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A
PRELIMINARY REPORT
ON THE
~~CANCELLED~~
VERTEBRATE PALEONTOLOGY
OF THE
LLANO ESTACADO.

BY
E. D. COPE.

~~CANCELLED~~

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Wm. H. W. W. W.
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INTRODUCTION.

The Llano Estacado, or Stockaded Plain, as Prof. J. D. Dana proposes to anglicize it, has long been a locality of note.

Its supposed desert conditions have been stated on many maps, and few expeditions have ventured across it, consequently little was known of its real character. With the gradual settling up of those portions of the State to the east came the steady westward extension of the frontier line of pioneers, who, coming to the plains, found them well adapted to grazing, and although the surface water was comparatively scarce, obtained abundant supplies at moderate depths. Thus, while the region is still sparsely settled, it is fully demonstrated that this so called desert is not only well adapted for cattle raising, but that its agricultural possibilities are of high order as well.

The geology of the Llano Estacado has been written of by the geologists who accompanied the different government expeditions which touched it at various points. Among the earliest of these was Dr. Geo. G. Shumard, who was geologist of the "Red River Expedition" under Captain R. B. Marcy.

He describes the borders of the Llano Estacado as presenting "a long line of bluffs six hundred feet high, and composed of horizontal layers of drift and sandstone, interstratified with white limestone. From the base of the bluffs to the river the country presented a gradual slope of four hundred feet."

The section which he gives in Plate 10 represents the geological formation from the river to the top of the bluff. He says: "The inferior strata, or those between the base of the bluff and the river, having been ascertained from numerous observations to consist of gypsum and red clay." His section shows 425 feet of this material, overlaid by 575 feet of "gray and yellow sandstone, interstratified with thin seams of non-fossiliferous limestone, and this in turn by 100 feet of "drift with small boulders." He says of this: "From the drift I obtained specimens of chalcedony, jasper, granite, and obsidian." *

* Marcy's Exploration of the Red River, Washington, 1854, pp. 168, 169.

The remarks of Prof. Hitchcock on the age of the drift (p. 152) may, but possibly do not, apply to the Llano drift, since Dr. Shumard does not mention any of the silicified wood as coming from the drift observed on top of the Llano.

Prof. Hitchcock says:

“I have been lead to suspect that what Dr. Shumard calls drift may be only a newer portion of the Tertiary strata, although, as already remarked, silicified wood is found in almost all the fossiliferous formations. All of the specimens sent by you, however, with one exception, are dicotyledonous. They resemble not a little the fossil wood from Antigua, and the desert near Cairo, in Egypt, both of which deposits are Tertiary. One specimen is a beautiful example of monocotyledon, a cross section showing vessels of the shape of a half or gibbous moon. This fact shows that the climate was warm enough for trees analogous to the palm tribe to flourish; yet the great predominance of dicotyledonous forms shows a close analogy with the existing vegetation of the southern part of our country; nor is there evidence in these specimens of a temperature above that now existing in our southern States, since several species of palms occur there.”

Captain Marcy himself makes this statement in regard to the same locality:

“The geological formation of these bluffs is a red indurated clay, resting upon a red sandstone, overlaid with a soft dark gray sandstone, and the whole capped with a white calcareous sandstone, the strata resting horizontally, and receding in terraces from the base to the summit.” *

Following this expedition came the surveys of the Pacific Railroad route. In volume II of this report Mr. W. P. Blake reports on the geology of the route along the thirty-second parallel from the collections of the party under Captain Pope. Of the Llano Estacado he says (p. 17):

“The specimens of the rocks from the Llano Estacado have a general resemblance to each other, and show the nearly uniform nature of the geological formation. They consist for the most part of light colored, whitish, or gray calcareous sandstones, with specimens of compact amorphous limestone, which resembles the specimens containing the Cretaceous fossils from the Big Springs. Three or four specimens consist of sand and gravel united by a calcareous cement, and looking as if these materials had been exposed to the infiltration of water highly charged with carbonate of lime. * * * These have a very modern aspect, and much resemble the sandstones and conglomerates of the Tertiary age.

* p. 50.

Indeed, all the specimens of the sandstones of the Llano are so much like those of the Tertiary, that if it were not for the presence of Cretaceous fossils, I would have been led to regard them as of that period."

Again he says (p. 21):

"The drift deposit, which has been described by Dr. Shumard as covering the rocks of the Llano, may, and very probably does, belong to the age of the Tertiary; but the materials and facts that were procured by Captain Pope are not sufficient to warrant any conclusions on this point."

In his description of the building stones of the collection, he says of those from the Llano Estacado:

"All these specimens have a modern look and resemble the Tertiary sandstones along the margin of the Colorado desert, where some of the upper beds are highly charged with carbonate of lime in the form of travertine, or calcareous tufa."

The survey along the thirty-fifth parallel had with them as geologist Mr. Jules Marcou. In his field notes, published in Volume III of the same report, he gives the following section, which he says "is the same at the foot of the Llano:"

"White limestone.

"Calcareous conglomerate.

"Limestone.

"Sandstone with numerous calcareous concretions.

"Red sandy marls of the New Red."

According to the journal here published, Mr. Marcou at first regarded the plains as probably Cretaceous, but afterwards decided that they were Jurassic.

In his *Geology of North America** he very fully gives his reasons for assigning it to this period, which are, the finding of fossils that he considered identical with European forms belonging to the Jurassic, in Pyramid mountain, which he considers as a continuation of the deposits of the Llano. He, therefore, colors the Llano as Jurassic in the map accompanying his work.

Mr. Blake, who discusses the geology of this line also, differs from Mr. Marcou, and from his understanding of the paleontological evidence makes the Plains Cretaceous. He states as follows (p. 80):

"Most, if not all, of these Cretaceous fossils were procured from the edges of the horizontal strata which compose the extensive table-lands

*Zurich, 1858.

along the route, and they indicate to us the Cretaceous age of the Llano Estacado.

“Further evidence of this is found in the collection made by Captain John Pope on the Llano further south, near the parallel of 32.

“He procured specimens of *Gryphæa* in the bluffs of the Llano at the Big Springs of the Colorado, and also on the surface, near the [southern end of the] sandhills, and these fossils, together with the specimens of the strata and other evidences, led me to describe the Llano as Cretaceous, in the report on the geology of that route.

“The Llano is doubtless continuous southeasterly from these localities to vicinity of Austin and San Antonio, where it forms bluffs filled with Cretaceous fossils, already described by Ferdinand Roemer.

“There is thus little doubt the strata of the Llano Estacado and the other plateaux along the route, resting upon the gypsum formation, are of Cretaceous age, surmounted, perhaps, in places by more recent deposits.”*

These Cretaceous fossils were the evidence which carried most weight with him, although, as we have seen, before he recognized the lithological resemblance of the Llano materials to those of Tertiary age.

He continues: “There is much reason to believe that the Cretaceous strata of the Llano are surmounted by Tertiary deposits over a part of the Plain. This is indicated by the second line of bluffs, or second step, seen from the valley of the Canadian. Dr. Shumard also, who examined the Llano at the sources of the Red River, found a layer of rounded gravel and pebbles upon the top, which he denominates *drift*, and which at some places was found to be about 100 feet thick. Fragments of agate and carnelian, and of silicified wood, appear to abound in this deposit. The same pebbly bed appears to be found west of the Sierra Madre, on the table lands of Zuni and its vicinity. These are in all probability Tertiary or Post-Tertiary deposits; but as they are not characterized by fossils, and as their extent is not known, I have not indicated them on the map.”

These are the first references of these beds to a Cenozoic age, and they are based upon as good evidence as any that is adduced in any subsequent publication prior to those of this Survey.

On the geological map prepared by Profs. Hall and Lesley to accompany the report of Major W. H. Emory on the United States and Mexican Boundary Survey,† a portion of the Llano Estacado is colored

*Pages 79, 80.

† Washington, 1857.

as Tertiary, but no reference is made to it in the text, owing, as Prof. Hall writes me, to some delay in the preparation of the map.

He also says:

"The geological formations and the boundaries between them were determined from the best information I could derive from all sources within my reach.

"I had before me all the publications which had reference to any portion of that country, and also the collections of rocks and fossils made by Dr. Parry and Mr. Arthur Schott. I had, moreover, the aid of Dr. Parry in giving me his oral explanations of the country passed over and examined during the exploration. There may have been other sources which have now passed out of my mind. I * * * absorbed all information which came within my reach, and did the best I could to express it upon the geological map."

Prof. Marsh, in his description of the Lake basins of the Rocky Mountains, makes this statement regarding the Pliocene lake basins:*

"At the close of the Miocene, a subsidence took place east of the Rocky Mountains. A great Pliocene lake was thus formed directly over the eastern Miocene basin, having nearly the same boundaries on the north and west, but extending much further east, and stretching south nearly to the Gulf of Mexico. It covered an area at least five times as great as the older lake, while its deposits attained a thickness of nearly or quite 1500 feet. This lake basin may with great propriety be called the Niobrara basin, since the Niobrara River cuts through its typical strata for more than 200 miles of its course.

"The beds in this basin lie nearly horizontal. They are light in color, and much more arenaceous than the Miocene below. The upper strata consist of hard sandstones or calcareous grits, which weather but slowly, and hence still form the great table lands over much of the area of the basin. * * *

"The fauna of this lake basin indicates a warm temperate climate. The more common mammals are a mastodon, rhinoceroses, camels and horses, the latter being especially abundant."

In accordance with this description of the Pliocene lake basins by Prof. Marsh, Prof. J. LeConte, in his "Elements of Geology," maps the Niobrara basin as extending southward over the area occupied by the Llano Estacado.†

* American Journal of Science, vol. IX, January, 1875, p. 52.

† Map of Tertiary Times, showing outlines of coast and places of principal Tertiary lakes. Elements of Geology. J. LeConte.

This statement is based on recent advice from Prof. LeConte.

The present report shows how nearly the facts were represented by this map made by Prof. LeConte years previous to the present investigation.

In the spring of 1887, while the law creating a geological survey was before the Legislature, Profs. W. F. Cummins and R. T. Hill addressed that body on the subject of geology. In his address, Prof. Cummins made the statement, as the result of his investigations, that the Llano Estacado was the site of a fresh water lake in Quaternary times.

During the next year, Prof. Hill crossed the State in two railroad trips, one via the Texas and Pacific, in company with Prof. Cummins, westward by Pecos City, passing over the southern part of the Plains; the other to Tucumcari, crossing the northern border of the Plains. In an article entitled "Notes on the Geology of Western Texas," published in the Geological and Scientific Bulletin for October, 1888, immediately after his return from the West, he says:

"The surface of the Llano Estacado is an early Quaternary loam, and a direct continuation of the great plains of Kansas and Nebraska."

Similar statements were made by him in other papers, but in none of them was there any reason given for thus referring the deposits which was more conclusive than those already offered by Shumard, Blake, Hall and Lesley, Marsh, Le Conte, and Cummins before him.

It will be observed that all of the statements, except that of Mr. Marcou, while agreeing upon the fact of the presence of Tertiary or Quaternary deposits in the Llano Estacado, are simply based upon the lithologic character of the materials, and in no case was any positive paleontologic evidence brought forward to substantiate the assertions.

The actual determination of the age of these deposits is the result of the work of this Survey.

In the winter of 1889-90 Prof. Cummins, while making his section across the Permian to the top of the Llano Estacado, found the first fossils in the plains material at Blanco Canyon, Crosby county. The beds were briefly described in his paper, "The Permian of Texas and Its Overlying Beds," in our First Annual Report (1889) under the name of "Blanco Canyon Beds" (p. 190), and stated to be later than the Cretaceous.

In the same Report the beds are referred provisionally (on account of lithological resemblance and diatomaceous earth) to the same horizon

as the upper portion of the Fayette beds as described by Penrose. In the Second Annual Report the deposits were described more in detail and referred to the Tertiary. The third year's field work of the party under Prof. Cummins was around the Llano Estacado, and much more extensive collections were made, some of which were sent to Prof. Cope for determination, and he, recognizing their great importance, kindly offered to visit the localities in person for the purpose of securing more complete collections from the various beds. Arrangements were accordingly perfected by which he made the trip, in company with Prof. Cummins, in order that the best possible returns might be obtained.

The results brought out by the report of Prof. Cope, which follow, are the determination of the occurrence of both Tertiary and Quaternary deposits, and that the forms of the Blanco and Goodnight beds not only present new species, but are strictly intermediate between the Loup Fork and Equus beds, and, as he says, more strictly Pliocene in character than any of the interior lake deposits heretofore described.

The paper here presented is therefore of importance, not only as definitely determining the ages of certain portions of the Plains deposits, but as a valuable addition to our knowledge of these most interesting forms of life which were the precursors of those of the present.

For the details of the stratigraphy, location of beds, and other information regarding the deposits themselves, reference is made to Prof. Cummins' paper on this area, which also forms a part of this Fourth Annual Report.

E. T. DUMBLE,
State Geologist

A PRELIMINARY REPORT
ON THE
VERTEBRATE PALEONTOLOGY
OF THE
LLANO ESTACADO.

E. D. COPE.

CHAPTER I.

THE VERTEBRATE REMAINS FROM THE DOCKUM TERRANE OF
THE TRIASSIC SYSTEM.

The Triassic formation is exposed extensively throughout the entire region at the eastern, northern, and western bases of the Staked Plains, as already pointed out by authors. An exploration conducted for two seasons by Mr. W. F. Cummins has demonstrated that it is not rich in fossils of any kind, and that such vertebrate remains as occur are very fragmentary. In the following pages such as are susceptible of identification are described.

The entire red region of Northern Texas and the Indian Territory was originally referred to the Trias by Marcou. In 1878 I obtained evidence that the greater part of this area belongs to the Permian terrane, and so stated in various publications.* During his exploration of 1890, Mr. Cummins obtained some teeth from the Dockum beds, which were sent me for identification, and I found them to belong to the Triassic reptilian genera *Belodon*, *Clepsysaurus* and *Palæoctonus*.† These genera have been found in the Triassic beds of the Atlantic States. The explorations of 1891-92 added the genera *Typothorax* and *Episcoposaurus*, which, with *Belodon*, I had previously detected in the Triassic bed of New Mexico.

*American Naturalist, 1878, May.

†Ann. Report Geol. Survey Texas, 1890, p. 423.

Fragments, probably representing the Batrachian genus *Eupelor* of the Atlantic Trias, also occur.

There can be no difficulty in distinguishing the Triassic from the Permian formations, if remains of the reptilian fauna are present; the change of type was radical, and there are no resemblances between the forms of the respective horizons.

The lacustrine conditions which I ascertained to have prevailed in New Mexico also characterize the formation in Texas. I obtained in the former region the *Unio terrærubra* of Meek; while Mr. Cummins discovered extensive beds of Unios in the Trias of Northwest Texas, composed of a species to which he has given the name of *Unio dockumensis*.

The vertebrate fossils are always fragmentary, so that but few of them can be satisfactorily determined.

BATRACHIA.

As already remarked, fragments of a species of this class are found in the Dockum beds. They have been found most abundantly near to Dockum. They consist of fragments of dermal and cranial bones, which exhibit the regular honey-comb pitting of the Pennsylvania species of *Eupelor*. A phalange found also resembles that of the Permian genus *Eryops*.

REPTILIA.

BELODON, Meyer.

Fragments of the skeleton of species of this genus are the most abundant fossils found in the Dockum beds. They are, however, generally scattered and fragmentary. An exception of this condition occurred near Dockum, where a considerable part of the skeleton of one individual was found together.

BELODON SUPERCILIOSUS, Cope.

Sp. nov. Plate I.

This saurian is represented by a number of fragments of the skull, including the left frontal bone, with the greater part of the postfrontal and parietal attached in place; fragments of the splenials, quadrates, arches, etc., with a very few fragments of vertebræ—one including the right half of a centrum; parts of femur, fibula, and other long bones, with numerous dermal bones and several teeth. These were all found together in a light gray bed not far from the red bed which contained the remains of the typical specimen of *Episcoposaurus haplocerus*.*

The dermal bones have the characters of those of the European Belo-

*Proceed. Amer. Philosoph. Soc., 1892, p. 129.

dons as described by Von Meyer.* They are subquadrate in form and have a more or less obtuse longitudinal keel in the center, which does not extend to the anterior or posterior borders. The latter are thinned out and more or less irregular, while the lateral borders are in the larger plates furnished with sutures, though of no great thickness. In the larger plates irregular rugosities extend for a short distance at right angles to the median keel; in the smaller plates the surface is nearly smooth. There are a good many small plates without keel or sutural border and which were evidently isolated in the integument of the animal. No plates showing spines were discovered.

The left frontal bone is preserved, minus a lamina from the internal side of its posterior third. Its measurements are one-half greater in any one direction than those of the *Belodon buceros*, Cope, and it differs from that species and the *B. kapfii*, Meyer, in the form of its superior surface. Instead of being plane as in those species, the supra-orbital border is flared upward so as to divide the frontal surface into three sub-equal parts, viz., a central flat-bottomed groove, and an oblique elevated plane on each side of it. The surface anteriorly is strongly irregularly pitted and ridged, much more so than the *B. buceros*. The posterior half is smooth except at the borders. The inferior lateral ridges diverge on each side to the inferior edge of the postfrontal suture. The latter advances to the anterior third of the orbital border as in the *B. kapfii*. The postfrontal is smooth at the borders, but presents rugosities which generally run to the parietal border. The latter is rough posteriorly.

The splenial bones unite to form part of the symphysis at an acute angle, and do not diverge from the latter in the concave line displayed by the *B. kapfii*. Their inferior surface is flattened, and is marked by three lines of narrow longate fossæ. The width of these bones exceeds the depth, while the reverse is the case in the *Episcoposaurus horridus*.

The best preserved and most characteristic tooth is of the longate type shown by Meyer to belong to the anterior part of the jaws. Of the diameters of the base, the longitudinal a little exceeds the transverse, and the two cutting angles separate a little convex interior face from a very convex exterior face. There are a few faint traces of grooves at the base of the latter. The crown is curved slightly inwards. A second well preserved crown is very different. It is shorter, and stouter at the base, where the transverse exceeds the anteroposterior diameter. The angular lines are only visible on the apical half of the crown, and the entire surface, except near the apex, is marked with well defined approximate grooves with rounded bottoms.

The type of tooth first described is characteristic of all *Belodons*, but Von Meyer figures and describes a specimen of the second type

* *Paleontographica*, Vol. VII, 1859-61.

which he is unwilling to regard as belonging to another species, as he finds every gradation between the two forms. As the collection of fragments of *Belodons* here described includes remains of but one species, and probably individual, I can not do better than follow Von Meyer's example for the present.

The fragment of femur includes the low trochanteric crest, which is characteristic of the genus. It is angulate at the middle, the superior half being directed toward the interior border of the shaft, and oblique to its axis. The external border of the shaft is much less robust than the internal border. It has been somewhat expanded above by pressure. The supposed fibula is a slender bone with an open sigmoid flexure, and a want of continuity of the inner or longest concave margin. The margin from one of the extremities of the bone advances on the flat side of the shaft and forms the boundary of a surface apparently for muscular insertion. The only extremity which is preserved is somewhat weathered. It is in section an oval, flat on one side. The condyle is simply convex in both directions.

Measurements.

	Mm.
Elevation of crown of ungrooved tooth	32
Diameters of same at base.....	{ anteroposterior..... 9.5
	{ transverse..... 9.5
Elevation of crown of grooved tooth.....	20
Diameters of same at base.....	{ anteroposterior..... 8
	{ transverse..... 9
Tranverse diameter of left frontal bone at orbit.....	34
Tranverse diameter of left frontal bone at prefrontal	17.5
Thickness frontal at median suture.....	16
Greatest width between olfactory ridges.....	42
Inferior width splenial at beginning of symphysis.....	37
Length splenial included in symphysis.....	135
Diameters of femur at third trochanter.....	{ anteroposterior..... 40
	{ transverse..... 70
Diameters fibula near middle.....	{ anteroposterior..... 29
	{ transverse..... 21
Diameters dermal scute.....	{ anteroposterior..... 72
	{ transverse (estimated)... 78
Thickness of same at sutural margin.....	10
Thickness with keel.....	27
Diameters of a free dermal bone.....	{ anteroposterior..... 27
	{ transverse..... 27
Thickness of same.....	8
Diameter of dorsal centrum.....	{ vertical..... 46
	{ anteroposterior..... 56

The measurements of the skull are about one-half larger than those of the *B. buceros*,

PALÆOCTONUS, Cope.

Proceedings Amer. Philos. Society, 1877, p. 182.

This genus embraces the largest known carnivorous Dinosauria of the Triassic age. Up to the present time the only remains referable to it consist of teeth. These are of two kinds, the one less compressed and more elongate, and the other more compressed and less elongate. The former I have supposed to occupy the more anterior position in the series in accordance with the characters of the Megalosaurid genera of the Jurassic and Cretaceous ages. This supposition is sustained by the fact that the two forms of teeth are generally found together. In *Zanclodon* Myr., the Megalosaurid of the European Trias, the teeth are of equal size. The only species known hitherto is the *P. appalachianus*, Cope (l. c.), from the Keuper Trias of Pennsylvania. The explorations of the Geological Survey of Texas, conducted by Mr. W. F. Cummins, in the northwestern part of the State, demonstrate the existence of two species in the Triassic beds which outcrop at the base of the eastern escarpment of the Staked Plains.

PALÆOCTONUS ORTHODON, Cope.

Sp. nov. Plate II, Figure 1.

Represented by a single anterior tooth of large size. The axis of the crown is straight, being curved neither inward nor posteriorly. The internal face is nearly flat transversely at the base, and is moderately convex from the middle to the apex. The posterior cutting edge is denticulate to the base of the crown; but the anterior edge is denticulate for the distal three-fifths of the length only, although it is continued to the base of the crown as a not very prominent ridge and a little within the anterior convex outline of the crown. The convex anteroexternal side is marked on the middle of its length by parallel ridges or folds of the surface, which are separated by shallow grooves wider than themselves. Their direction is inwards and upwards, and they are separated by a space from the anterior cutting edge. This space is marked by transverse concentric ridges, each of which is a continuation of a longitudinal ridge, and which curves upwards and then downwards to the anterior cutting edge. More than half the ridges which lie external to those which are thus recurved simply disappear at both extremities, and successively becoming indistinct, disappear entirely on the middle of the external face of the crown. No longitudinal grooves on the inner face of the crown, except a short one at the middle of the anterior cutting edge. Enameled surface minutely wrinkled.

Measurements.

	Mm.
Length of enamel covered crown	55
Diameters of base of crown.....	{ anteroposterior..... 25 { transverse 20

This species differs from the *P. appalachianus* in its straighter form, and the shorter crenate portion of its anterior cutting edge, both points of approach to the genus *Clepsysaurus*. Its peculiar sculpture distinguishes it from any of the species of either genus which are known. The dimensions are about those of the *P. appalachianus*.

