

NOTES ON SOME FOSSIL HORSES, WITH DESCRIPTIONS OF FOUR NEW SPECIES.

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The results detailed in the present paper have been arrived at during the writer's studies on the Pleistocene Vertebrata of North America, pursued under the auspices of the Carnegie Institution of Washington. The materials here mentioned are preserved in various collections, as follows: In the United States National Museum; the Academy of Natural Sciences of Philadelphia; the Wagner Free Institute of Science, Philadelphia; the American Museum of Natural History, New York; Yale University Museum, and the University of Kansas. To the officers of these institutions the thanks of the writer are due for freely given permission to study these materials. Especially is the writer indebted to the University of Kansas for permission to describe the fine skull made the type of *Equus laurentius*, and for photographs of it; and to the Carnegie Institution of Washington for permission to publish in advance these results.

EQUUS FRATERNUS Leidy.

In 1901 Mr. J. W. Gidley, now of the United States National Museum, published a valuable paper on the fossil horses of North America.¹ However, in that paper, as it seems to the present writer, Mr. Gidley fell into certain errors which it seems desirable should be corrected.

In discussing the status of Leidy's *Equus fraternus*, Mr. Gidley came to the conclusion that Cope,² in choosing out of the number of teeth which Leidy had included under his species, had picked out the wrong tooth as the type of *E. fraternus*. Mr. Gidley, therefore, selected another tooth as type of this species, the one which Leidy represented by figure 8 of plate 15 in Holmes's Post-pliocene Fossils of South Carolina. However, the tooth taken by Cope as the type was one of those before Leidy when he gave the name, and he likewise figured it in the same publication (pl. 15, fig. 6). It must, therefore, according to the established rules of nomenclature, remain the type

¹ Bull. Amer. Mus. Nat. Hist., vol. 14, pp. 91-142, pls. 18-21, figs. 1-25.

² Proc. Amer. Philos. Soc., vol. 34, p. 467.

of this species. This tooth is now in the American Museum of Natural History and has the catalogue No. 9202. The tooth selected by Gidley is in the same museum and bears the number 9200.

Mr. Gidley concluded, furthermore, that the type tooth selected by Cope has no characters by means of which it can be distinguished from *Equus complicatus*. The present writer agrees with him that this type, figured by Leidy¹ and again by Mr. Gidley, with some restoration,² is too large to belong to the same species as those teeth represented by Leidy's figures 8 and 16 of the plate referred to, and those figured by Gidley and designated as C and D. The fore-and-aft diameter of the crown is 27 mm.; but, inasmuch as the tooth had been worn down to within 35 mm. of the root, this diameter was originally probably somewhat greater, 29 mm., or even 30 mm. The width is 29.5 mm., somewhat greater than that of the type of *E. complicatus*. This is too great to permit us to suppose that the



FIGS. 1-3.—1, *EQUUS FRATERNUS*. $\times 1$. RIGHT UPPER PREMOLAR. 11489, YALE. 2, LEFT UPPER PREMOLAR. 11489, YALE. 3, RIGHT UPPER PREMOLAR. 11483, YALE.

tooth belonged to the Floridan horse with teeth of medium size which the name *fraternus* has generally been supposed to designate.

Whether or not we ought to regard the name *E. fraternus* as a synonym of *E. complicatus* is another question. We may not be able to distinguish the larger teeth found in that region from those of *E. complicatus*; neither does our insufficient knowledge of them enable us to say positively that they belong to the last-named species. Figures of some of these teeth of questionable species, found on our south Atlantic coast, are here presented. Figure 1 represents the grinding surface of a right upper tooth, apparently a third or fourth premolar, which is in the Yale collection, No. 11489. It is stated that it was found in the phosphate beds near Charleston, South Carolina. It had suffered only moderate wear, the crown having yet a height of 75 mm. The fore-and-aft diameter of the grinding surface (called the length of the tooth in this paper) is 31 mm.; the width, 27 mm. Another (fig. 2), having the same number and from the same place, is more strongly worn, the height being only 55 mm.

¹ Proc. Amer. Philos. Soc., vol. 34, pl. 15, fig. 6.

² Bull. Amer. Mus. Nat. Hist., vol. 14, p. 112, fig. 8, B.

It belongs to the left side and is taken to be the third or fourth premolar. Its length is 32 mm., the width, 27.6 mm. A third tooth in the collection at Yale, found also in South Carolina, and having the number 11483, is represented by figure 3. It is the third or fourth right upper premolar. The height of the crown is 65 mm., the length 28 mm., the width 28 mm. The enamel is strongly folded. A fourth tooth, which belongs to the collection of the Wagner Free Institute, Philadelphia, appears to belong with those just described, although the enamel is much more plicated than in figures 1 and 2. It has the catalogue No. 4086, and is one of several teeth collected along Peace Creek, in 1888, by Mr. Joseph Willcox. This tooth (fig. 4) has the crown 72 mm. high, 31 mm. long, and 26 mm. wide. A part of the inner face of the tooth is missing. These teeth resemble closely those of *E. complicatus*, although some of them have the enamel little folded.

In the collection of the Wagner Free Institute is a part of a lower jaw of a horse of apparently medium or moderately large size. This jaw was obtained by Mr. Willcox on the Caloosahatchie River, Florida, in 1888. It furnishes the symphysis and a part of the left ramus, with the right third incisor, all the left incisors, and the second and third premolars. The animal was young, but mature. This jaw was referred to *Equus fraternus* by Cope.¹ According to Cope, Doctor Leidy also determined it as *Equus fraternus*. By Cope it was associated with two upper cheek teeth from Peace Creek. One of these, whose diameters are given as 29 mm. and 24 mm., may be the tooth represented here by figure 5. The other, not recognized with certainty, designated by Cope as "No. 2," measured fore and aft 25 mm., transversely 26 mm. In his measurements of the third premolar of the lower jaw Cope gives as the width 17 mm. It is probable that he included the cement. This is not practicable, because it is often missing in fossil teeth.

Measurements of the lower jaw.

	<i>mm.</i>
Length of the symphysis.....	75
Width of the symphysis where narrowest.....	40
Width of the symphysis at third incisors.....	53±
Height of jaw at front of <i>pm</i> . ₂	60
Height of jaw behind <i>pm</i> . ₃	82
Distance from <i>i</i> . ₃ to <i>pm</i> . ₂	82
Width of <i>i</i> . ₁	16
Width of <i>i</i> . ₂	17
Width of <i>i</i> . ₃	18
Length of grinding surface of <i>pm</i> . ₂	31
Width of grinding surface of <i>pm</i> . ₂	14.5
Height of crown of <i>pm</i> . ₃	76
Length of crown of <i>pm</i> . ₃	29
Width of crown of <i>pm</i> . ₃	15.5

¹ Proc. Amer. Philos. Soc., vol. 34, p. 465.

Figure 1, on plate 69, represents the little worn incisors of the jaw. It has been prepared from a photograph of a cast of the front of the jaw. It will be seen that none of the teeth has a complete cup. In the first and second incisors the cup is open to the bottom on the lingual side; while the third incisor shows only traces of the cup. It is this simple condition of the incisors that led Cope to base on this jaw his genus *Tomolabis*.¹

Figure 6 shows the arrangement of the enamel in the second and third premolars. It is somewhat more complicated than usual in the corresponding teeth of species of *Equus*.

Because (1) of the close resemblance of the type tooth of *E. fraternus* to the tooth of *E. complicatus* and the possibility, even probability, that these species are identical, and (2) because the incisors of *E. complicatus* are very different from those of the lower jaw in the Wagner Free Institute, the writer was at first disposed to refer the jaw just mentioned to the species described below as *E. leidyi*. However, the third premolar seems to have the long diameter too great to belong with the type tooth of *E. leidyi*; although perhaps not too great to go with the tooth of figure 5 in case it belongs to *E. leidyi*. Under the circumstances, therefore, it seems best for the present, to retain the name of *E. fraternus* for those larger equine teeth which are found along our south Atlantic coast, and which approach more or less closely in size and structure the type of this species, as selected by Cope; furthermore, to associate with these teeth the lower jaw above described, following thus the example of Leidy and Cope. This appears to be the more advisable, because in the Peace Creek collection there are other lower teeth which it seems necessary to refer to *E. leidyi*, as noted below. It must be said, however, that it seems very probable that such teeth as those represented by figures 1 and 2 represent a species distinct from the typical *E. fraternus*.

EQUUS LEIDYI, new species.

Type.—One of six teeth in the Wagner Free Institute of Science, Philadelphia, which have the catalogue number 4086. Found in supposed Pleistocene deposits on Peace Creek, Florida.

Characterized by teeth of medium size, the length of the grinding surface of the first molar being about 25 mm., the width about 24 mm., excluding the cement. Enamel surrounding the lakes rather strongly folded. Type tooth moderately curved.

