

# Pleistocene Mammals of the Clear Creek Local Fauna, Denton County, Texas

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## ABSTRACT

Mammalian fossils collected from the second terrace above Clear Creek in Denton County, Texas, are here described as the "Clear Creek local fauna." Ecological inferences drawn from current habits and ranges of the extant species, in addition to a radiocarbon date and certain stratigraphic data, suggest that the fauna belongs to the Sangamon interglacial interval (*circa* 25,000 B.P. to 40,000 B.P.)

## THE CLEAR CREEK AREA

Late in 1960 Ritchie found macrovertebrate fossils in an abandoned gravel pit along Clear Creek north of Denton, Texas. A small collection was made, and zones of concentrated snail tests were also noted. During the following year approximately ten tons of matrix was removed from these zones and washed for microvertebrate remains, using a modified version of the technique outlined by Hibbard (1949a). The locality is here designated as the Trietsch Pit (pronounced Treech).

Clear Creek rises in eastern Montague County, runs southeastward through Cooke County, enters Denton County at its northwest corner, and joins Elm Fork of the Trinity River northeast of the city of Denton. The length of the creek is about fifty miles, and the collecting locality is four miles from the mouth. The Cross Timbers, a belt of blackjack and post oak separating the Black Prairie to the east from the Grand Prairie to the west, lie immediately eastward and can be seen from the Trietsch Pit. In the immediate vicinity of the pit, timber is restricted to lowlands along the streamways. The soil and mantle on the divides are rocky and shallow, and the vegetation consists mostly of short grasses. Annual rainfall aver-

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\* Shuler Museum of Paleontology, Southern Methodist University. We should like to express our appreciation to Dr. Ernest L. Lundelius of the University of Texas, who visited the site and offered valuable suggestions; to John A. Doering, who, in the absence of good topographic sheets, determined the exact elevations in the area; to Dr. Claude W. Hibbard, University of Michigan, for examining the *Peromyscus* material, for identifying the extinct white-footed mouse and for offering additional suggestions; to Drs. E. R. Hall and J. Knox Jones of the University of Kansas for the loan of comparative material; and to Mackey Coker for preparing the photographic plates. We are also indebted to B. Reed Hoover and Frank Schneider for aid in making the collections. Kathleen Crow, Kathleen Gilmore, Norma Hoffrichter, and Lorrain McGraw assisted in sorting the concentrate.

ages about thirty-five inches. The area falls within the "Texan" biotic province (Blair, 1950, p. 100).

Only two persistent terraces are found along Clear Creek. Although future geological work may prove the numbers to be ambiguous, we are calling the higher of the two terraces the T-2; the lower, the T-1; and the present floodplain, T-0.

The floodplain is capped with Recent dark sandy loam overlying sand and gravel of probable Pleistocene age. Pit operators report finding large bones in the sand and gravel which almost certainly were proboscidean.

The T-1 stands ten feet above the present floodplain and 35 feet above normal stream grade. It is capped with buff-gray sand underlain by three feet of red sandy clay. Artifacts found in these units were submitted to W. W. Crook Jr. and R. K. Harris, who identified them as Carrollton Focus types. The Carrollton Focus occurs in almost identical material of the Trinity River's T-1 terrace downstream in Dallas County. A radiocarbon date of  $5,945 \pm 200$  B.P. was reported for this focus by Crook and Harris (1959). Gravel below the artifact-bearing horizon contains proboscidean remains and may belong to the same Pleistocene deposit as the gravels underlying the present floodplain.

*Trietsch Pit.*—This excavation, located on the farm of Mr. Philip Trietsch, originally bottomed on the Cretaceous bedrock. The floor has since been covered by materials slumped from the walls and the strip piles.

Basal gravels, six to eight feet thick, are made of fossil shells and pebbles of limestone derived from the Fredricksburg and Washita groups of Cretaceous age.

Overlying the basal gravel is six to eight feet of coarse to fine sandy clay, iron-stained in some places and interbedded with freshwater marl elsewhere. It is from this zone that the Clear Creek fauna was collected.

The terrace is capped with fifteen feet of yellow-buff clay containing scattered tiny nodules of caliche. The elevation of the terrace at this point is 620 feet compared to 573 for the floodplain and 548 for normal stream grade. It is evident that deposition of at least part of the sandy clay exposed here was made in a small pond on the T-2 floodplain.

