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Equus (Asinus) Calobatus Troxell and Associated Vertebrates from the Pleistocene of Kansas

CLAUDE W. HIBBARD
Museum of Paleontology, University of Michigan
Ann Arbor, Michigan

INTRODUCTION AND ACKNOWLEDGEMENTS

At the Arkalon gravel pit on the south side of the Cimarron River in the W. ½ sec. 35, T. 33 S., R. 32 W., in Seward County, Kansas, approximately 120 feet of Pliocene and Pleistocene beds have been exposed by a short deep canyon that has cut headward toward the valley wall. The development of this canyon exposed Pleistocene sands and gravels along its east side which were extensively worked at the time this region was settled. The sands and gravels were hauled from the pits by a narrow gauge railroad to the Arkalon Station on the Rock Island Railroad, a distance of about 1½ miles to the west.

These exposures were first shown to me by Mr. Lee Larrabee of Liberal, Kansas, in the summer of 1936. Prior to this date numerous fossils had been removed during excavations for the sand and gravel. Some of the fossils were at the old Larrabee ranch at Arkalon, where they were kept by Mr. Larrabee's sister in a show case in an old store building. Some of these specimens were later donated to the Kansas University Museum of Natural History. In 1936, the deep canyon and its tributaries were filled with tumble weed, Russian thistle and blow dirt as were many of the pits developed by the removal of gravel. It was impossible to study much of the geological section or to do intensive collecting in the area until 1942. Since that time Hibbard and his field parties have visited the exposures nearly every summer to collect vertebrate remains exposed in the Pleistocene deposits. The mammal remains recovered from this area are here reported.

I am greatly indebted to the following persons for the loan of specimens used in this study: Dr. Joseph T. Gregory, Peabody Museum of Natural History, Yale University; Dr. A. K. Miller, Department of Geology, State University of Iowa; and Dr. Robert W. Wilson, Museum of Natural History, Kansas University. Financial support for the Research Assistantship held by Thomas M. Oelrich was provided by the Board of Governors of the Horace H. Rackham School of Graduate Studies of the University of Michigan. The illustrations were made possible by the financial support accorded to me by the Faculty Research Fund of the University of Michi-

gan. The photographs were made by Oelrich and the drawings by Jane S. Mengel.

DISCUSSION OF OUTCROP AREA

A geological section was measured beginning in the bed of the Cimarron River so as to determine the height of the "High Terrace" above the river level.

W. ½ sec. 35, T. 33 S., R. 32 W., Seward County, Kansas

	Thickness feet
Pleistocene	
11. Top soil (slope obscured by blow dirt and dune sand)	
10. Sandy silt, reddish, with nodules of caliche	6.00
9. High terrace sand and gravel; pebbles range up to more than 12 inches in largest diameter, and scoriaceous basalt. (Unconformity at base)	13.00
Crooked Creek Formation	
8. Silty ash; silt, sandy with lenses of clay, gray to light tan (fossils)	35.00
7. Sand and gravel. Stump Arroyo member?	11.00
Disconformity	
6. Sand, coarse to fine. Grading to fine sand at top. Cemented sand and gravel locally near base, weathers gray. Deeply channeled into underlying beds. Meade Gravels member?	11.00
Unconformity	
Pliocene	
Rexroad Formation	
5. Clay, blue gray with caliche, lower 18 inches sandy clay mottled with lime. Grades upward from blue gray to yellowish brown at top	12.75
4. Cemented, massive, fine sand and gravel, weathers gray to a light rust color	2.80
3. Silt, sandy, local lenses of blue gray clay, grading upward into coarse sandy silt	3.50
2. Sand, fine to coarse gravel, light tan, 6 to 18 inches, cemented zone locally near top	27.50
1. Covered interval	22.00
Bed of Cimarron River	
Total	144.55

The beds exposed in this area present a number of problems. Approximately 1½ miles to the north, on the north side of the Cimarron River, Smith (1940, p. 62) recovered a rhinoceros tusk from deposits of Pliocene age.

The Pliocene beds on the south side of the river at the site of the Arkalon gravel pit appear to have been more deeply channeled by the Pleistocene streams than those on the north side. No typical exposure of the Meade or Crooked Creek formations appears in the measured section.

Small tributaries have worked headward from the west side of the deep canyon and have exposed two horizons of sand and gravel which appear to be equivalent, in part, to the Meade and Crooked Creek formations.

Hibbard (1944, p. 743) stated that, "The ash at this locality is considered to have been deposited in running water. A stream of considerable size." At the time of the study of the Pearlette ash in the summer of 1942, a white lens of pure ash was observed in the face of the gravel pit on the east side of the canyon. The ash occurred in bed No. 7 of the measured section. Bed No. 7 grades upward from fine sand into the sandy silt in bed No. 8, which contains considerable silty ash. Whether the ash observed in the sand was part of the initial fall or was later reworked is not known.

