TABLE 23.—Measurements (in mm.) of *Perchoerus* nr. *P. minor*, *Perchoerus* nr. *P. nanus*, and *Perchoerus nanus*

	P. nr. *P. minor* No. 8237	No. 9000	*P.* nr. *P. nanus* No. 8236	No. 19873[a]	*P. nanus* No. 11784[b]
P^4, antero-posterior length	....	....	8.6	....	....
P^4, transverse width	....	....	10.8	....	....
M^1, antero-posterior length	....	....	10.2	....	....
M^1, transverse width	....	....	10.6	....	....
Crown length of P_1-M_3	....	....	....	80.0[c]	....
Crown length of P_3-M_3	....	....	....	62.6	....
Crown length of M_1-M_3	....	....	....	43.1	....
P_3, antero-posterior length	....	....	....	8.6	9.5
P_3, transverse width	....	....	....	4.5	....
P_4, antero-posterior length	10.5	....	....	10.7	11.0
P_4, transverse width	5.6	....	....	7.0	....
M_1, antero-posterior length	10.5	10.2	....	11.3	....[d]
M_1, transverse width	7.9	7.6	....	7.6	....
M_2, antero-posterior length	....	11.3	....	12.1	12.2
M_2, transverse width	....	8.6	....	9.3	....
M_3, antero-posterior length	....	....	....	18.3	15.2
M_3, transverse width	....	....	....	9.5	....
Depth of ramus at P_2	....	....	....	25.0	....
Depth of ramus at M_3	....	....	....	32.0	....

a. University of Colorado Museum.

b. Dr. JOSEPH T. GREGORY kindly supplied the measurements of the type specimen of *Perchoerus nanus* (Yale Univ., Peabody Mus. Nat. Hist. No. 11784). SCOTT's (1940, p. 503) measurements of the teeth of the type specimen were based on MARSH's illustration (1894, p. 271, fig. 28) of the specimen.

c. Estimated.

d. Damaged.

damaged, and most of the enamel has been weathered away. Enough of the tooth remains to show that it was bilophodont and that there was some complicated folding of the enamel about the cusps. M_2 is larger than M_1 and equally worn and weathered; it has a cingulum on the anterior face of the metaconid, and each lophid shows a complicated folding of the enamel on the anterior face. M_3 is weathered but not greatly worn. The metaconid has an anterior cingulum. Practically no valleys separate the cones of the metalophid and hypolophid, but the transverse valley between the two lophids is easily seen. This transverse valley is divided by a faint crest which unites the two lophids and runs from the hypoconid to the internal side of the protoconid. The third lobe is united to the hypoconid by a similar crest. The third lobe is large and seems to consist of one cusp. A small tubercle lies between the third lobe and the entoconid on the internal border of the tooth, thus enclosing a basin. On the external border, two small tubercles lie between the third lobe and the hypoconid. Although the rest of the teeth are the size of those of *Perchoerus nanus*, or smaller, M_3 is equal in size to M_3 of *P. probus*. The symphysis is long and seems to reach back to P_2; the ramus is thick and sturdy.

The most unusual features of No. 19873 are the shortness of P_3 and the unusual length of M_3 in relation to P_4-M_2, when compared with specimens of *P. probus*, *P. nanus*, and *P. minor* (Table 23). The specimen may be *P. probus*, rather than *P. nanus*, or it may be an unnamed species—a possibility enhanced by the relative sizes of the teeth, especially M_3. The M_1 and M_2 of *P. socialis* (MARSH) from the John Day beds of Oregon are also similar in size to this Whitneyan specimen, but other comparisons are not possible.

FAMILY ANTHRACOTHERIIDAE GILL, 1872

Heptacodon sp.

Referred specimen.—Cedar Creek member (middle): No. 8235; left jaw with P_4-M_3; N½ sec. 5, T. 11 N., R. 54 W., Logan County.

This is the first known occurrence of the genus in northeastern Colorado and seemingly only the second record of a lower jaw. The types for all species of *Heptacodon* are based on upper teeth and skulls, and none have lower jaws. The only other lower jaw known, AMNH No. 1360, was referred to *H. occidentalis* SCOTT by SCOTT (1940, p. 484) because of geological age (lower Brule), but he makes it plain that the jaw could equally well be assigned to *H. curtus* MARSH of the upper Brule. No. 8235 agrees with the description of AMNH No. 1360 in pattern and size, the dimensions of the teeth being, in all cases, within 1 mm. of those given by SCOTT (1940, p. 485).

Anthracotheriid sp.

Referred specimen.—Horsetail Creek member: No. 9788; fragment of upper molar; W½ sec. 16, T. 10 N., R. 51 W., Logan County.

This fragment of tooth is similar to the M^2 of *Bothriodon* but is insufficient to assign it, unequivocally, to this genus.

FAMILY AGRIOCHOERIDAE LEIDY, 1869

Agriochoerus antiquus LEIDY

Agriochoerus antiquus LEIDY, 1850a, p. 122.

Referred specimen.—No. 5029; anterior part of skull with cheek dentition; according to catalogue data this specimen was collected by H. T. MARTIN in northeastern Colorado.

Although the matrix and type of preservation is that seen in northeastern Colorado specimens, the reference of this particular specimen to a Colorado locality must remain in doubt because it was not catalogued by MARTIN personally and was not listed in his field notes. This, in itself, would not be of importance were it not that a second specimen, No. 206, is listed in the Museum records as coming from northeastern Colorado, but its preservation and matrix resembles material from South Dakota much more than from Colorado.

In size and other characters No. 5029 agrees closely with descriptions of *Agriochoerus antiquus.*

No. 206 deserves mention because of its large size. Although the dentition is the size of that in *Agriochoerus antiquus,* the skull has a length from the premaxillary to the occipital condyle that must have exceeded 235 mm. The sagittal crest is well developed; it has a relatively deep depression between the bifurcated anterior ends. The orbital region was probably wide, but the muzzle is narrow as in *A. antiquus.*

Agriochoerus cf. A. ryderanus (COPE)

Referred specimen. — ?Cedar Creek member: No. 112; fragment of left maxillary with M^1-M^3 (M^3 damaged); western Logan County.

Our catalogue states that this specimen was collected by H. T. MARTIN from "Cedar Creek." MARTIN's field notes, and the associated fossils collected on the same day, indicate that the specimen came from the Cedar Creek member somewhere in T. 11 N., R. 55 W., Logan County. It is my opinion that the reference to Cedar Creek by MARTIN did not mean the Cedar Creek member, inasmuch as he generally used letters of the alphabet to indicate horizons. Evidently MARTIN's, and probably MATTHEW's, concept of Cedar Creek was that of the stream draining this area and not the Cedar Creek of today, which lies to the south.

TABLE 24.—Measurements (in mm.) of *Agriochoerus* cf. *A. ryderanus*

	No. 112	No. 4955
Crown length of M^1-M^3	....	35.8
M^1, antero-posterior length	9.6	10.9
M^1, transverse width	10.5	11.7
M^2, antero-posterior length	12.8	12.4
M^2, transverse width	14.1	13.7
M^3, antero-posterior length	14.0[a]	14.3
M^3, transverse width	16.0[a]	17.0

a. Estimate based on badly damaged tooth.

No. 112 has the first molar relatively reduced. Otherwise the teeth do not differ in any respect from those of *Agriochoerus ryderanus.* The dimensions (Table 24) of the upper molars of No. 4955, a skull and associated right ramus of *A. ryderanus* from the John Day formation of Oregon, are given for comparative purposes.

FAMILY MERYCOIDODONTIDAE THORPE, 1923

The use of cranial dimensions and proportions for discriminating the various species and subspecies of *Merycoidodon,* as utilized by BUMP & LOOMIS (1930), THORPE (1937), and SCOTT (1940), was found to be unsatisfactory in studying the specimens from northeastern Colorado.

Using the criteria of size of skull and shape of nasals suggested by COPE (1884, p. 511), the merycoidodont skulls from northeastern Colorado fall into two groups — those of smaller size with the nasals acute posteriorly, *Merycoidodon gracilis;* and those of larger size with the nasals obtuse posteriorly, *Merycoidodon culbertsonii.* However, the specimens of each species show variation that does not permit further separation into subspecies (or additional species) as was done by COPE and others. The groups established by them seemingly represent selected variants of the total population.

Because the exact stratigraphic position is not known, the series of skulls and jaws of *Merycoidodon* from northeastern Colorado collected by H. T. MARTIN for the University of Kansas is not listed under the referred specimens.

Merycoidodon culbertsonii LEIDY

Merycoidodon culbertsonii LEIDY, 1848, p. 47.

Referred specimens.—Horsetail Creek member: No. 8496; left M^3; SE¼ sec. 1, T. 11 N., R. 54 W., Logan County. No. 9108; lower jaws; W½ sec. 29, E½ sec. 30, T. 11 N., R. 53 W., Logan County. No. 9128; lower jaws; NE¼ sec. 31, T. 11 N., R. 56 W., Weld County.

Cedar Creek member: No. 9141; damaged skull; NW¼ sec. 3, T. 11 N., R. 54 W., Logan County.

With the materials at hand it is difficult to recognize the subspecies of *Merycoidodon culbertsonii* by the criterion established by COPE, which does no more than differentiate the specimens with larger teeth [*M. c. culbertsonii* (COPE)] from those with smaller teeth [*M. c. periculorum* (COPE)]. Specimens from the Horsetail and Cedar Creek members show, seemingly, the same vertical range for both size groups, which suggests that selected variants make up the two subspecies. On the other hand, lack of material prevents a final answer to the problem of vertical range, and because it is unsettled there yet remains the possibility that the mean size of *M. culbertsonii* was increasing, with *M. c. periculorum* representing the earlier stage and *M. c. culbertsonii* the later stage. This is not indicated by the limited evidence at hand, but the idea warrants further investigation.

THORPE (1937) thought *M. c. periculorum* to be a small geographic variant or mutant confined mainly to Colorado, and he pointed out that this would not support the view that it could be the female of the more widespread *M. c. culbertsonii.* The contention of BUMP & LOOMIS (1930) that *M. periculorum* is a distinct species is not supported by present evidence. That *M. c. periculorum* represents the smaller individuals of the *M. culbertsonii* population appears to be the best supported possibility at present.

Merycoidodon gracilis (LEIDY)

Oreodon gracilis LEIDY, 1851a, p. 239.
Merycoidodon gracilis, HAY, 1902, p. 666.

Referred specimens.—Horsetail Creek member: No. 9107; fragments of upper and lower jaws; W½ sec. 29, E½ sec. 30, T. 11 N., R. 53 W., Logan County.

Cedar Creek member: No. 9143; skull; SW¼ sec. 12, T. 11 N., R. 54 W., Logan County. No. 9144; damaged skull and jaws; SW¼ sec. 21, T. 11 N., R. 53 W., Logan County. No. 9145; left P^4-M^2; SW¼ sec. 21, T. 11 N., R. 53 W., Logan County. No. 9147; skull; NE¼ sec. 28, T. 11 N., R. 53 W., Logan County.

This species may be recognized by its posteriorly acute nasals and small size of the skull. Some of the specimens have the broad frontals and length of skull that are attributed to *Merycoidodon affinis* LEIDY, but the size of the teeth is within the range of large *M. gracilis.* Like specimens of *Merycoidodon culbertsonii,* these specimens indicate a wide range of variation in size for the species. The specimens from this area which THORPE (1937) referred to *M. affinis* may be the males of *M. gracilis,* but it appears more likely that they are merely large variants of both sexes of *M. gracilis.*

Eporeodon major (LEIDY)

Oreodon major LEIDY, 1854, p. 55.
Eporeodon major, MARSH, 1875, p. 250.

MATTHEW reported (1901, p. 396) *Eporeodon major* as occurring in the Leptauchenia beds of northeastern Colorado. The specimens collected by the American Museum were described as a variety, *E. m.* var. *cedrensis* MATTHEW, because of their consistently smaller size.

No additional identifiable specimens have been found.

Leptauchenia decora LEIDY

Leptauchenia decora LEIDY, 1856, p. 88.

Referred specimens.—Vista member: No. 8497; right P^4-M^1, right M^1-M^3, left P_1-P_2; NE¼ sec. 3, T. 11 N., R. 54 W., Logan County.

MATTHEW (1901, p. 357) referred specimens from Colorado to this species. Our material is too incomplete to do more than make approximate measurements, but these measurements indicate that the specimens agree in size with those of typical *Leptauchenia decora.*

FAMILY CAMELIDAE GRAY, 1821

Eotylopus sp.

Referred specimens.—Horsetail Creek member: No. 8974; left M^1. No. 9116; left M^1-M^3. Both specimens from W½ sec. 9, T. 10 N., R. 51 W., Logan County.

Dr. PAUL O. MCGREW kindly compared the maxillary fragment No. 9116 with the type specimen of *Eotylopus reedi* MATTHEW and assures me that the specimen undoubtedly belongs to the genus. On the other hand, the strong internal cingula of the molars and the prominent internal pillar on M^3 lead Dr. MCGREW to think that the specimen is probably specifically different from *Eotylopus reedi.* Because of Dr. MCGREW's interest in this group, the material is referred to him for further study.

This discovery of *Eotylopus* in late Chadronian beds extends the range of this primitive genus upward and firmly establishes its presence in the Oligocene.

Poëbrotherium wilsoni LEIDY

Poëbrotherium wilsoni LEIDY, 1847, p. 322.

Referred specimens.—Cedar Creek member: Univ. Colorado Mus. No. 19123; skull and jaws; northwest of Sterling, Colorado. No. 9027; right jaw with P_1, P_3-M_3; SW¼ sec. 12, T. 11 N., R. 54 W., Logan County. No. 9028; right jaw with I_1, C-M_3; sec. 28, T. 11 N., R. 53 W., Logan County. No. 9029; right jaw with P_1-M_3; NW¼ sec. 3, T. 11 N., R. 54 W., Logan County. No. 9030; left M_1-M_3; sec. 28, T. 11 N., R. 53 W., Logan County.

This species has been found throughout the Cedar Creek member in numbers almost equal to those of the oreodonts. Considerable variation exists in the depth of the jaws part of which is owing to age and perhaps part to sex. Some variation is seen in the anterior teeth, but the cheek teeth seem remarkably constant. Notable in this respect are Nos. 9027, 9028, and 9029. These three specimens have light jaws, smaller diastemata, and trenchant canines and first premolars, while the cheek teeth are indistinguishable from specimens with larger jaws and caniniform canines and first premolars. Some specimens suggest, and better material may demonstrate, that the shallow jaws with trenchant canines and first premolars grade into the condition seen in the larger specimens of *Poëbrotherium wilsoni.* A possible conclusion is that these are small variants or females of *P. wilsoni.*

Among the specimens collected by H. T. MARTIN in northeastern Colorado are two poorly preserved skulls, Nos. 1 and 190. These two skulls seem to have no, or very small, lacrimal vacuities as compared with other northeastern Colorado specimens, and the depth of the skull is perhaps less than in other specimens.

Poëbrotherium labiatum COPE

Poëbrotherium labiatum COPE, 1881, p. 271.

Type.—AMNH No. 6520; Cedar Creek beds, head of

Cedar Creek, Logan County, Colorado (*fide* COPE & MATTHEW, 1915).

Referred specimen.—?Cedar Creek member (lower): No. 9031; left jaw with C, P_4-M_3; sec. 28, T. 11 N., R. 53 W., Logan County.

This species seems to be confined to the lowest Cedar Creek beds or upper part of the Horsetail Creek member, for nothing of comparable size has been found in higher beds. *Poëbrotherium labiatum* is distinctive in size (Table 25), although of the same general relative proportions as *P. wilsoni*, and there does not seem to be any intergradation between the two species.

The apparent restriction of *Poëbrotherium labiatum* to the lowest part of the Cedar Creek member, whereas the remains of *P. wilsoni* are found throughout the silty phase of the Cedar Creek member, would argue against the possibility of *P. labiatum* being the male of *P. wilsoni*. A ratio of about one specimen of *P. labiatum* to twenty specimens of *P. wilsoni* further suggests that the two kinds are two species instead of different sexes of the same species.

