Number 328 of the collection at the State University of Iowa is a left lower molar which appears to belong to *Equus complicatus*. It, too, was collected in the Cox pit, by Shimek.

In the collection is found a large second lower premolar of the right side which had not yet come into use; so that what in a worn tooth appear as dentine areas are here rounded cusps covered with enamel and a little cement. The specimen was discovered in the Cox pit, at Missouri Valley. It has the catalogue number 120. Views are here presented of both faces of the tooth (Pl. XIV, figs. 1, 2). The height of the tooth is 68 mm.; the length, 41 mm.; the width, 15 mm. The tooth had probably not reached its full height. Naturally, in the unworn condition of the tooth the details of the foldings of the enamel cannot be made out. Nevertheless, the size of the tooth indicates that it belongs to none of the known extinct horses, unless it be *Equus complicatus* or possibly *Equus scotti*.

Tooth No. 118, from Cox pit, Missouri Valley, is a right upper tooth, perhaps the fourth premolar, of an old horse. It was referred by Calvin (Bull. Geol. Soc. Amer., Vol. XX, p. 345, pl. xviii, fig. 6) to *Equus scotti*. The height of the tooth was given as 38 mm.; the length of the grinding face, 32 mm.; the width as the same. As in other cases, Calvin included the cement and measured on the extreme outer border. As determined by the present writer, the dimensions are: Height, 38 mm.; length, 29.8 mm.; width, 32 mm.; protocone, 15.5 mm. (Pl. X, fig. 6).

The most remarkable feature about the tooth is the excessive folding of the enamel. This affects not only the lakes but likewise to some extent the walls of the post-protoconal valley. The foldings of the enamel can best be understood from the drawing (Fig. 65). One is reminded of the teeth of Cope's *Equus fraternus pectinatus* (Jour. Acad. Nat. Sci. Phila., Ser. 2, Vol. XI, pp. 255, 257) found in Port Kennedy cave, Pennsylvania. A figure of the type specimen has been given by Gidley (Bull. Amer. Mus. Nat. Hist., Vol. XIV, p. 135, fig. 23), who recognized it as a distinct species. The present tooth differs from it in having a much broader protocone; although this character may not be distinctive. For the present the writer

prefers to regard the tooth as having belonged to an individual of *Equus complicatus* which possessed teeth with unusually strongly crimped enamel.

The specimen bearing the number 282 presents the outer half of the crown of an upper true molar of the left side. It was found in the Elliott pit, Turin, Monona county. The tooth had only just begun to be worn. The height is 90 mm.; the length, 32 mm. at the summit; 29 mm. at half the height. The lakes are both preserved. There is a good deal of folding in the enamel around the lakes. There appears to be no reason for refusing to refer the tooth to *Equus complicatus*.

In the collection are three teeth which were found in the Whitman pit about five miles south of Rockport, Atchison county, Missouri. The locality is in section 22, township 64, range 41. It seems to be on Nishnabotna river.

No. 364 *a* is a right lower molar or premolar, probably the former, which had not yet been cut. The height is 80 mm.; the length, 34 mm.; the width, 18 mm. On account of its size it is referred to *Equus complicatus*, admitting, however, that it may belong to *Equus scotti*, if this should be found to be a distinct species.

A second tooth in the collection is numbered 364 *b*. It belonged to the right side of the lower jaw and is probably a premolar, the third or the fourth, probably the third. It was relatively little worn during life, but it has been rolled and polished after death. The height of the tooth is 98 mm.; the length, 34 mm.; the width, 16 mm. The adjacent ends of the two longitudinal valleys almost touch and of course exclude the outer inlet.

In lack of evidence to the contrary the tooth is referred to *Equus complicatus*.

A third tooth, bearing the number 364 *c*, is the last true molar of the left side of the lower jaw. The crown is curved so that the front border is convex, the hinder concave. The tooth had not been greatly worn. The height is 77 mm.; the length, 36 mm.; the width, in front, 14 mm. The outer inlet does not press itself between the longitudinal valleys. It is broad and

has a loop in its hinder border. The heel of the tooth, or the entostylid, is unusually thick and truncated behind, the thickness being 9 mm. In this respect it is quite different from the next tooth. It is referred to *Equus complicatus*.

No. 364 *d* is another lower left last molar, but more worn than the one just described. The height is 55 mm.; the length, 39 mm.; the width, 16 mm. The "heel" is thinner (6 mm.) than in the tooth just described and is more prolonged backward. The tooth is supposed to belong to *Equus complicatus*.

No. 227, of the Iowa University collection, is a much worn lower left molar or premolar. It was found at Turin, Monona county, in the Elliott pit. The crown has a height of only about 30 mm., but there were two strong roots developed, an anterior and a posterior. The latter is still present and with it the tooth has a height of 69 mm. The length of the grinding surface is 30 mm.; the width is 18 mm. The external inlet does not get in between the longitudinal valleys. The tooth is referred to *Equus complicatus*.

A tooth bearing the catalog number 242 *b* is an upper right third milk molar. It was found in the Elliott gravel pit near Turin, Monona county. It is worn so that the enamel is presented and this is of a simple character. The tooth is referred provisionally to *Equus complicatus*. In size it agrees closely with the corresponding tooth of a specimen in the American Museum of Natural History, found at Hay Springs, Nebraska, and having the field number 81. The height of the tooth numbered 242 is 30 mm.; the length, 35 mm.; the width, 26.5 mm.; the protocone, 11 mm.

From the same pit was obtained a lower right fourth milk molar to which has been given the catalog number 242 *a*. Its height is 30 mm.; the length, 39 mm.; the width, 13 mm. This tooth so closely resembles the corresponding tooth of the specimen from Tule Canyon, Texas (Fig. 56) and referred here to *Equus complicatus*, that the present tooth is regarded as belonging to this species. It will be seen that it is quite different from the last milk molar represented by figure 70 and which belonged to one of the five horses of *Equus scotti* found originally by Mr. Gidley. It is possible that these variations occur within the limits of one species, but this is yet to be determined.

Another tooth, No. 184, found in the Elliott pit is referred provisionally to *Equus complicatus*. It likewise is an upper right third milk molar; but it had not yet come into use. The height is 40 mm.; the length, taken along the middle of the tooth, 37 mm.; the width, 25 mm.; the protocone, 14 mm. In its unworn condition it is impossible to determine the arrangement of the enamel.

Under the number 181 there are in the collection parts of two lower teeth; both of the right side. They were found at North Riverside, near Sioux City, in the Anderson pit. One of these, 181 *a*, shows the external inlet pushed in between the adjacent ends of the two longitudinal valleys. It is a tooth slightly smaller than m_2, of No. 127 (Fig. 64), but it is here assigned provisionally to *Equus complicatus*.

The second specimen has a portion on the outer side of the hinder end broken away. This tooth is somewhat abnormal in having the protoconid reduced and not separated from the metaconid by an anterior inner inlet. The tooth appears to be a premolar. Another tooth with the hinder third of the crown missing has the outer inlet between the longitudinal valley. In its condition it is impracticable to determine the species.

A tooth numbered 119, from the Cox pit, at Missouri Valley, belonged to the right side of the upper jaw and is probably the first true molar. It is much worn. The height is about 45 mm.; the length, 30.2 mm.; the width, 31 mm.; the protocone, 16 mm. The enamel of the lakes shows little complication, a condition probably due to the nearness to the base of the crown. The pattern resembles closely that of the molars of the specimen numbered 220 (Fig. 60) and described on page 168. The tooth is referred provisionally to *Equus complicatus*.

From Prof. J. E. Marshall, of the Council Bluffs High School, the writer has received for examination some fossil horse teeth which had been found at Henton Station, Mills county, Iowa. One specimen is an upper left true molar, probably the second. It is pretty well worn down. The height is 55 mm.; the length, 29 mm.; the width, 30 mm. The enamel around the lakes is considerably folded. There appears to be no reason why this tooth should not be referred to *Equus complicatus*.

Another specimen is a part of the left ramus of the lower jaw, containing the second, third, and fourth premolars. These are worn down almost to the roots, and the enamel in the central parts of the teeth is much modified. The cement is very thick. The teeth are referred, with slight doubt, to *Equus complicatus*. Accompanying these teeth is a molar which belongs to *Equus laurentius* and it is mentioned more particularly under that species.

In 1891 (Eleventh Annual Rep. U. S. Geological Survey, p. 495) the late Dr. W J McGee reported the discovery of the tooth of a fossil horse which he regarded as *Equus complicatus*, in Delaware county, Iowa. On inquiry Doctor McGee informed the writer that the tooth was found lying on a knoll of Niagaran limestone, on which were only meager remains of drift materials. According to the latest map showing the distribution of drift sheets (Iowa Geol. Surv., Vol. XXI, pl. iii) this vicinity is covered with Iowan drift; but as both Iowan and Kansan had been mostly removed, the tooth may have been placed there before either sheet was laid down.

A left lower milk molar, the third in the series, including the one in front that is seldom developed, has the number 135. It was found in the Cox pit, at Missouri Valley. The length is 33 mm., the width 14 mm., the height only 15 mm. There appears to be no reason why it should not be referred to *Equus complicatus*.

Beyond the limits of Iowa, remains of this species have been found at Natchez, Mississippi; at Petite Anse, near New Iberia, in southern Louisiana; at Big Bone Lick, Kentucky; in Bond county, Illinois; and apparently at Hay Springs, Nebraska.

Remains, especially teeth, have been reported from many other localities, but for various reasons there is doubt about the identifications. Teeth found east of the Alleghany Mountains and resembling those of *Equus complicatus* are here referred somewhat arbitrarily to *Equus fraternus*. So far as our knowledge enables us to judge, *Equus complicatus* ranged from the western slopes of the Alleghanies to the region of the Great Plains.