This name is intended to designate a horse which possessed teeth of medium size, examples of which have been found at various localities from North Carolina to Florida. Among these are certain teeth figured by Leidy² and others by Mr. Gidley.³ As the special type of

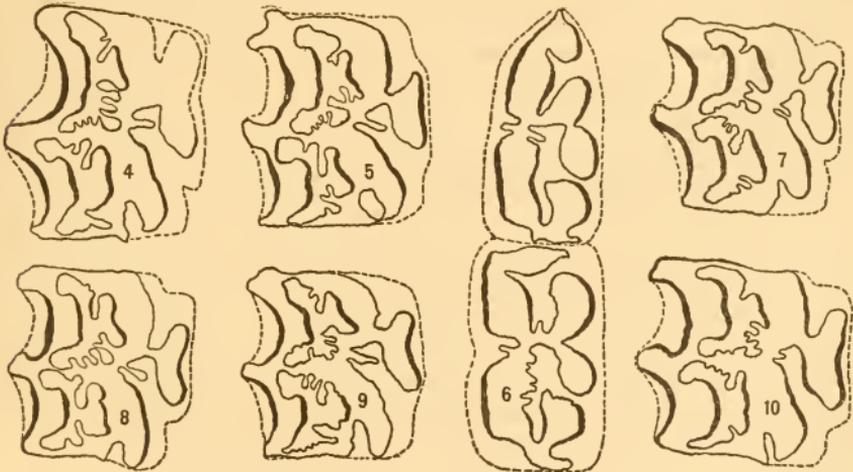
¹ Proc. Amer. Philos. Soc., vol. 30, p. 125; vol. 34, p. 466.

² Holmes's Post-Pliocene Foss. S. C., pl. 15, figs. 3, 16.

³ Bull. Amer. Mus. Nat. Hist., vol. 14, figs. 8, C. D.

the species there is taken a tooth (fig. 7) which belongs in the collection of the Wagner Free Institute and which is one of six found somewhere along Peace Creek by Mr. Joseph Willcox. It is impossible that all these teeth belonged to the same individual, and they probably did not belong all to the same species. One has already been referred to the species which it seems advisable to regard as *E. fraternus* (fig. 4). Two other teeth are referred to the species here described, and they may have belonged to the same individual (figs. 8, 9). The following are the dimensions of these teeth:

Teeth.	Height of crown.	Length of crown.	Width of crown.	Protocone.
	mm.	mm.	mm.	mm.
Tooth of fig. 7 (type).....	75	25	24	11
Tooth of fig. 8.....	62	25	24	12
Tooth of fig. 9.....	75	25	23	11



FIGS. 4-10.—4, 6, 10, *EQUUS FRATERNUS*. $\times 1$. 4086, WAGNER. 4, RIGHT UPPER MOLAR; 6, LEFT SECOND AND THIRD PREMOLARS; 10, RIGHT UPPER PREMOLAR? 5, 7, 8, 9, *EQUUS LEIDYI*. $\times 1$. 4086, WAGNER. 5, RIGHT UPPER PREMOLAR; 7, RIGHT UPPER MOLAR. TYPE. 8, RIGHT UPPER MOLAR; 9, RIGHT UPPER PREMOLAR?

The tooth taken as the type is believed to be a molar, either the first or the second. The other two are supposed to be premolars. It will be observed that in these teeth the enamel surrounding the lakes is much folded on the adjacent borders, while the front border of the anterior lake and the hinder border of the posterior are deeply notched. The post-protoconal valley, that entering the tooth on the inner face, behind the protocone, lacks much of reaching outward halfway to the median style of the outer face of the tooth.

One of the six teeth mentioned is represented by figure 5. It is a right premolar, either the third or the fourth. The height of the crown is 62 mm., the length 28 mm., the width 24 mm. This prob-

ably belongs to the species here described; although the length of the grinding surface is equal to some teeth that are referred to *E. fraternus*. Still another of the six teeth is doubtful (fig. 10). The height of the crown is 37 mm., the length 25 mm., the width 27 mm. This may be a third or fourth premolar of *E. fraternus* which has a short grinding surface, because the tooth was worn down to one-half or less of its original length.

In the American Museum of Natural History are several horse teeth which were collected some years ago by Prof. F. W. Putnam, on the Alifia River, near its entrance into Tampa Bay. One is here figured (fig. 11). It belonged to the right side and is a premolar, the anterior outer style (parastyle) being flattened and furnished with a furrow. It is worn down one-half its length, the height of the crown being 35 mm. The length of the grinding surface is 24 mm., the width 24 mm., the protocone 12 mm. The enamel of the lakes is pretty strongly folded. This tooth is to be referred to *E. leidyi*. Figure 12 is likewise from Alifia River, but is a considerably larger tooth and appears to approach *E. fraternus*. This, too, is a well-worn tooth; the height of the crown being 40 mm. The length of the grinding face is 30 mm., the width 27 mm., the protocone 14 mm. It belonged on the right side and seems to be a premolar.

Some of the difficulties under which the student of fossil horses labors are here illustrated. It may be perfectly obvious that two species are present and that they differed in size; but the teeth of the larger individuals of the smaller species may equal in size the teeth of the smaller individuals of the larger species. The matter is likewise complicated by the fact that the premolars are larger than the molars of the same individual. It may not always be possible to identify single teeth; but that the species that possessed such teeth as those of figures 7 and 8 was identical with that furnishing the teeth of figures 1 and 2 the writer regards as very improbable.

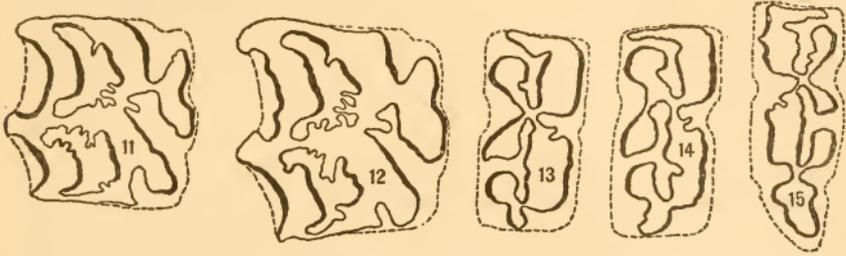
In the collection from Peace Creek, with the No. 4086 of the Wagner Free Institute, are six lower teeth of medium size which the writer refers to *E. leidyi*. Two of these are little worn and appear to have belonged to the same individual; one on the left side, the other on the right (fig. 14). A third has the crown more worn (fig. 13). A fourth, the last left molar, seems to have the crown worn down to about two-thirds its original height.

The following are the dimensions of the three figured:

Teeth.	Height of crown.	Length of crown.	Width of crown.
	mm.	mm.	mm.
Tooth of fig. 14.....	92	25	12
Tooth of fig. 13.....	25	13
Tooth of fig. 15.....	66	30	11

These lower teeth are remarkable because of their narrowness.

In the case of the tooth of figure 14 the fore-and-aft diameter is taken about 25 mm. below the grinding surface, because there the normal dimension is reached. The diameter of the actual surface is 28 mm. The tooth of figure 15 is longer than the others, because it is the hindermost tooth. It will be observed that in length of grinding surface these teeth agree with the upper molars of *E. leidyi*, being too small to belong to *E. fraternus* and too large to have armed the lower



FIGS. 11-15.—11, *EQUUS LEIDYI*. $\times 1$. RIGHT UPPER PREMOLAR. AMER. MUS. NAT. HIST. 12-15, *EQUUS FRATERNUS*. $\times 1$. 12, RIGHT UPPER PREMOLAR? AMER. MUS. NAT. HIST. 13, LOWER RIGHT MOLAR OR PREMOLAR. 4086, WAGNER. 14, LOWER RIGHT MOLAR OR PREMOLAR. 4086, WAGNER. 15, LOWER LEFT LAST MOLAR. 4086, WAGNER.

jaw of the species next to be described. Figure 16 represents a lower left premolar or molar from Alifia River, Florida. The height of the crown is 61 mm., its length 27 mm., its width 11.5 mm. on the worn face, but lower down 13 mm. It differs from the teeth of figures 13, 14, and 15 in the more plicated enamel.



FIGS. 16-18.—16, *EQUUS LEIDYI*. $\times 1$. LOWER LEFT MOLAR OR PREMOLAR. AMER. MUS. NAT. HIST. 17-18, *EQUUS LITTORALIS*. $\times 1$. 17, UPPER LEFT MOLAR. TYPE. 4086, WAGNER. 18, UPPER LEFT MOLAR. 4086, WAGNER.

EQUUS LITTORALIS, new species.

Type.—One of six teeth in the Wagner Free Institute of Science, Philadelphia, which have the No. 4086. Found in supposed Pleistocene deposits on Peace Creek, Florida.

