

Evidence of Evolution

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9.4 Fossils

Evolution has left a record in Earth's rocks in the form of fossils. Scientists can date fossils from the age of the rock formations they belong to and follow the evolution of groups of organisms over time. For example, did you know that whales are descended from mammals with hooves? Fossil whales show this. Fossil whales also tell us how many key whale traits evolved.

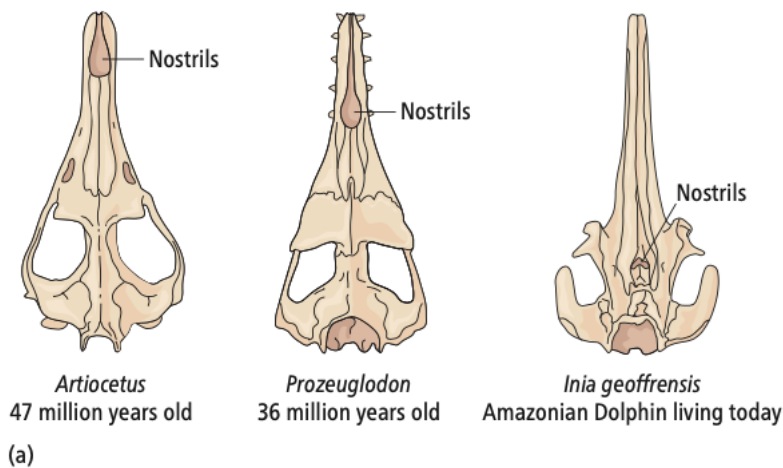
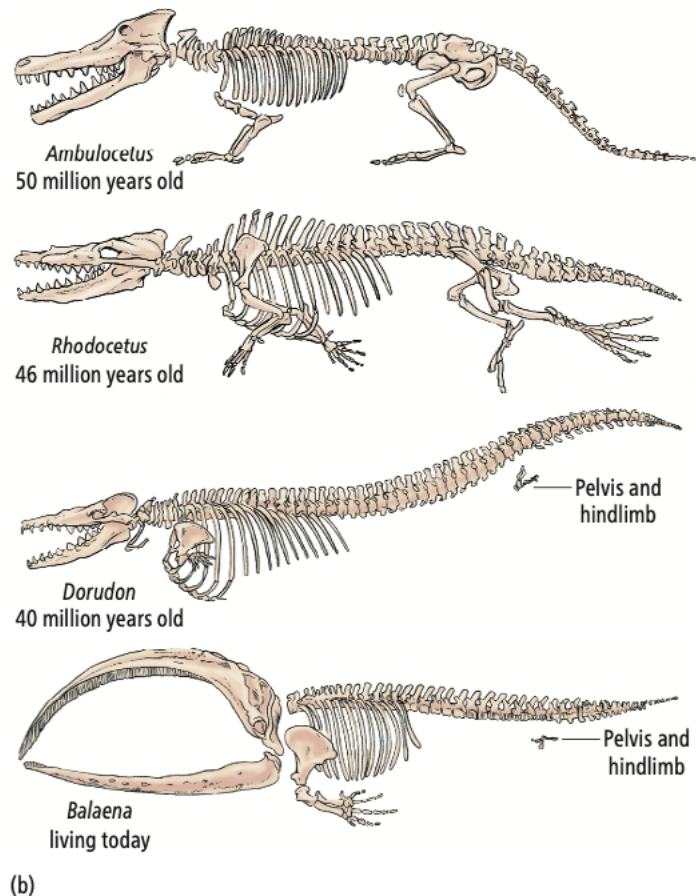


FIGURE 9.10

Fossil whales show how key features of these marine mammals evolved over time. (a) These fossil skulls show that the location of the nostrils shifted over time, from a position in front of the skull to a position on top of the skull—the “blowhole” seen in modern species.

(b) Fossil whales also show the reduction and loss of hind legs over time.



In Figure 9.10a, we can see how, over time, whale nostrils moved from the front of the skull to the top of the skull, forming a blowhole.

Fossil whales also show how whales lost their hind legs as they became better and better adapted to an aquatic existence. The oldest whale fossils, such as the 50-million-year-old *Ambulocetus*, have large hind legs that were used both on land and for swimming (Figure 9.10b).