Leonard (1950, p. 7, locality No. 37; and p. 41) reported on the invertebrates taken at this locality. Leonard's locality No. 37 is bed No. 8 of the measured section. He states, "At this place the deposition of the fossil mollusks is unusual, since they occur in the upper few feet of the Pearlette volcanic ash deposit, which is, however, more or less contaminated with silt."

Hibbard (1944, pp. 742–743) discussed the accumulation of the Pearlette ash deposits. From further study in the field, it is evident that almost immediately after the ash fall the ash was washed from the surrounding areas into basins or into streams. In many of the basins, soon after the deposition of the pure ash, the run off from the surrounding areas carried both silt and ash into some of the basins and streams. These silty waters in some cases may have been further mixed with the ash already deposited by wave action in shallow lakes. Due to the occurrence of the pure ash in the sand at the Arkalon gravel pit I believe that the silty ash above the sand was reworked, in part, by the stream carrying the sediments.

The study of the molluscan fauna by Leonard (1950) shows that the fauna is the same from below the base of the ash as above the ash in the silty ash horizon.

The silty ash deposit at the Arkalon ash pit may represent the closing phase of the deposition of the ash. This same phase of deposition appears to be represented at the Gate ash pit where an extensive zone of silty reworked ash containing abundant mollusks overlies approximately 35 feet of nearly pure Pearlette ash (Rinker and Hibbard, 1952). A locality was shown to me by Dr. Stuart L. Schoff in the summer of 1951, in NW. ¼ sec. 1, T. 5 N., R. 27 E.C.M., Beaver County, Oklahoma. This exposure is unique in the fact that the blue gray silt below the ash, the pure ash, and a silty horizon above the ash contain abundant shells of mollusks. Vertebrate fossils were observed in both the pure ash and silty ash along

with the abundant remains of mollusks. This is the only locality I know of where a statistical study could be made of the mollusks at a given locality from all three horizons.

The type of deposition at these two localities in Beaver County, Oklahoma, with extensive deposits of silty ash containing abundant mollusks above the pure ash, seem to indicate that the deposit at the Arkalon pit may have been laid down at approximately the same time.

The vertebrate fossils reported in this paper were taken from the clay underlying the silty ash, or from the silty ash, bed No. 8, of the measured section, with the exception of two specimens. One specimen, *Equus cumminsii* Cope, reported by Hibbard (1944, p. 716) which was donated to the University of Kansas Museum of Natural History and was reported as coming from bed No. 7 of the measured section. This specimen is discussed under *Equus (Asinus) calobatus* Troxell. The other specimen, teeth of an elephant, was taken at this locality in the summer of 1951, from terrace gravels which are younger than the Pearlette ash and are channeled through the older Pleistocene deposits and into the underlying Pliocene deposits. Hibbard (1949, p. 73) referred to fossils taken at the Arkalon gravel pit from the clay below the ash as occurring in sec. 21, T. 33 S., R. 32 W., Seward County, Kansas. This was an error and should have read sec. 35, T. 33 S., R. 32 W.

AGE OF THE VERTEBRATES

The vertebrates taken from the clay below the silty ash and from the silty ash came from unit No. 8 of the measured section. These deposits are part of the Crooked Creek formation (Hibbard, 1949) and are considered as slightly younger than the Cudahy fauna (Hibbard, 1944) which was recovered from the base of the Pearlette ash and the underlying silts. Hibbard (1944, p. 742) stated, "it seems evident that the Cudahy, Tobin and Wilson Valley faunas lived in western Kansas near the close of a glacial stage." Moore, *et al* (1951, p. 14) stated, "A fall of petrographically distinct ash occurred in latest Kansan time."

These vertebrates and invertebrates associated with the Pearlette ash member can be tentatively assigned to the latest Kansan, provided there were only four major continental glaciations during the Pleistocene.

On the basis of the above dating of the Pearlette ash by Moore, *et al* (1951), the terrace deposits along the Cimarron River can be rather closely dated. Hibbard (1948, p. 595) stated, "This caliche horizon marks the top of the high plains surface in this area. *** It is in this surface of deposition and distribution that the Cimarron River has cut its channel and developed its valley and terraces." "This caliche horizon" refers to the caliche above the Pearlette ash member in the Crooked Creek formation.

Hibbard (1941) described the Borchers interglacial fauna which was taken above the Pearlette ash and below the caliche horizon. On the basis of the tentative correlation the Borchers fauna would be Yarmouth in age. Therefore, the "High Terrace" along the Cimarron River is no older than latest Yarmouth and/or early Illinoian age.

At the site of the Arkalon gravel pit the "High Terrace" cobbles occur 125 feet above the present stream bed along the valley slope near the upland surface. The early Cimarron River entrenched itself rapidly to a depth of 70 feet during Illinoian? time. This entrenchment cut through the early Pleistocene deposits and into the Pliocene at the site of the Arkalon gravel pit. This rapid development and entrenchment of the Cimarron River was not due entirely to a change in climatic conditions but appears to be correlated with a decided Rocky Mountain uplift in the area to the west. McLaughlin (1946, p. 36) noted the relatively recent age of the Cimarron River and its terraces for he said, "During late Pleistocene and/or Recent time the high terrace deposits of the Cimarron River were laid down, the valley was deepened nearly to its present level, and the alluvium was deposited."