Characterized by teeth of small size, the grinding surface of the first molars having a length and a width of about 21 mm. Enamel surrounding the lakes rather strongly folded. The crown somewhat more curved than in *E. leidyi*.

Accompanying the teeth found by Mr. Willcox on Peace Creek, as mentioned on page 573, are others which belonged to a smaller horse than that described as *E. leidyi*. Two of these teeth are left upper molars and are shown in figures 17 and 18. To this horse, believed

to be hitherto without a name, is given the title *Equus littoralis*. The tooth represented by figure 17 is taken as the type, but that of figure 18 certainly belonged to the same species, possibly to the same individual. The anterior half of the outer wall of enamel of the type has been split off.

The following are the dimensions of these teeth:

Teeth.	Height of crown.	Length of crown.	Width of crown.	Protocone.
	mm.	mm.	mm.	mm.
Tooth of fig. 17 (type).....	62	21	20	11
Tooth of fig. 18.....	40	21.5	22	12

These teeth seem somewhat more curved than those of *E. leidyi*. A curved line representing the hinder border of the outer face has its chord 62 mm. long, and its middle point is about 6.5 mm. distant from the chord. The chord of the inner face is 53 mm. long and the middle point of the face is 7 mm. distant from the chord. The post-protoconal valley, as represented by the two teeth at hand, is narrow and falls much short of reaching half way to the median style of the outer face of the tooth. No lower teeth are known that agree in size with the upper teeth described above.

Mr. Gidley¹ states that there are in the American Museum of Natural History a small tooth from Peace Creek, Florida, and another from Lookout Mountain, Tennessee. It is suggested that these may belong to Owen's *Equus tau*, a species described from the Valley of Mexico. The present writer has not seen these teeth, but from Gidley's measurements, taken from Owen's figures, as well as from Owen's statement, it is to be noted that in all the premolars and molars the length of the grinding surface is greater than the width; whereas, in the teeth of *E. littoralis*, the width is greater than the length. Moreover, Owen's figure indicates no such complexity of the enamel in *E. tau* as characterizes the teeth of *E. littoralis*.

EQUUS NIOBRARENSIS, new species.

Type.—A nearly complete skull belonging to the United States National Museum and having the catalogue number 4999. Found in supposed lower Pleistocene deposits, at Hay Springs, Nebraska.

Characterized by teeth of rather large size, the length of the grinding surface of the first molar being about 27 mm., the width about the same. Enamel of the lakes of rather simple pattern.

The skull to which the name *Equus niobrarensis* is here given was discovered in 1886 by Prof. J. B. Hatcher, along the Niobrara River, near Hay Springs, Nebraska. When found it was in a more or less broken condition, and it was afterwards put in its present state by Mr. Alban Stewart. As shown by plate 69, figs. 2, 3, and plate 70, the bone is

¹ Bull. Amer. Mus. Nat. Hist.: vol. 14, p. 121.

lacking to some extent on the sides and middle of the face and here and there in other places; but the structure of the essential parts is evident. Other remains of evidently the same horse have been collected at Hay Springs and the neighboring region for the United States National Museum and the American Museum of Natural History, in New York. Some of these were identified by Mr. Gidley as *Equus complicatus*,¹ and the left side of the upper jaw of one specimen, No. 2725, was figured² under this name. In the same paper³ Mr. Gidley figured and identified as *E. complicatus* the left upper cheek teeth of a specimen which he had found in the canyon of Tule Creek, in Swisher County, Texas. This specimen likewise appears to belong to *E. niobrarensis*.

It is proper to say here that before the writer began to study the skull here described Mr. Gidley had recognized it as belonging to an undescribed species.

Below are found measurements which have been taken from the skull, No. 4999, United States National Museum. In another column are presented corresponding measurements taken on the skull of a domestic horse, No. 843, of the United States National Museum. The age of the latter seems to have been about 6 years, while the Niobrara horse appears to have been approximately a year younger. As the lower jaw of the skull, No. 843, of the domestic horse is missing, measurements of this part are supplied from No. 174960 of the United States National Museum, a large gelding, whose skull has a length of 640 mm. The upper row of cheek teeth, however, measures the same as in No. 843.

Measurements of skull in millimeters.

Distances.	<i>E. niobrarensis.</i>	<i>E. caballus.</i>
	<i>mm</i>	<i>mm</i>
From middle of incisive border to front of foramen magnum.....	530	550
From middle of incisive border to front of posterior nares.....	290	300
From middle of incisive border to rear of notch between nasal and premaxillæ..	200	196
From middle of incisive border to rear of occipital crest.....	552	602
From middle of incisive border to front of <i>pm.</i> ²	137	143
From middle of incisive border to front of orbit.....	340	362
Width across mastoid processes.....	110	129
Width across hinder nares.....	47	55
Width across articulation for lower jaw.....	217	213
Width from outside to outside of last molars.....	123	127
Width from outside to outside of outer incisors.....	78	75
Distance between fronts of orbits.....	158	153
Distance between the rear of the orbits.....	240	220
Width of skull on maxillary ridge at maxillo-malar suture.....	187	188
Width of palate at last molars.....	70	77
Width of palate at <i>pm.</i> ²	50	53
Distance across premaxillæ at middle of nasal opening.....	75	67
Least width of space between <i>i.</i> ³ and <i>pm.</i> ²	45	45
Distance between <i>i.</i> ³ and <i>pm.</i> ²	105	110
Diameter of orbit, fore and aft.....	84	70
From front of lower jaw to rear of ascending ramus.....	467
Length of symphysis of lower jaw.....	90
Height of jaw at front of <i>m.</i> ¹	96
Rear of <i>i.</i> ³ to front of <i>pm.</i> ²	93

¹ Bull. Amer. Mus. Nat. Hist., vol. 14, p. 132.

² Idem., pl. 18, fig. B.

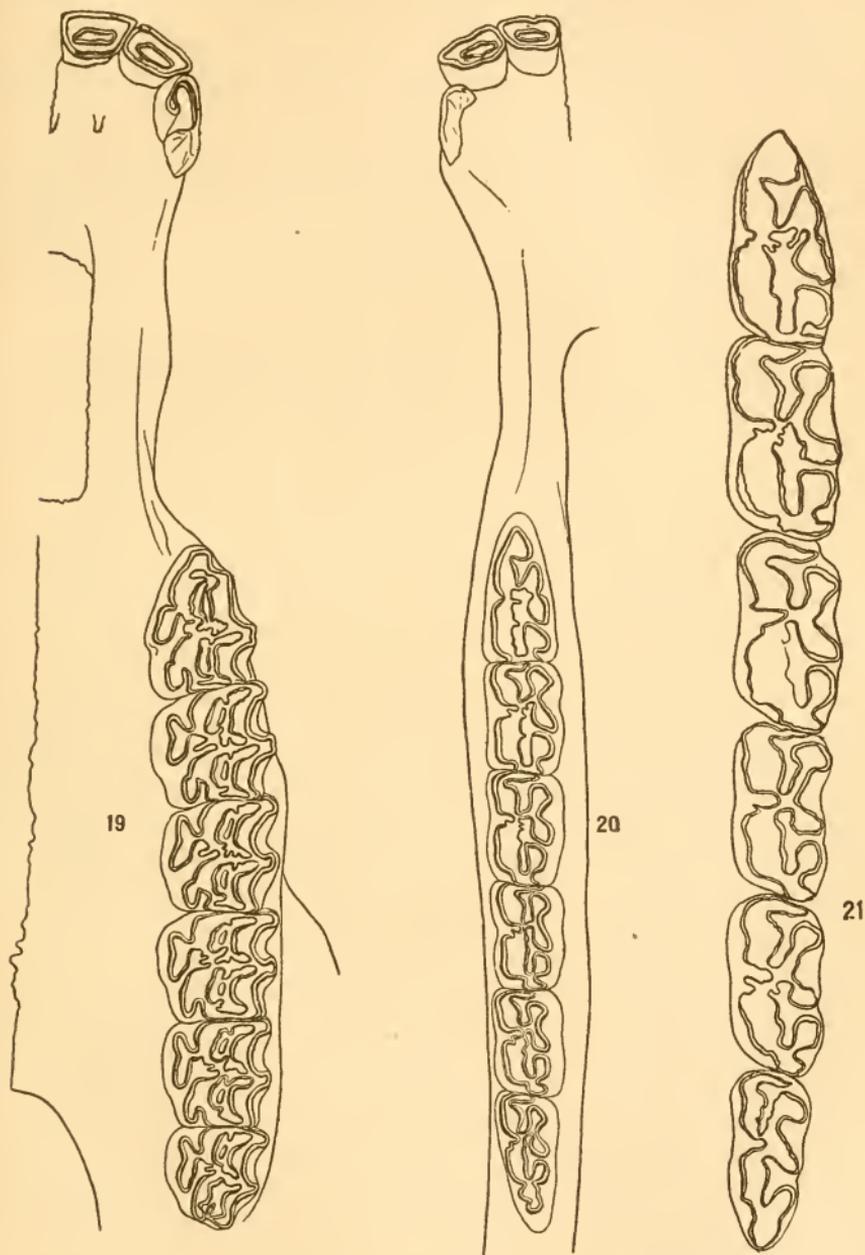
³ Page 132, fig. 22.