The basal part of a larger tooth, probably of this species, was obtained by Mr. Cummins at the same time and place. Its diameters are as follows :

	Mm.
Anteroposterior.....	28
Transverse.....	23

From Paloduro Canyon.

PALÆOCTONUS DUMBLIANUS, Cope.

Sp. nov. Plate II, Figures 4-6.

Numerous teeth found at the same time and place by Mr. Cummins belong to a species distinct from the preceding, and one more like the *P. appalachianus*. The canine-like tooth has an inward curvature, and the anterior cutting edge is not curved within the anterior convexity of the crown at the base, but continues as its most prominent line. The enamel is not plicate. It differs from corresponding teeth of *P. appalachianus* in the greater convexity of the internal face. Enamel minutely striate.

The posterior teeth, which agree in relative dimensions with the anterior one just described, differ in character from those of the *P. appalachianus* in several respects. Their internal face is more convex; there is no longitudinal angle dividing the external face into two unequal facets, and there is a shallow groove near the base on both sides of both of the cutting edges. These four grooves are present in two such teeth out of eight, which I think correspond in their posterior position with those typical of the *P. appalachianus*. In two others, probably from a more anterior position, there are three such grooves. In two others there are but two, while in two others, whose narrow form indicates the most anterior position, a trace of but one groove, the anterior external, remains.

The teeth of this species obtained are smaller than the types of either of the other species, but they indicate a reptile of large size.

Measurements.

		Mm.
Diameters of canine-like tooth	anteroposterior	20
	transverse	17
Diameters of more posterior tooth.....	anteroposterior	22
	transverse	14
Diameters of a superior tooth.....	anteroposterior	22
	transverse	14
Diameters of a posterior tooth	longitudinal.....	30
	anteroposterior	22
	transverse	15

Palodura Canyon; obtained by Mr. W. F. Cummins. Dedicated to Mr. E. T. Dumble, Director of the Geological Survey of Texas.

SUMMARY.

The following list represents the state of our knowledge of the vertebrate species of the Texas Trias:

BATRACHIA.

STEGOCEPHALI.

Eupelor, sp.

REPTILIA.

? PSEUDOSUCHIA.

Typothorax, sp.

CROCODILIA.

Belodon superciliosus, Cope.

Episcoposaurus haplocerus, Cope.

DINOSAURIA.

Clepsysaurus, sp.

Palæoctonus orthodon, Cope.

Palæoctonus dumblianus, Cope.

CHAPTER II.

THE VERTEBRATE FAUNA OF THE LOUP FORK BEDS.

Abundant remains of Vertebrata were found in the Loup Fork beds north of the South Fork of Red River, east of the eastern escarpment of the Staked Plains. With the exception of a tortoise, these belong exclusively to Mammalia of the superorder Ungulata. The extreme rarity of Carnivora and the absence of Glires, are noteworthy features of the localities examined. Of seventeen species obtained, fifteen are determinable, as follows:

	Species.	Determinable.
Testudinata.....	1	
Carnivora	1	
Proboscidea.....	1	1
Diplarthra—		
Perissodactyla	9	9
Artiodactyla	5	3
	17	13

Of the determinable species, two are new to science. All the others are species hitherto found only in beds of the Loup Fork terrane, thus fixing conclusively the age of the Texas bed. Much light is thrown on the structure of many of these species by the new material obtained which is now described in part.

It is evident that the locality at which the fossils were obtained was haunted by droves of three-toed horses and camels, with not a few mastodons. At one place a space of several acres was thickly strewn with bones of these animals; and smaller tracts similarly covered were numerous in the same neighborhood. The animals were of all ages, and one of the most interesting results of our expedition was the obtaining of the bones, skulls, and teeth of young animals with the deciduous dentition well preserved.

PROBOSCIDIA.

TETRABELODON, Cope.

Proceeds. Amer. Philos. Society, 1884, p. 2.

American Naturalist, 1889, p. 193.

TETRABELODON SERRIDENS? Cope.

American Naturalist, 1889, p. 205, figure 8; *Mastodon serridens*, Cope, l. c. 1884, p. 524; Plate III, figures 2, 3.

I refer to this species with much reserve a last inferior molar, which is for the most part in excellent preservation. It resembles the intermediate molar on which the species was established in most respects, but presents some important differences, among which is a relatively inferior size. The fact that the last molar exceeds very little in length the typical intermediate molar, renders the identification doubtful, unless it indicates a small race of the same species. I provisionally adopt the latter view.

The molar referred to supports only three crests and a well developed heel. These crests are elevated, with their apices contracted both longitudinally and transversely. The usual median fissure divides each crest into an internal and an external half, of which the former is obtusely serrate or tubercular, and the external expands anteroposteriorly toward the base, were it supports one or more small tubercles which obstruct the transverse valleys. There is an external, but no internal cingulum. The former extends round the external half of the anterior base, where it is coarsely crenate. The robust external anterior cusp, in place of an anterior basal tubercle, sends downward and inward a wide ledge, which passes cingulum-like round the base of the internal cusp to the inner side of the crown. In the characters so far enumerated this tooth resembles the typical specimen. The differences are as follows: In the new tooth the internal half of the middle cross-crest has three tubercles; in the type there are four (one smaller). On the external half of this crest there is no tubercle besides the main cusp; in the type there is one, in line with four of the other half. The new tooth shows a single tubercle behind the main external cusp; in the type there are two. The posterior crest has in both teeth three tubercles on the external half; on the internal half there are three, besides the principal in the type, and but one in the new tooth.

In both teeth the internal part of the first cross-crest is not serrate. In the new tooth the heel consists of three obtuse tubercles, of which the external is the largest. The valley separating it from the crest in front is not blocked by a tubercle. Enamel smooth.

Measurements.

	Mm.
Total length of crown.....	140
Width of crown at first crest.....	80
Width of crown at second crest.....	76
Width of crown at third crest.....	68
Width of apex of first crest.....	49
Width of apex of third crest.....	36
Elevation of first crest from cingulum	46
Elevation of third crest from cingulum	43

As already remarked, this tooth is relatively smaller than the corre-

sponding one in the type specimen should be. The latter should measure about 205 mm., whereas the length of the tooth now described is only 140 mm. It may pertain to a different species, but for the present I refer it to a small race of the *T. serridens*, under the name of *T. serridens cinarronis*.

This tooth was found alone, but other remains of Mastodons are not rare in the formation, some of them indicating large individuals.

DIPLARTHRA.

APHELOPS, Cope.

Proceeds. Amer. Philos. Society, 1873, p. 520.

Remains of this genus we found to be rather rare, but three individuals having come under our notice. Two of these are represented by badly damaged teeth, not yet determined, while another is represented by a skull of the species mentioned below.

APHELOPS FOSSIGER, Cope.

Bulletin U. S. Geol. Survey Terrs. 1878, p. 382; Amer. Naturalist, 1879, 771h., figs. 3 and 6; 1887, p. 1006, fig. 22.

A skull of this species was obtained, which does not differ from those previously known from Nebraska and Kansas.

PROTOHIPPIUS, Leidy.

Proceedings Academy of Philadelphia, 1858, p. 56, name only. Extinct Mammalia of Dakota and Nebraska, 1869, p. 275, first description. Cope, Bulletin U. S. Geol. Survey Terrs., No. 1, Jan., 1874, pp. 10-15.

Merychippus, Leidy, Proceed. Phila. Academy, 1858, 27 (defined), partim. Extinct Mammalia Dakota and Nebraska, 1869, 292 (deciduous dentition).

Parahippus, Leidy, op. cit., 1858, p. 26; Extinct Mammalia, etc., 1869, 314 (deciduous dentition).

Hypohippus, Leidy, op. cit., p. 26; Extinct Mammalia, etc., p. 311 (deciduous dentition).

Protohippus s. Merychippus, Leidy, Report U. S. Geol. Survey Terrs., 4to., I, p. 322.

Interior columns of the superior molars united to the inner crescents, their worn sections forming loops of the internal border of the crescents. Second and fifth digits present on both limbs and of reduced size. Bicapital groove double. Metapodials without trochlear keel anteriorly.

The genus is like *Hippidium* in dentition, and like *Hippotherium* in the structure of the feet. Its principal distribution is North American, where it is confined, so far as yet known, to the Loup Fork beds,

History. Dr. Leidy did not define this genus until 1869, several years after he had named it. At an earlier period, and in the same paper in which the name *Protohippus* was first used, Dr. Leidy named and described a supposed genus *Merychippus*, of which the type was *M. insignis*. Leidy afterwards questioned the distinctness of the two supposed genera, and placed the name *Protohippus* first in joining the two. Coinciding with this view, I place the name *Merychippus* in the position of synonym to *Protohippus*, although the name first mentioned was the one first published with a description. This course I believe justifiable when the names are those of the same author. In this instance the very objectionable name *Merychippus* has been suppressed with the apparent concurrence of the proposer.

So far as the characters go, those of the superior molars were pointed out by Dr. Leidy. As these are not sufficient to distinguish the genus from *Hippidium*, Dr. Leidy at a later date combined the two genera. My discovery in 1873 that *Protohippus* possesses three toes like *Hippotherium* proved its claim to distinction to be valid.

This genus is represented by a good many forms, which have an extensive range in size, from the *P. placidus*, said by Marsh to be two and a half feet in height, to *P. mirabilis*, Leidy, of about the size of a quagga. Specific differences are also seen in the form of the anteorbital part of the maxillary bone, which presents in some of the species one or more fossæ of various size and position. The forms of the teeth are much alike, and the enamel plates present complications in but few species, and then to a less degree than is found in various species of *Hippotherium*.

Important changes take place in the pattern of the molar teeth with the advance of age and prolonged use. The folds of the enamel disappear, so that the borders of the lakes which are plicate in the young become perfectly simple in old animals. The period at which the folds disappear differs in different species, coming earlier in the larger species as a rule. The time of simplification differs also in different individuals of the same species, as for instance in the *P. placidus* (see under that species below). In some of the species the anterior inner column (protocone) remains distinct from the anterior inner crescent (paracone) for a longer time than in others. In the *P. placidus* and *P. lenticularis* the union does not take place until half of the superior molar is worn away. This gave rise to the supposition that the younger individuals of *P. placidus* represent a species of *Hippotherium*, which was named *H. gratum* by Leidy, who, however, expressed doubts as to its validity. I have examined the specimens of the various species of *Hippotherium* in my collection, with a view of ascertaining whether any others would enter the genus *Protohippus* on continued wear, but I have failed to detect any except in the cases of isolated teeth. This occurs sometimes in molars of species of the group

II (Stylonus) of *Hippotherium** When the first premolar and third true molar of the *Protohippus perditus* are but little worn, the protocone is distinct as in *Hippotherium*, but this state of affairs lasts but a short time.

The temporary superior molars in this genus and *Hippotherium* resemble somewhat the permanent molars of *Anchitherium*. That is, the para and metaconules are not united longitudinally on the middle of the crown, but are in line with the protocone and hypocone respectively, and are more or less connected with them. Leidy refers to the deciduous molars of what is probably a species of my Sec. II of *Hippotherium*, under the name of *Merychippus insignis*†; and to those of a species of *Protohippus*, under the name of *Merychippus mirabilis*.‡ Both belong to species in which the lake borders are more or less plicate, but it is not possible at present to determine accurately the species to which they should be referred. Deciduous teeth of species with more simple enamel borders have been referred to distinct genera under the names of *Parahippus*, *Hypohippus*, and *Anchippus*.§ Those on which the first two names were established were suspected by Leidy to belong to the temporary dentition. It is probable that they belong to the *Protohippus*, while *Anchippus* may pertain to a species of *Hippotherium*.

In my private collection is a fragment of the left maxillary bone of the young horse from the Loup Fork bed of Colorado, which contains a permanent molar just protruded, and the crown of a temporary molar about to be shed. The species is probably the *Protohippus perditus* of Leidy, which was abundant at that locality. The deciduous crown is very similar in most respects to those figured by Leidy as *Merychippus mirabilis*. Another fragment of the right maxilla from the corresponding horizon in Wyoming, contains three deciduous molars and the alveolus of the single root of the first. These molars resemble the one described by Leidy as *Hypohippus affinis*, but presents a greater degree of wear. In the second (anterior) tooth the paraconule sends forward no process towards the metaconule, thus agreeing with Leidy's type. The third tooth possesses such a process, thus resembling the type of Leidy's *Anchippus*. In the fourth tooth this process is present and is confluent with the metaconule as in the permanent dentition. All of these teeth are considerably worn, and the protocone is confluent with the paraconule in all of them. In Leidy's type of *Anchippus* the protocone remains distinct, and, to judge from his figure, considerable trituration would be required to bring about a fusion. Hence it may be that the latter tooth belongs to a species of *Hippotherium*.

* A review of North American Species of *Hippotherium*, by E. D. Cope, Proceedings Amer. Philos. Soc., 1889, p. 429. See Plate II, figure 15; first true molar of *H. calamarium*.

† Extinct Mammalia Dakota and Nebraska., Plate XVII, figures 3 and 4.

‡ Op. cit., Plate XVII, figures 10 and 11.

§ Op. cit., pp. 311, 312, 313; Plate XVII, figures 7-13.

The Wyoming molars resemble closely the fragmentary specimen figured and described by Leidy as *Anchitherium australe*,* which was found in Washington county, Texas, in the southern central part of the State. It was found in association with an superior molar of the *Protohippus perditus*, according to Leidy, and very probably is a deciduous tooth of that species. The *Anchippus brevidens*, Marsh, is also apparently founded on the deciduous molars of some species.†

The Geological Survey collection contains the almost perfect cranium of a colt which was found at the same limited locality as that which produced the *Protohippus pachyops* and *P. fossulatus*; and from its characters I suspect that it belongs to the former species. The molar teeth, which are all present (four in number), resemble closely those described by Leidy as *Parahippus cognatus*, differing only in their considerably larger size. This is true of the last tooth of the series, while the others resemble more nearly the *Hypohippus affinis*. There can be no doubt then that these supposed genera were founded on milk teeth of Protohippus. The specimen of *P. cognatus* described by Leidy belongs to one of the medium sized Protohippi, as *P. labrosus*, etc., while *H. affinis* belongs to one of the larger forms.

The material at my disposal which represents this genus consists of numerous specimens from Nebraska, Kansas, Oregon, Montana, and Texas. Of the ten species here adopted, seven are represented by private collection, and six were obtained by the party of the Geological Survey of Texas, under the direction of Mr. W. F. Cummins, in the northwestern part of the State.

The species may be distinguished by the following characteristics.

I. No preorbital fossa.

Lake borders at first plicate; true molars 85 mm.; facial ridge very obtuse.....*P. pachyops*

Lake borders at first plicate; true molars 61 mm.; principal premolars 67 mm.; fourth premolar one-rooted.....*P. perditus*

True molars 43 mm.....*P. medius*

True molars 44 mm.; principal premolars 45 mm.; enamel simple in adults.....*P. parvulus*

II. A small preorbital fossa well anterior to the orbit.

True molars 69 mm.; enamel simple, facial ridge obtuse...*P. fossulatus*

III. A large preorbital fossa closely approximated to the orbit.

True molars 55 mm.; principal premolars 62 mm.; slightly plicate in the young; premolar one-rooted; facial ridge acute.....*P. sejunctus*

*Report U. S. Geol. Survey Terrs., I, 1873, p. 250. Plate XX, figure 19.

†Amer. Journal Science and Arts, VII, 1875, p. 254.

True molars 72 mm.; principal premolars 80 mm.; fourth premolar one-rooted; facial edge acute.....*P. mirabilis*
IV. Preorbital region unknown.

Principal premolars 59 mm.; fourth two-rooted; enamel simple; paracone cylindric.....*P. labrosus*
Lakes transversely extended; borders plicate but without special loop of the anterior lake; internal columns small, subcylindric; molars 21 by 23 mm.....*P. castilli*
Lakes narrower; borders plicate in young; the loop of the anterior long persistent; internal columns with oval section; crown averaging 15x17 mm..... *P. placidus*

In the species in which that part of the cranium is known, there is a longitudinal fossa above the position of the preorbital fossa, extending along the adjacent parts of the nasal and maxillary bones. That is, it is present in the *P. pachyops*, *P. fossulatus*, *P. sejunctus*, *P. insignis*, and *P. mirabilis*.

Species in which the protocone does not unite with the paraconule until late in life, are the *P. placidus*, *P. lenticularis*, Cope (described in the supplement to this chapter), and *P. supremus*, Leidy, Ext. Mammalia Dak. and Nebr., p. 328, pl. XXVII, figs. 3, 4.

Before describing the species contained in the collections made by the Geological Survey of Texas, I enumerate the species, and offer such remarks on them as may be appropriate.

PROTOHIPPIUS PACHYOPS, Cope, sp. nov. infra.

PROTOHIPPIUS PERDITUS, Leidy, Extinct Mammalia of Dakota and Nebraska, 1869, 275, pl. XVII, figs. 1, 2 (young adult); Report U. S. Geol. Survey Terrs., I., 1873, 248, pl. XX, fig. 16. *Parahippus cognatus*, Leidy, Extinct Mammalia, etc., p. 311, pl. XXI, figs. 7-10 (unworn deciduous molars). *Protohippus profectus*, Cope, Proceed. Amer. Philos. Society, 1889, p. 447, pl. II, figs. 9-12.

Of this species the most important specimens in my collection are the following: Two right maxillary bones with full sets of molars of adult but not old animals from northeast Colorado, collected by myself; part of maxillary with four molars and a part of the skeleton from northern Kansas, Dr. R. H. Hill; nearly all the molar teeth of both sides, with considerable part of skeleton from Hitchcock county, Nebraska, F. Hazard; right maxillary bone with facial region and four molars, from same locality and collector; numerous loose molar teeth of another individual, same locality and collector; numerous isolated molars, mostly from Colorado. Deciduous dentition, part of the molar series from northeast Colorado, E. D. Cope; entire series in maxillary bone from Laramie Peak, Wyoming, J. C. Isaac.

PROTOHIPPIUS MEDIUS, Cope, Amer. Naturalist, 1892, 944.

Protohippus insignis, Leidy, Cope, Bulletin U. S. G. Survey Terrs., 1874, No. 1, p. 13; Annual Report do., 1873 (1874), p. 523. *Merychippus insignis*, Leidy, part, Extinct Mammalia Dakota-Nebraska, 1869, p. 296, pl. XVII, fig. 5. *Hujus operis*, pl. XVIII, fig. 5.

In the uncertainty as to the species to which Leidy's typical specimen of deciduous dentition should be referred, I give this species a name as above. It is probably the animal described by Leidy as the adult at the later reference above cited. It is a smaller species than the *P. perditus*, with simple enamel plates of the lake borders. My collection contains a considerable part of a skeleton with incomplete skull of an old individual with four worn molar teeth from northern Kansas, by Dr. R. H. Hill. The facial portion of the skull is preserved and it presents no anteorbital fossa. I figure (pl. XVIII) three molars in a fragment of a maxillary bone from Cottonwood creek, Oregon, collected by Dr. J. L. Wortman. A single superior molar from Tehuichila, Vera Cruz, agrees with this species.

PROTOHIPPIUS PARVULUS, Marsh, Amer. Jour. Sci. Arts, 1874, p. 251; *Equus parvulus* Marsh, op. cit., 1868, p. 374, vol. XLVI.

Isolated teeth from Hitchcock county, Nebraska, F. Hazard; and specimens mentioned below, q. v. Probably referable to *P. placidus*.

PROTOHIPPIUS FOSSULATUS, Cope, sp. nov. infra.

PROTOHIPPIUS SEJUNCTUS, Cope, Bulletin U. S. Geol. Survey Terrs., 1873 (1874) I, p. 15; Annual Report U. S. G. Survey Terrs., 1873 (1874), p. 524; Amer. Naturalist, 1887, p. 1071, fig. 39. ? *Merychippus insignis*, Leidy, 2d specimen, Extinct Mamm. Dakota-Nebraska, p. 299, pl. XVII, figs. 8-9.

Of this species I have the skull with mandible and entire dentition, with considerable part of the skeleton of an individual obtained by myself in northeast Colorado, with a nearly entire mandible, and fragments of other individuals from the same locality; a nearly complete skull with dentition and a considerable part of the skeleton from Deep river, Montana, collected by J. C. Isaac. This species is about the size of the *P. medius*, and is considerably smaller than the *P. mirabilis*, to which it is related.

PROTOHIPPIUS MIRABILIS, Leidy; Cope, Bull. U. S. G. Survey Terrs., I, 1874, p. 15; Leidy Extinct Mamm. Dakota-Nebraska, part, 1869, pp. 299, 327, pl. XVII, figs. 10, 11, 12 (exclus. figs. 8, 9); ? *Protohippus supremus*, Leidy, op. cit., p. 328, pl. XXVII, figs. 3, 4.

The only material which has come under my observation was obtained in Texas, and is described below. As already remarked, one of the specimens referred by Leidy to this species and figured (figures 8, 9, plate XVI) by him, represents probably a large and old individual of the *P. sejunctus*. It was afterwards concluded by him, and so stated in the Report U. S. Geol. Survey Terrs., I, 1873, p. 322, to be probably the *P.*

perditus; but it differs from that species, as Leidy had already shown, in the deep preorbital fossa. On the other hand, the molars referred to a species under the name of *P. supremus* are appropriate in size and characters to the form whose deciduous molars form the type of Leidy's original description.

PROTOHIPPIUS LABROSUS, Cope, Bulletin U. S. Geol. Survey of Terrs., I, 1874, p. 13; Ann. Report U. S. G. Survey Terrs., 1873 (1874), 523.

Represented in my collection by a right maxillary bone which contains the five anterior molars, with which was found a nearly complete mandible containing nearly all the molars, with the canines and incisors. The form of the preorbital region can not be distinctly made out. The species differs from the *P. sejunctus* in the close contiguity of the canine and incisor teeth, which do not present a short diastema, as in *P. sejunctus*. In its measurements it is smaller than the *P. perditus*, and the enamel borders of the lakes are more simple than in either that species or the *P. sejunctus* at the corresponding age. Northeast Colorado.

PROTOHIPPIUS CASTILLI, Cope. Proceeds. Amer. Philos. Society, 1885, p. 151, fig. 2.

Represented by a single superior molar tooth in my collection from the Miocene clays of Tehuichila, Vera Cruz, presented to me by Dr. Santiago Bernard. This tooth is about the size of that of the *P. perditus*, and differs from corresponding ones of that species in the relatively greater transverse extent of the crown, proportionately greater width of the lakes, and smaller size of the internal columns. The opposed lake borders are folded as in the corresponding stage of *P. perditus*, but the loop of the anterior lake is not so well defined.

PROTOHIPPIUS PLACIDUS, Leidy, Extinct Mammalia Dakota-Nebraska, 1869, pp. 277-328, pl. XVIII, figs. 39-48; XXVII, figs. 6, 7; Cope, Bulletin U. S. Survey Terrs., 1873 (1874), (exclusive of bones of skeleton). *Hipparion gratum*, Leidy, op. cit., 287pl. XVIII, figs. 25-30. *Hippotherium gratum*, Leidy; Cope Proceeds. Amer. Philos. Society, 1889, figs. 16, 17.

