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FOSSILS FROM THE SEYMOUR FORMATION OF
KNOX AND BAYLOR COUNTIES, TEXAS, AND
THEIR BEARING ON THE LATE KANSAN
CLIMATE OF THAT REGION

BY

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VOLUME XXI

1. Fossils from the Seymour Formation of Knox and Baylor Counties, Texas, and their bearing on the Late Kansan Climate of that Region, by Claude W. Hibbard and Walter W. Dalquest, Pages 1-66, with 5 plates and 8 figures.

FOSSILS FROM THE SEYMOUR FORMATION OF KNOX AND
BAYLOR COUNTIES, TEXAS, AND THEIR BEARING ON THE
LATE KANSAN CLIMATE OF THAT REGION*

BY

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ABSTRACT

The vertebrates recovered from the Seymour Formation in Knox and Baylor counties, Texas, are listed herein. A systematic description is given of the fossil mammals. The presence of the Pearlette volcanic ash establishes the age of the fossils as no younger than late Kansan. The vertebrates recovered from the sand and gravel and sandy silt and clay below the horizon of the Vera faunule of the Cudahy fauna are regarded as a distinct local fauna (the Gilliland local fauna). This fauna is considered to be the same age as the Holloman local fauna of Oklahoma, and the Rock Creek local fauna of Texas. The fauna is post-Blancan and pre-Cudahy in age. Twenty-two genera of mammals were recovered in association with specimens of a giant land tortoise (*Geochelone*) which indicates that the climate was frost free in this part of Texas during that part of Kansan time that these tortoises lived. The associated fauna indicates a maritime climate with more effective moisture than now occurs in that region .

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INTRODUCTION

THE DISCOVERY IN January, 1956, of scutes of a glyptodon in a Pleistocene deposit along the north valley wall of the South Wichita River near Gilliland, Texas (Figure 1), by a biology student at Midwestern University resulted in the intensive collecting from the Seymour Formation along the valley walls of the South Fork of the Wichita River, in Knox and Baylor counties, Texas.

Dalquest and his students, Melton, Hibbard and his students between January of 1956 and the summer of 1962, recovered a large invertebrate fauna (Getz and Hibbard, 1965) and the large vertebrate fauna reported in this study. Some of the vertebrates have been reported by Brodkorb (1964*a* and 1964*b*), Hibbard and Dalquest (1960 and 1962), Holman (1965), Melton (1964), Preston (1966), and Tihen (1960).

The fossils from the Seymour Formation have been separated into two groups on the basis of their stratigraphic occurrence. Those recovered from the sand, gravel, and sandy silts below the horizon of the gray silt and silty clay at the base of the Pearlette volcanic ash have been named

the Gilliland local fauna. The fossils taken above the Gilliland local fauna from sediments just below the Pearlette ash have been named the Vera local faunule of the Cudahy fauna which has been reported from below the Pearlette ash in Texas, Oklahoma, Kansas, and Nebraska.



FIG. 1. Map showing location of Seymour Formation containing the Gilliland local fauna and the Vera faunule, in the area of Gilliland and Vera, Texas, and the Cudahy fauna in Kansas.

The Gilliland local fauna, reported here for the first time, consists chiefly of large vertebrates from the early middle Pleistocene of North America.

The fauna indicates that the winter climate of late Kansan (glacial) time in Knox and Baylor counties, Texas, was not as cool as the present climate of that region. It also indicates that the summer climate was not as warm and had more effective moisture, which gave the region a maritime-type climate.

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SEYMOUR FORMATION

W. F. Cummins (1893, p. 181) described the Seymour Formation and stated that "The formation, with its natural barriers, is well represented between the Brazos River and the Big Wichita River between Seymour, in Baylor County, and Benjamin, in Knox County, and I have named its beds Seymour beds, for the reason that I first saw them in that vicinity. They range in thickness from a few feet to fifty, the thickest being on the west, and are composed of unstratified beds of sandy clay resting upon the red beds of the Permian. Very often at the base there are beds of pebbles cemented into solid masses by lime."

The Seymour beds were considered by Cummins to have been deposited within a large inland lake. This interpretation was corrected by Gidley (1903), who asserted their fluvial origin.

Gordon (1913, Pl. I) described the Seymour Formation along the South Fork of the Wichita and mapped the probable extent of the formation. He included within the Seymour Formation some of the younger Pleistocene deposits of the area (see Stricklin, 1961, Fig. 3).

Stricklin (1961) made an intensive study of the Seymour Formation west of Seymour, Texas, in Baylor and Knox counties. He plotted (Fig. 9) the successive positions of the lateral shifting stream or streams that flowed

from the northwest into the ancestral Brazos River which deposited the Seymour Formation on the Permian bed rock. He shows the location of some of the many deposits of Pearlette ash and the approximate position of the lateral shifting stream at the time of the ash fall. It was some time after the deposition of the Seymour Formation that the stream (South Fork of the Wichita River) eroded headward into the region of the Seymour Formation and diverted this part of the early Brazos River System into the Red River. The pirated head waters of the Brazos contained *Pimephales vigilax vigilax* which accounts for its present distribution north of the Brazos Red River divide (Hubbs and Black, 1947; Clark Hubbs, 1957). The following information was furnished by Clark Hubbs (written communication, March 13, 1964): "Similar distribution patterns can be found in *Notropis oxyrhynchus*, *N. shumardi* and *N. potteri*. These three seem to fit the distribution in that they occur in the Red and Brazos systems but not in the Nueces-Sabine areas."

The Seymour Formation rests on the Permian approximately 150 feet above the bed of the present South Fork of the Wichita River where it is crossed by Farm Road 267 southeast of Gilliland in Knox County.

Numerous descriptions have been given for the formation as it varies from place to place. Generally it consists of sand and gravel with large pebbles of quartz, quartzite, blocks of Permian limestone or dolomite, and shells of *Gryphaea*. In some areas the basal part of the sand and gravel is cemented with lime. Lenses of red silt and clay which vary in thickness are often present in the sand and gravel. In a few places a bed of red sandy silt and clay was observed in contact with the Permian below the sand and gravel. The sand and gravel becomes finer upward in the section and more silty near the top where lenses of blue-gray to yellowish silty clay are found. These lenses generally contain fossil vertebrates. The sand and gravel give way to sandy silts and clays. The Pearlette ash, when present, is found within this unit. Where the upper silts have not been eroded away they are capped by a caliche. Eolian silt and sand of a much younger age are often observed resting on the caliche or the upper silts of the Seymour Formation.

Type locality of the Seymour Formation.—The geologic section 0.9 of a mile north of Highway U.S. 82, on the east side of Farm Road 267, in the west part of Lot 70 of Block C of the Houston and Texas Central Railroad Company Survey, is designated as the type section of the Seymour Formation measured from the Permian to the top of the lone point (Pl. I, Figs. 1 and 2) by William G. Melton, Jr. and Claude W. Hibbard, March 20, 1958.

<i>Unit</i>	<i>Description</i>	<i>Thickness (feet)</i>
Seymour Formation		
8.	Caliche rubble	
7.	Sandy silt, red	6.0
6.	Sandy silt, reddish, cemented, forms prominent bench	2.0 to 0.25
5.	Sandy silt, reddish tan, contains some nodules of caliche	5.0
4.	Pearlette ash, upper 2 feet slightly weathered	9.0
3.	Silty clay, grayish brown to darker at top (fragments of snail shells in top of unit)	8.0
2.	Sandy silt, grayish to buff	2.0
1.	Sand and gravel (large cobbles at top), lenses of sandy silt	5.5
Unconformity		
Permian		

The Pearlette ash may also be observed just west of the measured section in the road ditches along Farm Road 267. Another measured section published by Getz and Hibbard (1965) was made west of Farm Road 267 in N $\frac{1}{2}$ Sec. 101 of Block C of Houston Texas Central Railroad Company Survey, Knox County, Texas.

Age and Correlation

The presence of the Vera local faunule of the Cudahy fauna, which occurs directly below the Pearlette ash, and the fossil vertebrates taken from the lower part of the Seymour Formation brackets the age of the fossils recovered as post-Blancan [based on the absence of *Nannippus* (a little three-toed horse) and *Plesippus* (a zebrine horse)]. These vertebrates place that part of the Seymour Formation from which they were recovered as late Kansan or older in age. The mammals date the deposit as Irvingtonian, a North American land-mammal age (Hibbard *et. al.* 1965). To the northwest in Kansas, in Meade and Clark counties, both *Nannippus* and *Plesippus* are known from the Stump Arroyo member of the Crooked Creek Formation. Specimens of *Equus s.s.* and *Mammuthus* have been recovered in southwestern Kansas, in the Atwater member, which overlies the Stump Arroyo member. The Cudahy fauna, the Pearlette ash, and the Borchers local fauna (Hibbard, 1949) occur in the Atwater member in Kansas (Hibbard, 1958a).

The sand and gravel at the Arkalon gravel pit in Seward County, Kansas, questionably assigned to the Stump Arroyo member (Hibbard, 1953, p. 112) is now considered equivalent in age to part of the Atwater silts in Meade County, Kansas. Years ago Frye and Hibbard observed a pure volcanic ash lens in this gravel pit. The sand and gravel grades upward into impure silty ash (See Hibbard, 1944, p. 743, and Leonard, 1950, p. 7, locality No. 37, and p. 41).

The relationship of the Crooked Creek Formation and the Seymour Formation is shown in Figure 2.

		SOUTHWESTERN KANSAS		NORTHCENTRAL TEXAS			
KANSAN	CROOKED CREEK FORMATION	ATWATER MEMBER	<i>Caliche</i> Borchers Local Fauna <i>Pearlette Ash</i> Cudahy Fauna		SEYMOUR FORMATION	<i>Caliche</i> <i>Pearlette Ash</i> Vera Faunule Gilliland Local Fauna	
	STUMP ARROYO MEMBER	Seger Gravel Pit Local Fauna					

FIG. 2. Relationship of the Seymour Formation of Texas to the Crooked Creek Formation of Kansas.

The Gilliland local fauna, which was recovered below the Vera local faunule (Cudahy fauna), can be considered the same age as the Holloman local fauna of Oklahoma (Hay and Cook, 1930; Meade, 1953; and Wood, 1933). The Holloman local fauna was taken from the Holloman Alluvial Terrace (Sellards, 1932) approximately 150 feet above the North Fork of the Red River. These faunas appear to be of the same age as the Rock Creek local fauna (Troxell, 1915*a*, 1915*b*; Auffenberg, 1962; Cope, 1893; and Hay, 1924) from the Tule Formation of Cummins (1893, p. 199) and Gidley (1903). Cummins (1893, p. 199) gave a measured section of the Tule beds taken $\frac{1}{2}$ mile east of Tule Canyon, from exposures in several side canyons. Gidley (1903) gave a critical review of Cummins' work. Gidley removed Unit 2 (the 60 feet of reddish clay) from the Pleistocene section and assigned it to the Tertiary. The Rock Creek quarries are southeast of the type section. Gidley (1900) reported that the specimens of *Equus scotti* were taken in a bed of compact Pleistocene sand at the head of Rock Creek, Briscoe County, Texas. The bed in which the bones were found is near the middle of the *Equus* or Sheridan beds, which are about 100 feet thick at this place. The section given by both Gidley and Cummins for the Tule Formation is 30 feet of basal coarse sand, and is overlain by 15 feet of bluish clay, which is in turn overlain by 20 feet of coarse sand,

with pebbles that grade upward into fine white sand. This area has not been carefully studied but it is possible that Pleistocene sand and gravel of two different ages are involved in the Tule Formation. We visited the old quarry site on the Mayfield ranch and the horse quarry is located to the northwest. It appears that the Rock Creek local fauna was taken from the sand and gravel above the bluish clay. We did not observe the clay nor visit the type locality of the Tule Formation.

The following list gives the vertebrates in the Gilliland, Holloman, and Rock Creek local faunas:

	Gilliland	Holloman	Rock Creek
Class Osteichthyes			
<i>Ictalurus punctatus</i> (Rafinesque)	X	..	..
Class Reptilia			
Chelonia			
<i>Pseudemys scripta bisornata</i> Cope	X	..	..
<i>Terrapene</i> sp.	X	..	..
<i>Geochelone laticaudata</i> (Cope) .....	..	..	X
<i>Geochelone campester?</i> (Hay) .....	..	..	X
<i>Geochelone</i> sp. (large)	X	X	..
<i>Geochelone</i> sp. (small)	X	..	..
<i>Gopherus hexagonata</i> Cope	?	..	X
<i>Trionyx spinifera emoryi</i> (Agassiz) .....	..	X	..
<i>Trionyx spinifera</i> Le Sueur	X	..	..
Crocodylia			
<i>Alligator</i> sp.	X	..	..
Class Aves			
Accipitriformes			
<i>Caracara prelutosa</i> (Howard)	X	..	..
Galliformes			
<i>Agriocharis anza</i> Howard	X	..	..
Class Mammalia			
Carnivora			
<i>Procyon</i> sp.	X	..	..
<i>Canis</i> cf. <i>C. latrans</i> Say	X	..	..
<i>Canis</i> cf. <i>C. lupus</i> Linnaeus	X	..	..
<i>Canis dirus</i> Leidy .....	..	..	X
<i>Canis texanus</i> Troxell .....	..	..	X
<i>Canis</i> sp. ....	..	..	X
<i>Felis</i> cf. <i>F. concolor</i> True	X	..	..
<i>Felis</i> sp. ....	..	X	..
<i>Dinobastis</i> sp.	X	..	..
Rodentia			
<i>Cynomys ludovicianus arizonensis</i> Mearns .....	..	X	..
<i>Ondatra annectens</i> (Brown)	X	..	..
Edentata			
<i>Nothrotherium</i> cf. <i>N. shastense</i> Sinclair	X	..	..

	Gilliland	Holloman	Rock Creek
<i>Megalonyx jeffersoni</i> (Desmarest) .....	..	X	..
<i>Paramylodon harlani</i> (Owen)	X	X	X
<i>Chlamytherium septentrionale</i> (Leidy)	X	..	..
<i>Glyptodon fredericensis</i> (Meade)	X	X	..
<i>Glyptodon</i> sp. ....	..	..	X
Proboscidea			
<i>Stegomastodon</i> cf. <i>S. mirificus</i> (Leidy)	X	X	..
<i>Cuvieronius</i> sp.	X	..	..
<i>Mammuthus imperator haroldcooki</i> Hay	X	X	X
Lagomorpha			
<i>Sylvilagus</i> sp.	X	..	..
Artiodactyla			
<i>Platygonus</i> cf. <i>P. cumberlandensis</i> Gidley	X	..	..
<i>Platygonus</i> sp. ....	..	X	X
<i>Titanotylopus</i> sp.	X	..	..
<i>Camelops hesternus</i> (Leidy) .....	..	..	X
<i>Camelops niobrarensis</i> (Leidy) .....	..	X	..
<i>Camelops</i> sp.	X	X	..
<i>Tanupolama macrocephala</i> (Cope) .....	..	X	X
<i>Tanupolama seymourensis</i> Hibbard and Dalquest ..	X	..	..
<i>Tanupolama</i> cf. <i>T. blancoensis</i> Meade	X	..	..
<i>Odocoileus</i> sp.	X	X	..
Cervid, gen. et sp. indet. ....	..	X	..
<i>Tetrameryx?</i> <i>knoxensis</i> Hibbard and Dalquest ...	X	..	..
<i>Capromeryx</i> sp.	X	..	..
<i>Preptoceras?</i> <i>mayfieldi</i> Troxell .....	..	..	X
Bovid, gen. et sp. indet. ....	..	X	..
Perissodactyla			
<i>Equus giganteus</i> Gidley	X	X	..
<i>Equus scotti</i> Gidley	X	X	X
<i>Equus achates</i> Hay and Cook .....	..	X	..
<i>Equus semiplicatus</i> Cope .....	..	..	X
<i>Equus</i> sp.	X	X	X
<i>Tapirus copei</i> Simpson	X	X	..

The Seymour Formation and its faunas cannot be considered the same age as the Hardeman Alluvial Terrace and its fauna which was assigned a late Kansan age by Frye and Leonard (1963 and 1965). They also reported the presence of Pearlette volcanic ash in the terrace deposits. If this ash occurs in the deposits it is reworked from older beds. We have carefully examined the deposits and can find no exposures of the Pearlette ash. Furthermore the Hardeman Alluvial Terrace on the basis of the vertebrate fauna and C¹⁴ dates (16,775 ± 565 and 19,098 ± 1,047 B.P. years) is Wisconsin in age (Dalquest, 1965).

GILLILAND LOCAL FAUNA

Previous work.—Fossils have been recorded from a number of localities (Brodkorb, 1964a; Hibbard and Dalquest, 1960 and 1962; Melton 1964; and Preston, 1966).