As to the geological range of the species knowledge is as yet incomplete. Inasmuch as the Bond county, Illinois, specimen seems to have been found in a bog overlying Illinois drift, it is to be concluded that the species lived after the Illinoian stage. It is probably to be referred to the Sangamon. It seems probable that the specimens of *Equus complicatus* which have been found at Big Bone Lick, Kentucky, are likewise to be referred to the Sangamon.

Equus scotti Gidley.

This species was described by Mr. James W. Gidley in 1900 (Bull. Amer. Mus. Nat. Hist., Vol. XIII, pp. 111-116, figs. 1-5). In 1901 (Bull. Amer. Mus. Nat. Hist., Vol. XIV, pp. 103, 104, 134, 137, pl. xx, text-figs. 5, 6, 25, 26) it was further described and illustrated.

This species is better known, as regards its osteology, than any other of our fossil horses. At the head of Rock creek, in Briscoe county, Texas, Mr. Gidley discovered, in a compact deposit of Pleistocene sand, five skulls and numerous other bones, so that practically all parts of the skeleton are represented. Five of the skeletons belonged to young horses, but one skull, found at a later time, is that of an older individual. The specimens are in the American Museum of Natural History, in New York. This horse is stated by Mr. Gidley to differ from the domestic horse in having a skull larger relatively to the size of the body, the neck shorter, the body longer, the ribs of the belly region less curved near their heads, and the limbs shorter and slenderer. Figure 66 represents this horse, shown as mounted in the American Museum of Natural History.

Mr. Gidley compared the bones and teeth of this species with those of various skeletons of the domestic horse in the American Museum of Natural History, among them that of a large draught horse. The skull of the latter had nearly the same length as that of the type of *Equus scotti*. The series of dorso-lumbar vertebræ of the draught horse was about one inch longer than that of *E. scotti;* nevertheless, the neck of the latter was four inches shorter than that of the draught horse,

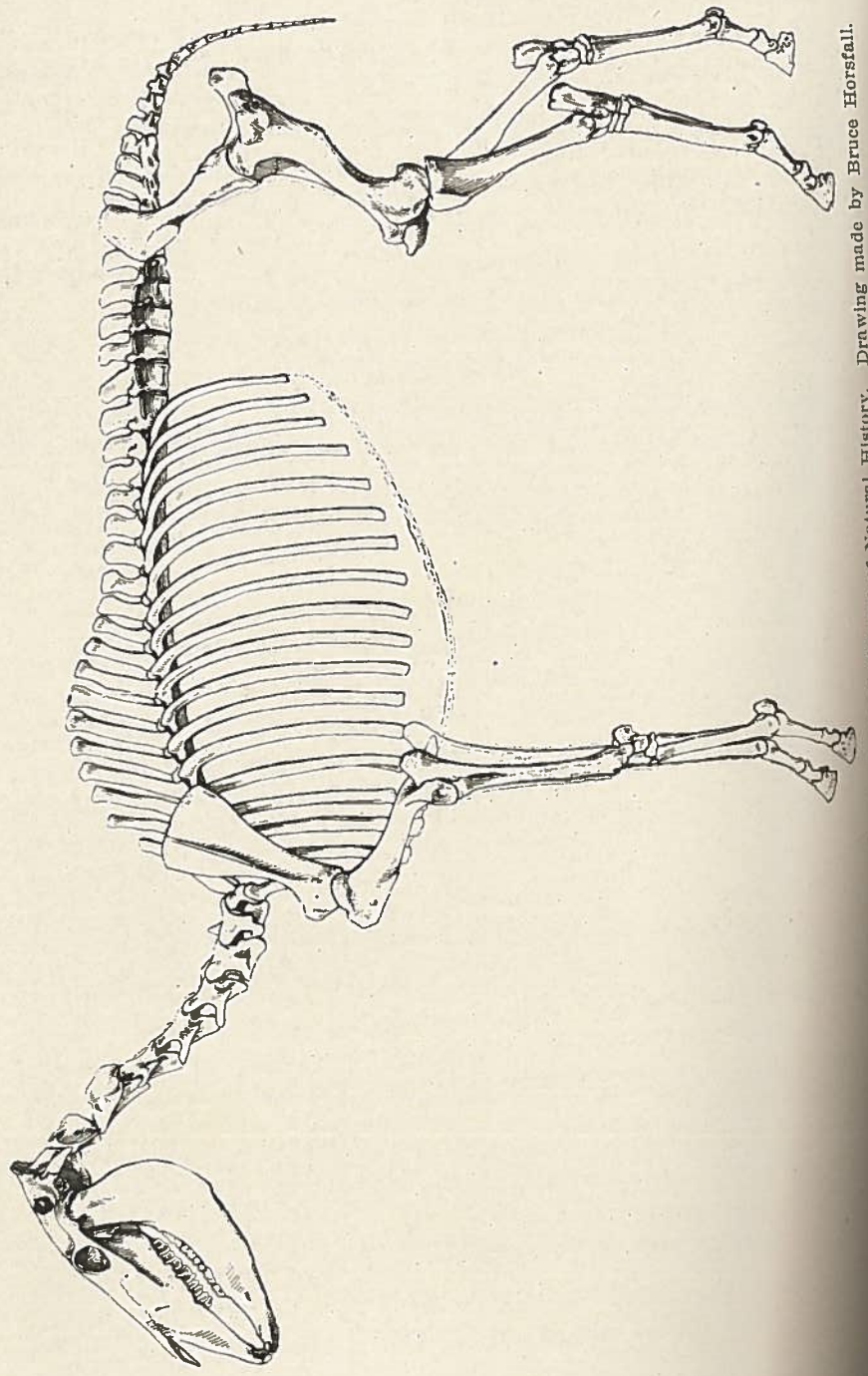

Fig. 68. *Equus scotti*. From skeleton mounted in American Museum of Natural History. Drawing made by Bruce Horsfall.

while the fore leg was about six inches shorter than that of the draught horse.

As may be seen from figure 67 the enamel of the teeth of the type of this species is, when compared with that of the domestic horse, hardly different in any essential respect. That surrounding the lakes appears to be somewhat less plicated than that of some domestic horses and more plicated than that of others. On the other hand, accurate measurements show that the teeth of *Equus scotti* are considerably larger than those of the domestic horse, larger than those of the large draught horse mentioned.

Fig. 67. *Equus scotti*. Grinding face of first left molar of type. X1.

The following measurements were made by Gidley on the type specimen of this species, No. 10606, of the American Museum of Natural History, and on the large draught horse, No. 528, of the same museum:

MEASUREMENTS OF TEETH.

		Equus scotti	Equus caballus
I^1	greater diameter	23mm.	18mm.
$Pm.^3$,	length of grinding face	33mm.	29mm.
	width of grinding face	31mm.	27mm.
$M.^1$	length of grinding face	32mm.	25mm.
	width of grinding face	30mm.	25.5mm.

The length of the premolar-molar series in the type of *E. scotti* is 190 mm.; in the large draught horse, 172 mm.

In further comparison with the domestic horse, Gidley found that the orbit of *E. scotti* is relatively nearer the hinder borders of the occipital condyles; the maxillary ridge extends further forward, reaching a point over the last premolar; the face is deeper over the anterior premolars; the occiput projects further backward, and is of a different shape; the basioccipital bone is not so compressed, and the fossa included between the paroccipital process and the condyle is much deeper; the posterior region of the skull, and the posterior nares and the palate are narrower; the lower jaw is much deeper and more massive in the dental region; and the symphysis is heavier and longer, than in *Equus caballus*.

Through the liberality of the American Museum of Natural History, the writer has been able to examine a considerable amount of the materials collected by Mr. Gidley. As a contribution to the knowledge of this species, the following measurements and notes are given regarding the more mature individual found by Mr. Gidley. The region about the occipital condyles is somewhat injured, so that the length of the skull cannot be exactly determined, and there are slight distortions at the orbits and in the palate, making the diameter of the orbit a little inexact; also the width at the orbits and the width of the palate at pm.^{2}, and the width of the nose. In the second column are measurements of the skull of No. 10609, being one of the five younger specimens. Mr. Gidley (Bull. Amer. Mus. Nat. Hist., Vol. XIV, p. 136, pl. xviii, fig. A) presented measurements of the upper teeth of No. 10628 and a figure of them.

MEASUREMENTS OF THE SKULL.

Dimensions Taken	No. 10628 mm.	No. 10609 mm.
From front of premaxillae to front of foramen magnum	570	545
From front of premaxillae to rear of glenoid fossa	508	---
From front of premaxillae to front of posterior nares	320	308
From front of premaxillae to front of pm.^{2}	167	166
From front of premaxillae to front of orbit	380	370
Width across mastoid processes	---	125
Width across hinder nares	45	50
Width across glenoid fossae	232	224
Width from outside to outside last molars	134	138
Width from outside to outside of outer incisors	85	85
Width between fronts of orbits, about	158±	173
Width of palate at last molars	75	82
Width of palate at pm.^{2}, about	52±	63
Distance across premaxillae at middle of nasal opening	83	71
Least width of space between i^3 and pm.^{2}	55	51
Distance between i^3 and pm.^{2}	117	109
Diameter of orbit fore and aft, about	70±	72
From front of lower jaw to rear of ascending ramus, about	455±	462
Length of symphysis of lower jaw	107	108
Height of lower jaw at front of m.$_1$	105	103
Height of lower jaw at front of pm.$_2$	75	72
Width of lower jaw at symphysis, least	---	50

The teeth are to be considered. All the incisors have deep cups. That of the outer incisor has a broad notch on the lingual, or inner, wall. The cups of the others are complete. The incisors are of large size. The following are the measurements taken. Of course, the diameters would vary according to the age of the animal.

MEASUREMENTS OF INCISORS.

