New Information on the Herpetofauna of Quarry 9, from the Late Jurassic Morrison Formation

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Introduction

The Morrison Formation is one of the most productive vertebrate-bearing strata in the world, yielding rich information about Late Jurassic terrestrial ecosystems. In spite of this, most attention has been directed toward dinosaurs and other large animals, because small vertebrates remain rare and understudied (1). This study focused on small vertebrates from Quarry 9, the most diverse Morrison locality and the most productive for small vertebrate fossils.

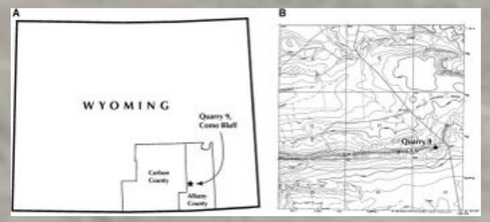

Figure 1. Maps showing location of Quarry 9: (A) in southeastern Wyoming and (B) along the Como Bluff anticline (1).

Our primary work involved identification and classification of small reptile fossils based on morphology and comparative anatomy. We paid particular attention rare crocodyliforms (e.g. *Macelognathus vagans*), choristoderes (e.g. *Cteniogenys antiquus*), and lepidosauromorphs, as well as more common crocodylian taxa. We compared our results to previous assessments of the Quarry 9 assemblage, re-examined diversities and relative abundances, assessed potential trophic relationships, and reinterpreted the paleoecology of the site.

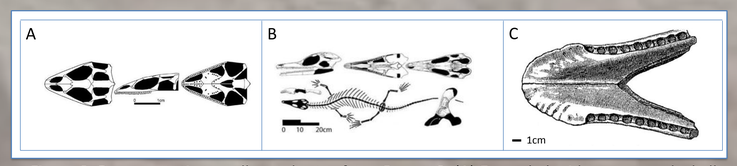

Figure 2. Representative small vertebrates from Quarry 9. (A) Example lepidosauromorph skull (2); (B) *Cteniogenys* skull and skeleton (3); (C) *Macelognathus* dentaries in dorsal view (4).

Materials & Methods

The fossils from Quarry 9 were collected in the 1880's by O. C. Marsh. Most work has concentrated on mammalian remains, but reptiles are actually the most abundant fossils.

We relied on comparisons with extant and fossil lepidosaurs and crocodylians, as well as detailed morphological study of individual elements within the Quarry 9 assemblage. Although separated from their modern relatives by more than 140 million years, many diagnostic anatomical structures are present. In addition, new discoveries of fossil reptiles from other Jurassic and Cretaceous deposits allow for comparison with other fossil forms.

Characterizations regarding diet and habitat were made based on knowledge from closely related forms or from more complete materials from other localities.

Results

We examined 784 specimens that had previously been assigned to Reptilia or Crocodylia. Among these, we identified 6 specimens of *Macelognathus vagans*, 25 of *Cteniogenys antiquus*, and 19 from at least two small, as-yet-unnamed lepidosauromorphs. An additional 175 specimens represented crocodylians and the remainder could not yet be identified beyond Reptilia.

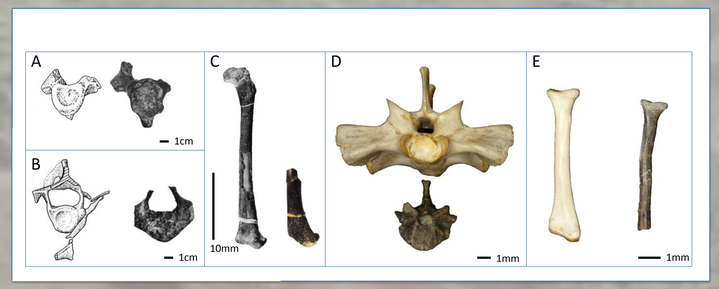

Figure 3. Comparisons between Quarry 9 specimens and previously known materials. (A) *Cteniogenys* vertebrae (5); (B) Lepidosauromorph vertebrae (6); (C) *Macelognathus* femora (7); (D-E) Crocodylian sacral vertebrae and radii.

With these new identifications, the abundances of lepidosauromorphs, choristoderes, and crocodylians at Quarry 9 have increased, but the latter remain the most abundant by far.

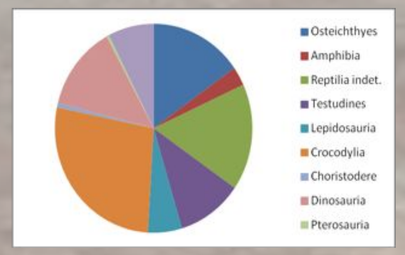

Figure 4. Taxonomic abundances of Quarry 9 vertebrate taxa.

Macelognathus is a sphenosuchian crocodyliform, a small, terrestrial carnivore (7). *Cteniogenys* represents an early, small-bodied choristodere, a semi-aquatic carnivore (5). The lepidosauromorphs were presumed to occupy terrestrial habitats similar to modern lizards (6). These additions increased the number of amphibious species at the expense of terrestrial forms. Thus, most of the fauna is either terrestrial or amphibious. At the same time, the number of large carnivores, small carnivores and insectivores has increased, with the latter being the most abundant group.

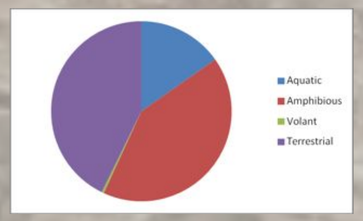

Figure 5. Habitat abundances of Quarry 9 vertebrate taxa.

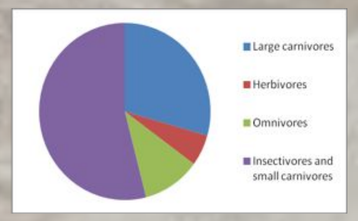

Figure 6. Ecological abundances of Quarry 9 vertebrate taxa.

Discussion

Identifying the hundreds of fragmentary reptile fossils in the Quarry 9 collection remains difficult, particularly because so few comparative specimens are available. Nonetheless, in just a few weeks we were able to identify four distinct taxa, two of which were previously known only from single specimens. We also discovered specimens remain indeterminate but likely represent additional taxa. Therefore it seems clear that Quarry 9 contains a high "hidden" diversity of small reptiles.

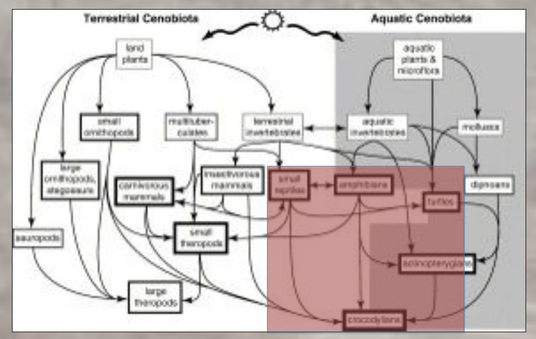

Figure 7. Schematic food web of the Quarry 9 assemblage, showing the predominance of small carnivores and amphibious taxa (1).

Our results showed more small carnivores and insectivores, and more amphibious forms, than had been previously described. This supports our claim that the low reported diversity of these groups is biased by the scarce amount of previous work focused on them. Given their potentially important role in both terrestrial and aquatic ecosystems, further study will be important in more fully understanding the paleoecology of this important Late Jurassic site.

Future Work

Continued study of these small vertebrates is crucial because there are still many more to be identified, which will doubtless continue to refine our understanding of Late Jurassic terrestrial vertebrate paleoecology.

Acknowledgements

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