Poëbrotherium sp.

Referred specimens.—Horsetail Creek member: No. 8492; left M^1-M^3; SE¼ sec. 1, T. 10 N., R. 54 W., Logan County. No. 9026; right M^2; N½ sec. 31, T. 11 N., R. 56 W., Weld County. No. 9115; left jaw with P_4-M_3; W½ sec. 9, T. 10 N., R. 51 W., Logan County.

Specimens Nos. 8492 and 9026 and specimens of *Poëbrotherium wilsoni* are closely similar except that the former are smaller and have weaker styles. No. 9115 has molars smaller than those of *Poëbrotherium wilsoni*, and the heel of M_3 relatively reduced. However, P_4 is relatively large—almost as large as the P_4 of *P. labiatum* (Table 25).

MATTHEW (1901, p. 422) commented upon finding a hind foot of *Poëbrotherium* in the "Titanotherium Beds" that was somewhat longer and about one-fourth heavier than "either" [*P. wilsoni* and *P. labiatum*] of the known species.

Protomeryx campester MATTHEW

Protomeryx campester MATTHEW, 1901, p. 422.

Type.—AMNH No. 8969; Leptauchenia beds, Colorado.

Referred specimen.—?Cedar Creek member: No. 133; mandible; sec. 3, T. 11 N., R. 54 W., Logan County.

Our specimen was found in 1925 by CURTIS HESSE and was recorded in the field notes as coming from "high" in the Orellan beds. On the basis of geographic locality alone it is possible that the specimen came from the Vista member, which is somewhat difficult to recognize at places in Chimney Canyon. Of course, the same statement is equally applicable to the age assignment given to the type specimen by MATTHEW. Our specimen is undoubtedly later than the silty phase of the middle part of the Cedar Creek member.

No. 133 is practically identical to the type in size and proportions.

One feature of *Protomeryx campester*, not mentioned by MATTHEW, is the smaller P_2-P_4/M_1-M_3 ratio as compared with species of *Poëbrotherium*. All the specimens of *Poëbrotherium* from north-

TABLE 25.—Measurements (in mm.) of *Poëbrotherium wilsoni*, *Poëbrotherium labiatum*, and *Poëbrotherium* sp.

	Poëbrotherium sp.			*P. wilsoni*		*P. labiatum*
	No. 8492	No. 9026	No. 9115	No. 9029	No. 19123[a]	No. 9031
Crown length of M^1-M^3	32.4	....	....	....	....	....
P^4, antero-posterior length	7.4	....	....	....	....	....
P^4, transverse width	....[b]	....	....	....	....	....
M^1, antero-posterior length	9.0	....	....	....	....	....
M^1, transverse width	10.4	....	....	....	....	....
M^2, antero-posterior length	11.3	11.5	....	....	....	....
M^2, transverse width	11.4	9.8	....	....	....	....
M^3, antero-posterior length	13.3	....	....	....	....	....
M^3, transverse width	12.1	....	....	....	....	....
Crown length of P_2-M_3	....	....	....	60.0	60.0	....
Crown length of M_1-M_3	....	....	34.2	36.5	35.5	43.5
P_2, antero-posterior length	....	....	....	7.6	7.7	....
P_2, transverse width	....	....	....	2.0	2.5	....
P_3, antero-posterior length	....	....	....	8.1	8.9	....
P_3, transverse width	....	....	....	2.8	3.4	....
P_4, antero-posterior length	....	....	9.5	7.9	8.9	10.0+
P_4, transverse width	....	....	3.8	3.1	4.0	4.7
M_1, antero-posterior length	....	....	9.6	10.7	9.0	11.4
M_1, transverse width	....	....	6.2	6.4	6.4	7.1
M_2, antero-posterior length	....	....	10.5	11.5	11.1	13.4
M_2, transverse width	....	....	7.1	7.3	7.7	8.2
M_3, antero-posterior length	....	....	13.8	14.7	15.9	19.5
M_3, transverse width	....	....	7.0	6.4	7.7	8.3
Depth of ramus at M_2	....	....	13.5	14.7	20.4	21.6

a. University of Colorado Museum.

b. Damaged.

eastern Colorado have a P_2-P_4/M_1-M_3 ratio that falls between 0.66 and 0.68, whereas the referred specimen and type of *P. campester* have a ratio of 0.57.

Attention is directed to a footnote by STOCK (1935, p. 122) in which *Protomeryx cedrensis* MATTHEW (1901) is made a synonym of *Protomeryx campester*.

FAMILY HYPERTRAGULIDAE COPE, 1879

Hypertragulus calcaratus (COPE)

Leptauchenia calcarata COPE, 1873b, p. 7.
Hypertragulus calcaratus, COPE, 1873d, p. 419.

Type.—AMNH No. 6518; Oligocene of northeastern Colorado.

Referred specimens.—Cedar Creek member: No. 9036; upper and lower teeth of several individuals (apparently representing one herd of animals); at boundary between secs. 17-18, T. 11 N., R. 55 W., Logan County.

Hypertragulus calcaratus is confined to the Cedar Creek member in northeastern Colorado. No noticeable differences were found in the specimens from the various levels.

Leptomeryx esulcatus COPE

Leptomeryx esulcatus COPE, 1889a, p. 154.

Referred specimens.—Horsetail Creek member: No. 9104; left P^2-M^2 and left P_2-M_3; W½ sec. 29, E½ sec. 30, T. 11 N., R. 53 W., Logan County.

Cedar Creek member (middle): No. 8998; right jaw with P_2-M_3; W½ sec. 7, T. 11 N., R. 53 W., Logan County.

MATTHEW (1903, p. 223) and CLARK (1937, p. 323) discussed P_3 of this species and pointed out that the internal ridge is connected with the heel in this species as opposed to the condition in *Leptomeryx evansi* where the external ridge connects with the heel. This is the only constant character that distinguishes the two species. MATTHEW thought the average size of *L. esulcatus* was greater, which may be true, but the specimens from northeastern Colorado seen by me have a size range similar to that of *L. evansi*, and it is doubtful if the average size is much different.

Specimens of *Leptomeryx* are not rare in the Chadronian beds of northeastern Colorado, but few have P_3 present, so that it cannot be determined whether *L. esulcatus* is the only member of the genus present in the Horsetail Creek beds.

Leptomeryx evansi LEIDY

Leptomeryx evansi LEIDY, 1853, p. 394.

Referred specimens.—Cedar Creek member: No. 9034; right P^2-M^3, P_3-M_3, left P^4-M^3, P_3-M_3 (in occlusion); at boundary between secs. 17-18, T. 11 N., R. 55 W., Logan County.

Vista member: No. 9013; left P^4-M^2; NE¼ sec. 17, T. 11 N., R. 53 W., Logan County.

No. 9034 is one of the largest of several hundred specimens of this species which I collected in northeastern Colorado. No. 9013 is slightly smaller, but otherwise similar to other specimens of this species.

Leptomeryx sp. (Small form)

Referred specimen.—Cedar Creek member: No. 9035; left M^1-M^3; center sec. 3, T. 11 N., R. 54 W., Logan County.

No. 9035 has an M^1-M^3 length of 16 mm. as compared with a length of 20.7 mm. in the specimen (No. 9034) referred to *Leptomeryx evansi*. In addition, this small specimen lacks the strong tubercle that is seen at the base of the postero-internal lobe of the molars in *L. evansi*, and the M^1 is relatively much smaller.

That there is a species of *Leptomeryx* smaller than *L. evansi* or *L. esulcatus* in the Cedar Creek member seems rather certain, but until enough material is collected to allow positive correlation of differences in occlusal pattern and in premolar and molar sizes, and to permit determination of the range of variation, this small species must remain undescribed. Perhaps this small species was the one MATTHEW (1902c, p. 314) had in mind when he mentioned a small, undescribed form from the Leptauchenia beds of northeastern Colorado.

Hypisodus minimus (COPE)

Leptauchenia minima COPE, 1873b, p. 8.
Hypisodus minimus, COPE, 1873d, p. 419.

Type.—AMNH No. 6543; Oligocene, northeastern Colorado.

Referred specimens. — Cedar Creek member (lower and middle): No. 8281; right and left P^4-M^3; SE¼ sec. 21, T. 11 N., R. 53 W., Logan County. No. 9040; associated upper and lower cheek teeth; locality same as No. 8281.

I have collected specimens of this species from all levels of the Cedar Creek member up to within 100 feet of the top of the beds. No. 9130 from the upper part of the Horsetail Creek member may be referable to this species.

In dental pattern these specimens correspond in general with the description given by SCOTT (1940, pp. 533-535), but the range in size includes specimens which are smaller than those indicated by his measurements, although none are as small as comparable teeth of *Hypisodus alcer* TROXELL. Another point of difference from SCOTT's description concerns P_2. Judged by the presence of alveoli in the Cedar Creek specimens, only one has a diastema between P_2 and P_3, whereas three do not; P_2 is not shed early in life, if at all, and was double rooted.

Of great interest is the rate of growth seen in the series of lower jaws and maxillaries. Apparently the permanent dentition was erupted before the jaws and skull attained full development, and M_1 was developing roots before the last deciduous tooth was shed. No upper or lower teeth were observed which did not have, at least, incipient roots—a statement also applicable to the Chadronian and Whitneyan species from northeastern Colorado. These observations are not wholly in

TABLE 26.—Measurements (in mm.) of *Hypisodus* sp. (Form A)[a]

	No. 8271				
Crown length of M^1-M^3	....	....	....	....	12.1
M^1, antero-posterior length	....	....	....	....	4.0
M^1, transverse width	....	....	....	....	2.9
M^2, antero-posterior length	....	....	....	....	4.35
M^2, transverse width	....	....	....	....	2.6
M^3, antero-posterior length	....	....	....	....	4.5
M^3, transverse width	....	....	....	....	2.3
Crown length of M_1-M_3	....	....	....	....	12.8
M_1, antero-posterior length	3.6	3.7	3.5	....	3.4
M_1, transverse width	2.1	....	2.2	....	2.1
M_2, antero-posterior length	....	4.3	3.7	....	3.8
M_2, transverse width	....	....	2.3	....	2.5
M_3, antero-posterior length	....	....	....	5.9	5.6
M_3, transverse width	....	....	....	2.3	2.15

a. The measurements are arranged so that the youngest specimen is at the left, and the oldest at the right of the table. All measurements were made at the occlusal surface. The transverse measurements of the upper molars were made from the antero-internal crescent to the external rib.

agreement with those of SCOTT, who thought that roots were developed in the molars only in old age. In my opinion, much could be gained by a study of the teeth of this genus with a view toward correlating growth of the skull, root development, tooth pattern, tooth size, and geological age. Comparisons already made between specimens from the Horsetail Creek and Cedar Creek members indicate possibilities in this study.

Hypisodus sp. (Form A)

Referred specimens.—Horsetail Creek member. No. 8271; five partial lower jaws containing one to three molars, and a left maxillary with P^4-M^3; NE¼ sec. 31, T. 11 N., R. 56 W., Weld County. No. 8285; left M_3; SE¼ sec. 1, T. 10 N., R. 54 W., Logan County. No. 8286; right M_3; W½ sec. 9, T. 10 N., R. 51 W., Logan County. No. 8973; left P^4-M^3; W½ sec. 9, T. 10 N., R. 51 W., Logan County. No. 9110; left M_2-M_3; W½ sec. 29, E½ sec. 30, T. 11 N., R. 53 W., Logan County.

?Horsetail Creek member: No. 8269; right maxillary fragment with M^1-M^3, and left lower M_3 (not associated); SE¼ sec. 17, T. 11 N., R. 65 W., Weld County.

Although the occurrence of *Hypisodus* in Chadronian beds is surprising, it is not entirely unexpected. The discoveries of CLARK (1937), and the stratigraphic position of some of the fossils in northeastern Colorado have already indicated that a large part of the fauna once thought to be restricted to Orellan beds also lived in Chadronian times.

Noteworthy characteristics of the teeth compared to those of *Hypisodus minimus* are: well-developed parastyle and rib on the antero-external crescent of all the molars; equally well-developed metastyle on the third molar; shorter crowns; and larger size (Table 26).

Hypisodus sp. (Form B)

Referred specimens.—Upper 40 feet of Cedar Creek member, and Vista member: No. 9037; right P_4-M_3; SW¼ sec. 2, T. 11 N., R. 54 W., Logan County. No. 9038; left M^3; sec. 22, T. 11 N., R. 52 W., Logan County. No. 9039; left P_4-M_2; E½ sec. 12, T. 11 N., R. 54 W., Logan County.

These teeth are large like those described from the Chadronian beds, but they lack the strongly developed styles. In size, they approach *Hypisodus* sp. (from the "Uppermost Brule" of E. Nebraska) mentioned by SCOTT (1940, p. 535).

THE MIOCENE FAUNA

Relatively little Miocene material was collected by me in northeastern Colorado and much of that which was collected adds nothing new to a knowledge of the species other than to clarify the stratigraphic position of some.[25]

Four species from the Marsh Collection at Yale University—*Proheteromys parvus*, *Nothocyon vulpinus*, *Mesocyon robustus*, and *Pseudaelurus marshi*—are listed, but it should be kept in mind that these specimens may not be from northeastern Colorado.

CLASS OSTEICHTHYES

Teleostean, sp. indet.

Referred specimen.—Pawnee Creek formation (Eubanks local fauna): No. 9252; maxillary; NE¼ sec. 1, T. 10 N., R. 59 W., Weld County.

This bone is damaged, but it is similar to the maxillary of a carp.

CLASS REPTILIA

ORDER TESTUDINES BATSCH, 1788

FAMILY TESTUDINIDAE GRAY, 1825

Testudo osborniana HAY

Testudo osborniana HAY, 1904, p. 504.

Type.—AMNH No. 5868; Pawnee Creek beds, northeastern Colorado.

25. Subsequent to the writing of this paper, a considerable number of Miocene specimens were collected. These are being prepared for study and should answer some of the questions posed in the faunal discussion and in the following pages.

Gopherus pansa (HAY)

Testudo pansa HAY, 1908, p. 420.
Gopherus pansa, WILLIAMS, 1950, p. 26.

Type.—AMNH No. 5869; Pawnee Creek beds, northeastern Colorado.

Specimens that approach the size of *Testudo osborniana* or *Gopherus pansa* have been found by me in bed No. 5 of measured section XIV in the Pawnee Creek formation at Martin Canyon. Smaller specimens of *Testudo* or *Gopherus* have been found in beds containing *Ustatochoerus* and *Merychippus* west of Sand Canyon.

CLASS AVES

Passerine, sp. indet.

Referred specimen.—Pawnee Creek formation (Martin Canyon local fauna): No. 9831; distal end of left tarsometatarsus; Quarry A, Martin Canyon, NE¼ sec. 27, T. 11 N., R. 53 W., Logan County.

CLASS MAMMALIA

ORDER INSECTIVORA BOWDICH, 1821

FAMILY ERINACEIDAE BONAPARTE, 1838

Brachyerix spp.

Referred specimens.—Pawnee Creek formation (Martin Canyon local fauna): No. 9358; outer half of left M^1; NE¼ sec. 27, T. 11 N., R. 53 W., Logan County.

Pawnee Creek formation (Kennesaw local fauna): No. 9175; left M^1 in fragment of maxillary; SW¼ sec. 26, T. 12 N., R. 55 W., Logan County.

These specimens have been referred to the genus *Brachyerix* but because of their large size they probably are not referable to *Brachyerix macrotis* MATTHEW.

Only the outer half of No. 9358 is preserved and it shows a low, rounded paracone and metacone with the cingulum and styles having about the same degree of development as in *Brachyerix macrotis*.