Width of $i.^1$	20mm.	diameter at right angles to this	14mm.
Width of $i.^2$	21mm.	diameter at right angles to this	13mm.
Width of $i.^3$	23mm.	diameter at right angles to this	12mm.
Width of $i._1$	20mm.	diameter at right angles to this	20mm.
Width of $i._2$	20mm.	diameter at right angles to this	12mm.
Width of $i._3$	24mm.	diameter at right angles to this	12mm.

Figures 68 and 69 represent as accurately as possible the grinding teeth of the upper and of the lower jaws. It is recommended that the structure of these be compared with corresponding teeth that have been referred to *Equus complicatus*, especially with the type of the latter. The following are the dimensions of the upper and the lower rows of teeth and of the separate teeth:

MEASUREMENTS OF TEETH OF *EQUUS SCOTTI*.

Upper Teeth.

Length of premolar-molar series	202	mm.
Length of premolar series	111	mm.
Pm.^{2}, length	42	mm.
width	31	mm.
Pm.^{3}, length	35	mm.
width	33	mm.
protocone	14	mm.
Pm.^{4}, length	33	mm.
width	33	mm.
protocone	15	mm.
$M.^1$, length	30	mm.
width	30	mm.
protocone	14.5	mm.
$M.^2$, length	31	mm.
width	29	mm.
protocone	15	mm.
$M.^3$, length	30	mm.
width	25	mm.
protocone	16	mm.

Lower Teeth.

Length of premolar-molar series	203	mm.
Length of premolar series	106	mm.
Length of molar series	97	mm.

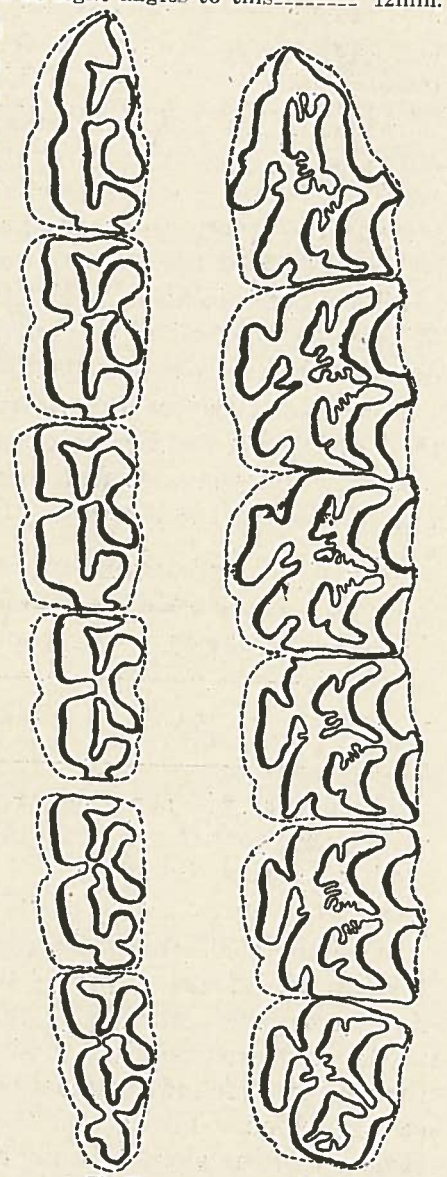

Fig. 68 Fig. 69

Figs. 68, 69. *Equus scotti*. Grinding faces of upper and lower cheek-teeth. X .733. No. 10628 American Museum Natural History.
68. View of the upper teeth.
69. View of the lower teeth.

Pm.$_2$,	length	37 mm.
	width	18 mm.
Pm.$_3$,	length	33 mm.
	width	17.5mm.
Pm.$_4$,	length	33 mm.
	width	18 mm.
M.$_1$,	length	29.5mm.
	width	17 mm.
M.$_2$,	length	31 mm.
	width	15 mm.
M.$_3$,	length	34 mm.
	width	15 mm.

As to the structure of the enamel of the upper teeth, it will be observed that the opposed borders of the two lakes in each tooth are much folded. In the anterior lake there is usually an M opposite the end of the post-protoconal valley. The latter does not lie wholly in the inner half of the tooth.

From No. 10608 of the American Museum of Natural History, one of the five horses originally found, the writer has secured the following description and figure (Fig. 70) of the third and fourth lower milk-molars of the right side:

MEASUREMENTS OF MILK TEETH.

Tooth	Length	Width
Dm.$_3$	36.5mm.	16 mm.
Dm.$_4$	35 mm.	14 mm.

The figures will show the arrangement of the enamel, and it will be seen that this is much more folded than that of the milk teeth of another horse found not far away (Fig. 56) and supposed to belong to *Equus complicatus* (p. 162).

With the skull above described, No. 10628, in the American Museum of Natural History, Mr. Gidley found the two hinder limbs complete. To add to the knowledge of the skeleton of this species, and possibly to aid in distinguishing other species from it, the following measurements are presented. In the second column are given the corresponding measurements from a trotting stallion in the collection of Mr. S. H. Chubb, of the American Museum of Natural History.

MEASUREMENTS OF SKELETON.

Bones Measured	Equus scotti No. 10628	E. caballus No. 74
Femur of left side—		
Total length	412 mm.	444 mm.
From top of head to inner condyle	375 mm.	390 mm.
From inner surface of head to outer face of bone	129 mm.	123 mm.
Fore-and-aft diameter at middle of length	51 mm.	54 mm.
Transverse diameter at middle of length	53 mm.	45 mm.
Fore-and-aft diameter at lower end	128 mm.	141 mm.
Width across articular surfaces at lower end	94 mm.	95 mm.
Tibia of left side—		
Total length of bone	370 mm.	392 mm.
Greatest width of upper end	107 mm.	108 mm.
Fore-and-aft diameter at middle of length	40 mm.	37 mm.
Transverse diameter at middle of length	49 mm.	43 mm.
Greatest width at lower end	93 mm.	86 mm.
Fore-and-aft thickness at middle of width of lower end	46 mm.	47 mm.
Tarsal bones—		
Total length of calcaneum	123 mm.	131 mm.
Depth of hinder process (tuber calcis)	49 mm.	46 mm.
Thickness of bone at front of the inner process	55 mm.	56 mm.
Greatest length of astragalus	67 mm.	70 mm.
Width of astragalar articulation for navicular	57 mm.	60 mm.
Metatarsal, median—		
Total length	285 mm.	290 mm.
Fore-and-aft diameter of upper end	46 mm.	47 mm.
Side-to-side diameter of upper end	58 mm.	53 mm.
Fore-and-aft diameter of lower end	35 mm.	44 mm.
Side-to-side diameter of lower end	40 mm.	55 mm.
Phalanges—		
Total length of first phalange	88 mm.	94 mm.
Greatest width of first phalange at upper end	63 mm.	62 mm.
Total length of second phalange	54 mm.	51 mm.
Greatest width of upper end of second phalange	86 mm.	78 mm.
Length of ungual phalange on front slope	64 mm.	60 mm.
Greatest width of ungual phalange	86 mm.	60 mm.

Measurements of the fore limbs of one of the younger individuals, No. 10609, of the American Museum of Natural History are here presented. The corresponding measurements of the trotting stallion already mentioned, are also given.

MEASUREMENTS OF SKELETON—Continued.

Bones Measured	Equus scotti No. 10609	Equus caballus No. 74
Scapula—		
Length along the spine	318 mm.	365 mm.
From rear of glenoid cavity to front of coracoid process	105 mm.	107 mm.
Diameter of neck, where least	66 mm.	68 mm.
Humerus—		
Total length	296 mm.	318 mm.
From top of head to inner condyle	286 mm.	310 mm.
Diameter, fore-and-aft, through head and greater tuberosity	110 mm.	117 mm.
Diameter side-to-side, through head and greater tuberosity	98 mm.	100 mm.
Fore-and-aft diameter of bone at middle of length	50 mm.	51 mm.
Side-to-side diameter of bone at middle of length	35 mm.	40 mm.
Fore-and-aft diameter of bone at inner side of lower end	95 mm.	97 mm.
Width of lower articulation	93 mm.	87 mm.
Radius—		
Total length	342 mm.	372 mm.
Side-to-side diameter near upper end	92 mm.	96 mm.
Fore-and-aft diameter near upper end	48 mm.	50 mm.
Fore-and-aft diameter at middle of length	30 mm.	31 mm.
Side-to-side diameter at middle of length	45 mm.	40 mm.
Greatest diameter near lower end	87 mm.	83 mm.
Side-to-side diameter of lower articulation	70 mm.	71 mm.
Metacarpal, median—		
Total length	236 mm.	252 mm.
Fore-and-aft diameter of upper articulation	35 mm.	34 mm.
Side-to-side diameter of upper articulation	57 mm.	55 mm.
Fore-and-aft diameter at middle of length	29 mm.	27 mm.
Side-to-side diameter at middle of length	38 mm.	36 mm.
Fore-and-aft diameter of lower end	40 mm.	42 mm.
Side-to-side diameter of lower end	54 mm.	53 mm.
Phalanges—		
Total length of first phalange	94 mm.	96 mm.
Width of upper end of first phalange	60 mm.	60 mm.
Width of upper end of second phalange	55 mm.	57 mm.
Width of lower end of second phalange	55 mm.	54 mm.

Equus excelsus Leidy.

This species is one of the horses that inhabited the region of the Great Plains, and it seems to have extended its range as far east as Iowa. For this reason it is here described as exactly as can be done in the present state of our knowledge of it. The type specimen, which is now in the U. S. National Museum, was found somewhere along Loup river, approximately at the center of the present state of Nebraska. The exact locality is not known; nor are the circumstances known under which it was found. The specimen was first briefly defined by Leidy in 1858 (Proc. Acad. Nat. Sci. Phila., p. 26); but it was not fully described and figured until 1869 (Jour. Acad.