VERTEBRATA

A systematic description is given of the mammalian remains taken in the area of the Arkalon gravel pit.

Class Mammalia
Order Rodentia
Family Castoridae
Castoroides sp.

A RM^3, U.M.M.P. No. 29072, of the giant beaver was picked up on the surface where it had weathered out of the silty ash. The height of the tooth is 39.5 mm. The anteroposterior length of the occlusal crown is 16.0 mm. The greatest width of the occlusal surface is 12.5 mm.

Order Carnivora
Family Canidae
Canis sp.

During the summer of 1951, a nearly complete skeleton, U.M.M.P. No. 29068, lacking skull and lower jaws, of a canid was removed from the silty ash. The humerus, femur and other elements are the length of those of a large *Canis latrans* Say. The bones are heavy and nearly as large in diameter as those of *Canis lupus* Linné.

Family Felidae
Felis or *Panthera* sp.

A right radius, U.M.M.P. No. 26965, of a cat larger than the cougar

was removed from a sandy lens in the silty ash. The distal end of the bone is missing. It is nearly straight and is a radius of a true cat. No skeleton of the jaguar was available for comparison.

Order Proboscidea
Family Elephantidae
Mammuthus haroldcooki (Hay)
Fig. 1A, B and C

Elephas haroldcooki Hay. 1928. Proc. Colo. Mus. Nat Hist. p. 33.

A badly weathered and shattered skull and lower jaws of this mammoth were found in place in the silty ash. The two lower second molars and the two upper second molars are nearly complete. One complete unerupted third molar and part of another were recovered. All teeth are catalogued under U.M.M.P. No. 29070.

The teeth possess broad ridge plates which are separated by broad dentine tracts. The enamel of the teeth is thick and slightly crenulated. The enamel of the LM_2 varies from 3.0 to 3.5 mm. in thickness. The anteroposterior length of 3 ridge plates which are separated by 2 dentine tracts is 60.0 mm. Measured along the lingual side there are 4 enamel plates and 3.7 dentine tracts in 100.0 mm. The greatest transverse width of the enamel plates of this tooth is 83.0 mm. The RM_2 has 9 ridge plates. The tooth is approximately 64.0 mm. wide at the anterior end. The greatest width, 83.0 mm., is across the fourth ridge plate counting from the posterior edge of the tooth. Posteriorly from this plate the tooth becomes narrower. The outstanding character of the sceond molars is that the dentine tract is as wide or wider than the enamel plates which it separates. The outer end of the loop of the enamel plate is turned forward on both the RM_2 and LM_2, while in the upper second molars the inner end of the enamel plate turns strongly to the posterior.

There is a lozenge-shaped expansion at the middle of each ridge plate in both the lower and upper second molars, as reported by Hay and Cook (1930). It is due to this character that the specimen is assigned to the species *M. haroldcooki* instead of *M. hayi* (Barbour). The symphisial region of the lower jaws was missing.

This is the earliest known elephant from Kansas, and is more primitive than specimen No. 15-007 of *Mammuthus imperator* (Leidy) in the collection of the State University of Iowa, taken from the gravels of the Peyton pit, at Pisgah, Harrison County, Iowa; for comparison, see O. P. Hay (1914, pp. 425–426, pl. 67).

Mammuthus cf. *imperator* (Leidy)

In the summer of 1951, at the time the teeth of *M. haroldcooki* were taken, part of a skull of a large old male elephant (mammoth) was collected. This skull fragment was found in the terrace sand and gravel which had been channeled into and through the beds containing *Mammuthus haroldcooki*. The right and left upper third molars were recovered.

