PAPERS OF THE MICHIGAN ACADEMY OF SCIENCE, ARTS, AND LETTERS
VOL. XLVIII, 1963 (1962 MEETING)

# PALEONTOLOGY

# A LATE ILLINOIAN FAUNA FROM KANSAS AND ITS CLIMATIC SIGNIFICANCE

CLAUDE W. HIBBARD
*The University of Michigan*

PAPERS OF THE MICHIGAN ACADEMY OF SCIENCE, ARTS, AND LETTERS
VOL. XLVIII, 1963 (1962 MEETING)

# PALEONTOLOGY

## A LATE ILLINOIAN FAUNA FROM KANSAS AND ITS CLIMATIC SIGNIFICANCE

CLAUDE W. HIBBARD
*The University of Michigan*

THE drainage by erosion of a large upland lake in the headwater region of Spring Creek during a torrential rainstorm laid bare new stratigraphic exposures along the north bank of Spring Creek on Big Springs ranch. One of these exposures, in SE$\frac{1}{4}$ Sec. 14, T. 32 S., R. 29 W., contains numerous remains of mollusks. The molluscan faunule from this locality (UM-K4-53) was reported by Miller (1961). During the period from 1953 to 1960, 5 tons of fossil-bearing matrix was removed for washing to recover the contained fossils.

In the summer of 1957, while measuring a geologic section at "The Lookout" (Mt. Scott), I discovered near the base of this promontory a fossiliferous bed (UM-K2-59). The fossils were exposed in a deep cow track. It was not until the summer of 1959 that it was possible to open a quarry and remove fossil-bearing matrix from this site (UM-K2-59). The quarry is located in the SE$\frac{1}{4}$ SE$\frac{1}{4}$ Sec. 18, T. 32 S., R. 28 W., 1$\frac{3}{4}$ miles downstream from locality UM-K4-53. During the summers of 1959 and 1960, 27 tons of matrix were removed from the quarry for washing. Etheridge (1961) published upon remains of a fossil glass lizard (*Ophisaurus*) recovered from the fossil concentrate. He named the fauna that was associated with the lizard the Mt. Scott local fauna.

In the summer of 1960 and 1961 a fossiliferous locality (UM-K1-60) in the SW$\frac{1}{4}$ SW$\frac{1}{4}$ Sec. 13, T. 32 S., R. 29 W. was worked for fossil remains. From this third locality 7 tons of matrix were removed. Locality UM-K1-60 is a short distance downstream from locality UM-K4-53 (Fig. 1).

The mammals recovered from these 3 localities are reported and are considered, on the basis of stratigraphic and taxonomic evidence, to belong to one fauna, the Mt. Scott local fauna.

STRATIGRAPHY

The three fossil localities producing the Mt. Scott local fauna are located near the base of the Kingsdown formation on the Big Springs ranch. Hibbard and Taylor (1960) summarize the occurrence of the Kingsdown formation in Meade County. They state: "A late Yarmouth-early Illinoian erosional interval is implied by the presence of Illinoian sediments in valleys below the top of the Crooked Creek formation.*** Sometime during this late Yarmouth-early Illinoian time ancestral Crooked Creek came into being, as a consequence of renewed movement along the Crooked Creek fault. The essentially unmodified surface of the Crooked Creek formation east of the fault, and the topographically low Illinoian sediments in the valleys west of it imply that the southwestward-flowing central part of the Crooked Creek dates from this time."

Miller (1961) gave a detailed description of the sediments at locality UM-K4-53. At this place the Kingsdown formation occurs in an old channel that had cut through the Crooked Creek formation and deep into the Ballard formation. The base of the Kingsdown formation is not exposed. Its depth below the bed of Spring Creek is unknown. The regional dip of the beds is slightly eastward toward the Crooked Creek fault. Most of the Kingsdown formation at this point has been removed by the development of the present valley of Spring Creek. There is a covered interval along the north bank of Spring Creek between the exposures of the Kingsdown formation at locality UM-K4-53 and locality UM-K1-60. The sediments at locality UM-K1-60 that contained the fossils consist of a lens of fine sand to sandy silt. The difference in the type of sediments between the two localities seems to be accounted for by local stream conditions at the time of deposition. Downstream from locality UM-K1-60 to Mt. Scott the Kingsdown formation has been removed mostly by erosion, buried by local collapse, or covered by slope wash, well back from the present north bank of Spring Creek. A short distance downstream from locality UM-K1-60 (Fig. 1, $M_3$), along the south bank of Spring Creek, is a good exposure of the Rexroad formation (Fig. 1, $R_1$) overlain by the Ballard formation.

East of the Rexroad exposure, downstream toward Mt. Scott, a basin was developed by a collapse or a series of collapses after the deposition of the Kingsdown formation. Mt. Scott appears to be part of a northeast wall of a local sink because upstream and on

the south side of Spring Creek a well-exposed bluff of the Ballard formation plunges steeply below the stream bed toward Crooked Creek. Between the dipping beds of the Ballard formation and Mt. Scott large springs occur in the bed of the present stream.

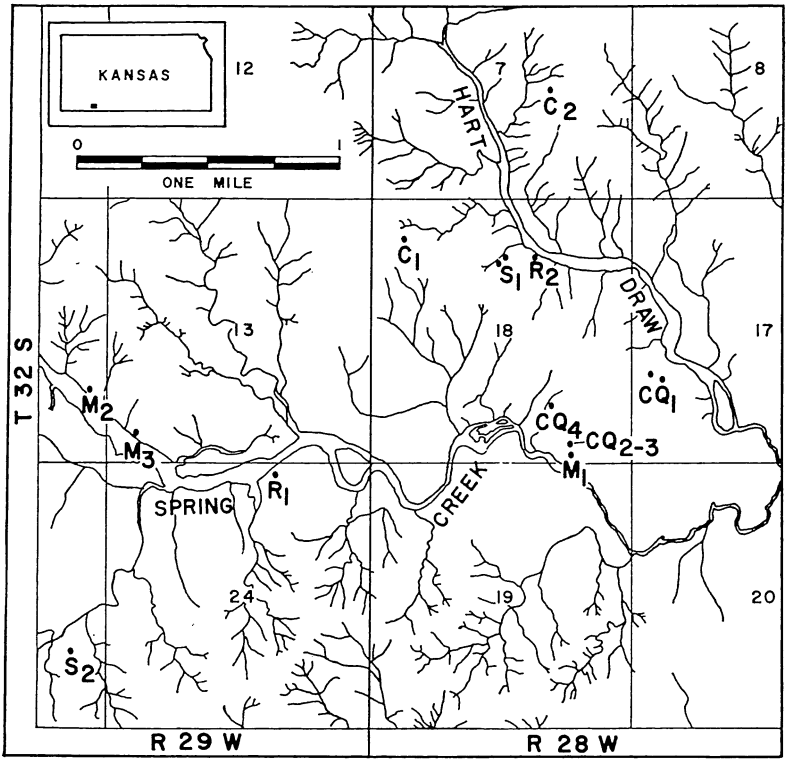


FIG. 1. Index map of Mt. Scott fossil localities and other fossil localities on the Big Springs Ranch, Meade County, Kansas. Abbreviations: $C_1$ and $C_2$, Cudahy fauna; $CQ_1$, $CQ_{2-3}$ and $CQ_4$, Cragin Quarry local fauna; $M_1$ (loc. UM-K2-59), $M_2$ (UM-K4-53), and $M_3$ (UM-K1-60), Mt. Scott local fauna; $S_1$ and $S_2$, Sanders local fauna; $R_1$ and $R_2$, Rexroad local fauna.

The quarry at the base of Mt. Scott (UM-K2-59) is located in the Kingsdown formation approximately 56½ feet below the caliche that caps the exposure (Hibbard and Taylor, 1960, fig. 3, and pl. 16, fig. 2). The fossils occur in a greenish-gray, sandy silt. An auger hole was put down to a depth of 93 inches in the quarry floor. The

first 31 inches consisted of a blue-gray sandy silt followed by 22 inches of coarse yellow to gray sand. This was followed by 40 inches of blue-green to reddish sandy silt. At the depth of 93 inches a caliche was encountered in a sandy silt, and it was not possible to auger to a greater depth. These lower beds are not exposed. A short way downstream is a small exposure of the Ballard formation at approximately the level to which we augered. It appears that the Kingsdown formation rests on the Ballard formation at the Mt. Scott locality.

## Mt. Scott Local Fauna

The fauna comprised of invertebrates and vertebrates was taken with remains of hackberry seeds (*Celtis*) from very limited areas along the north bank of Spring Creek on the Big Springs ranch (Fig. 1, $M_1$, $M_2$, and $M_3$).

Many samples of matrix have been taken for pollen analysis. These are being studied by Ronald O. Kapp.

## Phylum Mollusca

The mollusks of this fauna are being studied by Barry B. Miller. Miller (1961) reported 30 genera and 53 species collected at locality UM-K4-53, one of the three localities from which the fauna has been recovered.

## Phylum Arthropoda

The ostracods taken in association with other members of the fauna are being reported by Edwin D. Gutentag.