FAUNAL LIST

Class Pelecypoda

Lampsilis ventricosa (Barnes)

Unio merus tetralasmus (Say)

Class Osteichthyes

Ictalurus punctatus (Rafinesque), channel catfish.

Class Reptilia

Order Chelonia

Pseudemys scripta bisornata Cope, pond terrapin.

Terrapene sp., box turtle.

Geochelone sp., large land tortoise.

Geochelone cf. *G. johnstoni* Auffenberg, small land tortoise.

Gopherus sp., large land tortoise.

Trionyx spinifera Le Sueur, softshell turtle.

Order Crocodilia

Alligator sp., alligator.

Class Aves

Order Accipitriformes

Caracara prelutosa (Howard), extinct caracara.

Order Galliformes

Agriocharis anza Howard, Anza turkey.

Class Mammalia

Order Carnivora

Procyon sp., raccoon.

Canis cf. *C. latrans* Say, coyote.

Canis, cf. *lupus* Linnaeus, wolf.

Felis cf. *F. concolor* True, puma.

Dinobastis sp., sabre-toothed cat.

Order Rodentia

Ondatra annectens (Brown), extinct muskrat.

Order Edentata

Nothrotherium cf. *N. shastense* Sinclair, small ground sloth.

Paramylodon harlani (Owen), Harlan ground sloth.

Chlamytherium septentrionale (Leidy), giant armadillo.

Glyptodon fredericensis (Meade), glyptodon.

Order Proboscidea

Stegomastodon cf. *S. mirificus* (Leidy), short-jawed mastodon.

Cuvieronius sp., extinct mastodon.

Mammuthus imperator haroldcooki Hay, imperial mammoth.

Order Lagomorpha

Sylvilagus sp., cottontail rabbit.

Order Artiodactyla

Platygonyx cf. *P. cumberlandensis* Gidley, extinct peccary.

Titanotylopus? sp., giant camel.

Camelops sp., medium-sized camel.

Tanupolama seymourensis Hibbard and Dalquest, Seymour llama.

Tanupolama cf. *T. blancoensis* Meade, extinct llama.

Odocoileus sp., extinct deer.

Capromeryx sp., extinct pronghorn.

Tetrameryx? knoxensis Hibbard and Dalquest, four-horned pronghorn.

Order Perissodactyla

Equus giganteus Gidley, extinct giant horse.

Equus scotti Gidley, Scott horse.

Equus sp., medium-sized extinct horse.

Equus sp., small extinct horse.

Tapirus copei Simpson, Cope tapir.

Paleoecology.—Inferences about the conditions under which the fauna lived can be derived from the sediments containing the fossils, the fossils themselves, and from the habitats of some of the close living relatives of the extinct members of the fauna.

Knox and Baylor counties are situated in the southern part of the Osage Plains at an elevation of approximately 1500 feet. At the time the Seymour Formation was being deposited this area was transversed by a large river system (the ancestral Brazos and its tributaries), which flowed in a broad shallow valley well above the present flood plain of the Brazos River. The large gravels of the Seymour Formation are concentrated residual gravels of Mesozoic and Cenozoic origin that occurred on the surface east of the High Plains escarpment. The ancestral stream was not mountain fed. The region to the northeast was a flat rolling savanna with the Red River and its tributaries flowing at approximately 125 to 150 feet above their present channels. This is clearly shown by the stream deposits at the Holloman gravel pit north of Frederick, Oklahoma.

This Permian red plains area was assigned by Blair and Hubbell (1938) to the Mesquite Plains biotic district. Blair (1950 and 1954) gives a good

description of the vegetation and associated mammals of the mesquite Plains biotic district of Texas and Oklahoma.

We were unable to recover identifiable remains of fossil vegetation from the exposures of the Seymour Formation. Some remains of fossil plants were found but they were not well enough preserved for identification. Pollen was not found in the silt and clay below the Pearlette ash. A knowledge of the fossil flora would contribute greatly to the interpretation of the climate at the time the fauna lived.

Only two pelecypods were recovered with the vertebrate fauna.

Parts of channel catfish recovered indicate a fair-sized and permanent tributary stream.

Remains of five genera of turtles were taken. The genera *Pseudemys*, *Terrapene*, and *Trionyx* occur in the area at the present time. The presence of *Trionyx* indicates permanent water in the stream.

Associated with these in the fauna was a large *Gopherus*, larger than the Recent *G. flavomarginatus* of Mexico, and two species of the tortoise, *Geochelone*. One was a small species, much smaller than *Gopherus*, and the other a large species that reached a length of 6 feet. These land tortoises were herbivorous reptiles. The large *Geochelone* did not live in burrows nor did we find any evidence that the large *Gopherus* entered burrows. Hibbard (1960) summarized the literature on the habits of *Gopherus* and *Geochelone*. Since the specimens of the large fossil *Geochelone* are as large or larger than those found living on the Galapagos Islands, it is essential to quote from Townsend (1931), who gives an account of the giant tortoises brought from the Galapagos Islands in 1928 and located in small colonies at several points near the southern boundary of the United States. Townsend stated (p. 461) that "Climatic conditions at Riverside (California) are apparently more favorable than at San Diego, located on the coast in the same state and frequently exposed to chilly sea winds and at times frosty weather. Post-mortem examinations show that the losses here were from enteritis, the well-fed tortoises failing to seek shelter after the day's grazing, were too cold at night for digestion to proceed."

Hendrickson (1965) has published some very important observations on the large Galapagos tortoise and observed that these large turtles use pools of water where they float which allows rapid, deep breathing which they could not accomplish on land. This habit may account for the presence of five large *Geochelone* shells observed this past summer in a small area at the same stratigraphic level in the Rexroad Formation. The deposit was of slack water origin and all shells were upright and appeared as though the turtles had been buried where they had died.

At the time these turtles lived in this part of Texas, it can be assumed that the region was frost free, with a maritime climate, and lacked the strong continentality of the climate observed in that region at present.

The presence of the alligator in the fauna indicates that there was more vegetation along the streams of that region than now. Vegetation is required for the construction of the nest (Kellogg, 1929, and Reese, 1915).

The importance of cold-blooded reptiles in faunas was summarized by Auffenberg and Milstead (1965) when they stated: "However, the fact that reptiles are more restricted ecologically suggests that they will be found to play an exceedingly important role in Quaternary paleoecological studies. This importance is just starting to be realized."

If the Stump Arroyo sand and gravel of Meade County, Kansas, which contains the remains of *Nannippus* and *Plesippus* are Kansan in age, as has been considered in the past, then that part of the Seymour Formation below the horizon of the Vera faunule (Cudahy fauna) and Pearlette ash would have been deposited nearer the time of the retreat of Kansan ice, and the fauna living at that time may have had the advantage of a more moist and cloudy condition that would have produced a subhumid, subtropical, and frost-free climate in that part of Texas.

Remains of only two fossil birds were found. The specimen of *Caracara prelutosa* (Howard) is slightly smaller than those of the Recent caracara that ranges into Texas.

The remains of the turkey, *Agriocharis anza* Howard, is closely related to the Recent ocellated turkey (*Agriocharis ocellata* Cuvier). The present range of the Recent species is the Yucatán Peninsula and adjacent parts of Tabasco, Petén and British Honduras, as given by Paynter (1955, p. 84). He gives the habitat of the recent species as, "Open deciduous forest savannas, *milpas*, and other clearings; absent from the interior of dense rain forest, but present on the edges."

The fact that the fossil turkey is related to the ocellated turkey and not to *Meleagris gallopavo* (the Recent wild turkey of Texas, and other areas of the United States and Mexico) has a direct bearing on the associated fauna and the environment in which it lived.

Close relatives of the Recent ocellated turkey are known from the High Plains region during the Upper Pliocene and early Pleistocene. *Agriocharis progenes* Brodkorb (1964b) occurs in the Upper Pliocene Rexroad local fauna of southwestern Kansas. *Agriocharis leopoldi* (Miller and Bowman) occurs with the Cita Canyon local fauna of Aftonian age from Randall County, Texas, (Johnston and Savage, 1955; and Brodkorb, 1964a).

Wetmore (1944) and Howard (1963) consider that the turkeys represent birds of wooded and brushy areas.

It appears that these southern members were slowly displaced southward by the progressively cooler climates produced by each successive glaciation. The more northern turkey, *Meleagris gallopavo*, was able to extend its range southward with the development of the strong continentality of the climate during Wisconsin time.

The mammalian fauna is represented by 7 orders, 22 genera, and 17 probable species. This is a more diversified mammalian fauna than is known to have occurred in the area in Recent times. Only one genus and species of the Order Rodentia is known from the fossil fauna. The rodents make up the dominant fauna of the area at the present. Of the material recovered only parts of three skeletons were found. The two glyptodon skeletons had been badly damaged by the roots of mesquite trees and some erosion. Most of the fossils had been moved by the stream at the time of burial, which indicates that most of the specimens neither died in nor were trapped in the place where they were deposited.

The fossil mammals are grouped below in communities based on their adaptive characters and on the known habitats of living species of genera represented in the fauna. The forms are assigned to the community in which they have been considered to have spent most of their time.

Stream community.—Only three fossils recovered are confined entirely to this community. These are the mollusks *Lampsilis* and *Uniomerus*, and the channel catfish, *Ictalurus punctatus*. The pond terrapin, *Pseudemys scripta bisornata*, the softshell turtle, *Trionyx spinifer*, and the alligator spent much of their time in the stream but also encroached upon the Semi-aquatic or Stream-bank community, and the Savanna Valley community for egg laying.

Semiaquatic community.—The aquatic turtles and the alligators would use the stream bank for basking in the sun. The muskrat, *Ondatra*, would also use it for the construction of dens, as well as the Stream community. The great breadth of the valley indicates a braided stream. Such a condition would provide ox-bow lakes and marshes which would be used by *Ondatra* and *Pseudemys*. The raccoon, *Procyon*, would frequent the edges of the stream and marshes, and den in the forested community.

Forest community.—It is safe to assume that in areas along the stream bank, and the lowlands of the valley floor, there was an extensively developed gallery forest in which *Cuvieronius* and the deer browsed. The giant armadillo, *Chlamytherium*, probably spent most of its time rooting through

the litter of the forest floor. Along the edge of this woodland one would expect to find *Paramylodon*, and the tapir in the Forest community, and the brushy areas and clumps of trees of the Savanna community. The turkeys could have roosted here or in the clumps of trees present throughout the savanna. This community was also visited by the puma, *Dinobastis*, and by some members of the Savanna and Valley slope communities.

Savanna Valley community.—This large community extended from the Forest community or Semiaquatic community to the Upland community. It includes the Meadow and Marsh community, and the Valley slope community. The large percentage of the fauna is considered to have lived in the broad savanna region bordering the Stream and Forest communities. There is no evidence of steep or abrupt valley walls at the time the fauna lived in that region.

The large herbivores were found in this community. All of the evidence indicates the abundance of tall grasses. In this community lived the giant *Geochelone*, *Caracara* which fed on the carcasses of dead animals, *Nothrotherium* in part, *Paramylodon* (a large sloth), *Glyptodon*, *Stegomastodon*, and *Mammuthus*. The cottontail rabbit would be found on the valley floor and slopes.

Platygonus, the peccary, would be expected to range throughout the Savanna community and possibly into the Upland community. The deer would certainly range throughout this area from brush-covered areas to the scattered clumps of trees. The large *Gopherus* tortoise may have lived in the brushy areas and in the clumps of trees scattered over the savanna. The giant horse and the Scott horse are considered members of this community.

The habitat of the giant camel is unknown but it may have been an inhabitant of the broad valley. Because of the extreme hypsodont condition of the teeth of *Tanupolama seymourensis*, it may have lived chiefly in the savanna with *Tetrameryx*.

Upland community.—There was no marked upland region in the area. On the higher ridges and hills, also along the divide areas that were better drained, one would expect a mixed grass area where *Terrapene*, *Camelops*, *Capromeryx*, the coyote, the wolf, and the smaller species of the horses spent much of their time. It is not possible to suggest ecological relationships for all extinct forms.

Although many genera have been provisionally assigned to communities, it is known that they all had one common meeting place, which was the water hole, where some of the young fell prey to the large carnivores or drowned, and the old and sick came to die. The coyotes and wolves are

assigned to an Upland community. They certainly roamed throughout the region as did the puma.

Climate

The region under consideration is located in the southern part of the Osage Plains section of the Central Lowland physiographic province. It is also situated in the Mesquite Plains or Mesquite Savanna biotic province. The area between Benjamin and Seymour, Texas, varies in elevation from approximately 1500 to 1300 feet. The climatic records for the area are from Seymour (elevation 1,291 feet), 32 miles east of Benjamin: mean annual precipitation for 39 years (prior to 1953), 25.58 inches; based on 32 years prior to 1953, mean annual temperature 63.5 degrees F.; maximum, 120 degrees F.; minimum, —14 degrees F.

It is evident that the large *Geochelone* could not have lived in such extreme winter temperatures. These large tortoises indicate that winter temperatures did not drop to freezing.

The abundance of the large grazers in the fauna indicate the presence of tall grasses in the valleys. The presence of the browsers indicates the occurrence of shrubs and good stands of small trees.

The present vegetation in the region where the fossils were found could not support the large fauna that lived during Kansan time. For the development of tall grasses it is suggested that the region received at least 30 inches of rainfall. Under a more uniform climate the moisture would be more effective. The climate at the time the Gilliland local fauna lived is considered to have been mesothermal, subhumid, and of the maritime type.

Vertebrate faunas of the earlier Pleistocene that contain the giant land tortoise, clearly indicate that considerable work is needed to furnish more data for a better understanding of Pleistocene climates. The fossil record shows that the large land tortoises existed in Florida until Wisconsin time (Auffenberg and Milstead, 1965).

SYSTEMATIC DISCUSSION

Each member of the vertebrate fauna is noted. Catalogue numbers not otherwise identified are those of the University of Michigan Museum of Paleontology. Names of other collections are abbreviated as follows: MU, Midwestern University; UMMZ, University of Michigan Museum of Zoology.

The Gilliland local fauna consists of the remains of animals taken from the sand and gravel and the overlying red sandy silt and red clay

of the Seymour Formation that are stratigraphically below the Pearlette ash and below the gray silts which contain the Vera local faunule of late Kansan age.

Phylum MOLLUSCA

Mollusks are rare in the Seymour Formation below the horizon of the Vera local faunule but we recovered a specimen of *Lampsilis ventricosa* (Barnes), UMMZ 208243, from sandy silt, 3 miles northwest of Vera, Knox County, Texas.

A specimen of *Uniomerus tetralasmus* (Say), UMMZ 208244, was taken from the sand of the Seymour Formation on the Burnett ranch east of Farm Road 267 along the north valley wall of the South Wichita River. These specimens were identified by Henry van der Schalie.

Phylum VERTEBRATA

Class OSTEICHTHYES

Family Ictaluridae

Ictalurus punctatus (Rafinesque)

Part of a pectoral spine (No. 45858); a fragment of the weberian apparatus (No. 45859), and part of a right lower jaw (No. 45860) of the channel catfish were taken on the Burnett ranch from fine sand and sandy silt.

Class REPTILIA

Order CHELONIA

The pond and river turtles have been studied by Preston (1966).

Family Testudinidae

Pseudemys scripta bisornata Cope

(Fig. 3B)

Pseudemys remains are common. The posterior one-half of the plastron (No. 46748, Fig. 3B) has a width of 158.0 mm, and an anteroposterior length of 128.0 mm. It was recovered 6 miles southeast of Gilliland. A specimen (MU 4546) lacking the right posterior quarter of the shell had a carapace approximately 225.0 mm long.

Terrapene sp.

Part of a box turtle, a nuchal (No. 46757) was found $3\frac{1}{4}$ miles south of Gilliland.

Geochelone sp. (large)

The remains of the giant land tortoise (*Geochelone*) occur throughout the exposures of the Seymour sand and gravel. We collected parts of 4 asso-

ciated carapaces and plastrons. Specimen No. 34825 was found 2 miles north of Vera. The plastron (No. 40601) of a specimen that reached a length of 6 feet was recovered $3\frac{1}{2}$ miles south of Gilliland. The parts recovered of specimen No. 47098, 5 miles south of Gilliland are as large as those of specimen No. 40601. A large specimen (MU 3013) in the Midwestern University collection has not yet been prepared.

The present range of the giant land tortoises is confined to regions that are frost free. It can only be assumed that at the time they lived in this part of Texas the winter temperatures were above freezing (Hibbard, 1960).

Geochelone cf. *G. johnstoni* Auffenberg

The anterior part of a small carapace (No. 46787) belonging to the Turgida series (Auffenberg and Milstead, 1965) was taken 6 miles west of Vera, on the ranch of Bruce Burnett.

Gopherus sp. (large)

Remains of a large *Gopherus* tortoise were the most common turtle elements recovered from the Seymour Formation.