Measurements of the teeth.

Teeth.	Upper.		Lower.	
	<i>E. niobraren- rensis.</i>	<i>E. caballus.</i>	<i>E. niobraren- rensis.</i>	<i>E. caballus.</i>
	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 <i>m.</i> ³	75			
<i>Pm.</i> ² , length.....	38	40	35	36
width.....	27	27	15	16
protocone.....	10	10		
<i>Pm.</i> ³ , length.....	30	30	28	30
width.....	28	29	16	17.5
protocone.....	13.5	14		
<i>Pm.</i> ⁴ , length.....	29	29	30	30
width.....	27	30	16	17
protocone.....	14	15		
<i>M.</i> ¹ , length.....	27	27	27.5	27
width.....	28	29	14	15
protocone.....	13	15		
<i>M.</i> ² , length.....	27	28	27	28
width.....	25	28	13.5	15
protocone.....	14	16		
<i>M.</i> ³ , length.....	26	31	30	34
width.....	23	25	13	14
protocone.....	14	16.5		
<i>I.</i> ¹ , diameter, side to side.....	19	16	17	16
diameter, fore and aft.....	13	11.5	11	11
<i>I.</i> ² , diameter, side to side.....	20	18	17	19
diameter, fore and aft.....	12	11	11	11
<i>I.</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. Nevertheless, as will be seen from the table on page 590, the skull is wider in the present species than in the domestic horse and the nose is rather short. The size of the brain case is remarkable. Its width, measured above the hinder root of the zygomatic arch, is 122 mm. In the skull of the domestic horse, No. 843, the width is 115 mm. It will be seen that the teeth agree closely in their dimensions with those of *E. caballus*, although those of the fossil species are somewhat wider, above and below. 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. 19). 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 farther 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 of the median ridge, or style, on the outer face of the tooth. In *E. niobraren-
rensis*

the valley is usually extended somewhat farther toward the outward face. Here, as in other characters, deviations from the rule are to be expected.



FIGS. 19-21.—19, *EQUUS NIOBRARENSIS*. $\times \frac{1}{2}$. UPPER JAW, LEFT SIDE. TYPE. 4999, U. S. NAT. MUS.
 20, LEFT LOWER JAW. TYPE. 4999, U. S. NAT. MUS. 21, LEFT LOWER JAW. 2725, AMER. MUS.
 NAT. HIST.

In the lower cheek teeth, both premolars and molars (fig. 20), the loop of 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 (text-fig. 19; pl. 69, fig. 4). 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 (pl. 71, fig. 1). 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 by 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 *E. niobrarenensis*. It bears the collector's number 24. It presents all the permanent incisors, of which the first and second are somewhat worn (pl. 71, fig. 2). 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. Doubtless here 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. Gidley¹ 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. niobrarenensis* 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 jaw that is referred provisionally to *E. excelsus* (pl. 71, fig. 3). This has the catalogue number 2762 in the American Museum of Natural History.

The following notes and measurements have been taken from No. 2725 of the American Museum of Natural History, New York, the

¹ Bull. Amer. Mus. Nat. Hist., vol. 14, p. 103, fig. 5.

specimen figured by Gidley. By length of the tooth is meant, here as elsewhere, the fore-and-aft extent of the crown, not the height of the tooth. The fore-and-aft extent of the protocones is also given. It should be observed that in comparing the dimensions of the teeth, the lengths of $pm.^2$, $pm.^3$, and $m.^3$ are less constant than those of the other teeth.

Measurements of teeth.

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

Besides the maxilla and cheek teeth described here the type specimen presents the premaxillæ, the incisors and both canines. With this upper jaw there is present also a part of a lower jaw which belonged to the same individual and which presents the left ramus and symphysis, with all the cheek teeth (fig. 21), the left canine and all the incisors.

Measurements of teeth.

	<i>mm.</i>
Length of premolar-molar series.....	200
Length of premolar series.....	110
Length of molar series.....	90
$Pm.^2$, length.....	38
width.....	17
$Pm.^3$, length.....	33
width.....	19
$Pm.^4$, length.....	32
width.....	18
$M.^1$, length.....	30
width.....	16
$M.^2$, length.....	32
width.....	15
$M.^3$, length.....	31
width.....	11

In the upper jaw the first and second incisors have a deep cup; the third incisor has the cup widely open on the hinder face of the tooth. The canines were just emerging from the bone.

In the lower jaw the first and second incisors are a little worn, while the third had just begun to be worn. The second has the hinder border of its cup a little notched; while the third is widely open, as in the same tooth of the type specimen. The canines were just coming through the bone very close to the third canine. From the figure of the lower teeth (fig. 21) it will be seen that the valley at the middle of the outer face does not, or hardly at all, push itself in between the adjacent ends of the longitudinal valleys. These teeth differ but slightly from those of figure 5.

Measurements of upper and lower jaws.

	<i>mm.</i>
Height of maxilla above <i>pm.</i> ⁴	105
Height of maxilla above <i>pm.</i> ²	71
Width of upper jaw at <i>i.</i> ³	76
From front of <i>pm.</i> ² to canine (diastema).....	66
From front of <i>pm.</i> ² to front of premaxilla.....	137
Height of lower jaw at rear of <i>m.</i> ₃	123
Height of lower jaw at rear of <i>pm.</i> ₂	70
Width of lower jaw at <i>i.</i> ₃	65
Distance between <i>pm.</i> ₂ and <i>i.</i> ₃	90
Length of symphysis of lower jaw.....	82

It may be of value to describe some milk teeth which appear to belong to this species. In the collection of the American Museum of Natural History is a part of a right maxilla which contains the second, third, and fourth milk molars (fig. 22). It has the collector's number 81. The bases of the teeth are concealed and consequently one can determine only approximately the height of the crown. This appears to be about 45 mm. The state of wear of the teeth indicates a colt about 6 months old. At the stage of wear in which the teeth are found, the post-protoconeal valley opens into the anterior lake. The fourth milk molar is but little worn. Probably about 3 millimeters ought on this account to be added to its width as given below.

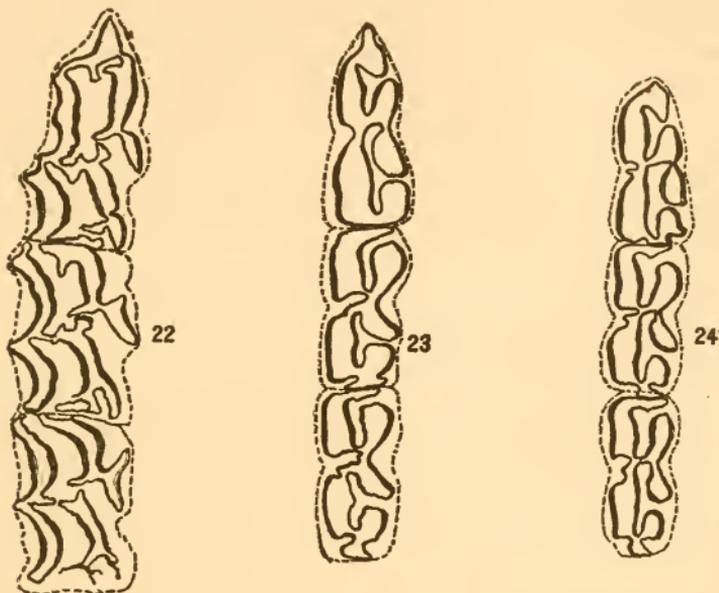
Measurements of upper milk molars.

Teeth.	Length of grinding surface.	Width of grinding surface.	Protocone.
	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
<i>Dm.</i> ₂	46	23	10
<i>Dm.</i> ₃	34	24	9
<i>Dm.</i> ₄	34	21	14

As is well known, the milk molars are distinguished from the premolars which succeed them by their relatively low crowns. It

will be observed also that these milk molars are both longer and narrower than the premolars.

In the American Museum of Natural History is a lower jaw of a young horse which the writer refers to *Equus niobrarensis*. It was found at Hay Springs, with the other remains obtained there. In this jaw there are present the three milk molars (fig. 23) and the anterior two permanent molars. The second of these is little worn. The first permanent incisors had not yet begun to wear and the others are missing from the specimen. The specimen is to be compared with a jaw of similar age described here under *E. excelsus* (fig. 24).