*Opitz Pit* (pronounced Opez).—In the summer of 1961, Mr. Reed Hoover located another gravel excavation in the T-2 terrace less than one mile downstream from the Trietsch Pit. The pond deposits are not in evidence here, although the gravel and capping clay

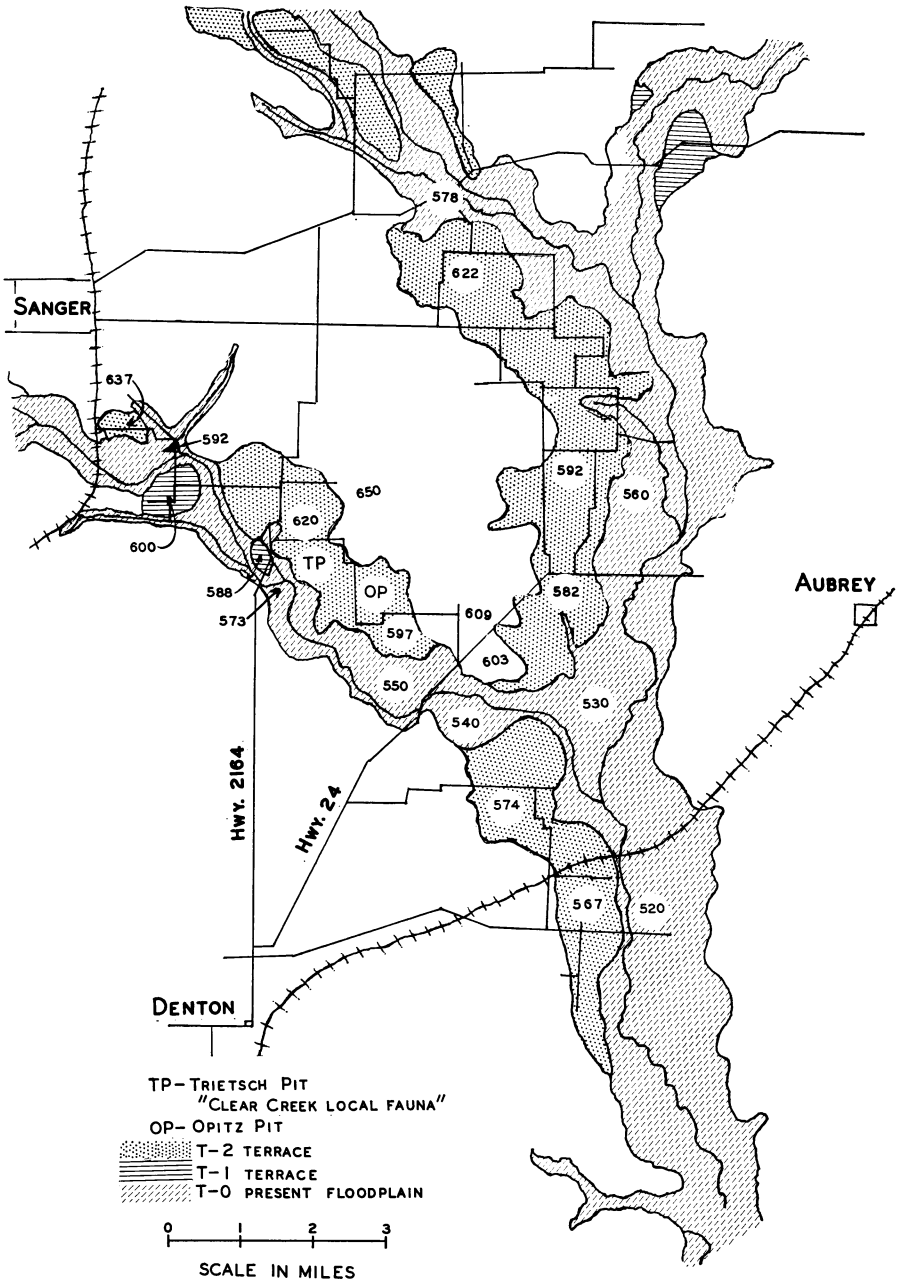


Figure 1.—Map showing the floodplains and terraces of Clear Creek and the Trinity River.

cannot be distinguished from those units at the Trietsch Pit. No small mammals or mollusks were recovered here, and all the vertebrate fossils that were found came from the basal gravel. These include: *Megalonyx* cf. *M. brachycephalus*, *Bison* sp. (large), *Camelops* sp., *Odocoilus virginianus*, *Equus* cf. *E. midlandensis*, *Tapirus* sp., and *Elephas columbi*. The tapir and ground sloth indicate a more moist situation than the Clear Creek local fauna suggests. This is reminiscent of the relation between the three fossiliferous members of the T-2 terrace on the Trinity River. Although that entire terrace has been considered to form a single sequence of deposits, Slaughter *et al.* (1962) suggested that the basal gravels (Hill) and the overlying cross-bedded sands (Lower Shuler) formed under moister conditions than the capping clay (Upper Shuler) and black gumbo (Richards).