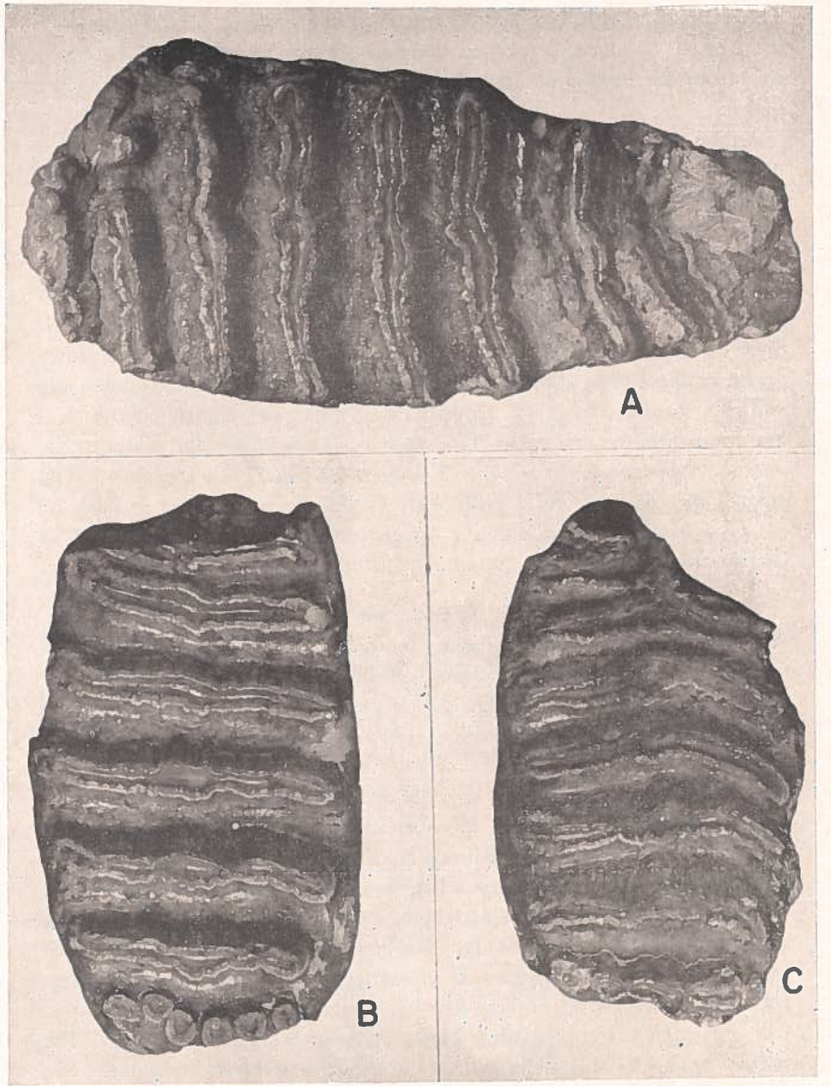

Fig. 1. A, B and C, Mammuthus haroldcooki (Hay), U.M.M.P. No. 29070.
A, right M_2; anterior end at left. X approx. 0.56.
B, left M_2. C, left M^2. Both approx. 0.46.

The teeth, U.M.M.P. No. 29049, appear intermediate in character between those of *M. haroldcooki* taken at the same locality and those of *M. imperator* from the Peyton pit in Iowa, based on the character of the enamel plates.

The grinding surface of left M^3 consists of 8 ridge plates and a posterior row of small round enamel conelets. The surface of RM^3 consists of 7 ridge plates and the posterior row of conelets. The anteroposterior grinding surface of LM^3 is 178.0 mm. The greatest width is 91.0 mm. across the sixth ridge plate (enamel fold, or double plates of some authors) from the posterior end of the tooth. There are 5 ridge plates in 100.0 mm. In the specimen from Iowa, my measurements agree with those of Hay in that there are 5½ ridge plates in 100.0 mm. In the Iowa specimen there is an abnormal ridge plate that divides on the lingual side and is Y-shaped, giving 6½ ridge plates if measured slightly off the midline toward the lingual side. The enamel forming the ridge plates in the Arkalon specimen is thicker than the enamel of the Iowa specimen. The enamel loop does not curve posteriorly in the upper molars as in those of *M. haroldcooki.* If the tentative correlation with the glaciated region is correct, this specimen, No. 29049, is of Illinoian age.

Order Perissodactyla
Family Equidae
Equus (Asinus) calobatus Troxell
Figs. 2A, B and C

Equus (Asinus) calobatus Troxell. 1915. Am. Jour. Sci., Vol. 39, No. 234, pp. 619–622.

Three metatarsals of this horse have been taken at the vicinity of the Arkalon gravel pit. The first specimen taken was a right metatarsal, No. 6842, Kansas University Museum of Natural History. This specimen was taken from the silty ash. It has a length of 330.0 mm. In the summer of 1950, a left metatarsal, U.M.M.P. No. 26963 (fig. 2A), was taken at a slightly lower level, from the clay, that has a length of 337.0 mm. In the summer of 1951, part of a tibia, in association with the tarsal elements, splint bones, metatarsal, and the first two phalanges, U.M.M.P. No. 29071, were taken from the silty ash. This metatarsal is 335.0 mm. long. The greatest width of the metatarsal at the proximal end is 53.0 mm. The width of the distal end is 40.0 mm. The length of the first phalange is 87.0 mm. The width of the proximal end is 41.5 mm., and the width of the distal end is 43.0 mm. The length of the second phalange is 45.0 mm. The width of the proximal end is 38.0 mm., and the width of the distal end is 36.5 mm.

