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1972, pp. 129-133. https://doi.org/10.56577/FFC-23.129

*in:*

*East-Central New Mexico*, Kelley, V. C.; Trauger, F. D.; [eds.], New Mexico Geological Society 23 rd Annual Fall Field Conference Guidebook, 236 p. https://doi.org/10.56577/FFC-23

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# VERTEBRATE PALEONTOLOGY OF THE SOUTHERN HIGH PLAINS

by

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The southern High Plains of eastern New Mexico and the Texas Panhandle cover an area of approximately 50,000 square miles. That portion lying south of the Canadian River forms a broad plateau called the Staked Plains or Llano Estacado which is bordered on the north, east, and west by escarpments and which grades southward into the Edwards Plateau without any physiographic break. North of the Canadian River, the plains are continuous with the High Plains of western Oklahoma, Kansas, and Nebraska. The present High Plains surface has developed on a widespread sheet of Late Tertiary and Quaternary deposits laid down on a low-relief surface of Permian, Triassic, and Cretaceous sedimentary rocks. In the southern High Plains, this surface is underlain by the thick caliche caprock which occurs in the upper part of the geographically extensive Ogallala Formation. Locally, basins and valleys eroded in the Ogallala Formation have been filled with lacustrine and fluvial deposits of Pleistocene age. Erosion and deposition during Pleistocene and Recent time have modified the surface features on the plains and have also developed or modified the canyons and escarpments along the margins of the plains thus exposing some of the older geological formations.

Today, strata of Permian, Triassic, Pliocene, and Pleistocene ages may be seen and studied along the "breaks" of the Canadian River and along the headward tributaries of the Red and Brazos Rivers. With the exception of the Permian, these beds contain abundant vertebrate fossils and, as a result, the southern High Plains, especially the Panhandle regions of Texas and Oklahoma, have long been known to vertebrate paleontologists throughout the world. During the past 80 years many institutions have made extensive collections of Triassic and Cenozoic vertebrates. Among these are the American Museum of Natural History and the Frick Laboratories of New York City, the University of California, the University of Michigan, Yale University, the University of Texas, the University of Oklahoma, West Texas State University, and Midwestern University. Associated with these expeditions are the names of well-known paleontologists such as Cope, Gidley, Case, Matthew, Stirton, Lull, Stovall, and Savage. Figure 1 is a map of the southern High Plains and "panhandle" regions showing some of the major fossil vertebrate localities. A generalized geologic column showing the stratigraphic relationship of these vertebrate faunas is given in Table 1.

Beds of Upper Triassic age belonging to the Dockum Group are exposed in the Tucumcari, New Mexico region and along the breaks of the Canadian River from Logan, New Mexico to just north of Amarillo, Texas, and along the eastern escarpment bordering the High Plains from about Amarillo south to Big Spring, Texas. These gray sandstone and maroon and orange shale beds were laid down in streams and swamps and have yielded numerous remains of phytosaurs and metoposaurid amphibians as well as occasional teeth of lungfish. One quarry site northeast of Amarillo was worked in 1940