FIGS. 22-24.—22, *EQUUS NIOBRARENSIS*. $\times \frac{1}{3}$. AMER. MUS. NAT. HIST. RIGHT UPPER MILK MOLARS. 23, LEFT LOWER MILK MOLARS. 2758, AMER. MUS. NAT. HIST. 24, *EQUUS EXCELSUS*. $\times \frac{1}{3}$. LEFT LOWER MILK MOLARS. 2758, AMER. MUS. NAT. HIST.

Dimensions of the jaw and teeth of No. 2757, A. M. N. H.

	mm.
Length from front of jaw to rear of the ascending ramus parallel with the teeth ..	460
Length of the symphysis.....	95
Height in front of first milk molars, dm_2	72
Height in rear of third milk molars, dm_4	90
Height of condyle above the surface on which the jaw rests.....	235
Length of the space between last incisor and first milk molar, dm_2	$82 \pm$
First milk molar, length.....	40
First milk molar, width.....	16
Second milk molar, length.....	32
Second milk molar, width.....	15.5
Third milk molar, length.....	33.5
Third milk molar, width.....	15
First true molar, length.....	33
First true molar, width.....	13

It is very probable that the width of the first true molar would have been considerably greater after it had been worn down further. It will be observed that the outer valley pushes itself in between the ends of the two longitudinal valleys in the second and third molars. The first permanent incisor is 19 mm. wide and the cup is complete.

From all ordinary specimens of *Equus complicatus* this species is distinguished by the smaller teeth and by the far simpler arrangement of the enamel. It is distinguished in the same way from *E. scotti*. In neither of the species just named does the post-protoconal valley usually extend so near the outer wall of the tooth as it does in *E. niobrarensis*.

It is important that this species should be distinguished from *E. excelsus*, which has teeth of practically the same size. For comparisons see page 592.

EQUUS LAURENTIUS, new species.

Type.—A nearly complete skull now in the University of Kansas and having the catalogue number 347. Derived from supposed Pleistocene deposits near Lawrence, Kansas.

Characterized by rather small teeth, the length of the first upper molar being about 22 mm., the width about 23 mm. Enamel of the lakes only moderately folded.

Through the generosity of the paleontological department of the University of Kansas, at the head of which is Prof. C. E. McClung, the writer is permitted to describe a skull of a horse found near Lawrence, which the writer regards as a hitherto undescribed species. It is hereby named *Equus laurentius*. The photographs from which the illustrations of the skull have been prepared were taken under the supervision of Mr. H. T. Martin, of the department of paleontology.

This skull (pls. 72, 73), which lacks no part except the extremities of the nasal bones, was found in 1910 on a sand bar on the north side of the Kansas River near North Lawrence. Prof. J. E. Todd tells the writer that with the skull were found the femur of a carnivore and the base of an elk's antler. The femur of the carnivore has been identified by Prof. Roy L. Moodie as belonging probably to *Smilodon*.

In 1903 there were secured, about 1 mile north of the place where the skull of the horse was found, some skulls of the existing bison, besides the horn core and hinder part of the skull of a bison which Professor McClung has described as *Bison kansensis*. The locality is given by Professor Todd as being about one-half mile north of Bismark Grove, which is itself about a mile and a half east of North Lawrence.

It is thought that all the remains mentioned, except probably the skulls of *Bison bison*, were derived from the same deposit. The writer has consulted Prof. J. E. Todd, of the University of Kansas, regarding the geological age of this deposit. He responds that the remains are from the level of the present river, which has been cut down nearly 100 feet since the ice of the Kansan stage was across the valley; and that he sees no geological reason for thinking that it has been many years since they were deposited in their resting place. He knows of no older bed in the vicinity from which they have been derived.

On the other hand, as the writer has endeavored to prove,¹ no native horse has left its remains on drift of the Wisconsin stage, from which fact it appears reasonable to infer that the native horses had by that time become extinct. The same statement appears to be true of the extinct species of bison and of the carnivores known as the saber-toothed cats. Moreover, the skull here described is believed to be specifically identical with a fine specimen from Hay Springs, Nebraska, at which place have been found also three species of camels. This specimen is described below. These considerations make it probable that the horse skull, the skull of *Bison kansensis*, and the femur identified by Professor Moodie as belonging to *Smilodon* belonged to a time antedating the Wisconsin drift stage. The skulls of *Bison bison*, found near Lawrence, are less thoroughly fossilized and are probably of a later time. It seems not unlikely that deposits of the Aftonian stage had been laid down in an old valley of the Kansas River and that the river is now attacking these deposits. This conclusion appears to be confirmed by the fact that teeth of a horse apparently identical with those of *E. laurentius* have been found in Aftonian deposits in western Iowa.

In describing the species of fossil horses we must continually deplore the fact that many of them resemble one another very closely. When one has the teeth only for study, one longs for complete skulls, which it is believed might furnish distinguished characters, but when these have come to hand it is found that one is little better off than before. The skulls and its parts, including the teeth, of what are certainly different species, are greatly alike in form and often in size. At the same time there is in the parts of each species of horse so much variation that it is often difficult to determine where are to be placed the lines which one is certain must be drawn somewhere. Only by careful work on all accessible materials can one hope to approach correct results, and future research must be depended on to eliminate such errors as may find their way into this paper.

¹ Smiths. Misc. Coll., vol. 59, p. 10.

The following measurements were taken from the skull found near Lawrence. It belonged to an individual probably 8 or 9 years old.

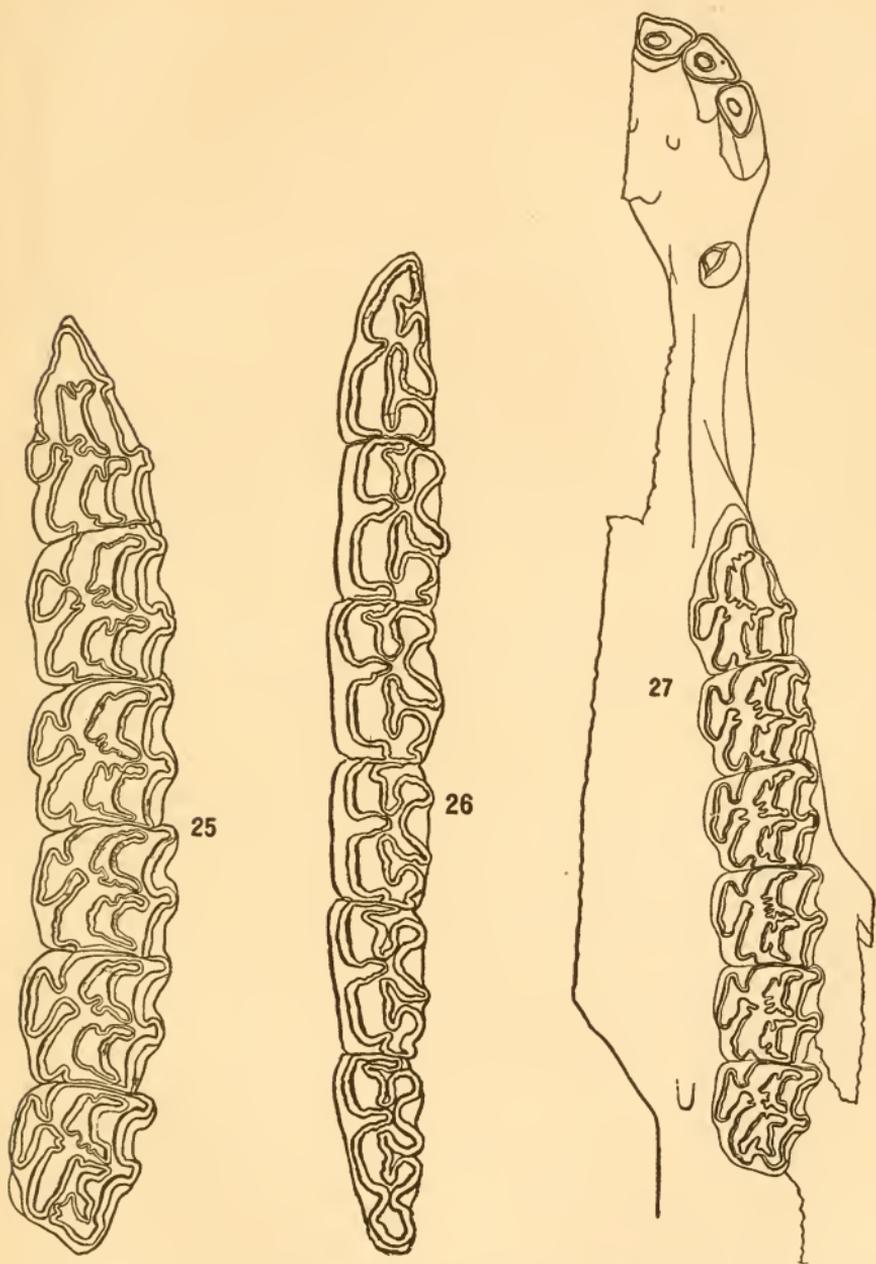
Measurements of skull.