No. 9175 is less worn than the corresponding tooth in *Brachyerix macrotis* and shows the four principal cusps to be sharp pointed with the paracone highest. The cingulum is absent except for the parastyle and metastyle which show greater development than in *B. macrotis* or No. 9358. The zygomatic arch is lighter than the arch in *B. macrotis* but occupies a position similar to that in *Brachyerix;* that is to say, the arch arises opposite M^1 and not farther back as in *Erinaceus europaeus*. Dimensions of No. 9175 are: length (parastyle to metastyle)—4.6 mm.; length (protocone to hypocone)—3.7 mm.; greatest width (protocone to parastyle)—4.5 mm.

Comparison of No. 9175 with the M^1 of *Erinaceus* shows the teeth to be similar in pattern and size except for the more reduced cingulum on No. 9175. The tooth is much larger than M^1 of *Parvericus montanus* KOERNER, and it is difficult to determine how much difference in pattern exists without comparison of the actual specimens. Differences between this tooth and M^1 in the type of *Metechinus nevadensis* MATTHEW are seen in the less concave borders and more quadrate shape of the former. Because of these differences, the tooth was referred to *Brachyerix* rather than to *Metechinus*.

FAMILY SORICIDAE GRAY, 1821

Soricid, ?n. gen. and sp.

Referred specimens.—Pawnee Creek formation (Martin Canyon local fauna): No. 9280; right 1st, 2nd, and 3rd upper teeth in fragment of bone. No. 9281; left upper incisor. No. 9282; posterior part of right jaw. No. 9341; fragment of left lower incisor. NE¼ sec. 27, T. 11 N., R. 53 W., Logan County.

These specimens were collected from Quarry A and are considered, tentatively, to be individuals of one species. If this be true, the soricid is an unusual and unnamed kind. It is left unnamed pending further exploration of the deposit.

The base of the first upper tooth overlaps the bone and has a basal cuspule as in other soricids. The tooth broadens anteriorly where a cuspule on the inner edge forms a second and smaller prong alongside the pointed principal cusp, thus producing a rather inefficient chisel-like cutting edge. The root of this tooth is deeply grooved on the inner surface, giving the impression of fused roots.

The second upper tooth is relatively broad, with the principal cusp close to the outer border. Two small cusps on the inner border form a "protocone" and a "hypocone," the first being united to the principal cusp by a ridge. Together these structures and the encircling cingulum make an incipient basin in the postero-internal part of the tooth.

The third upper tooth is relatively small but has a well-formed heel.

The posterior part of the lower incisor does not differ basically from the lower incisors of other soricoids: the upper surface is flattend and bordered by ridges; the sides converge below to give the tooth a roughly triangular shape; and the enamel is thick and rugose.

None of the teeth fluoresce under ultraviolet light.

No. 9282, the lower jaw fragment, does not have any part of the horizontal ramus preserved, but the broken edge of the fragment suggests that the missing part was shallow and weak. The coronoid process is narrow antero-posteriorly and rounded at the tip. No intertemporal fossa is present. The angular process is damaged. The condyle is undivided, and the supero-internal border is more concave than in similar structures of *Crocidura*. The neck of the condyle is short.

Without question these fragments (if associated) represent a new genus and species but do not suggest the affinities of the animal with other shrews. The undivided condyle and type of reduction seen

in the first three upper teeth suggest a crocidurine shrew, whereas the lack of an intertemporal fossa is a character found only in *Heterosorex delphinensis* GAILLARD (middle Miocene, Europe), considered to be a soricine shrew.

FAMILY TALPIDAE GRAY, 1825

Talpid sp.

Referred specimen.—Pawnee Creek formation (Martin Canyon local fauna): No. 9359; left M_1 or M_2; NE¼ sec. 27, T. 11 N., R. 53 W., Logan County.

This tooth, belonging to a large talpid, has well-developed cingula on its anterior and posterior faces and between the protoconid and hypoconid. A small ectostylid is present, anterior to the entoconid. The paraconid is compressed and close to the metaconid. The antero-posterior length of the tooth is 3.2 mm., or 2.6 mm. exclusive of the anterior and posterior cingula, and 2.4 mm. wide.

This specimen, although larger and proportionately wider, represents a species that could well be the structural ancestor of *Hesperoscalops* HIBBARD, which differs principally in having higher crowned teeth and more reduced anterior and posterior cingula.

Cf. Condylura

Referred specimens.—Pawnee Creek formation (Kennesaw local fauna): Nos. 9840-9841; left humerii; W½ sec. 26, T. 12 N., R. 55 W., Logan County. No. 9842; right humerus; SW¼ sec. 26, T. 12 N., R. 55 W., Logan County.
Pawnee Creek formation (Vim-Peetz local fauna): No. 9843; left humerus; W½ sec. 28, T. 12 N., R. 55 W., Logan County.

Nos. 9840 and 9841 compliment each other in respect to missing parts. Both specimens represent the same species and differ from the humerus of *Condylura cristata* in having the shaft slightly wider and heavier. The length of No. 9840 is 13.25 mm., which is 0.5 mm. longer than the humerus of a specimen of *Condylura cristata* from Michigan.

Nos. 9842 and 9843 possibly represent a second species of the genus represented by Nos. 9840 and 9841. Although both specimens lack the proximal articular surfaces, they seem to be shorter than the humerus of *Condylura cristata.* The shaft is intermediate in width and thickness between the sizes of the shaft of *C. cristata* and Nos. 9840 and 9841.

ORDER LAGOMORPHA BRANDT, 1855

FAMILY OCHOTONIDAE THOMAS, 1897

Oreolagus nr. O. nebrascensis MCGREW

Figure 23

Referred specimens.—Pawnee Creek formation (Martin Canyon local fauna): Nos. 9285, 9335-9337; lower cheek teeth. Nos. 9338-9339; upper incisors. No. 9356; right P^3. No. 9286; right $?M^1$. No. 9340; upper deciduous molar. No. 9287; left jaw with I, P_4-M_1. No. 9815; right jaw with P_4-M_1. No. 9829; right P_3. All specimens from NE¼ sec. 27, T. 11 N., R. 53 W., Logan County.

These specimens closely resemble *Oreolagus nebrascensis* in the following characters: the size is about the same (Table 27); the diastema is shorter than the cheek tooth row; the masseteric scar is faint and extends to a point below the posterior pillar of M_2; the anterior mental foramen is anterior to P_3; the posterior mental foramen is below M_1; and P_4, M_1, and M_2 are similar in pattern to those described by MCGREW. Despite the absence of P_3, the alveolus of No. 9287 shows that the tooth was approximately as long as it was wide. A small ridge of bone on the antero-external corner of the alveolus suggests that P_3 had only one fold like that seen in *Oreolagus*—a supposition supported by No. 9829, an isolated right P_3 from Quarry A that has a single fold (Fig. 23, *B*) and, presumably, belongs to this species. The incisor is missing from the type of *O. nebrascensis,* but MCGREW (1941a, p. 38), basing his judgment upon the alveolus, described the upper surface of the incisor as evenly rounded. In No. 9287, the incisor is flat on the internal surface (Fig. 23, *C*), is roughly triangular in shape, and extends back to a point below P_4.

In addition to the jaws found in Quarry A several isolated first and second lower molars were collected, which are listed with the referred specimens. The occlusal patterns of these isolated molars and those of the teeth of Nos. 9287 and 9815 resemble the patterns figured by MCGREW for the holotype of *Oreolagus nebrascensis,* with the exception of their having a greater concavity to the antero-external surface of the anterior pillar. In this one feature the molars from Martin Canyon resemble the teeth of *O. nevadensis* (KELLOGG). This may well be an individual age character, however. At no place along the axis of the teeth do the antero-posterior and transverse dimensions vary more than 0.1 mm. The dimensions of these isolated teeth reflect the one probably significant difference between these teeth and those of the type of *O. nebrascensis* — relatively greater antero-posterior length.

Assignment of the upper teeth found in Quarry A to the species represented by the lower jaws must remain tentative, although the association appears valid. The upper incisor (Fig. 23, *F*) has a groove similar to that seen in *Ochotona.* P^3 has the antero-external part of the tooth reduced, as in *Ochotona,* and the anterior arm of the crescent opens upon the grooved antero-external surface. The hypostria is continuous to the bottom of the root and is partly filled with cement. The permanent upper molar, No. 9286, is probably an M^1. The occlusal pattern of this tooth (Fig. 23, *E*) shows the hypostria to be deep, partly filled with cement, and, like the external groove, continuous to the bottom of the tooth. A faint trace of a small, J-shaped, crescentic valley is present which has its inner end posterior to the apex of the hypostria. The protocone and hypocone have sharp inner borders like those on the

teeth of *Ochotona*. No. 9286 is smaller but resembles in pattern the specimen from the late Miocene of Oregon referred to *Oreolagus*(?), n. sp. by WALLACE (1946, p. 125). The tooth is well advanced in development over the upper teeth of *Amphilagus antiquus* POMEL, as figured by VIRET (1929, fig. 12), in that the hypostria is deeper and the tooth more hypsodont. The tooth is also well advanced beyond the condition seen in *Desmatolagus*, which was suggested by MCGREW (1941a) as an ancestor to *Oreolagus*, but nothing in the structure of this one tooth prevents it from being derived from the type of tooth seen in *Desmatolagus*.

The importance of these specimens is dependent upon their belonging to the same species. If the association is valid and the material belongs to *Oreolagus*, it gives us additional knowledge of the upper teeth and indicates the relationship of this genus to the ochotonids—a point of doubt. The type of groove in the upper incisor, and the sharp edges of the inner cusps of the upper molar resemble the corresponding structures in *Ochotona*. However, these are not strictly diagnostic characters that may be used to assign the material to the Ochotonidae, although the specimens do not resemble the known Miocene leporids. Probably of more importance in indicating the relationship of this genus is the comparison of the Martin Canyon material with the specimens reported by WALLACE (1946). As will be recalled, prior to 1946 the genus *Oreolagus* was known by lower jaws whose characteristics suggested ochotonid affinities. In 1946 WALLACE reported the discovery of a maxillary with P^3-M^2 which had several ochotonid features, and a ramus with M_1-M_2 that resembled those of *Oreolagus*. Presumably not enough of the ramus was preserved to assign unequivocally the specimen to that genus. However, concerning these specimens WILSON (1949a, p. 56) commented: "If the genus

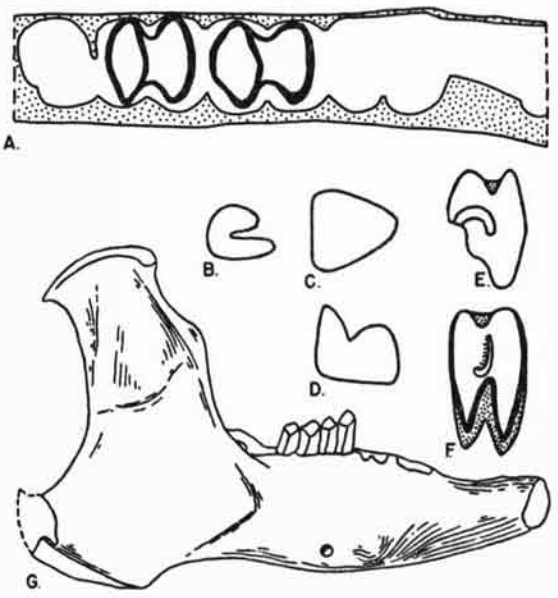

FIGURE 23.—*Oreolagus* nr. *O. nebrascensis*. (*A*) Dorsal view of left ramus of No. 9287 showing alveolus of P_3, occlusal pattern of P_4-M_1, alveolus of M_2, and mandibular foramen. (*B*) Occlusal pattern of right P_3 No. 9829. (*C*) Cross section of left lower I No. 9287 at alveolus. (*D*) Cross section of left upper I No. 9338 at alveolus. (*E*) Occlusal pattern of right P^3 No. 9356. (*F*) Occlusal pattern of right $?M^1$ No. 9286 (external border reconstructed). (*G*) External view of right jaw No. 9815 with P_4-M_1. *A-F*, approximately × 6.8; *G*, approximately × 2.5.

TABLE 27.—Measurements (in mm.) of *Oreolagus* nr. *O. nebrascensis*

	No. 9338	No. 9339	No. 9356	No. 9286	No. 9340
I, transverse width	1.56	1.30	....	....	....
P^3, antero-posterior length	....	....	1.47	....	....
P^3, transverse width	....	....	2.20	....	....
$?M^1$, antero-posterior length	....	....	....	1.50	....
$?M^1$, transverse width	....	....	....	2.30	....
dM, antero-posterior length	....	....	....	....	1.30
dM, transverse width	....	....	....	....	2.40

	No. 9287	No. 9335	No. 9336	No. 9337	No. 9285	No. 9815	No. 9829
Alveolar length of P_3-M_2	7.85	....	....	....	....	....	....
I, transverse width at alveolus	1.59	....	....	....	....	....	....
P_3, antero-posterior length of alveolus	1.50	....	....	....	....	....	....
P_3, transverse width of alveolus	1.57	....	....	....	....	....	....
P_3, antero-posterior length	....	....	....	....	....	....	1.07
P_3, transverse width	....	....	....	....	....	....	1.30
P_4, antero-posterior length	1.65	....	....	....	....	....	....
P_4, transverse width	1.65	....	....	....	....	....	....
M_1, antero-posterior length	1.80	....	....	....	....	1.86	....
M_1, transverse width	1.75	....	....	....	....	1.88	....
M_2, antero-posterior length	....	....	....	....	....	1.83	....
M_2, transverse width	....	....	....	....	....	1.82	....
M_1 or M_2, antero-posterior length	....	1.89	1.90	1.80	1.85	....	....
M_1 or M_2, transverse width	....	2.00	1.80	1.70	1.72	....	....
Depth of ramus at M_2	6.50	....	....	....	....	6.35	....

represented at Beatty Buttes is properly assigned to *Oreolagus*, the question of ochotonid affinities for the latter may be solved." It seems that the upper and lower teeth from Martin Canyon are at least generically similar to those from Beatty Buttes. This would indicate that the teeth from Beatty Buttes belonged to *Oreolagus* and that the association of the upper and lower teeth from Martin Canyon is valid—a conclusion not as circuitous as it seems when one considers that no other lagomorphs are known from either fauna, and that the chances of the association of the upper teeth of one genus with the lower teeth of a second genus in both faunas would be a coincidence that appears rather remote. This association is further substantiated by the *Oreolagus* material (mentioned in the discussion of the Martin Canyon local fauna) from southeastern Fremont County, Wyoming, in beds equivalent to the "lower Snake Creek." These specimens consist of two upper third premolars like those from Martin Canyon and a lower third premolar referable to *Oreolagus*.

I think that the argument for assignment of *Oreolagus* to the Ochotonidae is strengthened to the point where *Oreolagus* may be referred to that family. The upper incisors and molars from Quarry A in Martin Canyon are similar to those of *Ochotona* and are the only lagomorph remains that have been found in the quarry along with the lower jaws of *Oreolagus*. The similarity of these specimens to those from other faunas shows that the association is not fortuitous.

Until the range of variation of *Oreolagus nebrascensis* is known, it is thought best not to consider the material from Martin Canyon as conspecific with the type. The fact that most of the lower teeth are longer than wide, whereas *O. nebrascensis* has teeth wider than long, may or may not be significant. This may be an individual variation, as is suggested by the one tooth from Martin Canyon that is wider than long and by P_4 of No. 9287 which has the length equal to the width.

FAMILY LEPORIDAE GRAY, 1821

Hypolagus sp.

Referred specimen. — Pawnee Creek formation (Vim-Peetz local fauna): No. 9805; proximal end of left femur; NE¼ sec. 27, T. 11 N., R. 53 W., Logan County.

ORDER RODENTIA BOWDICH, 1821

FAMILY MYLAGAULIDAE COPE, 1881

Mesogaulus paniensis (MATTHEW)

Figure 24

Mylagaulus paniensis MATTHEW, 1902b, p. 299.
Mesogaulus paniensis, COOK & GREGORY, 1941, p. 551.

Type.—AMNH No. 9361; base of Loup Fork beds (Pawnee Creek beds), Courthouse Butte, near Pawnee Buttes, Colorado.