Troxell (1915) considered the isolated cannon bones of the long

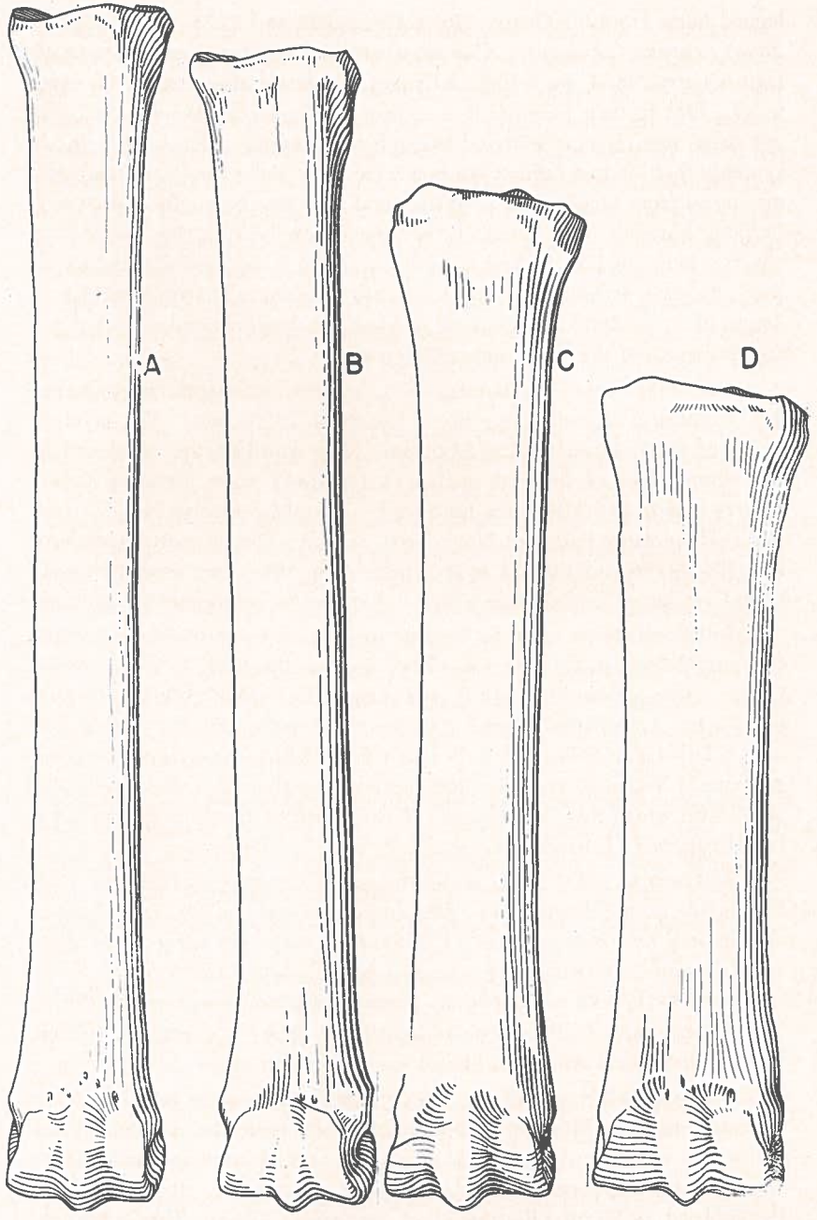

Fig. 2. A, B and C, Equus (Asinus) calobatus Troxell. A, left metatarsal, U.M.M.P. No. 26936. B, right metatarsal, Troxell's type, now designated as the lectotype, Peabody Museum, Yale University, No. 13470. C, right metacarpal, Troxell's type, P.M.Y.U. No. 13470, now designated as one of the cotypes. D, Equus (Equus) scotti Gidley, U.M.M.P. 24378, right metacarpal. All X ½.

legged horse from his Quarry No. 1 (Nos. 208 and 212) as the type of *Equus (Asinus) calobatus*. Associated with the metatarsal and metacarpal from Quarry No. 1 are 6 first phalanges which are also part of the type series. Due to their presence it is evident that at least two individuals, if not more, had remains scattered through the diggings. Since there is no evidence that the two cannon bones are from the same specimen, the right metatarsal from Quarry No. 1 (quarry and accession Nos. 208 and 3196) Peabody Museum, Yale University specimen, now bearing the No. 13470, which is No. 1 of Fig. 4 (Troxell, 1915, p. 618) is designated as the lectotype (fig. 2B) of *Equus (Asinus) calobatus* Troxell. The specimen has a length of 322.0 mm. The greatest width at the proximal end is 45.5 mm., and the width of the distal end is 43.0 mm.

The cotype, No. 13470, (fig. 2C), a right metacarpal from Quarry No. 1 (Nos. 212 and 3196) has a length of 283.0 mm. The greatest width of the proximal end is 53.0 mm. The width of the distal end is 45.5 mm. Two of the first phalanges (cotypes) from the Rock Creek Quarry appear to be from the hind foot. They bear Quarry Nos. 72 and 306. The greatest length of No. 72 is 91.0 mm. That of quarry specimen No. 306 (3196 and 13470) is 86.5 mm. The other four phalanges (cotypes) are longer and slightly wider and appear to belong to the forefoot.