A complete plastron (No. 41509) is 520.0 mm in length. A complete anterior part of a carapace and plastron (No. 41508) was taken on the Bruce Burnett ranch. This is probably the same species as *Gopherus hexagonata* (Cope) from the Rock Creek local fauna.

Family Trionychidae

Trionyx spinifera Le Sueur

(Fig. 3A)

Several parts of softshell turtles were recovered. A complete left hypoplastron (No. 39371, Fig. 3A) was taken on the Bruce Burnett ranch. The width along the hypoplastron-hyoplastron suture is 118.5 mm.

Order Crocodylia

Family Crocodylidae

Alligator sp.

Two dermal scutes, part of a third scute, and a fragment from a skull (No. 46453) were taken north of the O. L. Patterson ranch house from a bluish yellow sandy clay, 18 inches above the Seymour sand and gravel. Two dermal scutes (No. 46455) were found 2 miles north of Vera.

Remarks.—The dermal scutes were from fair-sized alligators indicating a stream larger than the present South Fork of the Wichita. The presence of the alligator also indicates conditions more equable at the time it lived

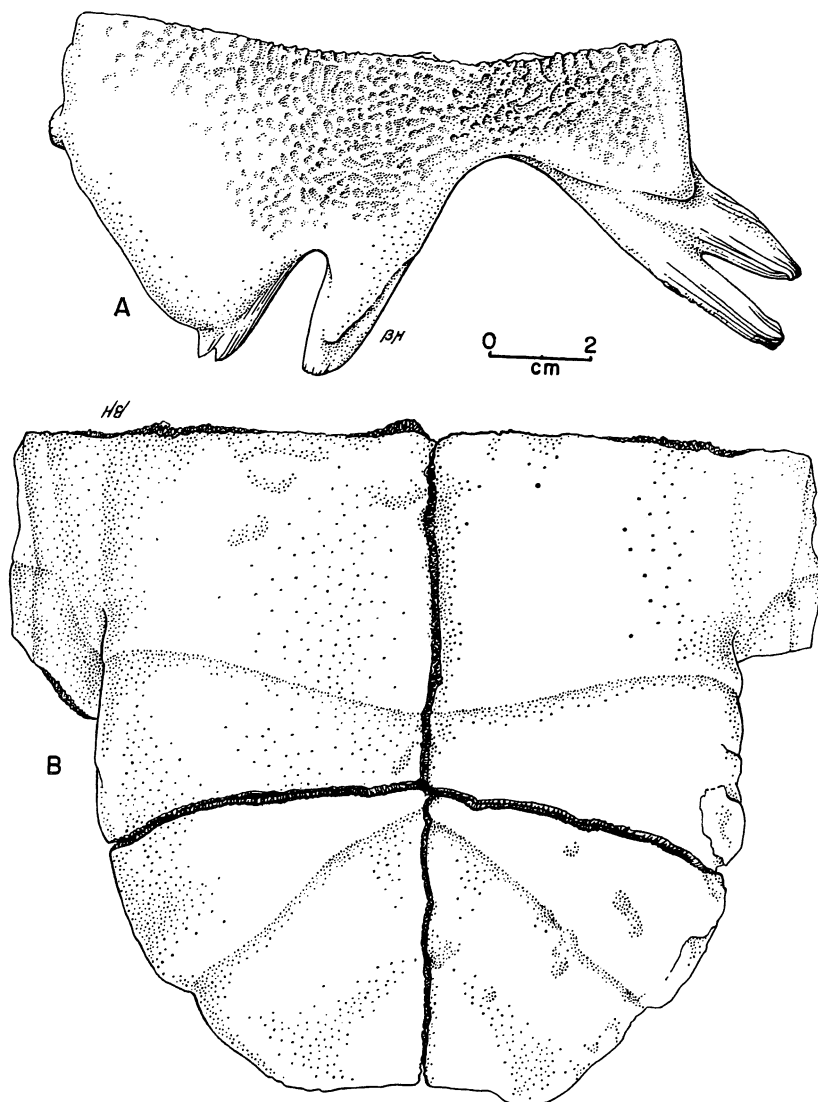


FIG. 3. Parts of fossil turtles. A, *Trionyx spinifera* Le Sueur, left hypoplastron, No. 39371. B, *Pseudemys scripta bisornata* Cope, posterior one-half of the plastron (No. 46748).

there than now and that there was more moisture in the region than occurs there today, since considerable lush vegetation is needed to construct the nest for the laying of eggs (Reese, 1915, p. 21).

Class AVES

Order ACCIPITRIFORMES

Family Falconidae

Caracara prelutosa (Howard)

The distal end of a tarsometatarsus (No. 39356) of a caracara was taken 6 miles southeast of Gilliland, April 4, 1957. The specimen was identified and reported by Brodkorb (1964a, p. 292).

Order GALLIFORMES

Family Phasianidae

Agriocharis anza Howard

Part of a right femur (No. 39387) of an ocellated turkey was taken from the sand of the Seymour Formation, 4 miles south and 1/2 mile east of Gilliland. This specimen was identified and reported by Brodkorb (1964a, p. 324; 1964b, p. 227).

Class MAMMALIA

Order CARNIVORA

Family Procyonidae

Procyon sp.

The distal end of a left humerus (No. 46473) of an adult raccoon the size of a large *Procyon lotor* Linnaeus was taken along the south valley wall of the South Wichita River on the Bruce Burnett ranch between the power line and Farm Road 267. The bone occurred in red silty sand below the horizon of the Pearlette ash. The greatest width across the proximal end of the humerus is 26.0 mm.

Family Canidae

Canis cf. *C. latrans* Say

A metacarpal (No. 46464) the size of the same bone of the Recent coyote, *Canis latrans*, was taken from the Seymour sand and gravel on the Bruce Burnett ranch.

Canis cf. *C. lupus* Linnaeus

A right parietal (No. 46460), an upper canine (No. 46479), and the anterior part of a skull (No. 46483) of a canid the size of the gray wolf were found on April 21, 1956, and during the fall of 1959, on the Bruce Burnett ranch. These specimens came from the red sandy silts just above the sand and gravel.

The anterior part of the skull consists of the premaxillaries, part of the maxillaries, and associated parts of the lower jaws. The upper and lower incisors and canines are present as well as the right and left P¹ and P², left P₁ and P₂, and the right P₁ and P₄. The distance from the posterior edge of the right canine to the posterior edge of P₄ is 60.5 mm.

Family Felidae

Felis cf. *F. concolor* True

A left femur (No. 46371) of a cat the size of the puma was taken from the Seymour sand and gravel on the Burnett ranch. The femur differs slightly from the Recent ones with which it was compared. These differences are: (1) the shaft is slightly curved; (2) the lesser trochanter is better developed; and (3) the area bounded by the lesser trochanter and the posterior intertrochanteric line is broader than in the Recent femurs. The length of the femur is 302.0 mm.

Dinobastis sp.

A nearly complete right upper canine (MU 3240) was found. The tip of the crown and also the end of the root are lacking. The length of the tooth would have been approximately 130.0 mm. The lingual side of the tooth is more flattened than the labial side. The crown of the tooth consists of slightly more than one-half of its length. This is in contrast to *Smilodon*, where about two-fifths of the total length of the tooth makes up the root (Merriam and Stock, 1932; and Meade, 1961).

The enamel extends slightly higher on the labial side of the crown than on the lingual side. The enamel appears to have extended to the border of the alveolus. The development of the enamel on the crown is more complete than in specimens of *Smilodon*. Both the anterior and posterior edges of the canine are serrated from the tip to the alveolar border. The anterior serrated edge turns inward at the base of the crown.

Specimen, MU 2027, is the tip of a deciduous right upper canine, or from a permanent tooth of a young adult animal. It is serrated to the tip and flattened on the lingual side.

This canine is distinct from the canine of *Smilodon*. The early Pleistocene sabre-toothed cats of North America are poorly known.

Order RODENTIA

Family Cricetidae

Ondatra annectens (Brown)

(Fig. 4B-E)

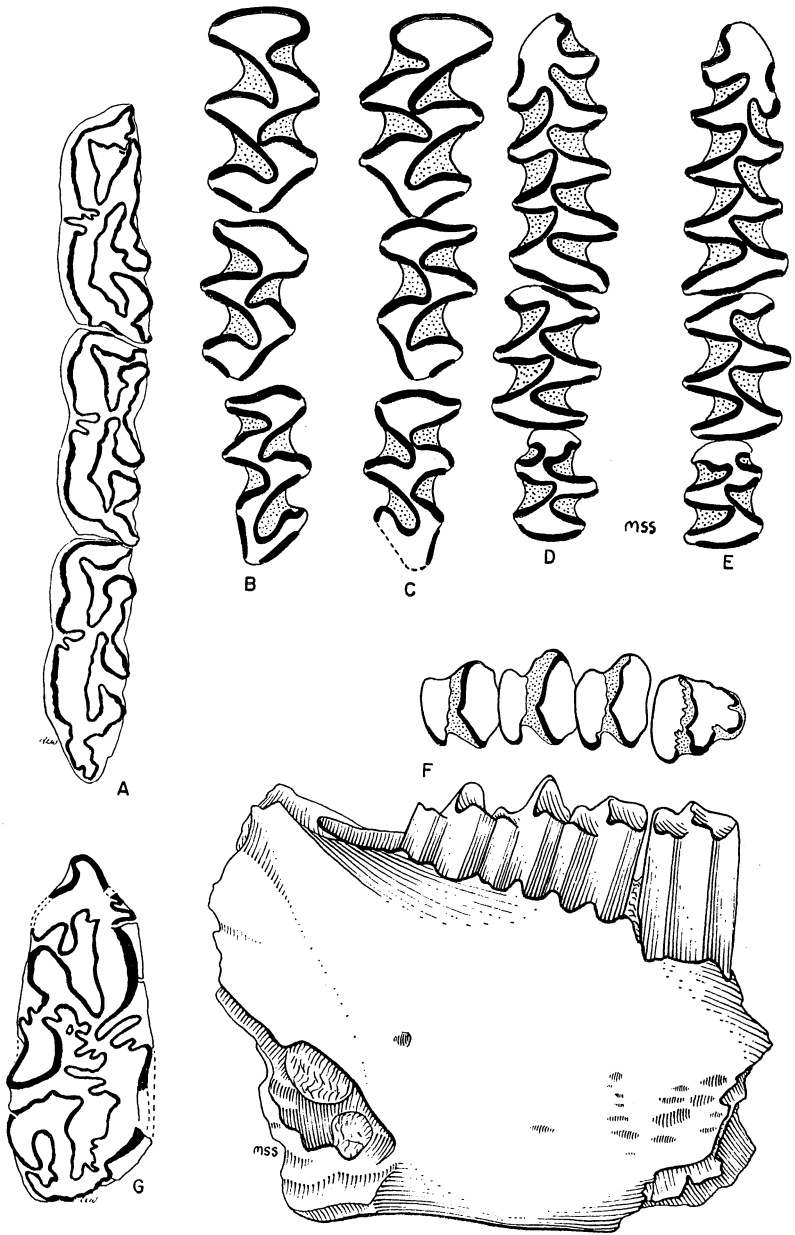


FIG. 4. Fossils from the Gilliland local fauna. A, *Equus scotti* Gidley, left deciduous premolars (DP₂ - DP₄, No. 39380), $\times 0.75$. B-E, *Ondatra annectens* (Brown), No. 46174, occlusal views of left and right upper molars (B and C) and lower molars (D and E), $\times 6$. F, *Sylvilagus* cf. *S. floridanus* (Allen), No. 52884, right jaw, P₃ - M₂, labial and occlusal views, $\times 6$. G, *Equus* ref. *E. giganteus* Gidley, No. 31356, left P₂, occlusal view, $\times 0.75$.

Part of a skeleton, including the skull and lower jaws (No. 46174) of a small muskrat was found approximately $3\frac{1}{2}$ miles south of Gilliland, Texas.

The partial skeleton was recovered from the stream deposited red sandy silt near the locality where the glyptodon tail and vertebrae (No. 34826) were taken. The skeleton is that of an old adult muskrat, and a few of the bones are complete enough for measurements. The greatest length of the tibia-fibula is 41.9; the femur, 35.5; the ulna, 33.5, and the humerus, 27.0 millimeters. The skull is badly fractured. The transverse width of the upper incisor is 2.4 mm. The occlusal length of M^1 — M^3 is 11.0 mm. (Fig. 4B), and the occlusal length of M_1 — M_3 is 11.1 mm. (Figs. 4D and E).

In *Ondatra annectens* the humerus length is approximately 76 per cent of the length of the femur. In two skeletons of the Recent *O. zibethica* the humeri were found to be 78 per cent and 78.7 per cent of the length of the femurs. The shaft of the femur of *O. annectens* is not as broad, or the anterior surface as flat in proportion to its length, as in Recent *O. zibethica*. It may not have been as good a swimmer as the Recent muskrat.

Order Edentata

Family Megalonychidae

Nothrotherium cf. *N. shastense* Sinclair

(Fig. 5A; Pl. II, Figs. 1, 2)

The genus *Nothrotherium*, a small ground sloth, is known from the Pleistocene of South and North America. In southwestern North America it is known from deposits from the late Kansan to late Wisconsin in age.

An ungual phalanx of the manus (No. 33518) and part of a left lower jaw with two teeth (No. 33521, Fig. 5A) were recovered $3\frac{1}{4}$ miles south of Gilliland. An isolated tooth (No. 46565) and a thoracic vertebra (No. 46568) were recovered in 1957, from the same area as the lower jaw and the ungual phalanx. The posterior part of a skull (No. 46566, Plate II, Figs. 1 and 2) and an atlas (No. 46569) were taken 6 miles southeast of Gilliland from the Seymour sand and gravel.

The exact age of the skull of *Nothrotherium* reported from Pleistocene deposits in Wheeler County, Texas, by Hay (1916) is unknown. The remains recovered from the sand and gravel of the Seymour Formation are parts of at least 3 individuals and may represent the earliest known occurrence of this sloth in North America.

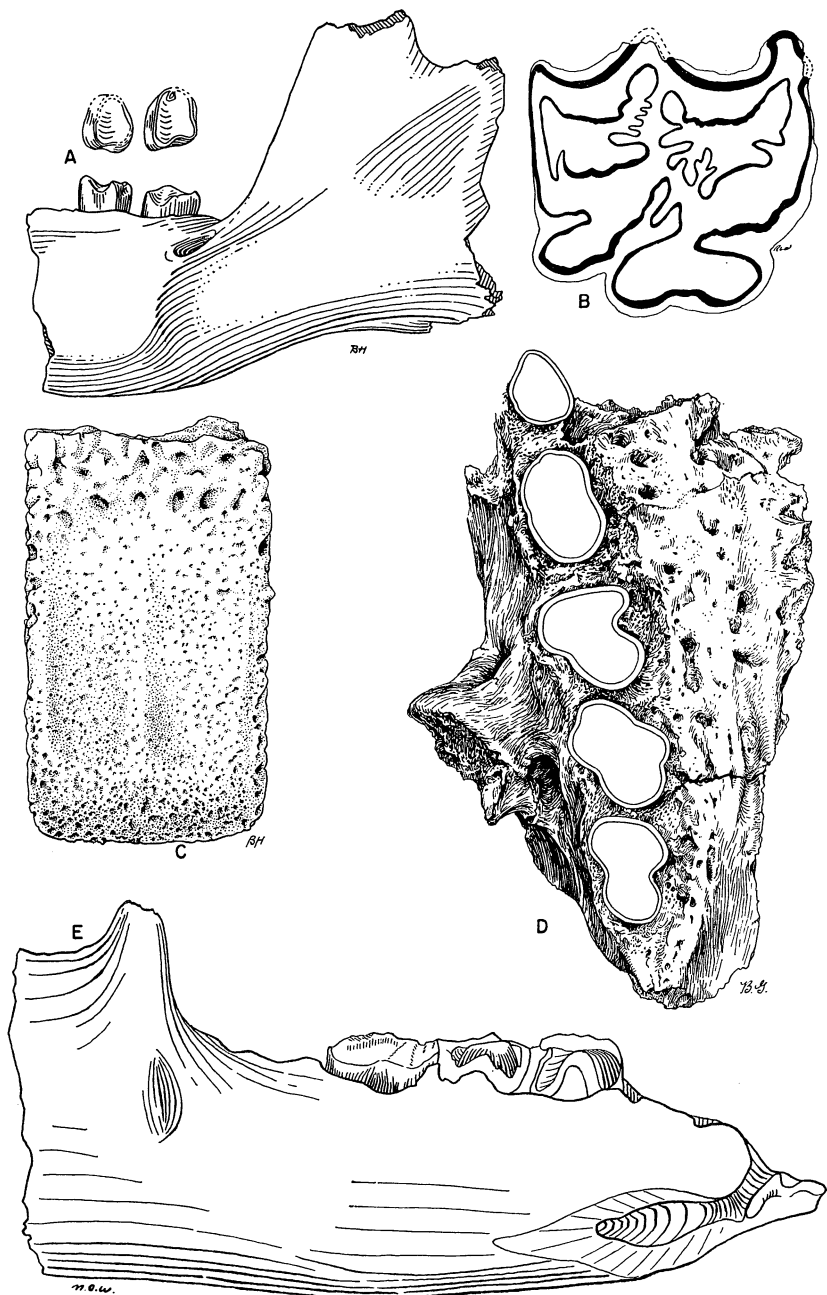


FIG. 5. Fossils from the Gilliland local fauna. A, *Nothrotherium* cf. *N. shastense* Sinclair, part of left jaw, No. 33521, with the last two molars, occlusal and labial views, $\times \frac{1}{2}$. B, *Equus giganteus* Gidley, RP⁴?, No. 46584, crown view, 26.0 mm below occlusal surface, $\times 1$. C, *Chlamytherium septentrionale* (Leidy), part of lumbar scute, No. 46456, dorsal surface, $\times 1$. D, *Paramylodon harlani* (Owen), part of right maxillary, ventral view, $\times \frac{1}{2}$. E, *Tapirus copei* Simpson, part of right jaw, No. 33523, labial view, $\times \frac{1}{2}$.

