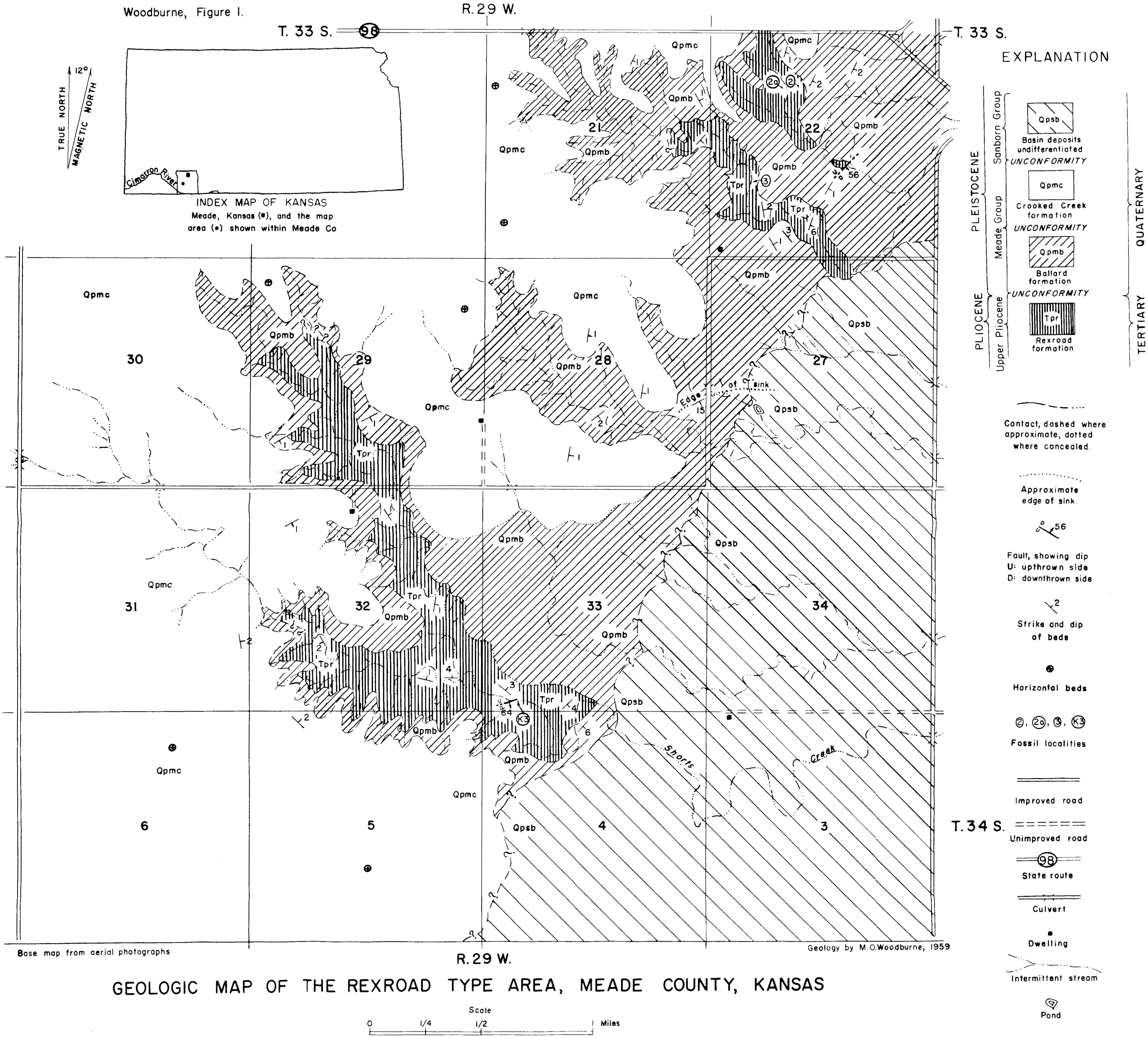
Woodburne, Figure I.



GEOLOGIC MAP OF THE REXROAD TYPE AREA, MEADE COUNTY, KANSAS

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PALEONTOLOGY

UPPER PLIOCENE GEOLOGY AND VERTEBRATE PALEONTOLOGY OF PART OF THE MEADE BASIN, KANSAS

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The Meade Basin of southwestern Kansas, or Meade trough as it was called by Erasmus Haworth in 1896, has long been an area of geologic interest. Fossil material, collected from Upper Pliocene deposits, was described by Claude W. Hibbard in 1938, and in the ensuing years late Cenozoic deposits of Upper Pliocene and Pleistocene age have been intensively studied. The Upper Pliocene fauna indicates an expected difference between the climate extant at that time and that of the Pleistocene or Recent.

The earliest detailed geologic study of this and surrounding areas was presented by H. T. U. Smith in 1940, and from it much of the supporting material for this report has been obtained. The term "basin" was applied to the area by John C. Frye (1940, p. 6) and has been used in all subsequent work. The Meade Basin extends north-northeast for about 30 miles across central Meade County and northward into southwestern Ford County (Smith, 1940, p. 133). The area of the present study is situated southwest of Meade County State Park, 8 miles south and 6 miles west of Meade, Kansas, as shown in Fig. 1, which is the first detailed map of the type area of the Rexroad formation.

Although this paper is concerned mainly with Upper Pliocene geology and paleontology, it was necessary to map the Pleistocene sequence in order to determine the limits of the Upper Pliocene deposits. In the summer of 1959 I was a member of a field party of The University of Michigan Museum of Paleontology under the direction of Claude W. Hibbard. During this period the geology was plotted on a base map which had been prepared from aerial photographs. Of the various problems encountered during the period of mapping, one of major importance was that, in any one location, the geology was usually exposed on only the outside of a stream meander. This side was typically a vertical wall up to 30 feet high whereas the opposite side would be a gentle slope, covered with soil, grass, and sagebrush, leading up to the interstream areas. It was rarely possible to measure strike and dip directly. In Sec. 22, T. 33 S., R. 29 W., the beds are highly variable in a lateral direction, and it was often difficult to find a well-marked horizon that extended over a usable distance. While resistant beds, i.e., consolidated sand and gravel, and caliche are present, they do not crop out continuously over large areas, but are usually found as rubble on slopes. The finer sediments of the deposits of the different formations are not lithologically distinct. These factors, combined with the slight dip of the beds in general, hindered mapping. The main basis for correlation of beds was stratigraphic position.

Stratigraphy

Pre-Cenozoic rocks.—The bed rock of the area is the Permian Whitehorse formation (Smith, 1940, p. 32). These red beds crop out in the east side of the bed of Crooked Creek about 4 miles east of the area mapped. The Permian rocks contain layers of salt and anhydrite, the solution of which has caused some solution depressions in the surrounding area (Frye and Schoff, 1942, p. 38). The most pronounced of these features are found in Clark County, to the east. There, in St. Jacob's Well, a slump block of the Ogallala has a dip of 35° (Smith, 1940, p. 131).

Cenozoic rocks.—Rocks representing the time span from the Lower Pliocene to Recent epochs are found in the Meade Basin. These consist mainly of clastic sediments whose particle sizes range from gravel to clay. Sand and gravel conglomerates may be held together with a calcium carbonate cement, but most of the sediments are unconsolidated. Caliche is the chief nonclastic deposit and is most commonly seen as nodules and stringers dispersed in poorly defined zones throughout the deposits. It may be, however, concentrated into definite bands 2 to 3 feet thick. The other nonclastic deposit of note is that of lignite, which occurs in the Rexroad formation at locality 3 (Fig. 1).

Lower Pliocene.—Deposits of the Lower Pliocene Laverne formation are not exposed in the area mapped. The nearest exposures of the Laverne formation are along the Cimarron River in southwestern

Meade County and in southeastern Seward County (Byrne and McLaughlin, 1948, pl. I).

Middle Pliocene.—The Middle Pliocene Ogallala formation crops out on the east side of Crooked Creek 4 miles east of the area mapped, and probably continues under it. Ogallala deposits have a great areal extent, being more or less continuous from the Panhandle of Texas to the Platte Valley of Nebraska. The formation is a stream-laid gravel and silt with lesser amounts of clay, which was derived from the Rocky Mountain Region (Smith, 1940, p. 39). In Meade County, the top of the formation is a light gray cap rock formed by secondary calcium carbonate cement. Here, the Ogallala formation is 103 feet thick (Smith, 1940, p. 67).

Upper Pliocene.—The Rexroad formation is found west of Crooked Creek in valleys where the streams have cut down through the overlying deposits, and generally occurs as discontinuous exposures. This formation was described by H. T. U. Smith (1940, p. 95) from exposures along tributaries of Crooked Creek in Meade County, Kansas, as "consisting of alternating beds of gray to reddish mudstone, buff sandy silt, rusty sand and gravel, and a few thin seams of lignite. The gravel is locally cemented to form a conglomerate very similar to that found in the Ogallala, but contains some calcareous pebbles seemingly reworked from the Ogallala." Part of this description pertained to beds of Pleistocene age, especially that referring to the consolidated sand and gravel. The sand and gravel exposed in this area is not of the Rexroad formation, but rather of the basal Pleistocene deposits (Frye and Hibbard, 1941, p. 407).

The most complete section of Rexroad deposits is exposed near the mouth of Wolf Canyon, along the Cimarron River in the southwestern corner of Meade County. In this area, Sec. 7, T. 35 S., R. 30 W., Meade County, Kansas, the Rexroad formation is 86 feet thick and rests directly on the Laverne formation (Byrne and McLaughlin, 1948, p. 74). The following description of the Rexroad formation is based on Byrne and McLaughlin (1948, p. 73). In Wolf Canyon the Rexroad consists of a lower sand and gravel part, a middle (transitional) coarse gravel to silt sequence, and an upper unit of silt and clay with nodules of caliche. The thickness of the basal part is variable because these deposits are channeled into the underlying material. The gravels consist of particles derived from igneous rocks, mainly feldspar and quartz with some mica. The sand is mainly quartz.

When the sand and gravel is locally cemented with calcium carbonate a conspicuous ledge-forming rock results. This ledge rock is coarser grained, contains less calcium carbonate, and weathers to a smoother surface than that of the Ogallala. The middle sequence is transitional to the lower gravel and the upper silt and clay. It is a poorly bedded, moderately indurated, heterogeneous accumulation of reddish clay, silt, sand, and gravel, with locally abundant nodules and stringers of caliche. The upper part consists of finer deposits, silts, fine sands, and clays which range in color from brown to various shades of gray. Near the top is often a bed of hard, cherty caliche, 2 feet thick, which weathers to irregular, rough, pitted boulders.

The Saw Rock Canyon fauna, known from a locality near the center of the west section line of Sec. 36, T. 34 S., R. 31 W., Seward County, Kansas, comes from the XI member near the bottom of the Rexroad formation (Hibbard, 1949, p. 93).

At the Fox Canyon fossil locality (UM-K1-47) in Sec. 35, T. 34 S., R. 30 W., Meade County, Kansas, the Rexroad deposits dip south toward the Cimarron River. The fossils occur in a local pocket of rusty gray to reddish tan sandy silt, which is 17 feet below a massive caliche zone 3 to 5 feet thick (Hibbard, 1950, p. 120).

The Rexroad deposits at the Keefe Canyon quarry (locality 22) in Sec. 3, T. 35 S., R. 30 W., consist of a reddish buff to buff silt. The silt contains stringers and nodules of caliche, and, in places, a massive caliche zone 2 feet thick occurs near the upper third of the exposure. The fossils were recovered from an artesian sand tube and its surrounding basin about 6 feet below the caliche horizon. The base of the deposits is not visible. The exposure is about 45 feet thick here, but a drilled section in the Rexroad in the SE¼, NE¼ Sec. 33, T. 34 S., R. 30 W., shows a thickness of 182 feet (Hibbard and Riggs, 1949, pp. 831–833).

The deposits in the Wendell Fox pasture contain one of the most recently developed Rexroad fossil quarries in the area. The following section was measured at that locality (K3, Fig. 1).