## MAMMALS OF THE CLEAR CREEK LOCAL FAUNA

## Check List

## Order INSECTIVORA

*Notiosorex crawfordi* (Coues)

or

*Cryptotis parva* (Coues)

## Order EDENTATA

\**Dasybus bellus* (Simpson)

## Order RODENTIA

*Cynomys ludovicianus* (Ord)

*Spermophilus* sp.

*Sciurus* sp. cf. *S. niger* Linnaeus

*Geomys* sp.

*Perognathus hispidus* Baird

*Castor canadensis* Kuhl

*Sigmodon hispidus* (Say and Ord)

?*Reithrodontomys* sp.

*Onychomys leucogaster* (Weid-  
Neuweid)

\**Peromyscus cochrani* Hibbard

*Peromyscus* near *maniculatus*  
(Wagner)

*Neotoma* sp.

*Ondatra zibethicus* (Linnaeus)

*Microtus pinetorum* (Le Conte)

or

*M. ochrogaster* (Wagner)

\**Synaptomys australis* Simpson

## Order CARNIVORA

*Procyon lotor* (Linnaeus)

*Bassariscus astutus* (Lichtenstein)

*Canis latrans* cf. *C. l. barriscrooki*

Slaughter

felid (large)

## Order PROBOSCIDEA

\**Elephas columbi* Falconer

## Order LAGOMORPHA

*Sylvalagus* sp.

## Order ARTIODACTYLA

†? *Platygonus* sp.

† *Camelops* sp.

*Odocoilus virginianus*

Zimmermann

\* *Bison* sp., cf. *B. latifrons* (Harlan)

† *Breameryx* sp.

## Order PERISSODACTYLA

\* *Asinus conversidens* (Owen)

\* *Equus* sp. (large)

\* *Equus* sp. (medium)

† Extinct genus

\* Extinct species

## Discussion of Species

*Notiosorex crawfordi* (Coues)

or

*Cryptotis parva* (Coues)

Plate 1, fig. F

*Referred specimens.*—Left lower jaw containing m1; SMUMP 60637. Right lower jaw containing p4 and m1; SMUMP 60638.

*Discussion.*—The size and form of these specimens match both *Notiosorex* and *Cryptotis*, but the parts preserved are inadequate for positive identification. *Cryptotis* has been reported from adjoining counties and probably lives in Denton County today. *Notiosorex crawfordi* lives some distance to the west, but unlike *C. parva* is sympatric with all of the other Clear Creek faunal elements, *Bassariscus*, *Cynomys*, and *Onychomys*. It seems probable, therefore, that it is the desert shrew that is here represented.

*Dasypus bellus* (Simpson)

*Referred specimen.*—Buckler scute; SMUMP 60626.

*Discussion.*—Slaughter (1961a) suggested that the habitat requirements of *D. bellus* were probably so similar to those of its modern counterpart, *D. novemcinctus*, that the latter's known climatic limitations may be used to infer the environment of the extinct species. The most important of these range-restricting factors are the armadillo's inability to withstand long periods of low temperature, and the lack of insects suitable to the armadillo's diet in extremely arid areas.

*Cynomys ludovicianus* (Ord)

*Referred specimens.*—Isolated teeth; SMUMP 60628.

*Discussion.*—The eastern border of the black-tailed prairie dog's range is over fifty miles west of Denton County. It lives on open grass prairies, where there is clay or similar material that will support tunnels. If it lived in the area today it would be restricted to the terraces, as the divides are far too rocky. If the uplands were denuded to their present rocky condition either before or shortly after the prairie dog became locally extinct, there would not be a suitable habitat connecting the present range to the terrace deposits where prairie dog requirements prevail today.

*Spermophilus* sp.

