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The first Mesozoic mammal from California

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A new specimen from the Upper Cretaceous (Campanian) marine deposits of the Chico Formation represents the first Mesozoic mammal from California. The specimen adds to the fauna, which includes dinosaurs, turtles, pterosaurs, and birds, known from this nearshore terrestrial environment. The specimen, a metacarpal, cannot be confidently identified beyond the level of Mammalia. However, the size of the specimen suggests that the animal was a medium to large-sized Mesozoic mammal, larger than the Late Cretaceous eutherian *Barunlestes butleri* and comparable to the modern day Eurasian hedgehog (*Erinaceus europaeus*).

INTRODUCTION

North America's record of Cretaceous mammals suffers from a clear geographic bias—few localities are known outside those from the fluvial deposits of the Western Interior. As a result, our view of early mammalian history is skewed toward the faunas from these ancient coastal lowlands along the western margin of the Western Interior Seaway. Mammalian faunas from other environments and areas west of the present day Rocky Mountains are sparse. Localities have only been reported from Baja California del Norte (Lillegraven 1976) and Eureka County, Nevada (Clemens et al. 1979). Thus far, none have been reported from California.

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Most of California's Mesozoic sedimentary rocks are marine deposits, and consequently, Mesozoic terrestrial vertebrates from the state are relatively rare. The only vertebrate fossils known from terrestrial deposits are dinosaur tracks from the Aztec Sandstone (Lower Jurassic) in the Mojave Desert (Reynolds 1989) and dinosaur bone and tooth fragments from the Trail Formation (Jurassic) of the northern Sierra Nevada (Christe and Hilton 2001, Hilton *in press*).

All other evidence of California's Mesozoic terrestrial life has come from marine deposits. Besides fossils of fish, plesiosaurs, mosasaurs, and sea turtles (Dupras 1988, Welles 1943, Parham and Stidham 1999), the marine Great Valley Group has yielded information regarding the nearshore terrestrial fauna. This includes fossils from the occasional dinosaur carcass that floated out to sea and sank (Deméré 1985, DeCourten 1997, Hilton and Antuzzi 1997), as well as fossils of terrestrial turtles, flying reptiles, and birds (Downs 1968, Hilton et al. 1999, Hilton *in press*).

Until now, the oldest mammalian remains reported from the state were from the Paleocene Goler Formation of southern California (McKenna 1960). Here, we report a metacarpal from the Campanian marine rocks of the Great Valley Group in Butte County, California. The specimen represents the first mammal reported from the Mesozoic of California.

Abbreviations: **UCMP**, University of California Museum of Paleontology, Berkeley, CA; **SC**, Sierra College Museum of Natural History, Rocklin, CA vertebrate locality; **VM**, vertebrate mammal fossil specimen prefix for Sierra College Museum of Natural History.

GEOLOGY

During the Late Cretaceous (99-65 million years ago) the shoreline of California was generally just inland from the present western base of the Sierra and Klamath Mountain Provinces (Nilsen, 1986). The present day Sacramento and San Joaquin Valleys were then an ocean shelf and slope area receiving sediment from rivers along the mountainous shore (Fig. 1).

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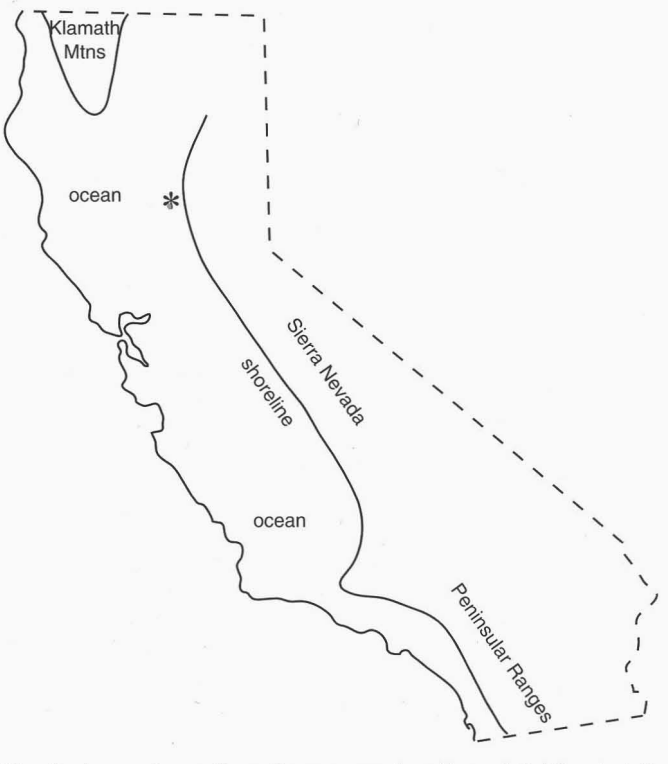