MEASURED SECTION NO. 1

In the SW¼, SW¼ Sec. 33, T. 33 S., R. 29 W., Meade Co., Kansas (locality UM-K3-53)

	Thickness in Feet
6. Topsoil	0.66
Rexroad Formation	
5. Caliche, massive	1.13

4. Silt, sandy, light green	7.13
3. Silt, sandy, light brown. Main fossil horizon	1.00
2. Clay, silty, green-gray, becomes lighter toward bottom	3.50
1. Caliche, with sand particles and clay, white. Base not exposed	0.85
Bed of Shorts Creek, total thickness	14.27

MEASURED SECTION NO. 2

Upstream from locality UM-K3-53, in the SE¼, SE¼ Sec. 32, T. 33 S., R. 29 W., Meade Co., Kansas

	Thickness in Feet
8. Topsoil	5.00
Rexroad Formation	
7. Silt, sandy, light tan, moderately indurated with calcium carbonate	2.00
6. Silt, sandy, brown, with caliche concentrated in lower one third	16.00
5. Silt, sandy, light brown, friable, with green clay layer 2 inches thick in middle. Irregular massive caliche rests locally on clay layer	22.00
4. Silt, sandy, brown, coarser near top, with irregular nodular caliche 10 inches below top	2.50
3. Silt, sandy, and silt, light green-gray, with irregular 4-inch lime-enriched zone about 10 inches below top	2.55
2. Silt, brownish green, with calcareous material. Correlates with unit 3 of measured section No. 1	0.66
1. Silt, greenish gray, base not exposed	0.25
Bed of Shorts Creek, total thickness	50.96

The deposits of measured section No. 2 are essentially continuous along Shorts Creek in Secs. 32 and 33, T. 33 S., R. 29 W. (Fig. 1). In this area there is not the great degree of lateral variation that is found in the Rexroad sediments of Sec. 22, T. 33 S., R. 29 W. To the present, fossils have been found concentrated in this area at only locality UM-K3-53. The beds surrounding this locality dip generally east to southeast, toward the main fault along Crooked Creek. From measured section Nos. 1 and 2 it may be seen that there are two zones of massive caliche development above the fossil horizon.

In the type area of the Rexroad formation, Sec. 22, T. 33 S., R. 29 W., Meade County, Kansas, the sediments show great lateral variation. The beds dip southeast, so that by progressing downstream, one moves upward in the section (Fig. 1). Just upstream from the type locality of the Rexroad local fauna (locality 3, Fig. 1), the sediments of the Rexroad formation consist of an orange-buff quartz sand which is indurated by calcium carbonate cement and contains scattered pebbles up to 2 inches in diameter. Stratigraphically below this deposit is a coarse sand and fine gravel, with some manganese stain, which exhibits cross-bedding. The base of this deposit is not exposed.

MEASURED SECTION NO. 3

In the W½, SW¼ Sec. 22, T. 33 S., R. 29 W., Meade Co., Kansas (locality 3, Fig. 1)

	Thickness in Feet
3. Covered slope interval	10.00
Rexroad Formation	
2. Clay, sandy, light gray, indurated, with a limonitic layer about three feet from the bottom. Weathers greenish, fresh surface is brownish gray	7.50
1. Lignitic zone. Brown lignitic matter interbedded with gray-brown clay. Lower one half is mostly brown clay with some sandy silt. The lignitic layer is local, grades laterally into gray clays and fine, limonite-stained sand. Base not exposed. Main fossil horizon	5.50
Bed of Stream, total thickness	23.00

Downstream from locality 3, in Sec. 22, T. 33 S., R. 29 W., 1400′ E., 930′ N. of SW. corner, there is a massive caliche about 3 feet thick. This caliche is stratigraphically above the fossil deposits at locality 3 and below the beds containing the Bender local fauna. An account of the Bender local fauna is given by Taylor (1960).

At the Bender faunal locality the basal sand and gravel member (Angell) of the Ballard formation does not overlie all of the Rexroad deposits. Instead, the Missler silt member of the Ballard directly overlies the Rexroad formation. (Pl. 1, Fig. 1). North and south of this point, the Angell member is found lying between the Missler silts and the Rexroad deposits. The following measured section was taken at the point where the Missler silts directly overlie a Rexroad "high." This situation is not unique. Similar conditions were found elsewhere in the area mapped, notably in Sec. 32, T. 33 S., R. 29 W., 900′ W., 2800′ S. of the NE. corner (Pl. I, Fig. 2).

MEASURED SECTION NO. 4

In SW corner of SW¼, SE¼ Sec. 22, T. 33 S., R. 29 W., Meade Co., Kansas (Bender local fauna locality)

	Thickness in Feet
Ballard Formation	
Missler member	
13. Silt and fine sand, brown to buff, friable	1.00
12. Silt, containing caliche, nodular	0.16
11. Silt, sandy, brown with limonite stain	0.91
10. Silt and fine sand, brown to buff, indurated with calcareous cement	0.33
9. Silt, sandy, limonitic, indurated	1.66
8. Silty, sandy, brown with green clay	0.60
7. Clay, green-gray, friable, with caliche stringers	0.66
6. Silt, sandy, green-gray, friable, limonite stain	1.00
5. Silt, with much calcium carbonate, fine, green-gray, friable. Found at contact between Angell member and Rexroad formation immediately to the north and south.	1.25
Disconformity	
Rexroad Formation	
4. Bender fauna zone, silt, brown to dark gray with gastropods.	1.33
3. Silt, green-gray, with limonite stain.	1.00
2. Silt, containing caliche, nodular.	0.25
1. Silt, green-gray, limonite stain, with caliche nodules becoming more concentrated at bottom. Base not exposed.	0.91
Bed of Stream, total thickness	11.16

It is interesting to note the presence of a well-defined calcium carbonate layer at the contact between the Ballard and Rexroad formations, a feature which is not everywhere found in this stratigraphic position.

There is one massive caliche exposed in the type area of the Rexroad formation. It is stratigraphically above the fossil deposits of locality 3. This caliche is thicker than those mentioned in measured section No. 2 in the Wendell Fox pasture. Measured section No. 2 shows two massive caliches, units 5 and 6, which are separated by about 10 feet of sandy silt. In this area, then, there were two periods of caliche formation with an intervening period of deposition. Upstream from the location of measured section No. 2, in SW¼ Sec. 32, there is a massive caliche 3 to 4 feet thick. It may be that the two caliche layers of measured section No. 2 coalesce further upstream into a unit similar in thickness to that found in the type area of the Rexroad formation. If this is true, the caliche in the Wendell Fox pasture and the one at the Rexroad type area may represent the same period of massive caliche development. In any case, the fossils found at both localities were deposited prior to the development of the massive caliches.

Pleistocene.—Pleistocene deposits in the Meade Basin consist of two main types. The earlier are widespread sheet deposits of the Meade Group. This group is composed of the Ballard and Crooked Creek formations, the Ballard being the older of the two. Much of the upland surface in the area surrounding Meade, Kansas consists of the Crooked Creek formation.

The second type of deposits, the Sanborn Group (Hibbard, 1958), consists of valley and sinkhole fillings which include the Kingsdown and Vanhem formations. Coarse material, indicating stream deposition, may be present in these beds, but the sediments exhibit no regular succession of coarse to fine particle size. These deposits are, generally, not so widespread as those of the earlier Pleistocene.

Structural relations.—From Fig. 1 it may be seen that the dip of the beds generally increases from west to east. It is also evident that the dip of the Rexroad deposits is generally greater than those of the overlying formations. The sediments of the Crooked Creek formation are mainly flat-lying.

Two small faults may be found on Fig. 1. One of these faults is developed in the Rexroad formation at locality UM-K3-53 (K3, Fig. 1). It strikes N. 72° E., dips 64° SE., and is downthrown to the southeast. The net slip is about 1 foot. The other fault disrupts Ballard and Rexroad deposits in the NW¼, SE¼ Sec. 22, T. 33 S., R. 29 W.; it strikes N. 46° E., dips 56° SE., and is downthrown to the southeast. The net slip is about 3 feet.

I interpret the faults as adjustment features associated with the main Crooked Creek fault to the east. The first of the small faults implies post-Pliocene movement, while the second is the result of post-Ballard activity. It is possible that both faults represent the later movement.

Haworth believed the Meade Basin to have been formed by a fault, the west side being the downthrown (Smith, 1940, p. 133). The present Crooked Creek is thought to flow generally along this fault (Smith, 1940, p. 135). Evidence for a fault can be seen in Crooked

Creek valley, 4 miles east of the area mapped. On the east side of Crooked Creek the Permian red beds are exposed at the bed of the stream. The red beds are overlain by the Ogallala formation, which is covered by the upper part of the Crooked Creek formation.

On June 13, 1942, a water well was drilled on the west side of Crooked Creek valley on the George Roberts farm in the NW¼, NW¼ Sec. 20, T. 33 S., R. 28 W. Water-bearing gravel was reached at a depth of 260–280 feet, and at that point salt water began flowing in the well at a rate of about 1,000 gallons per minute (Hibbard, field notes, June 13, 1942, p. 113), suggesting that the Permian bed rock may not have been much deeper. This would give at least 280 feet of displacement along the Crooked Creek fault. As a result of this movement a well-defined scarp, 75–100 feet high, has formed on the east side of the fault.

The presence of the fault is the main reason that the Rexroad deposits are found west of Crooked Creek in the Meade Basin (Frye and Hibbard, 1941, p. 395). Pleistocene movement along the fault is indicated by the presence of the upper part of the Crooked Creek formation on the eastern or upthrown side, whereas west of the scarp those deposits are buried beneath valley fill 50–75 feet below the upper contact. For further discussion of the Crooked Creek fault see Smith (1940) and Frye and Hibbard (1941).

Systematic Description

The fossils to be discussed in this section have been chosen for their paleontologic significance. Many of the specimens, including those from locality UM-K3-53, have not been described previously. The specimens are now in the following institutions: Chicago Natural History Museum (CNHM); University of Kansas Museum of Natural History (KUMNH); and The University of Michigan Museum of Paleontology (UMMP).

ORDER RODENTIA

Family Castoridae

Dipoides rexroadensis Hibbard and Riggs

(Fig. 2*A–P*)

Dipoides rexroadensis Hibbard and Riggs, 1949, Geol. Soc. Amer., Bull., 60: 835, fig. 1*G*.
D. rexroadensis Hibbard, Shotwell, 1955, Jour. Paleont., 29: 135.