	<i>mm.</i>
From middle of incisive border to front of foramen magnum.....	481
From middle of incisive border to front of posterior nares.....	260
From middle of incisive border to naso-premaxillary notch.....	163
From middle of incisive border to middle of occipital crest.....	541
From middle of incisive border to front of pm^2	128
From middle of incisive border to front of orbit.....	293
From middle of incisive orbit to naso-premaxillary notch.....	183
Width across mastoid processes.....	117
Width across articulations for lower jaw.....	197
Width from outside to outside of last molars.....	132
Width from outside to outside of last premolars.....	127
Width from outside to outside of canines.....	61
Width from outside to outside of outer incisors.....	65
Width of skull at the front of the orbits.....	153
Width of skull at the rear of the orbits.....	207
Width of skull on maxillary ridge at maxillo-malar suture.....	177
Width of palate at last molars.....	72
Width of palate at pm^2	68
Width of palate at diastema, least.....	45
Length of orbit.....	65
From front of symphysis of lower jaw to rear of ascending ramus.....	415
Length of symphysis.....	82
Height of jaw at front of m_1	73
From rear of canine to front of pm_2	68
From front of canine to rear of i_3	5

It is to be noted that in measuring the width of the crowns of the teeth, both upper (fig. 25) and lower (fig. 26), the cement layer is not included; but the measurement is taken from outside to outside of the enamel.

Measurements of the upper teeth.

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



FIGS. 25-27.—25, *EQUUS LAURENTIUS*. LEFT UPPER PREMOLARS AND MOLARS. $\times \frac{1}{2}$. TYPE. UNIV. KANSAS. 26, LEFT LOWER PREMOLARS AND MOLARS. $\times \frac{1}{2}$. TYPE. UNIV. KANSAS. 27, LEFT SIDE OF PALATE. $\times \frac{1}{2}$. 4991, U. S. NAT. MUS.

Measurements of the lower teeth.

	<i>mm.</i>
Length of premolar-molar series, pm_2 - m_3 , inclusive.....	175
Length of premolar series.....	89
Length of molar series.....	86
Pm_2 , length.....	32
width.....	15
Pm_3 , length.....	28
width.....	16.5
Pm_4 , length.....	29
width.....	16
M_1 , length.....	25
width.....	15
M_2 , length.....	26
width.....	14
M_3 , length.....	30
width.....	14

In the United States 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 catalogue number is 4991, and the specimen was collected by J. B. Hatcher in 1886, near Hay Springs, Nebraska. Figure 27 shows the dentition of the left side.

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.

	<i>mm.</i>
From middle of incisive border to line joining rear of m^3 of the two sides.....	275
From middle of incisive border to line joining front of pm^2 of the two sides....	117
Width of premaxillæ at base of i^3	70
Width of palate between c . and pm^2 , narrowest.....	40
Width at border of nasal opening just above last.....	69
Width of face opposite middle of pm^4	136
Width of face opposite m^2	180
Width of posterior nares.....	51
Length, premolar-molar series.....	158
Length, premolar series.....	87
Length, molar series.....	72
Pm^2 , length.....	36
width.....	23
protocone.....	11
Pm^3 , length.....	25
width.....	27
protocone.....	14
Pm^4 , length.....	25
width.....	25.4
protocone.....	15
M^1 , length.....	23
width.....	25
protoconc.....	14

Measurements of skull and teeth—Continued.

	mm.
M^2 , length.....	23
width.....	24
protocone.....	13
M^3 , length.....	27
width.....	21.5
protocone.....	13
i^1 , diameter from side to side.....	15
i^2 , diameter from side to side.....	15
i^3 , diameter from side to side.....	14

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 protocones 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.

In the Lawrence specimen it will be seen that the axis of the postprotoconal valley in the third and the 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 postprotoconal 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 pages 586 and 588 it is seen that the nose of the Hay Springs horse is slightly longer than in the type.

In the following table an attempt is made to determine the relations between the measurements of certain parts of the skull in *Equus caballus*, *E. niobrarensis*, and *E. laurentius*. In each case the shorter measurement is expressed as hundredths of the longer. The distance from the front of the premaxillary bones to the line joining the first cheek teeth, pm^2 , is called the nose. The width of this is taken at the middle of the length of the nasal opening.

In obtaining these ratios most of the measurements have been employed that are recommended by Prof. Henry F. Osborn in his paper *Craniometry of the Equidæ*.¹ The ratios have been obtained by multiplying the shorter length by 100 and dividing the product by the longer dimension.

¹ Mem. Amer. Mus. Nat. Hist., vol. 1, pp. 55-100.

Table of ratios.

Species and specimen.	Basilar length and width at glenoid fossæ.	Basilar length and width at rear of orbits.	Basilar length and width at front of orbits.	Basilar length and width on maxillary ridge at maxillo-malar suture.	Basilar length and length to rear of orbit.	Basilar length and length of tooth line.	Basilar length and length of nose.
	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
<i>Equus caballus</i> , 843, U.S.N.M.	39	40	27.8	34	76.6	33.6	25.1
<i>E. caballus</i> , 174960, U.S.N.M.	38.7	40	29.6	35	75.3	30.6	27.1
Arabian horse, No. 172454, U.S.N.M.	40	43	31.5	37	75	34.5	26.4
<i>E. niobrarensis</i> type	41	45	29.8	35.3	76	33.8	25.7
<i>E. laurentius</i> type	41	43	31.8	37	75	33.2	27.9

An examination of this table appears to show that *Equus caballus*, as represented by the two specimens used, stands out as a horse with a relatively narrow skull; the Arabian horse as one with a broad skull; *Equus niobrarensis* as one with a skull wide, especially at the glenoid fossæ and the orbits, but narrowing at the front of the jugals; while *Equus laurentius* has a broad skull and a rather long nose. It is possible that in the case of *E. niobrarensis* the width of the orbits has been somewhat increased by distortion; but this is not apparent to any considerable degree, and the distortion has certainly not affected the region across the glenoid fossæ. The Arabian horse which is mentioned above is supposed to be of pure blood. The skeleton was presented to the United States National Museum by the cartoonist Mr. Homer Davenport. It will be observed that the skull is relatively broad, but the face is not found to be particularly short. Shortness of face is given by Nehring¹ as the character of Arabian horses which distinguishes them from the large breeds of western Europe. Nevertheless, when Nehring's measurements of the face are employed to determine the ratio of the basilar length to the length of the line extending from the front of the premaxillæ to the middle of the line joining the rears of the orbits, there is found to be little or no difference between his so-called long-faced horses and the Arabs. In fact, the horse recorded by him as having the longest face, his number 51, has the facio-cephalic index only 72; whereas, his number 31, an Arab, has a facio-cephalic index of 75. It is to be remembered that Nehring's index for the length of the face is obtained, not by comparison with the basilar length, but with the distance from the rear of the orbit to the middle of the occipital crest.

As to *E. laurentius*, the type shows that the part in front of the orbit is relatively short; while the occipital crest is curved somewhat backward, but not so much as in the ass.

¹ Landw. Jahrb., vol. 13, p. 110.

A study of the arrangement of the enamel of *E. laurentius* shows that it is much like that of *E. niobrarensis*; and far more simple than in *E. complicatus*. The contiguous ends of the two lakes are about as much folded as in *E. niobrarensis*, probably more so. The post-protoconal valley differs from that of the latter species, being narrower and almost without a reentering loop at its inner end. Moreover, it is directed more nearly forward, and its extremity does not reach the center of the tooth.

In the lower jaw the cheek teeth have the enamel bands less crinkled than in *E. niobrarensis*. They differ from the latter in another respect. At the middle of the length of the outer, or buccal face of the tooth, there is a reentering loop, or valley, of enamel. In the species here described it will be seen that this valley pushes itself in between the adjacent ends of the two loops of enamel that run longitudinally near the middle of the tooth. Only in the two anterior premolars does this relation of the loops fail to develop. In the type of *E. niobrarensis* the longitudinal loops wholly exclude the outer loop. It will be noted further that the outer loop in *E. niobrarensis* is pretty deeply notched in its hinder side. The lower teeth of *E. laurentius* resemble, with respect to the loops, those of *E. caballus*; but those of the latter have a notch in the hinder border of the outer loop. It will be observed that the teeth of *E. laurentius* are smaller than those of *E. niobrarensis*.