Represented in my collection by molar teeth from Northeast Colorado (E. D. Cope) and Dundy county, Neb. (F. Hazard). It is the most abundant species in the Loup Fork bed of Donley county, Texas, as will be described below, with the *P. parvulus*, the smallest species of the genus.

PROTOHIPPIUS PACHYOPS, Cope.

Sp. nov. Plate XI, Figure 1; Plate XII; Plate XVII, Figures 2, 3.

Represented by a cranium with lower jaw, from which have been broken away all posterior to the orbits, and all anterior to the second pre-molars.

The malar-maxillary ridge is obtusely rounded, and there is no pre-

orbital fossa. There is an oval maxillo-nasal fossa, which is strongly pronounced. The infraorbital foramen issues above the middle of the first true molar. The maxillary bone projects about half the diameter of the last molar tooth posteriorly to it, but this dimension may increase a little, as the animal is not fully grown. The anterior orbital border marks a point above the middle of the last superior molar. The last superior molar is just protruding from the alveolus. The first and second molars are worn. Their crowns have a greater anteroposterior than transverse diameter, and the section of the protocone is greater longitudinally than transversely, although its junction with the paraconule is complete. The enamel of the lake borders is simple, except that that of the posterior wall of the anterior lake presents the usual loops well defined. The superior molars have the crowns long and well curved transversely. In the inferior molars the anterior and posterior lobes of the metaconid have but little anteroposterior extent, and the paraconid and hypostylid are well developed. The column of the last inferior molar, which forms the heel, is quite small.

Measurements.

	Mm.
Length of maxillary bone to anterior border of P. m. i	127
Length of ditto from orbit to preorbital foramen	64
Anteroposterior diameter of true molars	84
Diameter of crown of M. i. { anteroposterior	28
{ transverse	25
Length of crown of inferior true molars	88
Length of crown of last inferior molar	30
Diameters of M. i. { anteroposterior	31
{ transverse	13
Depth of ramus at front of M. i.	46
Depth of ramus at posterior end of M. iii.	67

Found by myself in the Loup Fork bed of Donley county, Texas. Mr. W. F. Cummins found the nearly complete skull of a colt at the same locality in which the above cranium was found, which from the character of its facial region and the dimensions of its teeth I can only refer to this species.

In its general form the skull exhibits the character of immaturity in the relatively large size of the brain case and orbits, and contraction of the muzzle and occiput and zygomatic foramina. The profile of the brain case is convex, descending rapidly posteriorly to the occiput. There is a feeble sagittal ridge originating from feeble, posteriorly converging temporal ridges. The sagittal ridge becomes a crest, and immediately divides into two lateral occipital ridges or rather angles, which include between them a triangular space with a doubly convex posterior margin, the inion. This heart-shaped area is longer than wide instead of wider than long, as in adult animals. The occiput is low, and has a median vertical angle, on

each side of which it is concave, the superior part of each concavity being horizontal from the overhanging of theinion. The occipital condyles are remarkably small. The zygomatic foramen is only about one-fourth as wide as the interorbital space. The superior orbital border is very prominent anteriorly, and is deeply openly emarginate posteriorly. The anterosuperior protuberance is bounded by a notch of the anterior orbital border. There is no malomaxillary angle, nor preorbital fossa. There is, on the other hand, a very large nasomaxillary fossa, with a rather abrupt inferior border, which rises anteriorly to a point above the infraorbital foramen. It is separated anteriorly by a narrow bony isthmus from a deep but small premaxillary fossa. Extremities of the nasal and premaxillary bones broken off. The infraorbital foramen issues above the anterior part of the penultimate deciduous molar.

The mastoid and basioccipital elements have fallen out, leaving clean the sutured surfaces of the squamosal and exoccipital. From the appearance of the latter it seems that basioccipital has no share in the composition of the condyles. The petrosal, as in the genus *Equus*, is divided into two parts by a horizontal suture. The inferior portion is more produced inferiorly than in the horse and quagga, presenting an angular ridge downward, which runs forwards and inwards and sends off a transverse branch posteriorly. The tympanic is separated from it by a groove, and diverges outwards and backwards from the postglenoid process, with which it is in contact at the interior extremity. The postglenoid process has considerable transverse extent, and its free border is directed downwards and inwards, but it is not produced into a process at this point, as in the *Protohippus mirabilis* and the *Equi*. The maxillary bone is produced posterior to the last molar about the length of the latter, and presents an obtuse angle into the zygomatic foramen. An angle of the first permanent molar is visible at a fracture. The palatal notch extends to opposite the metacone of the second molar.

The cusps and crests of the teeth are more acute than in the unworn teeth of the permanent dentition. The internal cusps are connected with the external cusps by oblique crests, which terminate opposite the ridges which form the anterior boundaries of the paracone and metacone. The metaconule is continuous with the hypocone in all of the molars, while the paraconule is swollen anteriorly, so as to make an emargination with the protocone in front. The trihedral hypoconule is large and isolated. It is concave posteriorly in the first and third molars. The parastylid of the first molar is larger than in the others and is more produced anteriorly, as in the permanent dentition. It sends a strong cingulum inwards along the anterior margin of the crown to the anterior base of the protocone. In this tooth the metaconule sends a process towards the paraconule, which it does not reach by a wide interval. This process is

wanting from the two other molars. In this point this tooth resembles the tooth described by Leidy as *Anchippus*, while the two others are identical in all respects with his *Hypolippus*. The first molar is relatively small, as in the permanent dentition, but it differs from the latter in having a strong internal crest, which is nearly as elevated as the external, and is separated from it by a deep fossa.

Measurements.

	Mm.
Total length of skull preserved from inion.....	290
From inion to posterior border of orbit (axial)	115
From inion to infraorbital foramen.....	242
Horizontal diameter of orbit.....	48
Width of skull at zygomatic arches	124
Width of skull between middle of orbits	81
Length from inion to palatal notch.....	210
Width below at D. m. i.....	44
Width below at front of D. m. iv.....	56
Width of palate at D. m. ii.....	14
Width of palate at D. m. iv posteriorly.....	32
Diameters of D. m. i.... { anteroposterior	16
{ transverse	14
Diameters of D. m. ii... { anteroposterior	33
{ transverse	27
Diameters of D. m. iv... { anteroposterior	30
{ transverse	28

Excepting in the case of the first molar, the dentition is much simpler than that of the adult, and is identical, each tooth taken by itself, with that of the genus *Anchitherium*. Their almost unworn condition is especially favorable for the exhibition of this resemblance.

PROTOLIPPUS PERDITUS, Leidy.

Plate X, Figure 2. For synonymy see above.

A single fragmentary superior molar is the only indication of this species which was obtained by the Survey from the locality of Donley county. It is evidently not common at this place during the Loup Fork epoch, contrary to what obtains in more northern regions, where it is the most abundant species.

PROTOLIPPUS PARVULUS, Marsh.

Plate XI, Figures 1, 2. For synonymy see above.

I found superior molar teeth of this species at three localities; one of the specimens consists of the maxillary bone of the right side, with all the molars except the fourth premolar in place. The animal is adult, as the anterior lake of the first true molar is obliterated by wear. The enamel border of all the lakes is simple, except that there is a loop on the poste-

rior border of the posterior lake of the last superior molar. The facial plate of the maxillary is not preserved to the orbital border, but extends sufficiently near to show that there was no preorbital fossa.

Measurements.

	Mm.
Total length of six molars.....	89
Length of true molars.....	44
Diameters of M. i.....	{ auteroposterior 14 transverse..... 18
Length of grinding face of P. m. iii.....	
	19

The measurements of the other molar teeth are a little less than the above. In one of these two superior molars are in place in the jaw.

I can not help suspecting that this species will turn out to have been established on teeth of the *P. placidus* in an advanced stage of wear. I discuss this question more fully under the head of that species.

PROTOHIPPIUS FOSSULATUS, Cope.

Sp. nov. Plates V, VI, VII.

Represented by a cranium, which has lost all posterior to the posterior frontal region and anterior to the premaxillary border, found by Mr. W. F. Cummins in the Loup Fork formation of Donley county, Texas.

The dimensions of this species are superior to those of any other members of the genus excepting the *P. pachyops* and *P. mirabilis*. It equals the former and is a little exceeded by the latter. The characters of the lateral facial fossæ are peculiar, and as they are exactly alike on both sides of the skull, I believe them to be normal. There is no fossa immediately in front of the orbit, but there is a narrow and deep maxillonasal fossa, whose posterior extremity approaches nearer to the superior part of the orbit than any other. Beneath it, and immediately above the penultimate molar tooth, is a small but well pronounced fossa, which is about as large as would be produced by an oblique impression of the end of the thumb in putty. Immediately anterior to the infraorbital foramen is a wider and shallower fossa. Anterior to this is a fossa directed obliquely downward and forward, as a continuation of the nasomaxillary; and below and in front of this one is a deep concavity of the alveolar border.

The posterior wall of the orbit is transverse, throwing the border outwards. The malomaxillary ridge is prominent, but is obtuse below the anteorbital region, and the small preorbital fossa, below whose anterior border it terminates; that is above the first true molar. The position of the infraorbital foramen is elevated, and is above the anterior border of the first true molar. The anterior border of the orbit is above the posterior border of the last superior molar.

The general form of the skull is cameloid, in the compression of the nasal region, and the expansion at the orbits superiorly and posteriorly. The supraorbital foramen is entirely intromarginal and is above the posterior part of the orbit.

The maxillary bone continues posterior to the last molar tooth, one and a half times the length of the latter. The palate is of moderate width, and contracts gradually forwards, becoming narrow posterior to the canine teeth and expanding slightly to the latter. The palatal notch extends as far anteriorly as the posterior border of the penultimate molar, and possibly a little further, as its anterior border appears to be notched, but whether this is normal or not is uncertain. The palatine foramen enters opposite the posterior borders of the penultimate molars. The pyramidal processes approach each other posterior to the maxillary bones; thus narrowing the nareal trough.

On one side of the skull the five posterior molars are well preserved. The space for the third premolar is shorter than in the *P. insignis*, and I can not find an alveolus for the fourth, but its position appears to be occupied by osseous tissue. In *P. insignis* this tooth is distinct. The grinding faces of the crowns are wider than long, excepting that of the last, where the proportions are reversed. The protocone is large and well fused with the protoconule, and it is rather more prominent inwards than the hypocone, which is not distinct in any of the teeth. The enamel borders are perfectly simple, and there is no loop between the protocone and hypocone. The dentition is not that of a very old animal, as the lakes of the first two molars are perfectly preserved. The sections of the roots of the canines show that they were of moderate size.

The free extremities of the nasal bones are short and acute, and the nareal fissure terminates above the position of the fourth premolar, were it present.

Measurements.

	Mm.
Length from posterior border of orbit to extremity of nasal bones.....	235
Diameters of orbit.....	{ anteroposterior 53
	{ vertical..... 53
Width of front at middle of orbit.....	120
Width of nasal bones above infraorbital foramen.....	28
Width of nasal bones at nareal fissure.....	35
Length of free part of nasal bones.....	25
Length of maxillary bone to canine.....	227
Length of maxillary posterior to M. iii.....	47
Width of posterior at extremity of maxillaries.....	24
Width of posterior at end of last molar.....	35
Width of palate at M. i.....	50
Width of palate posterior to canine.....	26
Diameters of M. i.....	{ anteroposterior 20
	{ transverse 25

Diameters of M. iii.....	} anteroposterior..... 27 transverse..... 24	
Total length of molar series.....		145
Length of true molars.....		69

The skull of this species indicates a species rather smaller than the ass.

PROTOMYPTUS MIRABILIS, Leidy.*

Plates VIII, IX, Figure 1; X, Figure 4. For synonymy above.

As already remarked, this species was founded on a part of the maxillary bone of a young animal which contains the last two temporary molars. The crown of a permanent molar was removed from this fragment and figured by Leidy. This fragment belongs to one of the largest species of this genus, and it agrees in dimensions and in its large preorbital fossa with a nearly entire eranium obtained by Mr. W. F. Cummins in Donley county.

This eranium lacks only the anterior part of the premaxillary bone, and the basioecipital. The parietal region is crushed on one side. But one zygomatic arch is perfect. The size is about that of the ass. The anterior border of the orbit marks the posterior border of the last molar. The malomaxillary ridge is prominent and acute, extending as far forwards as the infraorbital foramen, which is above the middle of the first true molar. The preorbital fossa is large and deep, and is separated from the orbit by a space two-fifths the width of the latter. In the *P. sejunctus* this space is only one-fifth the orbital diameter, while in the *P. fossulatus* the fossa is as far in advance of the orbit as its entire diameter. The nasomaxillary fossa is distinct, is continuous posteriorly with the preorbital fossa, and extends anteriorly to the infraorbital foramen. The latter becomes posteriorly a shallow fossa which extends anteriorly to above the anterior part of the third premolar. A rather deep fossa behind the line of the canine alveolus. The free portion of the nasal bones is acute, and is relatively longer than in the type specimens of *P. fossulatus*. The nasal fissure extends to above the anterior border of the root of the fourth premolar. The maxillary bone projects posteriorly to the last molar once and three-quarter times the diameter of the latter. The maxillary bones are somewhat crushed together, so that the dimensions of the palate are not determinable. The nareal notch extends to opposite the front of the last superior molar. The postorbital bar is subtransverse, the free border projecting forwards and outwards. The zygoma is short, its length equaling the space from the superior border of the orbit to the posterior border of the preorbital fossa. The glenoid surface is wide, and the postglenoid process has a rather posterior position, and short diameter. Paroecipital process lost.

The fourth premolar has a single robust root. The third premolar is

accuminate anteriorly. Excepting in this tooth and the last true molar, the molars have at their rather advanced state of wear a greater transverse than anteroposterior diameter. The last molar is strongly emarginate posteriorly. In all, the protocone is more prominent inwards than the hypocone. The enamel borders are everywhere perfectly simple.

Measurements.

	Mm.
Total length of incomplete skull.....	390
Length from extremity of nasal bones to posterior border of orbit.....	265
Length from extremity of nasal bones to posterior border of preorbital fossa.....	187
Longitudinal diameter of orbit.....	60
Longitudinal diameter of zygomatic foramen.....	62
Vertical diameter of skull at front of orbit.....	110
Length of dental series.....	155
Length of true molars	71
Diameters of P. m. iii.....	{ anteroposterior 34
	{ transverse..... 26
Diameters of M. i.....	{ anteroposterior..... 23
	{ transverse 30
Diameters of M. iii.....	{ anteroposterior..... 27
	{ transverse 25

This species is only inferior in dimensions to the *P. pachyops*. The molars have a smaller anteroposterior diameter than in that species, and the maxillary bone is produced much further posterior to them. The wide difference in the preorbital region separates this species from the *P. fossulatus*. Besides this, the muzzle is more produced, and the free portion of the nasal bones is more elongate.

The measurements of the teeth of this species agree sufficiently with those given by Marsh for his *Pliohippus pernix*,* and the "deep irregular fossa" in front of the orbit, and simple enamel ridges are found in both. Marsh, however, says that the skull is "comparatively short," while that of the present animal is elongate. If the *P. mirabilis* shall be ascertained to have no lateral digits, it must be transferred, with the *P. pernix*, to the genus *Hippidium*, Owen.

The anterior part of the skull of a colt containing the entire temporary molar dentition of both sides, presents the proportions of this species. Their transverse diameter is smaller than in the worn temporary molar of the *P. perditus* from Colorado already referred to, but this may be due to a less degree of wear. As the wear has, however, progressed beyond the earliest stages, this may be questioned; but as the dimensions and enamel pattern are appropriate, I refer it here provisionally.

The protocone and hypocone are, in the first (anterior) molar, confluent with the paraconule and metaconule respectively. The same occur:

* American Journal of Science and Arts, VII, 1874, p. 252.

in the second molar, but the junction of the protocone is by a very narrow isthmus. The third molar resembles the second in the narrower connection of the protocone with the paraconule. The lakes are isolated in all three of the teeth, and the anterior presents the usual loop posteriorly. The adjacent enamel borders of the lakes have in addition a deep inflection. The anterior border of the anterior lakes has an inflection also in the first and second molars, but there is none on the posterior border. The cementum is well developed. First tooth small, with an external crest and internal cusp.

Measurements.

		Mm.
Length of series of temporary molars.....		85
Diameters of D. m. i.....	{ anteroposterior	9
		transverse
Diameters of D. m. ii.....	{ anteroposterior	30
		transverse.....
Diameters of D. m. iii.....	{ anteroposterior.....	25
		transverse

These teeth resemble very much in their details the temporary molars on which Leidy proposed his *Merychippus insignis*, but are much more elongate anteroposteriorly, agreeing in their measurements with the *M. mirabilis*, of which the temporary molars iii and iv are also figured by Leidy. The latter appear to present a later stage of wear, and therefore a greater transverse diameter.

PROTOHIPPIUS PLACIDUS, Leidy.

Plate XI, Figures 3-8. For synonymy see above.

Teeth from eight different localities in Donley county represent probably ten individuals of this species. The characters of the superior molars differ much with age and wear, as already remarked. Younger animals with less worn teeth represent the *Hippotherium gratum* of Leidy. In the early stage of wear not only is the protocone distinct from the paraconule, but the adjacent enamel borders of the lakes are rather complex. Thus there are, besides the loop on the posterior internal border of the anterior lake, three folds of the opposed enamel lake border, but also sometimes an emargination of the posterior border of the posterior lake. The number of emarginations diminishes with wear, until in old teeth all, excepting perhaps the loop, disappear.

I give the following list of teeth, with their length and the complexity of enamel which they present:

I. Hippotheroid.

	Length Mm.
Inflections, 3 anterior, 2 posterior.....	36
Inflections, 2 anterior, 2 posterior.....	40

Inflections, 3 anterior, 1 posterior.....	31
Inflections, 3 anterior, 1 posterior.....	40
Inflections, 2 anterior, 1 posterior.....	36
Inflections, 1 anterior, 0 posterior.....	42

III. *Protohippoid*.

Inflections, 3 anterior, 3 posterior.....	24
Inflections, 1 anterior, 2 posterior.....	28
Inflections, 1 anterior, 0 posterior.....	26

In all these specimens the posterior loop of the anterior lake is present, and it is this circumstance that induces me to think that there may be another small *Protohippus*, which is a distinct species, in which this loop is always absent, and to which the name of *P. parvulus* is applicable. As has been already remarked, superior molars of three individuals of this character were obtained at the same locality as that from which the specimens of *Protohippus placidus* were found. These are all old individuals with well-worn molars, the length of the crowns in two of them being 24 mm. and 21 mm. respectively. Younger teeth of this kind I did not find. Considerable light is, however, thrown on this question by some teeth from Nebraska, obtained for me by Mr. Frank Hazard. They appear to be M. i and M. iii of one side, and M. iii of the opposite side of the same individual. In M. i the structure is fully protohippoid, and there is neither loop nor inflection; length 25 mm. In M. iii of the same side, the protocone is barely fused, there is rudimental loop and there are shallow plications 2-2; length 24 mm. In M. iii of the opposite side, the arrangement is hippotheroid; there is a rudimental loop, and 2-1 weak plications; length 25 mm. In two superior molars obtained by myself in northeast Colorado the protocone is connected with the paracoenule by a narrow isthmus. There is a mere trace of the loop, and the enamel borders are undulate, but not plicate. Crowns 16 and 14 mm.

It is thus evident that it is impossible to separate the *P. parvulus* from the *P. placidus* by characters of the superior molars.

A mandible lacking half the left ramus and the coronoid and angular portions of the right, is probably referable to this species. The right series of molars, with the crowns of three incisors, and alveoli of the others and of both canines are preserved. The teeth are well worn, but traces of the cusps of the incisors remain. The canine is separated by a short diastema from the third incisor. The third premolar is rather short. The third true molar is on the contrary elongate, and has a large heel, in great contrast to the *P. pachyops*. The molars are much worn, but it is evident that both lobes of the metaconid are tolerably well developed, and that the hypoconid is larger than the paraconid. The mental foramen is below the middle of the diastema. No trace of a fourth premolar. The last molar is elevated posteriorly on the sloping base of the ramus.

Measurements of Mandible.

	Mm.
Length from heel of last molar to incisive alveolus.....	143
Length from heel of last molar to symphysis.....	111
Length from heel of last molar to canine.....	123
Length of molar series.....	84
Length of true molars.....	43
Length of third premolar.....	14
Width of third premolar.....	9
Length of first true molar.....	13
Width of first true molar.....	10
Length of last true molar.....	19
Width of last true molar.....	8

HIPPOTherium, Kaup.

Cope, Proceeds. Amer. Philosop. Society, 1889, p. 429.

Hipparion, Christol. ?*Merychippus* and *Anchippus*, Leidy.

Species of this genus are much less abundant in the Loup Fork beds of Donley county than those of *Protohippus*, and these belong to the larger forms.

HIPPOTherium AFFINE, Leidy.

Extinct Mamm. Dakota-Nebraska, 1869, p. 286, pl. XVIII, figs. 20-24. *Hippotherium occidentale*, Cope, Proceeds. Amer. Philos. Society, 1889, pl. I, fig. 1 (not of Leidy).

A single superior molar found.

HIPPOTherium OCCIDENTALE, Leidy.

Proceeds. Acad. Phila., 1858, p. 27. *Hipparion occidentale*, Leidy, op. cit., 1856, p. 59; Extinct Mamm. Dakota-Nebraska, pp. 281, 326, pl. XVIII, figs. 1-5; pl. XXVI, fig. 2.

A fragment of a maxillary bone with four molars, and some bones of the skeleton of one individual; and a single superior molar of a second individual. These present the superior degree of complexity at an age at which the enamel plates are comparatively simple in the *H. affine*, as pointed out by Leidy.

PROCAMELUS, Leidy.

I have before me jaws of five species of this genus, and the examination of these, with previous examinations of other specimens, leads me to define the former as follows:

I. Mandibular ramus at M. ii, about three times as deep as the elevation of the crown of M. ii, above alveolar border.

a. Premolar series short, equal two columns of last inferior molar.

Inferior premolars 36 mm.; last inferior molar 43

mm.....*P. angustidens*, Cope.*

aa. Premolar series equaling or exceeding last inferior premolar in length.

Inferior premolars 47 mm.; M. $\frac{3}{3}$, 47 mm.....*P. robustus*, Leidy.

Inferior premolars 41 mm.; M. $\frac{3}{3}$, 38.5 mm.....*P. occidentalis*, Leidy.†

Inferior premolars 31 mm.; M. $\frac{3}{3}$, 33 mm.....*P. gracilis*, Leidy.‡

II. Mandibular ramus slender; at M. $\frac{2}{2}$, 1.5 times elevation of crown of M. $\frac{2}{2}$.

Length of M. $\frac{3}{3}$, 28.5 mm.....*P. leptognathus*, Cope.

PROCAMELUS ROBUSTUS, Leidy.