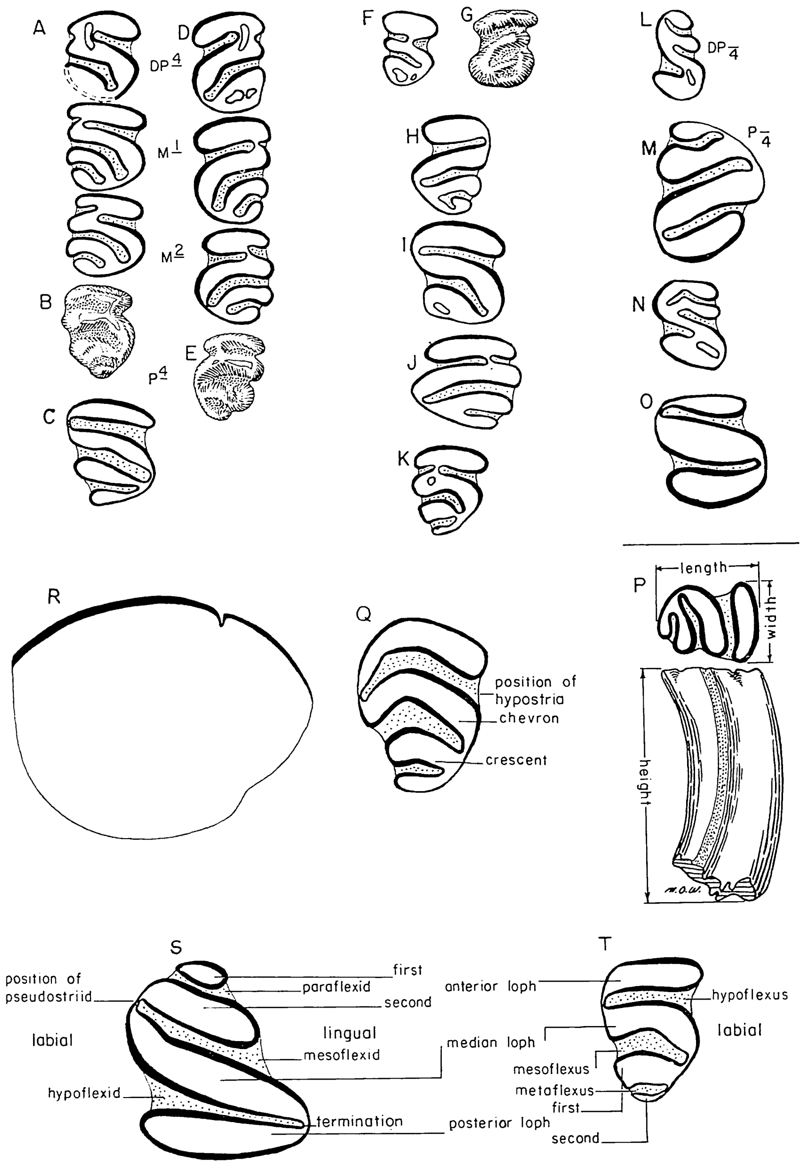

FIG. 2. *A–O*, *Dipoides rexroadensis* Hibbard and Riggs; *A–E*, UMMP 41149; *A*, right maxillary fragment, DP^4–M^2; B, RP^4; *C*, pattern at base of *B*; *D*, associated LDP^4–M^2; *E*, LP^4; *F*, UMMP 41153, RDP^4; *G*, UMMP 41153, unworn RDP^4; *H*, UMMP 41290, LM^1; *I*, UMMP 41153, RM^1; *J*, KUMNH 7281, LP^4; *K*, UMMP 41290, RP^4; *L*, UMMP 41290, LDP_4; *M*, KUMNH 7281, RP_4; *N*, UMMP 41290, left lower molar; *O*, KUMNH 7281, left lower molar; *P*, UMMP 35094, LM^2. *Q–T*, *Procastoroides sweeti* Barbour and Schultz; *Q*, UMMP 41290, RM^3; *R*, UMMP 41150, left upper incisor, cross-section; *S*, UMMP 42314, LP_4; *T*, KUMNH 3939, RM^3. All ×2.

Since 1938, when the first mention was made of a beaver from the deposits of the Meade Basin, much additional material has been collected. None of the specimens recovered with the Rexroad fauna has been extensively described or figured. It is now possible to indicate the range of variation found in the remains of *Dipoides rexroadensis* and *Procastoroides sweeti* Barbour and Schultz from the above area, and to submit some remarks concerning the phylogenetic position of these beavers.

Terminology.—In discussing the teeth of these beavers I have used the dental terminology applied to those animals by Stirton (1935, p. 392), which was expanded by Shotwell (1955, p. 130). The terms that follow are illustrated by Fig. 2*P*, *Q*, *S*, and *T*.

Many beaver teeth consist of three lophs, an anterior, a median, and a posterior loph (Fig. 2*S*, *T*). The anterior loph of P_4 is divided by the paraflexid into two parts, a first and a second anterior loph (Fig. 2*S*). The first anterior loph is the more anterior of the two. Similarly, the posterior loph of M^3 may be divided into a first and a second posterior loph by the metaflexus (Fig. 2*T*). Lophs may be *inflated* or *uninflated*. The inflated condition exists when the two bands of enamel that make up its sides are not parallel (posterior loph of Fig. 2*S*). When the enamel bands are parallel, the loph is uninflated, as in the second anterior loph of Fig. 2*S*. When a loph possesses curvature, either concave or convex anteriorly, it is referred to as *crescentic* (Fig. 2*Q*). If the curvature is so sharp and abrupt that it has a decided point or apex it is a *chevron* (Fig. 2*Q*).

Flexi and flexids are infoldings of enamel which separate the lophs. *Flexus* refers to that of an upper, *flexid* to that of a lower tooth. The space between the enamel infolds of the flexus or flexid is filled with cement. The internal end of a flexus or flexid is called the *termination* (Fig. 2*S*). It can be either flattened, rounded, or narrowed. The termination *abuts* when it touches the enamel of the side of the tooth opposite that on which the infold originates. A *fossette*, usually a roughly circular body of enamel which is surrounded by dentine, is shown in Fig. 2*A*. In a lower tooth, the counterpart of a fossette is a *fossettid*.

A *stria* or *striid* is a groove, filled with cement, which results from the formation of a flexus or flexid. A stria (Fig. 2*Q*) occurs on an upper tooth and a striid on a lower. *Pseudostria* and *pseudostriid*, terms presented here for the first time, are found on the enamel of the tooth wall in conjunction with a tightly abutting termination and are used to designate areas where the enamel of the wall of the tooth has become greatly thinned or worn through (Fig. 2*S*). This allows the enamel of the termination to be seen in a lateral view. Some of these are so well defined that at first they appear to be striae or striids, as though the cement associated with flexi and flexids had broken through the tooth wall. The presence of pseudostriae and pseudostriids may represent an evolutionary stage intermediate to one in which the tooth wall is penetrated by flexi or flexids, as is shown by the teeth of *Castoroides ohioensis* Foster. Other terms used are either commonly understood or self-explanatory.

Holotype.—The holotype, KUMNH 7693, a LM^1 ?, was recovered from Upper Pliocene deposits at locality 22, SW¼, SW¼ Sec. 34, T. 34 S., R. 30 W., in Keefe Canyon, Meade County, Kansas.

Referred material.—Collected at locality 22 were KUMNH 7281, RP_4,

LP^4, RM^1?, and a lower molar. At locality 3, W½, SW¼ Sec. 22, T. 33 S., R. 29 W., Rexroad Ranch, Meade County, Kansas, were UMMP 41149, associated right and left upper dentition, DP^4, P^4–M^2, UMMP 41153 RDP^4, LDP^4, LP^4, RM^1?; and at locality UM-K3-53, SW¼, SW¼ Sec. 33, T. 33 S., R. 29 W., Wendell Fox Pasture, Meade County, Kansas, UMMP 38435 LM^2, UMMP 41290, LDP_4, two RP^4, one LP^4, two LM^1, and a lower molar.

Diagnosis of species.—Since the holotype of the species was named from only one specimen, a diagnosis based on the holotype and the referred material seems worth while. The teeth of *Dipoides rexroadensis* are larger than those of the other species of the genus (Tab. I; cf. Shotwell, 1955, tab. 2). When present the paraflexus commonly passes anterior to the hypoflexus. The width of P^4 is generally not greater than the length, contrary to that in *D. smithi* Shotwell and *D. stirtoni* Wilson (see Shotwell, 1955, tab. 2). In none of the 6 P^4's examined was the anterior loph completely isolated by the cement of the hypoflexus, as is found in *D. wilsoni* Hibbard (Hibbard, 1952, fig. 5). In both upper and lower premolar, *D. wilsoni* seems more variable than does *D. rexroadensis*. In P^4–M^2 of *D. rexroadensis*, the mesoflexus is curved more posteriorly than in those teeth of *D. wilsoni*. This situation is especially evident in P^4. No other species of the genus is known to be found in the same stratigraphic position as *D. rexroadensis*.

Tooth variation.—The variation of the teeth of *Dipoides rexroadensis* examined does not seem to be so great as that found in the teeth of *D. wilsoni*. The dental variation found in other species of the genus is discussed by Shotwell (1955). Shotwell (1955, p. 129) mentions that *D. rexroadensis* may belong to a different genus. As a result of this study, I believe that the tooth variation of *D. rexroadensis* is well within the range of that shown by the genus, although the species is distinct.

Upper deciduous premolar.—In UMMP 41149, the only maxillary fragment available (Fig. 2*A*), DP^4 is in position, along with M^1 and M^2. The molars are in a fairly early stage of wear with parastria and metastria still present. There were 4 DP^4's available for study (Fig. 2*A*, *D*, *F*, and *G*). One of these (Fig. 2*G*). is unworn. The parastria, hypostria, and mesostria are present in all. A metastria is present in the unworn tooth. In each tooth, the parastria is shorter than the metastria and would disappear at an earlier stage of wear. In 2 of the 3 worn teeth, a hypofossette is present (Fig. 2*A*, *D*). Two metafossettes are present in each of the teeth in Fig. 2*D* and *F*. In all of the teeth the anterior loph is generally directed anterolingually and inflated lingually. The median loph is more or less crescentic and convex anteriorly. The posterior loph is inflated labially.

The paraflexus is short in all DP^4's and extends lingually or posterolingually. The termination of the paraflexus is rounded. In 2 of the worn teeth, the termination of the paraflexus is separated from a hypofossette by a tract of dentine (Fig. 2*A*, *D*).

The hypoflexus trends anterolabially or labially. Its termination may be rounded or flat and separated to a greater or lesser degree from the enamel of the hypofossette.

The mesoflexus is directed slightly posterolingually, but near the midline

TABLE I

MEASUREMENTS* OF TEETH OF *Dipoides rexroadensis*

Tooth	Mean Length	Mean Width	Range of Length	Range of Width	Number of Specimens
DP^4	5.7	4.4	5.7 ±	4.3–4.5	2
P^4	5.1	4.1	4.5–5.5	3.0–6.0	6
M^1	5.8	4.7	5.3–6.3	4.3–6.0	4
M^2	5.2	4.5	5.2–5.4	4.2–4.8	3

* In millimeters. For orientation of teeth during measurement see Fig. 2P. Most of the measured teeth were in an early stage of wear.

of the tooth, it turns more posteriorly. The termination of the mesoflexus is flat or rounded and does not abut tightly against the enamel of the tooth wall. The position of the metafossettes is shown in Fig. 2*D* and *F*.

Upper premolar.—Seven P^4's were collected, of which 4 are shown in Fig. 2*B*, *E*, *J*, and *K*. Fig. 2*C* shows the pattern at the base of Fig. 2*B*. The parastria, hypostria, mesostria, and metastria are present on all teeth. The metastria may disappear at the base of the tooth. In only 2 specimens does the parastria persist to the base of the tooth, a feature which is most significant in KUMNH 7281 from the Keefe Canyon locality (Fig. 2*J*). This tooth has a height of 16 mm., whereas that of the others is, at most, 12 mm. One specimen (Fig. 2*K*) has a fossette in the labial part of the median loph. In all teeth the anterior loph is crescentic, convex anteriorly as is the median loph. The posterior loph is inflated labially.

The paraflexus is usually directed slightly anterolabially in P^4. Its termination is flat or rounded and does not touch the enamel of the hypoflexus.

The hypoflexus generally extends anterolabially to a termination which is rounded or flattened. At the base of the tooth, the hypoflexus usually reaches the labial side of the tooth, and the termination may abut tightly with the wall enamel.

The mesoflexus trends posterolingually and may have the shape of either a broad or a tight curve. Its termination may be either flat or rounded, and in most cases does not abut tightly against the lingual wall of the tooth. This situation is found at both the occlusal surface and the base of the tooth.

The metaflexus is variable. It trends more or less labially and is often not present at the base of the tooth. When the metaflexus is present at the base, the tooth is usually short, the base probably having been broken off. The termination of the metaflexus is rounded and usually does not abut tightly with the enamel of the labial tooth wall.

Upper first and second molars.—Eleven M^1–M^2's were available for study, 7 of which are illustrated in Fig. 2*A*, *D*, *H*, *I*, and *P*. The teeth are subequal in size, M^1 being the largest. Only the hypostria and mesostria persist to the base of all of these teeth. In little-worn specimens, the parastria and metastria are also present, the parastria extending further down the side of the tooth than the metastria, but never to the base. In UMMP 41149, the parastria and metastria are longer in M^2 than in M^1. This suggests that at a given instant of time, M^1 may be in a more advanced stage of wear than M^2. UMMP 35094 (Fig. 2*P*) shows the hypoflexus extending completely across the tooth in an early stage of wear. This condition would disappear as wear progressed. The anterior loph is inflated lingually, or is crescentic, convex anteriorly. The posterior enamel band of the median loph of M^2 appears as a rather smooth curve (Fig. 2*A* and *D*) while that of M^1 has a sharp bend, and is more like a chevron. The posterior loph is inflated labially.