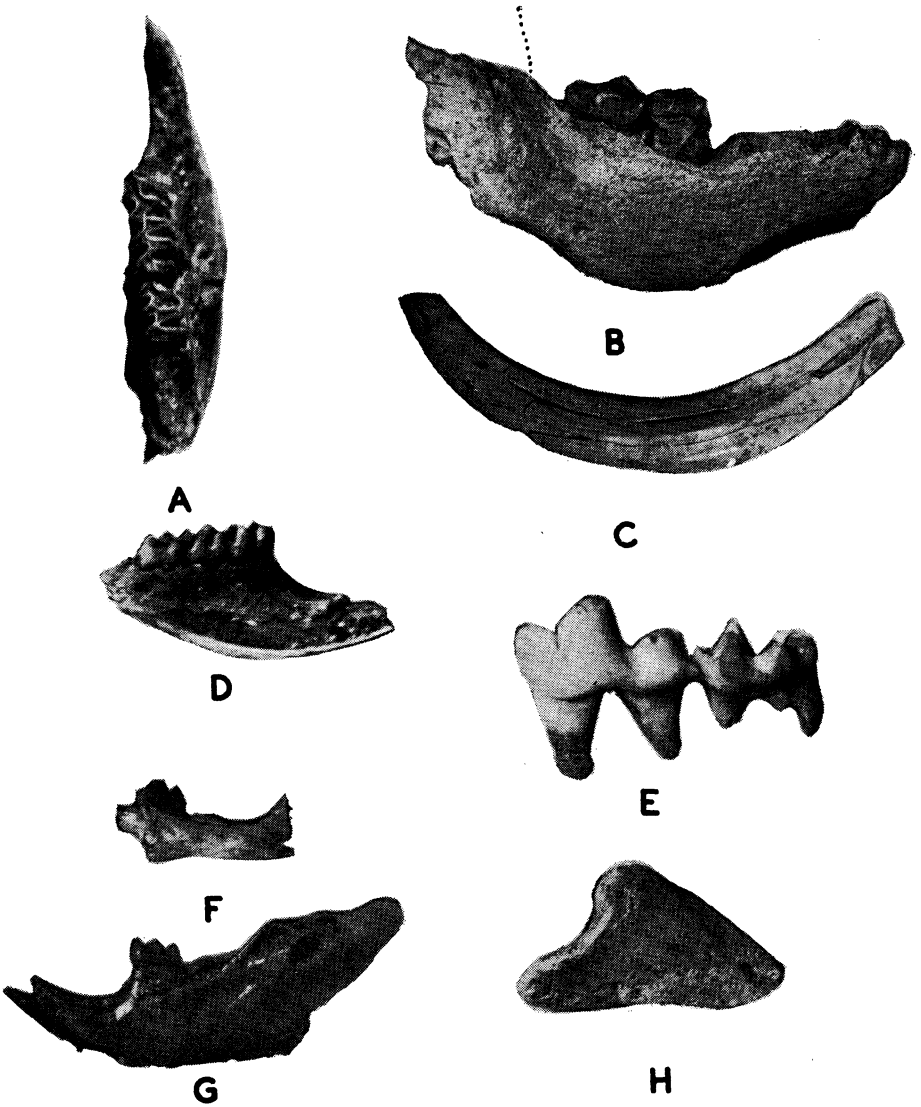
*Referred specimens.*—Isolated teeth; SMUMP 60711.

*Discussion.*—There are several species of ground squirrels in Texas, all of which range west from Denton County. Only one, *S. tridecemlineatus*, lives in the area today and this species is near the eastern edge of its range. Both *S. mexicanus* and *S. spilosoma* have ranges coinciding with the Clear Creek local faunal elements, *Onychomys*, *Cynomys*, and *Bassariscus*.

? *Reithrodontomys* sp.

*Referred specimen.*—Toothless lower jaw; SMUMP 60716.

*Discussion.*—Both the gray harvest mouse and the long-tailed harvest mouse are found in the area today and both inhabit grassy fields, which were no doubt present during Clear Creek times. Another possibility is that this specimen represents *Baiomys* which, like the harvest mouse, has been recorded as living in the area.



## PLATE 1

- Figure A — *Microtus pinetorum* or *M. ochrogaster*. Occlusal view of lower jaw; SMUMP 60642. Approximately  $\times 5$ .
- B — *Canis latrans* cf. *C. l. harriscrooki*. Labial view of right lower jaw fragment; SMUMP 60709.  $\times 1$ .
- C — ?*Platygonus* sp. Left lower canine; SMUMP 60448.  $\times 1$ .
- D — *Peromyscus* near *maniculatus*. Labial view of left lower jaw; SMUMP 60700. Approximately  $\times 5$ .

*Neotoma* sp.

*Referred specimens*.—Isolated teeth; SMUMP 60627.

*Discussion*.—*N. floridana*, the only wood rat in the modern fauna of Denton County, is considered a woodland dweller. However, both *N. micropus* and *M. albigula* are associated in western Texas with *Onychomys* and *Cynomys*, both elements of the "Clear Creek" assemblage. Therefore it is possible that two or more of the Recent species are represented.

*Onychomys leucogaster* (Weid-Neuweid)

*Referred specimen*.—An isolated m1; SMUMP 60699.

*Discussion*.—The short-tailed grasshopper mouse lives in the open semi-arid grasslands of the western half of the United States, but is not found within 150 miles of Denton County.

*Perognathus hispidus* Baird

*Referred specimen*.—Left lower jaw containing p4; SMUMP 60636.

*Discussion*.—The hispid pocket mouse is found in almost all parts of Texas today. Although it lives in sandy fields where vegetation is moderate to sparse, it is often found near brush or at the edge of woodlands.

*Castor canadensis* Kuhl

*Referred specimen*.—Isolated cheek tooth; SMUMP 60712.

