrial mammals. From the disclosed evidence, we get to understand that there are specific characteristics that the whales carried through their evolutionary life. These characteristics suggest that the ancestors of these whales were terrestrial mammals.

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