Extinct Mamm. Dakota-Nebraska, p. 148, pl. XV, figs. 1-4.

Very abundant, but well preserved jaws and teeth are rare.

PROCAMELUS GRACILIS, Leidy.

Op. cit., p. 155, pl. XIV, fig. 15.

Represented by the almost complete dentition of the lower jaw of one side. Bones of the skeleton not uncommon.

PROCAMELUS LEPTOGNATHUS, Cope.

Sp. nov.

This camel is represented by a skull which includes the cranium with lower jaw as far anteriorly to and including the last two true molars. The considerable part of the skeleton of a camel of appropriate size was found near to the skull. At present, I content myself with describing the latter. It was inclosed in a calcareo-siliceous concretion, from which it was cut with some difficulty. The lack of the premolar teeth renders its reference to the genus *Procamelus* uncertain; but it is nevertheless probable that such reference is correct.

The cranium is somewhat distorted by pressure, as it lay on its side, so that it is probable that the postoptic region has been somewhat extended beyond its normal length. This will not, however, account for the elongation of this region as compared with the crania of *P. angustidens* and *P. gracilis* (*P. occidentalis*, Cope olim), with which I have com-

* Bulletin U. S. Geological Survey Territories, I, 1874, p. 20.

†*Procamelus fissidens*, Cope, Report U. S. G. G. Surveys W. of 100th Meridian, IV, Vertebrata, p. 327. In the drawing of the grinding face of the molars in Leidy's Extinct Mamm. Dakota-Nebraska the last lower molar is too short by the measurements and by the profile view given in the same work.

‡Measurements taken from Texan specimen. *Procamelus occidentalis*, "Leidy," Cope, Reports U. S. G. G. Surveys W. 100th Meridian, IV, p. 329, pl. LIII, LXXVI, LXXVIII, LXXIX; *P. gracilis*, l. c., p. 328.

pared it. The vertical diameter of the orbit enters the postorbital length 3.5 times. In the *P. gracilis* it enters 2.5 times, and in the *P. angustidens* twice. The frontal width enters the same 1.25 times. In *P. gracilis* it enters .75 times, and in *P. angustidens* .66 times. The parietal profile is decurved posteriorly, as in *P. gracilis*, and theinion is a prominent convex crest. The sagittal crest is elongate in correspondence with the elongate parietal region. There is no evidence of the deep superciliary notch which is so striking in the two species of the genus above named. The paroccipital and postglenoid processes are elongate, the former a little the shorter, and fused with it for more than half the length of the latter. The latter dimension from the auricular meatus equals the vertical diameter of the orbit, as in *P. gracilis*. The maxillary bone projects posterior to the last molar 10 mm., or opposite to the anterior border of the posterior nares. The lateral palatine notches extend 13 mm. anterior to the posterior extremity of the maxillary bone.

The mandibular ramus is remarkable for its slender proportions. Its posterior border has a well defined offset near the extremity of the postglenoid process when in place. The coronoid process is greatly elevated, reaching when in place to a point above the frontal plane.

The crowns of the second and third true molars in both jaws (the only ones preserved), are compressed. Vertical ridges are little marked on the internal side of the crowns of the inferior molars. The third lobe of the last inferior molar is narrow, and only half as long anteroposteriorly as each of the other columns.

Measurements.

	Mm.
Length of fragment.....	200
Length from anterior border of zygomatic foramen to inion (axial).....	128
Length from foramen magnum to palatal border.....	98
Interorbital width.....	140
Width at auricular meatus (compressed?).....	58
Width of occipital condyles.....	45
Width of palate at front of last molar.....	27
Width of posterior nares.....	12.5
Elevation of lower jaw at coronoid.....	142
Elevation of lower jaw at M. ii.....	23
Width of lower jaw at condyle.....	43
Width of lower jaw at angle.....	67
Diameters superior M. ii.....	<div style="display: inline-block; vertical-align: middle;"> <div style="display: inline-block; vertical-align: middle;"> <div style="display: inline-block; vertical-align: middle;">anteroposterior</div> <div style="display: inline-block; vertical-align: middle;">24</div> </div> <div style="display: inline-block; vertical-align: middle;"> <div style="display: inline-block; vertical-align: middle;">transverse at base.....</div> <div style="display: inline-block; vertical-align: middle;">18</div> </div> </div>
Diameters superior M. iii.....	<div style="display: inline-block; vertical-align: middle;"> <div style="display: inline-block; vertical-align: middle;">anteroposterior</div> <div style="display: inline-block; vertical-align: middle;">25</div> </div> <div style="display: inline-block; vertical-align: middle;"> <div style="display: inline-block; vertical-align: middle;">transverse at base.....</div> <div style="display: inline-block; vertical-align: middle;">18</div> </div>

As already indicated, this species is of about the dimensions of the *P. gracilis* so far as preserved, but differs widely from this and from other species in the slender form of the mandibular rami. The vertical diameter of the latter is about half of that characteristic of the *P. gracilis*. The postorbital region is also more elongate.

BLASTOMERYX, Cope.

Report U. S. G. G. Surveys west of 100th meridian, IV, 1877, p. 350; American Naturalist, 1889, p. 125.

BLASTOMERYX GEMMIFER, Cope.

Op. cit., p. 360, pl. LXXXII, fig. 13 (*Dicrocerus*). *Merycodus gemmifer*, Cope, Ann. Report U. S. Geol. Survey of Terrs., 1873 (1874), p. 531 partim.

Parts of two individuals represent this species. The most important specimens include the posterior four molars of the right side, the P. m. i. and M. i fixed in a portion of the maxillary bone, and a part of the right ramus mandibuli with the posterior four molars in place. The second individual is a little larger than the first, and includes the left inferior M. i and a part of the left inferior M. iii. All these teeth were found by myself, lying close together.

As the characters of this species are little known, I give an account of these teeth. The molars are all moderately brachydont, with the basal shoulders visible on the alveolar border. The superior molars are without styloid tubercles between the bases of the internal columns, while they are present in all the inferior true molars. In this respect the superior molars differ from those of the larger *B. borealis*, Cope, where the stylets are present. The crowns of the superior molars contract rapidly transversely to the apex. The anterior and posterior bounding vertical ridges of the metacone are prominent and there is no median crest. The paracone presents a strong anterior bounding ridge and a strong median ridge; all as in the *B. borealis*. No cingulum. The first premolar is small, and its external border marks the anterior lake of the first true molar. The external face is concave on the anterior half. The part of the exterior wall anterior to this concavity is protocone, and it sends a process inward towards the internal crescent. Posterior to this process, the exterior wall is apparently tritocone,* and it is convex on the inner side. The internal crescent or deutocone is regular; and extends transversely in front anterior to the protocone, from which it is separated by a notch. Above (below) this notch the protocone presents an external ridge; proximad there is no ridge. No cingula.

* See Scott on Nomenclature of Premolar Cusps, in American Journal of Morphology, 1891, p. 49.

The first (posterior) premolar presents a crown constructed—first, of a posterior column with a crescentic section, the convexity forward; second, of a column with crescentic section, with the convexity backwards and outwards; and third, of a cusp which is compressed so as to be anteroposterior. These cusps are deeply separated on the inner side of the crown, but fused on the external side. In the true molars the tritocone and tetartocone are separated at the postero-external angle of the crown by a deep notch. The stylets diminish in size from the first to the third molar, and there is none between the second and third columns of the third molar. On the external side of the protocone in the true molars is a deep vertical groove, which is bounded in front by a fold. No eingula. Internal faces of columns gently convex in transverse section.

Measurements.

	Mm.
Length of superior true molar series.....	30
Diameters of base of M. i	<div style="display: inline-block; vertical-align: middle;"> <div style="display: inline-block; vertical-align: middle;"> <div style="display: inline-block; vertical-align: middle;">anteroposterior</div> <div style="display: inline-block; vertical-align: middle;">10</div> </div> <div style="display: inline-block; vertical-align: middle;"> <div style="display: inline-block; vertical-align: middle;">transverse</div> <div style="display: inline-block; vertical-align: middle;">10</div> </div> </div>
Diameters of M. iii	<div style="display: inline-block; vertical-align: middle;"> <div style="display: inline-block; vertical-align: middle;">anteroposterior</div> <div style="display: inline-block; vertical-align: middle;">11</div> </div> <div style="display: inline-block; vertical-align: middle;"> <div style="display: inline-block; vertical-align: middle;">transverse</div> <div style="display: inline-block; vertical-align: middle;">11</div> </div>
Diameters of P. m. i.....	<div style="display: inline-block; vertical-align: middle;"> <div style="display: inline-block; vertical-align: middle;">anteroposterior</div> <div style="display: inline-block; vertical-align: middle;">6</div> </div> <div style="display: inline-block; vertical-align: middle;"> <div style="display: inline-block; vertical-align: middle;">transverse</div> <div style="display: inline-block; vertical-align: middle;">6</div> </div>
Length of series of inferior true molars	30
Diameters M. ii.....	<div style="display: inline-block; vertical-align: middle;"> <div style="display: inline-block; vertical-align: middle;">anteroposterior</div> <div style="display: inline-block; vertical-align: middle;">9.5</div> </div> <div style="display: inline-block; vertical-align: middle;"> <div style="display: inline-block; vertical-align: middle;">transverse</div> <div style="display: inline-block; vertical-align: middle;">5.8</div> </div>
Diameters M. iii.....	<div style="display: inline-block; vertical-align: middle;"> <div style="display: inline-block; vertical-align: middle;">anteroposterior</div> <div style="display: inline-block; vertical-align: middle;">13</div> </div> <div style="display: inline-block; vertical-align: middle;"> <div style="display: inline-block; vertical-align: middle;">transverse</div> <div style="display: inline-block; vertical-align: middle;">5.8</div> </div>

There remains a doubt as to whether this specimen belongs to the *B. gemmifer*. The last inferior molar agrees closely with the one referred to that species by me in the Vertebrate Paleontology of New Mexico, in Volume V of the Report of the United States Geological and Geographic Survey West of the 100th Meridian; but this is a slender basis of identification. The typical specimens, which are from the Loup Fork beds of Colorado, I can not at the present find, but hope to do so before my final report to the Geological Survey of Texas is published.

APPENDIX TO THE REPORT ON THE LOUP FORK TERRANE.

A small collection made by Mr. Cummins near Goodnight's, on the Staked Plain, presents characters which distinguish it from the faunæ of the Loup Fork and Blanco formations. According to Mr. Cummins, the Loup Fork formation is overlaid by a bed of gravel, which passes under the fossiliferous formation at Goodnight. He consequently regards the latter as of later age than the Loup Fork, while he thinks it older than the Equus beds of Rock creek. The paleontology sustains this view.

The fossils include metapodial and the tarsal bones of a rhinoceros presumably of the genus *Aphelops*; fragments of a superior and inferior molars of a true horse (*Equus*); and superior molars of horses probably of the genera *Hippidium* and *Protohippus*. Neither the first nor last named of these genera has been found in the Blanco, while they do occur in the Loup Fork. The genus *Equus*, however, is not known in the latter formation, but first appears in the Blanco. The fragment preserved is quite characteristic, and I see no way at present of distinguishing it from the *Equus simplicidens*, Cope, of the Blanco bed, but better specimens may indicate another identification. The species which I can identify are the following:

PROTOHIPPIUS LENTICULARIS, Cope.

Sp. nov. Plate XII, Figures 1, 2.

Two superior molar teeth represent this horse in the collection from Goodnight's. They indicate a species of the size of the *Hippotherium speciosum*, and present several peculiarities. The most conspicuous is seen in the form of the protocone, which is long separate from the paraconule. It has an absolutely lenticular section, presenting acute angles anteriorly and posteriorly, and convex surface internally and externally. In this respect it differs from all the species of *Hippotherium* and *Protohippus* known to me. The column is fused towards the base with the paraconule, so that an old animal belongs to the genus *Protohippus*, as in the case with the *Protohippus placidus*, described on a preceding page. As both the teeth of *P. lenticularis* are only partially worn, the pattern of their grinding faces is that of the genus *Hippotherium*.

The enamel borders of the lakes are moderately complex, the anterior having the posterior loop nearly isolated, and a trace only of other irregularities, while there are two deep notches of adjacent borders of the posterior lake. The remote borders of the lakes have each a mere trace of a notch. There is one deep loop of the internal border, which extends to the protocone in one tooth and nearly to it in the other. It is rarely so pronounced in the three-toed horses, and when large is frequently double.

The crown is curved transversely but not anteroposteriorly.

Measurements.

		Mm.
Diameters crown No. 1.....	{ longitudinal	48
	{ transverse	19
	{ anteroposterior	21
Diameters crown No. 2.....	{ longitudinal	44
	{ transverse	18

The long separation of the protocone and paraconule allies this species to the *P. placidus*, Leidy, but from the latter it is well distinguished by its superior size and by the shape of the protocone. The *Hippotherium*

relictum, Cope, from the Pliocene of Oregon, is of approximately the same geologic age, but this is a true *Hippotherium*, and the column (protocone) has an oval section.

Another species of *Protohippus* was found by Mr. Cummins at the same locality. As it is represented by only an uncharacteristic superior molar, I do not attempt its identification.

PROTOHIPPIUS PERDITUS, Leidy.

A single right superior molar, moderately worn, presents no tangible differences when compared with corresponding teeth of *P. perditus* from the Loup Fork beds of Colorado. I nevertheless refer the animal to this species provisionally, as I can not prove that it is not a species of *Hippidium*.

HIPPIDIUM INTERPOLATUM, Cope.

Sp. nov. Plate XII, Figures 3, 4.

Established on two right superior molars, probably derived from the same animal. They are apparently the first and second true molars. The form and area of the grinding surfaces are similar to those of the corresponding molars of the domesticated horse (*Equus caballus*). They may be distinguished from the corresponding teeth of the species of *Protohippus* by the small size of the protocone and hypocone. The former reached posteriorly to the line of the anterior border of the posterior lake, but does not overlap it, as is the case with the species of three-toed horses generally. Its junction with the paraconule is strongly constricted. The internal enamel border between the protocone and hypocone is inflected to a point beyond the line of the internal border of the interior lake, and in front of its apex it sends inward a deep narrow loop. The lakes are relatively large, and the borders are quite simple. The anterior border of the anterior lake is simple; the posterior border has an inflection but no loop. The exterior border of the posterior lake has one inflection, and its posterior border a slight emargination. Owing to the transverse width of the lakes, their bones are little produced. The crowns are curved transversely, but scarcely anteroposteriorly. Cementum abundant. Roots very short.

Measurement.

		Mm.
Diameters of grinding face of M. i.....	anteroposterior.....	28
	transverse.....	27
Diameters grinding face of M. ii.....	anteroposterior.....	29
	transverse.....	29.5
Length of crown of M. ii.....		65

The crowns are sufficiently worn to present the character of maturity.

We learn then, that the emargination of the enamel borders of the lakes are not characters of immaturity. As compared with the Pampeian species,* the enamel borders of the *H. interpolatum* are more simple; while they are not so simple as in the species from Oregon which I have called *H. spectans*.† In the latter the posterior lake borders are not emarginate, and their external borders are more deeply concave. The lakes are wider, a character which may be due to wear; but a further difference is the greater posterior production of the protocone, which considerably overlaps the line of the anterior border of the posterior lake. The *H. interpolatum* is of about the size of the *H. spectans* and *H. neogeum*.

HIPPIDIUM ?SPECTANS, Cope.

American Naturalist, 1887, fig. 41. Huj. op. Plate XII, Figures 5, 6.

Two superior molars belong to a species allied to if not identical with the one above named. One of these is considerably worn, while the other, the posterior of the left side, is little worn. Both display characters different from those of the *H. interpolatum*, as follows: The protocone is large, and its posterior border is opposite the middle of the posterior lake. The enamel borders of the lake are simple, a slight notch in one lake of the younger tooth excepted. The size is smaller. The dimensions are about equal to those of the *Protohippus supremus* of Leidy, but in that species the anterior lake has a large loop, and the lake borders are elsewhere folded. It agrees with the *H. spectans*, especially in the simplicity of the lake borders, which the young molar shows is not a character of age, as in most other species of horses. The hypocone is not conspicuous in either of the teeth. Both exhibit transverse curvature, and the last molar a little anteroposterior curvature.

Measurements.

		Mm.
Diameters of older molar.....	{ anteroposterior.....	24
	{ transverse	27
	{ longitudinal	64
Diameters of last molar.....	{ anteroposterior	24
	{ transverse	20

EQUUS EURYSTYLUS, Cope.

Plate XII, Figures 7, 8; Plate XX, Figure 6.

This small but remarkable true horse was first brought to my notice by a broken inferior molar from the Paloduro canyon, where it was found by Mr. Cummins. The horizon of this locality was unknown to me, but

* Burmeister, Los Caballos Fossiles de la Pampa Argentina, Buenos Ayres, 1875.

† American Naturalist, 1887, p. 1072.

the discovery of four additional lower molars at Goodnight's by Mr. Cummins fixes it. It is the most characteristic species of the epoch which intervened between the Loup Fork and Blanco.

The species belongs with the *E. minutus*, Cope, to a section of the genus characterized by the relatively great width of the metaconid-metastylid column of the inferior molars, and its close appression to the protoconid and hypoconid, and hence by the relatively narrow molar crown; and also by the small size. The present species is superior in dimensions to the *E. minutus*, and differs from it materially in the small size of the hypostylid. From this it follows that the broad flat posterior channel of the internal side of the crown, which characterizes the *E. minutus*, is absent from this species, and a narrow channel with rounded base, rising to the metastylid side, takes its place. The terminal fourth of the crown has a considerable cementum investment, but the remainder of the crown is nearly naked, as in *E. minutus*. The hypostylid is separated from the metastylid by a sharp groove in the *E. simplicidens*; and this rib and the metaconid are more prominent in that species. In this species and in the *E. minutus*, as in some of the teeth of the horse and the quagga, the deep enamel inflection of the external wall enters the metaconid-metastylid isthmus. In the single molar of *E. eurystylus* this is not the case. The anterior and posterior faces of the crown are flat in both the *E. eurystylus* and the *E. minutus*, and the crowns of the teeth observed are gently curved anteroposteriorly.

Anteroposterior diameter of crown at middle, 20 mm.; ditto of metaconid-metastylid, 13 mm.; transverse width of crown restored, 11 mm. Corresponding measurements of *E. simplicidens*, 30 mm., 18 mm., and 18 mm. respectively.

Other specimens examined since the above description was written throw much additional light on its characters. These are four inferior molars, all from Goodnight's, and all apparently from as many individuals. From these it seems that the external faces of the protoconid and hypoconid are flat and not convex as is usual in this genus. Also that the hypoconid throws outwards an acuminate or acute loop just before joining the protoconid, which loop is the summit of an acute ridge of the middle of the external face of the crown. Next, the hypostylid is much more extended anteroposteriorly than is represented in Plate XX, fig. 6, where it is indeed rather smaller than in the tooth from which it was drawn, owing to the latter being fractured at that point (see fig. 6a). It is not flat on the inner face as in *E. minutus*, but is convex, and has a posterior recurved crest, which forms a posterior marginal ridge of the crown. This ridge is not equidistant from the metastylid in the different specimens. It is nearest the latter in the tooth first described (No. 1) and figured, as above cited. In another specimen (No. 5) it is not

further off, but is strongly recurved, forming a prominent narrow ridge bounding the inner side of the crown posteriorly. In the three other specimens (2, 3, 4) it is not prominent, and is separated from the metastylid by a rather flat gutter, as in *E. minutus*. Three of the crowns, including the type, are curved anteroposteriorly; the one with the strong bounding ridge is straight. None are curved transversely. All are wider anteroposteriorly at the grinding face than at the root, a difference most observed on the least worn crown. Cementum is present on the internal face near the grinding surface only; on the external face a thin layer extends nearly to the base. The anterior and posterior faces are naked.

Measurements.

	Mm.
Diameters No. 2	{ longitudinal 55
	{ anteroposterior 24
	{ transverse 10
Diameters No. 5	{ longitudinal 40
	{ anteroposterior 22
	{ transverse 12

As compared with this species the *E. minutus* differs as follows: (1) In the convex protoconid and hypoconid; (2) in the absence of external median keel (loop); (3) in the absence of an anterior marginal bounding ridge of the external side of the crown; (4) in the inferior size. The *E. minutus* is undoubtedly from the Blanco bed, and may be the direct descendant of the *E. eurystylus*.

SYNOPSIS OF SPECIES.

Mr. Cummins found in the bed above the gravel which overlies the Loup Fork formation, the following species:

Aphelops, sp.

Protohippus lenticularis, Cope.

Protohippus, sp. No. 2.

Protohippus ?*perditus*, Leidy.

Hippidium interpolatum, Cope.

Hippidium ?*spectans*, Cope.

Equus eurystylus, Cope.

Equus ?*simplicidens*, Cope.

As already remarked, the genera *Aphelops* and *Protohippus* are characteristic of the Loup Fork beds, but are not known to extend higher. *Equus*, on the contrary, has never been found in the Loup Fork formation, but is the only genus of horses found in the Blanco and *Equus* terranes. *Hippidium* is said to be derived from the Loup Fork beds of Kansas and Nebraska, but I have never found it in place. It is likely

to occur in higher beds, from its more equine foot structure. When we come to species, the three which are identifiable are new to science. Three of the others are not distinguishable from corresponding parts of known species. One of these is Loup Fork, one is Blanco, and the other (*Hippidium spectans*) is of uncertain horizon. It is evident that the bed in question represents an age intermediate between the Loup Fork and Blanco terranes.

CHAPTER III.

THE VERTEBRATE FAUNA OF THE BLANCO BEDS.

A report on collections made in these beds by Mr. W. F. Cummins was made by me and published in the Third Annual Report of the Geological Survey of Texas, 1891, p. 251. During the past season I accompanied Mr. Cummins in a more thorough exploration of this formation, near the eastern border of the Staked Plain, and we added materially to the knowledge of its vertebrate fauna. The results will be found in the following pages. The inference as to the position of the Blanco terranes in the Cenozoic series which I formerly announced, are confirmed; viz., that its position is between the Loup Fork and Equus terranes. The fauna is intermediate and peculiar, as not a single species occurs in it which has been found in the terranes prior or subsequent to it in time. The horizon is more nearly and strictly Pliocene than any of the lacustrine terranes hitherto found in the interior of this continent.

TESTUDINATA.

TESTUDO, Linn.

TESTUDO TURGIDA, Cope.

Proceedings Amer. Philosoph. Society, 1892, p. 127; Ann. Report Geol. Surv. Texas, 1891, p. 255 (published 1892).

Seven specimens of this species were found together at one locality, which did not yield any other vertebrate remains. Fragments of two other individuals were found at other localities in direct association with Mammalia.

TESTUDO PERTENUIS, Cope.

Proceedings Academy Nat. Sciences, Philadelphia, 1892, p. 226.