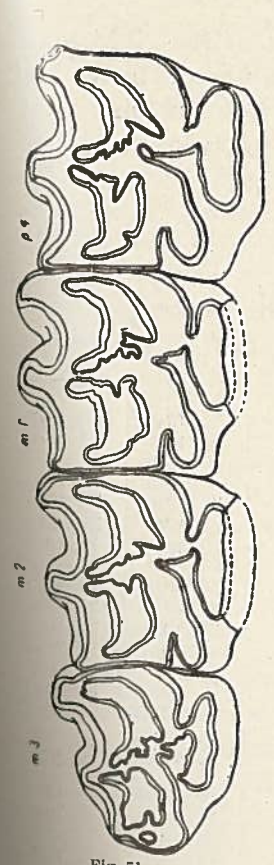

Fig. 71

Fig. 70

Fig. 72

Fig. 70. *Equus scotti.* Right third and fourth lower milk molars. Slightly less than natural size. No. 10608 American Museum Natural History.
Fig. 71. *Equus excelsus.* Last premolar and the three molars of the type. X1.
Fig. 72. *Equus excelsus.* Last premolar and the three molars of specimen 112 in American Museum Natural History. X1.

Nat. Sci. Phila., ser. 2, Vol. VII, p. 266, pl. xx, fig. 39; pl. xxi, fig. 31). However, the second and third true molars, represented by figure 39, of Leidy's plate XX, may in reality belong to some one of the other species which certainly inhabited that same re-

gion in Pleistocene times. Gidley (Bull. Amer. Mus. Nat. Hist., XIV, p. 114, fig. 9) presented a view of the grinding surface of the teeth which shows the details somewhat better than Leidy's figure, but the engraver has made the figure 4 mm. too short. There is presented here (Fig. 71) a reproduction of Gidley's figure brought to the size of nature.

The type specimen consists of a fragment of the right maxilla and a small part of the palatine bone, together with the last premolar and the three true molars. The teeth are only moderately worn, as may be seen from the following measurements.

MEASUREMENTS OF THE TYPE OF *EQUUS EXCELSUS*, AND OF ANOTHER SPECIMEN.

Parts Measured		Type	No. 112
Length of the molar series and the last premolar		107 mm.	113 mm.
Length of the molar series		78 mm.	84 mm.
Pm.⁴,	height	78 mm.	55 mm.
	length	28 mm.	29 mm.
	width	28 mm.	27.5mm.
	protocone	16 mm.	12.5mm.
M.¹,	height	66 mm.	58 mm.
	length	26 mm.	27 mm.
	width	28 mm.	26 mm.
	protocone	14.2mm.	13.5mm.
M.²,	height	77 mm.	53 mm.
	length	26 mm.	27 mm.
	width	25 mm.	25 mm.
	protocone	15.5mm.	13 mm.
M.³,	height	79 mm.	55 mm.
	length	28 mm.	29 mm.
	width	22 mm.	23 mm.
	protocone	14 mm.	15 mm.

These teeth are somewhat curved, so as to be convex on the outer face and concave on the inner, but somewhat less so than in the type of *Equus complicatus*. They are also slightly curved backward, so as to be convex on the anterior face. The anterior and median pillars of the outer faces are very prominent, so that between them is a very deep groove extending up and down on the tooth.

An examination of the enamel surrounding the lakes shows that it has a simple arrangement. The front border of each of the anterior lakes is without a notch, and the same is true of the hinder border of the posterior lakes, except there is a slight notch in that of the premolar and in that of the last molar. In the hinder border of the anterior lake of each tooth there is a deep notch opposite the head of the post-protoconal valley, followed further outward by some minute loops.

In the front face of the posterior lakes is a shallow notch. The post-protoconal valley is narrow, without a deep notch at its head, and, except for a prolongation at the head of the valley of the premolar, the valley is confined to the inner half of the tooth. It will be observed that the protocone is broad, occupying about six-tenths of the length of the grinding face.

As regards the characters shown by the bone present, it is seen that the maxillary ridge, running along on the outside above the lower edge of the jaw, extends forward about to the middle of the last premolar; slightly further than in the domestic and in the Arabian horse at hand. The post-palatine foramen is opposite the front half of the inner face of the second true molar, instead of being opposite the last molar, as seen in the domestic horse and the Arabian. The palatine bone in front of this foramen is about twice as thick as on the other horses mentioned.

Such are the characters presented by the type specimen. To what extent these will vary in different individuals can be determined with certainty only after much additional materials shall have been collected and studied.

In the American Museum of Natural History is a fragment of a right upper maxilla, which contains the same teeth as Leidy's type, the last premolar and the three molars. This specimen was found at Hay Springs, Nebraska, in 1893, by a party consisting of Messrs. Wortman, Peterson and Gidley. It bears the field number 112. The measurements of these teeth are given in the second column on page 188. Figure 72 represents the grinding surface of these teeth. It must be observed that these teeth, as shown by the reduced height, are more worn than those of the type. Hence, each one originally had

the grinding surface possibly slightly longer than it now is. In no case does the length or the breadth differ from the type by more than one millimeter. The protocones are, except in the case of the last molar, shorter than in the type. Two of the post-protoconal valleys have a little reëntrant fold at the head, and they are confined to the inner half of the tooth. The enamel which surrounds the various lakes is nearly as simple in its pattern as in the teeth of the type. The notch in the front border of the anterior lake of each is present, but very small; that in the hinder border of the posterior lake is absent or small. The lakes are not so broad as in the type and the front border does not sweep inward and backward with the same bold curve.

Notwithstanding these differences, the writer refers this specimen provisionally to *Equus excelsus*, and believes that additional materials will yet be found showing intermediate conditions. However, in referring specimens of teeth to this species one must take care not to depart far from the original. It is to be hoped that more complete skull materials will soon reveal to us the essential characters of the species.

No lower teeth are yet known which can with confidence be referred to this species.

TEETH FOUND IN IOWA AND REFERRED TO *EQUUS EXCELSUS*.

A tooth, numbered 125, (Fig. 73) from Missouri Valley, is here referred to *Equus excelsus*.

This tooth, apparently the first true molar of the right side, was found in the Cox pit at Missouri Valley. It was not figured by Calvin; but he gave its dimensions (Bull. Geol. Soc. Amer., Vol. XX, p. 345). In his measurements he included the enamel. The following measurements exclude this: Height, not including the root, 58 mm.; length, 30 mm.; width, 30 mm.; protocone, 15 mm. Calvin referred the specimen to *Equus scotti*. To the present writer it seems to belong rather to *Equus excelsus*. The dimensions are somewhat greater than of the corresponding tooth of the type. Excepting that the enamel on the hinder border of the anterior lake is slightly less folded than in the type, the pattern is the same.

The tooth having the catalog number 283 *b* (Fig. 74) was found at Turin, Monona county, in the Elliott pit. It belonged to the right side of the upper jaw and is apparently the first true molar. It was that of an old horse, the height of the crown

Fig. 73

Fig. 74

Figs. 73, 74. *Equus excelsus*. Upper molars. Slightly less than natural size.
73. Grinding surface of probably first upper right molar. No. 125 State University of Iowa.
74. Grinding surface of probably first upper right molar. No. 283 State University of Iowa.

being only 30 mm. The length of the grinding surface is 27 mm.; the width, 30 mm.; the protocone, 15 mm. In dimensions this tooth agrees closely with the first molar of *Equus excelsus*, and there appears to be nothing in the pattern of the enamel to exclude it from this species.

Equus niobrarensis Hay.

This species was described by the present writer in the Proceedings of the U. S. National Museum, Vol. XLIV, 1913, pp. 576-584, and illustrated on plates lxix-lxxi and by text figures 19-23. It is another of those horses which inhabited, during a part of Pleistocene times, the regions of the Great Plains. The type specimen is a nearly complete skull which is in the U. S. National Museum and which was found along Niobrara river, near Hay Springs, Nebraska, in 1886, by Prof. J. B. Hatcher. When found, this skull was in a broken condition, but it was afterwards reconstructed. The specimen has the catalog number 4999. Certain parts, indicated in the illustrations here presented (Plates XV, XVI) by lines ruled parallel, are missing, but the structure of the skull can be determined quite accurately. Other remains of the same horse have been collected at Hay Springs and the neighboring region for the United