Faunal list of vertebrates reported from the Mt. Scott local fauna:

Class Amphibia
- Order Salientia
  - *Bufo* sp., toad
  - ?*Acris* sp.
  - *Rana pipiens* Schreber, leopard frog

Class Reptilia
- Order Chelonia
  - *Terrapene llanensis* Oelrich, plains box turtle
- Order Squamata
  - *Ophisaurus attenuatus* Baird, glass lizard

Class Mammalia

Order Insectivora

*Sorex cinereus* Kerr, masked shrew
*S. arcticus* Kerr, arctic shrew
*S. palustris* Richardson, northern water shrew
*Blarina b. carolinensis* (Bachman), southern shorttail shrew
*Cryptotis parva* (Say), least shrew

Order Chiroptera

*Lasiurus cinereus* (Beauvois), hoary bat

Order Rodentia

*Cynomys* sp., prairie dog
*Citellus* cf. *C. tridecemlineatus* (Mitchill), ground squirrel
*C.* sp., ground squirrel
*Geomys* sp., pocket gopher
*Paradipoides* or *Castor* sp., beaver
*Reithrodontomys* sp., harvest mouse
*Peromyscus berendsensis* Starrett, deer mouse
*P. progressus* Hibbard, plains deer mouse
*P.* sp., mouse
*Neotoma* cf. *N. floridana* (Ord), packrat
*Oryzomys fossilis* Hibbard, fossil rice rat
*Synaptomys australis* Simpson, Simpson's bog lemming
*Ondatra zibethica* Linnaeus, muskrat
*Microtus pennsylvanicus* (Ord), meadow vole
*Pedomys ochrogaster* (Wagner), prairie vole
*Zapus hudsonius* (Zimmermann), meadow jumping mouse

Order Carnivora

*Mustela vison* Schreber, mink

Order Lagomorpha

*Sylvilagus* sp., cottontail rabbit
*Lepus* sp., hare

Order Artiodactyla

*Bison* cf. *B. latifrons* (Harlan), giant bison

*Age and correlation.*—The Mt. Scott local fauna underlies the Cragin Quarry local fauna of Sangamon age (Hibbard and Taylor, 1960, p. 32). Ecological inferences from the Mt. Scott fauna suggest that it lived in a climate with winters warmer than at the time the Illinoian Doby Springs, and Berends local faunas lived. The

Mt. Scott fauna lived in a climate considerably different from that in which the Cragin Quarry local fauna lived (Hibbard and Taylor, 1960, p. 37) and in a climate different from that of southwestern Kansas today.

The extant mammals of the Doby Springs and Berends local faunas (Stephens, 1960; Starrett, 1956) of markedly northern forms are considered to have lived in that region during colder winters than the Mt. Scott local fauna and therefore may have occupied the region at the time of maximum Illinoian glaciation. Hibbard and Taylor (1960, p. 47) considered the Butler Spring local fauna as late Illinoian. The microvertebrates needed to correlate this fauna with either the colder Doby Springs and Berends local faunas or with the slightly warmer (late Illinoian) Mt. Scott fauna are lacking. The placement of the Butler Spring fauna in its proper time sequence must await the recovery of certain microvertebrates unless the comparative study of the molluscan faunas can date this fauna more precisely.

A late Illinoian age is indicated for the Mt. Scott local fauna by the inferences of the climate under which it lived and by the population shifts that occurred in the region between the time the Doby Springs local fauna inhabited the area and the time the Mt. Scott local fauna lived there.

*Environment.*—Inferences about the conditions under which the Mt. Scott local fauna lived can be derived from the sediments containing the fossils, and the fossils, as well as from the habitats of Recent species represented also as fossils, or of their close living relatives.

The local habitat in which the fauna lived was a valley nearly as deep as that of the present Spring Creek valley through which flowed a perennial stream of cool water. This stream and valley were tributary to the ancestral Crooked Creek. The fossil locality UM-K2-59 (Fig. 1, $M_1$) is located approximately 2 miles from where the present Spring Creek empties into Crooked Creek. From all physical evidence this late Illinoian stream was not more than 12 miles in length. The entrenchment of this Illinoian stream upon the upland surface (Crooked Creek formation) cut through the Stump Arroyo sands and gravels, a large aquifer, which would have furnished abundant cool water for the local stream for a long time. Furthermore, at locality UM-K4-53 (Fig. 1, $M_2$) this stream

COMPARISON OF SIX LATE PLEISTOCENE VERTEBRATE FAUNAS FROM SOUTHWESTERN KANSAS AND WESTERN OKLAHOMA

| | Doby Springs | Berends | Butler Spring | Mt. Scott | Cragin Quarry | Jinglebob |
|---|---|---|---|---|---|---|
| *Terrapene llanensis* Oelrich | | | | X | X | X |
| *Ophisaurus attenuatus* Baird | X | | | X | | X |
| *Sorex cinereus* Kerr | X | X | X | X | | X |
| *S. arcticus* Kerr | X | | | X | | |
| *S. palustris* Richardson | X | | | X | | |
| *Blarina b. brevicauda* (Say) | X | X | | | | |
| *B. b. carolinensis* (Bachman) | | | | X | | X |
| *Cryptotis parva* (Say) | | | | X | | |
| *Notiosorex crawfordi* (Coues) | | | | | X | |
| *Lasiurus cinereus* (Beauvois) | | | | X | X | |
| *Dasypterus golliheri* Hibbard | | | | | X | |
| *Megalonyx* sp. | | | X | | | |
| *Paramylodon harlani* (Owen) | | | | | X | X |
| *Cynomys ludovicianus* (Ord) | | | | | X | |
| *C.* sp. | | | | X | | |
| *Citellus tridecemlineatus* (Mitchill) | X | | | | X | |
| *C.* cf. *C. tridecemlineatus* (Mitchill) | | | | X | | |
| *C.* cf. *C. richardsoni* (Sabine) | X | | | | | |
| *C.* sp. | | | X | X | | X |
| *Thomomys* sp. | X | | | | | |
| *Geomys bursarius* (Shaw) | X | | | | X | |
| *G.* sp. | | X | X | X | | X |
| *Perognathus hispidus* Baird | | | | | X | X |
| *P.* cf. *P. hispidus* Baird | | X | | | | |
| *P.* sp. | | | | | X | X |
| *Dipodomys* cf. *D. ordi* Woodhouse | | | | | X | X |
| *Castoroides* cf. *C. ohioensis* Foster | X | X | X | | | |
| *Paradipoides stovalli* Rinker and Hibbard | | X | | | | |
| *Castor* sp. | | X | | | | |
| *Paradipoides* or *Castor* sp. | | | | X | | |
| *Onychomys* cf. *O. leucogaster* (Wied-Neuwied) | X | | | | X | |
| *O. jinglebobensis* Hibbard | | | | | | X |
| *Reithrodontomys* cf. *R. montanus* (Baird) | | | | | | X |
| *R.* cf. *R. megalotis* (Baird) | | | | | X | |
| *R.* sp. | | | | X | | |
| *Peromyscus berendsensis* Starrett | | X | | X | | |
| *P. progressus* Hibbard | | | | X | X | |
| *P. cochrani* Hibbard | | | | | | X |

COMPARISON OF SIX LATE PLEISTOCENE VERTEBRATE FAUNAS FROM SOUTHWESTERN KANSAS AND WESTERN OKLAHOMA
(Continued)

| | Doby Springs | Berends | Butler Spring | Mt. Scott | Cragin Quarry | Jinglebob |
|---|---|---|---|---|---|---|
| *P.* cf. *P. cochrani* Hibbard | X | | | | | |
| *P. oklahomensis* Stephens | X | | | | | |
| *P.* sp. | | | | X | X | X |
| *Neotoma micropus* Baird | | | | | X | |
| *N.* cf. *N. floridana* (Ord) | | | | X | | |
| *N.* sp. | | | | | | X |
| *Oryzomys fossilis* Hibbard | | | | X | | X |
| *Synaptomys australis* Simpson | | | | X | | X |
| *Ondatra zibethica* (Linnaeus) | X | X | | X | | X |
| *Pedomys ochrogaster* (Wagner) | | X | | X | | X |
| *P.* sp. | | | | | X | |
| *Microtus pennsylvanicus* (Ord) | X | X | X | X | | X |
| *Zapus adamsi* Hibbard | | | | | | X |
| *Z. hudsonius* (Zimmermann) | X | | | X | | |
| *Arctodus simus* Cope | | | | | | X |
| *Aenocyon dirus* (Leidy) | | | | | X | |
| *Canis* cf. *C. latrans* Say | | | X | | X | |
| *Vulpes velox* (Say) | | | | | X | |
| *Mustela vison* Schreber | | | | X | | |
| *Spilogale interrupta* (Rafinesque) | | | | | | X |
| *S.* cf. *S. interrupta* (Rafinesque) | | | | | X | |
| *Panthera atrox* (Leidy) | | | | | X | |
| *Felis concolor* Linnaeus | | | | | X | |
| *Mammuthus columbi* (Falconer) | | | | | X | X |
| *M.* cf. *M. columbi* (Falconer) | | X | | | | |
| *M.* sp. | X | | X | | | |
| *Lepus* sp. | X | | | X | X | |
| *Sylvilagus* sp. | | | | X | X | |
| *Platygonus* cf. *P. compressus* LeConte | | | | | X | |
| *Tanupolama* sp. | | | | | X | |
| *Camelops kansanus* Leidy | | | | | X | |
| *C.* sp. | X | | X | | | |
| *Capromeryx furcifer* Matthew | | | | | X | |
| *Bison latifrons* (Harlan) | | | | | | X |
| *B.* cf. *B. latifrons* (Harlan) | X | | | X | | |
| *Equus conversidens* Owen | | | | | X | |
| *E. scotti* Gidley | | | X | | X | |
| *E.* cf. *E. niobrarensis* Hay | X | | | | | |
| *E.* sp. | X | X | X | | | |

had entrenched into the top of the Angell member (sand and gravel) (see Hibbard, 1958). Without doubt, local springs along the valley walls contributed greatly to the constant supply of cool water in the stream. There is no evidence that boil springs (artesian) existed at that time, as are now found in the lower part of Spring Creek, or at the Cragin Quarry site during Sangamon time. The presence of gar (*Lepisosteus*), muskellunge (*Esox masquinongy* Mitchill), and yellow perch (*Perca flavescens* Mitchill) indicates a fair-sized pool of clear cool water (C. L. Smith, 1954 and 1958, and G. R. Smith, in press). I have been unable to find any evidence of a collapse along the valley floor which would at that time have provided a small lake along the course of the stream. The pool or pools of water that furnished the habitat for these fishes were probably provided by beaver dams.

The presence of *Sorex cinereus, S. arcticus, Oryzomys fossilis,* and *Synaptomys australis* indicates a marshy habitat along part of the valley floor. *Blarina b. carolinensis* indicates the presence of some trees and shrubs, with the development of a humus and litter cover. *Zapus hudsonius* indicates some trees and shrubs as well as tall grasses. The meadow vole, *Microtus pennsylvanicus,* and the giant bison, *Bison* cf. *B. latifrons,* indicate areas of tall grasses. *Cryptotis parva* and *Pedomys ochrogaster* would be expected to inhabit the drier grass slopes of the valley and the nearby upland surface.