Founded on a large specimen measuring three and a half feet in length by three in width, and remarkable for the transverse width of the vertebral dermal scuta. The carapace is rather flat and descends steeply posteriorly, the anal marginal bone being somewhat incurved. Margins of carapace flare outwards above the legs. The plastron has a rather wide lip, with flat base and straight lateral borders; its anterior border is lost. The posterior lobe is deeply and widely notched, terminating on each side in a subequilateral angular prominence. Both carapace and plastron are without sculpture, the posterior angles of the plastron only being longi-

tudinally grooved below. The vertebral scuta are considerably wider than long, as is also the anal scutum. Both carapace and plastron are very thin, not exceeding one-quarter inch in the specimen described, except at the borders.

Measurements.

Length over all.....	4.2	feet
Width over all.....	4	feet
Width of penultimate dorsal scute.....	1.275	feet
Length.....	.85	feet
Width of last vertebral scute.....	1.35	feet
Width of anal scute.....	1.5	feet
Length.....	.6	feet
Length of penultimate costal scute.....	.9	feet
Length of last costal.....	.95	feet
Width of lip of plastron at base.....	.8	feet
Width of anterior lobe at axillæ.....	2	feet
Width of posterior lobe of plastron at base.....	2	feet
Width at fundus of median notch.....	1.1	feet
Width at apices of angular processes.....	.85	feet
Depth of notch.....	.5	feet

This is the largest species of land tortoise yet known from North America.

Fig. 1. *Testudo pertenuis*, Cope, one-fourteenth natural size.

1. Portion of carapace from above.
2. Posterior lobe of plastron from above.

EDENTATA.

MEGALONYX, Jeff.

MEGALONYX LEPTOSTOMUS, Cope.

Sp. nov. Plate III, Figures 1-3.

This species is represented by a number of fragments of the skull and a superior molar tooth, probably the last of the series. The most instructive fragments are the palatal portions of both premaxillaries, with the alveoli of the canine-molars; and portions of the palatal portions of the maxillaries, with parts of alveoli of several molars. The right occipital condyle is also preserved.

The only species in which the corresponding portions of the cranium are known are the *Megalonyx jeffersonii*, Harl., and the *M. leidy*, Lindahl, but the teeth of the other species may be compared with those of the

present one, especially the canine-molars, of which a good idea may be gained in the *M. leptostomus*, from the form of its alveolus.

The palatal portion of the premaxillary bones is bifurcate from an acute angle posteriorly, which is opposite the posterior border of the alveolus of the canine molar. Neither moiety extends anterior to the anterior border of that alveolus. The alveolar ridges approach posterior to these alveoli so as to be separated by an interspace equal to two-thirds that which separates the alveoli. In *M. jeffersonii* and *M. leidy* this width is equal to that which separates the canine-molars; and the premaxillary palatal emargination is rounded, broadly so in the *M. leidy*. The *M. leptostomus* is remarkable for the narrowness of the palate throughout, the width equaling about two-thirds that of the corresponding region in the two species mentioned. It is in consequence narrower than the transverse diameter of the molars, while it equals that diameter in the two species already described.

The form of the canine-molar is different from that characterizing the other known species of the genus. The alveoli, instead of having concave internal borders, divergent from each other outward and backward, as in *M. jeffersonii* and *M. leidy*, have their internal borders parallel and directly anteroposterior. They present posteriorly a wide border at right angles to the internal border, and passing into the latter by a rounded angle. The form of the tooth is therefore more or less triangular, or similar to that of a molar tooth placed longitudinally. This is a suspicion only, as the external and anterior alveolus walls are unknown. The form of the known part of the alveolus, however, shows that the canine molar is not only very different from that seen in the two species mentioned, but is equally distinct from those of the *M. loxodon*, *M. wheatleyi* and *M. tortulus*, Cope, and the *M. dissimilis* of Leidy. Neither the internal nor the posterior alveolar borders display any grooves or concavities, but are perfectly plane.

The alveoli of the molar teeth indicate that they differ in the anteroposterior diameters of their widest or internal extremity. The supposed last molar is about equal in dimensions to the middle molars of the *M. jeffersonii* and *M. leidy*, and is one-fourth larger than those of *M. wheatleyi* and *M. dissimilis*. Its diameters are uniform from base to crown. Its horizontal section is a narrow triangle with rounded angles. Its anteroposterior diameter is smaller in relation to its transverse than in any species known to me. The forms of the inner borders of the alveoli indicate that some of the other molars are relatively wider in the fore and aft direction.

Measurements.

	Mm.
Depth of premaxillary notch (axial)	33
Width between canine-molar alveoli	43
Width of inferior face of premaxillaries.....	35
Width posterior to canine molars.....	27
Width of premaxillaries at posterior external angle of canine-molar alveolus	83
Width of palate between molars.....	18
Transverse diameter of occipital condyle.....	28
Diameters canine-molar alveolus.....	{ anteroposterior 25
	{ transverse 18
Anteroposterior width inner face of alveolus of middle molar.....	15
Diameters of (?) last molar.....	{ longitudinal 61
	{ anteroposterior (greatest). 14
	{ transverse 25

The specimen above described was found by Mr. W. F. Cummins. The discovery is of much interest, as carrying back our knowledge of the presence of this genus of sloths in North America to an older terrane than that (the *Megalonyx* beds) in which it has been hitherto known to occur.

CARNIVORA.

Three species of this order were found, a number about in proportion to those of other orders. Their remains are in rather a poor state of preservation, as the conditions of deposit appear to have been unfavorable to the integrity of any but large and strong bones and teeth. Three families are represented, viz.: *Mustelidæ*, *Hyænidæ* and *Felidæ*. The discovery of *Hyænidæ* is a noteworthy circumstance, and adds materially to the Old World facies of this part of the fauna. The absence of the *Canidæ*, usually by far the most numerous family of *Carnivora*, is curious, and is probably accidental.

CANIMARTES, Cope.

American Naturalist, 1892, p. 1029.

True molars $\frac{2}{2}$; second inferior molar with one root; inferior sectorial with well developed blade, trenchant heel, and large metaconid. Superior sectorial with small protocone anterior in position, and without distinct anterior basal lobe.

As in the typical genera of the family, the first superior tubercular molar has an expanded obtuse internal cingulum. As compared with the genus *Mustela*, to which it approaches, *Canimartes* differs in the possession of the superior M. ii. Its dental formula is the same as those of *Stenoplesictis* Filh. and *Amphictis* Pom.; but it differs from both in important details. Thus the heel of the sectorial is cupped, and the inferior tubercular is elongate and quinquetubercular in the former; and in the

latter the superior tuberculars have no internal cingulum, and the first inferior tubercular is like that of *Stenoplesietis*.

In the two superior true molars we have the persistence of an ancient character in this family.

CANIMARTES CUMMINSHI, Cope.

Sp. nov. Plate XIV, Figures 12-14.

Represented by the posterior part of the skull and jaws with the accompanying molar teeth. Apex of paracone of superior sectorial in front of middle of length of crown; base of paracone with a small tubercle in front; no cingula; cingulum of M. i. rounded and thickened, and wider anteroposteriorly than the middle of the crown. Internal cingulum of M. ii. not so expanded anteroposteriorly as that of M. i.; protocone the apex of a triangle which includes a central basin. Paracone and metacone of both superior molars lost. Inferior premolar $\pm$ with a small conic cusp on the middle of the superior face of the short heel. Inferior sectorial with the blade a little longer than the heel. Metaconid not quite so high as the paraconid. No cingula except a low one on internal side of heel. Inferior M. ii. very small, grinding face nearly round, with two low opposite cusps connected by a low transverse ridge. No cingula. Enamel of all the teeth smooth.

The teeth of this species are about the size of the fisher, *Mustela pennantii*.

Measurements.

		Mm.
Diameters of superior sectorial.....	{ vertical	7
	{ anteroposterior.....	13
Diameter of M. i superior, anteroposterior.....		8
Diameter of M. ii superior, anteroposterior		5
Diameters of inferior sectorial.....	{ vertical	10
	{ anteroposterior.....	14
	{ transverse	5
Diameters of inferior M. ii.....	{ anteroposterior.....	5
	{ transverse	4

This important addition to our short list of American extinct Weasels was discovered by Mr. W. F. Cummins, to whom I take great pleasure in dedicating it.

BOROPHAGUS, Cope.

American Naturalist, 1892, p. 1028.

Probably family Hyænidæ. Second and probably the first premolars enormously larger than the third and fourth, and consisting of a conic anterior portion and robust posterior lobe and keel. Sectorial with a

short acute blade. Fourth inferior premolar present, one rooted. Third inferior premolar molariform.

This genus is established to receive a remarkable species of carnivore from the Blanco terrane. The typical individual of the typical species is represented by an anterior part of the lower jaw. Probably the same species is represented by the separate crowns of two inferior premolars and sectorial molar and some other fragments. These teeth are closely similar to those of the existing *Hyænas*, so that I refer the genus *Borophagus* to the *Hyænidae* provisionally, since the essential diagnostic parts have not yet been found. The conic character of the principal premolars, and their abrupt increase in size anteriorly, the low, almost molariform, character of the third premolar, together with the short blade of the inferior sectorial, constitute strong points of resemblance to the *Hyænas*. I refer the present form to a distinct genus, under the name *Borophagus*, on account of the presence of the fourth premolar.

In the Loup Fork epoch, the genus *Ælurodon* was represented by several species, varying from the size of a red fox to that of a grizzly bear, which performed the function of *Hyænas* in the economy of the fauna, in devouring the carcasses of the numerous large species of *Mammalia* with which they were contemporary. The premolar teeth of the larger species were more robust than in the true dogs, and were useful in breaking bones. In the Blanco fauna the genus *Borophagus* probably performed the same function, and they carried the development of the premolar teeth to a greater degree of effectiveness, as a mechanism for crushing bones. They resemble those of the *Hyænas* much more nearly than do those of the species of *Ælurodon*, and were as robust as those of the largest species of that old world type.

On a former occasion, in discussing the affinities of the extinct dogs of North America,* I expressed the view that the genus *Ælurodon* would prove to be the ancestor of the *Hyænidae*. At that time no genus of *Hyænidae* was known from North America, and the genus *Ælurodon* is not known from the old world. The transition I suggested might have been accomplished through the old world genera *Ichtherium*, and *Hyænictis*, which have been regarded as transitional between the *Viverridae* and *Hyænidae* by Gaudry. It seems, however, that the American continent possessed in *Borophagus* a representative of *Hyænictis*, with which it agrees in possessing the fourth premolar. Dr. Schlosser has agreed with my view that *Ælurodon* is probably ancestral to the *Hyænidae*. This hypothesis is, however, provisional only.

*American Naturalist, 1883, p. 224.

BOROPHAGUS DIVERSIDENS, Cope.

Plate XIII, Figure 4. American Naturalist, 1892, p. 1028.

Represented by the anterior part of the left mandibular ramus with two premolar teeth in place, and the alveoli of the anterior and of the canine. Another specimen included the separate crowns of three molars, including part of the sectorial, but the specimen is unfortunately at this time mislaid.

Owing to the absence of the entire dental series it is uncertain whether there are three or four premolars. The alveolus of the canine indicates a very large tooth, with the posterior face of the root broadly rounded. The fourth premolar has one alveolus, which is round, and is in immediate contact with that of the canine. The third premolar is three rooted, and the anterior root is separated by a short space from that of the fourth. The crown is obtuse and molariform, and is traversed by a low median longitudinal keel, whose direction is diagonal to the long axis of the jaw, and which has only a faint indication of a median cusp. The crown of the second premolar (first?) is much elevated and very robust. It consists of an anterior conic cusp, whose horizontal section at the base is a wide oval, a lobe of the posterior margin, and probably a large keel, but this is broken off. The posterior root is very large, its alveolus nearly equaling that of the canine. I infer from this the presence of a large keel, wider than long. This tooth has no anterior cutting edge, but an angular trace of one. The third premolar crown only reaches the base of the crown of the second. The mental foramen is below the space between the third and fourth premolars.

Measurements.

Icterus arizonensis.

	Mm.	
Transverse diameter canine alveolus.....	13	
Transverse diameter second alveolus, P. m. ii.....	13	
Diameters crown P. m. iii.....	<div><div>longitudinal.....</div><div>anteroposterior.....</div><div>transverse.....</div></div>	<div><div>4</div><div>10</div><div>8</div></div>
Diameters crown of P. m. ii.....	<div><div>longitudinal.....</div><div>anteroposterior*.....</div><div>transverse.....</div></div>	<div><div>17</div><div>28</div><div>15</div></div>

The second specimen includes a robust conic crown with a small conic cusp at its base, and an anterior blade of a sectorial. The conic cusp is without cutting edge. The blade has a rather short straight edge, which is in its unworn state finely serrate. It is no larger than the corresponding part in the *Elurodon saevus*.

This remarkable species was probably a scavenger, devouring the car-

*Partly estimated on account of absence of keel.

casses of the huge Mammalia that existed during the Blanco epoch. Its dental structure is adapted for crushing bones, while its canine teeth served their usual purpose of tearing into fragments the carcasses of the camels, horses, etc., that formed its food. The corresponding parts are similar in dimensions to those of the spotted hyena (*Crocuta maculata*).

FELIS, Linn.

A single species of Felidæ may be provisionally referred to this genus. The specimens which represent it consist of the second, third, and fourth metacarpals of the left side, a second metatarsal of the same side, an entocuneiform, an unciform, a calcaneum, the arch of a lumbar vertebra, and two superior canine teeth, found together, and a scapholunar bone found near at hand. The canine teeth indicate a mature animal.

The metapodials of the species here described are relatively shorter than in any species of Felidæ known to me. There were evidently five digits in the manus, and four in the pes. The distal extremities of the penultimate phalanges are not unsymmetrical, as in the larger cats of the genus *Uncia*, as the lion, etc.

FELIS HILLANUS, Cope.

Sp. nov. Plate XIV, Figures 1-11.

The superior canine tooth is large, but the greatest diameter is seen in the root at its inferior third. The crown has the horizontal section at the base a horizontal oval, much less convex on the inner than on the outer side. There are well marked obtuse cutting edges anteriorly and posteriorly, the anterior terminating at the base in a slightly projecting angle. Enamel smooth.

The separate neural arch of a vertebra presents the postzygapophyses. The articular faces of the latter are vertical, and not convex. The spine is of moderate elevation, and its base occupies the entire neural arch. Its anterior edge is subacute.

The distal face of the unciform is as broad as long; its posterior process is rather short. The entocuneiform is short, narrow, and deep antero-posteriorly, and the distal articular surface is crescentic. The metacarpals are rather robust, and the second is about four-fifths the length of the equal third and fourth. The diaclast* is present on the third as well as the fourth, as in other Felidæ, but that of the third is not overroofed on the anterior side, as is that of the fourth. The facet on the anterior side of the external proximal fossa of the fourth, shows that the diaclast is present on the fifth metacarpal. The proximal articular surface of the

*I propose this term for the interlocking process of a metapodial which occupies the external fossa of the adjacent metapodial in most Carnivora.

second metacarpal is not so convex anteroposteriorly as those of the third and fourth, and is openly grooved in the same direction, which is not the case with the others. The distal trochlear keels are acute.

There are no phalanges of the first row preserved, and but two of the second. They are rather elevated at the middle of the proximal extremity, while the shaft is depressed more toward one side than the other. The distal face has an arc of 180 degrees, and is openly emarginate in the longer phalange, but truncate in a short one. The long phalange is relatively longer than in any feline animal known to me, equaling two-fifths of the longer metacarpals.

The calcaneum has lost the extremity of the tuber, but is otherwise complete. It is wider at the sustentaculum than is usual in digitigrade carnivora, while the ectal facet is directly in the line bisecting the cuboid facet and the tuber. External cuboid tuberosity moderate; cuboid face semicircular, with a fossa on the inner border. The second metatarsal is equal in length to the second metacarpal, but is more slender. Its head is openly grooved anteroposteriorly, and displays on the inner side two longitudinal facets separated by a groove. Each facet shows two faces, one for the magnum and the other for the third metacarpal.

Measurements.

	Mm.
Length of superior canine (apex restored).....	60
Diameters at base of crown.....	{ anteroposterior 15
	{ transverse..... 11
Length of crown of superior canine (apex restored).....	24
Length of unciform.....	13
Distal diameters of unciform.....	{ anteroposterior 12
	{ transverse..... 14
Diameters entocuneiform.....	{ anteroposterior..... 12.5
	{ longitudinal 9
	{ transverse..... 6.5
Length of second metacarpal	50
Length of third metacarpal	61
Length of fourth metacarpal	61
Proximal transverse diameter, M. c. ii.....	11
Proximal transverse diameter, M. c. iii., with diaclast.....	10.5
Proximal transverse diameter, M. c. iv., with diaclast.....	11.5
Transverse diameter of shaft, M. c. ii.....	7.5
Transverse diameter of shaft, M. c. iii.....	8
Transverse diameter of shaft, M. c. iv	8.5
Distal diameter above condyle, M. c. ii.....	11.5
Distal diameter above condyle, M. c. iii	11.5
Distal diameter above condyle, M. c. iv	12
Length of calcaneum from ectal to cuboid facet inclusive.....	23
Width at sustentaculum.....	22
Diameters cuboid facet.....	{ anteroposterior..... 11
	{ transverse..... 12
Depth calcaneum at ectal facet.....	21

Depth calcaneum at middle of tuber	16	
Length M. t. ii.; transverse diameter	{ proximally..... 9 at middle of shaft..... 6 distally above condyle.. 10	
Length penultimate phalange No. i.....		13
Width of same at condyle.....		7
Length penultimate phalange No. ii.....	24	
Width of same at condyle.....	10	

The shortness of the metapodium and width of the calcaneum in this species indicate that this species was less digitigrade than the existing species of *Felis*. Its dimensions were probably about those of the cheetah (*Cynælurus jubatus*).

The typical specimens were found by Mr. W. F. Cummins. I name the species in honor of Prof. Robert T. Hill, who has done important work in the geology of the Staked Plains.

PROBOSCIDIA.

TETRABELODON, Cope.

Proceeds. Amer. Philos. Soc., 1884, p. 2; American Naturalist, 1889, p. 193.

TETRABELODON SHEPARDII, Leidy.

Plate XXIV.

Mastodon shepardii, Leidy, Proceeds. Acad. Philadelphia, 1870, p. 98; 1872, p. 472. Cope, American Naturalist, 1884, p. 524.

Dibelodon shepardii, Cope, Proceeds. Amer. Philosoph. Soc., 1884, p. 5, partim.

Mastodon obscurus, Leidy, partim, Report U. S. Geological Survey Terrs. I, p. 330. Pl. XXI., 1873.

A lower jaw of this species, lacking the condyles, and supporting the second and third true molars, was taken from the bluff at Mont Blanco from the same excavation that yielded the *Pliauchenia spatula*, Cope, and within fifty feet of that at which the tooth of *T. præcursor* was obtained. It came into possession of Mr. M. M. Cox of Estacado, from whom I obtained it by purchase after my return from Texas. The acquisition of this specimen is important as enabling me to determine the true characters of this species, since it has been known so far only from a last inferior molar, and possibly a fragment of a tusk, both from California.

The second true molars are much worn, but they show only three cross-crests without a rudimental fourth, as was to have been expected from the character of the third molar. The third true molar exhibits exactly the simple characters of the typical specimen described by Leidy;

that is, it has four well separated cross-crests, and a very rudimental heel. The external half of each cross-crest wears into a trefoil, while the internal half is simple and undivided, and is a little anterior in position to the external half. The tooth continues its width posteriorly, so that the transverse diameters at the first and fourth cross-crests are equal. A marked character of the species is the elevation of the anterior part of the ramus and the decurvature of the symphysis, from which it results that the superior face of the symphysis, or the spout, descends very steeply to its extremity from the second true molar quite as in the proximal part of the spout of *Dinotherium*. It has a very short horizontal portion anterior to the second true molar to represent the long horizontal production in *Dibelodon tropicus*, *Mastodon americanus*, etc. The symphysis is also much compressed above, so that the spout is narrow. The extremity of the spout is produced and contracted, and slightly recurved at the extremity, and there issues from the right side a well developed, vertically compressed mandibular tusk. On the left side is the empty alveolus of its counterpart, which was of much larger diameters than that of the right side. The portions of superior tusks found in California are stated by Leidy to possess an enamel band, and as there are various reasons for supposing that they belong to the *T. shepardii*, I refer provisionally the species to *Tetrabelodon* rather than to *Dibelodon*, as heretofore.

The contracted symphysis steeply descending forwards, and expanding downwards at the base, from a posterior elevation, distinguishes this species from any of those of the genera *Tetrabelodon*, *Dibelodon*, or *Mastodon*, known to me. Hence there is no question of its difference from the *T. productus*, Cope, with which it was identified by Leidy,* where the symphysis is flat and much longer. In the *Dibelodon andium*, according to D'Orbigny and Burmeister, the symphysis is not elevated behind, is produced and decurved at the extremity, and has a wide spout; all characters quite different from what is seen in *T. shepardii*. The symphysis is totally distinct in the *D. tropicus*, as can be seen in the accompanying plates, and the last true molar is much more complexed in the latter. I formerly identified the species so abundant in the Equus beds of the valley of Mexico with this species.† This determination must now be reconsidered, since the form of the mandibular symphysis is entirely different; there is no mandibular tusk, and the last lower molar is not identical in form,‡ though I formerly thought it not so different as

*By reference to it of specimens of *T. productus* from Santa Fe, New Mexico, in Report U. S. Geological Survey Terrs., I, 1873, p. 235.

†Proceeds. Am. Philosoph. Soc., 1884, p. 5.

‡A figure of this tooth is given by Felix in the *Paleontographica*, Vol. XXXVII, Pl. 30, 1891.

to preclude the possibility of the species being identical did no other differences exist. The differences observed in this tooth may, however, be of specific value. The relative width of the crown is greater, especially anteriorly, and the lateral borders of the latter are not parallel as in *T. shepardii*, but converge posteriorly, as in *M. præcursor*. The lobes of the cross-crests are opposite as in the latter species. From *M. præcursor* this tooth differs in the more tubercular and less crest-like character of the cross-crests, and in their more profound division on the median line, especially in the third and fourth crests. *M. præcursor* is zygolophodont while the Mexican species is bunolophodont. The various characters just mentioned also distinguish the *M. præcursor* from the *T. shepardii*. There is no evidence that the Mexican species possesses an enamel band on the superior incisors. My assertion to this effect was based on a specimen which presents this character which is preserved in the Escuela de Minas of Mexico. This specimen came from Tehuichila, in the State of Vera Cruz, from a formation which I subsequently determined to be of Loup Fork age, so that the identity of the species with that found in the Equus beds of the valley of Mexico is highly improbable. I therefore refer the latter to the genus Mastodon under the specific name of *M. oligobunis*, Cope. It differs from the *Dibelodon tropicus* in the smaller number of cross-crests of the last molar, and their greater simplicity, since they are not divided at all, and the external halves of the first and second only have anterior and posterior buttresses, in some individuals at least.

Measurements of T. shepardii.