Referred specimens.—Pawnee Creek formation (Martin Canyon local fauna): No. 9197; right P_4. No. 9292; left P^4. No. 9293; left P_4. No. 9294; left M_2. No. 9364; left P_4. No. 9370; left P_4. All specimens from NE¼ sec. 27, T. 11 N., R. 53 W., Logan County. No. 160; anterior part of skull, and lower jaws; northeastern Colorado.

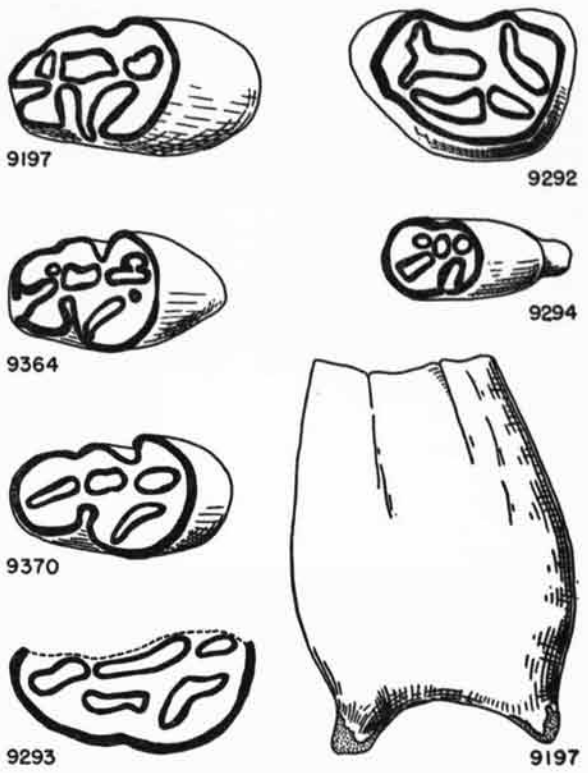

FIGURE 24.—*Mesogaulus paniensis* (MATTHEW). Occlusal patterns of Nos. 9197, right P_4 (reversed); 9292, left P^4; 9293, left P_4; 9294, left M_2; 9364, left P_4; 9370, left P^4; and internal view of No. 9197. The lower premolars are arranged vertically with the youngest at the top, and the oldest at the bottom. Approximately × 4.

Reference of these teeth and the skull to *Mesogaulus paniensis* is based on size of the teeth and similarity of occlusal pattern.

The crowns of all the teeth tend to be plump and bulbous, and the roots are small. Some of the teeth have traces of cement, reported to be absent on the type specimen. On the basis of occlusal pattern, antero-posterior length of occlusal surface, and depth of crown, the four lower premolars range in individual age from No. 9197, the youngest, through Nos. 9364 and 9370 to No. 9293, the oldest. This series gives a good picture of the development and loss of lakes in P_4 (Fig. 24). P^4, No. 9292, belonged to an old individual, as indicated by the occlusal pattern, yet there remains a considerable amount of crown—suggesting that the tooth was more hypsodont than P^4 in *Mesogaulus praecursor* COOK & GREGORY. No. 9294 is considered to be an M_2 on the basis of the angle of occlusal wear, size, presence of a pressure facet on the anterior face,

TABLE 28.—Measurements (in mm.) of *Mesogaulus paniensis*

	P_4, No. 9197	P_4, No. 9364	P_4, No. 9370	P_4, No. 9293	P^4, No. 9292	M_2, No. 9294
Antero-posterior occlusal length	5.1	5.1	5.9	8.2	6.5	3.2
Maximum antero-posterior length	8.6	7.0	8.3	8.2	6.7	3.6
Occlusal surface to notch between roots	9.9	8.2	8.1	6.0	....	....
Occlusal surface to tip of roots	11.7	10.7	10.7	8.8	10.3	....
Maximum transverse width	4.3	4.1	4.1	4.2	5.7	2.75

shape of tooth, and similarity to the M_2 in No. 160. The measurements in Table 28 show the changes in proportion of P_4 that take place with wear. Compared with a closely related species, *Mesogaulus praecursor*, *M. paniensis* shows an increase in size and hypsodonty and a simplification of the occlusal pattern in an earlier, or total, loss of some of the smaller lakes.

No. 160 consists of the damaged anterior part of the skull with left I, P^3-P^4, and right P^4 preserved. In size and proportions this specimen resembles the skull of *Mesogaulus vetus* more than that of *Mylagaulus laevis*. The lower jaws lack the posterior parts, but the dentition is complete except for the right M_2. There is no definite record of the locality or level in northeastern Colorado from which this specimen was collected. The appearance of the matrix and the preservation of the bone is similar to that of specimens of the Martin Canyon fauna collected from the nodular silts (horizon D of MATTHEW) at Martin Canyon. T. M. STOUT, of the University of Nebraska, has completed a study of this specimen in conjunction with his work on the mylagaulids and will present a detailed description and discussion of the material.

Ceratogaulus rhinocerus MATTHEW

Ceratogaulus rhinocerus MATTHEW, 1902b, p. 299.

Type.—AMNH No. 9456; Loup Fork (Pawnee Creek beds) of Colorado.

Mylagaulus laevis MATTHEW

Mylagaulus laevis MATTHEW, 1902b, p. 298.

Type.—AMNH No. 9043; Loup Fork (Pawnee Creek beds) Cedar Creek, Logan County, Colorado.

Referred specimens.—Pawnee Creek formation (Kennesaw local fauna): No. 9154; left P^4; W½ sec. 27, T. 12 N., R. 55 W., Logan County. No. 9155; right P_4; W½ sec. 27, T. 12 N., R. 55 W., Logan County. No. 9174; left P_4-M_2; SW¼ sec. 26, T. 12 N., R. 55 W., Logan County. No. 9808; damaged skull, lower jaws, and postcranial skeleton; SW¼ sec. 26, T. 12 N., R. 55 W., Logan County. No. 9807; anterior part of skull without cheek teeth; W½ sec. 27, T. 12 N., R. 55 W., Logan County.

No. 9807 is of more than usual interest because of the slight callosity appearing on the anterior one-half of each nasal bone.

Mylagaulus sp.

Referred specimens.—Pawnee Creek formation (Vim-Peetz local fauna): No. 9267; right P_4; E½ sec. 28, T. 12 N., R. 55 W., Logan County. No. 9801; right and left P^4; W½ sec. 28, T. 12 N., R. 55 W., Logan County.

No. 9267 is a relatively unworn specimen and is larger than any of the teeth referred to *Mylagaulus laevis* (Table 29). The occlusal pattern of this specimen is the same as that figured by GAZIN (1932, pl. 6, fig. 5, upper right specimen), who comments that the specimens from Skull Spring are larger than the type of *Mylagaulus laevis*. No. 9267 seems to be approximately the same size as the specimens from Skull Spring.

TABLE 29.—Measurements (in mm.) of *Mylagaulus* sp.

	No. 9267
P_4, maximum antero-posterior length	11.2
P_4, antero-posterior length of occlusal surface	6.0
P_4, maximum transverse width	5.4
P_4, maximum crown depth	14.9

FAMILY SCIURIDAE GRAY, 1821

Sciurus sp.

Figure 25

Referred specimen.—Pawnee Creek formation (Martin Canyon local fauna): No. 9290; right jaw with P_4, M_2-M_3; NE¼ sec. 27, T. 11 N., R. 53 W., Logan County.

This specimen is referred to *Sciurus* (*s. l.*) in order to emphasize its similarity to the jaws of tree squirrels. The tooth pattern bears features common to those of chipmunks, tree squirrels, and ground squirrels; but the brachyodont cheek teeth, narrow incisor, deep and heavy ramus, short diastema, and large inferior pterygoid fossa suggest a closer relationship to the tree squirrels than to the other groups.

Figure 25 shows most of the features discernible on this specimen, and the reconstructed parts are added primarily to prevent any misinterpretation of the figure. The masseteric fossa ends anteriorly below P_4 and is well defined ventrally by a sharp ridge. However, the upper border is poorly defined. The anterior tip of the fossa encloses a roughened area, which is less depressed than the remainder of the fossa. Table 30 gives the dimensions of this specimen.

P_4 has the protoconid and metaconid almost equal in development, set close together, and only slightly

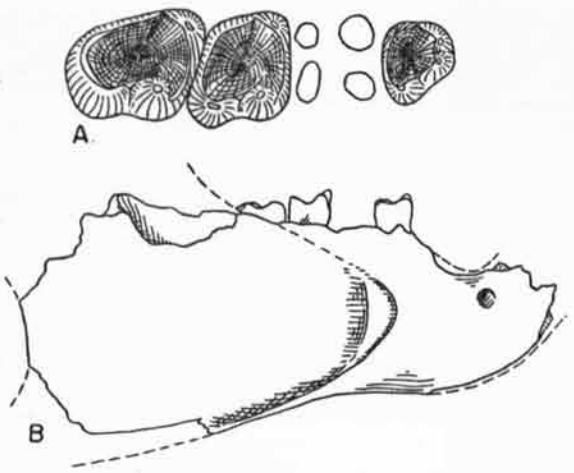

FIGURE 25.—*Sciurus* sp. No. 9290. (*A*) Occlusal view of right P_4, M_2-M_3. Approximately × 7.5. (*B*) External view of right jaw with teeth. Approximately × 3.4.

higher than the hypoconid. No anteroconid is present. The hypoconid is large and swollen, united to the protoconid by a weak (practically divided) ectolophid, and united to the entoconid by a posterolophid. A metastylid is present on the side of the metaconid and is separated from the entoconid by a notch.

M_2 is roughly quadrate in shape, with the entoconid angle more rounded and reduced than are the other corners. The metaconid is well developed and the highest of the cusps, and it has a strong anterolophid extending across the face of the tooth. The protoconid and hypoconid are of approximately equal development and are connected by a weak ectolophid bearing a small mesoconid. An incomplete metalophulid II extends into the basin of the tooth and fails to reach the metaconid. A posterolophid unites with the weak, but distinct, entoconid. The metastylid is separated from the metaconid by a notch deeper than that which separates the structure from the entoconid.

M_3, like M_2, has the metaconid highest. The anterolophid is thick and heavy. The protoconid is similar to the protoconid of M_2 in size, but smaller than the hypoconid of M_3. The metalophulid II is weaker than the arm on M_2. The ectolophid is weak, but the mesoconid is better developed on this tooth than on M_2. The hypoconid is large and inflated, this swollen condition continuing along the posterolophid to the entoconid, which is not discernible as more than a swelling on the rim of the basin. The metastylid is poorly developed and separated from the metaconid and entoconid by notches of equal size.

TABLE 30.—Measurements (in mm.) of *Sciurus* sp.

	No. 9290
Crown length of P_4-M_3	6.70
I, antero-posterior length at diastema	2.71
I, transverse width at diastema	1.32
P_4, antero-posterior length	1.37
P_4, transverse width of anterior lophid	1.00
P_4, transverse width of posterior lophid	1.37
M_2, antero-posterior length	1.65
M_2, transverse width	1.98
M_3, antero-posterior length	2.40
M_3, transverse width	1.95
Depth of ramus at P_4	6.40

Sciurid sp.

Referred specimens.—Pawnee Creek formation (Martin Canyon local fauna): No. 9291; fragments of right and left lower incisors (not associated); NE¼ sec. 27, T. 11 N., R. 53 W., Logan County.

The narrow and deep incisors (Table 31) suggest a sciurid, larger than *Sciurus niger* and more closely related to the tree squirrels than to other sciurids.

TABLE 31.—Measurements (in mm.) of Sciurid sp.

	No. 9291	
	Right incisor	Left incisor
Antero-posterior length	4.35	4.20
Transverse width	2.10	2.00

FAMILY HETEROMYIDAE ALLEN & CHAPMAN, 1893

Proheteromys parvus (TROXELL)

Diplolophus parvus TROXELL, 1923, p. 158.
Proheteromys parvus, WOOD, A. E., 1935, p. 170.

Type.—Yale Univ., Peabody Mus. Nat. Hist. No. 10362; ?Miocene of northeastern Colorado (*fide* WOOD, A. E., 1935).

Unfortunately, the type of this species does not have a reliable locality or age record. WOOD (1935, p. 171) discussed this problem and concluded that TROXELL's age assignment of middle Oligocene was incorrect.

Proheteromys spp.

Referred specimens.—Pawnee Creek formation (Martin Canyon local fauna): No. 9288; fragment of right jaw with P_4-M_1. No. 9289; left ?M^2. Both specimens from Quarry A, NE¼ sec. 27, T. 11 N., R. 53 W., Logan County.

Pawnee Creek formation (Kennesaw local fauna): No. 9159; right jaw with I, P_4-M_1; W½ sec. 27, T. 12 N., R. 55 W., Logan County.

No. 9289 is an isolated tooth which is questionably identified as an M^2 because of its size (Table 32) in relation to the lower jaw from the same site. This tooth has two well-developed lophs, each composed of two cusps, united at the lingual edge by a single cusp that blocks the transverse valley. Compared with the first or second upper molar of *Heliscomys*, this tooth shows a relative increase in width and reduction in length, a loss of the anterior cingulum, and better-developed lophs.

No. 9288, like No. 9289, was recovered from the matrix of Quarry A at Martin Canyon. Whether or not it represents the same species as No. 9289 is, of course, unknown; but the stage of development of both specimens, when compared with *Heliscomys*, appears to be about the same. P_4 has four equally developed conical cusps and a small anteroconid, which is more closely associated with the metaconid than with the protoconid. Weak ridges unite the metaconid, entoconid, and hypoconid and also connect the anteroconid to both the metaconid and the protoconid. These ridges do not seem to form the X pattern found in the *Perognathus* line. A hypoconulid is present on the posterior margin of the tooth. The metaconid and protoconid are not set so closely together as in other specimens of *Proheteromys*, but this is probably because of their large size and the development of the anteroconid, which extends back as a ridge between them. M_1 has an occlusal pattern that does not differ greatly from that described for *Proheteromys*? (Chicago Nat. Hist. Mus. No. PM381) from the Cedar Creek fauna, except as follows: the lophodont structure is better developed; the anterior cingulum is weaker; the notch between the protostylid and hypostylid is broader and deeper; and the posterior cingulum is absent. That P_4 of No. 9288 may be deciduous does not seem likely.

These specimens from Quarry A are referred to *Proheteromys* in a broad sense—actually as a structural stage between the ancestor of *Proheteromys* and *Heliscomys*, and the later forms such as *Peridiomys*. With the discovery of more material, it is becoming increasingly difficult to fit the size, structural pattern, and geological age of individual species and specimens now assigned to *Proheteromys* into a simple evolutionary scheme that would maintain *Proheteromys* as a taxonomic unit in the sense in which it is used at present.

No. 9159 is weathered and the tooth pattern is poorly preserved, but the following details seem evident. The incisor is asulcate. Both cheek teeth are subhypsodont. P_4 has four prominent cusps. M_1 is composed of a well-developed metalophid and hypolophid united buccally and possibly also at the center of the tooth. Both lophids retain vestiges of the component cusps, the one on the lingual end of the metalophid being especially prominent. In addition, an anterior cingulum composed of several cusps seems to be present. Because of its weathered condition, the structural details of this specimen are difficult to discern, but it does show that a small heteromyid (Table 32) was present in the Kennesaw local fauna.

TABLE 32.—Measurements (in mm.) of *Proheteromys* spp.

	No. 9289	No. 9159	No. 9288
?M^2, antero-posterior length	0.74	....	....
?M^2, transverse width	1.05	....	....
I, transverse width	....	0.60	....
P_4, antero-posterior length	....	0.65	0.84
P_4, transverse width	....	0.60	0.69
M_1, antero-posterior length	....	0.90	1.05
M_1, transverse width	....	1.00	0.95

Peridiomys sp.

Referred specimen.—Pawnee Creek formation (Kennesaw local fauna): No. 9177; right P^4-M^1; SW¼ sec. 26, T. 12 N., R. 55 W., Logan County.