Miller (1961), after a study of the mollusks from locality UM-K4-53, concluded that there was a small permanent stream of the same approximate size as the present Spring Creek; also, there would have been a temporary water situation, perhaps a slough or temporary pond located on the flood plain of the stream, with a woodland habitat near the stream.

*Climate.*—Conclusions about the climate in which the Mt. Scott local fauna lived are derived chiefly from the present distribution of living species represented in the fauna and from the habitat in which they live. Each major group of the fauna when analyzed separately gives a slightly different interpretation. No group is antagonistic to the other, and each clearly indicates that the climate at the time the Mt. Scott local fauna lived was markedly different from that for the same region today.

The Mt. Scott local fauna is considered to have lived in the

Meade County area when winter temperatures were not so low as those proposed by Hibbard and Taylor (1960) for the Butler Spring local fauna or by Stephens (1960) for the Doby Springs local fauna. I consider the winter temperatures to have been like those at the present in southern New Jersey, with cool summers as found at present in southeastern Wisconsin and northern New Jersey. The climate is considered to have been moist subhumid as defined by Thornthwaite (1948), and the region to have received from 20 to 25 inches of rainfall, which fell chiefly in the warmer part of the year.

Miller (1961), from a study of the mollusks at locality UM-K4-53, concluded that the climate at the time the mollusks lived was similar to that which now occurs in eastern South Dakota and extreme northeastern Nebraska.

Etheridge (1961) concluded, from the study of the occurrences of the fossil *Ophisaurus attenuatus*, that the present climate is somewhat drier in Meade County than anywhere within the modern range of the species and that the presence of fossil *O. attenuatus* in these areas may, however, indicate more mesic paleo-climates during the periods in which they occurred there.

*Climatic significance of faunal elements.—Sorex cinereus, S. arcticus, S. palustris,* and *Microtus pennsylvanicus* are all northern elements of the present-day fauna. None of these is living in Kansas at the present. *S. arcticus* and *S. palustris* may have been members of relic populations that had held on in the area due to a favorable microenvironment. *Blarina brevicauda* and *Zapus hudsonius* are now found to the east and north of southwestern Kansas.

It should be noted that at the time the Doby Springs local fauna lived in Harper County, Oklahoma, approximately 45 miles southeast of the Mt. Scott faunal sites, *Blarina b. brevicauda*, the northern subspecies, was associated with the above 4 mammals.

The climate in the region moderated sufficiently after the Doby Springs fauna lived, and by the time the Mt. Scott fauna occupied the area, so that the northern subspecies of *Blarina* had shifted out of the region and the southern subspecies, *Blarina b. carolinensis*, had spread northward into the area. *Cryptotis parva* (the only shrew now living in Meade County), the rice rat, and the large *Terrapene llanensis* also moved northward into the region with *Blarina b. carolinensis*. The rice rat was first reported from this

region as a member of the Jinglebob local fauna of late Sangamon age. It is a southern element of our Recent fauna and is confined chiefly to a marshy habitat. The fossil box turtle is a close relative of *T. carolina major* whose geographical range is restricted to the Gulf Coastal Plain from eastern Texas to western Florida (Conant, 1958, map 28).

Here is evidence, for the first time supported by stratigraphic control (Cragin Quarry fauna) and population shifts within the Illinoian, that demonstrates the climatic change in a given region from the Illinoian to the Sangamon.

## DESCRIPTION OF VERTEBRATE FOSSILS

### PHYLUM VERTEBRATA
### CLASS OSTEICHTHYES

Gerald R. Smith (1963) has a manuscript in press on the fish remains. It is the largest Pleistocene fish fauna recovered from that region. This fauna contains a number of new fossil records.

### CLASS AMPHIBIA

A number of fragmentary skeletal elements were recovered from the three localities. These have been examined by Joe A. Tihen. Most of the *Rana* specimens were consistent with identification as *R. pipiens*. Two specimens were decidedly larger than *R. pipiens* and might be referable to *R. catesbeiana*. A few limb elements were those of a small hylid that are probably referable to *Acris*. Parts of a *Bufo* skeleton were taken but lack specific characters.

### CLASS REPTILIA

The remains of pond and river turtles and those of the snakes have not been studied.

#### ORDER CHELONIA

#### FAMILY EMYDIDAE

*Terrapene llanensis* Oelrich

*Geologic range*—Illinoian and Sangamon.

*Distribution.*—Mt. Scott, Cragin Quarry, and Jinglebob local faunas of southwestern Kansas and Slaton local fauna of western Texas.

*Material.*—Mt. Scott (locality UM-K2-59), No. 43734, part of a plastron.

*Remarks.*—The fragments recovered are from one individual box turtle slightly larger than the specimen from the Cragin Quarry.

## ORDER SQUAMATA

### FAMILY ANGUIDAE

### *Ophisaurus attenuatus* Baird

*Geologic range.*—Upper Pliocene to Recent.

*Distribution.*—The fossil localities from which this slender glass lizard have been taken are some distance west of the western limit of this species (Etheridge, 1961, fig. 2). The present distribution is from Virginia to Florida, west to eastern Texas, north to southeastern Kansas, and then northeast to southeastern Wisconsin (Conant, 1958, map 74).

*Occurrence.*—Mt. Scott local fauna, localities UM-K2-59 and UM-K1-60.

*Material.*—Locality UM-K2-59, No. 43902, one body vertebra; Nos. 41238 and 43793, 2 body vertebrae; locality UM-K1-60, No. 44373, 1 body vertebra.

*Remarks.*—These specimens have been identified by Richard Etheridge. Specimen No. 44373 was recovered during the summer of 1961.

## CLASS AVES

The few remains of birds are being studied by Pierce Brodkorb.

## CLASS MAMMALIA

### ORDER INSECTIVORA

### FAMILY SORICIDAE

### *Sorex cinereus* Kerr

(Fig. 2A-B)

*Geologic range.*—Kansan (Cudahy fauna) to Recent.

*Distribution.*—In the High Plains Region the masked shrew ranges southward into northern Nebraska (see Burt, 1952, p. 5 for map showing present distribution). Most of the fossil records are from the southern High Plains, south of its present range.

*Habitat.*—"The cinereous shrew prefers a moist or damp but not necessarily watery habitat, preferably in woods either coniferous or deciduous, or sometimes marshy or grassy bogs, such as damp mossy woods, spruce-cedar swamps, alder thickets along brooks, mossy banks, and spruce, tamarack, or leather-leaf sphagnum bogs, and rarely found in dry woods or even fields," (Jackson, 1961, p. 29).

*Occurrence.*—Mt. Scott local fauna, localities UM-K4-53 and UM-K2-59.

*Material.*—Locality UM-K4-53, No. 41215, left jaw, $P_4$-$M_2$ and No. 44590, part of right maxillary, $M^1$-$M^3$. Locality UM-K2-59, No. 43819, left maxillary, $P^4$-$M^2$; No. 43821, left jaw, $M_1$-$M_3$; No. 43822, right jaw $M_1$-$M_3$; No. 43823, parts of 5 lower jaws, 2 left, $M_1$ and $M_2$, one left, $M_2$-$M_3$, one right with $M_1$ and $M_2$, and a right with $M_2$ and $M_3$. No. 41234, a right jaw, with $P_4$-$M_3$ (Fig. 2B).

*Remarks.*—The specimens compare in size with those of *Sorex cinereus* from the Doby Springs, Berends, and Jinglebob local faunas. The anteroposterior crown length of $P_4$-$M_3$ (No. 41234) is 4.0 mm.

*Sorex arcticus* Kerr

(Fig. 2D)

*Geologic range.*—Illinoian to Recent.

*Distribution.*—The fossil records from Harper County, Oklahoma, and Meade County, Kansas, are far south of its present range, which is from the southwest corner of the Northwest Territory to southeastern Wisconsin, and northeast to Quebec and Nova Scotia (Burt, 1952, p. 12).

*Habitat.*—Jackson (1961, p. 35) says, "this shrew is found chiefly in wet spruce, and tamarack swamps, or in alder or willow marshes; it rarely occurs in more or less open leather-leaf sphagnous bogs."

*Occurrence.*—Mt. Scott local fauna, locality UM-K2-59.

*Material.*—Part of right jaw, $P_4$-$M_3$, No. 43818 (Fig. 2D).

*Remarks.*—The teeth agree in shape and size with those of the arctic shrew taken in the Doby Springs local fauna (Stephens, 1960, p. 1687) and with Recent specimens from North Dakota.

