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Mammal footprints from the Miocene–Pliocene Ogallala Formation, eastern New Mexico

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Abstract

Mammal trackways preserved in the Miocene–Pliocene Ogallala Formation of eastern New Mexico represent the first report of mammal fossils from this unit in New Mexico. These trackways are preserved as infillings in a conglomerate near the base of the Ogallala Formation. At least four mammalian ichnotaxa are represented, including a single trackway of a large camel (*Gambapes* sp. A), several prints of an uncertain family of artiodactyl (*Gambapes* sp. B), a single trackway of a large feloid carnivoran (*Bestiopeda* sp.), and several indistinct impressions, probably representing more than one trackway of a small canid carnivoran (*Chelipus* sp.). The footprints are preserved in a channel-margin facies of an Ogallala braided stream.

Introduction

In eastern New Mexico, the Ogallala Formation is composed of alluvial, eolian, and lacustrine deposits of Miocene to early Pliocene age, about 12–4 Ma (Fig. 1; Hawley, 1984). In the Texas Panhandle, Ogallala Group strata produce the mammalian fossil assemblages characteristic of the Clarendonian and Hemphillian land-mammal "ages" of late Miocene–early Pliocene age (Wood et al., 1941; Tedford et al., 1987). However, no fossil mammals are known from the Ogallala Formation in New Mexico. Here we report mammal footprints from the Ogallala Formation, the first documentation of fossil mammals from the unit in New Mexico.

Locality and stratigraphy

The trackway locality (NMMNH L-3096, UTM Zone 13 3756410N 603114E) is on the west flank of San Juan Mesa, Chavez County, New Mexico. The Ogallala Formation consists of 21 m of conglomerate, sandstone, and caliche (Fig. 2). Trackways from NMMNH locality L-3096 are found above a 35-cm-thick, lenticular, sandstone and mudstone lens in the basal conglomerate of the Ogallala Formation. The lower 25 cm of this lens consists of a planar-bedded sandstone. The upper 10 cm is a mudstone drape with well-developed mudcracks. The trackways are developed on the mudstone drape but are preserved as infillings at the base of the overlying conglomerate (Figs. 2–4). Most tracks are preserved on the underside of a single, thick conglomerate block (Fig. 3). A few isolated mammal prints were also observed on the underside of adjacent blocks.he depth of the infillings suggest that tracks were made in a relatively soft substrate. Some prints are accompanied by marks indicating slippage on a slick, wet substrate (Fig. 5C). Infillings of mudcracks and narrow, cylindrical burrows and raindrop impressions are preserved over some areas of the trackway slab. Mammal trackways represent at least four ichnotaxa.

Description and identification

Bestiopeda sp.

A single trackway referred to *Bestiopeda* sp. parallels the trackway of *Gambapes sp. A* described below (Figs. 4, 5A). We follow Sarjeant and Langston (1994) in restricting *Bestiopeda* to carnivoran footprints that lack claw impressions. *Bestiopeda* are generally ascribed to feloids, which normally walk with claws retracted or held above the ground. These tracks also exhibit other characteristics distinctive of modern cats, such as plantar pads that have two lobes on the front (Halfpenny and Biesiot, 1986) and prints that have breadth greater than their length (manus length = 55 mm; breadth = 57 mm; digit II length = 21 mm; III length = 27 mm; IV length = 23 mm; V length = 22 mm).

Chelipus sp.

Several prints possibly representing several trackways of small, digitigrade footprints with four digits (II to V) are referred to *Chelipus* sp. (Figs. 4, 5B) (overall length = 35 mm; breadth = 32 mm; digit II length = 10 mm; III length = 20 mm; IV length = 20 mm; V length = 15 mm). Digital pads are ovoid and of equal or similar size. Prints are very shallow and indistinct. Manus and pes prints probably overlap. No defi-

