

# Comparative Cranial Morphology of the Late Cretaceous Protostegid Sea Turtle *Desmatochelys lowii*

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The phylogenetic placement of Cretaceous marine turtles, especially Protostegidae, is still under debate among paleontologists. Whereas protostegids were traditionally thought to be situated within the clade of recent marine turtles (Chelonioidae), some recent morphological and molecular studies suggest placement along the stem of Cryptodira. The main reason why the evolution of marine turtles is still poorly understood, is in part due to a lack of insights into the cranial anatomy of protostegids. However, a general availability of high quality fossil material, combined with modern analysis techniques, such as X-ray microtomography ( $\mu$ CT), provide ample opportunity to improve this situation. The scope of this study is to help resolve its phylogenetic relationships by providing a detailed description of the external and internal cranial morphology of the extinct protostegid sea turtle *Desmatochelys lowii* Williston, 1894. This study is based on the well-preserved holotype of *Desmatochelys lowii* from the Late Cretaceous (middle Cenomanian to early Turonian) Greenhorn Limestone of Jefferson County, Nebraska. The skulls of two recent marine turtles, *Eretmochelys imbricata* (Cheloniidae) and *Dermochelys coriacea* (Dermochelyidae), as well as the snapping turtle *Chelydra serpentina* (Chelydridae) provide a comparative basis. All skulls were scanned using regular or micro CT scanners and the scans were then processed with the software program Amira to create 3D isosurface models. In total, 81 bones are virtually isolated, figured, and described, including the nature of their contacts. The novel bone contact data is compiled and utilized in a preliminary phenetic study. In addition, an update phylogenetic analysis is conducted that utilizes newly obtained anatomical insights. The detailed examination of the morphology of the herein used specimens allowed to explore some features of the skull, to refine the scoring of *Desmatochelys lowii* in the recent global matrix of turtles, and develop five new characters. The alleged pineal foramen in the type skull of *Desmatochelys lowii* is shown to be the result of damage. Instead, it appears that the pineal gland only approached the skull surface, as it is in *Dermochelys coriacea*. Whereas the parasphenoid is confirmed to be absent in hard-shelled sea turtles, its possible presence in *Desmatochelys lowii* is unclear. The results of the phenetic study show that *Desmatochelys lowii* is least similar to the other examined taxa in regards to the nature of its bone contacts, and therefore suggests a phylogenetic placement outside Americhelydia for this protostegid sea turtle. The phylogenetic study results in a placement of Protostegidae along the stem of Chelonioidae, which is a novel position for the group more congruent with recent molecular calibration analyses.

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