In M^1 and M^2 the paraflexus, present in early stages of wear, is directed anterolingually. It is shorter in M^1 than in M^2. The termination of the paraflexus is rounded and overlaps anteriorly that of the hypoflexus in M^2 (Fig. 2*A* and *D*). In M^1 the termination of the paraflexus is narrowed and does not overlap anteriorly that of the hypoflexus. This situation may be correlated with the idea that M^1 is worn down first, causing the paraflexus to disappear in M^1 before it does in M^2.

The hypoflexus commonly extends anterolabially to a termination which may be rounded or flat. At the occlusal surface, no M^1 or M^2 shows the termination of the hypoflexus abutting tightly to the enamel of the labial tooth wall. At the base of the tooth the abutment is often tight.

The mesoflexus has either the shape of a crescent, convex anteriorly, or that of a chevron. It terminates on the lingual side of the tooth. The curve seems to be smoother in M^2. The termination of the mesoflexus is commonly flattened but does not abut tightly, in all cases, with the lingual wall enamel at either the occlusal surface or the base of the tooth.

Lower deciduous premolar.—Only 1 $DP_{\bar{4}}$, UMMP 41290, has been collected (Fig. 2*L*). The pattern is generally similar to that of an $LDP_{\bar{4}}$ of *Dipoides smithi* illustrated by Shotwell (1955, Fig. 2*A*). The Rexroad tooth is larger than that of *D. smithi*.

The parastriid, mesostriid, and hypostriid are present, but do not persist to the base of the tooth. The parastriid is the shortest, the hypostriid the longest of the striids. The first anterior loph is inflated lingually. The second anterior loph is crescentic, concave anteriorly, as is the median loph. The posterior loph is inflated and contains a hypofossettid.

The paraflexid curves anterolabially to a narrow termination which abuts tightly against the labial wall enamel. The mesoflexid extends anterolabially across only half of the tooth and the termination is rounded. The hypoflexid is directed posterolingually across only the labial half of the tooth and bears a flat termination. The termination is separated by dentine from the anterolabially directed hypofossettid. The hypofossettid is surrounded by dentine.

Lower premolar.—Only 1 $P_{\bar{4}}$ has been identified (Fig. 2*M*). The parastriid, mesostriid, and hypostriid are present, but only the mesostriid and hypostriid persist to the base of the tooth. The parastriid is open for 9.2 mm. down the side of the tooth. At this point the parastriid closes off and a parafossettid would be formed as wear progressed. The first anterior loph is inflated lingually, as is the second anterior loph. The median loph is inflated labially, while the posterior loph is crescentic, concave anteriorly.

The paraflexid is in the shape of a crescent and is concave anteriorly. The termination is flat and does not abut tightly to the labial wall enamel.

The mesoflexid is directed anterolabially to a flat termination. The termination is separated from the enamel of the labial tooth wall by a tract of dentine. This situation exists both at the occlusal surface and the base of the tooth.

The hypoflexid extends posterolingually in a sinuous manner. The termination of the hypoflexid is flat, but does not abut tightly against the wall enamel at the occlusal surface, although the abutment is tight at the base.

Lower molars.—Two lower molars have been examined (Fig. 2*N* and *O*). In an early stage of wear the parastriid is present, but it is very short. This tooth (Fig. 2*N*) has a hypofossettid. Only the mesostriid and hypostriid are persistent to the base of both teeth. The first anterior loph is constricted in the middle, and the second anterior loph is inflated lingually (Fig. 2*N*). The median loph is inflated labially. The posterior loph may be straight and inflated labially, or crescentic, concave anteriorly and inflated labially.

When present the paraflexid has a sinuous configuration and is directed labially. The termination of the paraflexid is rounded and separated from the wall of the tooth by dentine.

The mesoflexid trends anterolabially and has a rounded termination. At the occlusal surface, the termination of the mesoflexid does not abut tightly against the labial wall of the tooth. At the base of the tooth, however, the abutment is tight.

The hypoflexid extends posterolingually. The termination of the hypoflexid is flat and abuts tightly against the lingual tooth wall at the base of the tooth, but not at the occlusal surface.

Discussion.—*Dipoides rexroadensis* is the latest representative of the genus in North America. Its cheek teeth are larger than those of any other species of the genus. All specimens of *D. rexroadensis* were taken from Upper Pliocene deposits. The localities are given in the section on referred material.

The teeth are prismatic and hypsodont. On the basis of the present material the teeth of *Dipoides rexroadensis* show less variation than those of *D. wilsoni* or *Procastoroides sweeti*. The hypostria, mesostria, hypostriid, and mesostriid are present on, and persist to the base of, all adult cheek teeth. The parastria, metastria, parastriid, and metastriid are present on unworn or little-worn teeth. The parastriid is present for most of the height of $P_{\overline{4}}$. The molars have an S-shaped pattern. The parastria, when present, is opposite the hypostria. The hypostria or hypostriid is never opposite the mesostria or mesostriid. The metastria is shorter than the parastria. Fossettes and fossettids are present in young individuals only. There is no indication of closure of the pulp cavities in old individuals, and the patterns of the teeth are similar to those of other species of *Dipoides* illustrated by Shotwell (1955).

The features given above fit well with the diagnosis of the genus as given by Shotwell (1955, p. 142). Its large size is the main reason for retaining the species *rexroadensis* as being distinct. The paraflexus is commonly directed, or passes anterior to the hypoflexus in the Rexroad form. The mesoflexus of P^4–M^2 curves more posteriorly in *Dipoides rexroadensis* than in *D. wilsoni*, a condition which is most evident in P^4.

From the study of the material at hand it is evident that *Dipoides rexroadensis* is not the same animal as *D. wilsoni* or any other species of the genus. It is probable, however, that *D. rexroadensis* is a descendant of *D. wilsoni*. More definite ideas concerning the relationship of the Rexroad species to other species of *Dipoides* await the discovery of better fossil material.

ORDER RODENTIA

FAMILY CASTORIDAE

Procastoroides sweeti Barbour and Schultz

(Figs. 2*Q*–*T*, 3, and 4)

Procastoroides sweeti Barbour and Schultz, 1937, Am. Mus. Novitates, 942: 6, fig. 3.
Eocastoroides lanei Hibbard, 1938, Kans. Acad. Sci., Trans., 40 (1937): 244, fig. 2.
Procastoroides lanei (Hibbard), Hibbard, 1941, Kans. Acad. Sci., Trans., 44: 279, pl. II, fig. 1.
P. lanei (Hibbard), Hibbard and Riggs, 1949, Geol. Soc. Amer., Bull., 60: 836.
P. sweeti Barbour and Schultz, Hibbard, 1956, PMASAL, 41 (1955): 174.

There seems to be a great amount of variation shown by the teeth of this beaver from the Meade Basin. Many of these specimens were formerly referred to *Eocastoroides* or *Procastoroides lanei*, but I believe this material to be correctly assigned to *P. sweeti*. Characters found in *E. lanei*, i.e., narrow posterior transverse diameter of M_3, confluence of hypoflexus with labial side of P^4, have been found to be variable, and are also seen in specimens designated as *P. sweeti* from the Chicago Natural History Museum.

Referred material.—From the Sand Draw locality (Pleistocene), Brown County, Nebraska: CNHM P14974, right jaw with I, P_4–M_3 ; CNHM P15507, LP_4 ; CNHM P15508, RM^3; CNHM P26165, right maxillary fragment, P^4–M^2.

The following localities are in Meade County, Kansas: 1, 2, 22, 3, and UM-K3-53. From locality 1 (Pleistocene) in the SW¼ Sec. 15, T. 33 S., R. 29 W: KUMNH 3843, fragmentary left jaw with M_2 and M_3 ; KUMNH 4577, right maxillary fragment with P^4–M^3; KUMNH 7301, RM_3 .

Recovered from locality 2 (Upper Pliocene) in the NW¼ Sec. 22, T. 33 S., R. 29 W: KUMNH 3938, RM_3 ; KUMNH 3939, RM^3; KUMNH 4273, right upper molar; KUMNH 5967, LM_3 .

KUMNH 6847, LM_3 was collected at locality 22 in the NW¼ Sec. 36, T. 34 S., R. 30 W.

The specimens from locality 3, in the SW¼ Sec. 22, T. 33 S., R. 29 W., at the University of Kansas Museum of Natural History are: KUMNH 7403, right jaw with P_4–M_2 ; KUMNH 5189, Rp^4. The following specimens from locality

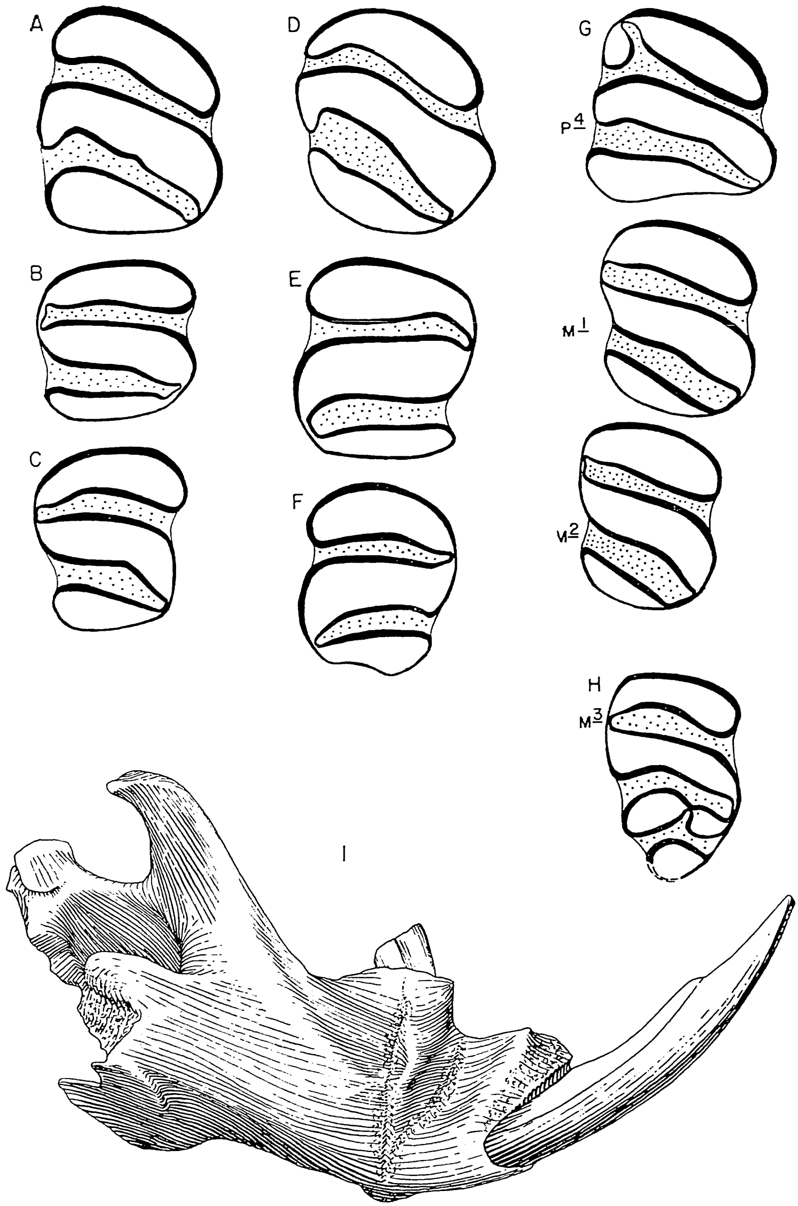

FIG. 3. *Procastoroides sweeti*. *A–F*, UMMP 41152; *A*, RP^4; *B*, RM^1; *C*, RM^2; *D*, RP^4; *E*, LM^1; *F*, LM^1; *G*, CNHM P26165, right maxillary fragment with P^4–M^2; *H*, CNHM P15508, RM^3. All $\times$-2. *I*, UMMP 42315, right jaw. $\times$-½.