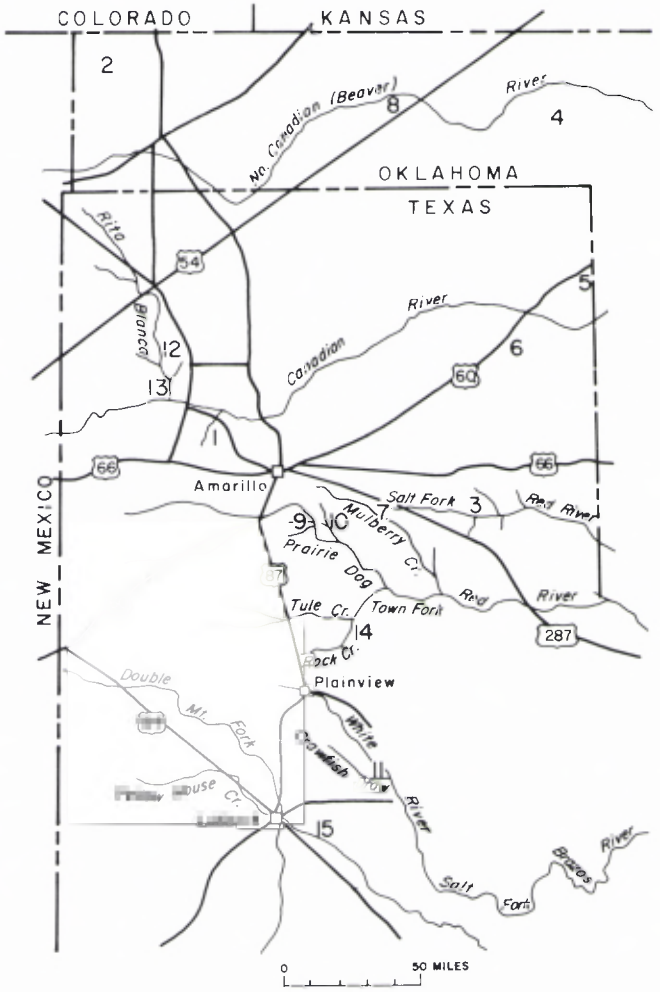


*Figure 1. Index Map Showing Principal Vertebrate Fossil Localities in the Southern High Plains.*

Key to Faunal Sites Shown on Figure 1 (Map)

1. LS (Ware) Ranch—Upper Triassic
2. Kenton Dinosaur Quarry—Upper Jurassic
3. Clarendon—Clarendonian (Early Pliocene)
4. Beaver—Clarendonian
5. Higgins—Early Hemphillian (Middle Pliocene)
6. Hemphill (Coffee Ranch)—Mid-Hemphillian
7. Goodnight—Mid-Hemphillian
8. Optima—Mid-Hemphillian
9. Axtel—Late Hemphillian
   Cita Canyon—Blancan
   Cudahy—Irvingtonian (Middle Pleist.)
10. Christian Ranch—Late Hemphillian
11. Blanco—Blancan
12. Channing—Blancan
13. Red Corral—Blancan
14. Rock Creek—Irvingtonian
    Cudahy—Irvingtonian
15. Slaton—Rancholabrean (Late Pleist.)

| Period or Epoch | Stage-Age | Vertebrate Faunas | Rock Unit |
|---|---|---|---|
| Pleistocene | Rancholabrean | Slaton | |
| | Irvingtonian | Cudahy<br>Rock Creek | Tule Fm. |
| | Blancan | Blanco, Cita Canyon, and Channing<br>Red Corral | Blanco Fm. and equivalents |
| Pliocene | Hemphillian | Axtel, Christian Ranch<br>Hemphill, Goodnight, Optima<br>Higgins | Ogallala Fm. |
| | Clarendonian | Clarendon, Beaver | |
| Cretaceous | Lower | | Purgatoire Fm. |
| Jurassic (eastern New Mexico, Okla.) | Upper | Kenton Dinosaur Quarry | Morrison Fm. |
| Triassic | Upper | LS (Ware) Ranch | Dockum Grp. |
| Permian | Upper | | Quartermaster Fm.<br>Cloud Chief |

*Table 1. Composite Geologic Column for the Southern High Plains*

with WPA help and yielded over 20 skulls and other skeletal elements of the large metoposaurid amphibian commonly known as *Buettneria.* This collection, housed in the Panhandle-Plains Historical Museum in Canyon, Texas, is one of the finest collections of these amphibians in North America.

Throughout much of the Texas Panhandle, a hiatus exists in the stratigraphic section between the Upper Triassic and the late Tertiary. In eastern New Mexico and in the western Oklahoma Panhandle, the Upper Jurassic is represented by continental deposits of the Morrison Formation and dinosaur bones have been found west of Boise City near Kenton, Oklahoma. Near-shore marine rocks of Lower Cretaceous age occur from the vicinity of Tucumcari, New Mexico southeastward toward Lubbock, Texas, but are generally absent northeast of this line except for a few small outliers. In addition to numerous invertebrates, the Cretaceous rocks have yielded occasional shark teeth.