*Discussion*.—No differences were noted between the fossil tooth and those of the species which lived in the area into historic times. Beavers are of little use in inferring climate as they are capable of "building" their preferred habitat.

*Sigmodon hispidus* (Say and Ord)

*Referred specimens*.—Isolated teeth; SMUMP 60633.

*Discussion*.—The hispid cotton rat is an inhabitant of tall grass meadows or glades which still exist as gaps in woodlands along the creeks of Denton County. As the cotton rat is apparently a relatively late immigrant to the U.S., its presence in fossil faunas may be of considerable importance. Its oldest appearance evidently is in the Lower and Upper Shuler faunas referred to the last major interglacial (?Sangamon) by Slaughter *et al.* (1962).

*Peromyscus cochrani* Hibbard

Plate 1, fig. G

*Referred specimen*.—Left lower jaw containing m1 and m3; SMUMP 60698.

*Discussion*.—The two previous reports of this extinct species are from deposits in southern Kansas: the Jinglebob local fauna and the Cragin Quarry local fauna. The former suggests a moister climate than that of

E — *Bassariscus astutus*. m1 and m2; SMUMP 60708. Approximately x2.

F — *Notiosorex crawfordi* or *Cryptotis parva*. Labial view of left lower jaw fragment; SMUMP 60637. Approximately x5.

G — *Peromyscus cochrani*. Labial view of left lower jaw fragment; SMUMP 60698. Approximately x5.

H — *Breameryx* sp. Hoof, SMUMP 60499. x2.

the latter. Thus little can be suggested in the way of habitat preference for this species, but it is interesting to note that both of the earlier occurrences are considered Sangamon by Hibbard (1955) and Hibbard and Taylor (1960).

*Peromyscus near maniculatus* (Wagner)

Plate 1, fig. D

*Referred specimens.*—Left lower jaw and maxillary fragment containing M2 and M3; SMUMP 60700.

*Discussion.*—Hibbard provisionally identified these specimens as a deer mouse closely related to *P. maniculatus*. The specimen apparently represents a form slightly smaller than *P. m. pallescens*, the deer mouse living in the area today.

*Ondatra zibethicus* (Linnaeus)

*Referred specimens.*—Isolated teeth; SMUMP 60630.

*Discussion.*—The muskrat, like the beaver, seems to have no preference as to climate, as long as adequate surface water is available. Muskrats now live along intermittent streams west of Denton County.

*Microtus pinetorum* Le Conte

or

*M. ochrogaster* (Wagner)

Plate 1, fig. A

*Referred specimens.*—Fifteen m1's and other isolated teeth; SMUMP 60643. Lower jaw containing m1 and m2; SMUMP 60642.

*Discussion.*—Isolated teeth and even lower jaws of these two species apparently cannot be distinguished, in spite of the fact that they belong to different sub-genera. There are no records of either species from Denton County, but *M. pinetorum* is present a short distance to the east. *M. ochrogaster* ranges currently some distance to the northwest. The former is essentially a woodland dweller and the latter prefers open grasslands. As both habitats are suggested for Denton County during "Clear Creek" times, it is possible that both species are represented.

*Synaptomys australus* Simpson

*Referred specimens.*—Isolated teeth; SMUMP 60461. Palate; SMUMP 60706.

*Discussion.*—The fossil species, *S. australus*, is distinguished from the living lemming, *S. cooperi*, only by its larger size. The isolated teeth from Clear Creek are within the size range of *S. cooperi* but may represent immature individuals. The palate, however, belongs to the fossil species. The length of the superior cheek tooth series, as indicated by the alveoli, is between 9 mm and 10 mm. This compares favorably with the length of 8.4 mm for an inferior series described by Olsen (1958) and referred to *S. australus*.

Because of the apparent close relationship between these two species, a cooler environment, such as preferred by *S. cooperi*, has been suggested for fossil faunas that include *S. australus*. If this supposition is correct *S. australus* is the only discordant element in the group of species that suggests "Clear Creek" climate was warmer than the present climate.



*S. australis* is being found in increasing numbers in fossil faunas as far south as Mexico. It seems likely that the extinct species did not have identical preferences with *S. cooperi*.

*Procyon lotor* (Linnaeus)

*Referred specimen*.—Isolated m1; SMUMP 60452.

*Discussion*.—With an antero-posterior diameter of 11.1 mm and a transverse diameter of 7.1 mm, this specimen is at the upper size limit for the living species. This was also found to be true of the more abundant material of *P. lotor* from the Dallas County Sangamon deposits (Slaughter, *et al.*, 1962).

*Bassariscus astutus* (Lichtenstein)

Plate 1, fig. E

*Referred specimen*.—Right lower jaw fragment containing m1 and m2; SMUMP 60708.