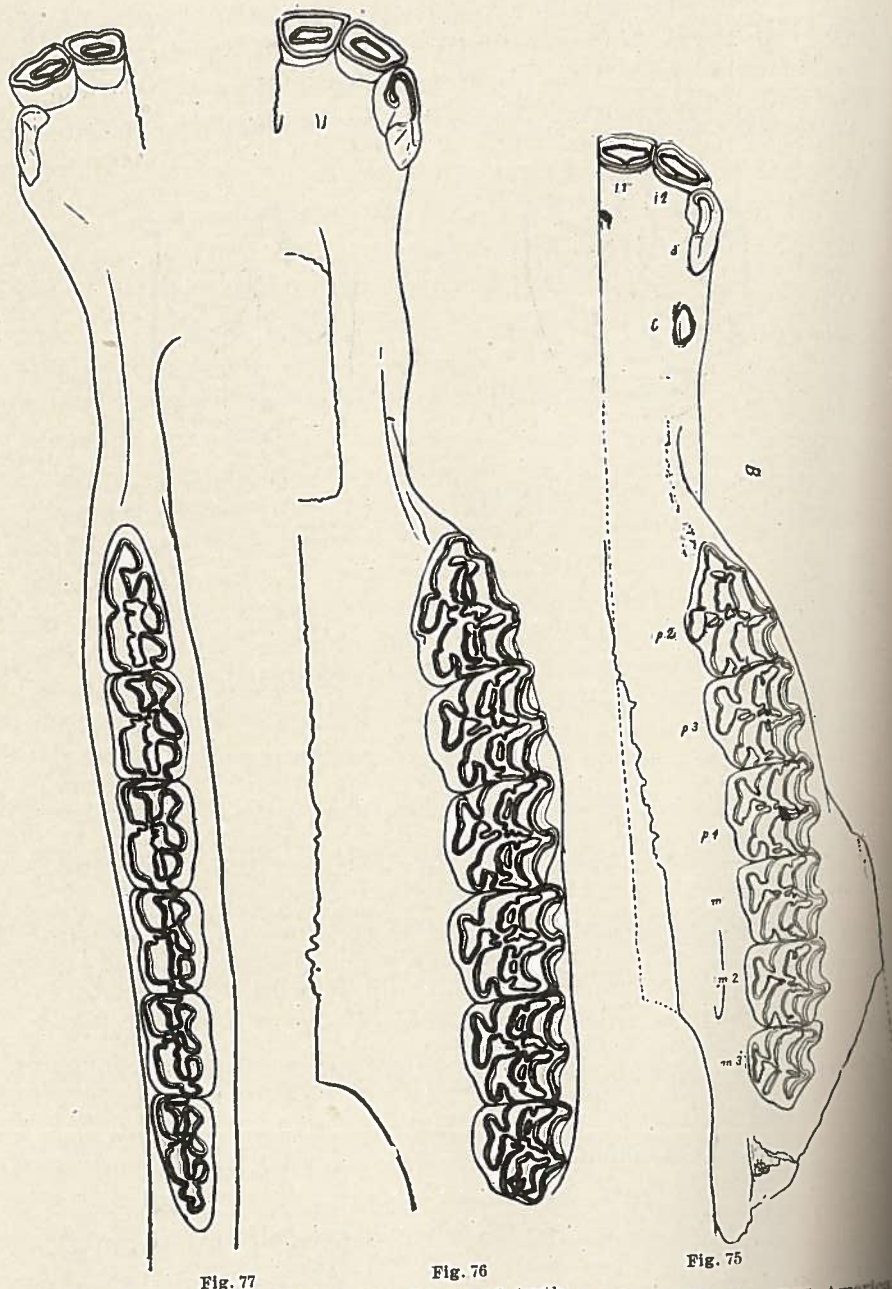

Fig. 77 Fig. 76 Fig. 75

Figs. 75-77. *Equus niobrarensis.* Jaws and teeth. X 2/5. No. 2725 American Museum of Natural History.
75. Maxilla, premaxilla and teeth of left side.
76. Left side of upper jaw of type, showing the teeth. X .49.
77. Left side of lower jaw of type, showing the teeth. X .49.

States National Museum, for Princeton University and for the American Museum of Natural History. Some of these materials were identified by Mr. Gidley (Bull. Amer. Mus. Nat. Hist., XIV, p. 132) as *Equus complicatus,* and the left side of the upper jaw of one specimen was figured (op. cit., pl. xviii, fig. B) under this name. Gidley's figure is here reproduced, but of only two-fifths the natural size (Fig. 75). In the same paper (p. 132, text-fig. 22) this writer figured and identified as *E. complicatus,* the left upper cheek-teeth of a specimen which he had found in the canyon of Tule creek, Swisher county, Texas. This specimen likewise seems to belong to *E. niobrarensis,* and it shows the range of the species in that direction.

While many bones of the skeleton belonging to two or three species of horses have been collected about Hay Springs, these have not been found, or at least recorded as being found, in such immediate association with teeth that they can be referred to their proper species. This is much to be regretted.

Below follow measurements taken from the type skull. In the second column are presented corresponding measurements taken on the skull of a domestic horse, No. 843, of the U. S. National Museum. The age of the latter seems to have been about six years, while the Niobrara horse appears to have been approximately a year younger. Inasmuch as No. 843 lacks the lower jaw, measurements of this bone have been supplied from No. 174960 of the U. S. National Museum, a large gelding, whose skull has a length of 610 mm. The upper row of cheek-teeth measure, however, the same as in No. 843.

MEASUREMENTS OF SKULLS.

Dimensions Taken	E. niobrarensis	E. caballus
From front of premaxillae to front of occipital foramen	530 mm.	550 mm.
From front of premaxillae to front of posterior nares	290 mm.	300 mm.
From front of premaxillae to rear of notch between nasal and premaxillae	200 mm.	196 mm.
From front of premaxillae to rear of occipital crest	582 mm.	602 mm.
From front of premaxillae to front of pm.[2]	133 mm.	143 mm.
From front of premaxillae to front of orbit	340 mm.	362 mm.
Width across mastoid processes	110 mm.	129 mm.
Width across hinder nares	47 mm.	55 mm.

MEASUREMENTS OF SKULLS—Concluded

Dimensions Taken	E. niobrarensis	E. caballus
Width across articulation for lower jaw	217 mm.	213 mm.
Width from outside to outside of last molars	123 mm.	127 mm.
Width from outside to outside of outer incisors	78 mm.	75 mm.
Width of skull on maxillary ridge at maxillo-malar suture	187 mm.	188 mm.
Distance between the rear of the orbits	240 mm.	220 mm.
Distance between the fronts of orbits	158 mm.	153 mm.
Width of palate at last molars	70 mm.	77 mm.
Width of palate at pm.[2]	50 mm.	53 mm.
Distance across premaxillae at middle of nasal opening	75 mm.	67 mm.
Least width of space between i.[3] and pm.[2]	45 mm.	45 mm.
Distance between i.[3] and pm.[2]	105 mm.	110 mm.
Diameter of orbit, fore-and-aft	84 mm.	70 mm.
From front of lower jaw to rear of ascending ramus	467 mm.	--
Length of symphysis of lower jaw	90 mm.	--
Height of jaw at front of m.[1]	96 mm.	--
Rear of i.[3] to front of pm.[2]	93 mm.	--

MEASUREMENTS OF THE TEETH.

Teeth		Upper Teeth		Lower Teeth	
		E. niobrarensis	E. caballus	E. niobrarensis	E. caballus
		mm.	mm.	mm.	mm.
Length molar-premolar series		179	185	180	187
Length premolar series		98	98.5	94	97
Length molar series		81	86	84	90
Height of crown of m.[2]		75	—		
Pm.[2],	length	38	40	35	36
	width	27	27	15	16
	protocone	10	10		
Pm.[3],	length	30	30	28	30
	width	28	29	16	17.5
	protocone	13.5	14		
Pm.[4],	length	29	29	30	30
	width	27	30	16	17
	protocone	14	15		
M.[1],	length	27	27	27.5	27
	width	28	29	14	15
	protocone	13	15		
M.[2],	length	27	28	27	28
	width	25	28	13.5	15
	protocone	14	16		
M.[3],	length	26	31	30	34
	width	23	25	13	14
	protocone	14	16.5		
I.[1],	diameter, side to side	19	16	17	16
	diameter, fore and aft	13	11.5	11	11
I.[2],	diameter, side to side	20	18	17	19
	diameter, fore and aft	12	11	11	11
I.[3],	diameter, side to side	21	20	17	17
	diameter, fore and aft	11	11	11	13

Having compared many of the measurements of the skulls, as given above, with the length, it is found that the ratios in the two species are not greatly different. However, it appears that the nose of *E. niobrarensis* is slightly longer than that of the domestic horse, the part of the skull in front of the premolars being eighty per cent of the length of the tooth-line, while in the domestic horse it is only seventy-seven per cent. Here again, no doubt, there will be found to exist some variations. In fact, the specimen, No. 2725, of the American Museum of Natural History, New York, has the nose about as in the domestic horse. It will be seen that the teeth agree closely in their dimensions. It appears, therefore, necessary to find most of the specific differences in the structure of the teeth. In general, the arrangement of the enamel of the cheek-teeth is simpler than in the domestic horse, as seen on the hinder border of the anterior and the front border of the posterior lakes (Fig. 76). Here the enamel band has merely one or two short loops; whereas, in the domestic horse, it is almost always considerably crinkled. The valley which enters the face of the tooth from the lingual side, the post-protoconal valley, appears usually to extend further outward than in the domestic horse. In the latter, the distance from the inner wall of the protocone to the anterior and outer extremity of the post-protoconal valley is equal to or less than the distance from the latter point to the enamel wall in front of the median ridge, or style, on the outer face of the tooth. In *E. niobrarensis* the valley is usually extended somewhat farther toward the outward face. Here, as in other characters, deviations from the rule are to be expected.

In the lower cheek-teeth, both premolars and molars (Fig. 77), the loop of the enamel which enters the crown at the middle of the outer face is short, not being permitted to push itself in between the adjacent ends of the two longitudinal loops of enamel. In the domestic horse the outer valley insinuates itself between the two longitudinal loops of the true molars.

The first and second upper incisors have deep cups (Figs. 76, 77; plate XIV, fig. 3). If there was originally a notch on the hinder, or lingual, lip of the cup of the first incisors, all traces

of it have been worn away. There seems to have been a very shallow notch on the lingual lip of the second incisor. The third incisors had just begun to suffer wear. Each has a cup about 20 mm. deep, but the lip on the lingual side is notched nearly to the bottom of the cup. The hinder part of this lip rounds into the opposite, or buccal, lip, between the middle and hinder thirds of the latter.

There was evidently a shallow notch in the lingual lip of the second lower incisor (Plate XIV, fig. 4). The cup of the third incisor is very incomplete. Its lingual lip is notched broadly and nearly to the bottom of the cup. This lip is represented by a descending ridge in front and a tubercle about the middle of the lingual face of the tooth. The remainder of this face is concave transversely.