Ambulocetus also has small hooves on its front legs, providing clear evidence that whales are descended from hoofed mammals. *Rhodocetus*, a 46-million-year-old fossil whale, shows reduced hind legs—these are not attached to the backbone and so could not have supported much weight. *Rhodocetus* also shows prominent tail muscles that would have been effective for swimming. In the 40-million-year-old *Dorudon*, hind limbs are present, but they are tiny: *Dorudon* was clearly a fully aquatic species. In modern whales, there is no evidence of hind limbs on the outside of the body, although tiny remnants of the pelvis and sometimes femurs remain inside the body.

Archaeopteryx, the famous 150-million-year-old fossil bird (Figure 9.11), also shows intermediate traits in the evolution of birds from their dinosaur ancestors. *Archaeopteryx* has many birdlike features, such as feathers, wings, and a wishbone. However, it also has dinosaur-like features absent in modern birds, including claws on its wings, bones in its tail, and teeth.

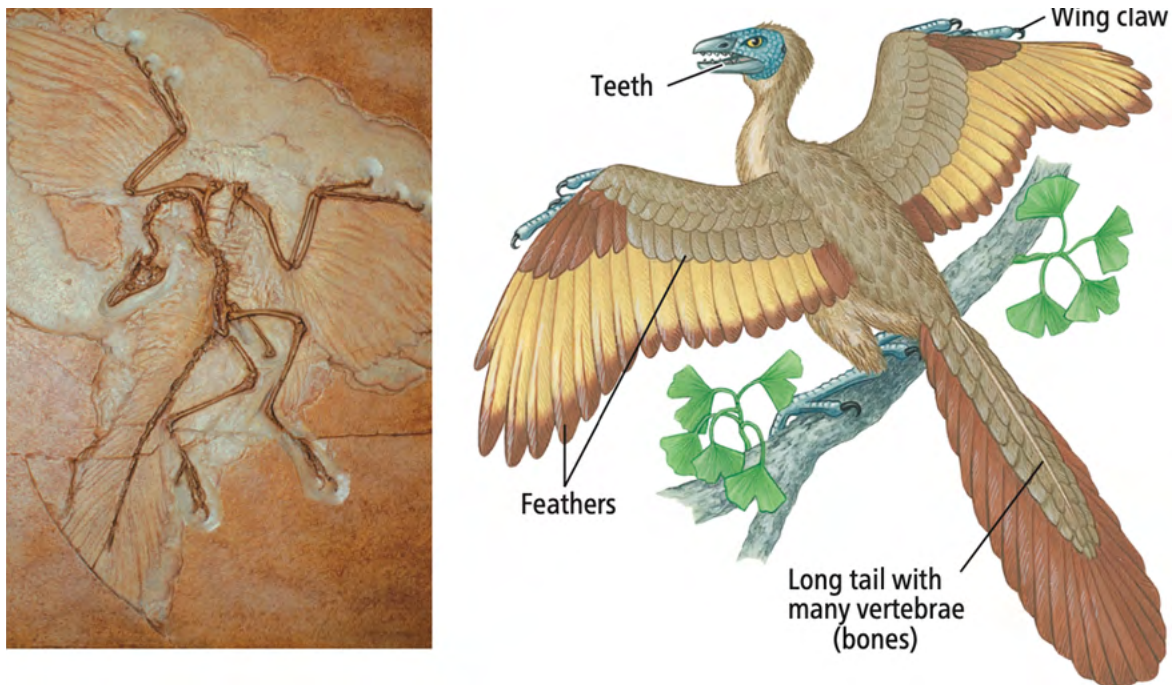


FIGURE 9.11

Archaeopteryx, an early bird, has features of both the dinosaurs it evolved from and modern birds.

READING CHECK

How do fossil whales provide evidence for evolution?

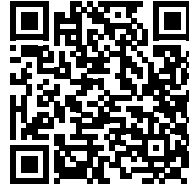
CHECK YOUR ANSWER

Fossils show how key traits evolved in whales. For example, the whale fossils that have been found show traits that are intermediate between the features of the ancestors (nostrils in front of the skull and large functional hind legs) and present-day whales (a blowhole on top of the skull and tiny vestigial hind limbs).



Read more about fossil whales here:

https://evolution.berkeley.edu/evolibrary/article/evograms_03



Learn more about *Archaeopteryx* here:

<https://www.livescience.com/24745-archaeopteryx.html>

