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New Fossil Shows How the Turtle Got Its Shell

Odontochelys semitestacea, the oldest turtle fossil yet, has a fully formed lower shell, or plastron, but lacks a fully formed upper shell

By Kate Wong



Artist rendering of *Odontochelys semitestacea*, from the late Triassic of China, the oldest known turtle.

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Vertebrate animals come in all shapes and sizes. But some have evolved truly bizarre forms. With beaks instead of teeth and shells formed by the ribs and other bits, turtles surely rank among the strangest of our backboneed brethren. Indeed, paleontologists have long puzzled over how turtles acquired their odd traits and who their closest relatives are.

Previously, much of what researchers knew about turtle origins derived from fossils of *Proganochelys* from Germany. Based on that creature, with its heavily built shell and spiked plates covering the neck and tail, researchers had proposed that turtles were kissing cousins of a group of extinct armored reptiles known as pareiasaurs. They also suggested that the first turtles lived on land, where a shield is a useful

defense for a slow-footed creature. *Proganochelys* furnished no clues to how the turtle shell evolved, however, because its own carapace is fully formed.

A newfound fossil from southwestern China's Guizhou Province paints a rather different picture of the origin of turtles and illuminates how their trademark armature took shape. Dating back to 220 million years ago, this transitional creature, named *Odontochelys semitestacea* ("half-shelled turtle with teeth"), is the oldest and most primitive turtle on record. Researchers led by Chun Li of the Chinese Academy of Sciences in Beijing describe the fossil in the November 27, 2008, issue of *Nature*.

Odontochelys possesses a plastron—the flat, lower half of the shell that protects the animal's soft belly—but lacks the domed upper half. What this suggests, Li and his colleagues say, is that the shell evolved from the bottom up. In addition, the deposits that yielded the fossil indicate that this animal lived in a marine environment. If so, the plastron would have shielded the turtle's underside from predators approaching from below.

Odontochelys also lacks osteoderms, bony plates in the skin that form the armor of reptiles such as crocodiles and dinosaurs. Some specialists had proposed that the turtle's shell began as rows of osteoderms that gradually, over millions of years, fused to form a carapace. In fact, last October researchers writing in the *Proceedings of the Royal Society B* reported on a 210-million-year-old turtle fossil from New Mexico believed to support exactly that hypothesis.

But critics have countered that findings from turtle embryology hinted that the backbones and ribs morphed to make a shell. *Odontochelys* bolsters the theory that ribs flattened and spread to form the top of the shell.

The absence of osteoderms in *Odontochelys* also challenges the idea that turtles are closely related to pareiasaurs. Taken together with molecular data, the new evidence aligns the shelled vertebrates with another group of reptiles, the diapsids.

Some aspects of the discovery team's interpretation of *Odontochelys* have alternative explanations, however. In a commentary accompanying the *Nature* paper, paleontologists Robert Reisz and Jason Head of the University of Toronto Mississauga argue that the animal did have an upper shell, just one that had not fully ossified. If correct, their supposition would suggest that the form of this animal's shell, rather than being a primitive intermediate, is a specialized adaptation. It turns out that aquatic turtles often have smaller, more delicate upper shells compared with their landlubber counterparts, as seen in sea turtles and snapping turtles.

Thus, rather than showing that turtles evolved in the water, Reisz and Head contend, *Odontochelys* may signal an early invasion of the water by turtles that originated on terra firma. "The morphology of *Odontochelys* suggests that this story is more complex and more interesting than suggested" by Li and his co-authors, Reisz remarks. "We feel that *Odontochelys* is not the final answer; it is instead one more piece in the fascinating puzzle of turtle origins."

Note: This article was originally printed with the title, "Shell Game".