Fig. 1. Approximate Late Cretaceous shoreline of California (after Nilsen 1986 and others). Dry Creek South locality (SC1612) is indicated by the asterisk.

The mammalian bone (SC #VM96) reported here was discovered by one of us (Eric Göhre) in the Upper Cretaceous (Campanian) rocks of the Chico Formation in Butte County, California. The Chico Formation is a marine unit in the Great Valley Group that is approximately 80 million years old. Where the specimen (SC #VM96) was found, the Chico Formation strikes nearly due north and dips an average of six degrees to the west. Deposition occurred in a fairly nearshore, shelf environment. Here the beds are predominantly shale and siltstone interbedded with meter scale carbonaceous glauconite and shell turbidites. The mammalian bone (SC #VM96), as well as those of the bird, pterosaur, plesiosaur, mosasaur, and marine turtles from the Chico Formation, were found in turbidite matrices (Hilton *in press*). The specimen probably found its way here after the animal's carcass floated down a river into the ocean or perhaps after a predator left its remains in the ocean environment. Furthermore, fossil angiosperms, ferns, and redwoods found at the site indicate that the area was just offshore from a lushly forested ancestral Sierra Nevada.

SYSTEMATIC PALEONTOLOGY

Class: MAMMALIA Linnaeus 1758

incertae sedis

Description—SC #VM96 (Fig. 2) is a left metacarpal from the Dry Creek South locality, SC1612. The articular surfaces and texture of the bone are well preserved. The maximum length is 12.8 mm. The widths of the base (proximal end) and the head (distal end) are 2.8 and 4.0 mm, respectively. At midlength, the maximum diameter of the shaft (diaphysis) is 1.9 mm. The proximal articular surface is flat and slightly sloped in a dorso-distal direction. In dorsal view (Fig. 2A), the base flares laterally from the midline. In proximal view (Fig. 2D), this lateral flange is also evident. The proximal aspect of the shaft is somewhat round in cross-section, but the distal aspect of the shaft is dorsoventrally compressed and mediolaterally wide (Fig. 2A). In lateral view (Fig. 2E–F), the metacarpal is slightly dorsally convex. The distal end of the head is round (Fig. 2C), whereas the medial and lateral sides have tuberosities that indicate articulations and insertions for tendons and ligaments (Fig. 2E–F). The ventral aspect of the head is rounded and has a clear sagittal ridge or keel that subdivides the articular surface (Fig. 2B).

Discussion—SC #VM96 was compared with metapodials from the UCMP collection of modern vertebrates. Special attention was given to modern representatives of the small tetrapods that lived in North America during the Campanian, including amphibians, lizards, and mammals. Examination of the complex nature of the articular surfaces, especially the sagittal ridge on the palmar aspect of the head, led us to refer the fossil specimen to Mammalia.

The specimen was identified as a metacarpal rather than a metatarsal because the shaft is both dorsoventrally compressed (at mid-length, the ratio of dorsoventral to mediolateral width is 1.5 mm/1.9 mm) and mediolaterally wide distally. Based on comparisons with the articulated manus of modern mammals, the morphology of the base (proximal end) of the metacarpal, particularly the asymmetrical flaring described above, suggests that it is a left. In the modern specimens examined, this flared aspect of the proximal end to some extent overlaps the dorsomedial aspect of the laterally adjacent metapodial. Furthermore, the slender nature of the metacarpal and its weak dorsal convexity suggest that it is most likely a metacarpal II, III, or IV, as