In the American Museum of Natural History is a mandibular symphysis which the writer regards as belonging to *Equus niobrarensis*. It bears the collector's number 24. It presents all the permanent incisors, of which the first and second are somewhat worn (Plate XIV, fig. 5). The third on each side had made its way through the bone, but not yet through the gum. Just outside of the front border of each is seen the root of the milk incisor just about to be displaced. The cup of the third permanent incisor has a low lingual lip, not well shown in the figure, but the bottom of the cup extends 25 mm. below it. This tooth is thus quite different from the corresponding one of the type. Here, again, as in other characters there is a good deal of variation. Even in the domestic horse there is considerable variation in the completeness of the cup of the third incisor. Mr. Gidley (Bull. Amer. Mus. Nat. Hist., Vol. XIV, p. 103, fig. 5) has referred to this variation and published three figures. Nevertheless, in the domestic horse, the absence of the cup is a rare occurrence; and we may expect to find in *E. niobrarensis* some condition that prevails. Possibly this tooth in the type is less completely developed than usual; or it is possible that the piece of jaw numbered 24 belongs really to some other species. The condition of the incisor in the type is not advanced really beyond that of the same tooth in a specimen supposed to belong to *Equus excelsus* (plate XIV, fig. 6).

In the American Museum of Natural History, New York, is a specimen, No. 2725, already referred to on page 195, from Hay Springs, which presents the upper jaw with all the teeth and a part of the lower jaw with the cheek-teeth (Fig. 75). To show the variations presented by the teeth the measurements are here given:

MEASUREMENTS OF THE TEETH OF NO. 2725, AMER. MUS. NAT. HIST. EQUUS NIOBRARENSIS.

Upper Teeth

Length of the upper premolar-molar series	190	mm.
Length of the upper premolar series	107	mm.
Length of the upper molar series	83	mm.
$Pm.^2$, length	42	mm.
width	30	mm.
protocone	12	mm.
$Pm.^3$, length	32	mm.
width	30	mm.
protocone	17	mm.
$Pm.^4$, length	31	mm.
width	30	mm.
protocone	16	mm.
$M.^1$, length	30	mm.
width	27	mm.
protocone	14	mm.
$M.^2$, length	30	mm.
width	25	mm.
protocone	15	mm.
$M.^3$, length	25	mm.
width	20	mm.
protocone	15	mm.

Lower Teeth

Length of premolar-molar series	200	mm.
Length of premolar series	110	mm.
Length of molar series	90	mm.
$Pm._2$, length	38	mm.
width	17	mm.
$Pm._3$, length	33	mm.
width	19	mm.
$Pm._4$, length	32	mm.
width	18	mm.
$M._1$, length	30	mm.
width	16	mm.
$M._2$, length	32	mm.
width	15	mm.
$M._3$, length	31	mm.
width	11	mm.

It will be seen on comparison of these measurements with those of the type skull, that the teeth of No. 2725 are, in nearly all cases, distinctly larger. As already stated, the nose is shorter than in the type specimen. We can hardly doubt, however, that the two specimens belong to the same species.

TEETH OF *EQUUS NIOBRARENSIS* FOUND IN IOWA.

The following teeth, found in Iowa, are referred to this species:

Two teeth numbered 124 and 121 were described and figured by Dr. Calvin in his paper on Aftonian Mammalia (Bull. Geol. Soc. Amer., Vol. XX, p. 347, pl. xxi, figs. 3, 4). They had been found in the Cox gravel pit at Missouri Valley, Harrison county. Both of these teeth are sawn across at the upper end, so as to show the arrangement of the enamel bands. In both teeth this resembles so closely that of the type of *Equus niobrarensis,* that they are referred without hesitation to that species. On account of the missing part of the crowns, the exact height cannot be determined.

The following are the other dimensions:

Tooth	Length	Width	Protocone
124	29 mm.	28 mm.	13 mm.
121	29 mm.	29 mm.	16 mm.

The tooth which bears the number 283 *a,* is one that has been rolled and water-worn. It was found in the Elliott pit, at Turin, Monona county. It is a left upper molar, the first or the second. The height of the crown is 55 mm.; the length, 29.5 mm.; the width, 29.5 mm.; the protocone, 14 mm. The dimensions of the tooth and the pattern of the enamel indicate distinctly that the tooth belonged to *Equus niobrarensis.*

A tooth, numbered 117 and which seems quite certainly to be a right upper premolar, probably the fourth, was described and figured by Calvin (Bull. Geol. Soc. Amer., Vol. XX, p. 345, pl. xviii, figs. 2, 4), who referred the tooth to *Equus scotti.* The

specimen was found in the Cox gravel pit at Missouri Valley. Professor Calvin gave as the height ("length") of the tooth 82 mm.; as the length ("antero-posterior diameter"), 35 mm.; and as the width ("transverse diameter"), 33.5 mm. In obtaining the last two dimensions that author included the cement; which for various reasons it is not well to include. The measurements obtained by the present writer are as follows: Height, 82 mm.; length, 33 mm.; width, 33 mm.; protocone, 15 mm. An accurate pen drawing is here presented showing the arrangement of the enamel on the grinding face (Fig. 78). Dr. Calvin's figures also are reproduced (Pl. X, figs. 2, 4). It will be observed that there is no great amount of folding around the lakes. Both of these are deeply notched in the front border, and

Fig. 78

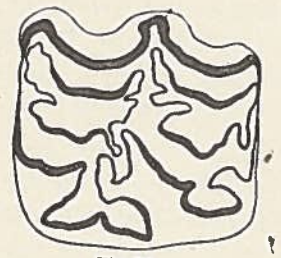

Fig. 79

Figs. 78, 79. *Equus niobrarensis.* Premolars. X1.
78. Grinding surface of supposed right upper fourth premolar. No. 117 State University of Iowa.
79. Grinding surface of supposed third premolar of left side of upper jaw. No. 185 State University of Iowa.

the anterior lake shows a deep inlet opposite the head of the post-protoconal valley. There is no such crimping of the adjacent faces of the lakes as usually appears in *Equus complicatus* and *E. scotti.* The lakes are very wide. The post-protoconal valley is wide and deeply notched at its head. The tooth is a very large one. In size it agrees with the fourth premolar of *E. scotti,* but is considerably larger than the molars of the latter. The arrangement of the enamel is much simpler than in the ordinary specimen of *E. scotti;* even simpler than in the first true molar of the type of the species, as figured by Gidley. The arrangement of the enamel resembles so strongly that in the type of *Equus niobrarensis,* that the tooth is referred to that species, notwithstanding that it is considerably larger than

the teeth of the type. It is possible, nevertheless, that it belongs to *E. complicatus*.

A left upper molar, No. 327, from the Cox pit, was collected by Shimek and is to be referred to *E. niobrarensis*. Here, too, belongs No. 123, collected by Shimek from the Cox pit. It is the left second premolar.

It can hardly be doubted that a tooth, numbered 185, belongs to the same species as No. 117, above mentioned. It was found at Missouri Valley, Harrison county, in the Cox pit. The height is 88 mm.; the length of the grinding face, 33 mm.; the width, 29 mm.; protocone, 15 mm. The anterior outer pillar is very flat and the tooth is certainly a left upper premolar, probably pm.^{3}. The lakes of No. 185 (Fig. 79) are not so wide as those of No. 117. The enamel of the adjacent border is very slightly more crimped than in No. 117. The post-protoconal valley is broad and it presents the peculiarity of sending far outward the hinder branch at its head, so as almost to touch the anterior lake. A loop of the latter enters the notch in the post-protoconal valley. These relations are doubtless due to the fact that the tooth had undergone but little wear. The tooth is referred to *Equus niobrarensis* with some doubt.

The portion of a tooth, bearing the number 122 *a*, was found in the Elliott gravel pit, at Turin, Monona county. It presents a little more than the hinder half of the crown of an upper left molar or possibly premolar. It was mentioned by Calvin (Bull. Geol. Soc. Amer., Vol. XX, p. 347), who referred it to *Equus complicatus*. In thus identifying the species Doctor Calvin followed Gidley who then referred to *E. complicatus* the horse here called *E. niobrarensis*. The tooth at hand appears to have just begun to wear, inasmuch as the two lakes are not completely separated. The tooth has a height of 70 mm.; and a width of 28 mm. The enamel has the arrangement seen in *E. niobrarensis*.

Number 136 of the catalog of the State University of Iowa collection is a fine large upper premolar of the right side. It was collected by Shimek in the Aftonian sands at Turin, Iowa. From the same locality is another premolar, still larger, credited to Mr. Babcock and found in the Aftonian gravels. It belonged on the left side. The height of the tooth is about 95 mm.;

the length of the grinding surface, 32 mm.; the width, 30 mm. The tooth has the number 284.

The number 369 has been given to a large upper premolar of the right side, probably the third, which was found in the Cox gravel pit at Missouri Valley, by Mr. Earl Barnum, and secured for the Iowa University collection by Prof. Geo. F. Kay. The tooth is in good condition and was only moderately worn at the death of the animal. The height of the crown is 76 mm.; the length, 33 mm.; the width, 28 mm.; the protocone, 18 mm. The tooth is identified as that of *Equus niobrarensis,* but it must be admitted that it belongs possibly to *Equus complicatus*. It is somewhat larger than the corresponding tooth of the type of *Equus niobrarensis,* but otherwise agrees with it.

In the collection at the Iowa University is a horse's tooth which was found in a well, near Montrose, Lee county, at a depth of twenty-five feet. The catalog number is 71. The grinding surface is covered with a part of what appears to have been a calcareous nodule, and on this account the species has not been determined. At the depth where it was found it seems probable that Aftonian deposits may have been reached.