In the collection made by Troxell are two lower premolars or molars that may belong to this species. They are not the teeth of *Equus scotti* Gidley. One, probably a right P_3 or P_4 from Quarry No. 1 (Nos. 406 and 3196), has a V-shaped groove separating the metaconid and metastylid; also, a left molar (Nos. 328 and 3196) from which the cement is eroded possesses a V-shaped groove. Both teeth are smaller than those of *Equus scotti* with which they were found. Lower teeth of *Equus scotti* possess a broad flattened U-shaped groove.

McGrew (1944, p. 61), under the valid characters of *Plesippus* (the North American Zebra), states, "Metaconid-Metastylid.—*Round, internally convex, and separated by a sharp V-shaped groove in the zebras; more flattened, concave internally, and separated by a U-shaped valley in the caballines.* *** It does not, however, permit distinction between the Zebras and African asses." It may be added that it does not permit distinction between the North American Pleistocene zebras and asses.

Hibbard (1944, p. 716, fig. 2A) reported a left lower jaw, No. 6021 Kansas University Museum of Natural History, from the Arkalon gravel pit, which was donated by Mr. Lee Larrabee and reported as coming from the sand and gravel below the clay and silty ash horizon. It was reported by Hibbard as *Equus (Plesippus)* cf. *cumminsii* Cope. This specimen, due to its small size and V-shaped grooves between the metaconid and metastylid, was referred to *cumminsii*. Intensive collecting in the area has revealed two teeth, apparently P_4 and M_1, in part of a right ramus, U.M.M.P. No. 29052, from the sand and gravel; and a left P^2 and a right and left M^3, U.M.M.P. No. 29063, which are badly worn, and which were taken from the clay above the sand and gravel. These teeth are like those reported as *Equus (P.) cumminsii*. All of these are from a medium sized horse. The lower teeth possess a V-shaped groove. So far only two types of horse limb bones have been taken at the exposure; also, only two types of horse teeth. From all evidence at hand the medium sized lower premolars and molars with the V-shaped groove belong to *Equus (Asinus) calobatus*. If Troxell was correct in assigning the limb bones of *calobatus* to the subgenus *Asinus*, it would be expected that it would possess tooth characters of *Asinus*.

If one is correct in considering these medium sized premolars and molars with the V-shaped groove between the metaconid and metastylid which were found with the limb bones of *Equus (Asinus) calobatus* as belonging to *E. (A.) calobatus*, then the separation of *Equus (Plesippus)* and *Equus (Asinus)* becomes a problem in areas of isolated finds. I have always found *Nannippus* and *Plesippus* associated in Kansas. I have never found the remains of *Equus (Equus)* with either of them. *Equus (Asinus) calobatus*, with identification based on the character of the cannon bones, has been found associated with *Equus (Equus)* in Kansas and Texas. It is also probable that some of the medium sized horse teeth from Iowa, which were considered by Hay (1914) as the teeth of *Equus laurentius* Hay, are those of *E. calobatus*.

Equus (A.) calobatus is a questionable name because the upper dentition is unknown. Cope (1893, p. 80, pl. 23, figs. 2 and 3) described *Equus semiplicatus* from Tule Canyon, Briscoe County, Texas. It is possible that the medium sized molar, described by Cope, belongs to the same species later described by Troxell, based on the cannon bones.

Equus (Equus) scotti Gidley

Figs. 2D; 3A, B and C

Equus scotti Gidley. 1900. Am. Mus. Nat. Hist., Bull. Vol. 13, Art. 13, pp. 111–116, 5 figs.

A number of isolated bones, teeth and parts of lower jaws of this large horse have been taken in the area of the Arkalon gravel pit from the clay and silty ash, unit No. 8 of the measured section.

In the Kansas University Museum of Natural History is a series of associated RP^3–M^3, No. 6498 KU, (fig. 3B) of this large horse; these teeth were collected by George C. Rinker. The teeth are from an adult