The teeth of this specimen are relatively unworn, and the metaloph of P^4 and both lophs of M^1 show their tricuspid origin. The lophs of M^1 are not united. In pattern and size (Table 33), the teeth are close to those of *Peridiomys oregonensis* (GAZIN) if allowance is made for wear. MATTHEW described *P. rusticus*, based on a lower jaw, from the "lower Snake Creek" beds of Nebraska. No. 9177 may represent the upper teeth of that species.

TABLE 33.—Measurements (in mm.) of *Peridiomys* sp.

	No. 9177
Crown length of P^4-M^3 at alveolus	5.30
P^4, antero-posterior length	1.35
P^4, transverse width	1.61
M^1, antero-posterior length	1.24
M^1, transverse width	1.58

FAMILY CASTORIDAE GRAY, 1821

Monosaulax curtus (MATTHEW & COOK)

Dipoides curtus MATTHEW & COOK, 1909, p. 381.
Monosaulax curtis, STIRTON, 1935, p. 420.

Referred specimen.—Pawnee Creek formation (Eubanks local fauna): Univ. Colorado Mus. No. 19836; right lower jaw with P_4-M_3; north of Pawnee Buttes in sec. 21, T. 10 N., R. 59 W., Weld County.

This specimen is identical to the type of *Monosaulax curtus*.

Monosaulax nr. M. curtus (MATTHEW & COOK)

Referred specimens.—Pawnee Creek formation (Martin Canyon local fauna): No. 9196; right P_4 and part of incisor (not associated). No. 9283; right P_4-M_2. No. 9284; right M_3. All specimens from NE¼ sec. 27. T. 11 N., R. 53 W., Logan County.

These specimens represent a species as small as *Monosaulax curtus* and similar to *M. curtus* in most respects. The occlusal pattern of the fourth premolars from Martin Canyon differs in having a crescent-shaped parafossettid resembling that of *M. pansus* (COPE). P_4 of No. 9283 has, in addition, a small fossettid anterior to the parafossettid which is lost early in wear. In all of the teeth, except the well-worn M_3 the hypoflexid appears to be shorter and wider than those of *M. curtus*.

Amblycastor? sp.

STIRTON (1935 p. 413) states that two beaver teeth from the Pawnee Creek beds (those reported

by MATTHEW, 1902b, p. 305, figs. 12-13) "appear to belong to this genus." The specimen designated as figure 12 (AMNH No. 9364) came from 10 feet above the base of the Pawnee Creek formation, three miles west of Pawnee Buttes, Weld County. So far as can be determined, the other specimen came from the Pawnee Creek formation, Pawnee Buttes.

FAMILY ZAPODIDAE COUES, 1875

Plesiosminthus? clivosus, new species

Figure 26

Holotype.—Left lower jaw with M_1-M_3, No. 9279, Vert. Paleont. Coll., Univ. Kansas Mus. Nat. Hist.

Geological age and locality.—Silts of Hemingfordian age in the Pawnee Creek formation, Quarry A, NE¼ sec. 27, T. 11 N., R. 53 W., Logan County, Colorado.

Diagnosis.—The lower molars of this species are characterized by small size (Table 34); rounded principal cusps; and well-developed internal arm of the anterior cingulum, posterior protoconid arm, and metastylid. When more specimens of this species are known, it may be possible to emend this diagnosis of the lower teeth and cite characters confined to single teeth.

Description.—Only the body of the jaw, lacking the inferior border, and the three molars are preserved. The scar for the masseter muscle extends forward to the anterior root of M_1, and the lower border is prominently marked by a ridge. The mental foramen lies anterior to M_1. There seems to be an inferior dental foramen on the damaged internal surface of the jaw above the angle of the jaw and below the root of the incisor.

The molars are short crowned, and all the structures comprising the occlusal surface are in one plane, except the protoconid, metaconid, and entoconid on M_1, and the metaconid and entoconid on M_2 and M_3, which extend above this plane. An anteroconid is present on all three teeth. It is free and small on M_1 but is united by ridges to both the protoconid and metaconid on M_2 and M_3. In both M_2 and M_3 a strong crest forming the internal arm of the anterior cingulum passes from the anteroconid along the anterior face of the molar and unites with the anterior face of the metaconid. On the same two teeth a weak external arm extends downward from the anteroconid to unite with the base of the protoconid. A strong posterior protoconid arm unites the protoconid and metaconid in all three teeth, thus forming a deep pit on M_2 and M_3. The mesoconid is large and roughly rhomboidal in shape on all the teeth and lacks a well-developed union with the protoconid. Posteriorly the mesoconid is connected to the crest that unites the hypoconid and entoconid, the union being closer to the latter cusp. Well-developed mesostylids, united to the metaconids by low ridges, are present on M_1 and M_2. However, the mesostylid on M_3 is weak and extends no higher than the ridge that connects it to the metaconid. A well-developed mesolophid unites the mesostylid and mesoconid on M_1 and M_2, but it is present only as a faint wrinkle on the surface of the tooth in M_3. The principal cusps are round and have a rounded pattern of wear. Except for the protoconid on M_1, the protoconid and hypoconid on all teeth are slightly posterior to the metaconid and entoconid.

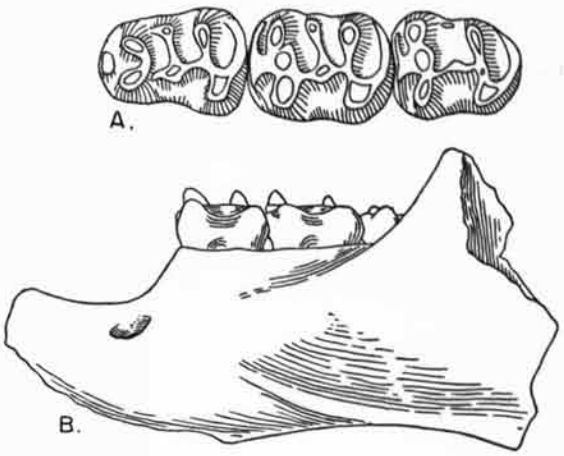

FIGURE 26.—*Plesiosminthus? clivosus*, n. sp. No. 9279. (*A*) Occlusal view of left M_1-M_3. Approximately × 20. (*B*) External view of left jaw with teeth. Approximately × 12.

Grooved upper incisors, No. 9295, also from Quarry A, are similar in cross section and enamel structure to the upper incisors of *Plesiosminthus schaubi* VIRET (SCHAUB, 1930, p. 621, fig. 4) but, without association, cannot be assigned to *Plesiosminthus? clivosus*.

Discussion.—It seems unlikely that this North American zapodid from the middle Miocene is congeneric with the lower Miocene zapodid of western Europe. Yet, until the upper teeth are found or enough material is collected to determine something of the range of variation of the structures on the lower teeth, it is advisable to refrain from naming a new genus. The similarities between this specimen and the European specimens of *Plesiosminthus* are evident, but, of course, these similarities may be those common to the plesiosminthid group. The differences between the two, especially those cited in the diagnosis, may be sufficient to dis-

TABLE 34.—Measurements (in mm.) of *Plesiosminthus? clivosus*

	No. 9279
Crown length of M_1-M_3	2.85
M_1, antero-posterior length	0.99
M_1, transverse width	0.72
M_2, antero-posterior length	0.99
M_2, transverse width	0.76
M_3, antero-posterior length	0.87
M_3, transverse width	0.72

tinguish the material generically; but with the range of variation recognized by SCHAUB in the species of *Plesiosminthus*, it is difficult (with one specimen) to select characters with any assurance that they will continue to be significant when more specimens are found.

ORDER CARNIVORA BOWDICH, 1821

FAMILY CANIDAE GRAY, 1821

Nothocyon vulpinus MATTHEW

Nothocyon vulpinus MATTHEW, 1907, p. 183.

THORPE (1922, p. 430) described and named as a "new mutant" *Nothocyon vulpinus coloradoensis*, which he based on a specimen (Yale Univ., Peabody Mus. Nat. Hist. No. 12812) from the "lower Miocene, Pawnee Buttes, Colorado." Concerning this specimen, Dr. JOSEPH T. GREGORY has informed me that it was part of a shipment of fossils from Pine Bluff, Wyoming, received in 1873, which included some Oligocene material from Gerry's Ranch (see account of *Phalacrocorax mediterraneus* for locality of Gerry's Ranch) and Pawnee Buttes. Inasmuch as Arikareean beds are unrecognized in the Pawnee Buttes area, but may be present in the Gerry Ranch area, it is suggested that the locality record is incorrect and that this specimen is from Gerry's Ranch —if in truth it is from Colorado.

Mesocyon robustus MATTHEW

Mesocyon robustus MATTHEW, 1907, p. 185.

THORPE (1922, p. 429) referred a specimen from Gerry's Ranch, Weld County, to this species. The importance of this specimen, like *Nothocyon*, lies in its possible stratigraphic value in indicating the presence of Arikareean beds in western Weld county. It is as yet, so far as I know, the only vertebrate fossil to support such a possibility. If Arikareean beds are present, they probably represent an extension of the Arikareean beds known in southeastern Wyoming.

Tomarctus brevirostris COPE

Tomarctus brevirostris COPE, 1873b, p. 2.

Type.—AMNH No. 8302; Pawnee Creek beds of northeastern Colorado (*fide* MATTHEW, 1924).

Tomarctus temerarius (LEIDY)

Canis temerarius LEIDY, 1858, p. 21.
Tomarctus temerarius, MATTHEW, 1924, p. 98.

This species was listed by MATTHEW (1901, p. 358; 1924, p. 71) as part of the Pawnee Creek fauna, which, of course, at that time included material from Martin Canyon. Although MATTHEW did not refer to the specimens by number, there is in the American Museum of Natural History material from "horizon E" in Martin Canyon which may have been the specimens MATTHEW had in mind. The specimen (No. 9220) listed below as *Tomarctus* sp. may well belong to this species.

Tomarctus sp.

Referred specimens.—Pawnee Creek formation (Martin Canyon local fauna): No. 9342; right M^1; NE¼ sec. 27, T. 11 N., R. 53 W., Logan County.

Pawnee Creek formation (Vim-Peetz local fauna): No. 9220; left P^4; NE¼ sec. 27, T. 11 N., R. 53 W., Logan County.

No. 9342 is smaller than most specimens of *Tomarctus*, being 13.9 mm. wide when measured along a line through the hypocone and paracone. The metacone is damaged and no maximum antero-posterior measurement can be obtained, but the diameter at the conules is 7.95 mm. This indicates that the specimen had the proportions of *T. confertus* MATTHEW, but it differs from this species, and others, in having small and delicate cusps.

No. 9220 has a maximum length of 17.1 mm. and a width of 6.9 mm. The protocone is reduced and lies well forward on the side of the tooth, having a position similar to that seen in *Tomarctus confertus* or *T. optatus* MATTHEW. This tooth, like No. 9342, although nearly the same size as P_4 in *T. optatus*, appears more slender and delicate.

MATTHEW reported *Tomarctus* cf. *T. temerarius* from beds in Martin Canyon which he assigned to DARTON'S horizon D and E. No. 9342 came from the surface of Quarry A which would place it in horizon D as recognized by MATTHEW, and No. 9220 came from beds (No. 5 of measured section XIV) near the top of the section in horizon E.

Leptocyon vafer (LEIDY)

Canis vafer LEIDY, 1858, p. 21.
Leptocyon vafer, MATTHEW, 1918, p. 190.

Referred specimen.—Pawnee Creek formation (Kenne-

TABLE 35.—Measurements (in mm.) of *Leptocyon vafer*

	No. 9157 left	right
Crown length of P_1-M_3	45.4	....
C, antero-posterior length at alveolus	4.8	....
C, transverse width at alveolus	3.5	....
P_1, antero-posterior length	2.9	....
P_1, transverse width	1.4	....
P_2, antero-posterior length	5.9	6.1
P_2, transverse width	2.4	2.1
P_3, antero-posterior length	7.1	7.1
P_3, transverse width	2.7	2.7
P_4, antero-posterior length	7.9	8.1
P_4, transverse width	3.2	3.3
M_1, antero-posterior length	12.2	12.2
M_1, transverse width	5.0	5.0
M_2, antero-posterior length	6.6	....
M_2, transverse width	4.3	....
M_3, antero-posterior length	2.5	....
M_3, transverse width	2.2	....
Depth of ramus at M_1	11.0	12.7

saw local fauna): No. 9157; left ramus with C-M_3, and part of right ramus with P_2-M_1; W½ sec. 27, T. 12 N., R. 55 W., Logan County.

In size (Table 35) and other characters this specimen agrees with the description of the type and the referred specimen of *Leptocyon vafer* from the *Merychippus paniensis* zone of the lower Snake Creek fauna.

Euoplocyon sp.

MATTHEW (1924, p. 71) lists this genus as occurring in the Pawnee Creek fauna.

Amphicyon sinapius MATTHEW

Amphicyon sinapius MATTHEW, 1902a, p. 288.

Type.—AMNH No. 9358; Loup Fork (Pawnee Creek beds), three miles northeast of Pawnee Buttes, Weld County, Colorado.

Amphicyon reinheimeri COOK

Amphicyon reinheimeri COOK, 1926, p. 29.

Type.—Denver Mus. Nat. Hist. No. 823; Pawnee Creek beds, E. C. Davis Ranch, six miles west of Pawnee Buttes, Weld County, Colorado.

The type locality of this species is in an area where there are exposures of the Pawnee Creek formation carrying equivalents of the Kennesaw and Martin Canyon local faunas.

FAMILY URSIDAE GRAY, 1825

(?)Ursavus pawniensis FRICK

(?)*Ursavus pawniensis* FRICK, 1926, p. 106.

Type.—AMNH no. 20801; Pawnee Creek Miocene, Tapir Hill, Pawnee Buttes, northeastern Colorado.

MATTHEW (1902a, p. 285) referred AMNH No. 9454, a carnassial and other fragments from northeastern Colorado, to ??*Ursavus* sp. but never specifically mentioned it again in faunal lists or discussions. Neither did FRICK refer to the specimen when he described (?)*Ursavus pawniensis*. I cannot determine which specimen MATTHEW had in mind when he included the entry "?*Ursavus* (Pawnee Creek)" in a chart (1929, p. 480) showing the phylogeny of the Ursidae.

FAMILY PROCYONIDAE BONAPARTE, 1850

Phlaocyon leucosteus MATTHEW

Phlaocyon leucosteus MATTHEW, 1899, p. 54.

Type.—AMNH No. 8768; American Museum Merycochoerus Quarry, Martin Canyon, Logan County, Colorado.

Concerning this specimen, WORTMAN & MATTHEW (1899, p. 131) wrote: "It represents a new and aberrant genus of Dogs, the characters pointing clearly in the direction of the Raccoons, so that if we adopt the genealogical conception of a family it must be placed in the Procyonidae, although it is nearer to such primitive Dogs as *Cynodictis* than to the modern Raccoons." HOUGH (1948a, p. 97) confirmed the close relationship of the specimen to the canids, but she pointed out that the procyonid-like characters could be the results of parallelism or convergence and would not necessarily indicate procyonid ancestry. Because of this and the similarities of the auditory region, she placed the genus in the family Canidae and denied any relationship to the Procyonidae.

On the other hand, MCGREW (1937a, 1938a, 1941) has considered the Procyonidae, including *Phlaocyon*, to be a highly diversified family held together by the fundamental similarities of the dental pattern.

Cynarctus saxatilis MATTHEW

Cynarctus saxatilis MATTHEW, 1902a, p. 281.

Type.—AMNH No. 9453; Loup Fork (Pawnee Creek beds), Cedar Creek, Colorado.

FAMILY MUSTELIDAE SWAINSON, 1835

Plionictis ogygia (MATTHEW)

Mustela ogygia MATTHEW, 1901, p. 383.
Plionictis ogygia, MATTHEW, 1924, p. 135.

Type.—AMNH No. 9042; Pawnee Creek beds, Cedar Creek, Logan County, Colorado.

Referred specimens.—Pawnee Creek formation (Kennesaw local fauna): No. 9271; right M_1 in fragment of jaw; E½ sec. 27, T. 12 N., R. 55 W., Logan County. No. 9810; left P_4-M_2 and right C, P_3 in fragments of jaws; SW¼ sec. 26, T. 12 N., R. 55 W., Logan County.