A much worn upper cheek-tooth of the right side, probably pm.^{3}, which after death had been rolled and waterworn, was found in the Whitman gravel pit, on section 22, township 64 north, range 41 west, about five miles south of Rockport, Atchison county, Missouri. It has the catalog number 361. Its height is about 40 mm.; the length, 31 mm.; the width, 33 mm.; the protocone, 18 mm. The latter is unusually wide. The enamel has a very moderate complication and seems to agree with that of *Equus niobrarensis*.

In the State University of Iowa is a tooth, loaned and without number, which was found in the Collins pit, one mile southeast of Sioux Falls, South Dakota. It appears to belong to the species here described.

Equus laurentius Hay.

Equus laurentius was first described by the present writer in the Proceedings of the U. S. National Museum, Vol. XLIV, 1913, pp. 584-591, and illustrated by plates lxxii, lxxiii and text fig-

ures 25-27. The plates are here reproduced (Pls. XVII, XVIII). For the photographs the writer is indebted to the University of Kansas and for figure 80 to the U. S. National Museum. The type of this species is a nearly complete skull which is preserved in the paleontological department of the University of Kansas. The only part that is missing is the extremities of the nasal bones. The specimen bears the catalog number 347.

This skull was found in 1910, after a period of high water, on a sand bar, on the north side of Kansas river, near North Lawrence. With the skull were found the femur of a carnivore which Prof. Roy L. Moodie has identified as that of Smilodon, and the base of an elk's antler. In 1903 there were secured, about one mile north of the place where the horse skull was found, some skulls of the existing bison, besides the horn-core and hinder part of the skull of a bison which Prof. C. E. McClung has described as *Bison kansensis*. The skulls of the existing bison appear to be less mineralized than the horse skull and the bison described by Professor McClung, and probably were derived from a more recent deposit. It would be interesting to know from what level the elk's antler had been derived. Taking into account all the circumstances the writer believes that Kansas river had attacked some deposit of the Aftonian interglacial stage and likewise some later deposits.

The form and proportions of this skull are illustrated here by several figures. The following measurements were taken from it by the writer during a visit at the Kansas State University. The animal was mature, but not old.

MEASUREMENTS OF SKULL OF *EQUUS LAURENTIUS*.

From middle of incisive border to front of foramen magnum	481 mm.
From middle of incisive border to front of the posterior nares	260 mm.
From middle of incisive border to naso-premaxillary notch	163 mm.
From middle of incisive border to middle of occipital crest	541 mm.
From middle of incisive border to front of pm.^{2}	128 mm.
From middle of incisive border to front of orbit	293 mm.
From front of orbit to naso-premaxillary notch	183 mm.
Width across mastoid processes	117 mm.
Width across articulations for lower jaw	197 mm.
Width from outside to outside of last molars	132 mm.
Width from outside to outside of last premolars	127 mm.
Width from outside to outside of canines	61 mm.
Width from outside to outside of outer incisors	65 mm.
Width on maxillary ridge at maxillo-malar suture	177 mm.
Width between the rear of the orbits	207 mm.

Distance between the front of the orbits	153 mm.
Width of palate at last molars	72 mm.
Width of palate at pm.^{2}	68 mm.
Width of palate at diastema, least	45 mm.
Length of orbit	65 mm.
From front of symphysis of lower jaw to rear of ascending ramus	415 mm.
Length of symphysis	82 mm.
Height of jaw at front of m.$_1$	73 mm.
From rear of canine to front of pm.$_2$	68 mm.
From front of canine to rear of i.$_3$	5 mm.

MEASUREMENTS OF THE UPPER TEETH (FIG. 80).

Length of premolar-molar series		160 mm.
Length of premolar series		87 mm.
Length of molar series		73 mm.
Pm.^{2},	length	35 mm.
	width	24.5mm.
	protocone	8 mm.
Pm.^{3},	length	26 mm.
	width	24.5mm.
	protocone	9 mm.
Pm.^{4},	length	25 mm.
	width	25 mm.
	protocone	10 mm.
M.^{1},	length	22 mm.
	width	23.5mm.
	protocone	10.5mm.
M.^{2},	length	23 mm.
	width	23.5mm.
	protocone	13 mm.
M.^{3},	length	30 mm.
	width	22 mm.
	protocone	14 mm.

MEASUREMENTS OF THE LOWER TEETH (FIG. 81).

Length of the premolar-molar series		175 mm.
Length of the premolar series		89 mm.
Length of the molar series		86 mm.
Pm.$_2$,	length	32 mm.
	width	15 mm.
Pm.$_3$,	length	28 mm.
	width	16.5mm.
Pm.$_4$,	length	29 mm.
	width	16 mm.
M.$_1$,	length	25 mm.
	width	15 mm.
M.$_2$,	length	26 mm.
	width	14 mm.
M.$_3$,	length	30 mm.
	width	14 mm.

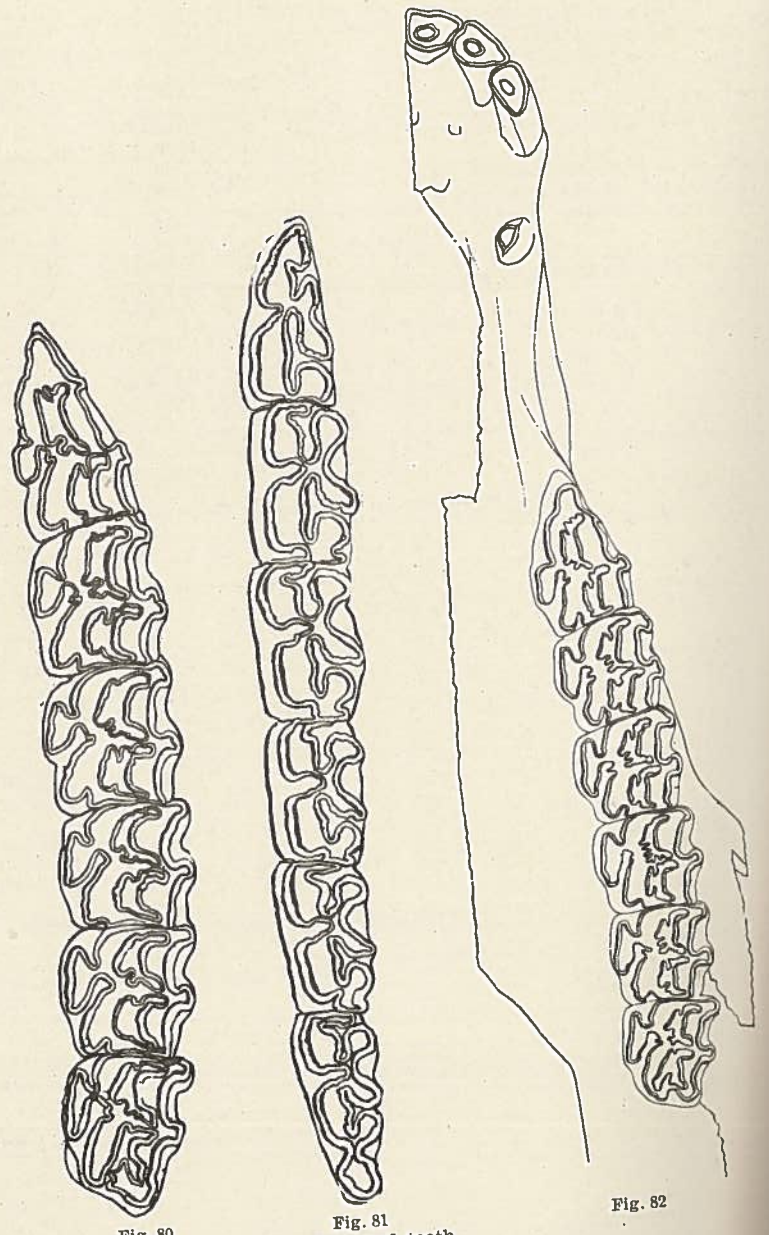

Fig. 80 Fig. 81 Fig. 82

Figs. 80-82. *Equus laurentius.* Jaw and teeth.
80. Upper cheek-teeth of left side of type. X .74.
81. Lower cheek-teeth of left side of type. X .74.
82. Left side of upper jaw, with teeth. X .53. No. 4991 National Museum.

In the U. S. National Museum there is a palate which presents the complete upper dentition of a horse which seems to have belonged to the species here described. Its catalog number is 4991, and the specimen was collected by J. B. Hatcher, in 1886, near Hay Springs, Nebraska. Figure 82 shows the dentition of the right side. The animal was considerably older than the type specimen.

The following measurements are given in order to show what seems to be the essential agreement of the specimen with the type and at the same time some deviations therefrom:

MEASUREMENTS OF SKULL AND TEETH.

From front of incisor to rear of line joining m.^{3} of the two sides	275	mm.
From line joining fronts of pm.^{2} to front of premaxillae	117	mm.
Width of premaxillae at base of i.^{3}	70	mm.
Width of palate between c. and pm.^{2}, narrowest	40	mm.
Width at border of nasal opening just above last	69	mm.
Width of face opposite middle of pm.^{4}	136	mm.
Width of face opposite m.^{2}	180	mm.
Width of posterior nares	51	mm.
Length premolar-molar series	158	mm.
Length premolar series	87	mm.
Length molar series	72	mm.
Pm.^{2}, length	36	mm.
width	23	mm.
protocone	11	mm.
Pm.^{3}, length	25	mm.
width	27	mm.
protocone	14	mm.
Pm.^{4}, length	25	mm.
width	25.4	mm.
protocone	15	mm.
M.^{1}, length	23	mm.
width	25	mm.
protocone	14	mm.
M.^{2}, length	23	mm.
width	24	mm.
protocone	13	mm.
M.^{3}, length	27	mm.
width	21.5	mm.
protocone	13	mm.
I.^{1}, diameter from side to side	15	mm.
I.^{2}, diameter from side to side	15	mm.
I.^{3}, diameter from side to side	14	mm.