	Mm.
Length of right ramus and symphysis	730
Length of right ramus to symphysis.....	515
Depth of ramus at posterior end of M. iii	135
Depth of ramus at anterior end of M. ii.....	175
Width across both rami at posterior end of M. iii.....	420
Width of right ramus at posterior end of M. iii	140
Width of both rami at base of symphyses.....	214
Width of snout at proximal end	65
Width of distal extremity of symphysis	120
Length of snout.....	215
Diameters of M. ii.....	{ anteroposterior..... 125 transverse at middle 75
Diameters of M. iii	
Diameters of right symphysal tusk.....	{ anteroposterior..... 164 transverse at middle 75
Diameters of left symphysal alveolus.....	
	{ vertical 68 transverse 27
	{ vertical 78 transverse 45

DIBELODON, Cope.

Proceeds. Amer. Philos. Soc., 1884, p. 2; American Naturalist, 1889, p. 193.

DIBELODON HUMBOLDTII, Cuvier.

Plates XV, Figures 2-4; XVI, Figure 4.

Cope, Proceeds. Amer. Philos. Soc., 1884, p. 5.

Mastodon humboldtii, Cuvier, Ann. de Museum, VIII, 1896, p. 413; De Blainville, Osteographie, Gravigrades; Gervais in Castelnau's Voyage en Amerique du Sud; Burmeister, Annales du Museum de Buenos Ayres.

The palate, with the penultimate superior molars of this mastodon, were found by myself, buried with a number of bones of the skeleton. Mr. W. F. Cummins found in two other localities two molars, probably the last premolar and first true molar of one individual, and a last premolar of another individual. No entire last true molar, no symphysis mandibuli, and no tusks were found. It follows that the identification of this species is not as definite as is to be desired; nevertheless I can find no important difference between the teeth obtained and the corresponding ones of *D. humboldtii*.

The penultimate molars of the *D. humboldtii* are figured by De Blainville and the (?) first true molar by Burmeister. The last molars are figured by all the authors above quoted, and I have a perfect specimen in the entire ramus with symphysis in my private collection from Buenos Ayres. The only character in which the Blanco molars differ from those figured and described as above mentioned, is the larger size of the heel, which forms a small fourth cross-crest on continued wear. It consists of three cusps, two on one side of the middle line and one on the other, whose combined section is crescentic, with the concavity backwards. Its transverse extent is about half that of the true crests. A distinct rudiment of this structure is represented as existing in the *D. humboldtii* of South America. The Blanco teeth can not, however, be regarded as tetralophodont.

This species is readily distinguished from all other American trilophodont species by the similarity in composition of the internal and external halves of the molar crests. Both have lateral internal tubercles, so that both wear into similar trefoils. The marginal portions of these trefoils are equidistant on the opposite sides of the crown, so that they do not come into contact on wear, while the two inner lobes of the trefoils come into contact on wear, and completely block the transverse valleys. There are robust but low cingular tubercles between the crests on the internal side at the base of the crown, but these are not connected with each other, so that there is no cingulum. There are no corresponding tubercles on

the external side of the crown. There are two or three accessory tubercles at the anterior extremity of the crown closely appressed to the first cross-crest. The lateral internal lobes of the trefoils are separated from the single external lobe by deep grooves.

Measurements of M. 2.

	Mm.
Anteroposterior diameter.....	127
Width at first crest at base.....	72
Width at third crest at base.....	80
Elevation of third crest.....	53

The probable first true molar is unworn, and lacks the anterior border and one-half of the anterior cross-crest. The tubercles composing the crests are very distinct, are defined by deep vertical grooves, and converge toward the median line with their apices. The cingulum passes round the base of the second cross-crest, and between the crests is serrate, and even pectinate. The principal cusp on one-half of the second and third cross-crests is a little posterior in position to the crests of the opposite side.

Measurements of ?M. 1.

	Mm.
Anteroposterior diameter.....	98
Width at middle cross-crest.....	59
Elevation of middle cross-crest	47

The supposed last premolar is still more complex than the first true molar. The enamel layer is more grooved, forming plications on wear, and the internal lobes of the trefoils of the external series are subdivided so as to produce on wear from five to seven lobes. An external cingulum is developed, which sends up strong tubercles at the valleys, but is weak at the cross-crests. There are rudiments of a cingulum on the opposite side.

Measurements of ? P. m. i.

	Mm.
Anteroposterior diameter of crown	78
Width at middle of cross-crest.....	50
Elevation of third cross-crest (little worn).....	35

The only other North American elephants with double trefoils are the *Mastodon* (?*Dibelodon*) *mirificus*, Leidy, and the *Tetrabelodon campester*, Cope. Both of these are fully tetralophodont, and belong to the older Loup Fork fauna. The *Dibelodon humboldtii*, on the other hand, belongs probably to a later fauna than the Blanco, viz., the Pampean of South America, which is more or less exactly equivalent to the Equus beds. It would not surprise me if future research would show that the Blanco spe-

cies occupies an intermediate position in structure, as it does in time, between the *M. (?Dibelodon) mirificus* and the *D. humboldtii*. The occurrence of the latter species in Texas indicates a great range in latitude, since its remains have been found hitherto principally in Buenos Ayres and Chili. Its supposed occurrence in Mexico I have shown to be based on a misapprehension.*

A specimen found not far from Pernambuco, Brazil, has, however, been recently presented to the Academy of Natural Sciences of Philadelphia by Dr. J. Cheston Morris, and this discovery shows that a tropical climate has been no obstacle to the migration of the species. The specimen referred to includes three crests of the last true molar, which is characteristic.

From its geological position, I suspect that the *Mastodon mirificus*, Leidy, will turn out to be a *Dibelodon*.

DIBELODON TROPICUS, Cope.

Plates XV, Figure 1; XVI, Figures 1-3.

Proceedings American Philos. Soc. 1884, p. 7.

Mastodon sp., Cope, loc. cit., 1892, 123, 123.

Mastodon humboldtii?, Cuv. Von Meyer Paleontographica, 1867, Studien neb. Mastodon, p. 64, Pl. VI.

Mastodon successor, Cope, Proceed. Academy Philadelphia, 1892, p. 227.

A few yards distant from the locality in which I found the superior molar teeth of the *Dibelodon humboldtii*, the head of a humerus projected above the surface of the ground. Following the shaft downwards, I reached a large tusk, which was lying in contact with its inferior third. On fully exposing the tusk, I found that it was resting upon a mandible with complete symphysis and two molar teeth on each side, but lacking angles and condyles. At various other points on the same hill I observed fragments of teeth and bones of mastodons. Besides this specimen, Mr. W. F. Cummins found near Mount Blanco a last premolar of two other individuals, and a last premolar from the Paloduro Canyon. It was from the teeth found by Mr. Cummins that the first indication of this species in the Blanco bed was obtained, as above cited.

The portion of tusk exposed is about four feet of the basal region. This did not display any enamel band, but its absence from this part of the length does not disprove its presence on the more distal region. The question of its presence or absence must be left in doubt for the present. The symphysis is short and is without incisors. It is nearly as short as in the elephants, and is much more contracted than in the *D. cordillerarum*. The constitution of the molar tubercles is as in that species, and

*Proceedings American Philosophical Society, 1884, p. 7.

various species of *Tetrabelodon*, but the last inferior molar has five well developed cross-crests and a prominent heel and one more cross-crest than any of the species cited, thus resembling the tetralophodont forms of both genera. I would have suspected that this species is tetralophodont had I possessed only the last molars, but the presence of the second true molar in both rami in excellent preservation shows that this is not the case. It agrees in the characters of its molars very closely with the typical specimen of the species from Michoacan, Mexico, described and figured by Von Meyer as above cited. The last true molars are not fully protruded, and the inference to be derived from the character of the second molars is that that tooth would have but four crests and a keel. On this supposition I suspected the animal to represent a species distinct from the *M. tropicus* and named it *M. successor*, as above cited. This name is now withdrawn.

In the inferior molars the apices of the crests are very obtuse. The external half of each cross-crest possesses a single accessory tubercle on each side of its internal extremity, which, together, produce the trefoil section on wear. The internal halves of the crests possess no accessory tubercles except on the first cross-crest, where they are present, and a trace at the posterior base of the second. Each half is divided at the summit and on the sides by a groove, into two lobes, which are only superficially distinguished, and more plainly in the anterior than in the posterior teeth. There are no cingula, but there are tubercles at the mouths of the external valleys.

The last inferior molars support, as above remarked, five cross-crests and a well developed heel of two tubercles. In the last two cross-crests the internal halves are situated a little in advance of the external halves. The general outline of the crown is that of an elongate wedge. The principal lobes of the fifth cross-crest converge upward, but the convergence is less than in the others.

The second molars are well worn, but not so as to obliterate the pattern at any point. On the external side the valleys remain open, but on the internal side the adjacent enamel borders of the crest are in contact so as to obliterate the valleys. The bilobate character of the external half of each crest is well preserved. There is a rudimental cross-crest behind the third, in close contact with it, which does not extend across the crown, and which is less developed than in the *D. humboldtii*. The enamel in both true molars is smooth, excepting some horizontal wrinkles on the ends of the cross-crests.

The symphysis is short and abruptly acuminate and slightly decurved at the apex. Its length is less than that of the second molar tooth, having shorter proportions than in the corresponding part in *D. humboldtii*, and very much shorter than in *D. cordillerarum*, as represented by Burmeister.

On the supposition that one cross-crest has been lost, the crown consists of five cross-crests, or four cross-crests and a very large heel, which has the constitution of the cross-crests, but is transversely contracted. The cross-crests are remarkable for their acute summits, in which they resemble those of *M. americanus* and *T. serridens*. They are, however, more contracted transversely, or shorter at the apex than is the case with either of those species. In their acuteness they differ from both the species which are found in the same formation. They have accessory ridges on the external halves only, which would produce lobes on wear, while the internal halves of the crests are entirely simple. These ridges have no distinct apices, but disappear upwards in the cross-crests, from which they are separated below by shallow open grooves only. They are wanting at the posterior bases of the third and fourth crests. They do not reach the median line, but the main axis is produced beyond them to reach it. The section of an external crest is then rather a four-lobed cross than a trefoil. The apices of both halves of the crest descend rapidly to the median fissure, meeting at a strong angle a little more than right. The edge of the internal half of the crest is slightly notched or bilobate, except on the fifth crest. The valleys are bounded on both sides of the crown by tubercular ledges, but there are no lateral or posterior cingula. Enamel smooth. A considerable deposit of cementum between the crests.

Measurements.

	Mm.
Length of last molar (anterior crest restored).....	160
Width same at second crest.....	68
Width same at fifth crest	41
Elevation of second crest.....	54
Elevation of fifth crest	30
Width of apex of second crest	29
Width of apex of fifth crest.....	18

The tusks of this species are unknown, and I refer it to the genus *Dibelodon* provisionally only. It must be compared with the *T. shepardii* and the *Mastodon americanus*, as the species to which it bears the nearest resemblance. It differs from the former in the five cross-crests, which are more elevated, more contracted in both directions and more acute. The outline of its base is more wedge-shaped. It differs from the *M. americanus* in the same features, and in the presence of accessory ridges of the external half of the cross-crests. Of all the *Mastodons* of America it approaches nearest to the *M. americanus* in the simplicity and acuteness of the crests, and further information as to its characters will be welcome, in view of a possible relationship with the latter species.

DIPLARTHRA.

The only species of this order which have been discovered in the Blanco beds belong to the genera *Equus*, *Platygonus* and *Pliauchenia*. No trace of rhinoceros or tapir has been observed.

EQUUS, Linn.

EQUUS SIMPLICIDENS, Cope.

Plate XX, Figures 1-3.

Proceedings Amer. Philos. Society, 1892, p. 124. Annual Report Geol. Survey of Texas, 1891 (1892), p. 252.

Inferior molars and bones of this species are abundant at Mount Blanco, but superior molars are less common, in a well preserved condition. The exploration of 1891 yielded only two superior molars which are determinable, and that of 1892 has yielded three which are determinable, though fractured, but none in better condition than the type. I shall therefore confine my remarks on the present occasion to the inferior molars.

In a former paper I have given a synopsis of the distinctive characters of the superior molars of the species of the genus *Equus**. I now mention characters which distinguish the inferior molars of some of the species of the true horses which are identified by their undoubted association with superior molars.

- I. Metaconid and metastylid separated by a sharp entrant-angular groove *E. simplicidens*.
- II. Metaconid and metastylid separated by an open gutter
as wide as the former at the middle of its depth. *E. occidentalis*,
E. argentinus (teste Burmeister) *E. montanus*, *E. caballus*.
- III. Metaconid and metastylid separated by a flat channel
much wider than each of the former. *E. eurystylus*, *E. minutus*

The above character distinguishes the inferior molars of the *E. simplicidens* constantly, as I observe it in the entire series of two animals, and numerous isolated teeth. From the South American Hippidiums, as represented by Burmeister, they differ as they do from the species of three-toed horses of the Loup Fork. The latter have a comparatively small anteroposterior extent of metastylid and metaconid, and only a slight concavity between them on the inner side of the crown. No bones or teeth of the three-toed horse were found in the Blanco terranes. Well preserved incisors show that this species is a true *Equus*, and not a *Tomolabis*.

*Proceedings American Philos. Soc., 1884, May.

EQUUS CUMMINSII, Cope.

Sp. nov. Plates XX, Figure 7; XXIII, Figure 1.

Three superior molars represent this species. They were found at different localities in the neighborhood from which we obtained the teeth of the *E. simplicidens*. They represent an animal of considerably smaller size than the latter, measuring with the *E. tau* and *E. semiplicatus*. Their enamel borders are entirely simple, as in *E. simplicidens* and are hence different from those of the *E. semiplicatus*. It differs from both the *E. simplicidens* and the *E. tau* in the prominent convexity of the internal wall of the paracone and metacone, from which it results that the external border of each lake is deeply concave, and the horns appear to be strongly produced. The protocone has a very short anteroposterior diameter, in which it resembles the *E. simplicidens*, *E. crenidens* and *E. stenorhis*, and differs radically from the *E. tau* and the other species of the Equus beds. It is not bilobate or grooved on the internal face. There is an angle of the posterior border of the anterior lake which represents the loop, but no other complications of the lake borders, except that in one specimen there is a notch in the anterior border of the posterior lake and a trace of a notch on the remote borders of both lakes.

The crowns are well worn in two of the molars, but that the characters of the enamel plates are not due to wear is shown by the third specimen, where the crown is 47 mm. long. The measurements of the best preserved crown are: length, 33 mm.; transverse diameter, 24 mm.; anteroposterior, 24 mm.

The subcylindric character of the paracone and metacone approach what exists in Hippidium and some species of the three-toed horses. The species is named in honor of Mr. W. F. Cummins, who has done so much for the geology and paleontology of Texas.

EQUUS MINUTUS, Cope.

Sp. nov. Plate XX, Figure 8.

This species is represented by an inferior molar from near the middle of the series from Mount Blanco. Some other fragments of teeth of the species were obtained, but I can not at this writing place my hands upon them.

The inferior molar is narrowly hypsodont, and has apparently had but a thin cementum investment. This appears probable, from the fact that it is as thin where protected from weathering as where exposed to it, i. e., in the groove between the external columns. The inner side of the crown shows marked peculiarities. The metaconid and metastylid are appressed to the hypoconid and protoconid, and are spread widely apart

so as to be connected by a narrow anteroposterior isthmus, and separated on the internal face of the crown by a wide channel which has a greater anteroposterior diameter than the metaconid and metastylid respectively near the apex of the crown, and an equal width at the base of the crown. The hypostylid is also appressed to the hypoconid and has a recurved posterointernal angle, which forms an acute ridge bounding the internal face of the crown posteriorly. This incloses with the metastylid a flat open gutter as wide as the metastylid. A sharp ridge marks the internal face of the anterior border, but it is closely appressed to the metaconid, which it does not equal in elevation.

Measurements.

	Mm.
Length of crown preserved	37
Anteroposterior diameter at middle	16.5
Transverse diameter at metastylid	8
Transverse diameter in front of metastylid	6

This species differs widely from any horse in the characters of its inferior molar. Besides the flattening and anteroposterior extent of the metaconid-metastylid, it is peculiar in the large size and internal flattening of the hypostylid. It is this flattening which causes the wide flat channel of the internal face, which equals in width that between the metaconid and metastylid, and is more sharply defined. The *Equus minutus* is also the smallest known species of true horse, as its teeth do not exceed in size those of a sheep.

PLATYGONUS, Leconte.

The species of this genus have been hitherto found in the cave formation of the Eastern States and Pleistocene deposits of Mexico (Duges). It is therefore of interest to find it in the older horizon of the Blanco.

PLATYGONUS BICALCARATUS, Cope.

Sp. nov. Plate XIII, Figure 5.

The remains of this species which have been obtained so far include only portions of the last inferior molar, and the superior canine which lacks most of the crown, and which were found together, and an inferior canine found at another place. These specimens display distinctive characters, and as they indicate an important peculiarity of the Blanco fauna, it is necessary to describe them.

The inferior molar lacks the anterior crest. The posterior crest and heel display characters that distinguish it from the corresponding parts of the *P. compressus*. The talon consists of two principal cusps, which are connected by a cross-crest, as is the case with the other cusps of the

erown. The *P. compressus* has but one cusp in this position, while the species of *Dicotyles* possess two which are disconnected. The root of the canine is not grooved.

This peccary is characterized by the acuteness and the posterior earination of the cusps of the posterior crest (hypoconid and metaconid), which are subequal, and for the prominence of the cusps of the heel. Of the latter the internal is the more elevated, and it sends an angle posteriorly to join the apex of a posterior eingulum, which presents a right angle upwards. The external cusp is elevated, but less so than the internal, and has a transverse angular apex. This joins a posterior external angle of a cusp of intermediate elevation, which is appendicular to the internal cusp at its anterointernal side. A strong rib aseends in front of the latter on the posterior face of the posterior cross-crest, which terminates just below the protoconid-metaconid noted. The metaconid presents a keel on the posterior face which incloses a groove with the median vertical rib just mentioned, and another groove corresponds to the former on the posterior face of the hypoconid. No external cingulum; enamel smooth.

Measurements.

	Mm.
Elevation of protoconid	15
Elevation of metaconid.....	15
Elevation of hypoconid	11
Length of talon	6
Width of talon	7
Width of posterior cross-crest	9

The superior canine has the triangular section of the known species of the *Dicotylidæ*, the anterior face of the root being about half as wide as each of the other faces. It is separated from these by obtusely rounded angles. It is slightly coneave or grooved, but the groove is filled with cementum for part of its length. No lateral grooves.

Measurements.

	Mm.
Length of root to base of crown	45
Diameters at base of crown	{ anteroposterior..... 16
	{ transverse 11

The inferior canine was obtained by Mr. Cummins during the season of 1891, and belongs to a rather smaller individual than the one above described. The apex of the erown is lost, but the remainder has the usual triangular section, and its surface is without grooves. The root is grooved posteriorly unsymmetrically, one side being much more contracted than the other. Length of specimen on outside of curve, 73 mm.; diameters at base of crown, anteroposterior, 15 mm.; transverse, 11 mm.

The molar tooth is about the size of that of the *P. compressus*, Lec., while the canine is more robust than any specimen of that species which I have seen. The corresponding parts of the *P. vetus*, Leidy, are unknown. The *P. alemanii*,* Dugés, from Mexico, is apparently about as large as the *P. vetus*, Leidy, and exceeds somewhat the present species in dimensions. Casts of the first and second inferior molars of the *P. alemanii* were kindly sent me by Dr. Dugés, and these display a basal cingulum, which is not present in the last molar of the *P. bicalcaratus*. The posterior faces of the cusps are not keeled.

PLIAUCHENIA, Cope.

Proceedings Academy Philadelphia, 1875, p. 278.

Report U. S. G. Surveys W. of 100th Meridian, IV, p. 340, 1875; American Naturalist, 1886, p. 621.

Camel bones are abundant in the Blanco beds, and their dimensions indicate the presence of two species. But one of these is represented in the collections by specimens sufficiently perfect for determination, and this is a large species of the genus *Pliauchenia*. This genus has hitherto obtained only in the Loup Fork beds of Santa Fe, New Mexico, where it is represented by species of considerably smaller dimensions than the one now under consideration.

PLIAUCHENIA SPATULA, Cope.

Sp. nov. Plate XXI, Figures 1, 2.

This camel is represented by a mandible which lacks all posterior to the coronoid process of the left ramus and all posterior to the second true molar of the right ramus. Well preserved representatives of all the teeth are preserved.

The dental formula is that of the *P. humphresiana*, Cope, viz.: I. $\frac{3}{3}$; C. $\frac{1}{1}$; P. M. $\frac{3}{3}$; M. $\frac{3}{3}$. The canines are large and distinct in character from the incisors; the fourth premolar is separated from the canine and from the second premolar by long diastemata, and is caniniform. The second and first premolars are without internal valley. The last true molar has a well developed third column.

The mandibular rami are compressed and of moderate depth, and the symphysis is a little longer than the series of true molar teeth, and its posterior extremity marks the anterior third the distance between the fourth and second premolars. The incisive portion of the mandible is more expanded than in the cameloids generally, to accommodate the large canine and incisor teeth. The region of the masseteric fossa is concave outward, and is thin; the anterior base of the coronoid process

*La Naturaleza Mexico, 1887, I, p. 16, plates I, II.

is, on the contrary, robust. There is a large *foramen mentale*, which is below the posterior border of the fourth premolar. The inferior face of the symphyseal region presents a deep groove on the middle line distally between the roots of the median incisors.

The median four incisors stand on a nearly transverse line, while the external ones are sublateral. In their present state of wear the masticating surfaces of the middle pair form very wide ovals, with the longer diameters converging posteriorly. The surfaces of the second incisors are narrower and are acuminate exteriorly, while those of the third are still narrower and more acuminate externally and posteriorly. The canines are very robust, and point forward, upward and outward. There is an enamel ridge on the outside of the oblique anterior face, and there is a less prominent ridge on the apical part of the middle line posteriorly. Between these crests the external face is much more convex than the internal one, and the latter exhibits a shallow groove just behind the antero-internal keel.

The fourth premolars have about half the linear dimensions of the canines, and the crowns are compressed and present cutting edges anteriorly and posteriorly near the apex. The internal walls of the other premolars and molars are less deeply grooved than the external walls, but they are not nearly so flat as in the *Holomeniscus hesternus*. The internal walls of the premolars present a gentle concavity, with an internal incurvature at the anterior apex. The external walls present two concavities, a long anterior and a short posterior. The posterior end of the crown is narrowed in p. m. $\frac{2}{2}$, and truncate in p. m. $\frac{1}{1}$. The true molars increase rapidly in size posteriorly. The first differs from the second and third in lacking vertical folds or ridges at the anterior and posterior extremities of the first and second columns, which give the anterior and posterior extremities of the latter respectively an incurvature. The same rib is present on the internal side of the posterior extremity of the third lobe of the last true molar. There are no cingula on any of the teeth. The enamel is everywhere longitudinally roughened, except where polished by use.