Pawnee Creek formation (Vim-Peetz local fauna): No. 9800; left I^1-P^1, P^4-M^1, right C-P^1, M^1, and left P_3-M_1, right C, P_2-P_4; W½ sec. 28, T. 12 N., R. 55 W., Logan County, Colorado.

No. 9271 is an unworn tooth similar to the type in structure but approximately 18 percent smaller in size—being 6.15 mm. long and 2.9 mm. wide. The first lower molars of the other two specimens are intermediate in size between No. 9271 and the molar of the type specimen.

Plionictis parviloba (COPE)

Aelurodon mustelinus COPE, 1873, p. 1.
Mustela parviloba, COPE, in SCOTT & OSBORN, 1890, p. 71.
Plionictis parviloba, MATTHEW, 1924, p. 135.

The present location of the type specimen of this species is unknown. MATTHEW (1924, p. 135) considered the specimen to have come from the Pawnee Creek beds.

Leptarctus primus LEIDY

Leptarctus primus LEIDY, 1856c, p. 311.

Referred specimen.—Pawnee Creek formation (Kennesaw local fauna): No. 9153; skull (lacking basicranial region) and lower jaws; W½ sec. 27, T. 12 N., R. 55 W., Logan County.

This skull is the same size as the skull (AMNH

TABLE 36.—Measurements (in mm.) of *Leptarctus primus*

	No. 9153[a]
Crown length of C-M^1	28.7
C, antero-posterior length	5.1
C, transverse width	4.1
P^2, antero-posterior length	3.1
P^2, transverse width	2.4
P^3, antero-posterior length	4.0
P^3, transverse width	3.8
P^4, antero-posterior length	7.7
P^4, transverse width	7.7
M^1, antero-posterior length	7.3
M^1, transverse width	7.6
Crown length of C-M_2	33.6
C, antero-posterior length	4.5
C, transverse width	4.0
P_2, antero-posterior length	2.9
P_2, transverse width	2.1
P_3, antero-posterior length	4.2
P_3, transverse width	3.6
P_4, antero-posterior length	6.0
P_4, transverse width	4.1
M_1, antero-posterior length	9.8
M_1, transverse width	5.2
M_2, antero-posterior length	4.4
M_2, transverse width	4.0
Depth of ramus at rear of M_1	13.0

a. Right tooth row.

No. 18241) from the "lower Snake Creek" beds referred to *Leptarctus primus* by MATTHEW (1924, p. 139). However, the temporal crests are less divergent in No. 9153. Another difference is seen in the greater length and width of P^4 when compared with the teeth in LEIDY's type and in the Snake Creek skull. Compared with AMNH No. 18270, a lower jaw from the Snake Creek beds that has been referred to the species, the jaw of No. 9153 is heavier and has P_4 and M_1 wider but not longer antero-posteriorly (Table 36). Comparison of this specimen with *Leptarctus progressus* SIMPSON from the Pliocene of Florida can be made only on the basis of P^4. The only significant similarity of the Colorado specimen to SIMPSON's figure and description (1930, p. 186, fig. 19) is seen in the relatively greater width. The two teeth differ in that the specimen from Colorado lacks all traces of a cingulum other than the prominent anterior cuspule, which seems to be approximately twice as wide as the cuspule on *L. progressus;* the external surface is not so broad as that on *L. progressus;* and possibly the metacone was much better developed. The width of P^4 in the skull from northeastern Colorado equals its length; therefore, it is intermediate in proportion between *L. primus* and *L. progressus*, but closer to the latter. From the evidence of the specimens of *Leptarctus* from the Miocene and Pliocene, one would judge that the width of P^4 was not a geographic nor an evolutionary trend, unless in the latter case two separate lines of development are represented—a circumstance certainly not reflected by any other structures in the skull. This suggests that the wider teeth might be the result of sexual or individual variation. It is possible also that the slope of the external face and the size of the protocone are related to transverse width.

Because of the similarity in tooth structure, length of tooth row, and length of skull in No. 9153 and *Leptarctus primus*, and despite the wider teeth of No. 9153, I think that it belongs to the species *L. primus*. From the evidence of the shorter tooth row and wide teeth in the Coloradan specimen, it may be concluded that *L. progressus*, with its wide and short tooth, was closer to *L. primus* than to *L. wortmani* MATTHEW, which has longer teeth. Although some of the differences between *L. primus* and *L. progressus* are probably the result of geographic variation and different geologic age, the greater width of the teeth in *L. progressus* and the differences associated with greater width may be the result of secondary sexual or individual variation.

FAMILY FELIDAE GRAY, 1821

Pseudaelurus intrepidus LEIDY

Pseudaelurus intrepidus LEIDY, 1858, p. 22.

So far as can be determined, COPE collected material from northeastern Colorado referable to this species, which MATTHEW (1924, p. 72) referred to the Pawnee Creek fauna.

Pseudaelurus marshi THORPE

Pseudaelurus marshi THORPE, 1922, p. 446.

THORPE (1922, p. 446) referred a specimen from the "middle or upper Miocene" of "northwest" Colorado to this species. However, the correct locality, according to the Yale Peabody Museum records, is Gerry's Ranch, Weld County, Colorado.

ORDER PROBOSCIDEA ILLIGER, 1811

The list of proboscidean species from northeastern Colorado is presented using SIMPSON's (1945) generic and suprageneric taxonomy and OSBORN's assignment of species. This appears to be the best method of recording and keeping clear the pertinent data on the material from the area. FRICK (1933) referred all the proboscidean material, except that mentioned under *Serridentinus productus*, to *Serridentinus proavus* (COPE); but OSBORN (1936) considered four species, *Serridentinus productus* COPE, *Serridentinus proavus* (COPE), *Rhynchotherium rectidens* OSBORN, and *Mammut* (*Miomastodon*) *merriami* OSBORN, to be present.

FAMILY GOMPHOTHERIIDAE CABRERA, 1929

Serridentinus proavus (COPE)

Mastodon proavus COPE, 1873c, p. 10.
Serridentinus proavus, OSBORN, 1936, p. 403.

Type.—AMNH No. 8523; Pawnee Buttes, Weld County, Colorado (*fide* OSBORN, 1936).

Concerning the age of this specimen OSBORN (1936, p. 403) wrote:

> The typical (lower) Pawnee Creek beds (*Merychippus sejunctus* zone) of the late Middle Miocene yield traces of mastodon, fragments of a humerus and tooth, and part of a lower jaw found at the head of Two Mile Creek (F. B. Loomis, letter of November 5, 1920). The (upper) Pawnee Creek beds (*Protohippus* zone), perhaps early Pliocene, also yield simple grinding teeth similar to the type of *M. proavus* (F. B. Loomis, 1921). We cannot be certain whether the type of *"Mastodon" proavus* comes from the lower *"Merychippus sejunctus"* or from the upper *"Protohippus"* zone of the Pawnee Creek.

However, it was OSBORN's opinion that this species was from the upper zone, which he stated to be upper Miocene. This is the same level and age to which he assigned *Rhynchotherium rectidens* OSBORN, and above the level assigned to *Mammut merriami* (OSBORN).

Serridentinus productus (COPE)

Mastodon productus COPE, 1874b, p. 221.
Serridentinus productus, OSBORN, 1923, p. 2.

FRICK (1933, p. 609) listed several specimens from the Pawnee Buttes area of Weld County, which he doubtfully thought might represent (?)*Amebelodon paladentatus* (COOK) collected from middle Pliocene deposits near Wray, Yuma County, Colorado. Most of the material is not adequate for purposes of identification, and no stratigraphic position is given. OSBORN (1936, p. 440), in some supplementary observations on the genus *Serridentinus*, referred one of these specimens (left M_3, F:AM No. 23336) to *Serridentinus productus*. Subsequent summaries of the proboscidean species in OSBORN's monograph, however, fail to mention this referred specimen.

Rhynchotherium rectidens OSBORN

Rhynchotherium rectidens OSBORN, 1923, p. 3.

Type.—AMNH No. 9366; upper Miocene, Pawnee Creek horizon, eight miles west of Pawnee Buttes on Davis Ranch, Weld County, Colorado.

FRICK (1933, p. 612) placed this species in synonymy of *Serridentinus proavus*. OSBORN (1936, p. 489) discussed such a possible synonymy without taking notice of FRICK's action.

FAMILY MAMMUTIDAE CABRERA, 1929

Mammut merriami (OSBORN)

Mastodon merriami OSBORN, 1921, p. 6.
Mammut merriami, HAY, 1930, p. 630.

OSBORN (1936, p. 156) referred to this species proboscidean material from northeastern Colorado which FRICK (1933, p. 612) assigned to *Serridentinus proavus*.

The stratigraphic level for these specimens was referred to by OSBORN (1936, p. 403) as "the classic Pawnee Creek horizon of Colorado" of "middle Miocene" age, which would be his *Merychippus sejunctus* zone or lower Pawnee Creek beds.

Proboscidean, sp.?

Referred specimens. — Pawnee Creek formation (Kennesaw and Vim-Peetz local faunas): Nos. 9148-9152; fragments of teeth and bones; secs. 28 and 36, T. 12 N., R. 55 W., and sec. 31, T. 12 N., R. 54 W., Logan County.

Pawnee Creek formation (?Vim-Peetz local fauna): No. 9201; fragment of tooth; NE¼ sec. 27, T. 11 N., R. 53 W., Logan County.

One of the critical specimens from Martin Canyon is a fragment of proboscidean tooth, No. 9201. Although recorded (tentatively) as belonging to the Vim-Peetz local fauna, this specimen was found by Dr. ROBERT WILSON and me on the surface of an exposure of nodular silts at the same level as and not far from the site of Quarry A. It seems unlikely that this specimen was part of the Martin Canyon local fauna. On the other hand, it seems rather coincidental that in two instances (for a similar occurrence see the discussion of *Teleoceras* sp.) specimens of immigrant genera were found under circumstances that would suggest that the arrival in North America of these genera had been set at too late a date, or that the age of the beds containing the Martin Canyon local fauna had been seriously misjudged.

ORDER PERISSODACTYLA OWEN, 1848

FAMILY EQUIDAE GRAY, 1821

Parahippus pawniensis GIDLEY

Parahippus pawniensis GIDLEY, 1907, p. 932.

Type.—AMNH No. 9085; "horizon D" (of MATTHEW 1901), Martin Canyon, Cedar Creek, Logan County, Colorado (*fide* AMNH catalogue records).

Referred specimens.—Pawnee Creek formation (Martin Canyon local fauna): No. 7730; left P_3-M_2. No. 9198; upper molar and fragments of lower teeth. No. 9375; two left upper molars. Univ. Colorado Mus. Nos. 19842 and 19847; right upper molars. Above specimens from NE¼ sec. 27, T. 11 N., R. 53 W., Logan County. No. 9212; two upper and two lower cheek teeth; W½ sec. 22, T. 11 N., R. 52 W., Logan County.

In pattern and size these teeth range from those similar to the type of *Parahippus pawniensis* to specimens that approach *P. coloradensis* in pattern and equal it in size, especially No. 9212. AMNH No. 8961a, the *Parahippus* tooth found in the American Museum Merycochoerus Quarry at Martin Canyon, is also similar to these teeth in size and pattern.

Parahippus coloradensis GIDLEY

Parahippus coloradensis GIDLEY, 1907, p. 932.

Type.—AMNH No. 9040; Pawnee Buttes, Weld County, Colorado (*fide* AMNH catalogue records).

Referred specimens indicate that earlier authors considered *Parahippus pawniensis* and *Parahippus*

coloradensis to be unchanging morphological types that coexisted over a considerable span of time in the Miocene. However, the range of variation seen in the *Parahippus* teeth from Martin Canyon suggests that *P. coloradensis* might be only a part of the *Parahippus pawniensis* population. If No. 9210, discussed in this paper as ?*Merychippus* sp., is referable to *Parahippus*, then this view is considerably strengthened. On the other hand, *P. coloradensis* has been described as more advanced than *P. pawniensis*, so it would appear reasonable to think that *P. pawniensis* represents a population of horses that evolved into a population typified by *P. coloradensis*, if they are not conspecific. When enough specimens of *Parahippus pawniensis* and *P. coloradensis* with stratigraphic records are known, it may be possible to determine the relationship of these two species and the bearing of this relationship on the correlation of the beds in the Pawnee Creek formation.

Some features that point out possibilities concerning the relationship and time span of these two species deserve comment. The "upper Rosebud" and "upper Harrison" localities in South Dakota and Nebraska, respectively, which OSBORN cites (1918, p. 75) for occurrences of these species, are probable equivalents of the Martin Canyon "horizon D." Nothing referable to either species has been reported as coming from either the Sheep Creek or Snake Creek faunas. Although OSBORN listed both species as coming from the "*Ticholeptus-Merychippus* zone" of Pawnee Buttes (OSBORN's Classical Pawnee Creek level; *M. paniensis* zone; or Pawnee Creek A), the type of *Parahippus pawniensis* came from "horizon D" at Martin Canyon. The association of *P. coloradensis* with *M. paniensis* has not been demonstrated, and the parahippine teeth that have been found associated with *M. paniensis* at Pawnee Buttes are not specifically identifiable. Consequently, a parahippine younger than *P. coloradensis* possibly is present at Pawnee Buttes in the Eubanks local fauna. In brief the most likely suggestions are: (1) the species are conspecific and limited to the early Hemingfordian; (2) the species are conspecific and range through the Hemingfordian and early Barstovian time span, but their presence or absence is controlled by facies differences or limited distribution; or (3) one species evolved into the other, and their presence or absence is due to time and facies differences or limited distribution.

Hypohippus osborni GIDLEY

Hypohippus osborni GIDLEY, 1907, p. 930.

Type.—AMNH No. 9407; Pawnee Creek beds, 8 miles west of Pawnee Buttes, northeastern Colorado.

Referred specimens.—Pawnee Creek formation (?Kennesaw local fauna): No. 9169; two upper cheek teeth; SW¼ sec. 26, T. 12 N., R. 55 W., Logan County.

These specimens consist of two damaged and worn teeth which are clearly referable to the genus *Hypohippus*. Reference to the species *H. osborni* is based on size, the teeth being smaller than those of *H. affinis* LEIDY and larger than those of *H. equinus* SCOTT.

Both specimens were found as float in beds bearing the Kennesaw local fauna, but under circumstances that make it possible that they came from higher beds.

On the Merychippine Specimens from Northeastern Colorado

The collection of merychippine material obtained by me in northeastern Colorado is highly unsatisfactory. Less than 100 specimens were collected, of which only two finds had associated upper and lower teeth, and in only nine instances were there more than two teeth preserved. Of the remaining specimens more than half were badly worn, weathered, or incomplete. The collection of *Merychippus* material made by H. T. MARTIN for the University of Kansas Museum of Natural History contains some excellent specimens but lacks stratigraphic and locality data, which makes it useless for this work.

The difficulties encountered in attempting to identify the specimens suggest that the range of variation in the species is rather large—perhaps great enough to allow synonymizing of some forms. Unfortunately, not enough material with accurate stratigraphic data is available to accomplish such a study, especially in the manner that species of *Merychippus* from the West Coast have been studied.

Poor as this collection may be, it nevertheless does show features that seem significant. As a whole, the milk teeth and occlusal patterns of the permanent teeth of the merychippines in the Vim-Peetz local fauna are more like those of the Pliocene, while the crown heights are distinctly shorter.

Merychippus paniensis (COPE)

Hippotherium paniense COPE, 1874, p. 12.
Merychippus paniensis, GIDLEY, 1907, p. 890.

Type.—AMNH No. 8249; Pawnee Creek formation, Pawnee Buttes, northeastern Colorado (*fide* OSBORN, 1918).

Referred specimens.—Pawnee Creek formation (Eubanks local fauna): No. 3125; skull and jaws; northeastern Colorado. Nos. 9233 and 9240; left P^2 and left upper molar (possibly associated); Pawnee Buttes volcanic ash layer, NE¼ sec. 1, T. 10 N., R. 59 W., Weld County.