The skull is so broken that it is impossible to compare its measurements with those given by Hay (1916) and Stock (1925). The pterygoid bullae are large (Plate II, Fig. 2). Width measured across the posterior ends of the zygomatic processes of the squamosals (opposite the ear openings) is 118.0 mm.

The lower jaw is broken just posterior to the anterior alveolar border of the first molar. The depth of the lower jaw anterior to the second molar is 50.0 mm. The least height of the lower jaw posterior to the last (third molar) is 38.5 mm. The greatest width of the atlas is 128.5 mm.

The specimens from the Seymour Formation appear to be slightly smaller than those previously reported from the Pleistocene of the United States.

The fauna found associated with this sloth indicates that the region at the time it lived, was not as arid as that around Rampart Cave at the time *Nothrotherium shastense* inhabited that cave in late Wisconsin time (Martin, *et al.*, 1961).

Family Mylodontidae

Paramylodon harlani (Owen)

(Fig. 5D; Plate III)

Remains of *Paramylodon*, a large ground sloth, were found throughout the region where exposures of the Seymour Formation occur. Most of the specimens were surface finds that had weathered from the Seymour sand and gravel or from the overlying red sandy silt.

In an area $3\frac{1}{4}$ miles south of Gilliland, 10 skeletal elements were found. Three tibiae (Nos. 33511, 33512 and 46571) taken in this area are of different sizes and are parts of 3 individuals. Associated with the tibiae were 2 astragali (Nos. 33513 and 46832); a calcaneum (No. 33514); the first and second phalanxes (Nos. 33516 and 33519); an ungula (No. 33517); a vertebra (No. 33522); and the back part of the skull of a young individual (No. 46567).

On the O. L. Patterson ranch part of a left lower jaw (No. 46562), vertebra (No. 44703), and 2 foot bones (Nos. 44712 and 46573) were taken.

In an area covering over 3100 acres on the Bruce Burnett ranch the following were taken: 2 teeth (Nos. 46348 and 46359), part of a maxillary (No. 46564, Fig. 5D), 2 toe bones (Nos. 44713 and 46574), a left tibia (No. 46570), part of an ulna (No. 46572), a right nasal (No. 44711), a vertebra (No. 46578), and the front end of a skull (No. 44710).

Fragments of very large associated lower jaws without teeth (No.

46561), 2 teeth (Nos. 46563 and 46461), and a humerus (No. 46575, Plate III) were recovered 2 miles north of Vera.

Part of a skeleton was recovered from the J. O. Robinson ranch $2\frac{1}{2}$ miles northwest of Red Springs, Baylor County. An oil company had "bulldozed" a road across an arroyo some years ago, uncovering in part what may have been a nearly complete skeleton (No. 35720). Twenty-six foot bones were recovered with the 2 tibiae, a fibula, the 2 astragali, a few fragments of vertebrae and the lower jaws. The greatest length of the lower jaws from the tip of the symphysis to the posterior edge of the condyle is 370.0 mm. The depth of the jaw measured between the third and fourth teeth is 75.6 mm. The depth of the fragmentary jaw (No. 46561) measured at the same place, is 98.5 mm. The great range in size is probably due to sexual variation.

Family Dasypodidae

Chlamytherium septentrionale (Leidy)

(Fig. 5C)

Part of one of the large rectangular scutes (No. 46456) from the lumbar region of a giant armadillo was recovered 2 miles northwest of Vera, in Knox County, from the Seymour sand and gravel. The scute is 32.0 mm. wide (Fig. 5C).

So far as known this is the earliest record of this large armadillo for North America. James (1957) gives a good description of a nearly complete specimen recovered in Harris County, Texas, from late Pleistocene deposits. He also gives a map showing the localities from which *Chlamytherium* had been recovered in the United States.

Family Glyptodontidae

Glyptodon fredericensis (Meade)

Melton (1964) reported on the specimens of *Glyptodon* recovered from the Seymour sand and gravel and the overlying red sandy silts. He estimated that parts of 80 individual carapaces had been collected in an area of more than 130 square miles. One is referred to his paper and to Ray (1965) for a detailed description of the material. The *Glyptodon* was a large, clumsy grazer that reached a length of 8 to 10 feet. It possessed a thick bony carapace, and weighed about 600 to 800 pounds.

The type of the species was taken from the Holloman gravel pit. The *Glyptodon* reported by Troxell (*vide* Hay, 1924, p. 239) from the Rock Creek local fauna is probably of the same species. It is interesting to note that 4 South American edentates occur in the Gilliland local fauna.

Order PROBOSCIDEA

Family Gomphotheriidae

Stegomastodon cf. *S. mirificus* (Leidy)

Stegomastodon priestleyi Hay and Cook, 1930

A greatly worn M_3 (No. 46632) and part of a molar (No. 46631) of a young individual of the short-jawed mastodon were taken 6 miles south-east of Gilliland.

Part of a molar (No. 33532) of an adult was found $3\frac{1}{4}$ miles south of Gilliland. A fragment of a left lower jaw with part of the third molar was recovered on the Bruce Burnett ranch.

Hay and Cook (1930) described *Gomphotherium priestleyi* from the Holloman gravel pit, which is north of Frederick, Tillman County, Oklahoma. Both Osborn (1936, p. 684) and Meade (1953) considered the type (a fragmentary tooth) as belonging to the genus *Stegomastodon*.

The occurrence of *Stegomastodon* in association with *Mammuthus* in the Holloman gravel pit is quite significant since this deposit is the same age as the Seymour Formation in which we find *Stegomastodon* associated with *Mammuthus*. The Holloman Alluvial Terrace of Sellards (1932, p. 788) is the same age as the Seymour Alluvial Terrace of Stricklin (1961). These terraces should not be confused with the Hardeman Alluvial Terrace of Frye and Leonard (1963), which they assigned to a Kansan age.

In so far as known these are the only two records of the occurrence of these two proboscideans in the same fauna. *Mammuthus* rapidly displaced *Stegomastodon*, which was chiefly a grazer and semibrowser. *Mammut* and *Cuvieronius* were better adapted to browsing than was *Stegomastodon* and it appears that the chief habitat of *Stegomastodon* was taken over by *Mammuthus*.

Cuvieronius sp.

(Pl. IV, Fig. 1)

A pair of lower jaws referable to *Cuvieronius*, an extinct mastodon, were found many years ago by Donald Hall and associates of Benjamin, Texas, on the north side of the South Fork of the Wichita River, in cemented sand and gravel of the Seymour Formation, on the Bruce Burnett ranch. The jaws and teeth were broken during their removal from the cemented layer. The specimen was then divided among the individuals and has since become lost, except for part of a LM_3 (No. 46630, Plate IV, Fig. 1). This specimen was donated by Donald Hall. Width across the posterior loph is 75.5 mm.

The tip of a tusk (No. 46633) was recovered January 15, 1956, 3 miles southeast of Gilliland from a cemented zone near the base of the Seymour Formation. The piece of tusk is 12 inches in length. There is no evidence of enamel. It is flattened and oval in cross section and unlike the tusk of *Stegomastodon* or *Mammuthus*. This part of a tusk is questionably referred to *Cuvieronius*.

The occurrence of another genus of mastodon, other than *Stegomastodon*, in the plains area in deposits of Kansan age was recorded by Hibbard (1944, Pl. 2, Fig. 1). This specimen was reported as *Stegomastodon mirificus* (Leidy). It has long been known that it was not *Stegomastodon*, but the tooth is in a private collection and has never been placed in a scientific institution where it can be studied. The tooth is an LM³. It consists of 4½ lophs. Its greatest width across the first loph is 97.0 mm. The antero-posterior length of the tooth is 194.5 mm. The tooth was recovered from a sand and gravel pit in SW¼ Sec. 20, T. 30 S., R. 23 W., Clark County, Kansas. The gravel pit was developed in the Crooked Creek sand and gravel of Kansan age. This deposit is older than the Seymour Formation. Taken from this gravel pit were parts of a *Nannippus* upper molar or premolar (No. 31805) and part of a right lower jaw (No. 31340) of a zebrine horse with P₂ - M₃.

The type specimen of *Nannippus cragini* Hay was taken from the Crooked Creek sand and gravel approximately 1 mile southwest of this sand and gravel pit (Hibbard, 1956, p. 158).

Family Elephantidae

Mammuthus imperator haroldcooki Hay

(Plate IV, Fig. 2)

Elephas (Euelephas) imperator Leidy, 1858.

Elephas haroldcooki Hay, 1928.

Elephas haroldcooki Hay, Hay and Cook, 1930.

Elephas columbi Falconer, Hay and Cook, 1930.

Mammuthus haroldcooki (Hay), Hibbard, 1953.

Part of a third molar (No. 33525) and an M₁ (No. 46625), of the Imperial Mammoth were collected 3¼ miles south of Gilliland. We recovered a third molar (No. 46627) with 14 enamel ridge plates, 4 miles south of Gilliland, and part of a third molar (No. 46626) 5 miles southeast of Gilliland. Part of the lower jaws (No. 34353) with a nearly complete RM₁, part of the LM₁; and part of a left lower jaw (No. 46629) with M₁? were taken on the Bruce Burnett ranch west of Vera. Part of a third molar (No. 46628) was taken 3 miles west of Vera. A lower third molar (No. 33769) with 14 ridge plates was recovered from the north val-

ley wall of the South Fork of the Wichita River, approximately $5\frac{1}{2}$ miles north of Vera. A skull with a tusk and associated fibula (No. 46641) of a young adult were found one mile north of Vera. The palate with the two M's is figured (Plate IV, Fig 2). All of these specimens were recovered from the sand and gravel of the Seymour Formation.

No complete upper or lower third molars were recovered. It is evident that more than 14 enamel ridge plates were included in the teeth. The thickness of the enamel varies from 2.5 to 3.5 mm.

The lower jaw (No. 34353) has a prolongation of the symphyseal rostrum as in Figure 903 (Osborn, 1942, p. 1014). Unfortunately, the tip is broken. The prolongation is heavier, longer, and more downwardly directed than that of specimens of *Mammuthus jeffersoni* in the University of Michigan collection.

From a study of the series of teeth from the Seymour Formation of Knox County it is evident that these specimens from below the Pearlette ash are the same as the type of *M. haroldcooki* from the Holloman gravel pit of Oklahoma, and the same as the specimen described by Hibbard (1953) which was associated with the impure Pearlette ash in Seward County, Kansas. The unerupted third molar (No. 29070) from Seward County, Kansas, has 16 enamel ridge plates.

Remarks.—We are unable to separate these specimens from the large number of species and subspecies assigned to the *Mammuthus imperator* group. The specimen of *Elephas columbi* Falconer, reported by Hay and Cook (1928) from the Holloman gravel pit was questioned by Dalquest (1957) as being a member of that fauna. The mammoth reported from the Rock Creek local fauna is also considered to be the same species. It is preferable to assign this southern population from below the Pearlette ash to *Mammuthus imperator haroldcooki* Hay, until this group of mammoths have been completely restudied.

We know of no earlier records of *Mammuthus* from the Plains region. *Mammuthus* has not been recovered with early Pleistocene local faunas, such as, the Blanco and Cita Canyon of Texas; the Dixon, Deer Park, Sanders and Seger gravel pit of Kansas; and the Broadwater-Lisco and the Sand Draw of Nebraska. No mammoths are known from the Grand View local fauna of Idaho, which occurs in the upper part of the Glens Ferry Formation (Malde and Powers, 1962). So far in North America no mammoth remains have been found in late Blancan faunas.

There are two potassium-argon dates on deposits that contain remains of *Mammuthus*. Evernden *et al.* (1964) reported a date of 1,360,000 years on the youngest flow of Bruneau Basalts which is interbedded with *Mam-*

muthus bearing sediments. N. Timothy Hall (1965, p. 156) reports a second date. He states, "Two occluded teeth of *Mammuthus columbi*(?) or perhaps *M. haroldcooki*, both of which indicate an Irvingtonian (Middle Pleistocene) age or younger, were found 55 feet stratigraphically above the top of the 'Upper Gastropod Bed' in a section showing no evidence of unconformity (Fig. 13-4). A few tens of feet above the *Mammuthus*-bearing strata is a distinctive one-foot-thick white vitric tuff consisting of more than 99 per cent tubular pumice. Hornblende crystals separated from the tuff give a potassium-argon age of 1.5 million years (age determined by G. H. Curtis)."

If the occurrence of *Mammuthus* west of the Rocky Mountains is comparable to their occurrence on the Plains it would indicate that they entered North America near the close of Aftonian time or earlier, and moved southward by population spread in front of the accumulating ice of Kansan time. There is no evidence that these early mammoths were adjusted to as severe a climate as were the woolly mammoth or the Jefferson mammoth.

Order LAGOMORPHA

Family Leporidae

Sylvilagus cf. *S. floridanus* (Allen)

(Fig. 4F)

Part of a left lower jaw (No. 46457) of a cottontail rabbit, with $P_3 - M_1$, was taken April 18, 1957, on the J. E. Jones ranch, from fine sand in the Seymour Formation. The posterior external re-entrant angle of P_3 is not crenulated nor is the re-entrant angle of P_4 and M_1 . The occlusal length of $P_3 - M_1$ is 7.5 mm.

Part of a right jaw (No. 52884) with $P_3 - M_2$ (Fig. 4F) was taken 6 miles southeast of Gilliland. The occlusal length of $P_3 - M_2$ is 10.0 mm. The dentition compares best with that of *Sylvilagus floridanus*. The anterior enamel wall of the posterior external re-entrant valley of P_3 is not crenulated. The enamel of the re-entrant valleys of $P_4 - M_2$ is simple. The enamel of the external valley walls of $P_3 - M_2$ in *Sylvilagus audubonii* and *S. nuttallii* are more crenulated than that of *S. floridanus*.

Order ARTIODACTYLA

Hibbard and Dalquest (1962) reported on the artiodactyls from the Seymour Formation of Knox County, Texas. Measurements and illustrations were given at that time. Only additional specimens or remarks are added to the previous list.

Family Tayassuidae

Platygonus cf. *P. cumberlandensis* Gidley

Remains of the peccary are not common in the Seymour Formation. Parts of 5 lower jaws and a metatarsal have been recovered from the sand and gravel. One would expect the long-nosed peccary (*Mylohyus*) to have been present in this southern fauna unless it arrived in the southern United States at a later time.

Family Camelidae

Genus *Titanotylopus?* Barbour and Schultz

(Pl. V, Figs. 1 and 2)

Hibbard and Dalquest (1962) referred a number of skeletal elements questionably to the genus *Gigantocamelus*, a giant camel. Webb (1965) has shown *Gigantocamelus* to be a synonym of *Titanotylopus*.

Dalquest recovered a 5th or 6th cervical vertebra (MU 1862, Plate V) from the Seymour sand and gravel that we questionably refer to the above genus.

The centrum has a length of 161.0 mm. The costellar processes are strongly developed. The distance from the outside of the left, to the outside of the right process is 185.5 mm. The greatest transverse width of the right process is 58.0 mm. The anteroposterior width is 64.0 mm. The length from the base of the centrum to the ventral tip of the process is 109.0 mm.

Camelops sp.

The size of the skeletal elements recovered indicate that at least two species of *Camelops* were present in the local fauna.

Tanupolama seymourensis Hibbard and Dalquest

Parts of two individuals of this small llama-like camel were recovered. Associated skeletons of these camels, as well as those of *Camelops*, are needed for a better understanding of the species that have been described. Webb (1965, pp. 34-35) reviews the genus *Tanupolama* Stock and its species.

Tanupolama cf. *T. blancoensis* Meade

Associated lower jaws of a llama-like camel that is similar to the above species were taken from near the base of the Seymour sand and gravel.