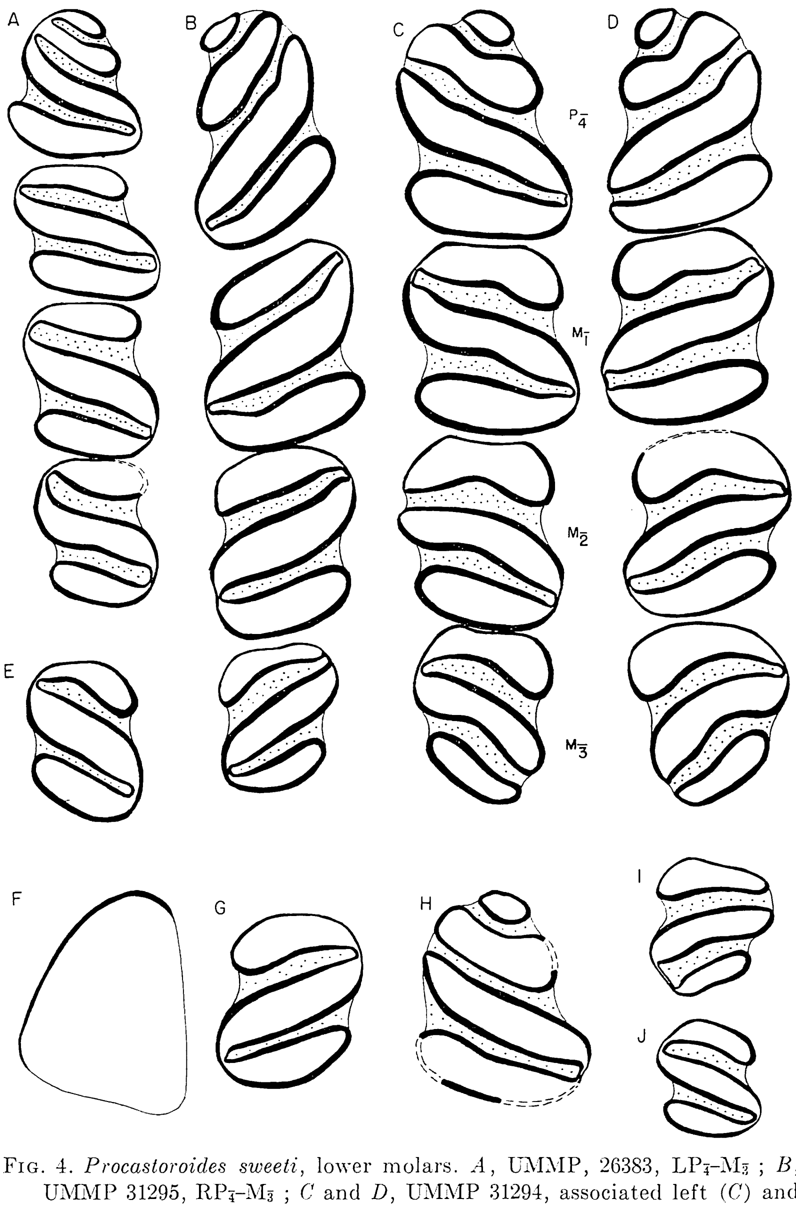

FIG. 4. *Procastoroides sweeti*, lower molars. *A*, UMMP, 26383, $LP_{\overline{4}}$–$M_{\overline{3}}$; *B*, UMMP 31295, $RP_{\overline{4}}$–$M_{\overline{3}}$; *C* and *D*, UMMP 31294, associated left (*C*) and right (*D*) dentitions, $P_{\overline{4}}$–$M_{\overline{3}}$; *E*, KUMNH 6847, $RM_{\overline{3}}$; *F*, UMMP 41151, left lower incisor, cross-section; *G*, UMMP 41152, $LM_{\overline{1}}$; *H*, CNHM P15507, $LP_{\overline{4}}$; *I*, KUMNH 7301, $RM_{\overline{3}}$; *J*, KUMNH 5967, $LM_{\overline{3}}$. All $\times$-2.

3 are in the collections of The University of Michigan Museum of Paleontology: UMMP 26383, associated left lower series, $P_{\overline{4}}$–$M_{\overline{3}}$; UMMP 29153, $RM^{\underline{2}}$? and $RM_{\overline{3}}$; UMMP 29645, left jaw with $P_{\overline{4}}$–$M_{\overline{2}}$; UMMP 31293, right jaw with incisor and $M_{\overline{2}}$; No. 31294, associated right and left jaws, I, $P_{\overline{4}}$–$M_{\overline{3}}$; UMMP 38419, left upper and lower incisor; UMMP 41152, two $RP^{\underline{4}}$'s, seven $M^{\underline{1}}$'s or $M^{\underline{2}}$'s, left and right $P_{\overline{4}}$, one $M_{\overline{1}}$?, right and left $M_{\overline{3}}$.

The remaining specimens were collected at locality UM-K3-53 in the SW¼, SW¼ Sec. 33, T. 33 S., R. 29 W: KUMNH 10293, $RP_{\overline{4}}$; UMMP 35070, right upper incisor, UMMP 41290, $RM^{\underline{3}}$ and $LM^{\underline{2}}$; UMMP 42314, $LP_{\overline{4}}$, $RM_{\overline{1}}$, and right upper incisor; UMMP 42315, right jaw with I and $P_{\overline{4}}$.

Upper premolar (Fig. 3*A*, *D*, and *G*).—Only 5 $P^{\underline{4}}$'s have been recovered. The $P^{\underline{4}}$ is the widest tooth, and the most curved, of the upper series. The curvature of the teeth decreases progressively from $P^{\underline{4}}$–$M^{\underline{3}}$. The hypostria and mesostria are present on and persist to the base of all teeth. The anterior loph is crescentic, convex anteriorly. The median loph is either similar to the anterior loph or sinuous. The posterior loph is inflated labially.

The hypoflexus trends generally anterolabially to about the labial third of the tooth, at which point the trend becomes posterolabial. In all teeth examined, the hypoflexus extends through the labial side, the cement breaks through the termination, and a stria is formed. This separates the anterior loph from the rest of the tooth.

The mesoflexus trends posterolingually to a flat termination which abuts tightly and is associated with a pseudostria.

Upper first and second molar.—$M^{\underline{1}}$ and $M^{\underline{2}}$ are represented by 10 teeth, 6 of which are shown in Fig. 3*B*, *C*, *E*, *F*, and *G*. The hypostria and mesostria are present in and persist to the base of all teeth. The pattern is S-shaped. $M^{\underline{1}}$ and $M^{\underline{2}}$ are subequal in size, $M^{\underline{1}}$ being the larger. The anterior loph is commonly crescentic, convex anteriorly, and inflated lingually. It may also be flat and uninflated. The median loph is usually bent posteriorly in the lingual part (Fig. 3*E*). The posterior loph is inflated labially and directed slightly anterolabially.

The hypoflexus usually passes anterolabially to a flat termination. One specimen, however, has a narrowed termination. The termination of the hypoflexus abuts tightly against the enamel of the labial wall in all but 4 teeth. Pseudostria occur on 4 other teeth.

The mesoflexus trends posterolingually to a flat termination which abuts tightly on the posterolingual tooth wall, and is associated with a pseudostria.

Upper third molar.—There are 4 $M^{\underline{3}}$'s, 3 of which are shown (Fig. 2*Q*, *T*, and 3*H*). The hypostria, mesostria, and metastria are present, and persist to the base of all of these teeth. The lophs are crescentic or chevrons and inflated or uninflated.

The hypoflexus trends, in various ways, more or less labially. Its termination is narrowed or flat. In 1 tooth the cement of the hypoflexus extends through the termination, and a stria is formed. This separates the anterior loph from the rest of the tooth. Pseudostria are associated with the termination of the hypoflexus in 2 teeth.

The mesoflexus passes, as a crescent or chevron, posterolingually. The termination of the mesoflexus is flat on all teeth. Pseudostria are found on 3 of the 4 $M^{\underline{3}}$'s.

The metaflexus is generally crescentic, convex anteriorly, although in 1 tooth (Fig. 3*H*), it is crescentic, concave anteriorly. The termination of the mesoflexus is narrowed. Note Fig. 3*H*, where the first posterior loph is constricted in the middle. At the base of this tooth 2 discrete circles of enamel have been formed.

Lower premolar (Fig. 2*S*, 4*A–D*, *H*).—Thirteen $P_{\bar{4}}$'s have been collected. The parastriid, mesostriid, and hypostriid are present on and extend to the base of all lower premolars. The first anterior loph is usually lenticular or tear-shaped (Fig. 4*A*). Where that loph is completely separated from the rest of the tooth, it is ovate (Fig. 1*S*). The second anterior loph is usually inflated lingually, but it may also be crescentic, concave anteriorly (Fig. 4*C* and *D*). The median loph may be smoothly crescentic, concave anteriorly (Fig. 4*A*), but it is more commonly directed anterolabially with a rather abrupt bend in the labial third (Fig. 4*C* and *D*). The posterior loph is usually inflated labially.

The paraflexid extends anterolabially, and in 4 teeth the cement breaks through the labial enamel, forming a striid on that side. Pseudostriids are associated with the termination of the paraflexid in all but 3 teeth, 1 of which, UMMP 26383 (Fig. 4*A*), appears to be that of a young individual. In this tooth the termination abuts tightly at the base of the tooth, and a pseudostriid appears only on the lower one-fourth. In all lower premolars the termination of the paraflexid with the labial wall of the tooth is flat.

The mesoflexid trends anterolabially. In 4 teeth the cement associated with it extends through the labial enamel and forms a striid on that side (Fig. 4*B–D*, and *H*). The termination of the mesoflexid with the labial tooth wall is flat in all specimens and abuts tightly against that wall in all but 1 tooth (Fig. 4*A*). Like the paraflexid, the termination of the mesoflexid of this tooth (UMMP 26383) abuts tightly at the base. A pseudostriid is formed here by the abutment of the termination of the mesoflexid in only the lower one-fourth of the tooth. In all other teeth the pseudostriid is associated with the termination of the mesoflexid for the full height of the tooth.

The hypoflexid trends posterolingually and may break through the lingual tooth wall (Fig. 4*D*). Other teeth have a definite tract of dentine separating the termination of the hypoflexid from the lingual wall of the tooth. The termination is rounded in UMMP 26383 (Fig. 4*A*) and flat in UMMP No. 31295 (Fig. 4*B*). In the former, the termination is flat and abuts tightly against the lingual tooth wall at the base.

Lower first and second molar (Fig. 4*A–D* and *G*).—There are 21 of these teeth. $M_{\bar{1}}$ and $M_{\bar{2}}$ are subequal in size, $M_{\bar{1}}$ being the larger. The pattern is S-shaped since only the mesostriid and hypostriid are present on and persist to the base of all of these molars. Pseudostriids are found on 8 teeth. The anterior loph is either inflated and crescentic, convex anteriorly (Fig. 4*C*, *D*, and *G*), inflated and straight (Fig. 4*B*) or uninflated and straight, in an anterolabial direction. The median loph trends anterolabially and is usually bent anteriorly on the labial side (Fig. 4*B–D*). It may be straight and slightly inflated (Fig. 4*G*) or straight and uninflated (Fig. 4*A*). The posterior loph is either crescentic, concave anteriorly and inflated labially (Fig. 4*D*, $M_{\bar{2}}$), or straight, in an anterolabial direction, and inflated labially (Fig. 4*C*, $M_{\bar{2}}$).

The mesoflexid trends anterolabially. The terminations are flat and abutments of the terminations tight in all but 1 tooth. This tooth has a definite tract of dentine between the rounded termination and the labial wall enamel. $M_{\overline{2}}$ of Fig. 4*C* has a mesoflexid in which the cement breaks through the labial enamel, completely separating the anterior loph from the rest of the tooth.

The hypoflexid trends posterolingually. The termination of the hypoflexid is flat in all but 3 teeth, 2 of which are shown in Fig. 4*B*, $M_{\overline{2}}$, and 4*C*, $M_{\overline{1}}$. Pseudostriids are found on 11 teeth. The termination of the hypoflexid does not abut tightly against the lingual tooth wall in 2 specimens.