*Discussion*.—Although the ringtail has been recorded as living east of Denton County at lower latitudes, it is essentially a western and south-western animal. The only other fossil occurrence of this species outside of its current range is at Port Kennedy, Pa. This occurrence is also considered as interglacial (Yarmouth; see Hibbard, 1957).

*Canis latrans* cf. *C. l. harriscrooki* Slaughter

Plate 1, fig. B

*Referred specimen*.—Right lower jaw fragment containing m2 and posterior heel of m1; SMUMP 60709.

*Discussion*.—The holotype of *C. l. harriscrooki* is a lower jaw collected from the Lewisville local fauna, thirty miles south of the Clear Creek locality. The two assemblages appear to be closely related.

The diagnostic premolar is missing from the Denton County specimen, but the position of the last molar alveoli (closer to the ascending ramus, Slaughter, 1961b) more closely matches the Sangamon than the Recent coyote.

Large felid

*Referred specimen*.—First phalanx; SMUMP 60707.

*Discussion*.—This specimen is smaller than those of *Smilodon californicus*, but the same may be said of all *Smilodon* material from Texas. It is also possible that the Denton County specimen represents a puma.

*Elephas columbi* Falconer

*Referred specimen*.—Superior molar; SMUMP 60705.

*Discussion*.—Seven enamel plates bisect a one hundred millimeter line drawn antero-posteriorly on the grinding surface, thus suggesting this species rather than *E. imperator*, the other species sometimes listed in southern fossil faunas.

*Camelops* sp.

*Referred specimens*.—Third lower incisor; SMUMP 60714. Middle portion of metatarsal; SMUMP 60625.

*Discussion*.—The measurements of both the incisor and the metatarsal fragment (43mm, transverse diameter at mid-shaft) agree exactly with

the same elements collected at Dallas, where two skulls were referred to *C. buerfanensis dallasi* Lull (Lull, 1921; Slaughter *et al.*, 1962).

*Odocoileus virginianus* Zimmermann

*Referred specimens.*—Isolated M2; SMUMP 60715. Antler fragments; SMUMP 60540.

*Discussion.*—The tooth approximates the size of those in *O. v. texanus*. The diagnostic tooth (m3) of *O. v. aplodon*, a Sangamon race from Texas, has not been recovered.

? *Platygonus* sp.

Plate 1, fig. C

*Referred specimen.*—Left lower canine; SMUMP 60448.

*Discussion.*—This specimen was compared with material of both *Mylobyus* and *Platygonus*, on deposit at the University of Texas, by Dr. Ernest Lundelius. It was found to match *Platygonus* canines from Blackwater Draw, New Mexico, more closely than any other. However, the generic reference is not considered conclusive, even though *Platygonus* is present in the Upper Shuler fauna of similar age collected thirty miles south of Clear Creek.

*Breameryx* sp.

Plate 1, fig. H

*Referred specimen.*—Hoof; SMUMP 60499.

*Discussion.*—Observed hooves of very young artiodactyls are rather porous and spongy in appearance, whereas this fossil is quite dense and firm. Considering the specimen's size, and on the supposition that it represents an adult, it could only belong to *Capromeryx* or *Breameryx*. Reference is made to *Breameryx* as this genus is present in the Shuler faunas downstream on the Trinity River.

*Equus* sp. (large)

*Referred specimens.*—Right P2; SMUMP 60704.

*Discussion.*—The specimen at hand was compared with numerous teeth referred by various workers to three different species. The material examined included: (1) A series from the Pitts Bridge locality on the Brazos River, which is deposited in the Texas A&M College Museum. These teeth were referred to *E. complicatus* by O. P. Hay; (2) teeth from the Seymour formation referred by Dalquest and Hibbard to *E. scotti*; (3) the type of *E. midlandensis* deposited at the Texas Memorial Museum; and (4) teeth referred to *E. midlandensis* by Slaughter *et al.* (1962), which were collected from the Sangamon terrace in Dallas County, Texas.

Hibbard and Taylor (1960, p. 193) suggested that *E. complicatus* is synonymous with *E. scotti*. The Denton County specimen, like the Sangamon material from Dallas County, is slightly larger than the type of *E. midlandensis*, but post-cranial materials of the largest size from these deposits are not as large as those associated with Dalquest and Hibbard's *E. scotti* teeth. Under the circumstances it seems best not to refer the large "Clear Creek" horse to either species.

*Asinus conversidens* (Owen)

*Referred specimens.*—RM2; SMUMP 60574. LP2; SMUMP 60516.

*Discussion.*—Although this is the most abundant horse in the Lower

Shuler faunas downstream at Dallas, it has not been recovered from Upper Shuler localities, where horse material is certainly not lacking. The presence of *A. conversidens* in the Clear Creek local fauna is thus not consistent with the closer faunal similarity between Clear Creek and the Upper Shuler local faunas. It may be that environmental conditions changed slightly earlier upstream on small creeks than in the main river valleys.