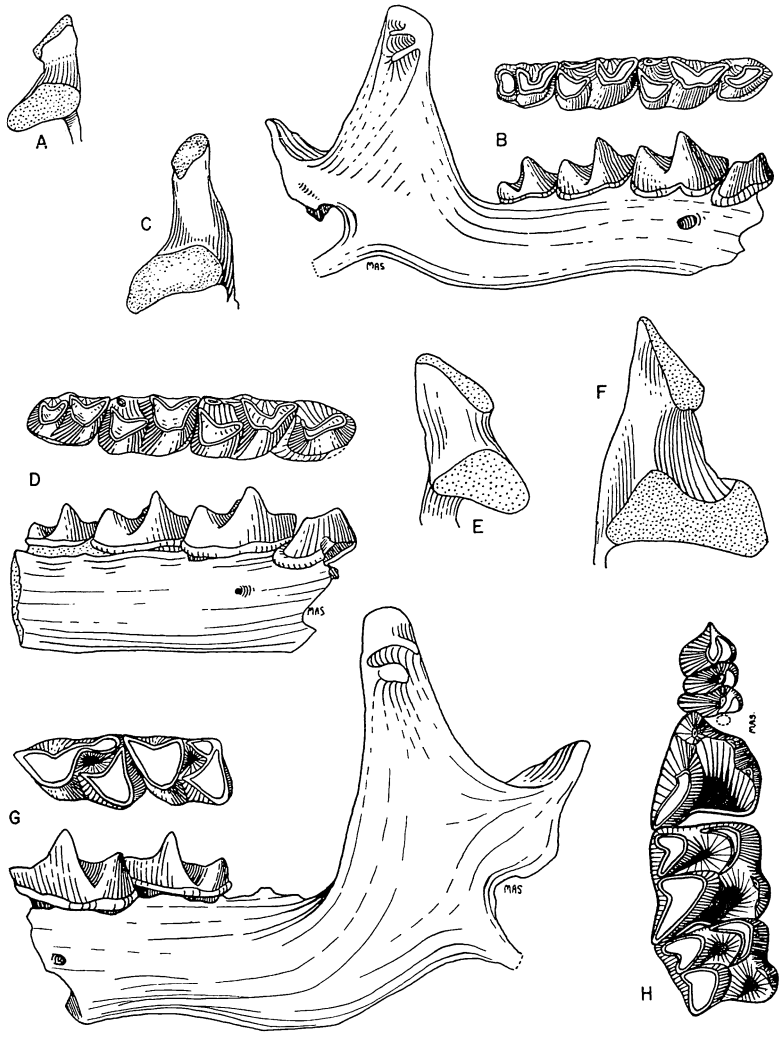


FIG. 2. *Sorex* and *Blarina*. A, C, E, and F, posterior views of condyles: A, *Sorex cinereus*, No. 41234; C, *Cryptotis parva*, No. 43802; E, *S. palustris*, No. 41235. All × 10. F, *Blarina b. carolinensis*, No. 43808. × 8. B, *S. cinereus*, No. 41234, part of right jaw with $M_1$-$M_3$, lateral and occlusal views. D, *S. arcticus*, No. 43818, part of right jaw with $P_4$-$M_1$, lateral and occlusal views. G, *S. palustris*, No. 41235, part of left jaw with $P_4$-$M_1$, lateral and occlusal views. All × 10. H, *Blarina b. carolinensis*, No. 44591, right maxillary with $I^2$-$M^2$, occlusal view. × 8.

*Sorex palustris* Richardson
(Fig. 2E and G)

*Geologic range.*—Illinoian to Recent.

*Distribution.*—Present distribution is from the extreme southeastern tip of Alaska south into California and northeastern New Mexico, east across Canada to Quebec and Nova Scotia, and south into Wisconsin and New York (Burt, 1952, p. 12). The fossil specimens from Harper County, Oklahoma, and Meade County, Kansas, are well east of its present southern range in the Rocky Mountains.

*Habitat.*—" This species, being near aquatic or at least amphibious, inhabits marshes, bogs, and wet areas near the borders of streams, lakes, or water-holes. It frequently inhabits beaver and muskrat houses, particularly in winter. It seems to prefer a more or less wooded habitat, and is rarely found in marshes devoid of bushes or trees " (Jackson, 1961, p. 38).

*Occurrence.*—Mt. Scott local fauna, locality UM-K2-59.

*Material.*—Part of left jaw with $M_1$-$M_3$, No. 41235.

*Remarks.*—The dentition and lower jaw (Fig. 2G) are like those of the northern water shrews from the Doby Springs local fauna. Like *Sorex arcticus* it appears to be a rare member of the fauna. Probably both species were members of a southern plains peripheral population at the time the Mt. Scott fauna inhabited the region.

*Blarina b. carolinensis* (Bachman)
(Figs. 2F and H; 3B)

*Geologic range.*—Kansan? to Recent.

*Distribution.*—The fossil records of the short-tailed shrew are found from Pennsylvania south to Florida and west to northwestern Oklahoma. The present distribution of the Recent species is from southeastern Canada, south to Florida, west to the southeastern edge of Texas, and northwest to the southeast corner of Saskatchewan (Burt, 1952, p. 12). Many of the fossil records have been taken west of its present range.

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

*Occurrence.*—Mt. Scott local fauna, localities UM-K4-53, UM-K2-59, and UM-K1-60.

*Material.*—Locality UM-K4-53: associated lower jaws, right maxillary and part of left maxillary No. 44591. Locality UM-K2-59: No. 41233, parts of 3 right lower jaws, 1 with I-$M_1$, another with $M_1$-$M_2$, the third without teeth, and a left maxillary with $P^3$-$M^1$; Nos. 43804-43812 are parts of 8 right and 11 left lower jaws varying from No. 43808 with a complete dentition, to 3 jaws without teeth; Nos. 43813-43815, fragments of 5 right and 5 left maxillaries, each bearing from 1 to 3 teeth. Locality UM-K1-60: No. 37751, right jaw, $M_1$-$M_3$, and No. 44600, left jaw, $M_1$-$M_3$.

*Remarks.*—In 11 jaws the anteroposterior length of $M_1$-$M_3$ varies from 4.75 mm to 5.0 mm, with an average of 4.85 mm. The anteroposterior length of C-$M_3$ in 2 specimens is 6.3 mm and 6.5 mm. The anteroposterior length of $P^4$-$M^2$ in 2 maxillaries is 5.0 mm and 5.25 mm. The anteroposterior length of $M^1$-$M^3$ in 2 specimens is 3.85 mm and 4.0 mm.

The teeth are like those in *Blarina b. carolinensis,* and the heel of $M_1$ (Fig. 3B) is reduced as in the southern form and not so broad as in specimens of the larger *B. b. brevicauda.* The third and fourth upper unicuspids are not so flat as in *B. b. brevicauda.*

Whether or not it is correct to use the Recent subspecific names for the fossil populations recovered from the Illinoian deposits of this region, there occurred in this region two distinct *Blarina* populations during the Illinoian. The *Blarina* that are associated with the colder phase of the Illinoian glaciation and lived in the region at the time of the Doby Springs and Berends local faunas are large like the specimen of *B. fossilis* Hibbard from the Rezabek local fauna, and compare in size with very large *B. b. brevicauda* from the north. The specimens of *Blarina* recovered from the Mt. Scott local fauna, of late Illinoian age, which underlies the Cragin Quarry local fauna (Sangamon), are distinct from the large species or subspecies that inhabited the region during earlier Illinoian time. In size and dental characters these smaller *Blarina* show a close relationship to the Recent *Blarina* named *B. b. carolinensis.* For that reason I have assigned them to *carolinensis* to show that this population is distinct from the earlier Illinoian population. Whether one should use Recent subspecific names for these fossil populations

or assign new names to them is not so important as the fact that there was a population shift from a large *Blarina* to a smaller *Blarina* in that region during this interval of time.

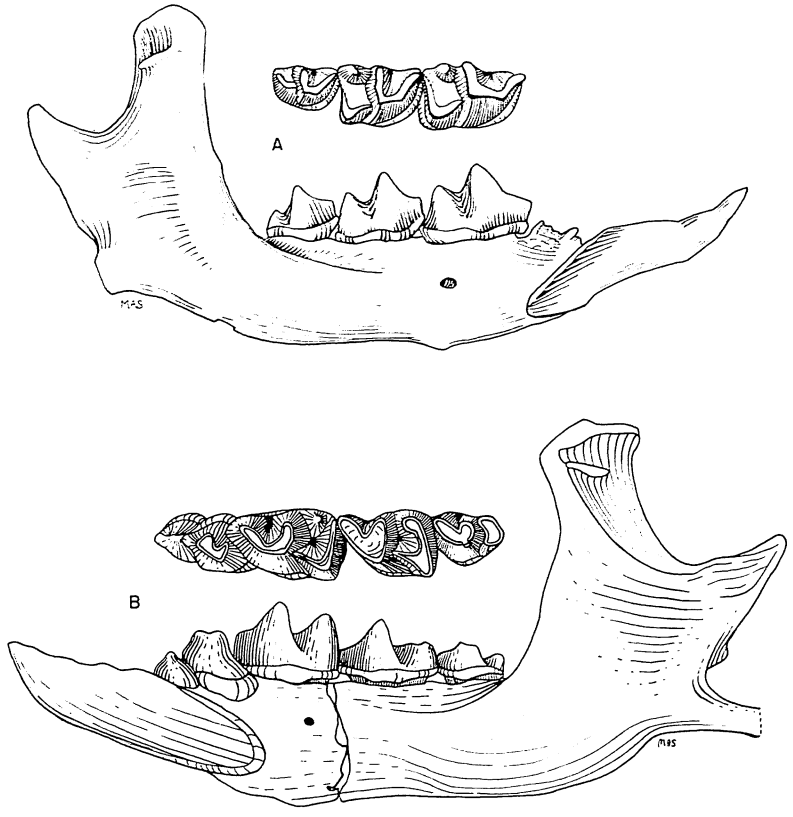


FIG. 3. *Cryptotis* and *Blarina*. A, *Cryptotis parva*, No. 43802, right jaw with I, $P_4$-$M_3$, lateral and occlusal views. × 10. B, *Blarina b. carolinensis*, No. 43808, left jaw, with I-$M_3$, lateral and occlusal views. × 8.

*Cryptotis parva* (Say)

(Figs. 2C and 3A)

*Geologic range.*—Illinoian to Recent.

*Distribution.*—The present range is from southern New York west to southeastern Wisconsin and southwest to extreme eastern Colorado and then southeast and east to the Gulf and Atlantic

Coast (Burt, 1952, p. 12, and Jackson, 1961, p. 57). The previous fossil records of this species have been from Wisconsin deposits in the southern part of its present range.

*Habitat.*—Dry grassy areas in association with *Peromyscus maniculatus* (Wagner). In the southwestern part of its range it occurs in the moist grasslands along streams and around springs (Hibbard and Rinker, 1942).

*Occurrence.*—Mt. Scott local fauna, localities UM-K2-59 and UM-K1-60.

*Material.*—Locality UM-K2-59: part of right jaw, $M_1$ and $M_2$, No. 41236; right jaw, I and $M_1$-$M_3$, No. 43802 (Fig. 3A); left jaw, $M_1$-$M_3$, No. 43803; part of right jaw, $P_4$-$M_3$, No. 43817; part of right jaw, $P_4$ and $M_1$ and left maxillary, $M^1$ and $M^2$, No. 43820. Locality UM-K1-60: part of right jaw, $P_4$-$M_3$, No. 44601.

*Remarks.*—This is the first record of the least shrew from the Pleistocene in Kansas. Parts of 5 individuals were recovered. The crown length of the $P_4$-$M_3$ in the 2 dental series are 4.20 mm and 4.25 mm. The crown length of $M_1$-$M_3$ of the 4 specimens is 3.50 mm, 3.65 mm, 3.70 mm, and 3.70 mm. The heel on $M_3$ is reduced as in Recent specimens of *Cryptotis parva*. This is the only shrew now living in Meade County. It is confined chiefly to the tall grasses in the moister habitats along the valleys. It is of interest that this shrew was later replaced at least in part by *Notiosorex crawfordi* (Coues) during part of the Sangamon at the time the Cragin Quarry fauna occupied the region.

