Study of oldest turtle fossil

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With hard bony shells to shelter and protect them, turtles are unique and have long posed a mystery to scientists who wonder how such an elegant body structure came to be.

Since the age of dinosaurs, turtles have looked pretty much as they do now with their shells intact, and scientists lacked conclusive evidence to support competing evolutionary theories. Now with the discovery in China of the oldest known turtle fossil, estimated at 220- million-years-old, scientists have a clearer picture of how the turtle got its shell.

Working with colleagues in China and Canada, Olivier Rieppel, PhD, chairman of The Field Museum's department of geology, has analyzed the Chinese turtle fossil, finding evidence to support the notion that turtle shells are bony extensions of their backbones and ribs that expanded and grew together to form a hard protective covering.

The fossilized turtle ancestor, dubbed Odontochelys semitestacea (translation: half-shelled turtle with teeth), likely lived in the water rather than on land.

A report from Chun Li of the Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences in Beijing, and Xiao-Chun Wu of the Canadian Museum of Nature in Ottawa, along with Field's Rieppel, will appear in the journal Nature. Other co-authors include Li-Ting Wang of the Geological Survey of Guizhou Province in Guiyang, China, where the fossil was discovered and Li-Jun Zhao of the Zhejiang Museum of Nature History in Hangzhou, China.

Prior to discovery of Odontochelys, the oldest known turtle specimen was Proganochelys, which was found in Germany. Because Proganochelys has a fully-formed shell, it provides little information about how shells were formed. Odontochelys is older than Proganochelys and is helpful because it has only a partial shell, Rieppel said.

"This is the first turtle with an incomplete shell," Rieppel said. "The shell is an evolutionary innovation. It's difficult to explain how it evolved without an intermediate example."

Some contemporary reptiles such as crocodiles have skin with bony plates and this was also seen in ancient creatures such as dinosaurs. Some researchers theorized that turtle shells started as bony skin plates, called osteoderms, which eventually fused to form a hard shell.

There are problems with this idea, including studies of how shells form in turtle embryos as they develop within eggs, Rieppel said. Embryo studies show that the turtle backbones expand outward and the ribs broaden to meet and form a shell, he said.

While paleontologists take such studies into account, they aren't sufficient to prove how anatomy evolved over time, and evidence can be read in different ways. The limbs of Proganochelys, for example, show signs of bony plates in the skin.

But Odontochelys has no osteoderms and it has a partial shell extending from its backbone, Rieppel said. It also shows a widening of ribs. Although Odontochelys has only a partial shell protecting its back, it does have a fully formed plastron – complete protection of its underside – just as turtles do today.

This strongly suggests Odontochelys was a water dweller whose swimming exposed its underside to predators, Rieppel said. "Reptiles

living on the land have their bellies close to the ground with little exposure to danger," he said.

Other arguments favor the notion that turtle shells evolved as extensions of the reptile's backbones and ribs, Rieppel said, but the partial shell of Odontochelys speaks very clearly.

"This animal tells people to forget about turtle ancestors covered with osteoderms," he said.

Source: Field Museum