No. 3125 was collected by H. T. MARTIN, and its position in the Pawnee Creek section is unknown.

Merychippus sejunctus (COPE)

Protohippus sejunctus COPE, 1874, p. 15.
Merychippus sejunctus, HAY, 1902, p. 618.

Type.—AMNH No. 8291; Pawnee Creek formation, Pawnee Buttes, northeastern Colorado (*fide* OSBORN, 1918).

Referred specimens.—Pawnee Creek formation (Eubanks local fauna): No. 9238; right M^1. No. 9811; left I_1-I_3, C, P_2-M_1 in fragment of jaw. Both specimens from NE¼ sec. 1, T. 10 N., R. 59 W., Weld County.

Merychippus sphenodus (COPE)

Hippotherium sphenodus COPE, 1889, p. 449.
Merychippus sphenodus, GIDLEY, 1907, p. 908.

Type.—AMNH No. 8281; Pawnee Creek formation, Pawnee Buttes, northeastern Colorado (*fide* OSBORN, 1918).

Referred specimens.—Pawnee Creek formation (Kennesaw local fauna): No. 9164; left P^2; W½ sec. 27, T. 12 N., R. 55 W., Logan County. No. 9173; right P^2; SW¼ sec. 26, T. 12 N., R. 55 W., Logan County. No. 3122; right P^2-M^3; northeastern Colorado. No. 9167; right P_3-M_2; W½ sec. 27, T. 12 N., R. 55 W., Logan County. No. 9178; left upper molar and right lower molar (associated); W½ sec. 27, T. 12 N., R. 55 W., Logan County. No. 9172; palate with all teeth except left molars; SW¼ sec. 26, T. 12 N., R. 55 W., Logan County.

OSBORN (1918, p. 112) designated a skull (Princeton Univ. Mus. No. 12291) as the neotype of this species.[26] The locality from which this Princeton specimen was obtained seems to be approximately the same as that from which I collected the referred specimens listed above, with the exception of No. 3122 which was collected by H. T. MARTIN.

No. 3122 is smaller than the type or neotype but has an occlusal pattern similar to that of the neotype. Nos. 9164 and 9173 differ from the type in having the protocone united with the protoconule.

Merychippus republicanus OSBORN

Merychippus republicanus OSBORN, 1918, p. 125.

Referred specimen. — Pawnee Creek formation (Vim-Peetz local fauna): No. 9802; right P^2-M^3; W½ sec. 27, T. 12 N., R. 55 W., Logan County.

No. 9802 is the best of several specimens collected from the level of the Vim-Peetz local fauna in the exposures west of Sand Canyon. This specimen has an occlusal pattern close to that of *Neohipparion coloradense,* but the crowns of the teeth are short and curved.

Merychippus labrosus (COPE)

Protohippus labrosus COPE, 1874, p. 13.
Merychippus labrosus, HAY, 1902, p. 617.

Type.—AMNH No. 8266; Pawnee Creek formation, Pawnee Buttes, northeastern Colorado (*fide* OSBORN, 1918).

GIDLEY (1907, p. 891) considered this species to be "of rather uncertain standing."

Merychippus proparvulus OSBORN

Merychippus proparvulus OSBORN, 1918, p. 117.

Type.—AMNH No. 9394; Pawnee Creek beds, Pawnee Buttes, northeastern Colorado.

Merychippus eoplacidus OSBORN

Merychippus eoplacidus OSBORN, 1918, p. 114.

Type.—AMNH No. 9397; Pawnee Creek beds, Pawnee Buttes, northeastern Colorado.

Merychippus eohipparion OSBORN

Merychippus eohipparion OSBORN, 1918, p. 117.

Type.—AMNH No. 9402; Pawnee Creek beds, Pawnee Buttes, northeastern Colorado.

Merychippus proplacidus (OSBORN)

Protohippus proplacidus OSBORN, 1918, p. 139.
Merychippus proplacidus, STIRTON, 1940, p. 182.

Type.—AMNH No. 9115b.

This specimen is listed as having been collected from the "Upper Pawnee Creek beds," Sand Canyon, head of Pawnee Creek, Logan County, by BARNUM BROWN in 1898. The locality "head of Pawnee Creek" was a *lapsus* on OSBORN's part and should have been "head of Cedar Creek." STIRTON (1940, p. 182) tentatively considered that the specimen might be a "lower Pawnee Creek" form. Possibly this species is synonymous with one of the species of *Merychippus* known by permanent teeth.

Merychippus campestris GIDLEY

Merychippus campestris GIDLEY, 1907, p. 928.

Type.—AMNH No. 9096.

GIDLEY gave the number of the type as 9069 and the age and locality as middle Miocene, Pawnee Creek formation, Pawnee Buttes, Colorado. OSBORN (1918, p. 114) repeated this information and pointed out that the specimen was collected by W. D. MATTHEW in 1898 (an error since MATTHEW did not collect at Pawnee Buttes in 1898). The American Museum records, in MATTHEW's handwriting, state that the type specimen of this species was collected by MATTHEW in 1898 from the Pawnee Creek beds, horizon D, at Martin Canyon, Cedar Creek, Colorado. The specimen number given by GIDLEY seems to be a typographical error inasmuch as the records and the description of the material indicate that specimen No. 9096 is the type.

While there is no reason to doubt that this specimen came from the Martin Canyon area, MATTHEW's assignment to "horizon D" appears to have been an error. The type and referred specimens bear a resemblance to *Pliohippus* that suggests a horse greatly advanced over anything known from beds of Hemingfordian age. In my opinion the level of occurrence probably was "horizon E" (Vim-Peetz local fauna of this paper).

MATTHEW (1901, p. 359) reported a specimen of "*Pliohippus mirabilis*" which would indicate the

26. Although OSBORN wrote "Amer. Mus. 1291" for the neotype, reference to page 114 and the legend for plate 12 leaves no doubt as to what specimen he had in mind.

presence of an advanced protohippine in the Logan County area, but it is not known whether or not the specimen referred to by MATTHEW was the same *Pliohippus* (AMNH No. 9093) which OSBORN mentioned as being associated with *Neohipparion coloradense*. Another specimen that might fit into this advanced protohippine group is AMNH No. 9459, referred to *Merychippus campestris* by OSBORN (1918, p. 114) and recorded as coming from the uppermost beds at Cedar Creek, 40 miles north of Sterling, Colorado. Possibly the "*Pliohippus*" and referred specimens of *M. campestris* are the same species. The general similarity of *M. campestris* to *Pliohippus* (OSBORN, 1918, pp. 114, 146), and the almost imperceptible intergradation of *Pliohippus* with the protohippine species of *Merychippus*, commented upon by STIRTON (1940, p. 190), suggest that these specimens are transitional between typical protohippine and pliohippine horses.

Merychippus sp. (Advanced protohippine)

Referred specimens. — Pawnee Creek formation (Vim-Peetz local fauna): No. 9803; left P_2; W½ sec. 27, T. 12 N., R. 55 W., Logan County. No. 9804; external wall of lower cheek tooth; NE¼ sec. 27, T. 11 N., R. 53 W., Logan County.

These teeth show little more than that the protohippine horses at this level had not reached a stage of development typical of the horses of the lower Clarendonian.

?Merychippus sp.

Referred specimen. — Pawnee Creek formation (Martin Canyon local fauna): No. 9210; fragment of upper molar preserving only the metaloph and part of the metacone; NE¼ sec. 27, T. 11 N., R. 53 W., Logan County.

This specimen was collected at Quarry A in Martin Canyon. The metaloph shows multiple plications similar to those seen in *Merychippus paniensis* and *M. sphenodus* and better developed than those of *M. primus* and *M. gunteri*. The fragment indicates a tooth nearly the size of *M. primus* in antero-posterior and transverse diameters. However, it seems to have been shorter crowned.

Calippus sp.

Referred specimens. — Pawnee Creek formation (Kennesaw local fauna): No. 3131; right P^3-M^2; northeastern Colorado. No. 7731; incomplete left M^2; NE¼ sec. 31, T. 12 N., R. 54 W., Logan County. No. 9166; right M_2; W½ sec. 27, T. 12 N., R. 55 W., Logan County. No. 9188; right M_3; SW¼ sec. 25, T. 12 N., R. 55 W., Logan County.

These teeth, because of their pattern and small size, are referred to *Calippus*. However, they are not referable to any known species of this genus, having less crown height and being more curved than in other species.

In antero-posterior and transverse diameters, these specimens are similar to the teeth of *Merychippus westoni* SIMPSON. Also, as in the teeth of *M. westoni*, the protocone of P^3 is more internal in position than the hypocone, and less so on the others. Unlike *M. westoni*, the protocone is strongly united to the protoconule in every specimen.

The specimens also bear some similarity to *Calippus* sp.?[27] of HESSE (1936, p. 65) from the Clarendonian Pliocene of Oklahoma but seem to be more primitive and of a different species.

FAMILY **CHALICOTHERIIDAE** GILL, 1872

?Macrotherium matthewi (HOLLAND & PETERSON)

Moropus matthewi HOLLAND & PETERSON, 1913, p. 230.
?Macrotherium matthewi, MATTHEW, 1929, p. 519.

Cotypes.—AMNH Nos. 9076, 9077, 9078, 9080; Pawnee Creek horizon, Martin Canyon, Cedar Creek, Colorado. AMNH No. 9368; Loup Fork horizon, near Pawnee Buttes, Weld County, Colorado.

Referred specimen. — Pawnee Creek formation (Martin Canyon local fauna): No. 9378; right $?P_4$ (damaged); NE¼ sec. 27, T. 11 N., R. 53 W., Logan County.

The stratigraphic position of the chalicothere remains collected by MATTHEW (Nos. 9076-9080) cannot be exactly determined to my satisfaction. MATTHEW stated (1901, p. 359), "It appeared probable that the heavy beds of coarse gravel filling erosion valleys are connected with these upper beds [horizon E or bed No. 5 of measured section XV, Fig. 6] rather than with the finer concretionary sandstones [bed No. 4 of measured section XV, Fig. 6] and are continuous with the shingle bed overlying the latter *rather than the one* [bed No. 3 of measured section XV, Fig. 6] *underneath it* [italics mine, E. C. G.]. The *Moropus* and other species should therefore also be added to this list [fauna of horizon E]." In the N½ of sec. 27 the relationship of the channels are as MATTHEW described them, but the American Museum records state that MATTHEW collected the chalicothere remains at the "gravel hill west of spring," which appears to have been one of the exposures near Sand Butte and west of Willow Spring (the only spring in the immediate area, in N½ sec. 34, and one with a long and well-known history). In this locality at least some, if not all, of the coarse gravel beds are thought to be associated with the fine concretionary sandstones or the underlying rubble bed.

No. 9378 was found near the base of the fine concretionary sandstones, and it must be kept in mind, on the surface. Although it appears improbable, the possibility of the specimen drifting down to this level cannot be overlooked, since MATTHEW thought his specimens came from the higher level.

There is much to suggest that the chalicotheres were part of the Martin Canyon local fauna found in the concretionary sandstones: the probability

27. *Calippus* sp.? was based on one of 17 specimens catalogued under No. 3736 in the University of Kansas Museum of Natural History. Some of the remaining 16 teeth in lot No. 3736 and part of a collection of much larger teeth catalogued under No. 3738 in this Museum were referred to *Nannippus* sp.? by HESSE (1936, p. 64). Inasmuch as the remaining 16 teeth in No. 3736 are also referable to *Calippus* sp.?, I think that at least part of the discussion of *Nannippus* sp.? by HESSE refers to the species represented by *Calippus* sp.?.

that MATTHEW collected his material near Willow Spring where there are channel gravels older than those to which he assigned the specimens; and the mixed fauna of the gravels (as given by MATTHEW, 1901, p. 358) which suggests that he had the channels confused. The level from which the Pawnee Butte specimen was collected cannot be determined.

Unfortunately, chalicotheres are much too rare as individuals to allow conclusions based on their presence or absence in a fauna. However, the absence of chalicotheres from the lower Snake Creek fauna, which has many forms in common with the Pawnee Creek fauna, is suggestive that they occur in the Martin Canyon fauna but not the Pawnee Creek fauna in northeastern Colorado.

FAMILY TAPIRIDAE BURNETT, 1830

Tapiravus? sp.

Referred specimen.—AMNH no. 9367; upper jaw fragment with two premolars.

Mrs. RACHEL H. NICHOLS brought this specimen to my attention and supplied the following data: "A. M. no. 9367, labeled '*Tapir*', . . . found at Davis' Ranch, Weld Co., Colo., in Pawnee Creek beds, by Loomis, 1901." Presumably it is the same specimen referred to by MATTHEW (1901, p. 445) as *Tapiravus*(?). FRICK (1926, p. 106) reported that a specimen of *Tapirus* had been collected in the Pawnee Buttes area in 1922 from beds containing *Merycodus* and *Merychippus*. This specimen seems to be lost, but these reports indicate that Miocene tapirids were present in northeastern Colorado.

FAMILY RHINOCEROTIDAE OWEN, 1845

Diceratherium? persistens (OSBORN)

Caenopus persistens OSBORN, 1904a, p. 318.
Diceratherium? persistens, WOOD, H. E., 1927, p. 72.

Type.—AMNH No. 9081; middle (p. 318), or upper (p. 326) Miocene of northeastern Colorado (OSBORN, 1904a).

American Museum records state that the specimen was collected in 1898 from the Loup Fork beds, Pawnee Creek, Colorado. However, the catalogue number and the year of collection indicate that the locality would probably be either the Martin Canyon or Sand Canyon area in Logan County.

This specimen has been discussed by WOOD (1927, p. 72) and MATTHEW (1932, p. 418), but neither author offers a satisfactory taxonomic allocation of the type specimen. WOOD thought that the specimen was a female dicerathere, but specifically indeterminate. MATTHEW thought the skull characters too primitive to fall into any of the genera *Aphelops, Peraceras,* or *Teleoceras,* but "might be compared with '*Diceratherium*' *palaeosinense* of the Chinese Pliocene, which is not *Diceratherium* but not readily referable to any described genus." WOOD considered the age of the specimen to be middle Miocene, whereas MATTHEW gave the age as upper Miocene. The age may have influenced the thinking of each author.

Aphelops profectus (MATTHEW)

Aceratherium profectum MATTHEW, 1899, p. 71.
Aphelops profectus, MATTHEW, 1901, p. 358.

Type.—AMNH No. 9082; Loup Fork of northeastern Colorado.

American Museum records state that this specimen was obtained from "horizon D," Martin Canyon [NE¼ sec. 27, T. 11 N., R. 53 W., Logan County].

Aphelops profectus is known only by the one lower jaw. Possibly our material from Martin Canyon that is listed under *Aphelops* sp. belongs to this species.

Aphelops megalodus (COPE)

Aceratherium megalodus COPE, 1873, p. 1.
Aphelops megalodus, COPE, 1873, p. 1.

Type.—AMNH No. 8292; Pawnee Buttes, Colorado (*fide* OSBORN, 1904).

This specimen probably came from the Eubanks local fauna in the Pawnee Creek formation, but the vertical range of the species is unknown. STIRTON (1936, p. 190) thought that possibly this species belonged to the "upper Pawnee Creek fauna" of northeastern Colorado. MATTHEW (1924, p. 150) tentatively listed it in the Sheep Creek fauna and more certainly in the *M. paniensis* zone of the lower Snake Creek fauna. He considered *Aphelops megalodus* to be more primitive than the Pliocene species. More recently HENSHAW (1942, p. 95) stated that *A. megalodus* was more primitive than the late Miocene rhinoceroses of the Tonapah fauna. Although the species may have survived into the latest Miocene or early Pliocene, an earlier age for the form seems more probable.

Aphelops spp.

Referred specimens.—Pawnee Creek formation (Martin Canyon local fauna): No. 9376; right dM^3; NE¼ sec. 27, T. 11 N., R. 53 W., Logan County.

