Name_____

Evolution of Whales

Introduction

Call it an unfinished story, but with a plot that's a grabber. It's the tale of an ancient land mammal making its way back to the sea, becoming the forerunner of today's whales. In doing so, it lost its legs, and all of its vital systems became adapted to a marine existence -- the reverse of what happened millions of years previously, when the first animals crawled out of the sea onto land.

Some details remain fuzzy and under investigation. But we know for certain that this back-to-the-water evolution did occur, thanks to an abundance of intermediate fossils that have been uncovered over the past few decades.

Elomeryx (El-o-mir-ix**)**

Elomeryx is an Anthracothere from Eocene Asia and Europe. This was a very important mammal because it evolved from the Condylarths into whales, hippos, and manatees. It was also one of the earliest Anthracotheres. First Discovered in 1894, late Eocene, it had five fingers and have four toes. Long slender legs and a digitigrade stance gave few clues that this taxon was ancestral to whales.

Pakicetus (Pa-key-SEE-tuhs**)**

Paleontologist Phil Gingerich discovered a 50-million-year-old skull in Northen Pakistan that resembled fossils of creodonts -- wolf-sized carnivores that lived in the early Eocene epoch. But the skull also had characteristics in common with the *Archaeocetes*, the oldest known whales. The new bones, dubbed *Pakicetus*, proved to have key features that were transitional between terrestrial mammals and the earliest true whales. One of the most interesting was the ear region of the skull. In whales, it is extensively modified for directional hearing underwater.

Over time, fossils also revealed that Pakicetus had an ear bone with a feature unique to whales and an ankle bone that linked it to artiodactyls, a large order of even-toed hoofed mammals that includes hippos, pigs, sheep, cows, deer, giraffes, antelopes, and even cetaceans, the only aquatic artiodactyls.

Ambulocetus (am-byoo- SEE -tuhs**)**

Another, slightly more recent form also found in Northern Pakistan, called *Ambulocetus*, was an amphibious animal. Its forelimbs were equipped with fingers and small hooves. The hind feet of *Ambulocetus*, however, were clearly adapted for swimming. Functional analysis of its skeleton shows that it could get around effectively on land and could swim by pushing back with its hind feet and undulating its tail, as otters do today.

Rodhocetus (roh-doh-SEE-tuhs**)**

Found in Eastern Pakistan, *Rodhocetus* shows evidence of an increasingly marine lifestyle. Its neck vertebrae are shorter, giving it a less flexible, more stable neck -- an adaptation for swimming also seen in other aquatic animals such as sea cows, and in an extreme form in modern whales. The ear region of its skull is more specialized for underwater hearing. And its legs are disengaged from its pelvis, symbolizing the severance of the connection to land locomotion.

Name_____

Basilosaurus
Originally given the name – which means “king lizard” – because it was mistaken for a giant sea serpent, Basilosaurus was a creature more than 55 feet (16 meters) long. *Basilosaurus* -- clearly an animal fully adapted to an aquatic environment -- was swimming the ancient seas, propelled by its sturdy flippers and long, flexible body. Yet *Basilosaurus* still retained small, weak hind legs -- baggage from its evolutionary past -- even though it could not walk on land. Basilosaurus was one of the first named fossil whales in the world. It represents a sidebar in whale evolution. Because it has strangely long trunk vertebrae not found in any other whales, scientists believe it was an evolutionary dead end and thus it is a fascinating story about the twists and turns evolution takes over time.

Fossils of Basilosaurus have been discovered in Southern United\States of America. Fossils of these animals were so common (and sufficiently large) that they were regularly used as furniture in the American South. Basilosaurus Fossils have also been found in Egypt.

Zygorhiza (Zie-go-rye-za**)**

Zygorhiza is an extinct genus of basilosaurid early whale known from the Late Eocene. Zygorhiza was discovered in the early 1800’s and the first complete skeleton was finished in 1834.Known locations for Zygorhiza is almost exclusively the East coast of the United States, primarily in the Gulf Coast states, and many fossils have been found in Louisiana, Mississippi, and Alabama. There also have been a few finds in Georgia, Florida, South Carolina, and North Carolina. Outside North America, Zygorhiza has been reliably identified only in New Zealand. It is a forerunner of the modern toothed whales (e.g., sperm whales, killer whales, porpoises, etc.). During its lifetime, the Earth was mostly ice free and many of the continents that we have today were connected (i.e., Antarctica and Australia, and North America and Europe).

None of these animals is necessarily a direct ancestor of the whales we know today; they may be side branches of the family tree. But the important thing is that each fossil whale shares new, whale-like features with the whales we know today, and in the fossil record, we can observe the gradual accumulation of these aquatic adaptations in the lineage that led to modern whales.

As evolutionary biologist Neil Shubin points out, "In one sense, evolution didn't invent anything new with whales. It was just tinkering with land mammals. It's using the old to make the new.”

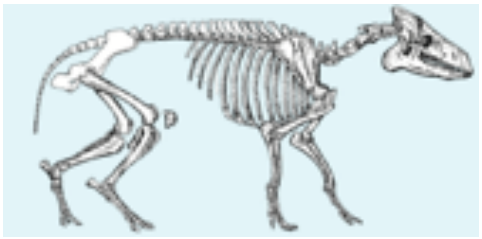
Whales in the Making


a


b


c

1. *Zygorhiza*, *Prozeuglodon*, *Dorudon* ~ 36 mya (million years ago)



2. Elomeryx,, Anthracotheriidae - 55 mya

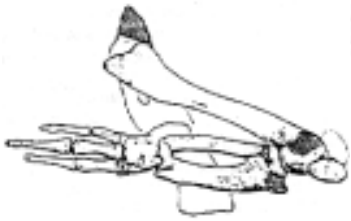

a


b

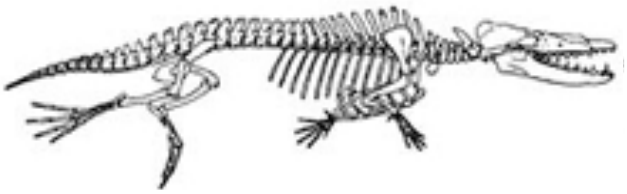

c

3. (1983) *Pakicetus inachus* ~ 50 mya


a


b

4. (1834) *Basilosaurus isis* ~ 37 mya



5. (1994) *Rodhocetus kasrani* ~ 46 mya


a

6. (1994) *Ambulocetus natans* ~ 48 mya

Whale Evolution Data Table

Name	***Elomeryx***	*Pakicetus*	*Ambulocetus*	*Rodhocetus*	*Basilosaurus*	*Zygorhiza*
Year reported						
Country where found						
Geological age (mya)						
Habitat (land, fresh water, shallow sea, open ocean)						
Skull, teeth, ear structure types most like... whale or land mammal?						
Limbs and tail: Description; Did it swim? How?						

Name_____

Name_____

Analysis:

1. What is the closest living relative to whales and dolphins?

2. Why are whales and dolphins not actually that closely related to the hippopotamus?

3. Based on the fossil record when can we conclude that the ancestors of whales and dolphins lived entirely in the water?

4. How can we tell when the ancestors of whales and dolphins became entirely aquatic species?

5. Why is Basilosaurus a misleading name?

6. Look at the fossils below, describe how it shows the evolution of the blowhole on whales and dolphins.