*Bison* sp., cf. *B. latifrons* (Harlan)

*Referred specimen*.—M2; SMUMP 60713.

*Discussion*.—The landowner, Mr. Trietsch, tells of his sons' discovery of a huge "buffalo" skull in the pit wall several years ago. They excavated the specimen and carried it to Mr. Trietsch's home, where they measured the horn core spread at seven feet, tip to tip. The skull was left in the weather and has long since disintegrated. The apparent large size as described separately by members of the Trietsch family almost certainly places the specimen with the giant species, *B. latifrons*.

#### ENVIRONMENT

If one does not consider the preferences of the fossil lemming species as necessarily identical with those of the living species, there is not a single mammal in the Clear Creek local fauna that would be considered a northern type. On the contrary, the only areas in which all of the extant species may be found living today are northwestern and southwestern Texas, where the annual rainfall is from five to ten inches less than in Denton County (See fig. 2). The positively identified species, *Bassariscus astutus*, *Onychomys leucogaster*, and *Cynomys ludovicianus*, as well as the provisional faunal member, *Notiosorex crawfordi*, are all presently restricted to areas west of Denton County. It may also be significant that *Bassariscus*, *Dasypus*, and *Sigmodon* had their origin south of the United States.

If the vole that is present is *M. ochrogaster*, rather than *M. pine-torum*, it too suggests a prairie environment. If, however, it is the latter—an eastern type essentially—the climate here suggested is not negated, as there is an isolated population of pine voles still living in southcentral Texas associated with *Cynomys* and *Bassariscus*.

It would appear that during the time of the Clear Creek local fauna, winters were at least as warm as today, or perhaps warmer. Annual rainfall was five to ten inches less, unless warmer winter temperatures made the moisture less effective.

#### AGE

The warm-dry conditions suggested by the current ranges of the extant species are more suggestive of an interglacial-interstadial climate than of a glacial stage. An apparently reliable report of the giant bison, *B. latifrons*, reduces the probability of an interstadial

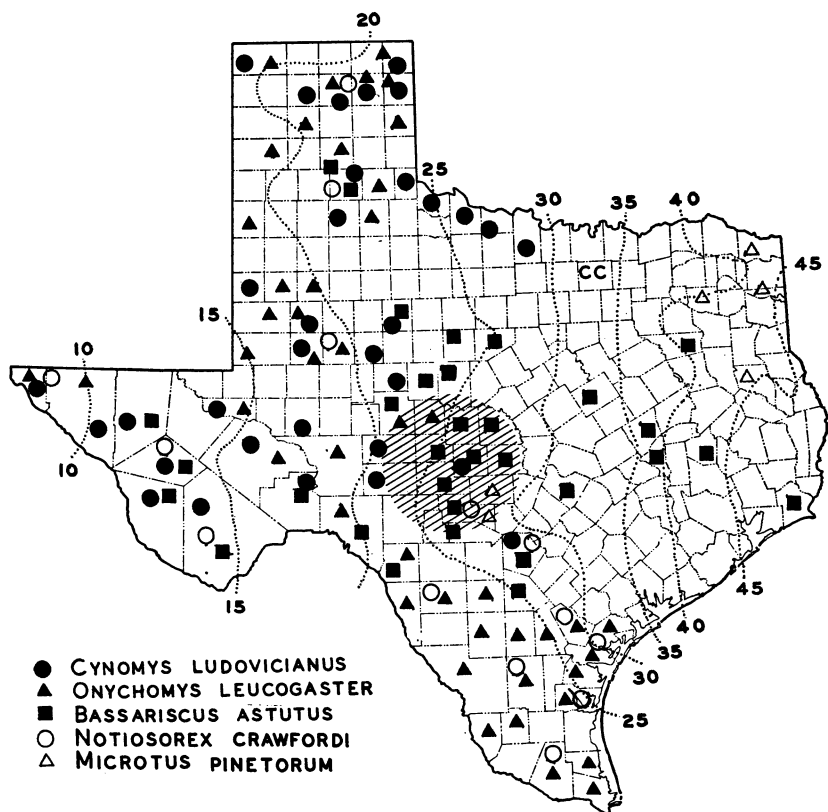


Figure 2.—Map showing modern county reports of the significant extant mammalian species from the Clear Creek local fauna. Shaded area shows current range overlap.

within the Wisconsin. Moreover the presence of bison has not been demonstrated in pre-Illinoian faunas. All things considered, an assignment of the Clear Creek local fauna to the Sangamon seems to be the best that can be made in the light of present evidence.