The early and middle Tertiary was apparently a time of erosion or nondeposition in the southern High Plains. No rocks of Paleocene through Miocene age are known from the region. During the Pliocene, however, streams flowing eastward out of the Rocky Mountains deposited the silts, sands, and gravels of the Ogallala Formation—easily recognized by its general buff color and by its thick caprock of caliche which forms the High Plains surface. At times, environmental conditions favored the burial and preservation of vertebrates in lakes, ponds, channels, sinkholes, and on flood plains. Erosion has now exposed these fossiliferous units in many areas. The great abundance and variety of Lower and Middle Pliocene horses, camels, mastodons, rhinoceroses, deer, and carnivores which have been found in certain parts of the Texas Panhandle prompted Wood and others (1941) to designate these areas and their faunas as the basis for the Clarendonian (Lower Pliocene) and Hemphillian (Middle Pliocene) mammalian ages of North America. These, along with the other mammalian ages of the Tertiary, are generally defined on the basis of the first and last appearances and joint associations of certain characteristic mammalian genera.

The term Clarendonian is derived from the town of Clarendon in Donley County, Texas. North of Clarendon, the Salt Fork of the Red River flows through Permian rocks. Along the divides north of the river are exposures of Pliocene strata where fossils belonging to the Clarendon fauna are found. The earliest discoveries were made by Cope and Cummins in the early 1890's. Cope referred the sediments and their contained fossils to the "Loup Fork" because of their resemblance to the "Loup Fork" of Nebraska. Gidley (1903) referred to these strata as the "Clarendon beds" but the name has not found general application. The fossil-bearing beds are now recognized as being a facies of the Ogallala Formation. Unfortunately, no comprehensive study or description of the Lower Pliocene Clarendon fauna has ever appeared in print although single species have been described in short papers or in larger publications dealing with certain taxonomic groups. In addition, papers on other Lower Pliocene faunas have from time to time made reference to fossils from the Clarendon fauna. At the present time, more than 30 fossil sites are known from the area north of the Salt Fork. No detailed biostratigraphic analysis has been done on these sites and no individual site has ever been chosen as the basis for a "type" Clarendon fauna. The large number of fossil sites makes it quite probable that they may represent slightly different ages and horizons. Careful biostratigraphic studies are needed to demonstrate these relationships.

Starting about 10 miles north of Clarendon, the fossil sites occur along a belt which extends eastward for about 15 miles along the divides north of the Salt Fork. In the western part of this belt, the fossils occur encased in a hard concretionary matrix or free in a greenish-gray clay whereas farther east they occur mainly in coarse-grained ferruginous sand of fluvial origin or encased in ferruginous sandstone concretions in sinkhole deposits developed in Permian redbeds. The clays probably represent accumulations in oxbow lakes and flood-plain ponds where animals came to drink, but the coarser sands are fluvial deposits of a stream or streams which trended in an easterly direction. The sink holes developed as a result of subsurface solution of evaporite minerals and resultant collapse of overlying sediments.