Measurements.

	Mm. Pli. spatula.	Mm. Hol. hesternus.
Length of ramus from posterior extremity of M. iii. to incisive alveolar border.....	401	302
Length of symphysis.....	150	90
Width of mandible at I. iii. inclusive.....	95	57
Width of mandible at P. m. iv.....	65	
Length from alveolar border to canine (inclusive).....	60	55
Length from canine to P. m. iv.....	23	
Length from canine to P. m. ii.....	145	
Length from canine to P. m. i.....	168	85

		Mm. Pli. spatula.	Mm. Hol. hesternus.
Diameters I. ii.....	longitudinal.....	30	52
	transverse at middle.....	17	19
	anteroposterior at middle..	14	16
Diameters I. iii.....	longitudinal.....	25	39
	transverse at middle.....	22	12
	anteroposterior at middle..	8	6
Diameters P. m. iv.....	longitudinal.....	25	
	anteroposterior.....	17	
	transverse.....	12	
Diameters P. m. ii.....	anteroposterior.....	23	
	transverse.....	10	
Diameters P. m. i.....	anteroposterior.....	29	27
	transverse.....	13	16
Diameters M. i.....	anteroposterior.....	35	38
	transverse.....	22	19
Diameters M. ii.....	anteroposterior.....	45	44
	transverse.....	25	20
Diameters M. iii.....	anteroposterior.....	65	56
	transverse.....	24	16
Depth ramus half way between C. and P. m. ii.....		52	42
Depth ramus at front of M. iii.....		82	74
Thickness ramus at end of M. iii.....		45	28

As compared with the two species of *Pliauchenia* already described, the much superior dimensions readily distinguish the *P. spatula*. It farther differs from the larger of the two, the *P. vulcanozum*, Cope, in having the premolar diastema at least double the length. This is, in fact, the largest species of camel yet discovered, exceeding the *Camelus dromedarius*, L., and the *Holomeniscus hesternus*, Leidy, which agree in dimensions by one-fourth. Prof. F. W. Cragin* has described a large lama from the late Cenozoic of Colorado and Kansas, under the name of *Auchenia huerfanensis*, whose dimensions about equal those of the two species mentioned. According to Cragin, the dental formula is that of the genus *Auchenia*. The last true molar is also represented to be smaller than the penultimate, which is, if true, an exceptional character. I suspect, however, a typographical error.

The relatively wider symphyseal region of the mandible also distinguishes this species at once from the *Procamelus robustus*, the *Holomeniscus hesternus*, and the known camels and lamas.

The mandible of the *Holomeniscus hesternus*† above measured is from Austin county, Texas, and has already been referred to by me in the annual report of the Geological Survey of Texas, 1891, p. 251. It is the best preserved specimen of this species yet obtained, and displays various peculiarities. One of these is the procumbent and overlapping position

*American Geologist, 1892, p. 257.

†Plate X, Figures 3, 4.

of the incisors, the second overlapping the first, and the third overlapping the second still farther. Another peculiarity is the small size of the canine and its separation from the I. iii by a distance of 23 mm. The molars are very flat on the internal face, and the crowns have a relatively smaller transverse diameter than in the *Pliauchenia spatula*. The ramus is much lighter than in that species or than in the camel.

I excavated the specimen of *Pliauchenia spatula* from the side of a bluff near Mount Blanco, Texas.

SUMMARY.

The species of the Blanco fauna described in the preceding pages are the following:

TESTUDINATA.	2
<i>Testudo turgida</i> , Cope.	
“ <i>pertenuis</i> , Cope.	
AVES.	1
<i>Crecoides osbornii</i> , Schuf.	
EDENTATA.	1
<i>Megalonyx leptostomus</i> , Cope.	
CARNIVORA.	3
<i>Canimartes cumminsii</i> , Cope.	
<i>Borophagus diversidens</i> , Cope.	
<i>Felis hillanus</i> , Cope.	
PROBISCIDIA.	4
<i>Tetrabelodon shepardii</i> , Leidy.	
<i>Dibelodon humboldtii</i> , Cuvier.	
“ <i>tropicus</i> , Cope.	
“ <i>præcursor</i> , Cope.	
DIPLARTHRA.	5
<i>Equus simplicidens</i> , Cope.	
“ <i>cumminsii</i> , Cope.	
“ <i>minutus</i> , Cope.	
<i>Platygonus bicalcaratus</i> , Cope.	
<i>Pliauchenia spatula</i> , Cope.	—
Total number of species	16

The stratigraphic significance of these species is as follow: In the first place all of them are peculiar to this horizon. In the next place the genera have the following distribution:

From base of Miocene to recent	2
From Loup Fork to Equus beds, inclusive.....	1
Loup Fork only.....	2
Equus bed to recent, inclusive.....	1
Equus bed only	2
Peculiar to the Blanco	3
Total	11

Thus five genera occur in the Loup Fork, four in the Equus bed and not in the Loup Fork, and three are peculiar, while three genera still exist. This statement indicates the intermediate character of the horizon.

In first characterizing this fauna, I pointed out the occurrence of the genus *Equus* in connection with mastodons with molar teeth of the angustidens type as a relation not previously observed on the North American Continent. I had, however, previously shown such a co-existence in the ancient fauna of the valley of Mexico. Three species of horses coexist there apparently with the *Mastodon oligobunis*, provided the specimens preserved in the Mexican museums really came from the same horizon. While this coexistence is possible, it is at the same time not yet demonstrated by exact observations on the stratigraphic position of the fossils. No such association has been detected in the *Equus* beds in North America. Should it be proven to have actually existed in Mexico, a possible antiquity somewhat earlier than that of the *Equus* bed of the north may be indicated for the bed at Tequixquiac.

CHAPTER IV.

THE FAUNA OF THE EQUUS BEDS.

The *Equus* beds form the superficial formation of the country at various points on the Staked Plains and about its eastern escarpment. They are always to be distinguished by the presence of *Elephas primigenius* when other forms less easily preserved are not recognized. *Mastodon* is always absent from Texas localities so far as yet observed, as in Oregon. The terranes are more generally sandy than are those of either the Blanco or Loup Fork epochs. In passing north from Big Springs, we first definitely identified the *Equus* beds on Wild Horse creek, a tributary of the Colorado, where they rested immediately on the Trias. Mr. Cummins discovered a tract of the same on Rock creek, a tributary of the Prairie Dog head of the Red river, on the Tule canyon, and from this locality most of the specimens described in the following pages were derived. The identification of species is interesting as showing the complete difference which exists between this fauna and that of the Blanco epoch.

TESTUDINATA.

TESTUDO, Linn.

As no determination of tortoises has yet been made from undoubted *Equus* beds, it is of interest that two species of terrestrial habits were obtained by Mr. Cummins.

TESTUDO LATICAUDATA, Cope.

Sp. nov. Plate XXII, Figure 1.

This tortoise is represented by a nearly entire left epiplastral bone and a greater part of the right xiphiplastral. As these pieces present the characters which define species of *Testudo* most readily, I can describe the present form and compare it with its congeners, in spite of the absence of other parts of the skeleton.

The borders of both the elements in question are robust, and the lip of the epiplastral is quite large. The mesoplastron is quite thick, but the middle parts of the xiphiplastron are rather thin. The hyoplastral sends a strong gamphosis into the epiplastral within the border, and the

hypoplastral does the same into the xiphiplastral. The projecting lip of the epiplastral is marked off by only a slight constriction of the external border from the rest of the bone. Its free border is doubly convex, owing to the presence of a concavity near the middle. The posterior border of the lip is very much elevated, bounding in front a strong thoracic excavation. This raised border descends rapidly, and is obsolete from the middle to the posterior border of the epiplastral. An angular ridge bounds externally the convexity of this part of the superior surface, disappearing opposite the point where the internal appears. The depth of the lip at the internal base is equal to its anteroposterior length from the same point. The inferior face of the epiplastral is flat and not turned upwards, as in *T. polyphemus*, and the inferior surface of the lip exhibits two shallow longitudinal fossæ, which extend to the border. The gulo-humeral scutal suture describes a segment of a circle forwards and cuts across the anterior part of the mesoplastron.

The xiphiplastron is characterized by the wide divarication of the posterior angles, whose external border is continuous with that of the posterior lobe of the plastron. The posterior median emargination is very wide, and the projecting angle is broadly rounded. The ridge which borders the external level of the lobe reaches the free border behind, external to the median suture. The femoro-anal scutal suture is nearly parallel with the border of the emargination, whence it follows that it leaves the median suture at a right angle, and that the anal scutum is much wider than long. The area of this scutum is thickened along the anterior border and diagonally across from this to the median suture. The surfaces are smooth. Scutal grooves well marked.

Fragments of costal bones are rather thin, and their surfaces are perfectly smooth.

Measurements.

	Mm.
Measurements of lip at gulohumeral suture..	
{ anteroposterior.....	57
{ transverse	73
Thickness of lip at thoracic border.....	44
Length of epiplastral bone (diagonal).....	138
Thickness of border of same at hyosternal suture.....	20
Length of xiphiplastral (diagonal).....	157
Thickness of border of same at hyposternal suture	28
Width of posterior median notch of plastron	122
Depth of posterior median notch at plastron	30
Diameters of anal scutum.....	
{ anteroposterior	48
{ transverse.....	98

This species is not without resemblance to the *T. polyphemus*. It is much more robust, and the posterior plastral angle is more developed. The anterior lobe of the plastron is not recurved in *T. laticaudata* and the lip is not festooned on the border in the existing species. As com-

pared with *T. hexagonata* of the same horizon or locality, there are several differences of importance, which are mentioned in the description of the latter, which do not seem to be explicable on varietal or sexual grounds.

Rock Creek; W. F. Cummins (No. 46).

TESTUDO HEXAGONATA, Cope.

Sp. nov. Plate XXII, Figure 2.

Represented by an entire chelonite; a considerable part of the plastron, with fragments of costal bones of a second individual; and fragments of plastron and carapace of a younger individual of probably the same species.

The chelonite is that of a species having much the form of the *T. polyphemus* and of the *T. pertenuis* of the Blanco bed. That is, it is a depressed, rather short oval, with wide extremities. The plastron is flat and not sloped upward, as in *T. polyphemus*, and the lip is relatively less prominent than in that species. As compared with *T. pertenuis* the lip of the plastron is less abruptly contrasted with the rest of the anterior lobe border, and the posterior lobe is less deeply emarginated. The size is much less; but the value of this character is not now determinable.

The lip of the plastron has a simple, regularly rounded outline, which is distinctly set off from the rest of the anterior border. The thoracic cavity excavates deeply its posterior border, so that the superior edge of the latter overhangs it. This border soon fades out posteriorly, and there is no angular ridge external to it posteriorly, as in *T. laticaudata*.

The posterior lobe is rather deeply notched, and the angle bounding the notch on each side is quite prominent; much more so than in *T. laticaudata*, but not so much as in *T. pertenuis*. The external border is distinctly notched at the femoro-anal suture, and is turned outwards toward the apex of the posterior angle, which it is not in *T. laticaudata*. The external ridge or border of the abdominal cavity reaches the median suture at the fundus of the notch.

The mesoplastral bone is a transverse hexagon, the lateral angles being truncate. The borders so produced are shorter than the other four, which are equal. The gulo-humeral scutal suture is straight and crosses part of the mesoplastron. The humero-pectoral suture approaches, but not very nearly, the pectoro-abdominal at the middle line. The abdomino-anal suture is, as in *T. laticaudata*, parallel in the corresponding border of the xiphiplastral notch, and therefore forms an acute instead of a right angle with the median suture. The posterior free marginal bones are not stout. In one belonging to the presumed third specimen, the supero-external surface is concave on each side of the scutal suture, and the free border is entire. A part of the anterior border of the carapace not far from the middle line is slightly recurved at the edge. Below and

within the edge it is much thickened and displays three surfaces. These are: first, a flat level extending to the border; second, a flat face looking downwards; and third, the concavity forming the superior wall of the thoracic cavity. Surfaces everywhere smooth.

Measurements of No. 1.

	Mm.
Diameters of plastron	<div style="display: inline-block; vertical-align: middle;"> <div style="display: inline-block; vertical-align: middle;">{</div> <div style="display: inline-block; vertical-align: middle;"> anteroposterior 365 transverse 310 </div> </div>
Diameters of anterior lobe of plastron.....	<div style="display: inline-block; vertical-align: middle;"> <div style="display: inline-block; vertical-align: middle;">{</div> <div style="display: inline-block; vertical-align: middle;"> anteroposterior 89 transverse 186 </div> </div>
Diameters of posterior lobe of plastron.....	<div style="display: inline-block; vertical-align: middle;"> <div style="display: inline-block; vertical-align: middle;">{</div> <div style="display: inline-block; vertical-align: middle;"> anteroposterior..... 110 transverse 240 </div> </div>
Width of posterior notch of plastron.....	70
Depth of posterior notch of plastron.....	25
Length of epiplastron (diagonal)	87
Width of lip (total) at base	90
Length of lip on middle line above.....	40
Thickness of lip at fundus of thoracic cavity.....	27
Diameters of inferior aspect of mesoplastron .	<div style="display: inline-block; vertical-align: middle;"> <div style="display: inline-block; vertical-align: middle;">{</div> <div style="display: inline-block; vertical-align: middle;"> anteroposterior..... 58 transverse 80 </div> </div>
Distance between humero-pectoral and pectoro-abdominal scutal suture on middle line.....	25

The lip of the plastron is not produced and bifurcate, as in *T. agassizii* (from S. E. California), but the posterior lobe is quite similar to that of the latter species. The posterior lobe of the *T. laticaudata* is intermediate in proportions between those of *T. hexagonata* and *T. polyphemus*. Both of the extinct species may belong to the genus *Xerobates*, Ag., but this can not be determined until the crania are discovered.

The specimens of this species are smaller than the single one which represents the *T. laticaudata*. Though allied to the latter, the forms of the lobes of the plastron display too many differences to permit me to regard them as identical.

Rock Creek; W. F. Cummins.

EDENTATA.

MYLODON, Owen.

MYLODON ?SODALIS, Cope.

Bulletin U. S. Geological Survey Terrs., 1878, p. 385.

The distal part of a femur, lacking part of the internal condyle and adjacent epicondyle, represents a gigantic species of *Myiodon*. At present it is not possible to determine exactly its specific relations, but its association with the species of the *Equus* fauna renders it possible that it is the animal which has been found associated with the same fauna in Oregon, and which I have named as above. The measurements of the

part preserved are about equal to those of the *M. robustus*, Owen, from Argentina. The transverse extent of the condyle is about 210 Mm. (restored), of which the popliteal fossa is about 60 mm.

Since the species was described, I have received from Mr. George Duncan, of Paisley, Oregon, an imperfect symphysis mandibuli from near the original source of the *M. sodalis*, which presents characters appropriate to that genus and species. It is accompanied by a symphysis of a large peccary, the first found in that horizon and locality.

PROBOSCIDIA.

ELEPHAS, Linn.

ELEPHAS PRIMIGENIUS, Blum.

Remains of this species are quite abundant in the Equus beds of the Staked Plains and neighborhood, but are generally in a fragmentary condition. The teeth from Rock creek are neither thick plated nor thin plated, but are much as in the typical variety of *E. primigenius*, and some plates are slightly crenate, while others are plain.

DIPLARTHRA.

EQUUS, Linn.

As elsewhere in the Equus beds, several species of true horse occur, and they are represented by numerous specimens of all parts of the skeleton. No entire skeleton has been found, and until this is done it will be impossible to associate positively the bones with the appropriate dentition. The superior molars may be distinguished as follows:

- a. Smaller species; molars $25 \times 25 \pm$ mm.
 - Enamel borders, simple *E. tau.*
 - Enamel borders, complicated at middle of crown *E. semiplicatus.*
- aa. Larger species; molars $30 \times 35 \pm$ mm.
 - Enamel borders, a little folded at middle of crown *E. excelsus.*
 - Enamel plates much complicated on both anterior and posterior lake borders *E. major.*

EQUUS TAU, Owen.

Philos. Trans. Royal Soc., 1869, p. 565; *Equus barcenæi*, Cope, Proceeds. Amer. Philos. Society, 1884, p. 15.

A single superior molar from Tule Canyon. This tooth is perfectly straight, and presents very simple enamel borders, and the anterior lake has an imperfect loop. The crown is slightly curved, both transversely and posteriorly. I have already indicated this species from beds near San Diego, in southwest Texas.

EQUUS SEMIPLICATUS, Cope.

Plate XXIII, Figures 2, 3.

Sp. nov. *Equus fraternus*, Leidy, Cope, Am. Naturalist, 1889, p. 161; not of Leidy.

Represented by two superior molar teeth from the Tule Canyon, found by Mr. Cummins, and by two superior molars in my private collection from San Diego, in southwest Texas, from Mr. Wm. Taylor.

These teeth indicate a species of about the dimensions of the *E. tau*, but characterized by a greater complexity of the enamel foldings. These complications are confined to the adjacent or median borders of the lakes, the remote borders being simple or marked by a single emargination. There is no distinctly defined loop of the posterior border of the anterior lake, but its place is taken by three smaller loops (in one south Texas tooth by two), and external to these are one or two other folds. There are two or three emarginations of the opposed border of the posterior lake. In all the Texas specimens the anteroposterior diameter of the protocone is more than half that of the grinding face of the crown. This character places the *Equus semiplicatus* in the same group as the *E. excelsus* and *E. tau*. From the former its inferior size distinguishes it, as well as the closer plications of its enamel borders. Some specimens of the larger species, however, approach it in this respect.

Measurements.

		Mm.
Diameters superior molar (Tule Canyon)....	anteroposterior	25
	transverse.....	25
Diameters superior molar sp. from San Diego	anteroposterior.	25
	transverse	27

The crowns of the Tule specimens are rather short and are not curved; the least worn San Diego specimen has a long crown, which is slightly curved anteroposteriorly, but not transversely.

The characters of the grinding face resemble those of the *E. conversidens*, Owen, so far as the latter can be understood from Owen's figures. But in that species, according to Owen, the crowns are transversely curved, while in *E. semiplicatus* they are straight.

EQUUS EXCELSUS, Leidy.

Plate XX, Figures 4, 5; XXII, Figures 4, 5.

This is the characteristic true horse of the Equus bed of the western parts of North America and of Mexico. It is represented in the Staked Plain collection from Mr. Cummins by the following specimens: First, two superior molars (one entire) and an inferior molar, found together (No. 48); second, a nearly entire superior molar (No. 51); third, two in-

ferior molars with a fragment of lower jaw (No. 35); two inferior with part of a superior molar (No. 39); molars lots 2, 4 and 49, and a symphysis mandibuli with incisors (No. 12).

The inferior molars display the characters already pointed out under the head of the *E. simplicidens* (page 66). They may be distinguished from those of that species by the wide and deep channel of the internal face of the crown, which is due to the wide divergence of the metaconid from the metastylid; in this respect resembling the small species *E. eurystylus* and *E. minutus*. The greater approach to isolation of the entostylid also distinguishes them from those of *E. simplicidens*.

Leidy united with this species his *Equus occidentalis**. In my synopsis of the American species of this genus,† I have retained them as distinct on the ground of the smaller size of the protocone in the latter. It is, however, the fact that the diameter of this column is frequently less on the premolar than the molar teeth in this genus, although not always. The types of Leidy's description display this character in a marked degree, and I have not observed it in the numerous specimens that have come under my notice from the Staked Plains, while it is to be observed in a majority of the teeth from the beds of the Oregon desert. Transitions between the two types are not rare, and may be seen in passing from the front to the back part of the full series in a skull described by me from southwest Texas.‡ See Plate XXII, Fig. 3.

The symphysis mandibuli repeats exactly the characters which I assigned to that of the *E. occidentalis* in my paper above cited (page 11). That is, the mental foramen issues entirely anterior to the posterior border of the symphysis, and not entirely or partly posterior to it, as in *E. caballus*. The canine is separated from the external incisor by a shorter symphysis than in the *E. caballus*, resembling in this respect the quagga. The symphysis is a little shorter in the Texas than in the Oregon specimen.

A remarkable molar (No. 12, July 19), exhibits an unusual peculiarity. The hypocone embraces posteriorly the enamel fold which separates it from the metaconule, so that it becomes a columnar tube, and its section on the grinding face an oval area. The position is remarkable, being immediately posterior to the internal half of the posterior lake, instead of entirely interior to its internal margin, as is the usual position of the inflection. This is probably due to the fact that this molar is the last one of the series. In addition to this column there is a similar, but smaller, one just posterior to the external bone of the posterior lake, which does not extend so far posteriorly as the larger column already described.

*Report U. S. G. Survey Terrs., I, 1873, p. 242. Pl. XXXIII, Fig. 2.

†Proceeds. Amer. Philosoph. Soc., 1884, p. 10.

‡American Naturalist, 1891, p. 912.

The cutting off of this posterior loop so as to make it a circle in section (a column) occurs frequently in the *Protohippus placidus* (Pl. XI, Fig. 5a); and Leidy figures a small circle in the *Equus excelsus* (Ext. Mamm. Dako. Nebr., Plate XXI, Fig. 31), but the presence of two such columns is unprecedented in my experience.

I have already called attention to various characters in which this species differs from *E. caballus**. These are chiefly in the proportions and details of the skull and limbs. I can not find any character of permanent value in the dentition; that mentioned by Leidy†, the absence of the loop of the inner enamel border at the middle emargination, not being constant. It is present in all the molars of the present collection, and in the premolars of the skull from San Diego, Texas. The affinities of the *E. excelsus* are nearer to the asinine division than to the caballus division. While the molar teeth equal in dimensions those of the *E. caballus*, the bones of the limbs and feet are more slender. I find the presence of a cuboid facet on the astragalus to be almost universal in the *E. excelsus*, viz., in five astragali from Rock creek, Texas, and in fifteen out of nineteen astragali from the Oregon desert. It is present in the quagga in my collection, but is wanting in two horses in my collection, while it is present in fourteen horses in the collection of the veterinary school of the University of Pennsylvania, to which I have had access through the courtesies of the authorities of that institution.

I give the following measurements of the metapodial bones of two specimens, as compared with those of the horse:

Metacarpus.

	<i>E. caballus.</i> Mm.	<i>E. excelsus</i> Texas. Mm.	<i>E. excelsus</i> Oregon. Mm.
Length.....	257	251	241
Proximal diameters.. { anteroposterior	44	32	40
{ transverse.....	68	53	60
Distal width	65	48	55

Metatarsus.

Length.	297	275	297
Proximal diameters.. { anteroposterior.....	52	48	50
{ transverse.....	67	51	60
Distal width	59	50	57

The bones of the *E. caballus* belong to the same individual, while the pertinence of the others to identical individuals is probable, but not certain. The relatively greater robustness of the *E. caballus* is shown by the fig-

*Proceeds. Amer. Philos. Soc., 1884, p. 11.