*Lasiurus cinereus* (Beauvois)

*Geologic range.*—Late Illinoian to Recent.

*Distribution.*—Boreal North America from the Atlantic to the Pacific, breeding as far south as Pratt, Kansas, but migrating southward at least to Central Chihuahua (Miller and Kellogg, 1955, p. 106).

*Habitat.*—This large tree-dwelling bat inhabits chiefly the broadleaf forests, but it also occurs along wooded streams, in cities with wooded parks, and in western Kansas in groves of large cottonwoods wherever an open water supply is available.

*Occurrence.*—Mt. Scott local fauna, locality UM-K2-59.

*Material.*—No. 41232, anterior part of a left jaw bearing alveoli for I-$M_2$.

*Remarks.*—The jaw is the size of that of the hoary bat. The foramina in the jaw agree in size and position with those of *Lasiurus cinereus.* The $P_4$ was single-rooted, which distinguishes the jaw from that of *Eptesicus,* which has a $P_4$ with two roots.

## ORDER RODENTIA

### Family Sciuridae

#### *Cynomys* sp.

*Occurrence.*—Mt. Scott local fauna, locality UM-K2-59.

*Material.*—No. 43786, an $RP^4$ or $M^1$.

*Remarks.*—The tooth is from a prairie dog smaller than *Cynomys ludovicianus* Ord and near the size of *C. vetus* Hibbard.

#### *Citellus* cf. *C. tridecemlineatus* (Mitchill)

*Geologic range.*—Illinoian to Recent.

*Distribution.*—Central United States north into Canada (Burt, 1952, p. 68).

*Habitat.*—Dry grasslands.

*Occurrence.*—Mt. Scott local fauna, locality UM-K2-59.

*Material.*—No. 43954, 6 isolated teeth.

#### *Citellus* sp.

*Occurrence.*—Mt. Scott local fauna, localities UM-K2-59 and UM-K1-60.

*Material.*—Locality UM-K2-59, 1 upper and 1 lower molar (No. 43787), and No. 36294, an $RM_2$. Locality UM-K1-60, 3 lower molars, No. 44608.

*Remarks.*—The characters of the teeth are more like those of *Citellus franklini* (Sabine) than like those of *C. richardsoni* (Sabine).

Family Geomyidae

*Geomys* sp.

*Occurrence.*—Mt. Scott local fauna, localities UM-K4-53 and UM-K2-59.

*Material.*—Locality UM-K2-59, parts of 3 upper incisors and 5 lower premolars and molars, No. 43737. Locality UM-K4-53, 2 upper teeth, an $RM^3$ and $LM^2$, No. 41226.

*Remarks.*—The teeth are either those of a small species of pocket gopher or from young individuals.

Family Castoridae

*Paradipoides* or *Castor* sp.

*Occurrence.*—Mt. Scott local fauna, locality UM-K1-60.

*Material.*—A nearly complete ulna (No. 44613) of a small beaver.

*Remarks.*—The ulna is the size of a small *Castor canadensis* Kuhl. The small beavers are not well known from the late Pleistocene of this area. Both *Paradipoides* and *Castor* are members of the Berends fauna. The latter is known from an $LM^1$ (No. 44641) taken in the summer of 1959. The skeleton of *Paradipoides* is unknown, but the lower jaw (holotype) is the size of a small *Castor*; therefore, the ulna may belong to either genus of beaver.

*Reithrodontomys* sp.

(Fig. 4G)

*Occurrence.*—Mt. Scott local fauna, localities UM-K2-59 and UM-K1-60.

*Material.*—Nos. 41247, 43847, and 43947, parts of 2 right lower jaws, 1 with $M_2$ and $M_3$, and the other with $M_2$; a left lower jaw with $M_2$; also, parts of 3 right maxillaries, 1 with $M^1$-$M^3$, all from locality UM-K2-59. No. 44619, part of a right jaw with $M_2$ and $M_3$, and a right maxillary with $M^1$ and $M^2$ from locality UM-K1-60.

*Remarks.*—The specimens are quite fragmentary. Most of the teeth are well worn but 2 of the lower jaws which contain $M_2$ are of young adult specimens. These 2 teeth have a distinct shelf that extends from the anterolophid to the hypoconid (Fig. 4G). This

character was not present in the teeth of harvest mice from the Cragin Quarry fauna. The specimens seem to represent individuals from a distinct population. This shelf occurs in *Reithrodontomys humulis* (Audubon and Bachman) and *R. burti* Benson. The cusps are like those of *R. montanus* Baird, though the teeth have styles and stylids as observed more commonly in specimens of *R. megalotis* (Baird).

*Peromyscus berendsensis* Starrett

(Fig. 4C)

*Geologic range.*—Illinoian (Berends and Mt. Scott local faunas).

*Distribution.*—Known only from Beaver County, Oklahoma, and Meade County, Kansas.

*Habitat.*—Unknown, probably an upland form.

*Occurrence.*—Mt. Scott local fauna, localities UM-K4-53 and UM-K2-59.

*Material.*—No. 41224, locality UM-K4-53, part of left jaw with $M_1$; and No. 41244, part of right lower jaw with $M_1$-$M_3$ (loc. UM-K2-59).

*Remarks.*—The specimens are larger than *Peromyscus cragini* Hibbard from the Cudahy fauna and smaller than *P. progressus* Hibbard from the Cragin Quarry fauna. $M_1$ of the above specimens agrees in size and shape with *P. berendsensis.* Specimen No. 41244 has a small mesolophid between the metaconid and entoconid of $M_1$ and $M_2$. A broad valley separates the protoconid and hypoconid of $M_1$, $M_2$ and $M_3$ (Fig. 4C). The anteroposterior length of $M_1$-$M_3$ is 3.55 mm. $M_1$ of specimen No. 41224 lacks the mesolophid. In both specimens the teeth are narrower than those of *P. progressus.*

*Peromyscus progressus* Hibbard

(Fig. 4A)

*Geologic range.*—Late Illinoian and Sangamon.

*Distribution.*—Known only from Meade County, Kansas.

*Occurrence.*—Mt. Scott local fauna, localities UM-K4-53, UM-K2-59, and UM-K1-60.

*Material.*—Locality UM-K4-53, part of a left jaw with $M_1$ (No. 43949). Locality UM-K2-59, parts of 5 left jaws with $M_1$, or $M_1$-$M_2$,

and 1 specimen with $M_2$-$M_3$, and parts of 8 right jaws $M_1$, or $M_1$ and $M_2$ (Nos. 41245, 43790, 43839-43845). Locality UM-K1-60, part of a right jaw with $M_2$-$M_3$ (No. 44620).

*Remarks.*—6 of the above jaws contain $M_1$, or $M_1$ and $M_2$, without mesolophid, mesostylid, ectolophid, and ectostylid. The other

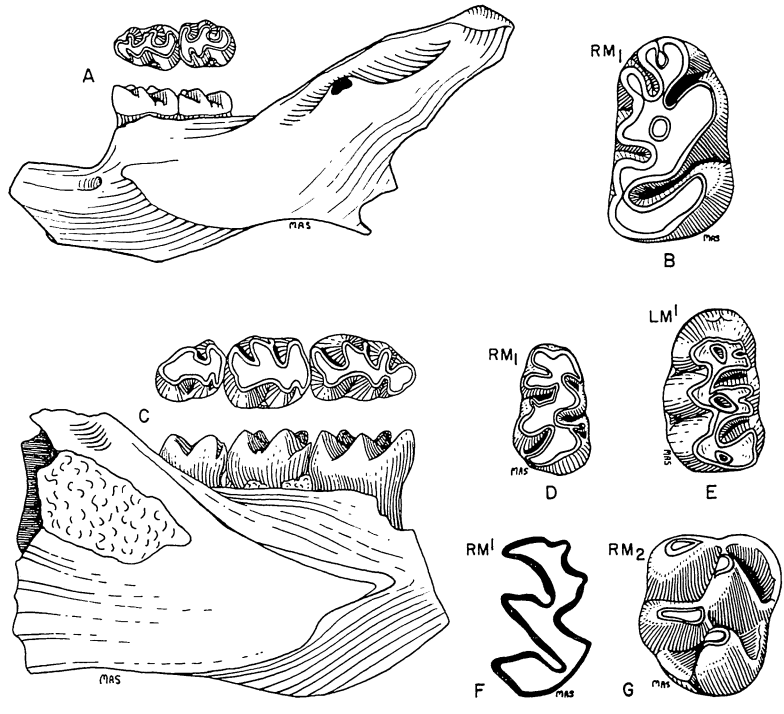


FIG. 4. Pleistocene rodents. A, *Peromyscus progressus*, No. 43840, left jaw with $M_1$-$M_2$, lateral and occlusal views. × 6. B, *Zapus hudsonius*, No. 44599, a right $M_1$, occlusal view. × 20. C, *P. berendsensis*, No. 41244, part of right jaw with $M_1$-$M_3$, lateral and occlusal views. × 10. D, *Peromyscus* sp., No. 43789, a right $M_1$, occlusal view. × 10. E, *Oryzomys fossilis*, No. 43788, a left $M^1$, occlusal view. × 10. F, *Neotoma* cf. *N. floridana*, No. 43948, a right $M^1$. × 6. G, *Reithrodontomys* sp., No. 43947, a right $M_2$, occlusal view. × 20.

jaws had teeth with a very small mesolophid on $M_1$ or a very small mesostylid on $M_2$ to the extreme in specimen No. 43840 which has an $M_1$ with a mesolophid, and an ectostylid present on $M_1$ and $M_2$ (Fig. 4A).

The lophids and stylids are not as well developed on the teeth

from the Mt. Scott fauna as they are on certain individuals of *Peromyscus progressus* from the overlying Cragin Quarry fauna.

The anteroposterior length of $M_1$-$M_2$ in 5 specimens varies from 2.70 mm to 2.75 mm, with an average of 2.74 mm.

*Peromyscus* sp.