Since the first fossil collections were made for the Texas Geological Survey by Prof. Cope in 1892, many other institutions have worked in the area including the American Museum of Natural History and the Frick Laboratories of New York, the University of California, and West Texas State University. A number of new mammalian species have been described. The fauna is an impressive one consisting for the most part of various kinds of horses but including also a variety of camels, deer, and carnivores as well as representatives of the rhinoceros, peccary, oreodont, and mastodon groups. Many forms are represented by complete skulls, jaws, and, in the case of sinkhole deposits, complete skeletons. The horses range in size from the tiny goat-sized *Calippus* up to the pony-sized *Pliohippus*. Three-toed horses are represented by grazers such as *Neohipparion* and *Pseudhipparion* and by the last of the browsing horses, *Hypohippus*. Camels include large and small species of *Procamelus* and a giraffe-necked form called *Aepycamelus*. Among the deer is an unusual form called *Synthetoceras tricornatus* which possessed a pair of horns above the eyes and a third horn which extended forward from the nose and then forked into two branches like a slingshot. Carnivores, while not abundant, are, nevertheless, varied. Dogs include large bearlike forms (*Ischyrocyon*), large heavy-jawed bone-eaters (*Aelurodon*), and terrier-sized forms like *Tomarctus*. Mustelids and saber-toothed cats are among the rarer carnivores. *Teleoceras* is a rather common, short-legged, barrel-chested rhinoceros, whereas the oreodonts, so common in Nebraska and South Dakota during Oligocene time, and here represented by one of the last surviving genera, *Ustatochoerus*. Among the lower vertebrates, remains of large tortoises are frequently encountered and alligator scutes have been found occasionally.

The Hemphillian Age is based on an assemblage of Middle Pliocene mammals from a quarry located in Hemphill County, Texas, about 8 miles northeast of Miami. This locality on the Coffee Ranch was first discovered by two oil company geologists while engaged in a reconnaissance of the county in 1928. The first significant fossil collections were made by the University of California a few years later. According to Dalquest (1969, p. 2) the fossils at this site accumulated in a seasonal lake or bog of moderate but unknown area. The lacustrine sediments, a facies of the Ogallala Formation, are now exposed in a 20-foot vertical section for a distance of about 300 feet along a tributary of Red Deer Creek. Most of the fossils have been found in the greenish sand and sandy clay at the base of the section. These include well-preserved skulls and jaws of *Osteoborus*, a bone-eating dog; a nearly complete skeleton of *Machairodus*, a saber-toothed cat; four different kinds of horses; large and small camels; deer; peccary; antilocaprid; rhinoceros; and an assortment of rarer carnivores. The fauna is more advanced than the Clarendon fauna as evidenced from a comparison of the horses and other taxa. A paleoecological study of the fauna by Shotwell (1955) suggests that the proximal community at the Hemphill site lived in a grassland habitat on the basis of the large number of herbivores present.

Overlying the main fossil beds at the Hemphill quarry is a thick bed of volcanic ash which preserves the tracks of birds and mammals along certain bedding planes. The absolute age and the source of the ash have not been determined but the ash fell in sufficient quantities to completely fill the lake basin and to seal off the fossil beds below.

In some of the tributary canyons of the Red River such as Palo Duro and Cita Canyons, located about 20 miles south of Amarillo, faunas of a Late Hemphillian or Late Middle Pliocene age have been found. By this time, rhinoceroses were nearly extinct in North America and other lineages were evolving new genera. Climates were changing too. During most of the earlier Pliocene, climatic conditions were subhumid and subtropical as evidenced by remains of large tortoises and alligators in some of the faunas. At the close of Hemphillian time, conditions became more arid and extensive development of caliche occurred in the upper part of the Ogallala Formation. During subsequent Blancan time, there was a return to moist conditions. Basins developed in which the early Pleistocene Blanco Formation and the middle Pleistocene Tule Formation accumulated.

The type locality for the Blancan Mammalian Age (Late Pliocene—early Pleistocene) of Wood and others (1941) is about 40 miles northeast of Lubbock, Texas. According to Evans and Meade (1945), the Blanco Formation is a localized basin accumulation and is predominantly of lacustrine origin although a fluviatile origin has been advocated by Gidley (1903), Matthew (1924), and by Frye and Leonard (1957).

The best exposures of these white beds occur for a distance of 2 or 3 miles along the upper walls of White River Canyon (Blanco Canyon) and along Crawfish Draw which enters it from the west. In this region, the Blanco beds unconformably overlie the reddish-brown sand and clay of the middle Pliocene Bridwell Formation (locally defined equivalent of part of the Ogallala Formation). They are in turn overlain by widespread aeolian sands, silts, and caliche of middle or late Quaternary age.