Family Cervidae

Odocoileus sp.

Fragmentary parts of antlers, limb bones, and a left lower jaw of a small species of deer were found.

Family Antilocapridae

Capromeryx sp.

Parts of a lower jaw and limb bones of this small pronghorn were found in the Seymour sand and gravel.

Tetrameryx? knoxensis Hibbard and Dalquest

This large antilocaprid is known from the left horn-cores (Hibbard and Dalquest, 1960), and a fragmentary right horn-core. A few large teeth have been referred to this species.

Order PERISSODACTYLA

Family Equidae

The most common fossils found in the Seymour sand and gravel are remains of horses. Melton (1964) estimated 130 square miles had been covered in the collection of the remains of glyptodons. This area includes in part the valley of the South Fork of the Wichita River and its flood plain. The fossils were recovered only from exposures of the Seymour Formation along the valley walls of the South Fork of the Wichita River. The horse remains were taken from the same exposures of the Seymour Formation as the glyptodons. In this area over 250 individual finds of the remains of horses were made. This does not include parts of teeth and fragments of other skeletal parts that were seen throughout the area.

The better material recovered for study includes parts of 4 skulls, 2 sets of maxillaries with teeth, 8 halves of lower jaws, 2 complete sets of lower jaws with associated teeth, 9 metatarsals, 3 metacarpals, 7 pedals or hoof bones, 1 associated calcaneum, astragalus, metatarsal, and the first, second and third phalanges, 24 first phalanges and 8 second phalanges, 12 radii, 8 tibiae, 4 patellae, parts of pelves, femurs, humeri and scapulae, and 138 isolated premolars and molars.

Equus giganteus Gidley

(Figs. 4G and 5B)

In the collection from the Seymour sand and gravel are two upper teeth taken on the Bruce Burnett ranch, 5 miles west of Vera, of a horse as large as *Equus giganteus* from southwestern Texas. Because of their large size, the complicated pattern of the prefossette and postfossette, and

the development of the pli caballin fold, the following teeth are referred to the above species. In such an assignment it is assumed that the holotype of *Equus giganteus* (Gidley, 1901) is a LP³ and not a LM² because of the anteroposterior length of the protocone, which is 16.5 mm taken 35.0 mm below the crown of the section of the type (No. 8616, Amer. Mus. Nat. Hist.).

The teeth found on the Bruce Burnett ranch were not in direct association. If associated, No. 46584 would be a slightly worn RP⁴. The base of the tooth is broken. The upper part of the crown possesses a thick covering of cement. The tooth was sectioned 26.0 mm below the occlusal surface (Fig. 5B). The anteroposterior length of the sectioned enamel surface (through the midportion of the fossettes) is 38.0 mm. The greatest enamel length is 39.0 mm. The mesostyle is missing. The anteroposterior length of the protocone is 20.0 mm.

The RM¹ (No. 46585), if it belonged to the same individual, had been exposed to considerable weathering. The crown is more worn and roots had just begun to develop. The upper part of the parastyle is missing, and also part of the profossette. The upper one half of the metastyle is missing. The height of the crown measured along the mesostyle is 103.8 mm. The anteroposterior enamel length of the occlusal surface is 36.0 mm. The transverse width across the mesostyle to the lingual enamel wall of the protocone is 35.0 mm. The length of the protocone is 20.0 mm. Lower teeth of this horse are unknown.

But a LP₂ (No. 31356) taken from the Atwater member of the Crooked Creek Formation in Meade County, Kansas, is questionably assigned to *Equus giganteus*. This tooth was found in place, at the horizon of the Borchers local fauna along the north side of the highway, by William A. Clemens, July 24, 1953, near the south section line of Sec. 16, T. 33 S., R. 28 W., less than one-eighth of a mile from the Borchers quarry site. This LP₂ (Fig. 4G) is the largest and most complicated of any we have seen. It is logical to assume that it may belong to the above species. The anteroposterior enamel occlusal length is 44.0 mm. The height of the tooth is 79.5 mm. The base of the crown has not closed.

We have not seen the large left upper premolar from the Holloman gravel pit which was assigned by Hay and Cook (1930) to *Equus pacificus* Leidy. Because of its large size we refer it to *E. giganteus*.

Equus scotti, Gidley

(Figs. 4A, 6A-D, and 7B-F)

The most common fossils found in the Seymour sand and gravel are

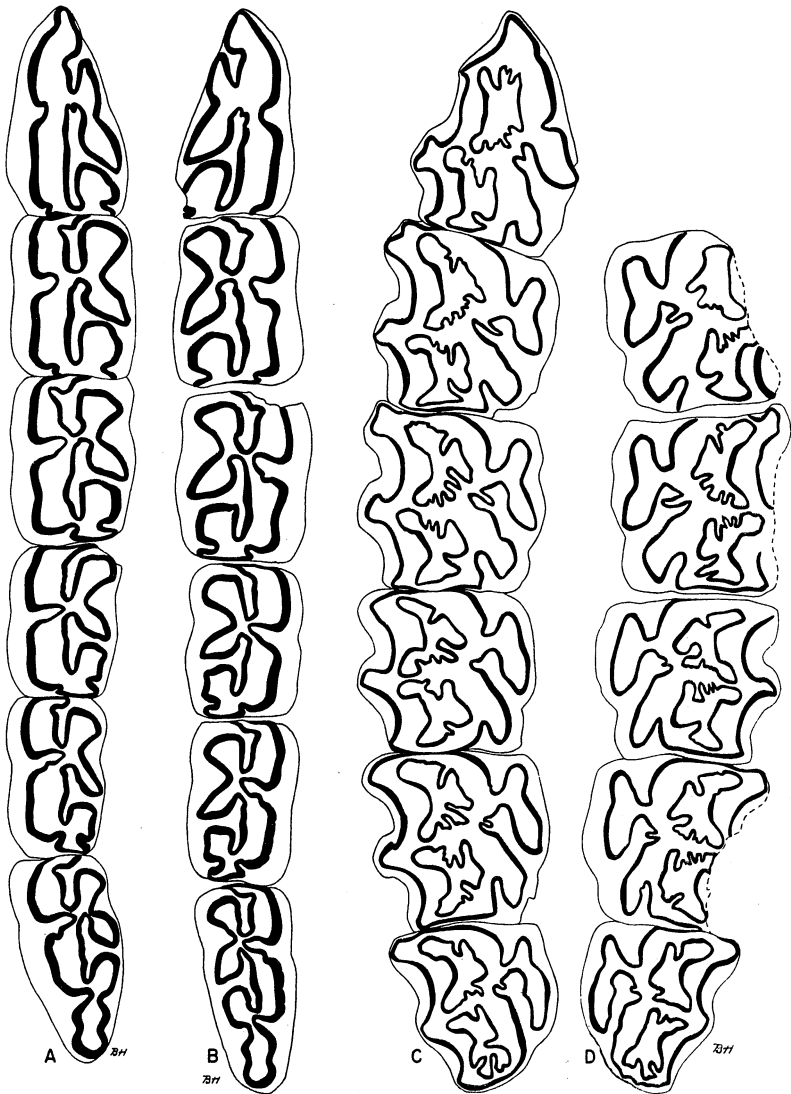


FIG. 6. *Equus scotti* Gidley; A, left $P_2 - M_3$, No. 39380; B, right $P_2 - M_3$, No. 39374. C and D, associated right and left upper premolars and molars, No. 46898, occlusal views, all $\times 34$.

parts of this horse. Teeth and limb bones assigned to this species compare well with the type and other specimens of *Equus scotti* from the Rock Creek quarries, Brisco County, Texas, and those from the Cudahy fauna of Seward County, Kansas (Arkalon, impure ash horizon, Hibbard, 1953).

Parts of the three skulls (Nos. 46344, 46899 and 52885) are not perfect enough to permit a detailed description or measurements. Number 46344 is that of a very old adult and the teeth (RP² - M¹, and LP³ - M¹) are all worn below the crown surface except RP². The skull (No. 52885) was taken from the red clay and is badly shattered because of the drying and weathering of the clay before it was found. Measurements of the teeth are given in Table I in comparison with the upper teeth found in a fragmentary palate (No. 46898, Fig. 6C and D).

TABLE I

OCCLUSAL MEASUREMENTS OF UPPER PREMOLARS AND MOLARS OF *Equus scotti*
(In Millimeters)

Dimension	No. 52885 (Enamel)		No. 46898 (Enamel)	
	Left	Right	Left	Right
P ² , occlusal length	41.0	41.0	...	41.6
Occlusal width	28.5	30.0	...	28.2
Anteroposterior diameter of protocone ...	12.7	12.3	...	11.5
P ³ , occlusal length	30.0	30.0	30.0	31.4
Occlusal width	30.4	30.0	...	30.0
Anteroposterior diameter of protocone ...	18.0	18.2	15.8	14.5
P ⁴ , occlusal length	30.3	30.3	30.8	31.5
Occlusal width	29.4	31.0	...	31.4
Anteroposterior diameter of protocone ...	19.0	19.0	16.5	16.4
M ¹ , occlusal length	26.5	26.0	28.0	28.5
Occlusal width	27.7	27.6	28.0	...
Anteroposterior diameter of protocone ...	15.5	15.3	14.5	15.0
M ² , occlusal length	27.9	27.5	30.0	30.0
Occlusal width	27.3	27.7	...	29.0
Anteroposterior diameter of protocone ...	17.5	17.6	16.6	16.5
M ³ , occlusal length	30.0	29.0	28.4	30.0
Occlusal width	24.3	24.0	25.0	25.4
Anteroposterior diameter of protocone ...	18.0	17.9	17.0	16.7

TABLE II
 OCCLUSAL MEASUREMENTS OF LOWER PREMOLARS AND MOLARS OF *Equus scotti*
 (In Millimeters)

Dimension	No. 35678 (Enamel)		No. 52886 (Enamel)	
	Left	Right	Left	Right
P ₂ , occlusal length	36.7	36.5	38.3	40.0
Occlusal width	17.8	17.5	17.8	16.5
P ₃ , occlusal length	32.8	32.8	33.5	33.5
Occlusal width	19.0	18.7	19.6	20.0
P ₄ , occlusal length	31.4	31.3	31.3	32.5
Occlusal width	19.0	20.4	20.0	18.6
M ₁ , occlusal length	29.0	29.0	30.0	28.5
Occlusal width	17.0	17.8	19.5	...
M ₂ , occlusal length	30.0	29.7	31.4	31.0
Occlusal width	18.0	18.0	18.0	16.3
M ₃ , occlusal length	37.5	37.5	40.0	41.9
Occlusal width	16.5	17.0	17.0	18.0

Occlusal length of No. 35678, LP₂ — LM₃ = 193.8 mm.

Length of diastema C — P₂ = 75.0 mm.

The following measurements were taken from the skull, No. 46899.

Frontal width, at posterior border of orbits	230.0 mm.
Width across zygomatic arches at tips of condyles	240.0 mm.
Muzzle width, at posterior alveolar border of I ³	75.0 mm.
Diastemal length, I ³ — C	30.5 mm.
Diastemal length, C — P ²	73.2 mm.

The dentition of a fourth skull from this local fauna was described by Dalquest (1964).

The lower jaws recovered are fragmentary. Seven of them contain a complete premolar-molar series. Measurements of associated premolar-molar series (Nos. 35678 and 52886) are given in Table II. The lower occlusal patterns of the two adult premolar-molar series (Nos. 39374 and 39380) are shown in Figure 6A and B. Part of a left lower jaw (No. 46355) contains DP₂ — DP₄ (Fig. 4A). The occlusal length is 118.0 mm.

Part of a right lower jaw (No. 39382, Fig. 7B) with P₂ — M₁ taken 3 miles west of Vera, shows considerable complication of the labial enamel wall of the entoflexids. M₁ was removed from the jaw. It has a crown length of 93.0 mm. It was sectioned 54.0 mm below the occlusal surface. The complicated enamel has disappeared at this level (Fig. 7B). A RP₄

(No. 46432) was taken 7 miles west of Vera on the Bruce Burnett ranch. The tooth has a crown height of 94.5 mm. The enamel is as complicated as that of the other RP₄. These are the only young occlusal patterns that show such complications of the enamel. The teeth are the size of other teeth assigned to *Equus scotti* and are considered to be individual variation of young occlusal patterns.

Two metacarpals (Nos. 39375 and 39376) are assigned to *E. scotti*. No. 39375 has a length of 233.0 mm. The transverse width of the proximal end is 57.5 mm. The transverse width of the distal end is 52.2 mm. The length of No. 39376 is 255.0 mm (Figs. 7E and F).

The metatarsals range in length from 259.0 to 292.0 mm. The width of the proximal end of metatarsal No. 39377 is 55.1 mm. The width of the distal end is 53.0 mm. The width of the proximal end of metatarsal No. 39378 (Fig. 7D) is 53.5 mm., and the width of the distal end is 52.0 mm.

In the Midwestern University collection is a metatarsal (MU 1856) with a length of 310.0 mm. The transverse width of the proximal end is 56.4 mm, and the transverse width of the distal end is 54.3 mm. It is not known whether this belongs to *E. scotti* or *E. giganteus*.

The length of the first phalanx (No. 46518) of the forefoot is 86.0 mm. The proximal transverse width is 61.0 mm, and the distal transverse width is 50.4 mm.

The length of the first phalanx (No. 35669) of the hindfoot is 91.0 mm. The transverse width of the proximal end is 62.0 mm, and the transverse width of the distal end is 45.5 mm.

Remarks.—If our interpretation of the tooth pattern of *Equus scotti* is correct, then the teeth from the Holloman gravel pit, assigned by Hay and Cook (1930) to *Equus complicatus* Leidy, are referable to *E. scotti*.

Equus sp.

(Fig. 7A)

Part of a right lower jaw (No. 39383, Fig. 7A) taken on the Bruce Burnett ranch is from a medium-sized horse.

Remarks.—*Equus semiplicatus* Cope, a medium-sized horse from Rock Creek, Texas, is known from an upper tooth and a skull, described by Cope from southwestern Texas. These possess characters of the ass. *Equus calobatus* Troxell (1915a) was described from Rock Creek, Texas, and the identification was based on slender metacarpals, metatarsals, and the first phalanx and other limb bones, which are more like those of *Hemionus* than

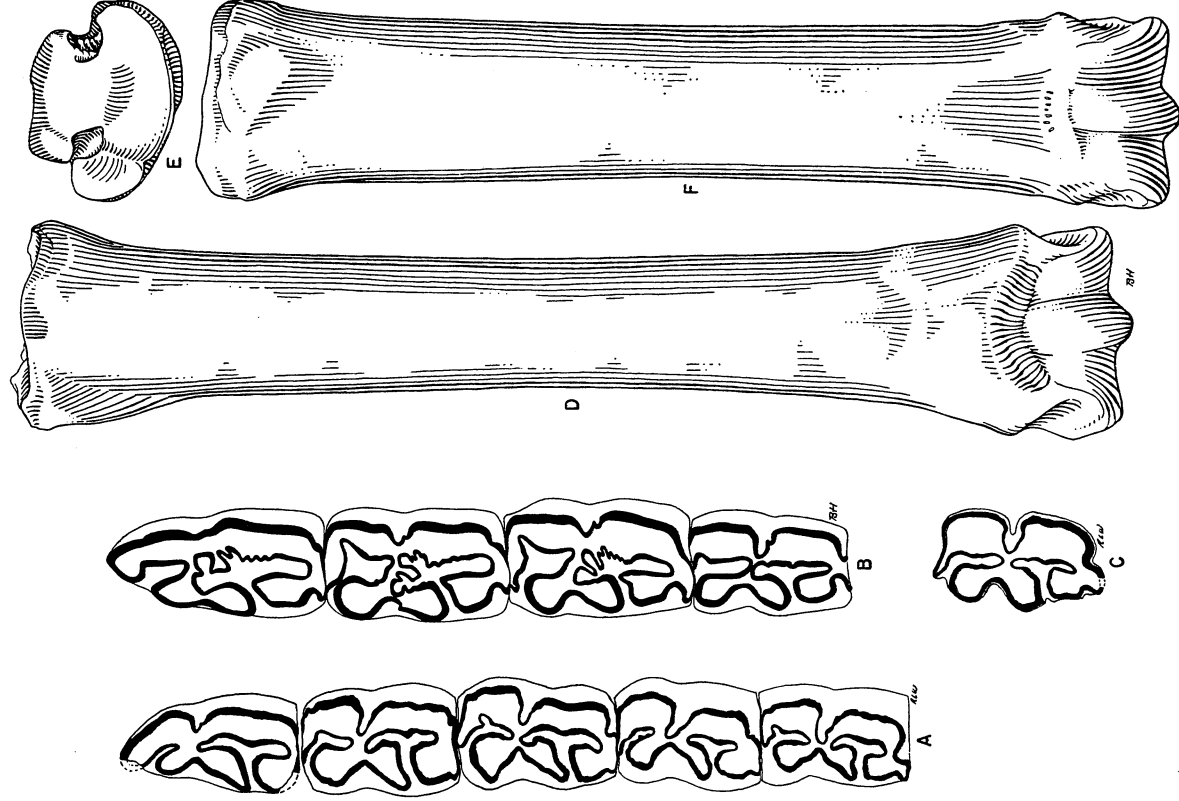


FIG. 7. *Equus* sp., right P_2 — M_2 , No. 39383, occlusal view, $\times \frac{3}{4}$. *Equus scotii* Gidley; B, right P_2 — M_1 , No. 39382, occlusal view; C, M_1 , No. 39382, sectioned 54.0 mm below occlusal surface, $\times \frac{3}{4}$. D, metatarsal, No. 39378, anterior view, $\times \frac{1}{2}$. E and F; metacarpal, No. 39376; E, proximal, and F anterior, views, $\times \frac{1}{2}$.

those of *Asinus*. These two species have long been considered synonymous by numerous students of paleontology. No skull with associated jaws, or skeletons have been recorded. The patterns of the lower permanent teeth are unknown.