Lower third molar.—Thirteen $M_{\overline{3}}$'s were available for study, 7 of which are shown in Fig. 4*A–E*, *I*, and *J*. The teeth are short, with a height of 10–20 mm. The tooth is generally straight. The mesostriid and hypostriid are present on and persist to the base of all teeth. The occlusal pattern is S-shaped except when the cement of the hypoflexid extends through the labial and lingual enamel and separates the posterior loph from the rest of the tooth. The anterior loph is inflated lingually and directed anterolabially (Fig. 4*A*), or crescentic, convex anteriorly. The median loph is crescentic, convex anteriorly (Fig. 4*C* and *D*), or inflated and directed anterolabially (Fig. 4*J*). The posterior loph is often directed more anteriorly than the others and inflated labially (Fig. 4*C*, *D* and *J*). It may also parallel the trend of the median loph (Fig. 4*E*).

The mesoflexid passes anterolabially to terminate on the labial side of the tooth. All terminations abut tightly except in 3 teeth, 2 of which are shown in Fig. 4*E* and *J*. In these 3 specimens the terminations are rounded and have no associated pseudostriids. One of them (Fig. 4*A*) has a rounded termination at the occlusal surface, but a flat one at the base of the tooth and no pseudostriid. Pseudostriids are associated with the abutments of the terminations of 5 teeth.

The hypoflexid passes posterolingually and terminates on the lingual side of the tooth. In 3 specimens the cement extends completely across the tooth from labial to lingual side. This isolates the posterior loph in 2 teeth (Fig. 4*C* and *D*). The termination of the hypoflexid is flat and abuts tightly against the labial wall in all specimens, with the exception of the 2 teeth. In these 2, the termination is rounded and separated from the lingual wall of the tooth by a tract of dentine. In Fig. 4*E* the termination is flattened and abuts tightly at the base of the tooth. Pseudostriids are found on 3 teeth.

Incisors.—The upper incisor is larger in width (15.7–19.2 mm.) and depth (13.8–15.4 mm.) than the lower. None of the upper incisors was directly associated with material that can definitely be assigned to the genus *Procastoroides*. No other large upper incisors have been collected from these deposits, however, so that it seems reasonable to assign these teeth to that genus. All 6 upper incisors examined have a groove on the internal surface (Fig. 2*R*) which is labial to the midline of the tooth and may be either very faint or very pronounced. In 3 teeth there is also a groove on the outer (enamel) surface at, or labial to, the midline (Fig. 2*R*). Like the internal groove, the outer one can be either shallow or deep. In 1 specimen, UMMP 35070, the groove is double. This tooth is the widest and has the most pronounced outside groove of the 6 incisors. If it is correctly assigned to *Procastoroides* it may represent a different species, but the incisor is not directly associated with any other definitive material.

TABLE II

MEASUREMENTS* OF TEETH OF *Procastoroides sweeti*

	Mean Length	Mean Width	Range of Length	Range of Width	No. of Specimens
P^4	11.3	10.7	10.5–12.6	9.5–11.8	5
M^1	9.3	8.7	8.0–10.5	8.0–9.3	2
M^2	8.8	8.3	7.5–10.0	7.5–9.0	2
M^3	9.3	6.9	8.0–11.1	6.0–7.5	4
P_4	12.3	9.0	9.2–14.2	8.3–11.3	13
M_1	11.4	9.3	10.2–13.0	7.6–10.2	7
M_2	11.1	8.9	9.5–12.5	7.8–10.0	9
M_3	9.8	8.2	9.0–11.0	6.6–9.2	5

* In millimeters. See Fig. 2*P* for illustration of method.

There is now no valid basis for proposing a new species name for this specimen, but its differences are interesting and may prove to be significant when more material is collected.

The lower incisor is triangular in cross section (Fig. 4*F*), bears no grooves on the outer or inner surfaces, and has no crinkling of the enamel. Its form and configuration seem to be stable. The lower incisor is nearly as wide as deep (Tab. III), is twisted labially in the posterior part, and passes directly beneath P_4, and lingual to M_1 and M_2. In KUMNH 3843 the base of M_3 rests wholly on the incisor, whereas in 3 other jaws the incisor covers only the lingual part of the base of M_3. This is similar to the condition in *Castoroides* (UMMP 3109).

Lower jaw.—None of the 9 jaws or jaw fragments is complete, and only 4 have P_4–M_3. That of CNHM P14974 is in poor condition, but the jaw is interesting for its small size. The length of the occlusal surface (Tab. III) is much less than that of the other 3, but the tooth pattern is completely compatible with that of other rami. This mandible is quite probably that of a young adult. Some of the teeth of UMMP 31294, associated right and left jaws with complete dentitions, represent the most advanced stages of development with respect to complete separation of the lophs by tracts of cement (Fig. 4*C* and *D*). Most of the mandibles are rugose and have a well-developed masseteric ridge which is, in general, proportionately more developed than in *Castoroides* (UMMP 3109). The capsular process on UMMP 42315 is slightly more pronounced than that of *Castoroides*. The articulating surface of the posterior condyle of UMMP 31294 and 42315 is less broad laterally than that of *Castoroides*. KUMNH 3843 is fragmentary and contains only M_2 and M_3 (Hibbard, 1938, fig. 2). No measurements could be taken on this specimen. CNHM P26165, with P^4–M^2, was available for study, but it was not sufficiently complete. No measurements could be taken on it. Measurements involving the tip of the incisor were not used because of the possibility of slippage of the incisor in the alveolus. Such measure-

TABLE III

MEASUREMENTS* ON JAWS OF *Procastoroides sweeti*

Specimen No.	Length, $P_{\overline{4}}$–$M_{\overline{3}}$, at Occlusal Surface	Depth of Jaw below Anterior Edge, $P_{\overline{4}}$	Length, Posterior Condyle to Tip of $P_{\overline{4}}$	Width of Incisor	Depth of Incisor
UMMP 31294 (right)	51			10.0	11.2
UMMP 31294 (left)	50	46	90	10.0	11.2
UMMP 31295	50	44			
UMMP 42315		44	90	12.0	12.8
UMMP 31293		43		9.6	10.6
UMMP 29645		46			
KUMNH 7403		44			
CNHM P14974	41	40			

* In millimeters.

ments as could be taken are presented in Table III. The figures obtained seem to correspond well to those published by Barbour and Schultz (1937, p. 7).

Diagnosis.—The cheek teeth are strongly hyposodont and prismatic, with complete hypostria, mesostria, hypostriid, and mesostriid. $P_{\overline{4}}$ has a complete parastriid, $M^{\underline{3}}$ a complete metastria. There is no tendency for the base of the teeth to close with age. Pseudostria and pseudostriid are often well developed in association with the tight abutment of terminations. There is a tendency for the lophs to become isolated from each other by tracts of cement. This is most well developed in the $P_{\overline{4}}$, but occurs to varying degrees in all other teeth. Upper and lower M1 and M2 most commonly display the S pattern. No fossettes or fossettids were found on the teeth examined. The dorsal surface of the lower incisor is twisted labially posteriorly, passes below $P_{\overline{4}}$, lingual to $M_{\overline{1}}$ and $M_{\overline{2}}$, and usually covers only the lingual part of the base of $M_{\overline{3}}$. The depth of the lower incisor is proportionately less than that of *Castoroides*. The upper incisor is larger than the lower, possesses grooves on the internal, and variably, on the outer, enamel surface. There is no crenulation of enamel on either upper or lower incisor. The masseteric ridge is proportionately more developed, the capsular process relatively more pronounced than in *Castoroides*. Dental foramen usually better developed than the mental.

Discussion.—This is a large beaver, larger than *Dipoides* or the modern beaver, but about two thirds the size of *Castoroides*. There is, in *Procastoroides*, a tremendous amount of variation indicated by the teeth, with a tendency toward separation of the lophs by tracts of cement. There is no observable trend toward an increase in size through time. The Pleistocene forms studied are about the same size as, or smaller than, the Pliocene forms. In the material at hand, there are no characters by which one age group can be separated from the other. As far as can be seen, there is no valid reason for not retaining the same species name for the forms of both ages. The group is apparently an end line; it exhibits characters which are too specialized to be transitional to the modern beaver. *Procastoroides* probably developed independently the tendency toward the complete separation of lophs by tracts of cement. It is interesting to note, in contrast with the variation in the cheek teeth and the variable presence and position of grooves in the outer surface of the upper incisor, the apparent stability of the form and configuration of the lower incisor. If *Procastoroides* were the ancestor of *Castoroides*, whose earliest fossil record is Kansan, why is there no observed trend toward crenulation of the incisor enamel also?

Although the parastriid is long, and variably occurs for the complete height of the tooth in Dipoides, there is no species of that genus in which a persistent parastriid is a consistent feature. I do not believe that *Procastoroides* arose directly from *Dipoides*, but probably from some stock near the *Eucastor-Dipoides* transition in the lower or early middle Pliocene.

ORDER PROBOSCIDEA

Family Gomphotheriidae

Stegomastodon rexroadensis Woodburne sp. nov.

(Pls. II–IV)

Stegomastodon successor (Cope), Hibbard and Riggs, 1949, Geol. Soc. Amer., Bull., 60: 838.

Holotype.—UMMP 41207, associated right and left upper and lower M2 and M3 collected from locality 3.

Paratypes.—Additional remains collected at locality 3 are: KUMNH 4637, fragmentary right jaw with $M_{\overline{1}}$ and $M_{\overline{2}}$; KUMNH 4638, right and left $M^{\underline{3}}$; KUMNH 4640, right and left upper and lower M3; UMMP 29996, $RM_{\overline{2}}$, at locality UM-K3-53; UMMP 28125, $RM_{\overline{3}}$; UMMP 33366, right and left jaw with $M_{\overline{3}}$; UMMP 35099, $RM^{\underline{3}}$; and UMMP 40245, $RM^{\underline{3}}$.

Horizon.—All specimens were taken from beds of the upper Pliocene Rexroad formation. Locality 3 is in the W½, SW¼ Sec. 22, T. 33 S., R. 28 W., Rexroad Ranch, and locality UM-K3-53 is in the SW¼, SW¼ Sec. 33, T. 33 S., R. 29 W., Wendell Fox Pasture, Meade County, Kansas.

Diagnosis.—A short-jawed mastodont whose teeth show a simple, primitive trefoiling. Enamel is not present on adult tusks. No double trefoils are developed on the lower teeth. Trefoil spurs are simple. It is possible that double trefoils would form as wear progressed on the proto- and metaloph of $M^{\underline{3}}$. The teeth and jaws are smaller than is usual for *Stegomastodon mirificus* (Leidy) or *Haplomastodon waringi* (Holland). Upper and lower M3 of *S. rexroadensis* are the same size as those teeth of *S. primitivus* Osborn, but the jaw of *S. rexroadensis* is smaller. The intermediate molars of *S. rexroadensis* are less ptychodont than those of *S. mirificus* and *S. primitivus*, and probably *H. waringi*. The third molars of the Rexroad species have 5+ lophs. The ptychodonty of $M_{\overline{3}}$ of *S. rexroadensis* equals that of $M_{\overline{2}}$.

Description of holotype.—The terminology used is that set forth by Osborn (1936) and clarified by Savage (1955, p. 51). Measurements of these and other teeth are included in Table IV.

The teeth of the holotype (Pls. II and III) are those of a mature individual; the tetartoloph and tetartolophid of M3 had begun to be affected by wear. M^2 has 2 anterior roots and exhibits slight centroversion of the lophs, while M_2 has but one anterior root, and the lophids are proverted internally. The 3 lophs and lophids of upper and lower M2 are worn nearly to the cingulum, but that part of the enamel remaining shows no indication of ptychodonty (plication).