The cheek-teeth are worn down to a height of about 50 mm. It is to be noted here that, while the diameters of the corresponding teeth in the two specimens are practically the same, the length of the protocone in No. 4991 is considerably greater than in the type specimen. It appears, however, in general, that one must not place too much reliance in the size and form of the protocone in identifying species.

Fig. 83. *Equus laurentius*. Cheek-teeth of right side. X1. No. 133 State University of Iowa.

In the Lawrence specimen it will be seen that the axis of the post-protoconal valley in the third and fourth premolars is directed nearly to the anterior outer corner of the tooth. In the molars the axis prolonged strikes the middle of the next tooth in front; or, in the case of the last molar, the front of the next tooth. In the Hay Springs specimen the prolongation of the axis of all the molars reaches the anterior pillar of the next tooth in front or even farther in front. The front border of the anterior lakes is more deeply notched in the Hay Springs specimen than in that from Lawrence, and the same statement is true regarding the hinder border of the posterior lakes. In that border of the anterior lake which is opposite the head of the post-protoconal valley, there is in the Hay Springs horse a double folding of the enamel resembling an M; whereas, in the horse from Lawrence, the fold is usually simple. From the table on page 203 it will be seen that the nose of the Hay Springs horse is slightly wider than in the other horse. Nevertheless, one would hardly be justified in regarding the two specimens as belonging to distinct species.

The writer's studies on the horses seem to indicate that *Equus niobrarensis* possessed a skull which was wider in the rear than

that of the domestic horse but that it narrowed more in front; while *Equus laurentius* had a skull relatively nearly as wide, but with a long nose. These conclusions may, of course, be modified by other specimens.

To this species the writer refers certain teeth which have been found in Iowa, as follows:

In the collection of the University of Iowa is a part of the left maxilla with five teeth. The number is 133. It was found somewhere near Sioux City. The specimen was figured and described by Calvin in his paper on Aftonian Mammalia (Bull. Geol. Soc. Amer., Vol. XX, pp. 347, 348, pl. xx). This plate is here reproduced on plate XIII, figure 3. In order to illustrate more clearly the arrangement of the enamel, a pen drawing is here presented (Fig. 83).

This specimen was identified by Calvin as *Equus scotti*. He regarded as belonging to the latter species the materials collected at Hay Springs and described in the present work as a distinct species, *Equus niobrarensis*. However, the present writer identifies the Sioux City specimen as *Equus laurentius*. The specimen belonged to an old horse and the teeth are not in a good condition for identification. They are worn down to about an inch from the roots; and, as a result, the arrangement of the enamel is much modified. In the first true molar the anterior lake has disappeared and the posterior one is nearly gone. It seems probable that the length of each grinding surface has been shortened somewhat, but this is not necessarily true; and, in the case of the front two premolars, the shortening may be wholly compensated by the obliquity of the worn grinding face.

The following are the measurements secured:

MEASUREMENTS OF TEETH.

$Pm.^2$ to $M.^3$, inclusive	137 mm.
Length of the premolars	91 mm.
$Pm.^2$, length	37 mm.
width	24 mm.
protocone	10 mm.
$Pm.^3$, length	28 mm.
width	27.5mm.
protocone	13 mm.

Pm.⁴,	length	25 mm.
	width	28 mm.
	protocone	13 mm.
M.¹,	length	23 mm.
	width	26 mm.
	protocone	13 mm.
M.²,	length	24 mm.
	width	27 mm.
	protocone	13 mm.

In size these teeth exceed somewhat those of the type of *Equus laurentius* and of the specimen referred to it, now in the U. S. National Museum, No. 4991 (Fig. 82). In size they do not differ much from those of the type *Equus niobrarensis;* but there was originally evidently more complication of the enamel around the lakes than in *E. niobrarensis,* and there is no indication that the protoconal valley had the deep re-entering loop at its head or the great prolongation of this to the center of the tooth. Furthermore, the third premolar has almost exactly the same size as that of No. 4991 of the U. S. National Museum.

The specimen here described shows that the posterior palatine foramen opened opposite the last molar, and that the bone of the hinder region of the palate was thin, differing thus from the type of *Equus excelsus.*

In the State University collection, with the number 250, are three lower right molars which are referred to this species. These were secured by Professor Shimek in the second cut along the Illinois Central railroad east of Sioux Falls, South Dakota. They were found in the Aftonian silts. In the same collection, with the number 128, is an upper last molar which Shimek found in the Cox pit at Missouri Valley. It appears to belong to this species. Another, a left lower tooth, No. 126, likewise appears to belong here, and was found in the Cox pit.

From Prof. J. E. Marshall, of Council Bluffs, the writer has received for examination various teeth of horses which had been found at Henton Station, Mills county. A part of these have already been mentioned under *Equus complicatus.* One very fine tooth, a left upper premolar, probably the last, is found to belong to *Equus laurentius.* This had begun to wear only a short time before the death of the animal. The height is 76 mm.; the length of the grinding surface, 26 mm.; the

width, 25 mm. The tooth is considerably curved, so as to be concave on the inner face and on the hinder. The enamel of the lakes is somewhat more folded than in the type, but there can be no hesitation in referring the tooth to *E. laurentius.*

At the close of the descriptions of the horse remains which may, with some certainty, be referred to their proper species may be mentioned two specimens which are in the collection of the State University of Iowa and whose specific relationships are undeterminable.

The first of these is a femur of the left side, No. 320. This was found by Mr. W. E. Babcock, in the Elliott sand pit, at Turin. The following measurements were taken: Length from the upper surface of the head to the distal end, 393 mm.; width across the head to the outer side of the bone, 120 mm.; fore-and-aft diameter at the middle of the length, 47 mm.; transverse diameter at the middle of the length, 54 mm.; fore-and-aft diameter of the outer condyle, 105 mm.; same diameter across inner condyle, 122 mm.

Number 136 of the same collection belongs to a left tibia which was found by Ira A. Williams, in the Cox pit, at Missouri Valley. The proximal end, including about that part belonging to the proximal epiphysis, is missing. The following measurements were taken: Length of fragment, 345 mm.; width of upper end, on hinder face, at the level of the nutritious foramen, 56 mm.; transverse diameter of shaft 100 mm. below the nutritious foramen, 49 mm.; fore-and-aft diameter at the same place, 42 mm.; transverse diameter at the lower end, 75 mm.

From this locality were obtained four cannon-bones, three phalangeal bones, and a left radius.

Superfamily TAPIROIDEA.

The Lophiodonts and Tapirs.

Under this superfamily are arranged the tapirs and their extinct relations, which were so numerous during the Tertiary period. The group is to be regarded as one far less progressive than is that to which the horses belong. The cheek-teeth

are always low-crowned and the upper ones lack the intermediate cusps. Those of both jaws are characterized by having the crown traversed by two prominent crests; those of the upper jaw by having, besides, a prominent wall joining the outer ends of the two crests. Thus there is, between the two crosscrests, a valley which opens on the side of the tooth next the tongue. In the animals of this group the digits are never less than three.

Although tapirs, belonging apparently to two species, continued to exist in North America well into the Pleistocene period, no remains of these have yet, so far as the writer knows, been found in Iowa. A map showing the localities where tapirs' remains have been found in the United States may be found in volume LIX of the Smithsonian Miscellaneous Collection, 1912, No. 20, page 11. None of these fall within the region covered by Wisconsin drift; from which fact the writer believes the conclusion justified that these animals had, by the time of the Wisconsin stage, been driven far to the south in the United States, if not into Central and South America, where three or four species yet exist.

Superfamily RHINOCEROTOIDEA.

The Rhinoceroses.

During the Tertiary period the group to which the Rhinoceroses belong was represented in our country by numerous genera and species; but none are known to have lived at any time during the Pleistocene.

Suborder ARTIODACTYLA.

The Even-toed Hoofed Mammals.

Ungulata which have the third and fourth digits of each limb equally developed; second and fifth digits more or less reduced, sometimes ending in hoofed phalanges, sometimes wholly wanting; presacral vertebræ always twenty-six; femur without third trochanter; the astragalus with a grooved trochlear surface for the tibia, and another for the navicular

and cuboid; fibula articulating with the calcaneum; teeth variously modified, sometimes in full number, forty-four, sometimes with some of those in front of the second premolar wanting; incisors never furnished with a cup, or pit.

The Artiodactyla include, besides a considerable number of extinct families, the swine, the hippopotami, the camels, the deer, the giraffes, the antelopes, the sheep, the goats, the musk-oxen, and the oxen. Richard Lydekker has recently called attention to the fact that, while there are yet existing less than a score of perissodactyls, there are between one and two hundred species of existing artiodactyls. All the continents have been occupied by members of the group; but Australia only through recent introduction by man. The oldest forms are found in the Lower Eocene. In the Upper Eocene and succeeding epochs the group is represented by increasing numbers.

As to their food habits, all nourish themselves on vegetable material; but some of them, as the swine, readily devour animal matter.

In the Pleistocene of North America the following superfamilies are represented: Suöidea (piglike ungulates), Cameloidea (camels) and Boöidea (deer, sheep, goats, and oxen).

Superfamily SUOIDEA.

The Hogs and Peccaries.

Even-toed ungulates with usually four functional digits in each foot; but these in some cases reduced to three or even to two; tooth formula, i. $\frac{3-3}{3}$, c. $\frac{1}{1}$, pm. $\frac{4-4}{4-4}$, m. $\frac{3}{3}$; the molars furnished with four conical cusps which are connected so as to form two cross-crests, between which may be found few or many accessory tubercles; canines usually large and trenchant.

Although remains of true hogs, Suidæ, have been reported from the Pleistocene deposits of the United States, they have probably in all cases belonged to the introduced domestic swine. On the other hand, the peccaries (Tayassuidæ) are numerously represented.