(Fig. 4D)

*Occurrence.*—Mt. Scott local fauna, locality UM-K2-59.

*Material.*—No. 43789, an $RM_1$.

*Remarks.*—The tooth is distinct from that of any *Peromyscus* previously found in the Pleistocene deposits of that region. The pattern is more advanced and complicated than that of specimen No. 29302 from the Jinglebob fauna that appeared to belong either to the *truei* or *boylei* group of *Peromyscus.* It is the size and shape of $M_1$ of *Peromyscus boylei* (Baird) and *P. nuttalli* (Harlan). The tooth was compared with a series of $M_1$s of the 2 species. I could not place it with certainty with either species. In some respects it appears more like *P. nuttalli* than *P. boylii* (Fig. 4D). A series of the fossil specimens are needed for accurate determination.

*Neotoma* cf. *N. floridana* (Ord)

(Fig. 4F)

*Occurrence.*—Mt. Scott local fauna, locality UM-K2-59, base of Mt. Scott (The "Lookout").

*Material.*—5 lower and 4 upper isolated teeth, Nos. 41237, 43752, and 43948.

*Remarks.*—The teeth are the size of those recovered from the Cragin Quarry fauna. The $M^1$ has the enamel along the side (base) of the lingual part of the anterior loop flattened (Fig. 4F), while this part of the tooth is rounded in *Neotoma micropus* Baird. Furthermore, the posterior loop of $M_1$ is rounded as in *N. floridana.* The anteroposterior length of $RM^1$ (No. 43948) is 3.65 mm.

*Oryzomys fossilis* Hibbard

(Fig. 4E)

*Geologic range.*—Illinoian to late Sangamon.

*Distribution.*—Known only from Meade County, Kansas.

*Habitat.*—The fossil record indicates a moist to marshy habitat.

*Occurrence.*—Mt. Scott local fauna, localities UM-K2-59 and UM-K1-60.

*Material.*—No. 43788, an $LM^1$; No. 43951, an $LM_1$ and $LM_2$ from locality UM-K2-59, and No. 44621, an $LM_3$ and an $RM_2$ from locality UM-K1-60.

*Remarks.*—Only isolated teeth were recovered. They agree in size and dental characters with those of *Oryzomys fossilis* from the Jinglebob fauna. The external reentrant valleys between the cusps and crescentic enamel islands are larger and deeper than those of the Recent *O. palustris* (Harlan) (see Fig. 4E).

*Synaptomys australis* Simpson
(Fig. 5)

*Geologic range.*—Illinoian to late Sangamon.

*Distribution.*—Late Pleistocene deposits of Florida and southwestern Kansas.

*Habitat.*—The fossil record of this large extinct bog lemming indicates a moist to marshy habitat.

*Occurrence.*—Mt. Scott local fauna, localities UM-K4-53, UM-K2-59, and UM-K1-60.

*Material.*—Locality UM-K4-53, an $LM^3$ (No. 41225). Locality UM-K2-59, 5 $LM_1$s (No. 36293); 4 $RM_1$s, an $RM_2$ and an $RM_3$ (No. 43750); part of a right jaw with $M_1$ and $M_2$ (No. 43825); and 3 $LM^1$s, an $LM^2$, 2 $LM^3$s, an $RM^1$ and an $RM^2$ (No. 43952). Locality UM-K1-60, an $RM_2$, and $LM^2$, an $RM^3$ and 2 upper incisors (No. 44618).

*Remarks.*—The teeth vary slightly in size since some are from young individuals. The anteroposterior length of $M_1$ and $M_2$ (No. 43825, Fig. 5) is 5.3 mm. 2 of the $LM_1$s are as large as the $M_1$ in *Synaptomys australis* Simpson from the Jinglebob local fauna. The large specimens are bigger than *S. c. paludis* Hibbard and Rinker now found living in the bog areas of Meade County. The enamel of the reentrant angles is thicker in specimens of *S. australis* than in *S. cooperi*. The internal reentrant angles on $M_1$-$M_3$ of the Kansas specimens of *S. australis* are directed more posteriorly than in Recent specimens of *S. cooperi*.

At the time I (Hibbard, 1955) reported *Synaptomys australis* Simpson from the Jinglebob fauna I mentioned that the lower incisor extended posteriorly past $M_3$. In a study of the Mt. Scott specimens I compared the specimens with the Jinglebob material, the Recent specimens of *S.* (*S.*) *cooperi paludis* from Meade County and other more northern subspecies of *S. cooperi*. It was noted that the more northern specimens of *S. cooperi* are smaller than the southern subspecies. *S. c. paludis* is the largest of the Recent

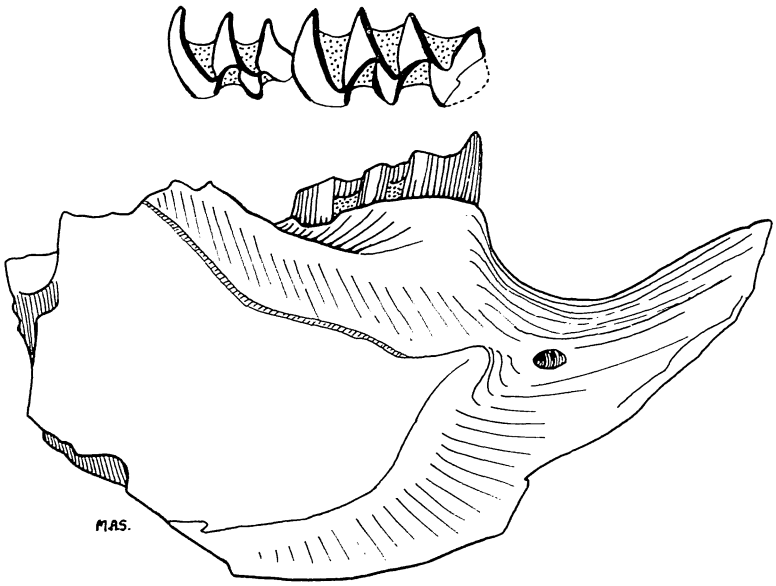


FIG. 5. *Synaptomys australis*, No. 43825, part of a right jaw with $M_1$ and $M_2$. Lateral and occlusal views. × 6.

populations. It was also observed that in northern specimens of *S. cooperi* the lower incisor never extends posterior to the posterior edge of $M_3$. Of the 137 lower jaws examined from Michigan, no lower incisor extended posteriorly farther than $\frac{3}{4}$ the length of $M_3$, and then in only 6 specimens. In 14 of the 137 specimens the incisor extended posteriorly to the midline of $M_3$, and in 78 it extended posteriorly $\frac{2}{3}$ the length of $M_3$. The rest of the incisors extended only $\frac{1}{3}$ the anteroposterior length of $M_3$. 11 specimens were examined from New Hampshire, in which the incisor ex-

tended to $\frac{1}{2}$ or $\frac{3}{4}$ the length of $M_3$. Specimens from North Carolina, West Virginia, and Virginia were also examined. None of these specimens had the incisor extending posteriorly more than $\frac{3}{4}$ the length of $M_3$. Yet the holotype of *S. australis* from the late Pleistocene of Florida has the incisor extending just posterior to $M_3$ but not as far posteriorly past $M_3$ as in the specimens from the Jinglebob fauna. 12 specimens were examined from Ohio; 3 of these had the incisor extending to the posterior edge of $M_3$. 1 specimen from Illinois had the incisor extending posterior to $M_3$. The 3 specimens examined from Missouri had the incisor extending posterior to $M_3$, as in the Recent specimens of *S. c. paludis* from Meade County, but not as far posteriorly as in the specimen from the Jinglebob fauna. Miller (1896, p. 33) states, "Lower incisor terminating posteriorly a little in front of the hinder edge of the back molar." Howell (1927, p. 8) states, "The roots of the mandibular incisors terminate at a point slightly anterior to the posterior portion of the third molar." There is a definite gradient or cline from north to south in the increase of the length of the lower incisor. Also, *Synaptomys* (*Synaptomys*) is one of the exceptions to Bergmann's rule, where the smaller races occur in the north and the larger specimens along the southern limits of its range. There is also a slight west-east gradient in size as reported by Wetzel (1955), which is probably comparable to the west-east gradient observed in the size of *Blarina* (Guilday, 1957).

The cline observed in *Blarina brevicauda* is the opposite of that observed in *Synaptomys* (*Synaptomys*). These clines may prove most significant in the study of middle and late Pleistocene faunas. In the cooler Doby Springs and Berends local faunas remains of the large *B. b. brevicauda* (or a large species) were recovered. One cannot say at present why remains of *Synaptomys* were not recovered with these faunas. But with a slight climactic moderation the smaller *B. b. carolinensis* (or a smaller species) replaced the large *Blarina*. Associated with the smaller *Blarina* is the large *S. australis* in the late Illinoian Mt. Scott local fauna and the late Sangamon Jinglebob local fauna. Unfortunately, the posterior part of the lower jaw of *S. bunkeri* Hibbard from the Nye sink in Beaver County, Oklahoma, is unknown. Also, the exact age of the deposit is unknown; it can be Illinoian or Wisconsin. But when the entire jaw is found, I expect it to possess (due to the size of the species

which is smaller than *S. c. paludis* now living in Meade County) a lower incisor that does not extend posterior to $M_3$, and to represent a member of a cooler fauna than either the Mt. Scott or the Jinglebob. When *Synaptomys* is found in association with *B. b. brevicauda* in the Pleistocene faunas of that region it would be expected to be smaller than *S. australis* and with a shorter lower incisor.

*Ondatra zibethica* (Linnaeus)

(Fig. 6E and F)

*Geologic range.*—Illinoian to Recent.

*Distribution.*—Most of North America north of Mexico (Burt, 1952, p. 134).

*Habitat.*—Aquatic. The muskrat lives along the edges of lakes and streams where it burrows into the bank below the water level and the burrow ascends upward in the bank above the water level to the dry nest. It also inhabits bogs and marshes where nests are constructed of vegetation extending well above the water with an underwater entrance to the dry chamber.

*Occurrence.*—Mt. Scott local fauna, localities UM-K4-53, UM-K2-59, and UM-K1-60.