Evans and Meade (1945) state that "the Blanco beds consist mainly of well-bedded light gray calcareous sands and clays with some fresh-water limestones, tufa, diatomite, and coarse gravels. The finer-grained materials make up the main body of the deposits but grade marginally to coarser sand and gravel." In an outcrop distance of about 1.5 miles, Evans and Meade recognized from 10 to 12 traceable beds and noted a range in thickness of 56 to 74 feet for the formation.

Disagreement exists as to the environment in which the Blanco Formation was deposited. In 1900 and 1901, Gidley made a large fossil collection for the American Museum of Natural History and concluded (1903) that the beds were of limited extent and represented a valley deposit of an aggrading stream. He wrote that "the occasional beds of diatomaceous earth are easily accounted for by supposing that there were in this ancient valley occasional ponds filled with clear water enduring for various periods of time, partially or totally isolated from the stream that ran through the valley." Matthew (1924) also considered the Blanco to be a stream valley deposit but thought that the light-colored fossil-bearing strata were a channel facies wiwhich interfingered with the bordering reddish-brown Pliocene sand and clay which he took to be a flood plain facies of the Blanco. He wrote "the Blanco beds were deposited in a broad and shallow slowly aggrading stream valley with a slow-flowing, probably intermittent stream of about the type of the present Blanco Creek. The valley would be partly occupied then as now by abandoned stream channels forming ponds and muckholes. . . ."

Evans and Meade (1945, p. 492) believed the Blanco beds "to be lacustrine deposits laid down in broad shallow basins rather than deposits of a large stream valley." Their evidence consists of the fact that the coarser clastics are indigenous pebbles of caliche caprock occurring along the margins of the basin, the excellent stratification persistent over much of the exposed area, the presence of diatomite, bentonitic clay, and fresh-water limestone, and the absence of any connecting filled valley segment between the two main areas of Blanco bed exposures. Their summary of the geologic history of the region consists of the following stages or steps: (1) development of a caliche caprock on the plains surface during an arid interval near the end of Pliocene time, (2) development of a basin or basins to a depth of 60 or 70 feet during an arid interval—perhaps due to deflation, (3) occupation of these basins by lakes and filling of these lakes with lacustrine sediment of the Blanco Formation during a wet period (viz. Nebraskan), (4) deposition of wind-blown silt and volcanic ash during a subsequent arid interval to complete the filling of the basins to the level of the present plains surface.

Frye and Leonard (1957, pp. 20-21) have argued against Evans and Meade's interpretation of the environmental history of the Blanco citing as evidence the significant absence of aquatic mollusks and certain types of vertebrate fossils such as fish and amphibians—all of which should have been present had a large permanent lake existed under humid climatic conditions for any period of time. They state that "all the known facts . . . point to alluviation by streams of very low gradient flowing across a semiarid terrain."

Since the Blanco Formation disconformably overlies deposits of middle Pliocene age and is disconformably overlain by aeolian silts and sands, the age of the Blanco fauna is based mainly upon the evidence of fossil vertebrates. Included are such short-range genera as *Borophagus* (bone-eating dog), *Titanotylopus* (large camel), and *Plesippus* (zebrine horse) which are known only from the Blancan. There are present, in addition, longer range genera such as *Camelops* (camel), *Tanupolama* (llama), and *Platygonus* (peccary), which first appear in the Blancan but survive through most or all of the Pleistocene. The fauna also includes surviving genera typical of the Pliocene such as *Nannippus* (3-toed horse) and *Rhynchotherium* (mastodon) which did not survive the Blancan. The presence of Pliocene genera in early collections from the Blanco appears to be responsible for the original assignment of a Pliocene age to the fauna by Gidley, Matthew, and others. The typical Pleistocene genera in the fauna were not recognized until later. A number of forms were added to the faunal list by Meade (1945) who assigned an early Pleistocene age on the basis of faunal composition. This, together with the evidence that the deposits were formed in a humid climate which would likely correspond with a glacial stage, indicated, in the opinion of Evans and Meade, that the Blanco beds are of Nebraskan age. Others have argued for an Aftonian or a pre-Nebraskan age.