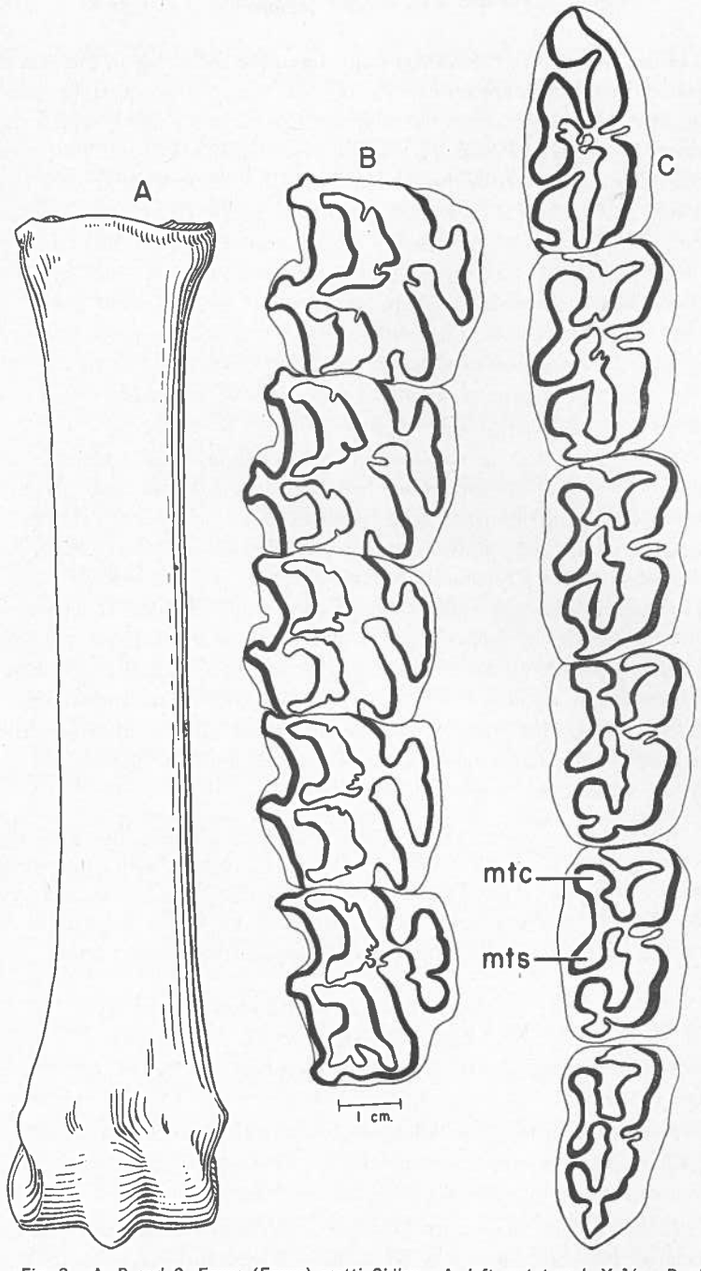

Fig. 3. A, B and C, Equus (Equus) scotti Gidley. A, left metatarsal. X ½. B, right P^3–M^3, University of Kansas Museum, No. 6498. X approximately 0.87. C, right P_2–M_3, U.M.M.P. No. 29069. X approximately 0.87. Abbreviations: mtc, metaconid; mts, metastylid.

horse. They have well developed roots. The height of the crown of RM^1 above the roots is 40.0 mm.

Measurement of teeth in millimeters (KUMNH No. 6498)

P^3,	anteroposterior length of crown, enamel measurements	33.0
	transverse width of crown	34.0
	length of protocone	16.0
P^4,	anteroposterior length of crown	31.5
	transverse width of crown	33.5
	length of protocone	18.2
M^1,	anteroposterior length of crown	27.5
	transverse width of crown	30.5
	length of protocone	15.2
M^2,	anteroposterior length of crown	30.0
	transverse width of crown	30.0
	length of protocone	17.5
M^3,	anteroposterior length of crown	33.5
	transverse width of crown	27.5
	length of protocone	17.4

Another series of upper teeth (KUMNH No. 6878) of this horse was taken in McPherson County, Kansas (Hibbard, 1952, p. 12, fig. 14B). These teeth are from a younger individual.

In the University of Michigan Museum of Paleontology are parts of associated lower rami of a colt with DP_2–DP_4, No. 24386. The anteroposterior length of the premolars is 115.5 mm.; depth of ramus below DP_2 is 44.0 mm. There is part of a left ramus of an adult horse, U.M.M.P. No. 26961, with P_2–M_3. The anteroposterior length of occlusal surface of P_2–M_3 is 189.0 mm. Depth of ramus between P_2 and P_3 is 92.0 mm. (all measurements on labial side). Depth of ramus between P_4 and M_1 is 108.0 mm. Depth of ramus at posterior border of M_3 is 138.0 mm.

Specimen U.M.M.P. No. 29069, is a pair of associated right and left jaws of a young adult horse (fig. 3C). The anteroposterior occlusal length of P_2–M_3 is 194.0 mm. I_3 has just erupted. The depth of the ramus between P_2 and P_3 is 104.5 mm. Depth of ramus between P_4 and M_1 is 119.0 mm. Depth of ramus at posterior border of M_3 is 141.5 mm. Length of diastema from C–P_2 is 88.0 mm.

Another jaw of this horse, U.M.M.P. No. 26962, is that of a young individual. It contains DP_2–DP_4, M_1; and M_2 which is just erupting. All of these specimens were taken from the silty ash.

A number of tarsal and carpal elements and a few metatarsals and metacarpals were found in the same deposit.