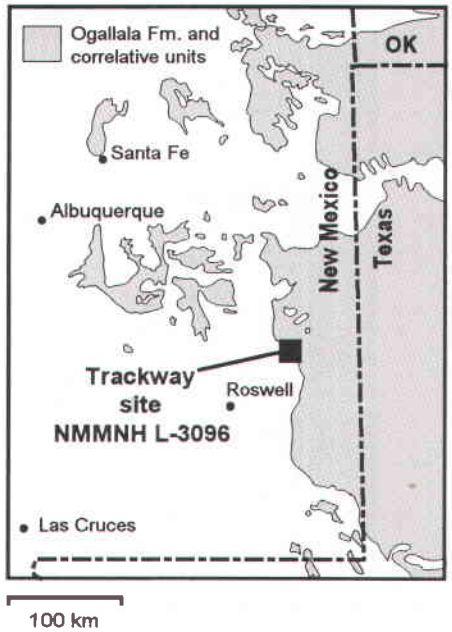

FIGURE 1—Map showing trackway location (NMMNH locality L-3096). Trackway locality is in the Pliocene Ogallala Formation, San Juan Mesa, Chavez County, eastern New Mexico. Ogallala Formation and correlative deposits (Santa Fe Group) are shaded (modified from Hawley, 1984).

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MEASURED STRATIGRAPHIC SECTION

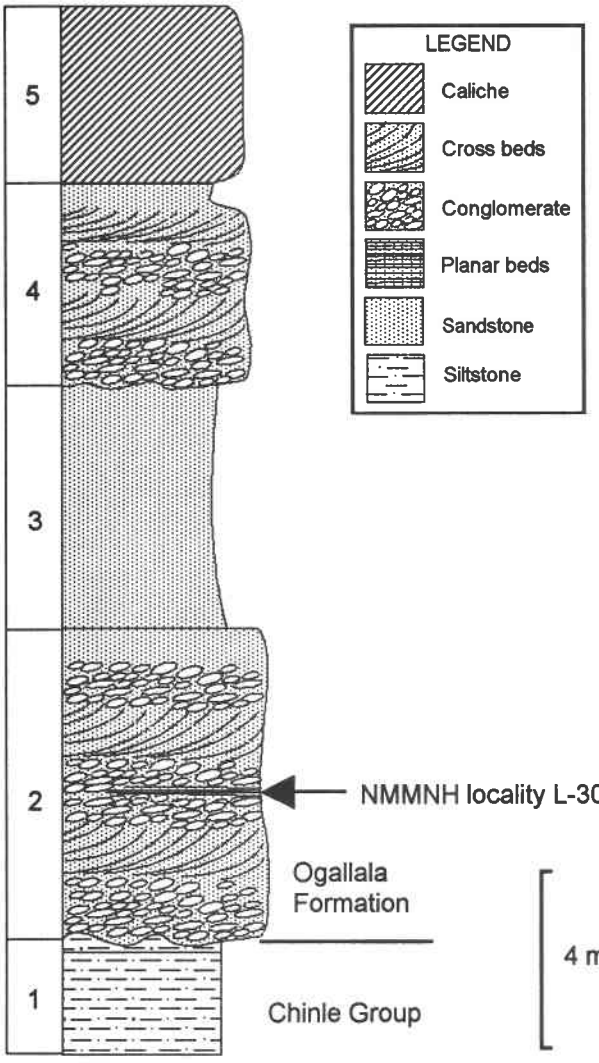

FIGURE 2—Measured stratigraphic section and lithologic description of Ogallala Formation at trackway locality, sec. 22 T4S R29E, San Juan Mesa, New Mexico.

	Ogallala Formation	Thickness (m)
5	Caliche; white (N9) weathers pinkish gray (5 YR 8/1); forms extensive caprock over San Juan Mesa.	4.0
4	Conglomerate; light brown (5 YR 6/4); poorly sorted; crudelybedded with some crossbeds; subarkosic; quartzite, sandstone, chert and gneiss clasts; clasts imbricated; subrounded; calcareous.	4.0
3	Sandstone; light brown (5 YR 6/4); moderately sorted; fine- to coarse-grained; subangular; calcareous; subarkosic; slope-forming.	5.5
2	Conglomerate; light brown (5 YR 6/4); poorly sorted; crudely bedded with some crossbeds; subarkosic; quartzite, sandstone, chert and gneiss clasts; clasts imbricated; subrounded; calcareous; fines upward over last 1 m. Trackways are found above 35-cm-thick, lenticular, sandstone and mudstone lens. Lower 25 cm consist of planar-bedded sandstone. Upper 10 cm consist of mudstone with well-developed mudcracks. Trackways are developed on mudstone and preserved as infillings at base of overlying conglomerate. Conglomeratic blocks preserving trackways are slumped.	7.0
	Unconformity	
	Chinle Group (Upper Triassic)	
1	Siltstone and mudstone; light brown (5 YR 6/4); calcareous. Upper 0.5 m is greenish.	not measured