Although opinions still differ on the precise age, the climatic conditions, and the depositional environment, new contributions to our knowledge of the Blanco Formation and its fauna are being made. It is now known, for example, that the volcanic ash which overlies the Blanco horizon matches petrographically the rhyolite air-fall tephra (Guaje Pumice bed) that underlies ash flows of the Bandelier Tuff in the Jemez Mountains of northern New Mexico. The Guaje has been K/Ar dated at about 1.4 million years (Izett and Wilcox, 1972, p. 384). Furthermore, paleomagnetic studies are presently being carried out to determine if magnetic reversals of the earth's field are recorded in the rocks here.

The Blanco fauna is an extremely interesting one and it has had a long history of study. Over the years a number of institutions have made collections and many new species have been described. Most of the fossils consist of disarticulated specimens although in a few cases articulated skeletons have been found in the white clay including those of *Plesippus*, the zebrine horse, collected by Matthew and Simpson in 1924 for the American Museum. At one locality Meade collected the remains of about 18 individuals of a large camel, *Titanotylopus*. Although no articulated skeletons were found, there were several articulated skulls and jaws and a number of articulated leg bones. According to Meade, these fossils may represent a herd of camels which ventured into the shallow waters of the ancient lake and were trapped or overcome by carnivores at the edge of the water. Other significant discoveries include the skull and jaws of a large jaguar, *Felis palaeoonca*, and the carapace of a large glyptodont.

Basins similar to that at the Blanco site occur elsewhere in the southern High Plains. In Cita Canyon, southeast of Amarillo, excavations by W.P.A. crews in the late 1930's produced an exceptionally large Blancan fauna, the Cita Canyon fauna, which includes horses, camels, deer, peccary, bone-

eating dogs, coyote, saber-toothed cats, puma, ground sloth, glyptodonts, and turtles. Unusual finds include two teeth of an early ursid (bear) and the lower jaw of the only genus of hyena known to have been native to North America.

Basins of middle Pleistocene age are also present in the region. One of the largest of these is the Tule Basin between Tulia and Silverton, Texas. Here the gray clay and sandy silt of the Tule Formation have nearly filled the basin to the level of the High Plains surface. Fossils have been collected from the Tule Formation since the days of Cope and Cummins. One of the best known sites is at the head of Rock Creek, a tributary of Tule Canyon. The Rock Creek fauna has produced new species of turtle, camel, and horse as well as numerous remains of ground sloth. Of great significance is the occurrence of the horse, *Equus scotti.* Since its discovery by Gidley in 1900, about 20, more or less, articulated skeletons have been removed from one quarry and are now in the collections of Yale University, the American Museum, the Smithsonian, and West Texas State University.

The recent trend in vertebrate paleontology has been the collection of microvertebrates through screen-washing techniques. A number of microfaunas of middle and late Pleistocene age have been found in the southern High Plains. One of the best known of these is the Cudahy fauna which is known from localities in Nebraska, Iowa, Kansas, and north Texas. The fauna includes an abundance and variety of rodents which indicate cool, wet climatic conditions. At present, the fauna is assigned to the Late Kansan glacial stage. Overlying the Cudahy faunal horizon at some of the fossil sites is a layer of volcanic ash which is about 600,000 years old (Pearlette Type 0). The source area for this ash fall is Yellowstone Park. Within the last two years this author has located several good Cudahy fauna sites in the Texas Panhandle which have produced a large number of fossils.

The possibilities for further paleontological study in the southern High Plains are unlimited and there is a great need for additional work to be done in the Triassic and Pliocene and especially in the Pleistocene.

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