The patterns of the teeth of the jaw (No. 39383) from the Seymour Formation are like those of *Equus* and not like those of the Recent and fossil asses we have studied. Furthermore no limb bones were found that could be assigned to the stilt-legged horse.

TABLE III
OCCLUSAL MEASUREMENTS OF LOWER TEETH OF SPECIMEN NO. 39383

Dimension	P ₂	P ₃	P ₄	M ₁	M ₂
Length of crown	31.6 mm	28.0 mm	28.0 mm	25.0 mm	26.0 mm
Width of crown	13.8 mm	15.3 mm	17.2 mm	14.8 mm	15.0 mm

Equus sp. (small)

Parts of three premolars, or molars, of a small horse were taken 3¼ miles south of Gilliland. Tooth No. 46399, has a crown height of 68.0 mm. The occlusal length is 23.4 mm, and the occlusal width is 23.0 mm. The length of the protocone is 13.0 mm.

Taken in this area were two first phalanges (Nos. 46508 and 46509). No. 46508 has a length of 73.0 mm. The transverse width at the proximal end is 36.0 mm, and the transverse width of the distal end is 31.5 mm. The other phalanx has a length of 81.5 mm. The transverse width of the proximal end is 44.0 mm, and the transverse width of the distal end is 34.6 mm.

A small left M³ (No. 46476) was taken on the Bruce Burnett ranch. Height of the crown is 50.0 mm. The anteroposterior length of the occlusal surface is 23.0 mm, and the width is 15.5 mm.

Remarks.—It is evident that at least four species of horses were present in the Gilliland local fauna. The large *Equus scotti* was by far the most abundant.

Family Tapiridae
Tapirus copei Simpson
(Fig. 5E)

Two lower jaws of a large tapir were found. A right ramus (No. 33523) has the base of the crowns of P₄ – M₃ present. This specimen was taken

3½ miles south of Gilliland. The width of the lower jaw between P₄ and M₁ is 35.0 mm. The depth of the lower jaw measured on the lingual side at the alveolar level between P₄ and M₁ is 61.5 mm. Depth between M₂ and M₃ is 62.5 mm. Alveolar length of P₄ - M₃ is 111.0 mm (Fig. 5E).

The anterior part of a left lower jaw (No. 46486) with part of P₂, P₃, and the anterior part of P₄ was found 6 miles southeast of Gilliland. The anteroposterior length of P₂ is approximately 30.5 mm. The anteroposterior length of P₃ is 26.0 mm, the anterior width is 18.8 mm, the posterior width is 20.4 mm. The anterior width of P₄ is 21.4 mm.

The measurements of the teeth fall within the range given by Simpson (1945) and Ray (1964) for *Tapirus copei*.

Remarks.—The Port Kennedy local fauna from Montgomery County, Pennsylvania, seems to be closely related to the Gilliland local fauna, to the overlying Cudahy fauna below the Pearlette ash, and to the Borchers local fauna of Yarmouth age. On the basis of the primitive *Ondatra* tooth from the Borchers local fauna, Hibbard (1958*b*) assigned a probable Yarmouth age to the Port Kennedy local fauna. We believe that the abundance of microtines in the Port Kennedy local fauna, and the evidence furnished by the entire vertebrate fauna from the Seymour Formation, indicate a late Kansan age for the Port Kennedy vertebrates.

It appears that *Tapirus copei* had a wide geographical distribution during the early middle Pleistocene. Only further faunal and stratigraphic studies will determine its distribution through time.

VERA LOCAL FAUNULE

Previous work.—The Vera faunule was recovered from silt and clay just beneath the Pearlette volcanic ash (Powers, Young, and Barnett, 1958) in the Seymour Formation. The Vera faunule is part of the Cudahy fauna of late Kansan age of northwestern Texas (Johnston and Savage, 1955), western Kansas, and western Nebraska (Hibbard, 1944 and 1953; Frye and Leonard, 1952; Paulson, 1961; and Taylor, 1965).

Approximately 9 tons of fossiliferous matrix were removed from beneath the Pearlette ash at three localities for washing to recover microfossils. The locality numbers are those of the University of Michigan Museum of Paleontology series:

Locality UM-T1-56. Baylor County, Texas. The SW¼ Sec. 152 of Block A of Buffalo, Bayo, Brazos, and Colorado Railway Company Survey. J. O. Robinson ranch, 2½ miles northwest of Red Springs, Texas. Pearlette ash did not overlie the molluscan horizon where the matrix was

taken from an exposure along the bank of a small gulley. One ton of matrix was washed for fossils.

Locality UM-T1-57. Knox County, Texas. In the southwest corner of the N $\frac{1}{4}$ Sec. 101 of Block C of the Houston and Texas Central Railroad Company Survey. On the J. E. Jones ranch, west of Farm Road 267; the exposure was along the south wall of an old gravel pit. Matrix with fossils was removed from beneath the Pearlette ash Getz and Hibbard (1965, Pl. 1, Fig. 1). Vertebrates occurred with the mollusks at this locality. Five tons of matrix were washed.

Locality UM-T1-58. Knox County, Texas. East of catchpens in SW $\frac{1}{4}$ SE $\frac{1}{4}$ Sec. 110 of Block C of the Houston and Texas Central Railroad Company Survey. On the O. L. Patterson ranch, exposures occur near the head of a deep ravine. Fossil-bearing matrix was removed from the east wall from beneath the Pearlette ash Getz and Hibbard (1965, Pl. 1, Fig. 2). Mollusks and vertebrates, the latter including the ilium of *Syrrophus* cf. *S. marnocki* (Cope), (Tihen 1960), were taken at this locality. Three tons of matrix were washed.

Getz and Hibbard (1965) reported upon the molluscan faunule. Tihen (1960) described part of a leptodactylid frog. Holman (1965) published on the snakes recovered with the faunule. Brodkorb (1964a) listed the occurrence of ducks.

Following is a list of the Vera local faunule, which is compared with the Cudahy fauna of Kansas, based on the studies of Frye and Leonard (1952), Getz (1960), Hibbard (1944 and 1953), Klingener (1963), Paulson (1961), and Tihen (1955 and 1962). A summary of the climate in which the Cudahy fauna lived in Kansas is given by Taylor (1965). The reptiles and birds of the Cudahy fauna of Kansas have not been studied. This fauna was taken in Meade and Seward counties, Kansas, in the High Plains region 270 miles to the northwest at an elevation of approximately 2550 feet.

FAUNAL LIST	CUDAHY FAUNA OF KANSAS	VERA LOCAL FAUNULE
Pelecypoda		
<i>Sphaerium partumeium</i> (Say) .....	..	X
<i>Sphaerium striatinum</i> (Lamarck)	X	X
<i>Pisidium casertanum</i> (Poli) .....	..	X
<i>Pisidium compressum</i> Prime	X	X
<i>Pisidium ferrugineum</i> Prime .....	..	X
Gastropoda		
<i>Valvata tricarinata</i> (Say) .....	..	X

FAUNAL LIST	CUDAHY FAUNA OF KANSAS	VERA LOCAL FAUNULE
<i>Annicola integra</i> (Say) .....	..	X
<i>Annicola limosa parva</i> Lea	X	..
<i>Pomatiopsis cincinnatiensis</i> (Lea) .....	..	X
<i>Carychium exiguum</i> (Say)	X	X
<i>Fossaria dalli</i> (Baker) .....	..	X
<i>Fossaria obrussa</i> (Say) .....	..	X
<i>Lymnaea caperata</i> Say	X	X
<i>Lymnaea bulimoides techella</i> (Haldeman)	X	X
<i>Lymnaea palustris</i> (Müller)	X	..
<i>Lymnaea parva</i> Lea	X	..
<i>Lymnaea reflexa</i> Say	X	X
<i>Omalodiscus pattersoni</i> (Baker)	X	..
<i>Gyraulus circumstriatus</i> (Tryon) .....	..	X
<i>Gyraulus parvus</i> (Say)	X	X
<i>Gyraulus similaris</i> (Baker)	X	..
<i>Helisoma anceps</i> (Menke) .....	..	X
<i>Helisoma antrosa</i> (Conrad)	X	..
<i>Helisoma trivolvis</i> (Say)	X	X
<i>Planorbula armigera</i> (Say) .....	..	X
<i>Planorbula vulcanata</i> Leonard	X	..
<i>Promenetus kansasensis</i> (Baker) .....	..	X
<i>Promenetus umbilicatellus</i> (Cockerell)	X	..
<i>Ferrissia meekiana</i> (Stimpson) .....	..	X
<i>Ferrissia parallela</i> (Haldeman)	X	..
<i>Physa anatina</i> Lea	X	X
<i>Physa elliptica</i> Lea	X	..
<i>Physa gyrina</i> Say .....	..	X
<i>Physa skinneri</i> Taylor	X	X
<i>Aplexa hypnorum</i> (Linnaeus)	X	..
<i>Strobilops labyrinthica</i> (Say) .....	..	X
<i>Strobilops lonsdalei cansasiana</i> Ho and Leonard	X	..
<i>Gastrocopta armifera</i> (Say)	X	X
<i>Gastrocopta contracta</i> (Say)	X	..
<i>Gastrocopta cristata</i> (Pilsbry and Vanatta)	X	X
<i>Gastrocopta falcis</i> Leonard	X	..
<i>Gastrocopta</i> cf. <i>G. holzingeri</i> (Sterki)	X	X
<i>Gastrocopta proarmifera</i> Leonard	X	..
<i>Gastrocopta procera</i> (Gould) .....	..	X
<i>Gastrocopta tappaniana</i> (Adams)	X	X
<i>Pupoides albilabris</i> (Adams)	X	X
<i>Pupilla blandi</i> Morse	X	..
<i>Pupilla muscorum</i> (Linnaeus)	X	..
<i>Pupilla sinistra</i> Franzen	X	..
<i>Vertigo gouldi</i> (Binney)	X	..
<i>Vertigo milium</i> (Gould)	X	X

FAUNAL LIST	CUDAHY FAUNA OF KANSAS	VERA LOCAL FAUNULE
<i>Vertigo ovata</i> Say	X	X
<i>Vallonia gracilicosta</i> Reinhardt	X	X
<i>Vallonia parvula</i> Sterki .....	..	X
<i>Vallonia pulchella</i> (Müller)	X	X
<i>Cionella lubrica</i> (Müller)	X	..
<i>Succinea</i> sp.	X	X
<i>Oxyloma navarrei</i> Leonard	X	..
<i>Discus cronkhitei</i> (Newcomb)	X	X
<i>Helicodiscus parallelus</i> (Say)	X	X
<i>Helicodiscus singleyanus</i> (Pilsbry) .....	..	X
<i>Deroceras aenigma</i> Leonard	X	X
<i>Euconulus fulvus</i> (Müller)	X	X
<i>Nesovitrea electrina</i> (Gould)	X	X
<i>Hawaiiia minuscula</i> (Binney)	X	X
<i>Zonitoides arboreus</i> (Say)	X	X
<i>Stenotrema leai</i> (Binney)	X	X
Fishes		
<i>Lepisosteus</i> sp. ....	..	X
<i>Notemigonus crysoleucas</i> (Mitchell) .....	..	X
<i>Ictalurus punctatus</i> (Rafinesque) .....	..	X
<i>Ictalurus</i> cf. <i>I. melas</i> (Rafinesque) .....	..	X
<i>Fundulus</i> sp. ....	..	X
<i>Lepomis</i> cf. <i>L. cyanellus</i> (Rafinesque) .....	..	X
Amphibians		
<i>Ambystoma tigrinum</i> (Green), neotenic	X	..
<i>Ambystoma</i> cf. <i>A. tigrinum</i> (Green) .....	..	X
<i>Syrrophus</i> cf. <i>S. marnocki</i> (Cope) .....	..	X
<i>Bufo</i> cf. <i>B. hemiophrys</i> Cope	X	..
<i>Bufo</i> sp. ....	..	X
<i>Acris</i> cf. <i>A. crepitans</i> Baird .....	..	X
<i>Rana</i> sp.	X	X
Reptiles		
<i>Thamnophis</i> sp. ....	..	X
<i>Tropidoclonion lineatum</i> (Hallowell) .....	..	X
<i>Heterodon nasicus</i> Baird and Girard .....	..	X
Birds		
<i>Oxyura bessomi</i> Howard .....	..	X
<i>Querquedula discors</i> (Linnaeus) .....	..	X
Mammals		
<i>Sorex cinereus</i> Kerr	X	X
<i>Sorex</i> (<i>Sorex</i>) <i>cudahyensis</i> Hibbard	X	..
<i>Sorex</i> (<i>Sorex</i>) <i>lacustris</i> (Hibbard)	X	..
<i>Sorex</i> (<i>Neosorex</i>) <i>megapalustris</i> Paulson	X	..
<i>Microsorex pratensis</i> Hibbard	X	..
<i>Cryptotis parva</i> (Say) .....	..	X

FAUNAL LIST	CUDAHY FAUNA OF KANSAS	VERA LOCAL FAUNULE
<i>Blarina</i> cf. <i>B. brevicauda</i> (Say) .....	..	X
<i>Blarina</i> sp.	X	..
<i>Scalopus</i> sp. ....	..	X
<i>Canis</i> sp.	X	..
<i>Mustela</i> cf. <i>M. erminea</i> Linnaeus	X	..
<i>Mustela</i> cf. <i>M. vison</i> Schreber	X	..
<i>Felis</i> sp.	X	..
<i>Citellus richardsoni</i> (Sabine)	X	..
<i>Citellus</i> cf. <i>C. tridecemlineatus</i> (Mitchill)	X	..
<i>Citellus</i> nr. <i>franklini</i> (Sabine)	X	..
<i>Citellus</i> sp. ....	..	X
<i>Thomomys</i> sp.	X	..
<i>Geomys tobinensis</i> (Hibbard)	X	X
<i>Perognathus</i> sp. ....	..	X
<i>Castoroides</i> sp.	X	..
<i>Reithrodontomys moorei</i> (Hibbard)	X	..
<i>Peromyscus cragini</i> Hibbard	X	X
<i>Onychomys</i> sp. ....	..	X
<i>Ondatra annectens</i> (Brown)	X	X
<i>Ondatra</i> sp. (large) .....	..	X
<i>Microtus paroperarius</i> Hibbard	X	X
<i>Pitymys meadensis</i> Hibbard	X	..
<i>Pedomys llanensis</i> Hibbard	X	X
<i>Synaptomys (Mictomys) meltoni</i> Paulson	X	..
<i>Zapus sandersi sandersi</i> Klingener	X	..
<i>Megalonyx</i> sp.	X	..
<i>Mammuthus imperator haroldcooki</i> Hay	X	..
<i>Sylvilagus</i> sp.	X	..
<i>Platygonus</i> sp.	X	..
Camel sp.	X	..
Antilocaprid gen. and sp. indet	X	..
<i>Equus scotti</i> Gidley	X	..
<i>Hemionus calobatus</i> Troxell	X	..

Paleoecology.—The Vera molluscan faunule consists of 45 species, of which 5 are pelecypods. There are 18 aquatic, and 22 terrestrial gastropods. The following ecological interpretations are taken from Getz's study (Getz and Hibbard, 1965, p. 286):

Recovery of aquatic species at all three localities indicates the former presence of shallow permanent streams (approximately 1–3 feet in depth) with at least some quiet backwater areas, portions of which were subjected to seasonal drying. The collection of *Pisidium compressum*, *Sphaerium striatinum*, *Valvata tricarinata*, and *Helix*

soma anceps at Locality UM-T1-58 suggests that at least some sections of this stream were somewhat deeper and had a swifter current than did parts of the streams associated with Localities UM-T1-57 and UM-T1-56.