†Extinct Mammalia Dakota and Nebr., 1869, p. 266.

ures; that is, the transverse diameters are relatively greater. A metacarpus and metatarsus of a second (and probably the same) individual, from Oregon present the same characters. Both are rather larger in all their dimensions than the corresponding bones from Rock creek. Such variations, however, are not greater than those that occur in the *Equus caballus*. The phalanges are always relatively and absolutely smaller in the *E. excelsus* than in the average *E. caballus*, as shown by a considerable number of specimens.

The peculiarities of the basioccipital and exoccipital bones are constant in my material (four individuals from Oregon), and the relatively shorter diastema in front, and less production posteriorly, of the maxillary bone, are always observable. My only specimen with a full series of teeth (Plate XXII, Figure 4), shows that the M. iii is considerably smaller than in the true horse.

EQUUS MAJOR, Dekay.

This horse is represented in the Staked Plains collection by parts of four superior molars found together (No. 11). They display the typical characters of the species. I have already identified this species from Wharton county, in Southern Texas,* and Leidy has reported †it from various localities in the same State.

The relations of the species of *Equus* found in the Cenozoic beds of the Staked Plains, as to horizon, size, and complexity of enamel folds, may be represented as follows:

Equus bed.	<i>E. excelsus.</i>	<i>E. semiplicatus.</i>	<i>E. tau.</i>	<i>E. major.</i>
Blanco.	<i>E. simplicidens.</i>	<i>E. cumminsii.</i>		<i>E. minutus.</i>
Goodnight's.	<i>E. ?simplicidens.</i>			<i>E. eurystylus.</i>

The lines of the above diagram indicate relationship, but we do not yet know enough of the species to determine the phylogenies.

HOLOMENISCUS, Cope.

Proceeds. American Philosophical Society, 1884, p. 16.

HOLOMENISCUS HESTERNUS, Leidy.

Plate XXI, Figures 3, 4.

Cope, loc. cit., p. 17; *Auchenia hesterna*, Leidy. Report U. S. Geol. Survey Terrs., I., 1873, p. 255, Plate XXXVII, Figures 1, 3.

A fine mandibular ramus containing all the molars, with the symphysis containing all the incisors but one, was obtained by Mr. B. S. Brown from

*Proceeds. Amer. Philos. Soc., 1892, p. 123.

†Report U. S. Geol. Survey Terrs., 1873.

Austin county, in Southern Texas.* It is described under the head of *Pliauchenia spatula*, antea, and is figured on Plate XXI, Figures 3, 4. Mr. Cummins did not obtain it in Northwest Texas.

HOLOMENISCUS SULCATUS, Cope.

Sp. nov. Plate XXIII, Figure 4.

This large lama is represented by a mandibular ramus, from which the condyle, coronoid process, angle and symphysis are wanting. The molar teeth are all preserved. The length of the series of the latter is about the same as in the *H. hesternus*, but the forms of the teeth are different. The ramus is also much deeper in proportion to the other measurements. The first premolar presents a grinding face of an elongate triangular form, with the apex anterior and a little incurved. The true molars increase rapidly posteriorly, the anteroposterior diameter of the first being less than half that of the third. The inner wall of the true molar is not flat as in the *H. hesternus*, but it is divided by an open groove opposite the deeper internal groove, as in the species of *Pliauchenia*, thus distinctly marking off the anterior from the second column. In addition to this there is an anterior and a posterior marginal internal rib on the second molar, and an anterior marginal rib on the third. These do not exist in the *H. hesternus*, but are present in the *Pliauchenia spatula* and the camel. The camel possesses a keel on the internal side of the crown in the position of the groove in the *H. sulcatus*.

Owing to the loss of the anterior part of the ramus, the character of the canine tooth can not be ascertained. The first true molar is crowded by the adjacent teeth, so that its internal wall overlaps the latter by a little. This is probably an individual peculiarity.

The following comparative measurements show the relations of this species with the *H. hesternus*:

* Mr. J. B. Walker makes the following note on the locality and occurrence of this fossil:

"The locality should be Bowie Bend, Austin county. The fossil was found by my assistant, Mr. B. S. Brown. * * * The bluff is in two terraces, and the bones, when in place were in the upper part of the lower terrace, mixed with the small siliceous pebbles, which are in moderate quantity at one locality only, and this is where the river has made the greatest excavation, or in the bend proper."

It may be of interest in this connection to note the fact that this is the same locality from which the fossils were obtained which were described by Dr. W. M. Carpenter in American Journal of Science in 1846, p. 244. E. T. D.

Measurements.

		<i>H. sul-</i> <i>catus.</i> Mm.	<i>H. hes-</i> <i>ternus.</i> Mm.
Length of molar series		146	157
Length of true molars.		122	134
Diameters M. i.	{ anteroposterior	25	35
	{ transverse	17	18
Diameters M. ii.	{ anteroposterior	40	44
	{ transverse	20	19
Diameters M. iii.	{ anteroposterior	55	56
	{ transverse of middle column	20	18
Depth of ramus at M. i.		68	51
Depth of ramus at M. iii, middle column		85	79

Numerous bones of camels of size and character appropriate to this species were found by the expedition, but positive reference can not be made at present.

HOLOMENISCUS MACROCEPHALUS, Cope.

Sp. nov. Plate XXIII, Figure 5.

This lama is determined from a nearly complete lower jaw. One ramus is lacking in nearly all the parts posterior to the last molar, while in the other these parts are present, lacking only the condyle and angular hook. The dentition can be completely restored from one side or the other.

This species is intermediate in dimensions between the *H. vitakerianus*, Cope, and the *A. lama*, Linn, being smaller than the former in dental measurements, and larger than the latter. The symphysis mandibuli has about the length of that of the *A. lama*, but the rami are considerably more elongate, the extremity of the last molar in the *A. lama* reaching only to the middle of the anterior column of the corresponding tooth of the *H. macrocephalus*. I observe here that it is not certain as yet that the species now described is not an *Auchenia*, as the superior dentition is not known.

The canine is separated from the third incisor by a diastema, which is a little less than one-third the length of that which separates the canine from the anterior premolar, and the latter is about equal to the dental series, less the last molar. In its proportions to the other teeth the premolar is much like those of the *A. lama*, and is smaller than in the *H. vitakerianus*. The disproportion in the sizes of the molars is not so great as in the *H. sulcatus*. As in the latter species, the internal wall of each molar is slightly concave at the point of junction of the columns, but in the second and third true molars this concavity is bounded in front by a narrow ridge, which is wanting in the *H. sulcatus*, and in the first true molar of *H. macrocephalus*. A similar ridge exists at the front of the anterior column of the second and third true molars, as in *A. lama*. The

first molar is injured at its anterior border, so that this point can not be determined. The internal faces of the columns are but little convex on M. ii and iii, but more so in M. i. The anterior part of P. m. i. is straight, as in the other species of the genus described in this report, and not incurved as in *A. lama*. The heel of the M. iii is more strongly incurved than in the other species, and is more as in *A. lama*.

The canines are robust and are recurved, with a sharp posterior edge and obtuse front at the base. The incisors are of graduated lengths, and are entirely procumbent; the cutting edges of the second and third have a strongly concave emargination of the border. Whether this is characteristic of the species, I do not know, but the crown of I. iii is more expanded outwards than in the *H. hesternus* and *A. lama*. The dental foramen enters opposite the base of the keel of the M. iii, and it is not slit downwards as in *A. lama*. The mental foramen issues below the posterior border of the canine, as in *A. lama*.

Measurements.

	Mm.
Total length of ramus with incisors.....	292
Length of symphysis.....	69
Elevation of precondylar notch above inferior border.....	118
Length of ramus posterior to M. iii.....	72
Depth of ramus at long diastema	22
Depth of ramus at P. m. i.....	33
Depth of ramus at heel of M. iii.....	51
Length of crown of I. i.....	14
Length of crown of I. ii.....	20
Length of crown of I. iii.....	17
Width of crown of I. iii.....	9
Length of dental series.....	93
Length of grinding face of P. m. i.....	14
Length of grinding face of M. i.....	20
Length of grinding face of M. ii.....	24
Width of crown of P. m. i., posteriorly.....	5
Width of crown of M. i., posteriorly	13
Width of crown of M. ii., posteriorly	13

In the *A. vitakeriana* we have the following measurements of the superior molars; the inferior molars are unknown. Length of molar series without M. iii., 69 mm.; length of base of P. m. i., 20 mm.; length of grinding face of M. i., 24 mm. As the length of the grinding face of the P. m. i. exceeds that of the base, it can not be much shorter than that of the M. i., so that the aggregate length of the two is at least 45 mm. In the present species this dimension is 34 mm.

The *Holomeniscus macrocephalus* approaches more closely the existing lama than any other extinct species of North America.

Rock Creek, near Tule Canyon; W. F. Cummins.

SUMMARY OF SPECIES OF THE EQUUS BEDS OF THE STAKED PLAINS.

TESTUDINATA.

Testudo hexagonata, Cope.

Testudo laticaudata, Cope.

EDENTATA.

Myiodon ?sodalis, Cope.

PROBOSCIDA.

Elephas primigenius, Blum.

DIPLARTHRA.

Equus excelsus, Leidy.

Equus semiplicatus, Cope.

Equus tau, Owen.

Equus major, Dekay.

Holomeniscus sulcatus, Cope.

Holomeniscus macrocephalus, Cope.

PLATES.

PLATE 1.

FRAGMENTS OF BELODON SUPERCILIOSUS, COPE, ONE-HALF NATURAL SIZE,
EXCEPT FIGURES 2, 3.

- Figure 1. Left frontal bone with postfrontal and parietal, lacking posterior portion, from above; *a*, same, fractured surface, posterior view.
- Figure 2. Anterior tooth, natural size, from edge; *a*, from inside.
- Figure 3. Groved tooth, natural size, from edge; *a*, from outside.
- Figure 4. Anterior parts of splenial bones from below.
- Figure 5. Portion of femur, external side.
- Figure 6. Supposed fibula; *a*, distal fractured extremity; *b*, proximal entire extremity.
- Figure 7. Dermal bone from above; *a*, same, from behind.
- Figures 8, 9, 10. Dermal bones; 8 fractured.

BELODON SUPERCILIOSUS.

PLATE II.

TEETH OF TRIASSIC SAURIANS, NATURAL SIZE.

- Figure 1. *Palæoctonus orthodon*, Cope. Crown of anterior tooth, interior side; *a* and *b*, edge views; *c*, section at inferior extremity of long cutting edge.
- Figure 2. *Palæoctonus appalachianus*, Cope. Anterior tooth; lettering as in figure 1.
- Figure 3. *Palæoctonus appalachianus*, Cope. Posterior tooth, external side; *a*, internal side.
- Figures 4-6. *Palæoctonus dumblianus*, Cope. Anterior and posterior teeth; lettering as in figures 1-3.

TRIAS. PLATE II.

1. PALÆOCTONUS ORTHODON. 2-3. P. APPALACHIANUS. 4-6. P. DUMBLIANUS.

PLATE III.

LOUP FORK EPOCH.

- Figure 1. Portion of skull of *Protohippus pachyops*, Cope, type; left side; one-half natural size.
- Figure 2. *Tetrabelodon serridens cimarronis*, Cope; last inferior true molar of left side, one-half natural size, from above.
- Figure 3. Same as figure 2, from inner side.

1. PROTOHIPPIUS PACHYOPS. 2-3. TETRABELODON CIMARRONIS.

PLATE IV.

LOUP FORK EPOCH.

Protohippus pachyops, Cope; colt skull, one-half natural size.

Figure 1. Left side.

Figure 2. Inferior aspect.

Figure 3. Posterior view.

PLATE V.

LOUP FORK EPOCH.

Figure 1. *Protohippus fossulatus*, Cope; skull of typical specimen, left side; one-half natural size.

Figure 2. Five molars of right side of the same skull from below; natural size.

LOUP FORK. PLATE V.

PROTOHIPPIUS FOSSULATUS.

PLATE VI.

LOUP FORK EPOCH.

Protohippus fossulatus, Cope; fragment of skull figured in Plate V; one-half natural size, from above.

LOUP FORK. PLATE VI.

PROTOHIPPIUS FOSSULATUS.

PLATE VII.

LOUP FORK EPOCH.

Protohippus fossulatus, Cope; fragment of skull figured in Plate V; one-half natural size, from below.

LOUP FORK. PLATE VII.

PROTOHIPPIUS FOSSULATUS.

PLATE VIII.

LOUP FORK EPOCH.

Protohippus mirabilis, Leidy; skull, left side; one-half natural size.

LOUP FORK. PLATE VIII.

PROTOHIPPIUS MIRABILIS.

PLATE IX.

LOUP FORK EPOCH.

Grinding faces of molar teeth, natural size.

Figure 1. *Protohippus mirabilis*, Leidy; specimen figured on Plate VIII.

Figure 2. *Protohippus pachyops*, Cope; specimen figured on Plate IV, superior molars.

Figure 3. *Protohippus pachyops*, Cope; inferior molars of specimen represented in last figure.

1. PROTOHIPPIUS MIRABILIS. 2-3. P. PACHYOPS.

PLATE X.

LOUP FORK EPOCH.

Molar teeth of species of *Protohippus*, natural size.

Figure 1. Temporary dentition of colt of *Protohippus ?pachyops*, Cope; from skull figured in Plate XII.

Figure 2. *Protohippus perditus*, Leidy; an old deciduous and two young permanent molars, external view (*d4* should be at the lower side of the figure); *a*, grinding faces; from northeast Colorado.

Figure 3. Temporary molars of a species of *Protohippus*; from Wyoming.

Figure 4. *Protohippus ?mirabilis* Leidy; with dentition.

Figure 5. *Protohippus medius*, Cope; superior molars; from Cottonwood Creek, Oregon.

PLATE X.

1-4. TEMPORARY DENTITION OF THREE-TOED HORSES. 5. PROTOHIPPIUS MEDIUS, PERMANENT DENTITION.

PLATE XI.

LOUP FORK EPOCH.

Dentition of species of *Protohippus*, natural size.

Figure 1. *Protohippus ?parvulus*, Marsh; superior molars.

Figure 2. *Protohippus ?parvulus*, Marsh; part of lower jaw, from above.

Figures 3-8. *Protohippus placidus*, Leidy; lateral views, and *a*, grinding faces of molars.

Figures 3-5. Less worn molars.

Figure 5. Last superior molar.

Figures 6-8. Molars presenting more wear.

PLATE XII.

Figures of horses' teeth from Goodnights; all natural size.

Figures 1-2. Superior molars of *Protohippus lenticularis*, Cope; in an early stage of wear; 2*a*, posterior side of figure 2.

Figures 3-4. Superior molar teeth of *Hippidium interpolatum*, Cope; grinding faces: 3*a*, posterior view of figure 3.

Figures 5-6. Superior molar teeth of *Hippidium ?spectans*, Cope; grinding faces: figure 6, last molar; 6*a*, same, anterior face of figure 6.

Figures 7-8. *Equus eurystylus*, Cope; inferior molars of different individuals, grinding faces; 7*a*, 8*a*, interior faces; 7*b*, 8*b*, exterior faces of crowns.

1-2. PROTOHIPPIUS LENTICULARIS. 3-4. HIPPIDIDIUM INTERPOLATUM.
5-6. H. ? SPECTANS. 7-8. EQUUS EURYSTYLUS.

PLATE XIII.

BLANCO EPÔCH.

- Figures 1-3. *Megalonyx leptostomus*, Cope; natural size; from Mont Blanco.
Figure 1. Fragments of palate from below, with supposed positions of teeth.
Figure 2. Last superior molar, from below; *a*, from side.
Figure 3. Occipital condyle from above.
Figure 4. *Borophagus diversidens*, Cope; fragment of left mandibular ramus, external view; *a*, from above; *b*, posterior view.
Figure 5. *Platygonus bicaratus*, Cope; last inferior molar, external view; *a*, from behind; *b*, from above.

1-3. MEGALONYX LEPTOSTOMUS. 4. BOROPHAGUS DIVERSIDENS.
5. PLATYGONUS BICALCARATUS.

PLATE XIV.

BLANCO EPOCH.

Figures 1-11. *Felis hillanus*, Cope; natural size.

Figure 1. Superior canine, internal side; *a*, external side; *b*, apical view.

Figure 2. Spine with postzygapophyses of lumbar vertebra from right side; *a*, posterior view.

Figures 3, 4, 5. The left second, third and fourth metacarpals, front views; *a*, internal views; *b*, external views; *c*, proximal extremities.

Figure 6. Trapezium, proximal extremity.

Figure 7. Unciform from front; *a*, proximal; *b*, external, and *c*, distal views.

Figure 8. Calcaneum from above; *a*, distal view.

Figure 9. Second left metatarsal, front view; *c*, proximal extremity.

Figure 10. Phalange of first series from front; *a*, posterior; *b*, proximal views.

Figure 11. Phalange of second series from front; *a*, posterior; *b*, proximal, and *c*, distal views.

Figures 12-14. *Canimartes cumminsii*, Cope; dentition, natural size.

Figure 12. Superior sectorial, external size; *a*, internal side.

Figure 13. P. m. iv and m. m. i and ii of superior dental series, from below.

Figure 14. P. m. iv and m. m. i and ii of inferior dental series, from outer side; anterior half of P. m. iv wanting; *a*, internal view; *b*, from above.

1-11. FELIS HILLANUS. 12-14. CANIMARTES CUMMINSII.

PLATE XV.

BLANCO EPOCH.

Figure 1. *Tetrabelodon shepardii*, Leidy; mandible from left side; one-half natural size.

Figure 2. Same; right mandible as far as last molar, inclusive, from above.

TETRABELODON SHEPARDII.

Figur

Figur

PLATE XVI.

BLANCO EPOCH.

- Figure 1. *Dibelodon tropicus*, Cope; part of mandible from above, one-half natural size; 1a, last molar tooth seen directly on upper surface, partly from inner side of ramus; same proportion.
- Figure 2. *Dibelodon humboldtii*, Cuv.; ? last deciduous molar, grinding face; natural size.
- Figure 3. *Dibelodon humboldtii*, Cuv.; first inferior molar of the right side from within; 3a, same from without; both natural size.
- Figure 4. *Dibelodon humboldtii*, Cuv.; second superior true molar of the left side, natural size, from below. Found separately.

3

3a

1. DIBELODON TROPICUS. 2-4. D. HUMBOLDTH.

PLATE XVII.

BLANCO EPOCH.

Figure 1. *Dibelodon tropicus*, Cope; left mandibular ramus from outside; one-half natural size.

Figure 2. *Dibelodon tropicus*, Cope; first inferior true molar of left side from above; 2a, same, inner side; both natural size.

Figure 3. *Dibelodon tropicus*, Cope; first superior molar of left side from below; natural size.

Figure 4. *Dibelodon humboldtii*, Cuv.; first inferior molar of right side, figured on Plate XVI, seen from above; natural size.

4.

2

3

4

2a

1

Figur

Figur

Figure

)

Figure

(

PLATE XVIII.

BLANCO EPOCH.

Dibelodon præcursor, Cope; last inferior true molar of left side, from above;
anterior cross-crest supplied; natural size.

PLATE XVIII.

DIBELODON PRÆCURSOR.

PLATE XIX.

BLANCO EPOCH.

Dibelodon præcursor, Cope; tooth figured in Plate XVIII, from the inner side; natural size.

DIBELODON PRÆCURSOR.

PLATE XX.

TEETH OF EQUIDÆ OF THE BLANCO EPOCH, NATURAL SIZE.

- Figure 1. Superior molar of *Equus simplicidens*, Cope; grinding face, from below; *a*, lateral face.
- Figure 2. *Equus simplicidens*, Cope; inferior molars, grinding face, from above.
- Figure 3. *Equus simplicidens*, Cope; inferior m. ii. side view; from a different individual from those figured in figures 1 and 2.
- Figure 4. *Equus occidentalis*, Leidy; two inferior molars from above; from Fossil Lake, Oregon.
- Figure 5. *Equus occidentalis*, Leidy; probably temporary inferior molar from above; from Fossil Lake, Oregon.
- Figure 6. *Equus eurystylus*, Cope; inferior molar, grinding surface, the right extremity too short, see plate; *a*, lateral view of same; from Paloduro Canyon.
- Figure 7. *Equus cummingsii*, Cope; left superior molar.
- Figure 8. *Equus minutus*, Cope; inferior molar, grinding face; *a*, internal; *b*, external views.
- Figure 9. *Equus* sp.; part of right superior molar, from Paloduro Canyon.

1-3. *EQUUS SIMPLICIDENS*. 4-5. *E. OCCIDENTALIS*. 6. *E. EURYSTYLUS*. 7. *E. CUMINSII*. 8. *E. MINUTUS*.

PLATE XXI.

MANDIBLES OF CAMELS, ONE-HALF NATURAL SIZE.

- Figure 1. *Pliauchenia spatula*, Cope; left mandibular ramus, external view;
Mont Blanco.
- Figure 2. Same, from above.
- Figure 3. *Holomeniscus hesternus*, Leidy; left ramus mandibuli, external view;
Austin county.
- Figure 4. Same, from above.

1-2. PLIAUCHENIA SPATULA. 3-4. HOLOMENISCUS HESTERNUS.

PLATE XXII.

EQUUS BED.

Figure 1. *Testudo laticaudata*, Cope; fragments of plastron, one-half natural size; *a*, anterior lobe from below; *b*, same from above; *c*, posterior lobe from below; *d*, same from above.

Figure 2. *Testudo hexagonata*, Cope; plastron from below; one-fourth natural size.

Figure 3. *Equus excelsus*, Leidy; right half of inferior surface of cranium anterior to glenoid facet. seen from below; one-half natural size. From specimen from San Diego, Texas, from W. Taylor, in collection of E. D. Cope.

Figure 4. *Equus excelsus*, Leidy; right superior molar, little worn grinding face; natural size.

Figure 5. *Equus excelsus*, Leidy; right inferior molar, of probably the same individual as that represented in figure 4; both from the Equus beds of Rock Creek; *5a*, same tooth from inner side; all natural size.

1. TESTUDO LATICAUDATA. 2. T. HEXAGONATA. 3-5. EQUUS OCCIDENTALIS.

PLATE XXIII.

EQUUS BED.

- Figure 1. *Equus cumminsi*, Cope; external part of superior molar, showing lakes; from the Blanco bed at Mont Blanco; natural size.
- Figures 2-3. *Equus semiplicatus*, Cope; superior molars, grinding faces; natural size; from the Equus bed of Rock Creek.
- Figure 4. *Holomeniscus sulcatus*, Cope; part of left mandibular ramus supporting all the molar teeth; one-half natural size; *a*, molar teeth from above; from the Equus bed of Rock Creek.
- Figure 5. *Holomeniscus macrocephalus*, Cope; right side of mandible; one-half natural size; *a*, the same, with symphysis viewed from above.

1. EQUUS CUMMINSI. 2-3. E. SEMIPLICATUS. 4. HOLOMENEISCUS SULCATUS. 5. H. MACROCEPHALUS.

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