*Material.*—Locality UM-K4-53, 3 isolated teeth from at least 2 individuals, an $LM_1$, an $LM_2$ and an $LM_3$ (No. 41222). Locality UM-K2-59, parts of at least 3 individuals, No. 41228, 1 $LM_1$, 3 $RM_1$s, 2 $LM_2$s and an $RM_3$. From locality UM-K1-60 parts of at least 3 individuals were taken: No. 44611, part of a humerus of a young muskrat; No. 37190, part of a right jaw, with $M_1$-$M_3$; No. 37191, a left maxillary, with $M^1$-$M^3$; No. 44610, part of a right jaw, with $M_1$-$M_2$; No. 37745, 6 isolated upper teeth; and No. 44609, 2 isolated $M_3$s.

*Remarks.*—The anteroposterior length of $RM_1$-$M_3$ (No. 37190, Fig. 6E) is 12.8 mm. The anteroposterior length of $LM^1$-$M^3$ (No. 37191, Fig. 6F) is 12.8 mm. The teeth agree in shape and size with those from the Doby Springs and Jinglebob local faunas.

*Microtus pennsylvanicus* (Ord)
(Fig. 6A-D)

*Geologic range.*—Illinoian to Recent.

*Distribution.*—Boreal region of North America, southeast to northern New Mexico, southern Nebraska, northern Missouri, northern Kentucky, and southeast to southern South Carolina.

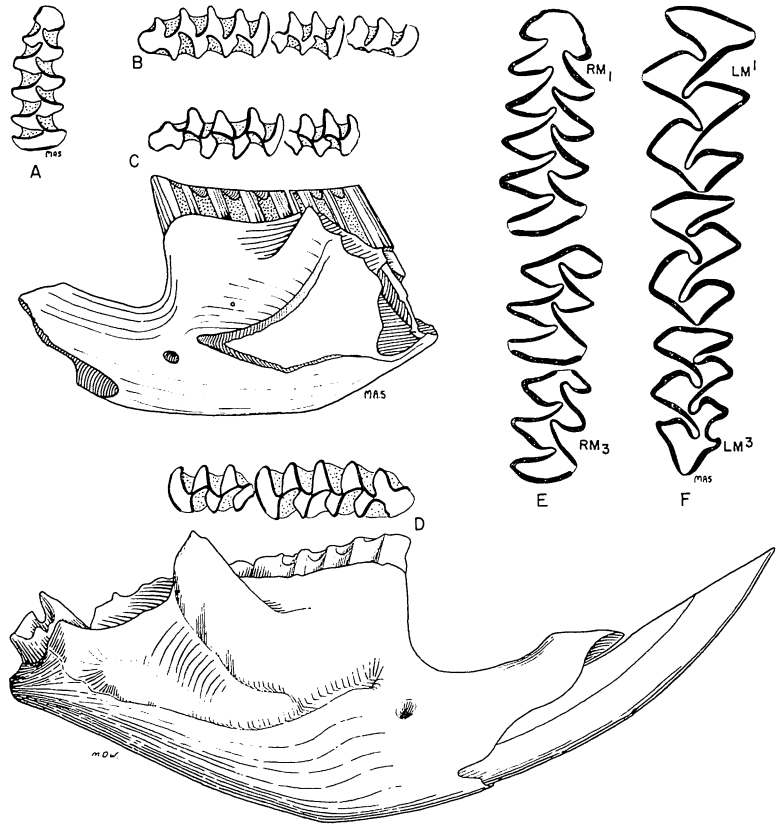


FIG. 6. *Microtus* and *Ondatra*. A, B, C and D, *M. pennsylvanicus*. A, right $M_1$, No. 43769; B, left $M_1$-$M_3$, No. 44612. Occlusal views. C, part of left jaw with $M_1$ and $M_2$, No. 43831; D, part of right jaw with $M_1$ and $M_2$, No. 34793. Lateral and occlusal views. All × 6. E and F, *O. zibethica*. E, right $M_1$-$M_3$, No. 37190; F, left $M^1$-$M^3$, No. 37191, occlusal views. Both × 5.

*Habitat.*—Grassy areas throughout range. In the southern limits of their range these voles are confined to the moister areas with good grass cover.

*Occurrence.*—Mt. Scott local fauna, localities UM-K4-53, UM-K2-59, and UM-K1-60.

*Material.*—There are parts of at least 138 individuals based on the number of right $M_1$s. From locality UM-K4-53, parts of 2 right and 1 left jaw with $M_1$-$M_2$ were recovered, along with 9 more right $M_1$s and 5 left $M_1$s (Nos. 34793-34795, 41218 and 41219). At the base of Mt. Scott (UM-K2-59) parts of at least 124 individuals were taken. These include parts of 6 right and 11 left jaws with $M_1$-$M_2$. In addition, there were 118 right $M_1$s and 96 left $M_1$s (Nos. 36288, 41240-41243, 43765-43769, 43829-43837). The only complete lower dentition was recovered at locality UM-K1-60, a left jaw (No. 44612) with $M_1$-$M_3$ (Fig. 6B). Also, 3 right and 7 left $M_1$s (No. 44605) were included.

*Remarks.*—19 of the jaws have $M_1$-$M_2$. The anteroposterior length of these 2 teeth varies from 4.65 mm to 6.0 mm, with an average of 5.17 mm. Only 1 jaw contains $M_1$-$M_3$ (No. 44612). The anteroposterior length of $M_1$-$M_3$ is 7.0 mm (Fig. 6B). 3 of the $M_1$s had 7 closed triangles (Fig. 6A). 190 $M_1$s had 5 closed triangles (Fig. 6C), and the remaining 66 $M_1$s had 6 closed triangles (Fig. 6D). The teeth are indistinguishable from those of the Recent species. The present range of the meadow vole does not extend as far south as Kansas. Many isolated upper teeth of *Microtus* and *Pedomys* were recovered. These have not yet been cleaned and sorted.

*Pedomys ochrogaster* (Wagner)

(Fig. 7)

*Geologic range.*—Illinoian to Recent.

*Distribution.*—Central Alberta, southeast to north central Oklahoma, northeast to eastern Ohio, and northwest through southwestern Saskatchewan (see Burt, 1952, p. 130).

*Habitat.*—The prairie vole frequents tall-grass and mixed-grass land throughout the upper Missouri and Mississippi valleys, and south in the Plains region. When occurring in the range of *Microtus pennsylvanicus* the prairie vole occupies the drier upland habitat. In the southwestern limits of its range it lives in the moist habitats of the valleys with *Reithrodontomys megalotis.*

*Occurrence.*—Mt. Scott local fauna, localities UM-K4-53, UM-K2-59, and UM-K1-60.

*Material.*—Parts of at least 2 individuals, 2 right $M_1$s and an $LM_1$ (No. 41227) were recovered at locality UM-K4-53. At locality UM-K2-59, parts of at least 10 individuals were recovered. This count is based upon the number of left $M_1$s either isolated or in

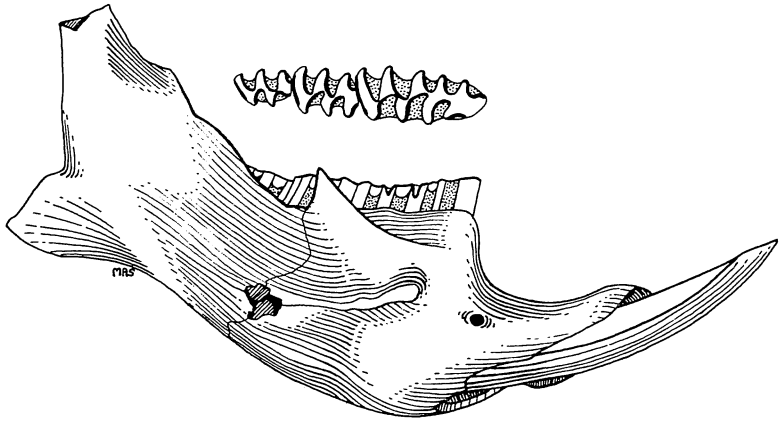

FIG. 7. *Pedomys ochrogaster,* No. 44603, part of right jaw, with incisor, $M_1$-$M_3$. Lateral and occlusal views. × 5.

jaw fragments; also, 9 right $M_1$s were taken (Nos. 36289, 43826-43828). The better specimens were recovered at locality UM-K1-60; No. 37750 is part of a right jaw with $M_1$-$M_3$; No. 44603 is a right jaw with $M_1$-$M_3$; also, 4 left and 3 right isolated $M_1$s (No. 44604) were taken.

*Remarks.*—The fossil specimens fall within the size range of *Pedomys ochrogaster.* $M_1$-$M_3$ of specimen No. 44604 has an antero-posterior length of 6.60 mm (Fig. 7).

The small number of *Pedomys* recovered is probably reflected by the moist habitat in the immediate vicinity of the deposits. *Pedomys,* requiring a drier habitat than *Microtus pennsylvanicus,* was not taken in the lake sediments that produced the Doby Springs fauna (Stephens, 1960).

FAMILY ZAPODIDAE

*Zapus hudsonius* (Zimmermann)

(Fig. 4B)

*Geologic range.*—Illinoian to Recent.

*Distribution.*—From Alaska eastward and southeast to the northeastern corner of Oklahoma and east to the Atlantic coastal area.

*Habitat.*—The meadow jumping mouse is found in, "Meadows, shrubby fields, brushland and thickets along the edge of woods; usually in a moist grassy situation, and preferably near a stream or lake" (Jackson, 1961, p. 263).

*Occurrence.*—Mt. Scott local fauna, localities UM-K2-59 and UM-K1-60.

*Material.*—Locality UM-K2-59, an $RM_1$ (No. 44599), and an $LM_1$ and an $RM_2$, No. 41249. An isolated $M_3$, No. 44423, was taken at locality UM-K1-60.

*Remarks.*—The material has been studied by David J. Klingener (1963) in a comprehensive study of late Cenozoic zapodids of western North America. I have followed his identification. But the *Zapus* from the Doby Springs and Mt. Scott faunas is distinct, due to its smaller size (Fig. 4B), from the larger *Z. adamsi* from the Jinglebob local fauna. It is impossible to assign either the Doby Springs-Mt. Scott populations or the Jinglebob population to different subspecies of *Z. hudsonius* as has been done with different populations of *Blarina*. If the specimens of *Zapus* recovered from Illinoian and Sangamon faunas remain as distinct in the future as the Doby Springs-Mt. Scott populations are distinct from the Jinglebob population, it would be best to consider these as distinct subspecies. Recent *Zapus* does not occur in this part of Kansas.

