

Fossil Whale Feet: A Step in Evolution

Paleontologists digging in Pakistan have discovered the 50-million-year-old remains of a whale with legs and feet — a missing link in the evolutionary chain connecting aquatic cetaceans with their landlubbing forebears.

The new-found fossil, called *Ambulocetus natans*, is the first known ancient whale with large, functional hind limbs, says J.G.M. Thewissen of the Northeastern Ohio Universities College of Medicine in Rootstown. He and his colleagues report their find in the Jan. 14 SCIENCE.

Paleontologist Annalisa Berta of San Diego State University calls *Ambulocetus* “a very significant discovery. It shows us for the first time a whale that had well-developed hind limbs. It’s very clear this animal was using its hind limbs in locomotion.”

Researchers believe that modern whales descended from four-legged carnivorous mammals, somewhat like large wolves, that once roamed the continents. Sometime around the start of the Eocene period, 57 million years ago, these carnivores gave up their dry lifestyle for one under the waves, forcing their bodies to undergo a profound evolutionary transformation. Among the changes, ancient whales lost their legs and pelvises and developed the characteristic fluked tail that propels these modern leviathans through the seas.

Living whales have no visible hind limbs, but some have internal finger-size bones that are vestiges of hips and legs, an indication that they evolved from land creatures. Three years ago, Philip D. Gingerich of the University of Michigan in Ann Arbor reported the discovery of a 40-million-year-old whale in Egypt that had external legs, although they were too small to help propel the animal (SN: 7/14/90, p.21). Gingerich suggested that this animal, called *Basilosaurus*, used its tiny hind limbs to grasp its partner during copulation.

While *Basilosaurus* most likely spent all of its time in water, Thewissen suggests that the sea-lion-size *Ambulocetus* led an amphibious lifestyle. *Ambulocetus* could walk on land, but the shape of its bones suggests it had weak hind limbs. It may have walked by dragging its body as sea lions do, Thewissen says.

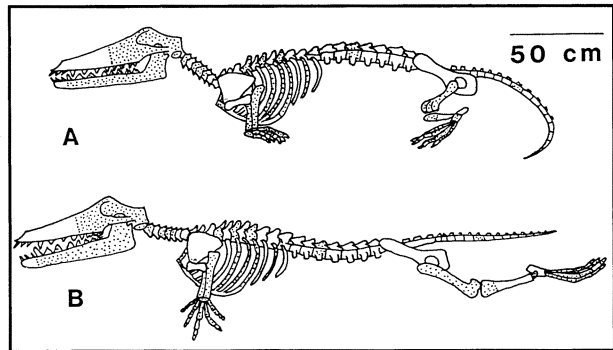
In the ocean, *Ambulocetus* probably swam by flexing its back up and down, using the surface area of its big feet to push against the water, Thewissen suggests. Modern whales swim with the same undulating motion, but their broad tails provide the propulsion surface.

Berta argues that paleontologists will need to find more fossils to decipher how *Ambulocetus* swam. Because Thewissen

did not unearth a pelvis with the rest of the bones, he cannot determine how the whale’s legs attached to the rest of its skeleton, a critical factor in understanding the animal’s locomotion.

The *Ambulocetus* discovery is one of several recent fossil finds that has spurred interest in early whale evolution. While in Pakistan in 1991 and 1992, Thewissen unearthed a well-preserved skull of *Pakicetus*, the oldest known whale species, which apparently spent much of its life on land.

Researchers in Georgia are studying an as-yet-unnamed species of whale discovered in that state. The 40-million-year-old creature had a pelvis like that of a land mammal, suggesting that the whale had large hind limbs, says Richard C. Hulbert Jr. of Georgia Southern University in



Ambulocetus standing on land (A) and swimming (B).

Thewissen/SCIENCE

Statesboro.

Early cetaceans have captured the attention of paleontologists because the trek from land to sea provides a dramatic picture of evolution at work, Hulbert says. Throughout history, other animals have made the same voyage, but whales are the most recent group, giving scientists their best chance at documenting this transition.

— R. Monastersky

Mars Observer: Piecing together the puzzle

Astronomers had hailed the mission as the first U.S. venture to Mars in 17 years. And for nearly 11 months, as the Mars Observer spacecraft hurtled through space to keep its planetary appointment, it seemed destined to explore the Red Planet in unprecedented detail. But last Aug. 21, three days before Mars Observer was to begin orbiting the planet, the craft mysteriously fell silent (SN: 9/4/93, p.149).

Now, a panel of independent investigators reports the likely cause of the craft’s disappearance. Leaky valves probably allowed Mars Observer’s oxidizer and fuel to mix and spontaneously ignite at exactly the wrong place: inside the system’s fuel lines instead of at its rocket thrusters. Such premature ignition would have ruptured the fuel lines, causing fuel to spew out in all directions and spinning the craft out of control.

Several experts say that if the panel’s conclusions are correct, NASA might have averted the catastrophe had it not decided, just months before launch, to delay pressurizing the craft until it reached Mars.

Panel leader Timothy Coffey, director of research at the Naval Research Laboratory in Washington, D.C., announced the investigation’s results at a press conference last week. In their report, Coffey and his coauthors emphasize that their suggested scenario, though “probable,” is not conclusive, since ground controllers had

turned off the craft’s transmitter just before the Observer was lost. As a result, says Coffey, the panel lacked a “smoking gun” that would indicate exactly what went wrong.

After evaluating some 60 explanations for the craft’s loss, the panel eliminated all but a few possibilities and focused on flaws in the propulsion system. Tests revealed that a group of valves, known as check valves, were leakier than expected. Common in sprinkler systems, check valves ideally allow material to flow in only one direction.

Aboard the Mars Observer, two sets of check valves allowed high-pressure helium gas to rush through, pushing out from their respective tanks the desired amount of either the oxidizer nitrogen tetroxide (NTO) or the fuel monomethyl hydrazine (MMH). At the same time, the valves were designed to prevent the two liquids from flowing backward and thus inadvertently mixing and igniting in the fuel lines.

Experiments revealed that during the craft’s 11-month journey, as much as 2 grams of NTO could have seeped through the check valves, condensing on the fuel lines’ cold titanium tubing and setting the stage for disaster.

On Aug. 21, ground controllers took final steps in preparation for Mars Observer to fire its thrusters and enter an orbit around the Red Planet. Temporarily turning off the craft’s transmitter as a