Pawnee Creek formation (Eubanks local fauna): No. 9250; left P_3. No. 9812; paroccipital and exoccipital bone. No. 9813; astragalus. All three specimens from Pawnee Buttes ash layer, NE¼ sec. 1, T. 10 N., R. 59 W., Weld County.

Pawnee Creek formation (Vim-Peetz local fauna): No. 7734; damaged left tibia; NE¼ sec. 27, T. 11 N., R. 53 W., Logan County. No. 9799; cuneiform; W½ sec. 29, T. 12 N., R. 55 W., Logan County.

No. 9376 agrees in size and shape with the corresponding milk tooth figured by MATTHEW (1918, p. 206, fig. 13) from the Snake Creek beds. This specimen, and other rhinocerotid fragments from the Martin Canyon fauna, seem advanced in comparison with *Diceratherium.*

The premolar from Pawnee Buttes is 49.5 mm. long and 27.7 mm. wide.

The tibia from the Vim-Peetz local fauna belonged to an individual that perhaps exceeded *Aphelops mutilus* in size.

Teleoceras medicornutus OSBORN

Teleoceras medicornutus OSBORN, 1904a, p. 319.

Type.—AMNH No. 9832; OSBORN gave the locality of the type specimen as 25 miles north of Pawnee Buttes. There does not seem to be any evidence in the American Museum records for any locality other than 15 feet above the base of the Loup Fork, 15 miles northeast of Grover, Weld County, Colorado.

MATTHEW (1932, p. 418) thought that *Aphelops planiceps* OSBORN (1904a, p. 321), from northeastern Colorado, probably was synonymous with this species.

Teleoceras spp.

Referred specimens.—Pawnee Creek formation (Vim-Peetz local fauna): No. 9795; right radius. No. 9796; left humerus. No. 9797; left nasal bone. Above specimens from W½ sec. 29, T. 12 N., R. 55 W., Logan County. No. 9389; nasal bones; NE¼ sec. 27, T. 11 N., R. 53 W., Logan County.

Except for their smaller size, Nos. 9795-9797 resemble the respective structures in *Teleoceras fossiger.*

No. 9389, consisting only of the blunt, fused nasal bones with a well-developed callosity, most closely fits the nasals of *Teleoceras medicornutus.* The assignment of this specimen to the Vim-Peetz local fauna must be tentative for the present. It was found by Dr. ROBERT WILSON on the surface of "horizon D" beds a few feet above the University of Kansas Quarry A. The topography of the area seemingly precludes deriving the specimen from younger beds by drifting; therefore, its presence on "horizon D" beds cannot be explained unless it was carried in by human agency.[28]

ORDER ARTIODACTYLA OWEN, 1848

FAMILY TAYASSUIDAE PALMER, 1897

Tayassuid sp.

Referred specimens.—Pawnee Creek formation (Martin Canyon local fauna): No. 9325; canine. No. 9347; fragment of upper molar. NE¼ sec. 27, T. 11 N., R. 53 W., Logan County.

These specimens and some unprepared material indicate that a peccary as small as *Perchoerus* was present in Quarry A.

FAMILY MERYCOIDODONTIDAE THORPE, 1923

The post-Oligocene oreodonts from northeastern Colorado have been discussed recently by SCHULTZ & FALKENBACH (1940, 1941, 1947). These authors reidentified the material collected by earlier workers with but little change other than to assign specimens regarded by MATTHEW (1901, p. 412) as pertaining to "*Merycochoerus rusticus*" to *Ustatochoerus medius* (LEIDY).

Ustatochoerus medius (LEIDY)

Merychyus medius LEIDY, 1858, p. 26.

Ustatochoerus medius, SCHULTZ & FALKENBACH, 1941, p. 23.

Referred specimens.—Pawnee Creek formation (Kennesaw local fauna): No. 9809; palate and lower jaws; SW¼ sec. 26, T. 12 N., R. 55 W., Logan County.

Pawnee Creek formation (Vim-Peetz local fauna): No. 9186; skull, jaws, atlas, and axis; W½ sec. 28, T. 12 N., R. 55 W., Logan County.

Isolated teeth and fragments of bone, probably referable to this species, are not uncommon in the basal 50 feet of the Pawnee Creek formation west of Sand Canyon, Logan County, but good specimens are rare.

Ustatochoerus? schrammi SCHULTZ & FALKENBACH

Ustatochoerus? schrammi SCHULTZ & FALKENBACH, 1941, p. 49.

SCHULTZ & FALKENBACH (1941, p. 50) have referred specimens from the "basal part of the Ogallala deposits (lower Valentine)," Pawnee Creek area, Weld County [29] to this species.

Ustatochoerus sp.

Referred specimen.—Pawnee Creek formation (Eubanks local fauna): No. 9814; left P_2; NE¼ sec. 1, T. 10 N., R. 59 W., Weld County.

Merycochoerus proprius magnus (LOOMIS)

Merycochoerus magnus LOOMIS, 1924, p. 28.

Merycochoerus proprius magnus, SCHULTZ & FALKENBACH, 1940, p. 286.

Referred specimens.—Pawnee Creek formation (Martin Canyon local fauna): No. 9206; right lower jaw with teeth. No. 9363; muzzle of skull with canines and anterior premolars. No. 9392; damaged skull and mandible. Specimens from NE¼ sec. 27, T. 11 N., R. 53 W., Logan County. No. 9213; left P_2, M_2, M^3, and right M_2. No. 9214; fragments of left M^3. No. 9276; right P_3 and M_3. Last three specimens from sec. 22, T. 11 N., R. 52 W., Logan County.

In addition to the well-known *Merycochoerus proprius magnus* slab (AMNH No. 8968) from the lowest Miocene exposures at Martin Canyon, there are several specimens (AMNH Nos. 9051-9053, 9055, 9057-9058, and 9064) from the nodular silts (horizon D of MATTHEW) above the beds containing No. 8968. These specimens were assigned by MATTHEW (1901, p. 401) to *Merycochoerus proprius.* Later (1909, p. 115) he listed the *Merycochoerus* of northeastern Colorado as *M.* cf. *M.*

28. All doubt concerning the age of this specimen was dispelled with the discovery of a nearly complete skull and some limb bones of a teleocerine in Quarry A in the summer of 1952. The nasal bones of the newly discovered skull are similar in all respects to the nasals found by WILSON. Therefore, Teleocerine sp. should be added to the Martin Canyon local fauna.

29. The authors state Logan County, but this is evidently a *lapsus.*

proprius. To just which specimens (or all?) MATTHEW was referring at this time is unknown. SCHULTZ & FALKENBACH referred AMNH No. 9052 to *Merycochoerus p. magnus* but did not commit themselves on the remaining specimens. From the same locality and level as AMNH Nos. 9051-9064, several specimens have been collected in recent years, of which the three best are listed above. No. 9206, a lower jaw, was examined by Mr. CHARLES FALKENBACH and considered to be close to *Merycochoerus matthewi* LOOMIS (personal communication). Mr. FALKENBACH pointed out, however, that the assignment of lower jaws to species of *Merycochoerus* was a precarious practice subject to error (at this time the other specimens had not been prepared). No. 9363 also agrees in size and description with *Merycochoerus matthewi*, but No. 9392 has the size and appearance of *M. p. magnus*. The specimens were collected from the immediate vicinity of the University of Kansas Quarry A and stratigraphically within a few feet of each other. It is questionable whether Nos. 9206 and 9363 represent anything more than sexual or individual variants of *Merycochoerus p. magnus*.

Merychyus elegans LEIDY

Merychyus elegans LEIDY, 1858, p. 25.

Referred specimens.—Pawnee Creek formation (Martin Canyon local fauna): No. 9207; mandible. No. 9312; left M^2, and right M_1-M_3. No. 9313; left M^2. All from NE¼ sec. 27, T. 11 N., R. 53 W., Logan County. No. 9378; left P_4; sec. 22, T. 11 N., R. 52 W., Logan County.

For the most part, the specimens collected by the American Museum party of 1898 were subsequently discussed by MATTHEW (1901, p. 418), LOOMIS (1924, p. 34), COLBERT (1943, p. 303), and SCHULTZ & FALKENBACH (1947, p. 202). Insofar as I can determine, the University of Kansas specimens from Martin Canyon came from the same beds as the specimens collected by the American Museum party.

SCHULTZ & FALKENBACH (1947, p. 202) referred AMNH Nos. 9442-9444 from Pawnee Buttes, Weld County to *Merychyus elegans*. They also tentatively referred a specimen from Weld County to the subspecies *M. elegans bluei*.

FAMILY CAMELIDAE GRAY, 1821

Camelid specimens were collected from most of the Miocene localities in northeastern Colorado, but none of the fragments were sufficiently complete to permit specific identification or, with few exceptions, even generic identification. No. 9248, fragments of foot bones, from the Pawnee Buttes volcanic ash layer in the NE¼ sec. 1, T. 10 N., R 59 W., Weld County, probably belongs either to *Protolabis heterodontus* or to *Protolabis angustidens*.

Protolabis fissidens (COPE)

Procamelus fissidens COPE, 1876, p. 145.
Protolabis fissidens, MATTHEW, 1924, p. 190.

Type.—AMNH No. 8297; Pawnee Creek beds, northeastern Colorado (*fide* MATTHEW, 1901).

Protolabis heterodontus (COPE)

Procamelus heterodontus COPE, 1873d, p. 420.
Protolabis heterodontus, COPE, 1876, p. 145.

Type.—AMNH No. 8296; Pawnee Creek beds, near Pawnee Buttes, Weld County, Colorado (*fide* COPE & MATTHEW, 1915).

Protolabis angustidens (COPE)

Procamelus angustidens COPE, 1874, p. 20.
Protolabis angustidens, MATTHEW, 1899, p. 74.

Type.—AMNH No. 8294; Pawnee Creek beds near Pawnee Buttes, Weld County, Colorado (*fide* COPE & MATTHEW, 1915).

Protolabis longiceps MATTHEW

Protolabis longiceps MATTHEW, 1909, p. 115.

Type.—AMNH No. 9108; Pawnee Creek beds (horizon D), Cedar Creek, northeastern Colorado.

The record of occurrence of this type specimen in "horizon D" refers to MATTHEW's "horizon D" at Sand Canyon, Logan County, and indicates that the specimen is probably late Barstovian in age.

Alticamelus leptocolon MATTHEW

Alticamelus leptocolon MATTHEW, 1909, p. 115.

Type.—AMNH No. 9116; brown Miocene sandstone, Sand Canyon, Cedar Creek, Colorado.

In the designation of the type of this species MATTHEW (1909, p. 115) referred to specimens discussed (1901, pp. 427-428) as *Procamelus robustus*, and including AMNH Nos. 9112, 9112a, 9114, 9116, 9117. Later (1924, p. 187) MATTHEW stated that the type was No. 9115. Dr. G. G. SIMPSON and Mrs. RACHEL NICHOLS kindly investigated this problem for me and found that MATTHEW (1924, p. 187) had described the material numbered AMNH 9116, but used the number 9115. The use of number 9115 was a typographical error, and the correct number for the type is 9116.

Alticamelus giraffinus MATTHEW

Alticamelus giraffinus MATTHEW, in MATTHEW & COOK, 1909, p. 402.

Type.—AMNH No. 9109; Pawnee Creek formation; SW¼ sec. 25, T. 12 N., R. 55 W., Sand Canyon, Logan County, Colorado.

Referred specimens.—Pawnee Creek formation (Vim-Peetz local fauna): Nos. 9793-9794; ulna and distal end of radius; W½ sec. 29, T. 12 N., R. 55 W., Logan County.

Originally, MATTHEW (1901, p. 430) referred the type specimen to *Alticamelus altus*. This specimen was found by H. T. MARTIN. MARTIN later pointed

out the site to CURTIS HESSE, who subsequently gave the locality information to Dr. ROBERT WILSON.

The referred material is assigned to this species because of its size.

FAMILY CERVIDAE GRAY, 1821

Little identifiable cervid material was found in the Pawnee Creek formation. Recovered teeth are generally comparable to specimens from the Sheep Creek beds.

Blastomeryx gemmifer (COPE)

Merycodus gemmifer COPE, 1874, p. 22.
Blastomeryx gemmifer, COPE, 1877, p. 350.

Type. — AMNH No. 8301; Pawnee Creek fauna (*fide* MATTHEW, 1924).

Blastomeryx cf. B. elegans MATTHEW & COOK

Referred specimen. — Pawnee Creek formation (Martin Canyon local fauna): Univ. Colorado Mus. No. 19837; right P^4-M^3. Nos. 9209, 9318, 9319, 9346; isolated upper molars. All specimens from NE¼ sec. 27, T. 11 N., R. 53 W., Logan County.

Isolated teeth of this form and of *Blastomeryx* cf. *B. medius* were numerous in the University of Kansas Quarry A at Martin Canyon.

Blastomeryx cf. B. medius MATTHEW

Referred specimen. — Pawnee Creek formation (Martin Canyon local fauna): No. 9316; left jaw with P_4-M_3; NE¼ sec. 27, T. 11 N., R. 53 W., Logan County.

Barbouromeryx pawniensis FRICK

Barbouromeryx pawniensis FRICK, 1937, p. 133.

Type.—F:AM No. 31290; two miles west of Mastodon Quarry, Pawnee Creek, Weld County, Colorado.

Dromomeryx pawniensis FRICK

Dromomeryx pawniensis FRICK, 1937, p. 115.

Type.—F:AM No. 31297; near Pawnee Buttes, Pawnee Creek, Weld County, Colorado.

The *Dromomeryx borealis* of the Pawnee Creek fauna (MATTHEW, 1924, p. 72) was referred to this species by FRICK.

Cranioceras pawniensis FRICK

Cranioceras pawniensis FRICK, 1937, p. 93.

Type.—F:AM No. 31294; middle horizon, west of Buttes, Pawnee Creek, Colorado.

FAMILY ANTILOCAPRIDAE GRAY, 1866

No merycodonts other than *Ramoceros osborni* were reported by MATTHEW from northeastern Colorado, and nothing identifiable, other than this same species, has been found by any University of Kansas party in beds of the Pawnee Creek formation.

Merycodus furcatus (LEIDY)

Cosoryx furcatus LEIDY, 1869, p. 173.
Merycodus furcatus, HAY, 1902, p. 683.

Meryceros warreni (LEIDY)

Cervus warreni LEIDY, 1858, p. 23.
Meryceros warreni, FRICK, 1937, p. 354.

Meryceros minor FRICK

Meryceros minor FRICK, 1937, p. 403.

FRICK (1937) has reported the above three species from northeastern Colorado. He gives no indication of the age of the beds except to state that they were late Tertiary.

Ramoceros osborni (MATTHEW)

Merycodus osborni MATTHEW, 1904, p. 107.
Ramoceros osborni, FRICK, 1937, p. 328.

Type. — AMNH No. 9476; middle Miocene (Pawnee Creek beds), northeastern Colorado.

Referred specimen. — Pawnee Creek formation (Vim-Peetz local fauna): No. 9183; left horn; W½ sec. 28, T. 12 N., R. 55 W., Logan County.

No. 9183 was removed from indurated, coarse, channel sandstone approximately 10 feet above the base of the Pawnee Creek formation.

THE PLIOCENE FAUNA

One early Clarendonian species of mammal is known from northeastern Colorado. Possibly some of the species assigned to the Barstovian faunas have a range in time extending into the Clarendonian, but until the Sand Canyon local fauna (*i. e., Neohipparion coloradense*) is associated with a definite set of beds, little can be done about this problem.

The Kimball member of the Ogallala formation in northeastern Colorado has not yielded any fossil material.

CLASS MAMMALIA

ORDER PERISSODACTYLA OWEN, 1848

FAMILY EQUIDAE GRAY, 1821

Neohipparion coloradense (OSBORN)

Hipparion coloradense OSBORN, 1918, p. 183.
Neohipparion coloradense, HESSE, 1936, p. 62.

Type. — AMNH No. 9094; upper Pawnee Creek beds, Sand Canyon, Logan County, Colorado.

Attention has already been given to the problem of the locality and level of this specimen in the discussion of the Sand Canyon local fauna.

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