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New turtle fossils from Uinta Basin represent last documented members of the extensive Baenidae radiation

The baenid turtles were an extinct clade of North American freshwater river turtles with an extensive radiation spanning from the early Cretaceous (125 million years ago) to the middle Eocene (40 million years ago). More than 30 different baenid species have been recognized from the Cretaceous fossil record, making baenids the most abundant, diverse, and speciose turtle family from that time period Baenids also survived the Cretaceous-Paleocene (K-Pg) mass extinction event, when many other reptile taxa died out. The baenid clade disappeared entirely from the fossil record during the Eocene, with the last documented appearance of this family occurring during the Uintan North American Land Mammal Age (NALMA; 46.5–40 million years ago).

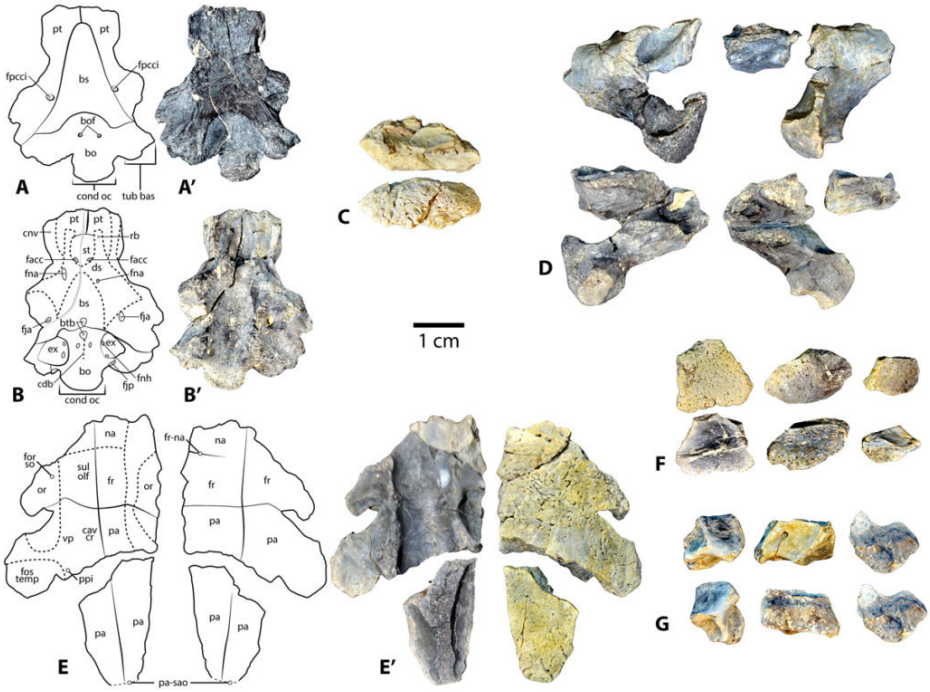

Fig. 1. Newly discovered cranial fossils from an Eocene turtle species, Baena arenosa, from the Uinta Basin, Utah. (A-A') Ventral view of basicranium. (B-B') Dorsal view of basicranium. (C) Right squamosal. (D) Left and right quadrates. (E-E') Neurocranium. (F) Maxillary fragments (G) Lower jaw fragments. Figure by Brent Adrian.

Our team recently discovered 27 new baenid turtle fossils from the final period of baenid evolution, the Uintan NALMA. These new specimens include a partial skull of the baenid species *Baena arenosa* (Fig. 1), several relatively complete shells of *Baena arenosa* and *Chisternon undatum* (Fig. 2), and some previously undescribed limb bones and vertebrae. Our new *B. arenosa* skull (Fig. 1) is only the second skull of this species ever described from the Uinta Basin, and the first in over 100 years. Thus, we were able to describe parts of the cranial anatomy of this species that had never been documented. While its morphology is consistent with known specimens of *B. arenosa*, we also observed several distinct differences, especially in

the shape of the basioccipital bone (the lower, back region of the skull), and an additional suture (intersection of bones) between the frontal and nasal bones. These findings suggest that late surviving baenids evolved cranial differences from their earlier ancestors.