TABLE IV

MEASUREMENTS* OF TEETH OF *Stegomastodon rexroadensis*

Museum No.	Tooth	Crown Length	Crown Width	Approx. Index	Lophs or Lophids	Width of Penta-loph or Penta-lophid of M3	Stage of Wear
UMMP 41207	RM^2	98	72	73	3+		Mature
"	LM^2	99	71	71	3+		Mature
"	RM^3	193	82	42	5+	65	Mature
"	LM^3	192	83	43	5½	63	Mature
KUMNH 4640	RM^3	171+	80	?	5+	51	Late mature
"	LM^3	183	76	41	5+	52	Late mature
KUMNH 4638	RM^3	188	81	43	5+	52	Mature
"	LM^3	191	84	44	5+	59	Mature
UMMP 40245	RM^3	190	83	44	5+	53	Young adult
UMMP 35099	RM^3	225	100	40	5½	77	Mature
KUMNH 4637	RM_1	90	60	66	3		Young adult
"	RM_2	123	72	58	3+		Young adult
UMMP 29996	RM_2	110	74	67	3		Young adult
UMMP 41207	RM_2	98	69	70	3		Mature
"	LM_2	97	69	70	3		Mature
"	RM_3	204	89	44	5+	67	Mature
"	LM_3	208	87	42	5½	73	Mature
KUMNH 4640	RM_3	209	81	39	5+	78	Mature
"	LM_3	192+	81	?	5½	62	Mature
UMMP 33366	RM_3	206	79	38	5½	66	Old age
"	RM_3	204	77	38	5½	67	Old age
UMMP 28125	RM_3	196	76	39	5½	70	Young adult

* In millimeters. Index $= \left(\frac{\text{width}}{\text{length}} \times 100\right)$

There are no double trefoils present at this stage of wear, and no accessory conules or conulids are apparent.

Like M^{2}, M^{3} has 2 anterior roots; the lophs are centroverted. The lophids of M_{3} show internal proversion, and there is only 1 anterior root. The occlusal surface of M_{3} has begun to wear concave dorsally, while the outline of that of M^{3} is concave ventrally. The third molars are well formed, 5+ lophs are present on the M^{3}, and an equal number of lophids are found on M_{3}. The pro-protoloph and pro-protolophid are absent. The dental pattern is best, but not fully, developed on the protoloph and protolophid. The pattern of upper and lower M3 shows primitive, incipient, double trefoils.

In M^{3} the configuration of the lophs is such that the development of double trefoils is possible on the proto- and metaloph. With wear, entotrefoils would develop on the tritiloph, and perhaps on the tetratoloph as well. The tritiloph would also bear either the anterior or posterior spur of an ectotrefoil, but not both. No trefoils would form on the penta- and hexaloph. Accessory ectoconules are present anterior and posterior to the tritiloph.

No complete double trefoils will form on M_{3}. Ectotrefoils will develop on the proto-, meta-, triti-, and possibly the tetartolophid. The protolophid has the posterior spur of an entotrefoil. The meta-, triti-, and tetartolophid each have an anterior spur of an entotrefoil. No trefoils will form on the pentalophid or hexalophid. An accessory entoconulid is present between the proto- and metalophid. Anterior and posterior spurs of trefoils in both upper and lower teeth are simple. Neither the hexaloph of M^{3} nor hexalophid of M_{3} is well developed, and it is not possible to determine with certainty the number of elements of which they are composed. In all cases the enamel pattern is simple.

Segments of tusk material, totaling at least 18 inches in length, were found associated with the teeth of the holotype. None of these segments was collected because the plates of the tusk fell apart quite readily. There was, however, no evidence of enamel found, either with the segments or as loose plates in the surrounding matrix. On the basis of the above features, the number of lophs and lophids, the nature of the trefoils, and the absence of tusk enamel in the adult, the holotype is placed in the genus *Stegomastodon*. It is noted further that the animal represented by this material seems to be a primitive one, in the stegomastodont line, and may be closely related to *Haplomastodon* as well. These ideas will be discussed in more detail below.

Description of paratypes.—The ptychodonty of upper and lower M3 is neither more nor less complex than that of upper and lower M1 or M2. The enamel of all teeth is simple, not plicated. Trefoil spurs are simple. All stages of wear from young adult to old age are represented by the third molars. The dental variation of this species is slight, and most teeth are comparable to those of the holotype. Measurements taken from the teeth are compiled in Table IV.

First lower molar.—Only 1 first molar is available for study. It is an M_{1} and is associated with M_{2} in the fragmentary jaw, KUMNH 4637 (Pl. IV, Fig. 2). It is shorter than M_{1} of *Haplomastodon waringi* (Holland) (see Simpson and de Paula Couto, 1957, tab. 6), but its width closely approximates the mean width of that tooth in *H. waringi*. The enamel of M_{1} of *H. waringi* (Simpson and de Paula Couto, 1957, pls. 4, 7, 8) is more plicated than that of *Stegomas-*

todon rexroadensis. The enamel of $M_{\overline{1}}$ of *S. mirificus* (Leidy) (see Savage, 1955, pl. 2) is also more plicated than that of *S. rexroadensis*. There is no evidence of accessory conulids on $M_{\overline{1}}$ in the Rexroad species.

Second upper and lower molars.—The lophs of the upper and lower M2's of all specimens except KUMNH 4637 and UMMP 29996 (Pl. IV) are worn nearly to the cingulum. When the enamel of M2 is nearly worn away, its anterior end becomes abraded and shortened, giving a false impression of the length. This is the case with M2's of the holotype. The configuration of these teeth has been mentioned above. It can be seen from Table IV that $M^{\underline{2}}$ is shorter and wider than $M_{\overline{2}}$. The relatively unworn $M_{\overline{2}}$'s of specimen KUMNH 4637 and UMMP 29996 have no accessory conulids, and ectotrefoils are present. The protolophid would also form a posterior spur of an entotrefoil. The meta- and tritilophid would each develop an anterior spur of an entotrefoil. Wear is not yet extensive on either the anterior or the posterior end of these teeth, so it is believed that the measurements obtained here represent better lengths of $M_{\overline{2}}$. The widths of the upper and lower M2's of the Rexroad species fall within the range of the widths of M2 of *Haplomastodon waringi* given by Simpson and de Paula Couto (1957, Tab. 6). Only the length of $M_{\overline{2}}$ KUMNH 4637 is compatible with the figure for *H. waringi*. All other M2's of *Stegomastodon rexroadensis* are shorter. $M^{\underline{2}}$'s of the Rexroad sample are as wide as, but shorter than, those of *S. mirificus* from Cita Canyon, Texas (Savage, 1955, Tab. 4), $M_{\overline{2}}$'s of *S. mirificus* from that locality are wider and longer than those of the Rexroad species. Savage (1955, p. 59) notes that "$M_{\overline{2}}$ is more ptychodont than $M_{\overline{3}}$ in the Cita Canyon materials." This is not the case in the Rexroad species, but rather ptychodonty is the same for $M_{\overline{3}}$ as for $M_{\overline{2}}$. M2's of *S. mirificus* (Savage, 1955, pl. 2) are more ptychodont than those of *S. rexroadensis*.

Third upper and lower molars (Pls. II and III).—The enamel pattern of these teeth is directly comparable to that of the holotype. UMMP 28125 and UMMP 40245 are in an early stage of wear and show well the configuration of the unworn lophs and lophids. Even at this stage of wear the pro-protoloph and pro-protolophid are not well defined and were probably worn away earlier by M2. In only 2 teeth, UMMP 33366, is the enamel worn nearly away.

UMMP 35099 is large, but it is split and fractured in many places. These openings are filled with matrix, so that the apparent large size may be misleading. On the basis of centroversion of its lophs, this tooth is a $RM^{\underline{3}}$. It is in a late mature stage of wear and is significant in that no double trefoils are evident. Double trefoils would probably not develop at any stage of wear in this tooth. The right and left $M^{\underline{3}}$'s, KUMNH 4638, are in a mature stage of wear; the pro-protoloph is absent. Ectotrefoils will not form on any of the lophs. The protoloph has the posterior spur of an ectotrefoil, but not the anterior; the metaloph has the anterior spur, but not the posterior. The other lophs are so constructed that none would have even the beginning of an ectotrefoil pattern. $M^{\underline{3}}$'s of KUMNH 4640 are in a late mature stage of wear, and it is not possible to determine the complete pattern clearly. Ectotrefoils are developed on the proto-, meta-, and possibly the tritiloph. A double trefoil is present on the protoloph of $LM^{\underline{3}}$. On other lophs of these teeth, incipient double trefoils are variably present, but none is well formed. Accessory conules are variable in their occurrence on M^3, but ectoconules are commonly found anterior and posterior to the metaloph.

M_3's of KUMNH 4640 are in a mature stage of wear and show no double trefoil development. Ectotrefoils are well formed on the first 3 lophids. On the tetartolophid, an ectotrefoil of sorts is present, but it is skewed. No trefoils would develop on the pentalophid. Entoconulids are most commonly situated anterior to the metalophid. While M_3's of UMMP 33366 are so worn that there is almost no enamel remaining, their size fits well with that of M_3's of the holotype. The significance of these worn teeth lies in the fact that they sit in associated right and left jaws. The remaining M_3's in the Rexroad sample have been mentioned above.

The size of upper and lower M3 in *Stegomastodon rexroadensis* falls into the lower size limit of those of *S. mirificus* from Cita Canyon (Savage, 1955, tab. 2 and 3), and fairly close to the average upper and lower M3 of *Haplomastodon waringi*, as compiled by Simpson and de Paula Couto (1957, tab. 6). The measurements for upper and lower M3 of *S. primitivus* (Osborn, 1936, p. 727) are contained within those given for these teeth of *S. rexroadensis* in Table IV. From Fig. 675 of Osborn (1936, p. 726) it seems that double trefoils would develop on the first 2 lophs of M^3 in *S. primitivus*, but that none would form on M_3 . M^3 of *S. primitivus* appears more complex, in the composition of the lophs, than that of the Rexroad species, but M_3 of *S. primitivus* is quite similar to that of *S. rexroadensis*. One of the main differences between *S. primitivus* and *S. rexroadensis* lies in the more complicated character of the enamel in upper and lower M2 of *S. primitivus*. This form also has a very large jaw in comparison with its tooth size (Savage, 1955, p. 66).

Lower jaw.—UMMP 33366 represents the only measurable set of jaws in the Rexroad collection. The jaws contain right and left M_3's whose sizes are close to those of the holotype. This right and left mandible was compared with associated right and left jaws of *Stegomastodon mirificus*, UMMP 26363 and 24314, from the Pleistocene of Kansas. The symphyseal length of the Rexroad specimen is 115 mm., while those of the Pleistocene forms are 115 mm. and 107 mm., respectively. In the Rexroad species, the distance from the tip of the jaw to the anterior border of the posterior mental foramen is 180 mm. The same measurement for *S. mirificus* is 150–175 mm. (Savage, 1955, Tab. 7). The average length of M_3 of *S. rexroadensis* can be shown to be 85 per cent of the average length of M_3 in specimens of *S. mirificus*. It can also be demonstrated that the length of the pretooth part of the jaw of *S. rexroadensis* is the same as, or slightly larger than, that part of the jaw of *S. mirificus*. Thus, the pretooth part of the jaw of *S. rexroadensis* is longer than that which would be expected from the size of its teeth. However, the shape of that part of the jaw of the Rexroad species is nearly identical to that of *S. mirificus*. The pretooth part of the jaw of *Haplomastodon waringi* is more rhynchorostrine than that of either *S. mirificus* or *S. rexroadensis*.

Discussion.—Hibbard and Riggs (1949, p. 838) assigned KUMNH 4640 to *Stegomastodon successor* (Cope), but Savage (1955, p. 64) is of the opinion that the features of the type of this species are contained within the Cita Canyon material of *S. mirificus*. I believe that the Rexroad material is different from

TABLE V

MEAN INDICES OF MOLARS*

Tooth	*H. waringi*	*S. primitivus*	*S. mirificus*	*S. rexroadensis*
M^2	61		62	72
M_2	56		62	66
M^3	45	41	38	42
M_3	38	42	37	40

* Compiled from Simpson and de Paula Couto (1957), Osborn (1936), Savage (1955), and Table IV of this report.

the other species of *Stegomastodon* and have accordingly given it a new species name.