In differentiating the present species from *E. excelsus* Leidy we are, at present, limited to comparison with the type specimen of the latter. This is in the United States National Museum. It was figured by Leidy¹ and again by Gidley.² It consists of a fragment of the right maxilla and the last upper premolar and the three molars. These four teeth measure in length but a little more than the corresponding teeth of *E. laurentius*. Three differences in the arrangement of the enamel are noted between the two species. (1) In *E. laurentius* the post-protoconal valley keeps closer to the lingual side of the tooth than in *E. excelsus*. (2) In the latter species the front border of the anterior lake is without notch and it swings backward in a curve to near the head of the post-protoconal valley and then turns abruptly outward to form a notch. In *E. laurentius* this front border is conspicuously notched; while, facing the head of the post-protoconal valley, the border rounds backward and outward to form a notch that is often M-shaped. (3) Both the front and the hinder borders of the posterior lake are more deeply notched than in *E. excelsus*. In general, there is in *E. laurentius* a higher degree of complication of the enamel than in *E. excelsus*.

¹ Ext. Mamm. Fauna Dak. and Nebr., pl. 21, fig. 31.

² Bull. Amer. Mus. Nat. Hist., vol. 14, p. 114, fig. 9.

EQUUS EXCELSUS Leidy.

Equus excelsus was, as already stated, described and figured by Dr. Joseph Leidy in 1869. The exact locality where the specimen was found is not known, but it was somewhere along the Loup River, approximately at the center of the present State of Nebraska.

The teeth of *E. excelsus* (type) are but little smaller than those of *E. niobrarensis*. That they may be compared, measurements are here given. Gidley's figure of these teeth¹ is accurate, except that the engraver has made it 4 mm. too short.

Measurements of teeth of the type of E. excelsus.

Teeth.	Type.	"112" A.M.N.H.
	<i>mm.</i>	<i>mm.</i>
Length of last premolar and 3 molars.....	107	113
Length of 3 molars.....	78	84
<i>Pm.</i> ³ , height.....	78	55
length.....	28	29
width.....	28	27.5
protocone.....	16	12.5
<i>M.</i> ¹ , height.....	66	58
length.....	26	27
width.....	28	26
protocone.....	14.2	13.5
<i>M.</i> ² , height.....	77	53
length.....	26	27
width.....	25	25
protocone.....	15.5	13
<i>M.</i> ³ , height.....	79	55
length.....	28	29
width.....	22	23
protocone.....	14	15

It will be seen that no important differences are to be found between the teeth of this species and those of *E. niobrarensis* as regards size. There appear, however, to be differences of specific value in their structure. The post-protoconal valley of *E. niobrarensis* is broader than that of *E. excelsus*; it extends nearer the center of the tooth, and it is more deeply notched at its anterior end. The front border of the anterior lake in *E. niobrarensis* is deeply notched, but not notched in *E. excelsus*. The form of this lake in the two species is very different. The hinder border of the posterior lake in *E. niobrarensis* is deeply notched; in *E. excelsus*, little or not at all.

In *E. niobrarensis* the post-palatine foramen is placed opposite the front half of the last molar; in the type of *E. excelsus*, it is opposite the front end of the second molar.

In the American Museum of Natural History is a fragment of a right upper jaw which furnishes the same teeth as the type does, the last premolar and the three molars (fig. 28). It bears the field number 112 and is part of a collection made at Hay Springs, Nebraska, in 1893, by Wortman, Peterson, and Gidley. For comparison the measurements are given in the second column of the preceding table.

¹ Bull. Amer. Mus. Nat. Hist., vol. 14, p. 114, fig. 9.

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. It will be seen that the front border of most of the anterior lakes is slightly notched and likewise the hinder border of some of the posterior lakes. The post-protoconal valleys resemble those of the type of *E. excelsus*.

Figure 24 presents a view of the left lower milk molars of a jaw, No. 2758, from Hay Springs, now in the American Museum of Natural History. This jaw belonged to a colt of practically the same age as the jaw, No. 2757, described under *E. niobrarensis*, but slightly younger. M_1 is in use; m_2 is not quite through the bone; the permanent incisors had not begun to wear. The jaw is 100 mm. shorter than that numbered 2757.

Measurements of lower jaws.

	mm.
Front of jaw to rear of ascending ramus.....	360
Length of symphysis.....	63
Height of jaw at front of dm_2	60
Height of jaw at rear of dm_4	76
Height of condyle above lower border of jaw.....	220
Dm_2 , length.....	32
width.....	12
Dm_3 , length.....	30
width.....	13
Dm_4 , length.....	32
width.....	12
M_1 , length.....	32
width.....	11

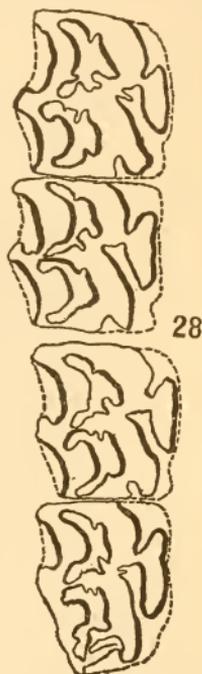


FIG. 28.—EQUUS EXCELSUS. LAST PREMOLAR AND THREE MOLARS OF RIGHT SIDE OF UPPER JAW. $\times \frac{1}{4}$. "112," AMER. MUS. NAT. HIST.

It is probable that most of these teeth, especially the last milk molar and the first true molar, have the grinding surface longer than it would have been at a little later stage of wear; and the true molar is narrower than it would have been later. On comparison of these milk molars with those supposed to belong to *E. niobrarensis*, it will be seen that the latter are both longer and considerably broader. Also the median outer valley pushes in between the longitudinal valleys, whereas they fail to do so in No. 2758.

It is impossible to refer this jaw with certainty to any described species, but it seems more probable that it belongs to *E. excelsus* than to any other known species. It may be stated that among the Hay Springs horses was one whose lower premolars and molars formed a row even longer than that of *E. niobrarensis*; but these teeth were much narrower.

EXPLANATION OF PLATES.

PLATE 69.

- Fig. 1. *Equus fraternus*. Lower incisors. $\times 1$. Wagner.
2. *Equus niobrarensis*. Skull viewed from above. $\times \frac{1}{4}$. Type.
3. *Equus niobrarensis*. Skull viewed from below. $\times \frac{1}{4}$. Type.
4. *Equus niobrarensis*. Upper incisors. $\times \frac{3}{4}$. Type.

PLATE 70.

Equus niobrarensis. Skull seen from side. $\times \frac{1}{4}$. Type.

PLATE 71.

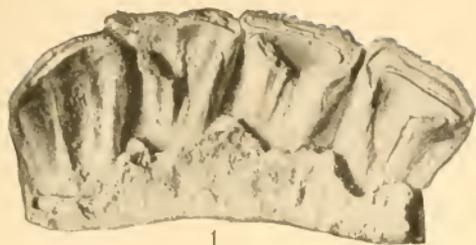
- Fig. 1. *Equus niobrarensis*. Lower incisors. $\times 1$. Type.
2. *Equus niobrarensis*. Lower incisors. $\times \frac{3}{4}$. "24," Amer. Mus. Nat. Hist.
3. *Equus excelsus?* Lower incisors. $\times 1$. 2762, Amer. Mus. Nat. Hist.

PLATE 72.

Equus laurentius. Skull viewed from the side. $\times \frac{1}{4}$. Type.

PLATE 73.

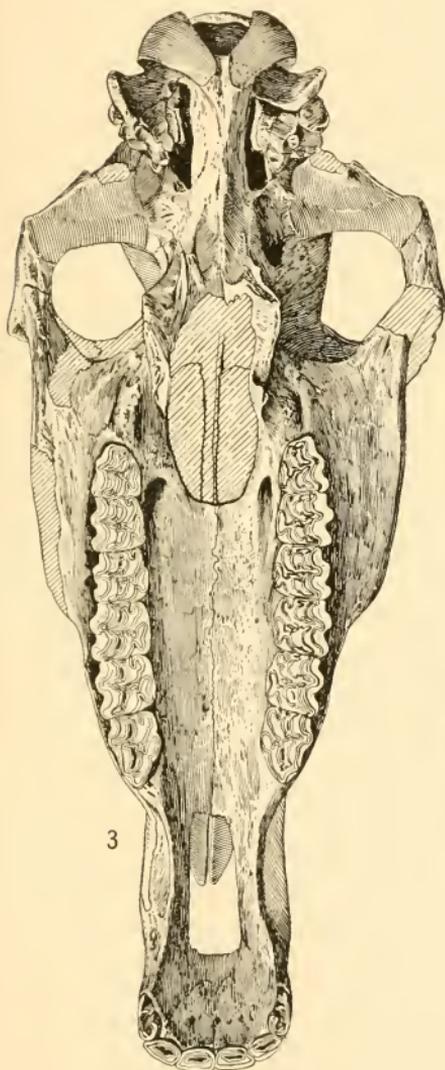
- Fig. 1. *Equus laurentius*. Skull seen from above. $\times \frac{1}{4}$. Type.
2. *Equus laurentius*. Skull seen from below. $\times \frac{1}{4}$. Type.