This new sample of baenid shell elements also expands the documented morphological variation in both *B. arenosa* and *C. undatum* (Fig. 2). Unique shell characters include variation in the shapes of the scutes (scales) and associated bony grooves. We also discovered several baenid shells that exceeded the expected ranges of variation in thickness of shell bone and in height of shell dome, indicating that these late-surviving specimens were more variable than their precursors. We discovered several juvenile baenid specimens, which shed light onto developmental processes in baenids, and showed that diagnostic differences between species were present from an early age. Baenids were characterized by complete fusion of the bones of the shell in adulthood, so the study of juvenile specimens provides insight into the processes by which that fusion takes place. We discovered that the bones grow through a series of increasingly interdigitating shapes until they finally fuse into a single, undivided unit.

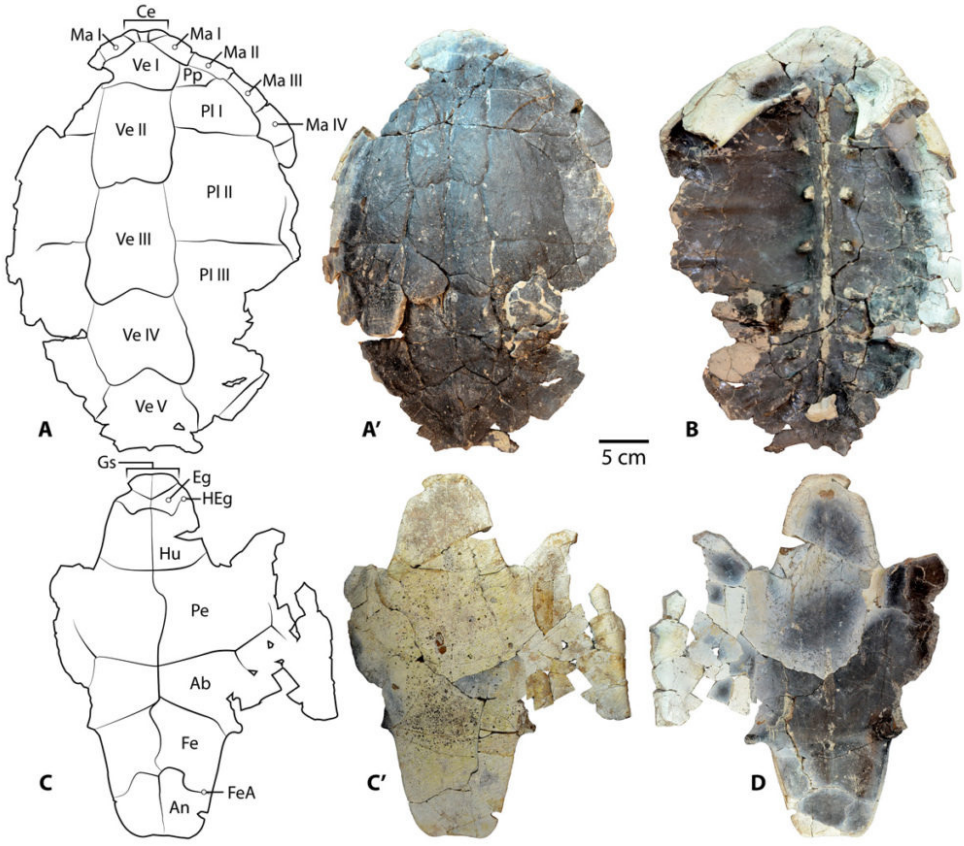

Fig. 2. New shell of Eocene baenid turtle species Chisternon undatum from the Uinta Basin, Utah. (A) Dorsal view of carapace. (B) Ventral view of carapace. (C) Ventral view of plastron. (D) Dorsal view of plastron. Abbreviations: Ab = abdominal scale; An = anal scale; Ce = cervical scale; Eg = extragular scale; Fe = femoral scale; FeA = femoral-anal sulcus; Gs = gular scale; Hu = humeral scale; HEg = humeral-extragular sulcus; Ma = marginal scale; Pe = pectoral scale; Pl = pleural scale; Ve = vertebral scale. Figure by Brent Adrian.

These newly discovered Uintan Baenid specimens provide valuable insight into the morphology and evolution of this diverse and speciose family at the end of its radiation. They greatly increase the known variation in these late-surviving taxa, and indicate that several characters thought to delineate the species should be redefined. By the end of the Uintan NALMA within the study area, lakes diminished in size and more rapidly moving rivers dominated the landscape. At this time, the large bodied aquatic baenids, the final surviving species of the abundant and speciose baenid radiation, have their final documented appearance in the fossil record.

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Publication

Morphological variation, phylogenetic relationships, and geographic distribution of the Baenidae (Testudines), based on new specimens from the Uinta Formation (Uinta Basin), Utah (USA).
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