Further evidence for this assignment is found in the relatively small numbers of extinct small mammals. Of the eighteen Clear Creek mammals which are smaller than a raccoon, only three are extinct. In the case of the Borchers Fauna, considered by Hibbard (1949b) as Yarmouth in age, fifteen of twenty small mammals are extinct.

Through the courtesy of Dr. E. E. Bray of the Socony Mobil Field Research Laboratory, a radiocarbon test was run on the shells of small mollusks associated with the Clear Creek fauna. The number

of the test is SM-534, and the suggested age is  $28,840 \pm 4,740$  B.P. Whether the last major interglacial eventually is designated as Sangamon or is assigned to a new interstadial within the Wisconsin, this date indicates that the Clear Creek fauna was in existence prior to the major lowering of sea level which began about 25,000 years ago.

#### COMPARISON WITH OTHER FAUNAS

*Hill-Shuler faunas.*—The Clear Creek (T-2) terrace has been traced downstream to its merger with the T-2 terrace of the Trinity River (See fig. 1). The Trinity River T-2 terrace has been divided into three fossiliferous members: basal gravel, cross-bedded sand, and sandy clay (informally named the Hill, Lower Shuler, and Upper Shuler, respectively). Although these three members are regarded as a single sequence of alluvial deposits, it has been suggested that the gravel and sand members were deposited under moister conditions than the clay.

The same trend toward dryness may be in evidence at Clear Creek. *Tapirus* and *Megalonyx* are present in the basal gravels of Clear Creek's T-2 terrace as they are in the Hill and Lower Shuler members on the Trinity River. These animals have not been identified from the Clear Creek local fauna, nor have they been recovered from Upper Shuler localities. Little age difference is suggested between the Clear Creek local fauna and the Upper Shuler, Hickory Creek local fauna, Lewisville local fauna, etc. (Slaughter *et al.*, 1962).

*Jinglebob local fauna.*—This Meade County, Kansas, fauna is considered Sangamon by Hibbard (1955). The most pronounced difference between Clear Creek and Jinglebob is in the suggested climate. Jinglebob deposition appears to have been made under somewhat moister conditions than Meade County enjoys today, whereas Clear Creek times were evidently slightly drier than today. The fauna of the basal gravels on the T-2 terrace at Clear Creek and the basal gravels and sand members (Hill and Lower Shuler respectively) of the T-2 on the Trinity River demonstrate that the climate of north-central Texas was much like that suggested for Jinglebob just prior to the Clear Creek-Upper Shuler dessication. This similarity may not be meaningful, however, as it has been suggested that Jinglebob may be older than these Texas occurrences because of its apparent lack of *Dasybus bellus* (Slaughter, 1961a) and *Sigmodon hispidus* (Slaughter *et al.*, 1962).

*Good Creek fauna.*—The local faunas of the Good Creek formation are referred to Sangamon by Dalquest (1962). Although this

occurrence is almost two hundred miles west of Denton County, there are northern and eastern species in the Good Creek fauna that are not present in the Clear Creek local fauna (*Microtus pennsylvanicus*, *Blarina brevicauda*, etc.). Dalquest considered the absence of *Sigmodon* significant, and felt that had this prolific species been in the Good Creek area it would have been represented in the fossil collection. The presence of *Sigmodon hispidus* at Clear Creek as well as in the Lower and Upper Shuler faunas downstream, may place these assemblages slightly later than both Good Creek and Jinglebob. On the other hand, if the absence of *Dasypus bellus* at Jinglebob truly indicates an earlier age, as Slaughter (1961a) suggested, the armadillo's presence at Good Creek may prove that occurrence to represent an age between Jinglebob and Clear Creek.

*Cragin Quarry*.—The climate indicated by the mammals of this Kansan occurrence is quite like that of Clear Creek. However, two apparently late immigrants, *Dasypus bellus* and *Sigmodon hispidus*, were not recovered there. Hibbard and Taylor (1960) suggested that rainfall at the time of deposition was no more than falls in Meade County, Kansas, today. Armadillos avoid truly arid areas, and if Cragin Quarry climate was as arid or perhaps more so than today, one would not expect *D. bellus*. Hibbard and Taylor (1960, p. 35) suggested that *Sigmodon* habitat was not indicated for the immediate collecting locality. Therefore the absence of these species may be entirely environmental rather than temporal. This is not the case with the other Sangamon occurrence in Meade County, the Jinglebob. The Jinglebob's suggested climate is well suited for both *Dasypus* and *Sigmodon*.

The relative number of extinct rodents at Cragin Quarry, two in twelve, is not significantly different from that of Clear Creek with two of fifteen extinct. As a matter of fact, Jinglebob—with five extinct species in sixteen—is rather striking when compared with either.

If Cragin Quarry is older than Jinglebob, as Hibbard suggests, apparently there have been at least two dry periods within the Sangamon.

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