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FIGURE 3—Exposures of Ogallala Formation on the west side of San Juan Mesa, eastern New Mexico. Trackways occur in the conglomeratic slump blocks near the base of the Ogallala Formation (see arrow). Note two people to the left of blocks for scale.

nite claw impressions are preserved. However, prints have a single lobe on the front of the plantar pad as is seen in modern canid tracks (Halfpenny and Biesiot, 1986) and are longer than wide, indicating that they were not made by a feloid.

Gambapes sp. A

A single trackway is referred to *Gambapes* sp. A (Figs. 4, 5C). The prints are relatively large (overall length = 146 mm; maximum width = 132 mm), didactyl, and symmetrical. The hoofprints of digits III and IV are separated by a continuous interdigital space, and each taper to a pointed apex. At least two of the prints (manus and pes) are followed by marks indicating slippage on the substrate (Fig. 5C). The hoofprints themselves are convex rather than flat, indicating that a fleshy pad was present. Each print is relatively broad with a maximum breadth greater than 35% of its length (Sarjeant and Langston, 1994). They are therefore confidently referred to *Gambapes*. The maximum breadth of hoofprints of the pes is about 50% of its length (medial hoofprint length = 146 mm; maximum breadth = 72 mm). The prints referred to *Gambapes* sp. A differ from *Pecoripeda* (*sensu* Sarjeant and Langston, 1994) in having shorter hooves and from *Cervipeda* (*sensu* Sarjeant and Langston, 1994) in lacking dewclaw impressions.

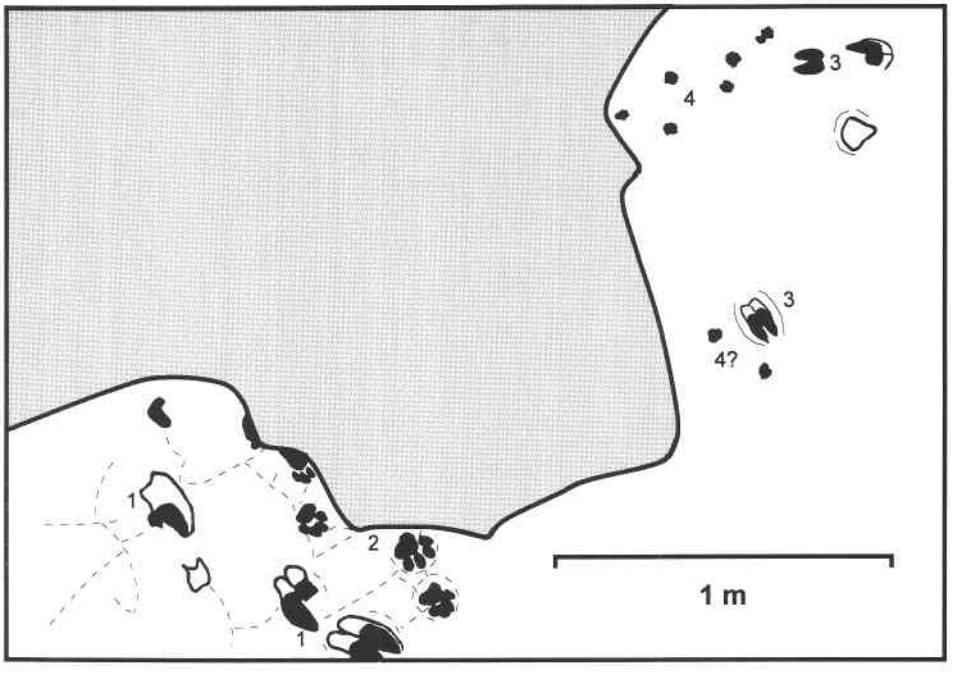

FIGURE 4—Map of trackway, traced from underside of conglomeratic block. Tracks are preserved as infillings: **1**, *Gambapes* sp. A; **2**, *Bestiopeda* sp; **3**, *Gambapes* sp. B; **4**, *Chelipus* sp. Shading indicates area beyond block.