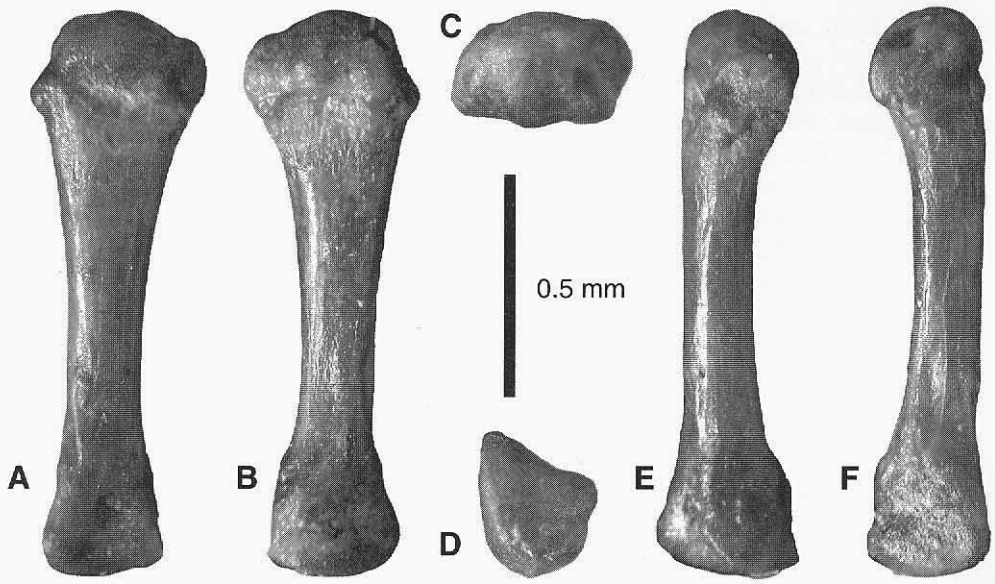

Fig. 2. Mammalian left metacarpal (SC #VM96) from the Chico Formation in **A.** dorsal , **B.** ventral , **C.** distal, **D.** proximal, **E.** medial, and **F.** lateral views.

opposed to the more stout proportions of metacarpal I or V.

To our knowledge, no metapodial characters exist that allow further taxonomic distinction between the various mammal clades living at this time (i.e., eutherians, metatherians, and multituberculates). Detailed measurements of the metapodials from a wide array of extant mammals and from fossil taxa with associated skeletons would be helpful but are beyond the scope of this paper. However, measurements of the specimen are consistent with those from today's Eurasian hedgehog (*Erinaceus europaeus* Linnaeus 1758), which weighs between 400 and 1100 grams, and slightly smaller than those from the water opossum (*Chironectes minimus* Illiger 1811), which weighs up to 800 grams (Nowak 1999). As for fossil taxa, the length of SC #VM96 is greater than the metacarpal III length (approximately 7.5 mm) provided by Kielan-Jaworowska (1978) for the Late Cretaceous eutherian *Barunlestes butleri* Kielan-Jaworowska 1975 and the metacarpal II length (10.8 mm) provided by Rose (1999) for the Eocene leptictid *Palaeictops multicuspis* Granger 1910. Although most of the metacarpals (II-IV) of the Paleocene multituberculate *Ptilodus kummae* reported by Krause and Jenkins (1983) are incomplete, the metatarsal III length (11.8 mm) for their specimen suggests that metacarpals of this animal were smaller than SC #VM96 as well. Thus, based on metacarpal size, the Chico mammal was probably a medium to large-sized Campanian mammal.

CONCLUSIONS

The discovery of the Chico mammal extends the documented geographic range of Mesozoic mammals into California. Late Cretaceous faunas from areas west of the Western Interior are meager, but preliminary findings from faunas, such as that from Baja California, Mexico, suggest that these areas may hold clues to poorly sampled environments or faunal provinces (Weil and Clemens 1998). Although the metacarpal from a probable medium to large-sized Mesozoic mammal is of limited taxonomic or biogeographic utility, it does suggest that further treasures lie in the sediments west of the well-sampled Western Interior, including those in California.

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