Most of the stream banks apparently were rather low so as to form a zone of mud flats which graded gradually into one of wet debris (leaf litter, logs, etc.). Of the species in the faunule, *Pomatiopsis cincinnatiensis* probably has the most exacting ecological needs (van der Schalie and Getz, 1962). This form requires well-developed, exposed banks (it does not occur on mud flats); it lives in a relatively narrow zone along such banks (a restriction to a soil saturation of approximately 70 per cent). In addition, the water level of the stream must remain sufficiently high so that it reaches the base of the bank throughout almost the entire year. The presence of a few *P. cincinnatiensis* at Locality UM-T1-58 is, therefore, evidence that at least some areas of that stream or its tributaries had definite, angular banks. Most importantly it indicates a rather constant flow of water in the stream during the summer months.

Apparently, wooded vegetation was present along the stream at Locality UM-T1-58, but such vegetation did not necessarily occur at Localities UM-T1-57 and UM-T1-56. In general, it is presumed that Locality UM-T1-58 was a permanent stream with an adjacent wooded floodplain and that Localities UM-T1-57 and UM-T1-56 were somewhat shallower permanent streams flowing through a prairie area in which wooded floodplains were absent or poorly developed. UM-T1-58 and UM-T1-57 are without doubt along the same stream but with slightly different conditions in the surrounding floodplains; they are about $\frac{1}{2}$ to $\frac{3}{4}$ mile apart.

The presence of *Lepisosteus* and the channel catfish indicate a rather large stream with permanent water. The gar, a fisheater, consumed a large number of fish and its presence, "can only mean that the fish fauna as a whole was very rich," (Rostlund, 1952, p. 13).

The golden shiner inhabits sluggish or weedy waters (Jordan, 1929, p. 71). The larval salamander would also occur in such a habitat. The bullhead and sunfish occur in quiet waters.

Acris and *Rana* would occur along the edges of streams or pools of still water. The toad (*Bufo*) would range from the waters edge and throughout the lowland area.

Thamnophis, the garter snake, would occur in and around marshy areas. The lined snake (*Tropidoclonion*) is found in moist grassy areas with some scattered driftwood or stones. The western hog-nosed snake is a good indicator of the presence of sandy areas. Its food is chiefly toads.

The ducks indicate pools of quiet water and the presence of marshes around the waters edge.

The masked shrew (*Sorex cinereus*) is chiefly northern in distribution and is found in a moist habitat. It would be found in the marshy areas (see range map, Burt and Grossenheider, 1964, p. 4). This shrew does not live in Texas, Oklahoma, or Kansas at present.

Blarina, the short-tailed shrew, occurs in moist stream valleys which

support a moderate number of trees and shrubs. It does not occur in this area at present, but is found in extreme eastern Texas (Davis, 1960).

Cryptotis parva, the little short-tailed shrew, lives in mixed grasslands and in drier habitats than *Blarina*. It and *Notiosorex* have been recovered from owl pellets in Knox County. The specimens are in the Midwestern University collections.

The mole (*Scalopus*), *Citellus* (the ground squirrel), *Geomys* (the pocket gopher), *Perognathus* (the pocket mouse), *Onychomys* (the grasshopper mouse) and *Ondatra* (the muskrat) occur in this area at the present time.

Microtus does not occur in the area at present. It now occurs in the Guadalupe Mountains in Culbertson County in the extreme west part of Texas, and in Hardin County in the southeast corner of the state. Its presence in the Vera faunule indicates a more moist climate with cooler summers that supported a vegetation of tall grasses and sedges.

Getz (Getz and Hibbard, 1965, Fig. 1) found that 43 of the 45 species of mollusks of the Vera faunule now occur as sympatric species in eastern South Dakota, southwestern Minnesota and extreme northwestern Iowa. The region of sympatric species is approximately 650 miles north of the Pleistocene localities in Texas.

Climatic interpretation.—The normal summer temperature of the South Dakota-Minnesota-Iowa region is 70–75 degrees F., while that of Knox and Baylor counties is 75–80 degrees F. The daytime temperatures do go above 90 degrees F. in this part of Texas for 80 to 100 days as compared with only 10 to 30 days in the South Dakota-Minnesota-Iowa region. In this northern region the summer rainfall is about 10 per cent greater than in Knox and Baylor counties, Texas. The rate of evaporation of water from pans during the summer is less in the former region. This indicates a moister condition with higher summer humidities in the region of sympatry. Getz (Getz and Hibbard, 1965) considered the terrestrial mollusks present in the Vera faunule to be indicative of a climate of cooler and moister summers with milder winters in northern Texas during late Kansan time.

The presence of *Sorex cinereus*, *Blarina* and *Microtus* in the faunule also indicates cooler and more moist summers than occur in that area today. At present there is no data to furnish the information needed regarding the winter climate as there is for the summer climate. The most southern element recognized in the fauna to date is the cliff frog (*Syrrophus* cf. *S. marnocki*). At present it does not occur this far north in Texas.

In using regions of sympatry for the interpretation of summer climates it is important to realize that the winter climatic data for the region of sympatry can not be applied to the region of the fossil fauna.

It is not known whether this Texas region became cooler in the winter after the Gilliland local fauna lived. If it did become cooler we would not expect it to have been colder than the present climate if as cold because the large *Geochelone* (land tortoise) is found in the Borchers local fauna of Yarmouth age in Meade County, Kansas, at an elevation of 2500 feet.

Systematic Discussion

Phylum MOLLUSCA

The mollusks of the Vera faunule were reported by Lowell L. Getz and Claude W. Hibbard (1965).

Phylum VERTEBRATA

Class OSTEICHTHYES

Gerald R. Smith identified the specimens reported here from the Vera faunule of the Cudahy fauna.

Family Lepisosteidae

Lepisosteus sp.

A gar scale (No. 46903) and a vertebra (No. 45705) were taken at locality UM-T1-58 on the Patterson ranch, and two skull fragments (No. 46905) from locality UM-T1-57 on the Jones ranch.

Family Cyprinidae

Notemigonus crysoleucas (Mitchill)

Parts of three pharyngeal bones of the golden shiner (No. 45706) and one pharyngeal bone (No. 46902) are from locality UM-T1-58 on the Patterson ranch. Parts of three pharyngeal bones (No. 46907) are from locality UM-T1-57 on the Jones ranch.

Family Ictaluridae

Ictalurus punctatus (Rafinesque)

A left angular (No. 46912) of a channel catfish was taken from locality UM-T1-58 on the Patterson ranch.

Ictalurus cf. *I. melas* (Rafinesque)

Parts of two dentaries, and part of a cleithrium (No. 46904) of a bullhead were taken at locality UM-T1-58 on the Patterson ranch.

Family Cyprinodontidae

Fundulus sp.

Two killifish pharyngeal bones (No. 46908) from locality UM-T1-57 on the Jones ranch; one pharyngeal bone (No. 46911), and a second pharyngeal bone (No. 46914) were recovered at locality UM-T1-58 on the Patterson ranch.

Family Centrarchidae

Lepomis cf. *L. cyanellus* (Rafinesque)

A prevomer (No. 46901); and two dentaries, a cleithrium and six premaxillaries (No. 46913) were recovered at locality UM-T1-58 on the Patterson ranch. Three pharyngeal bones (No. 46906) were taken at locality UM-T1-57 on the Jones ranch. These bones compare best with those of the living green sunfish.

Class AMPHIBIA

Order CAUDATA

Family Ambystomidae

Ambystoma cf. *A. tigrinum* (Green)

Three specimens of a larval salamander include an otic bone (No. 48462) part of a femur (No. 48456), and a vertebra (No. 39795). They were taken at locality UM-T1-58 on the Patterson ranch. The specimens were identified by J. A. Tihen.

Order ANURA

Family Leptodactylidae

Syrrophus cf. *S. marnocki* (Cope)

An ilium (No. 39796) of the cliff frog, a member of a large family of American tropical frogs (Tihen, 1960) was recovered from the Patterson ranch, locality UM-T1-58.

Family Bufonidae

Bufo sp.

A vertebra (No. 48455) and part of a urostyle (No. 48457) of a toad were taken at locality UM-T1-58, on the O. L. Patterson ranch. The specimens were identified by J. A. Tihen.

Family Hylidae

Acris cf. *A. crepitans* Baird

A left ilium (No. 52908) of a cricket frog was taken at locality UM-T1-58, on the O. L. Patterson ranch. The specimen was identified by Charles J. Chantell.

Family Ranidae

Rana sp.

A number of skeletal parts of a frog (*Rana*) were recovered at locality UM-T1-58, on the O. L. Patterson ranch. These parts were identified to genus by J. A. Tihen.

Class REPTILIA

Order SERPENTES

Family Colubridae

The remains of the snakes listed were studied and reported by J. Alan Holman (1965).

Thamnophis sp.

A fused basisphenoid and parasphenoid (No. 39792, Holman, 1965, Fig. 1C), a right quadrate (No. 39805), and 22 precaudal vertebrae (No. 39791) of a garter snake, were taken at locality UM-T1-58 on the O. L. Patterson ranch. Twenty precaudal vertebrae (No. 39654) were recovered at locality UM-T1-57 on the J. E. Jones ranch in Lot 101, just east of the Patterson ranch.

Tropidozonion lineatum (Hallowell)

Two precaudal vertebrae were recovered of the lined snake. One vertebra (No. 45720) was taken at locality UM-T1-57 on the J. E. Jones ranch, and the other vertebra (No. 52908) was taken at locality UM-T1-58 on the O. L. Patterson ranch.

Heterodon nasicus Baird and Girard

Two precaudal vertebrae (No. 45727) of the western hog-nosed snake were recovered at locality UM-T1-57 on the J. E. Jones ranch, and three precaudal vertebrae (No. 45699) were taken at locality UM-T1-58 on the O. L. Patterson ranch.

Class AVES

Bird remains recovered below the Pearlette ash in association with the Vera faunule are being studied by Pierce Brodkorb. Only two of the specimens have been reported.

Order ANSERIFORMES

Family Anatidae

Oxyura bessomi Howard

Remains of a duck showing characters slightly closer to the masked duck than to the ruddy (Howard, 1963) were reported by Brodkorb (1964a, p. 232) from locality UM-T1-58 on the O. L. Patterson ranch.

Querquedula discors (Linnaeus)

Part of a blue-winged teal was reported by Brodkorb (1964a, p. 241) from locality UM-T1-58 on the O. L. Patterson ranch.

Class MAMMALIA

Order INSECTIVORA

Family Soricidae

Sorex cinereus Kerr

(Fig. 8I)

Distribution.—In the Plains region the masked shrew ranges southward into northern Nebraska. Its range extends southward in the Rocky Mountain region to north central New Mexico and southward in the Appalachians to southwestern Carolina (see Burt and Grossenheider 1964, p. 5, for map showing present distribution). There are many fossil records from the southern High Plains, south of its present range. The most southern record is from Wisconsin deposits of the San Josecito Cave near Aramberri, Nuevo Leon, Mexico (Findley, 1953).

Habitat.—The masked shrew prefers a moist habitat. Hamilton (1939, p. 292) said of this small shrew: "Within its range this mammal mite . . . occupies diverse ecologic niches, from the driftwood-lined beaches of the Atlantic Coast to the coniferous forests and Arctic Barren grounds of Northern Canada."

Part of a right lower jaw with P₄ and M₁¹ (No. 45849) was recovered at locality UM-T1-57 on the Jones ranch.

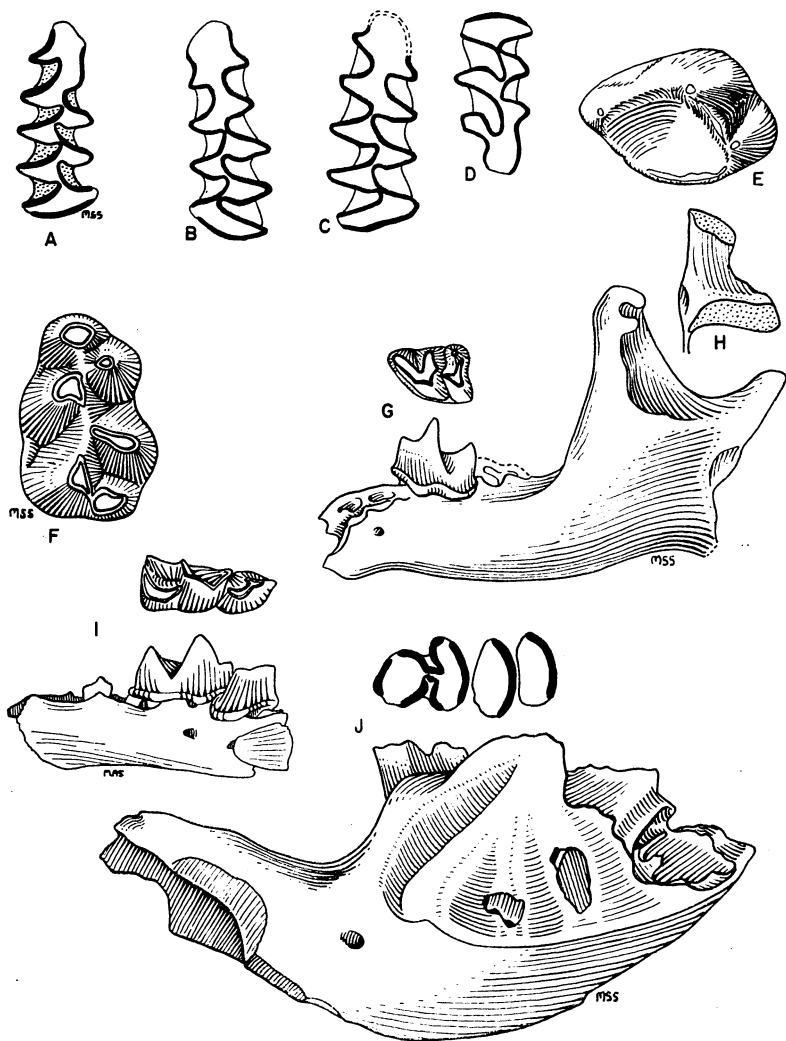


FIG. 8. Fossils from the Vera faunule. A, *Microtus paroperarius* Hibbard, right M_1 , No. 45845, occlusal view, $\times 10$. B-D, *Pedomys llanensis* Hibbard, left and right M_1 , No. 39643, and LM³, No. 39644, occlusal views, $\times 10$. Drawn by Michael O. Woodburne. E, *Citellus* sp., right M_2 , No. 39646, occlusal view, $\times 8$. F, *Onychomys* sp., left M_1 , No. 45837, occlusal view, $\times 8$. G and H, *Cryptotis parva* (Say), part of left jaw with M_2 , No. 45848, labial and occlusal views; H, posterior view of articular facets, $\times 10$. I, *Sorex cinereus* Kerr, part of right jaw with P_4 and M_1 , No. 45849, labial and occlusal views, $\times 10$. J, *Geomys tobinensis* (Hibbard), part of left jaw with $P_4 - M_2$, No. 45861, labial and occlusal views, $\times 4$.

The depth of the lower jaw and the size of P_4 and M_1 are as large as that of *Sorex cinereus miscix* Bangs from Labrador. The specimen compares in size with those of *Sorex cinereus* from the Cudahy fauna taken in Meade County, Kansas. Paulson (1961, p. 128) noted that the lower jaw and teeth of *S. cinereus* from the Cudahy fauna are generally more robust than is normal in Recent *S. cinereus*.

Cryptotis parva (Say)

(Fig. 8G-H)

Distribution.—The present range is from southern New York west to southeastern Wisconsin, southwest to extreme eastern Colorado, south to the Gulf of Mexico, and east to the Atlantic Coast (see Burt and Grossenheider, 1964, p. 8).

Part of a left jaw, No. 45848, with M_2 (Fig. 8G-H), and part of the right maxillary, No. 45854, with M^2 was taken at locality UM-T1-57 on the Jones ranch.

Remarks.—This is the earliest record of the least shrew, *Cryptotis parva*, from the Pleistocene. It was previously reported from this region by Dalquest (1962) from the Easley ranch local fauna of Foard County, Texas, and by Hibbard (1963) from the Mt. Scott local fauna of Meade County, Kansas.

Blarina cf. *B. brevicauda* (Say)

Distribution.—The present distribution of the Recent species of the short-tailed shrew is from southeastern Canada to Florida, west to the southeastern edge of Texas and northwest to the southeastern corner of Saskatchewan (see Burt and Grossenheider, 1964, p. 12). Many of the fossil records are from west of its present range.

Habitat.—This shrew is found in moist soils with humus which is covered with leaves or other litter. Recent western records are from moist stream valleys that support some trees and shrubs.