The ichnogenus *Cervipeda* as emended by Sarjeant and Langston (1994) is intended to embrace didactyl artiodactyl footprints made by cameloids, traguloids, cervoids, and bovoids. The tracks we refer to *Gambapes* sp. A can confidently be referred to a large camel because of their large size and indications that a fleshy, spreading hoof pad similar to that seen in living camels was present.

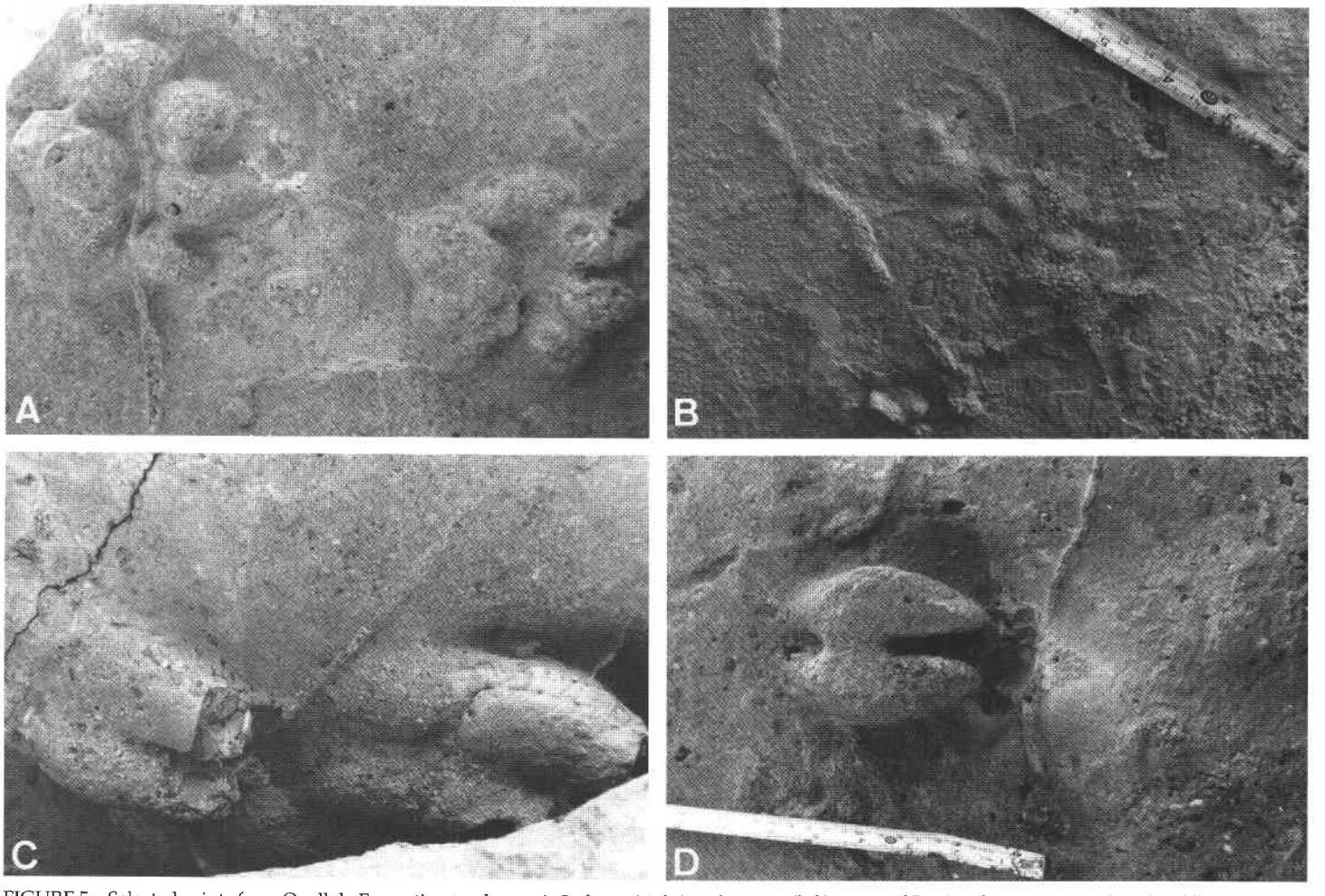

FIGURE 5—Selected prints from Ogallala Formation trackway. **A**, Left pes (right) and manus (left) prints of *Bestiopeda* sp. Note mudcrack infillings. Manus length is 55 mm. **B**, manus? and pes? prints of *Chelipus* sp. showing possible overlap of pes on manus. Note sinuous invertebrate trace and raindrop impressions. **C**, Manus (left) and pes (right) prints of *Gambapes* sp. A. Note slippage marks behind both prints. Manus length is 146 mm. **D**, Single print of *Gambapes* sp. B.