Measurements of metatarsal, U.M.M.P. No. 24384, (fig. 3A) are given for comparison with that of *Equus (A.) calobatus* with which it was found. The length is 286.0 mm. The greatest width of the proximal

end is 55.5 mm. The greatest width of the distal end is 56.0 mm. The length of metacarpal, U.M.M.P. No. 24378, (fig. 2D) is 230.0 mm. The greatest width of the proximal end is 56.0 mm. The greatest width of the distal end is 55.5 mm. A first phalange, No. 26981, has the following measurements: the length is 89.0 mm.; the greatest width of the proximal end is 62.0 mm.; the greatest width of the distal end is 48.0 mm.

Troxell (1915, p. 617) made the following statement regarding *Equus (E.) scotti*, "*E. scotti* was a ponderous animal, a form not suited to rapid movements but one probably living in a region surrounded by luxuriant vegetation with plenty of food and water and close in its habits to the mammoth and ground-sloth with which it may have been associated."

Troxell, p. 621, makes the following statement in regard to *E. (A.) calobatus*, "In spite of the fact that the 'speed index' generally indicates a cursorial adaptation, it is quite probable that the slenderness and elongation have gone too far in this fossil type for the best speed development."

In all probability *E. (A.) calobatus* was an inhabitant of the upland region and came only into the valleys and lowlands for water.

Order Artiodactyla
Family Camelidae

Two types of camel metapodials have been recovered from the clay below the silty ash, and from the silty ash.

Part of a right ramus, No. 27541, of an immature individual with DP_3 and DP_4 was taken from the silty ash. M_1 is just beginning to erupt. The anteroposterior occlusal length of DP_3 is 17.0 mm., that of DP_4 is 57.0 mm.

CORRELATION WITH OTHER VERTEBRATE HORIZONS

Two major problems arise in North America in the correlation of Pleistocene vertebrates from a given horizon with those from a given horizon at another locality. First, the deposits are discontinuous. Second, the vertical and horizontal ranges of genera, subgenera and species of vertebrates are unknown for the Pleistocene. Furthermore, an attempted correlation of deposits in the non-glaciated region with those in the glaciated region is especially open to question, since it has not been possible to prove which non-glacial deposits in the High Plains region are equivalent to the Nebraskan, Aftonian, Kansan, Yarmouth, Illinoian and Sangamon stages.

Probable correlation with vertebrate horizons in the non-glaciated region

The Meade formation, the oldest Pleistocene formation in the High Plains region, has yielded but few vertebrate fossils. Remains of *Equus (Plesippus), Nannippus, Stegomastodon mirificus* (Leidy) and camels have been taken from the basal sands of this formation. No remains of *Equus (Equus)* have been recognized from the Meade formation.

The remains of *Equus (Plesippus), Nannippus* and *Stegomastodon mirificus* have been taken from the Stump Arroyo member of the Crooked Creek formation which overlies the Meade formation (Hibbard, 1951). In the typical exposures of the Stump Arroyo sand and gravel no remains of *Mammuthus* or *Equus (Equus)* have been recovered. It is probable that the Stump Arroyo member was deposited during pre-Kansan, early and middle Kansan time. There is a definite break in the fauna in the Crooked Creek formation in southwestern Kansas. It is unknown how much of the apparent break is due to accidental collecting or the failure of specimens to occur as fossils. At some time between the deposition of the basal part of the Stump Arroyo sand and gravel and the time of the deposition of the silt below the Pearlette ash, it appears that *Plesippus* and *Nannippus* as well as *Stegomastodon* became extinct in that area or shifted their range southward at the onset of the peak of glaciation never to return. It appears that as the climate moderated the area was reinvaded from the south by *Equus (Asinus), Equus (Equus)* and *Mammuthus,* the elephant. If the fauna in the silty ash, at the Arkalon ash pit, is equivalent in age to the fauna below the Pearlette ash, as considered by Leonard (1950), and the ash fall occurred in latest Kansan (Moore, *et al*, 1951), then it can be postulated that *Mammuthus* arrived in North America at the very close of Aftonian time or at the very beginning of Kansan time to move southward by population spread in front of the accumulating ice. There is no evidence that these early mammoths were adjusted to as severe a climate as the "Woolly" mammoth was or the Jefferson mammoth. It may be that *Mammuthus haroldcooki* is ancestral to *M. imperator.*

On the basis of the vertebrate fossils known from the Crooked Creek formation, and their apparent stratigraphic occurrence, it appears that the vertebrates from the silty ash at the Arkalon gravel pit are equivalent in age to some of the vertebrates from the Holloman gravel pit at Frederick, Oklahoma, and to those from Rock Creek, Texas.

Meade (1950, p. 1485) reported the presence of *Gigantocamelus, Stegomastodon* and *Hippotigris (=Plesippus)*, associated with the remains of the mammoth and *Equus*, at the Holloman gravel-pit deposits at Frederick, Oklahoma. Meade considers *Gigantocamelus, Stegomastodon* and *Hippotigris* as short-range genera characteristic of the Blanco (Nebraskan). He considers faunas of Kansan age as being characterized, in part,

by the presence of the mammoth and *Equus* and by the absence of the above three genera which he considers characteristic of the Blanco.

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