The following specimens were taken on the Jones ranch at locality UM-T1-57; No. 45834, parts of a right and a left lower jaw with the alveoli of M_2 and M_3 ; No. 45835, left lower incisor; No. 45850, a left upper incisor; No. 45851, a right P^4 ; No. 45852, right M^1 and M^2 ; No. 45853, left M_1 ; and No. 45855, a left P_4 . A right lower incisor, No. 39803, and a right M_1 or M_2 , No. 45709, were recovered at locality UM-T1-58 on the Patterson ranch.

No teeth were as large as those reported by Paulson (1961) from the Cudahy fauna of Kansas. At least three of the teeth are as large as in

individuals of *Blarina brevicauda*. A left M_1 (No. 45853) has an antero-posterior length of 2.0 mm; the greatest width is 1.25 mm. A right P^1 (No. 45851) and a left P_4 (No. 45855) are as large as those of *B. b. brevicauda*. The other specimens are smaller, and the size of *Blarina b. carolinensis* (Bachman). Better material is needed to determine whether there were two species of *Blarina* present in the fauna or whether the difference in size is due to a greater range of individual variation within the population at that time. We have not observed as great a variation as the above in other Pleistocene faunas or in any Recent population of *Blarina* from a given locality.

Family Talpidae

Scalopus sp.

Part of a right humerus (No. 46172) of a mole was recovered at locality UM-T1-58 on the Patterson ranch.

Order RODENTIA

Family Sciuridae

Citellus sp.

(Fig. 8E)

Six teeth, No. 45846, of a ground squirrel were taken at locality UM-T1-57 on the Jones ranch and four teeth, Nos. 39646 and 39787, were recovered at locality UM-T1-58 on the Patterson ranch. The teeth represent a ground squirrel approximately the size of *Citellus franklinii* (Sabine).

Family Geomyidae

Geomys tobinensis (Hibbard)

(Fig. 8J)

Six teeth, No. 39653, and 45 teeth, No. 45838, were taken at locality UM-T1-57 on the Jones ranch. Two teeth, No. 39642, 3 teeth, No. 39647, 9 teeth, No. 39786, 16 teeth, No. 45711, and part of left jaw, No. 45861, with $P_4 - M_2$, are all from locality UM-T1-58 on the Patterson ranch.

The isolated teeth and the lower jaw (Fig. 8J) are comparable in size and dental characters to those of *Geomys tobinensis* from the Cudahy fauna of Kansas (Hibbard, 1944, p. 736).

Family Heteromyidae

Perognathus sp.

An isolated left M^1 (No. 45839) of a large species of pocket mouse was

taken on the J. E. Jones ranch at locality UM-T1-57. The tooth is as large as that of *Perognathus hispidus spilotus* (Merriam).

Family Cricetidae

Onychomys sp.

(Fig. 8F)

A left M_1 (No. 45837, Fig. 8F) of a young grasshopper mouse was recovered on the J. E. Jones ranch at locality UM-T1-57. The tooth is smaller than the M_1 of *Onychomys fossils* Hibbard from the Borchers local fauna. The anteroposterior length of M_1 is 1.75 mm. The greatest width is 1.25 mm. This is the first record of *Onychomys* from the Cudahy fauna.

Ondatra annectens (Brown)

Distribution.—Cudahy fauna of Kansas and Texas; Conard Fissure local fauna of Arkansas. Closely related species are from the Grand View local fauna of Idaho, and the Port Kennedy local fauna of Pennsylvania.

Habitat.—This species is thought to have inhabited marshy areas and stream borders as do its living relatives.

At locality UM-T1-57 on the Jones ranch there were recovered 2 right M^2 , No. 45730, and at locality UM-T1-58 on the Patterson ranch there were taken a left M_1 , a right M_3 , and left M^2 , No. 39789, and No. 45710, a left M_1 and M_2 , and a left M^3 .

The dental pattern and the occlusal size of the teeth agree with those of the small muskrat from the Cudahy fauna of southwestern Kansas.

Ondatra sp.

Recovered with the teeth of *Ondatra annectens* on the J. E. Jones ranch at locality UM-K1-57, was a fragment containing the three posterior triangles of a left M^1 (No. 46340) of a young adult muskrat. The tooth is not only larger but is higher crowned than teeth of *O. annectens*. The enamel of the first labial triangle has a dentine tract extending from the base of the tooth to within 0.75 mm of the occlusal surface. The posterior triangle (or second labial) has the dentine tracts extending from the base of the tooth to the occlusal surface on the labial and posterior sides.

An M^1 of *O. annectens* in a comparable stage of wear has a shorter crown and there is no dentine tract on the labial side of the first labial triangle (second triangle). The posterior triangle (fourth) has a dentine

tract extending upward from the base of the tooth, 1.5 mm.; and the posterior dentine tract where the triangle rests against the anterior loop of M^2 lacks 2.0 mm of extending to the occlusal surface.

This is the first evidence of a larger and more advanced muskrat in the Cudahy fauna. The specimen approaches the dental pattern of *Ondatra zibethica* (Linnaeus). For a detailed discussion of the development of size of muskrat teeth and the increase in height of the dentine tract see Semken (1965, pp. 154-55).

Microtus paroperarius Hibbard

(Fig. 8A)

A right M_1 (No. 45845, Fig. 8A); and a right M_2 (No. 46227) were collected in 1961 on the Jones ranch at locality UM-T1-57. M_1 consists of a posterior loop, four alternating closed triangles and a fifth triangle that opens broadly into the anterior loop. The occlusal length of M_1 is 2.8 mm. M_2 consists of a posterior loop and four closed triangles.

Remarks.—This was the most abundant microtine associated with the Cudahy fauna in Meade County, Kansas. Paulson (1961) reported the recovery of parts of 723 individuals in the summer of 1958.

Pedomys llanensis Hibbard

(Figs. 8B-D)

Numerous isolated upper and lower molars; Nos. 39643-45, 39650, 39788, 45712-13 were taken at locality UM-T1-58 on the Patterson ranch. Nos. 45827-33, 45841, 45844, and 45847 were taken at locality UM-T1-57 on the Jones ranch. Included in this lot of teeth are 18 left M_1 s, and 15 right M_1 s.

Of thirteen adult M_1 s, the range in the anteroposterior occlusal length is 2.6 to 3.1 mm, average 2.8 mm (Figs. 8B and C). The range of measurements taken by Paulson (1961) on 3 M_1 s, is 2.8 to 3.0 mm, average 2.9 mm. The occlusal pattern of M_2 recovered with the Vera local faunule consists of a posterior loop and four alternating triangles with the third and fourth triangles confluent.

Remarks.—In the Cudahy fauna from Meade County, Kansas, Paulson (1961) reported from the material recovered in the summer of 1958, the presence of 206 individuals of *Pitymys meadensis* Hibbard, and 4 individuals of *Pedomys llanensis*. The count was based on M_1 s. *Pitymys meadensis* was not recognized in the Vera faunule.

The rarest microtine found in the Cudahy local fauna in southwestern Kansas becomes the dominant species 270 miles to the south, by east, in Knox County, Texas.

The specimens from Kansas were taken in the High Plains region at approximately 2,550 feet elevation, while the fauna recovered in Knox County is located east of the High Plains in the Osage Plains of the Central Lowland Province (Fenneman, 1931) at an elevation of approximately 1,450. It is not known what factors determined the distribution of *Pedomys llanensis* at the time it lived. Besides the difference in elevation, the only other known difference in the environment of the two areas, was the cooler summers and the cooler winters in Meade County, Kansas, at the time the Cudahy fauna lived.

SUMMARY

The fossils from the Seymour Formation have been separated into two faunal groups, (1) the Gilliland local fauna from the sand, gravel and reddish sandy silt below the Pearlette volcanic ash and, (2) the Vera local faunule of the Cudahy fauna from the gray silty clay just below the Pearlette ash.

The presence in the Gilliland local fauna of the giant land tortoise (*Geochelone*) which is now confined to subtropical and tropical regions establishes the fact that a much warmer interval, than now, occurred in north central Texas during part of Kansan time prior to the deposition of the Pearlette ash. The climate at the time this fauna lived is considered to have been frost free, mesothermal, moist, subhumid and of the maritime type.

The Vera local faunule (of the Cudahy fauna) was taken from silt and clay just below the Pearlette ash near the top of the Seymour Formation. This faunule consists chiefly of mollusks. Forty-three of the forty-five species recovered now occur as sympatric species in eastern South Dakota, southwestern Minnesota and extreme northwestern Iowa. We have used the region of sympatry for the interpretation of summer climate for the region in Texas. For the interpretation of the winter temperature we have used the most southern element recognized, the cliff frog (*Syrrophus* cf. *S. marnocki*). It is assumed that the winter temperatures were not colder than the present climate of that part of Texas, if as cold, because the large *Geochelone* (land tortoise) occurs in the Borchers local fauna of Yarmouth age in Meade County, Kansas, at an elevation of 2,500 feet. The climate in which the Vera local faunule lived is considered to have had a low degree of continentality and was moist sub-

humid of the maritime type. Winter climatic data for the region of sympatry of living species can not be applied to the region of the fossil fauna.

The past distribution of the giant land tortoises in the United States during the Pleistocene, indicates that the strong continentality of our present climate was developed during the late Wisconsin time.

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PLATES

EXPLANATION OF PLATE I

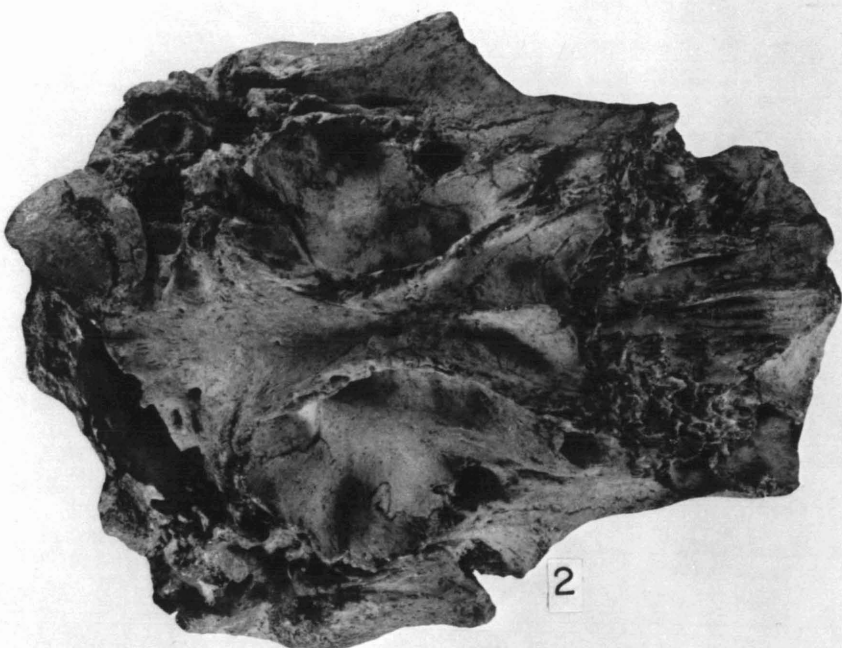
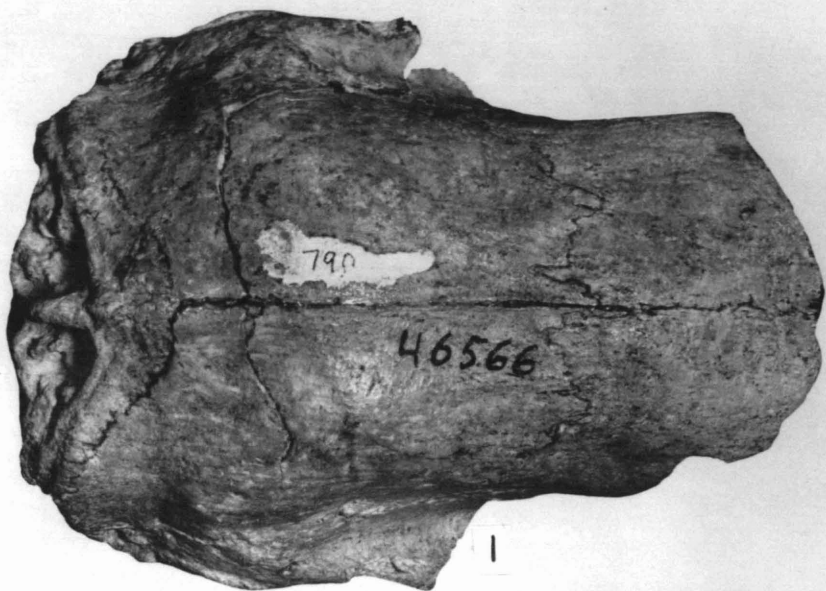
FIG. 1. Designated type section of the Seymour Formation on the east side of Farm Road 267, approximately 0.9 of a mile north of U. S. Highway 82, in Knox County. Man standing on Permian deposits.

FIG. 2. Residual gravels from the Seymour Formation.

PLATE I



PLATE II



EXPLANATION OF PLATE II

	PAGE
<i>Nothrotherium</i> cf. <i>N. shastense</i> Sinclair	23

FIGS. 1, 2. Posterior part of skull, No. 46566, dorsal and ventral views, $\times 0.65$.

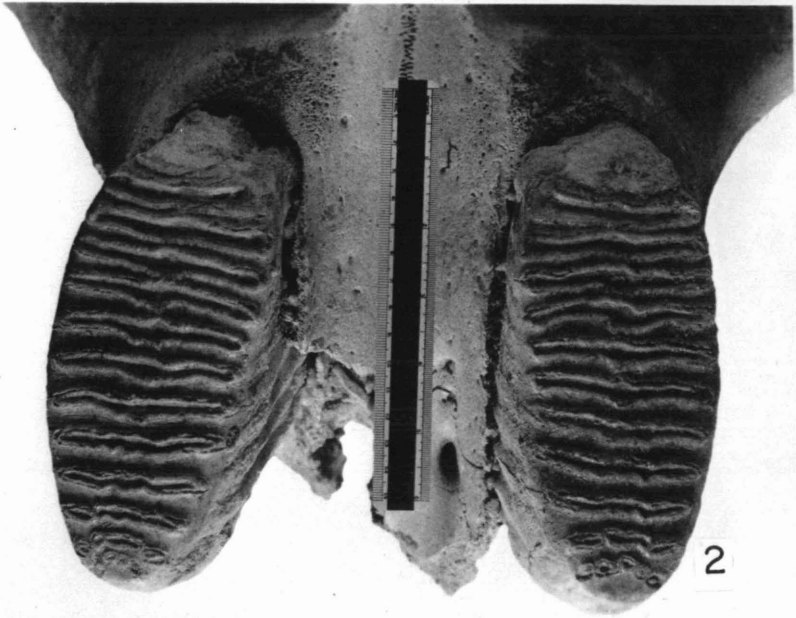
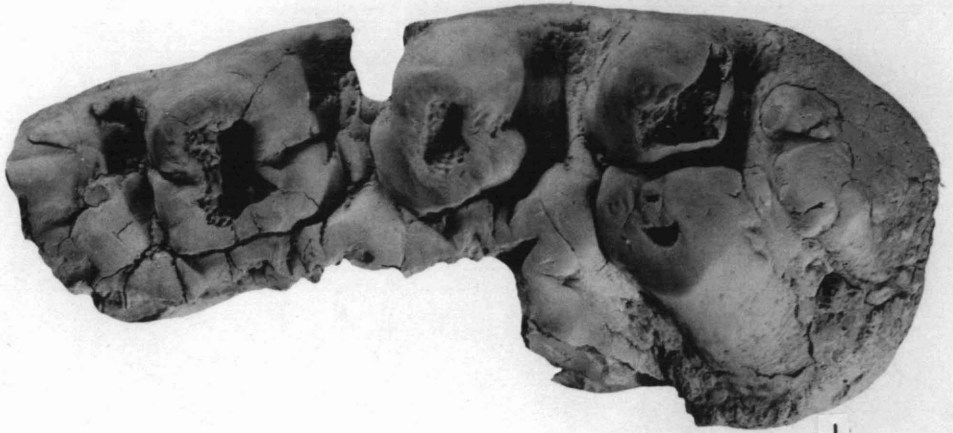
EXPLANATION OF PLATE III

	PAGE
<i>Paramylodon harlani</i> (Owen)	25
Right humerus, No. 46575, posterior view, \times 0.37.	

PLATE III



PLATE IV



EXPLANATION OF PLATE IV

	PAGE
<i>Cuvieronius</i> sp.	27
FIG. 1. Part of a left M_3 , occlusal view, approx. $\times \frac{3}{4}$.	
<i>Mammuthus imperator haroldcooki</i> Hay	28
FIG. 2. Part of palate, No. 46641, with right and left M^2 , occlusal view, $\times 0.37$.	

EXPLANATION OF PLATE V

	PAGE
<i>Titanotylopus?</i>	31

FIGS. 1, 2. Part of a 5th or 6th cervical vertebra, MU 1862, anterior and lateral views, approx. $\times \frac{1}{2}$.

PLATE V