Gambapes sp. B

Several isolated prints or short trackways are referred to *Gambapes* sp. B (Figs. 4, 5D). Prints are symmetrical, didactyl, and smaller than those referred to *Gambapes* sp. A described above (overall length = 100 mm; overall breadth = 86 mm). Hoofprints taper to a point anteriorly and are separated by a nearly continuous interdigital space. One print was deeply impressed into the substrate and preserves the impression of interdigital tissue (Fig. 5D). The base of the hoofprints are flat, rather than convex, as in the prints of *Gambapes* described above, suggesting a lack of a fleshy foot pad. The maximum breadth of the hoofprints is greater than 35% of its length (hoofprint length = 100 mm; breadth = 40 mm).

Sarjeant and Langston (1994) revised the ichnogenera *Pecoripeda* and *Cervipeda*. They distinguished *Cervipeda* from *Pecoripeda* by the presence of dew-claw impressions. They noted, however, that in living cervids such as deer, dew-claw impressions are not left when the animal is walking, or moving over a hard substrate. At least one print is very deeply impressed and lacks accompanying dew-claw impressions, suggesting that these were not made by a cervoid, traguloid, or bovoid. It may represent a large antilocaprid or medium-sized, primitive camelid.

Discussion

This is the first documentation of mammal trackways from the Ogallala Formation of New Mexico. Several Miocene to early Pliocene mammal trackways have been reported from western North America (Alf, 1966; Johnston, 1937; Lockley and Hunt, 1995; Nations et al., 1981; Nininger, 1941; Scrivner and Bottjer , 1986; Williamson and Morgan, 1995), but they are generally poorly documented. Many of these trackways are dominated by camels. Williamson and Morgan (1995) reported on a late Miocene trackway from the "middle red member" of the Zia Formation of the Santa Fe Group in Sandoval County. That trackway is also dominated by camel tracks but includes two trackways of a large feloid carnivoran. The trackways reported here are unusual in preserving trackways of at least two different carnivorans, one camel and another large artiodactyl.

The Ogallala footprints documented here are assigned to ichnogenera with long temporal ranges that go back to at least the late Eocene (Duchesnean) (Sarjeant and Wilson, 1988; Sarjeant and Langston, 1994). Therefore, they are of little biochronological significance. Ogallala fossil mammals from the Texas Panhandle include camelids and other ruminant artiodactyls as well as canid and feloid carnivorans (e.g., Johnston, 1937; Savage and Russell, 1983). Two unreported localities in the Texas Panhandle also produce tracks and track fillings of camels (Schultz, personal communication 1995). Specimens from these localities are in the collections of Panhandle–Plains Historical Museum and West Texas A&M University. The localities include a site in the Ogallala Formation of Moore County, Texas that exposes about 30 sandstone cast fillings and a site that produces tracks and fillings in a lacustrine limestone of late Hemphillian or Blancan age in the Rita Blanca beds west of Channing in Hartley County, Texas (Schultz, personal communication 1995). The trackways reported here repre-

sent constituents of the Ogallala mammalian fauna known elsewhere from tracks and body fossils.

The occurrence of fossil mammal trackways in the Ogallala Formation reported here is in a laminated lens of sandstone and mudstone in a trough-crossbedded conglomerate. We interpret the conglomerate to represent a low sinuosity, rapidly flowing stream channel (also see Seni, 1980). The trackway-bearing lens can readily be understood as a channel margin/proximal floodplain facies where sandstone is deposited in sheets during upper flow regime conditions and draped with mudstone during times of slack flow. Such surfaces are often subaerially exposed on braided-river floodplains (for example, the modern Rio Grande). Mammals coming to the stream to ford it or drink from it would impress their footprints into the sand, and those impressions would be preserved if buried soon thereafter by sand and gravel during an episode of high river discharge. This scenario well explains the formation and preservation of the Ogallala footprints described here.

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