ORDER CARNIVORA

FAMILY MUSTELIDAE

*Mustela vison* Schreber

(Fig. 8A)

*Geologic range.*—Middle Pleistocene to Recent.

*Distribution.*—Southern Alaska, most of Canada, and the United

States except the arid southwest (see Miller and Kellogg, 1955, pp. 741-744; and Burt, 1952, p. 43).

*Habitat.*—Banks of streams and lakes, also marshes.

*Occurrence.*—Mt. Scott local fauna, locality UM-K2-59.

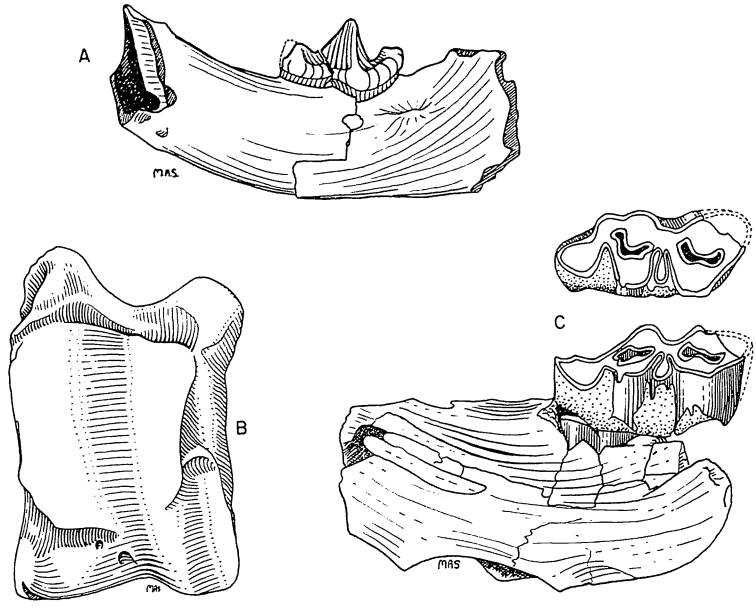


FIG. 8. *Mustela* and *Bison*. A, *M. vison*, No. 43751, part of right jaw with $M_1$, lingual view. × 2. B and C, *Bison* cf. *B. latifrons*. B, left astralagus, No. 43850, posterior view; C, fragment of right jaw with $M_3$, No. 43733, lateral and occlusal views. Both × ½.

*Material.*—Part of right lower jaw with $M_1$, and alveoli of canine, $P_2$-$P_4$, and $M_2$ (No. 43751).

*Remarks.*—The jaw (Fig. 8A) is as large as that of a large male mink from Michigan. The alveoli of $P_2$ are set oblique to the long axis of the jaw, and the tooth was crowded in between the canine and $P_3$. Mink occur at the present time along Crooked Creek and the Cimarron River.

ORDER LAGOMORPHA

FAMILY LEPORIDAE

*Sylvilagus* sp.

*Occurrence.*—Mt. Scott local fauna, localities UM-K2-59 and UM-K1-60.

*Material.*—Locality UM-K2-59, an $RP^2$ (No. 41231); and 5 $P_3$s (No. 43735). Locality UM-K1-60, 2 lower molars (No. 44607).

*Lepus* sp.

*Occurrence.*—Mt. Scott local fauna, localities UM-K4-53 and UM-K2-59.

*Material.*—Locality UM-K4-53, an $RP^3$ (No. 41223); locality UM-K2-59, an $RP^4$ (No. 43736).

*Remarks.*—Some of the teeth are from immature rabbits. It is impossible to identify them generically.

ORDER ARTIODACTYLA

FAMILY BOVIDAE

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

(Figs. 8B and C)

*Geologic range.*—Illinoian to early Wisconsin.

*Distribution.*—The giant bison ranged from California to Florida, South Dakota to Texas, and Kentucky to the Gulf of Mexico.

*Habitat.*—The kind of deposits from which remains are recovered in North America indicate that this long-horned bison lived either along permanent streams, which supported some shrubs and some trees, or in well-wooded stream valleys, in which there were intermittent areas of tall-grass land (meadow).

*Occurrence.*—Mt. Scott local fauna, locality UM-K2-59.

*Material.*—A fragment of a right jaw with $M_3$ (No. 43733).

*Remarks.*—The only remains of a large bison recovered to date from this region in Illinoian and Sangamon deposits were the horn-core of *Bison latifrons* in association with the Jinglebob fauna, and parts of a giant bison from the Doby Springs local fauna. The $RM_3$

(Fig. 8C) has an anteroposterior length of 49.5 mm. At locality UM-K2-59 a slight disconformity (sand and gravel zone) occurs above the Mt. Scott faunal horizon. Approximately 7 feet above the disconformity but below the Cragin Quarry horizon a left astralagus (No. 43850, Fig. 8B) was taken. It appears to belong to the same species of bison as the fragment of the lower jaw. The greatest length of the astralagus is 96.5 mm.

ACKNOWLEDGMENTS

I am greatly indebted to the members of the 1959 and 1960 field parties for their enthusiastic work. Members of the 1959 party were William G. Melton, Gerald R. Paulson, James B. Stevens, Barbara K. Tihen, and Michael O. Woodburne. Those of the 1960 party were William G. Melton, in charge, Norman Hodge, Howard Hutchison, Barry B. Miller, and David S. Winsted. The services during 1958-60 of Research Assistants Barry B. Miller, Gerald R. Paulson, Margaret Anne Skeels, and Michael O. Woodburne were made possible by the National Science Foundation project G-5635. Also, the services of Holmes Semken, research assistant, and Margaret Anne Skeels, research assistant and artist (MAS) for 1960-61 were made possible by NSF project G-19458.

I am grateful to Dave Leahy, director of the Kansas Forestry, Fish, and Game Commission, and to Harry Smith, superintendent of Meade County State Park, for permission to live in the park and to wash the fossil-bearing matrix there. I owe sincere thanks to Arthur D. Sanders and Jack T. Sanders, Big Springs Ranch, for allowing us to collect on their ranch and for the help they have given me.

This study was greatly aided by permission to examine specimens under the care of W. H. Burt and Emmet T. Hooper, of the University of Michigan Museum of Zoology.

## LITERATURE CITED

BURT, W. H. 1952. A Field Guide to the Mammals. Boston: Houghton Mifflin Co., 200 pp., 37 pls., 52 maps.

CONANT, ROGER. 1958. A Field Guide to Reptiles and Amphibians of the United States and Canada East of the 100th Meridian. Cambridge, Mass.: Riverside Press. vi + 366 pp., 40 pls., 57 figs., 248 maps.

ETHERIDGE, RICHARD. 1961. Late Cenozoic Glass Lizards (*Ophisaurus*) from the Southern Great Plains. Herpetologica, 17 (3) : 179-186, 2 figs.

GUILDAY, JOHN E. 1957. Individual and Geographic Variation in *Blarina brevicauda* from Pennsylvania. Ann. Carnegie Mus., 35 (5) : 41-68, 14 figs.

HIBBARD, CLAUDE W. 1955. The Jinglebob Interglacial (Sangamon?) Fauna from Kansas and Its Climatic Significance. Univ. Mich. Mus. Pal., Contrib., 12 (10) : 179-288, 2 pls., 8 figs., 1 chart.

——. 1958. New Stratigraphic Names for Early Pleistocene Deposits in Southwestern Kansas. Amer. Jour. Sci., 256: 54-59, 1 fig.

——. AND GEORGE C. RINKER. 1942. A New Bog-lemming (*Synaptomys*) from Meade County, Kansas. Univ. Kans. Sci. Bull., 28 (2) : 25-35, 3 figs.

——. AND DWIGHT W. TAYLOR. 1960. Two Late Pleistocene Faunas from Southwestern Kansas. Univ. Mich. Pal., Contrib., 16 (1) : 1-223, 16 pls., 18 figs.

HOWELL, A. BRAZIER. 1927. Revision of the American Lemming Mice (Genus *Synaptomys*) . North Amer. Fauna, 50: 1-38, 2 pls., 11 figs.

JACKSON, H. H. T. 1961. Mammals of Wisconsin. Madison: Univ. Wis. Press. 504 pp., 81 maps, illus.

KLINGENER, DAVID J. 1963. On the Fossil History of *Zapus* in Western North America. Jour. Mammal., in press.

MILLER, BARRY B. 1961. A Late Pleistocene Molluscan Faunule from Meade County, Kansas. PMASAL, 46: 103-125, 1 fig.

MILLER, GERRIT S., JR. 1896. Genera and Subgenera of Voles and Lemmings. North Amer. Fauna, 12: 5-84, 3 pls., 39 figs.

—— AND R. KELLOGG. 1955. List of North American Recent Mammals. U. S. Nat. Mus., Bull. 205: iii-xii + 954 pp.

SMITH, C. L. 1954. Pleistocene Fishes of the Berends Fauna of Beaver County, Oklahoma. Copeia, (4) : 282-289, 7 figs.

——. 1958. Additional Pleistocene Fishes from Kansas and Oklahoma. Copeia, (3) : 176-180, 3 figs.

SMITH, GERALD R. 1963. A Late Illinoian Fish Fauna from Southwestern Kansas. Copeia, in press.

STARRETT, ANDREW. 1956. Pleistocene Mammals of the Berends Fauna of Oklahoma. Jour. Paleont., 30 (5) : 1187-1192, 1 fig.

STEPHENS, JOHN J. 1960. Stratigraphy and Paleontology of a Late Pleistocene Basin, Harper County, Oklahoma. Bull. Geol. Soc. Amer., 71: 1675-1702, 1 pl., 9 figs.

THORNTHWAITE, C. W. 1948. An Approach toward a Rational Classification of Climate. Geogr. Rev., 38 (1) : 55-94, 1 pl.

WETZEL, RALPH M. 1955. Speciation and Dispersal of the Southern Bog Lemming, *Synaptomys cooperi* (Baird) . Jour. Mammal., 36 (1) : 1-20, 1 fig.