Since a larger molar index indicates that a tooth is wide relative to its length, a general comparison of tooth proportions may be made between various forms. It can be seen from Table V that upper and lower M2's of *Stegomastodon rexroadensis* are relatively wider than those of *S. mirificus* or *Haplomastodon waringi*. M^3 of the Rexroad species is intermediate in relative width between those teeth of *H. waringi* and *S. mirificus*, but has nearly the proportions of M^3 of *S. primitivus*. On the other hand, M_3's of *H. waringi* and *S. mirificus* are relatively narrower than those of *S. rexroadensis* and *S. primitivus*.

When these points are considered with the close correspondence in pattern of upper and lower M3 of *Stegomastodon primitivus* and *S. rexroadensis*, it appears that these 2 are more closely related than the Rexroad form is to either *S. mirificus* or *Haplomastodon waringi*.

In considering the features of *Stegomastodon primitivus*, Savage (1955, p. 66) noted that although the teeth of this form are small, 1 of the jaws referred to this species is nearly 100 mm. longer than any of the jaws of *S. mirificus* from Cita Canyon. Savage also mentiones that M^2 and M^3 of *S. primitivus* are as ptychodont as most of those teeth of the Cita Canyon and Blanco specimens. From this, it seems as though *S. primitivus* also possesses features which are typical of *S. mirificus*.

Savage (1955, p. 67) studied KUMNH 4637 and 4640; UMMP 28125 and 29996, and stated that "if all these specimens belong to one population, such a population is distinct from other brevirostrine gomphotheres and merits a new species name." From a study of the above and additional specimens I believe that Savage's statement is correct. The main feature which distinguishes *Stegomastodon rexroadensis* from other species of the genus is the simple configuration of the enamel in the first and second molars. The lack of plication in these teeth has been referred to by Savage (1955, p. 68) as a "simple gomphothere type of enamel folding." Savage compared the Rexroad materials mentioned above with specimens from Miñaca and Santa Ana de Babícara localities in Mexico. He believes that the specimens from the Mexican sites closely resemble the Rexroad materials, and that, compared to these, the trefoils of the Cita-Blanco specimens are much more complex.

The teeth of *Haplomastodon waringi* are also less ptychodont than those of *Stegomastodon mirificus*. The Brazilian form apparently tends to develop, in some specimens, double trefoils on the proto- and metalophid of $M_{\overline{3}}$, as well as on the protoloph and metaloph of $M^{\underline{3}}$. The enamel of $M_{\overline{3}}$ of *H. waringi*, while less ptychodont than that of *S. mirificus*, is more so than $M_{\overline{3}}$ of *S. rexroadensis* (see Simpson and de Paula Couto, 1957, pls. 10 and 11). The trefoil spurs of these teeth of *H. waringi* also appear to be more complex than in similar specimens of *S. rexroadensis*. None of $M^{\underline{3}}$'s of the Rexroad species is composed of less than 5+ lophs, whereas many $M^{\underline{3}}$'s of *H. waringi* consist of only 5 lophs.

According to Simpson and de Paula Couto (1957, p. 163), the age of the deposits from which *Haplomastodon waringi* has been collected is fairly late Pleistocene or, in some cases, early Rexent, and "it is questionable, depending on decision as to the Pliocene-Pleistocene boundary, whether the mastodonts had yet reached South America in the earliest Pleistocene." On the other hand, Savage (1955, p. 69) proposes the idea that "the early haplomastodont stegomastodonts reached the South American continent at about the time of existence of the Rexroad, Miñaca, and Benson faunas, or slightly earlier." This view would put the mastodonts in South America by the Upper Pliocene. To my knowledge no record of mastodonts existing in South America at that time has been reported.

That the Rexroad species is related to *Haplomastodon waringi* is shown by the simple trefoiling in the enamel pattern of the intermediate molars, and the absence of enamel on the tusks in the adult stage. This relationship is noted by Savage, who states that "in animals of this character there appear to lie the structural annectants between earlier, rhynchorostrine gomphotheres and later, brevirostrine ptychodont stegomastodonts" (Savage, 1955, p. 68).

Concerning this, I believe that the pretooth part of the jaw is more rhynchorostrine in *Haplomastodon waringi* than in *Stegomastodon rexroadensis*, and that of the two, *H. waringi* is possibly closer to the rhynchorostrine complex (see Savage, 1955, fig. 8). The pretooth part of the jaw of *S. rexroadensis* is similar to that of *S. mirificus*.

In the area of the Rexroad fossil localities the fossiliferous deposits are overlain by about 50 feet of sediments. These contain massive caliches and, in one locality, the strata of the Bender local fauna. The Rexroad silts are overlain by the discontinuous sand and gravel of the basal Pleistocene. The discontinuous nature of this sand and gravel suggests that erosional forces, acting over a long interval, shaped deep valleys or gullies in the Rexroad deposits. These low areas were receptacles for the sand and gravel, but were so deep that the sediment-carrying streams did not completely fill them with the coarse material. Filling of the low areas occurred later, when the streams were carrying finer sediment. Prior to the next glacial stage, when little or no sediment was being deposited, agents of erosion again began to carve the topography. That the sand and gravel of the next glacial stage is widespread and continuous would tend to indicate that the erosional interval between the first 2 glacial stages was not so great as that between the end of Rexroad time and the first stage of the Pleistocene.

The evidence suggests that there was a considerable amount of time available for dental alteration between the days of *Stegomastodon rexroadensis* and the appearance of *S. mirificus* or *S. primitivus* in the early Pleistocene. Savage (1955, p. 69) suggests that the Rexroad species "is phyletically primitive in the *Stegomastodon* line and is an early representative of this line in North America." If this is so, it would appear, from *S. primitivus*, that ptychodonty began to develop first in the upper molars. That M_3 of *S. primitivus* is nearly identical to those teeth of *S. rexroadensis*, even after the time lapse from the deposition of the Rexroad material to the early Pleistocene, seems to be a fairly reasonable indication of the affinity between the 2 forms. This, along with the nature of the pretooth part of the jaw, the presence of more than 5 lophs on on M^3, the greater tendency toward the development of double trefoils in M^3 rather than in M_3, and its closer geologic and geographic proximity to other species of *Stegomastodon* than to *Haplomastodon*, would indicate that *S. rexroadensis* is, in fact, a primitive member of the stegomastodont line, and is more closely related to *Stegomastodon* than to *Haplomastodon*.

Paleoecology

According to Hibbard (1941b, p. 101), the Rexroad fauna indicates a more moderate climate than that found at the present in southwestern Kansas. As originally described, the Rexroad fauna contained some Pleistocene fossils from Meade County locality 1. They were *Pliolemmus antiquus* Hibbard and *Pliopotamys meadensis* Hibbard, and carried northern connotations. It was pointed out by Hibbard (1941b, p. 101) that these forms probably belonged to a later fauna. Evidence was presented by Hibbard (1956, pp. 174–176) that *Pliolemmus* and *Pliopotamys* were members of the early Pleistocene faunas. It has been noted by Hibbard (1941b, p. 101) that if the genera mentioned above were excluded from the Rexroad fauna, the fauna would have southern and southwestern affinities, rather than northern. From the preceding discussion it seems as though the Rexroad fauna does, indeed, carry a southern connotation.

Of the forms discussed in this report, the beavers will be considered first. There is no direct evidence as to the habitat requirements of *Dipoides* and *Procastoroides*. The modern beaver occurs in continental North America, south to the Rio Grande (Hall and Kelson, 1959, map 321). It is found in aquatic situations, usually along streams, and feeds on willow, alder, birch, aspen, and other trees (Hall and Kelson, 1959, p. 542). While it cannot be assumed that

Dipoides and *Procastoroides* had requirements identical to those of the modern beaver, there is a definite implication of permanent water.

The teeth of *Stegomastodon* indicate browsing food habits which would require wooded areas, perhaps along the streams (Hibbard, 1941b, p. 99).

Further evidence of the ecologic situations mentioned above is given by the avian fauna. In his study of the birds of the Rexroad fauna, Wetmore (1944, p. 91) states that "Of the identified specimens more than one-half belong to aquatic species that live in and around marshes, streams and ponds. Remains of turkeys represent birds of wooded areas, while parrots, pigeons and quail are species of forests, or regions where thickets and groves grow amid plains, prairies or savannas. The passeriform birds may have lived in prairie land, in thickets or in forests."

Thus, it seems as though the Upper Pliocene climate of the Meade Basin, as shown by the Rexroad fossils, was considerably moister than that of the present. An indication of the Upper Pliocene temperatures is given by the large terrestrial tortoises which occurred at that time. Hibbard (1960, p.16) has noted that "The remains of these large tortoises [*Geochelone rexroadensis* (Oelrich), 1952] have been found in stream, artesian spring, and flood plain deposits of the Upper Pliocene, in Meade County, Kansas (elevation 2500–2600 feet). It is assumed that they lived in the region at a time when freezing conditions did not exist." From this it is evident that the annual temperature extremes were not as great when the Rexroad fauna existed as they are now.

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I have prepared all the illustrations used in this report.

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PLATE I

FIG. 1. Contact (arrows) between Rexroad and Ballard formations in the SE¼, SW¼ Sec. 22, T. 33 S., R. 29 W., Meade County, Kansas. Consolidated Angell sands in contact with Rexroad on right, Missler silts in contact with Rexroad on left.

FIG. 2. Contact (arrows) between Rexroad formation and Missler silt of Ballard formation in NE¼, SE¼ Sec. 32, T. 33 S., R. 29 W., Meade County, Kansas.

PLATE I

FIG. 1

FIG. 2

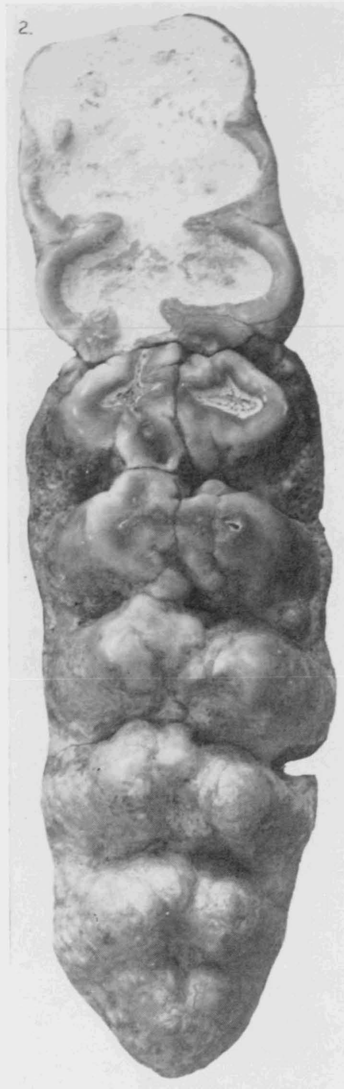

PLATE II

Stegomastodon rexroadensis, sp. nov., UMMP 41207, holotype

FIG. 1. RM^2 and RM^3. $\times$-$\frac{1}{2}$.

FIG. 2. LM^2 and LM^3. $\times$-$\frac{1}{2}$.

PLATE III

Stegomastodon rexroadensis, sp. nov., UMMP 41207, holotype

FIG. 1. $\mathrm{LM}_{\overline{2}}$ and $\mathrm{LM}_{\overline{3}}$. ×-½.

FIG. 2. $\mathrm{RM}_{\overline{2}}$ and $\mathrm{RM}_{\overline{3}}$. ×-½.

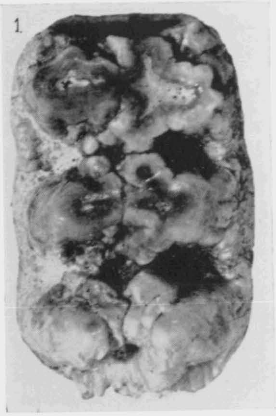

PLATE IV

Stegomastodon rexroadensis, sp. nov.

FIG. 1. UMMP 29996, $RM_{\overline{2}}$. ×-½.

FIG. 2. KUMNH 4637, $RM_{\overline{1}}$ and $RM_{\overline{2}}$. ×-½.