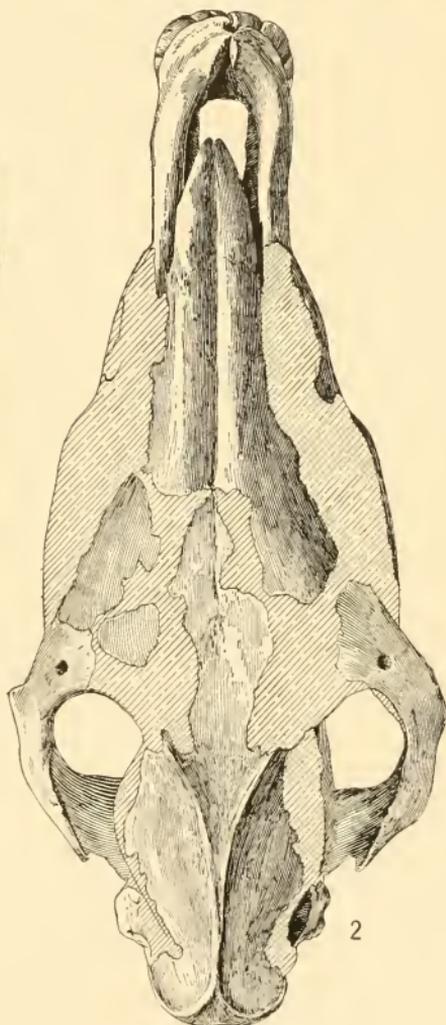
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4



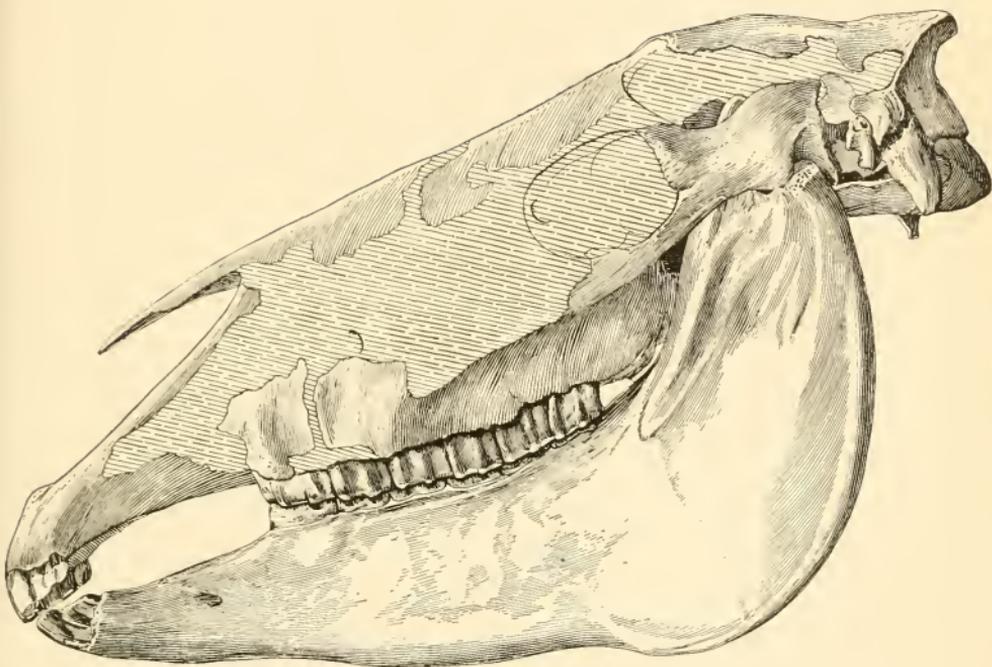
3



2

EQUUS FRATERNUS AND *EQUUS NIOBRARENSIS*.

FOR EXPLANATION OF PLATE SEE PAGE 594.



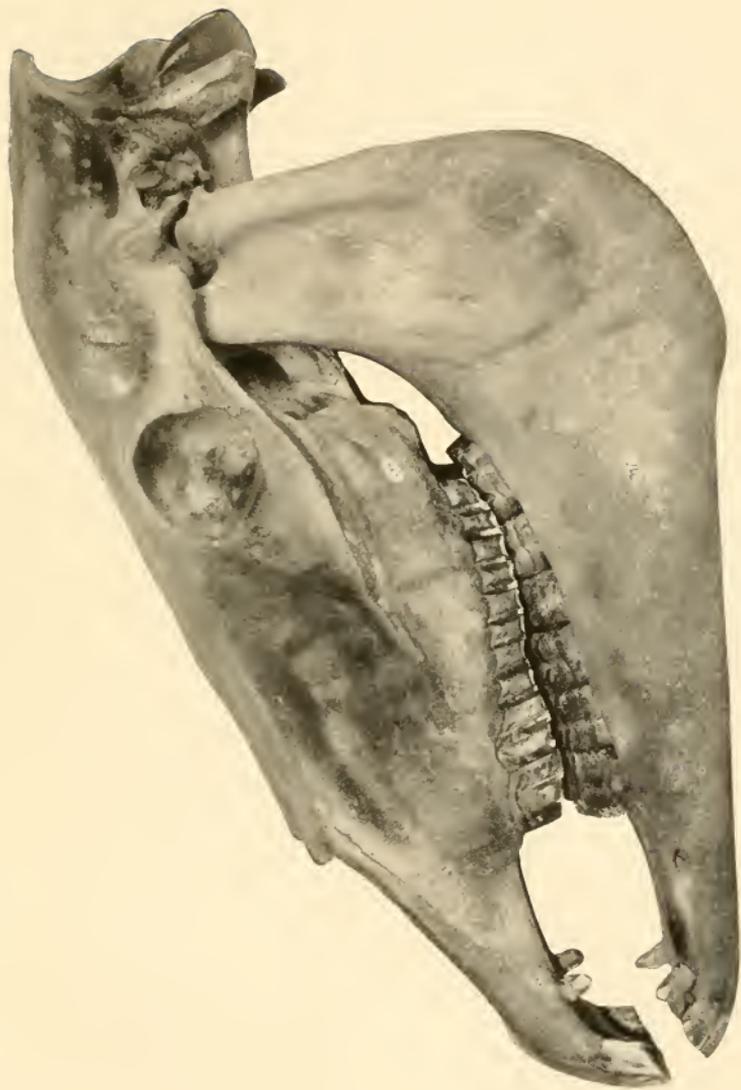
EQUUS NIOBRARENSIS.

FOR EXPLANATION OF PLATE SEE PAGE 594.



EQUUS NIOBRARENSIS AND EQUUS EXCELSUS?

FOR EXPLANATION OF PLATE SEE PAGE 594.

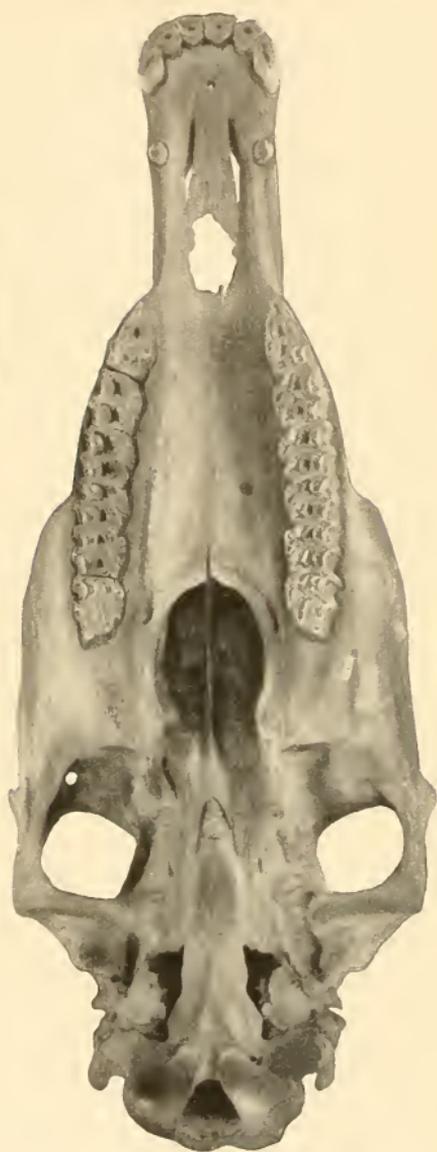


EQUUS LAURENTIUS.

FOR EXPLANATION OF PLATE SEE PAGE 594.



1



2

EQUUS LAURENTIUS.

FOR EXPLANATION OF PLATE SEE PAGE 594.

