

Article XXVI. — THE FRESH-WATER TERTIARY OF
NORTHWESTERN TEXAS. AMERICAN MUSEUM
EXPEDITIONS OF 1899-1901.

By J. W. GIDLEY.

PLATES LII-LVIII.

In the spring of 1899 Professor Henry F. Osborn sent an expedition, under the leadership of the writer, to the Llano Estacado or Staked Plains in northwestern Texas, for the purpose of exploring the Miocene, Pliocene, and Pleistocene beds previously reported from that region by Professor E. D. Cope and Mr. W. F. Cummins, of the Texas Geological Survey. This expedition met with such success that a second and third expedition were sent to this region in the successive summers of 1900 and 1901. The results of the work of the three years are comprised in this report.

The following brief itinerary of the three expeditions seems necessary to a clearer understanding of the region explored and the relations of the different localities visited.

EXPEDITION OF 1899.

Clarendon, the county-seat of Donley County, a little town on the Fort Worth and Denver City Railway, was the chief base of outfitting and supplies, and the initial starting-point of the three expeditions.

The writer, with Mr. Alban Stewart as assistant and Mr. Alfred Brown as cook and teamster, left Clarendon July 1, 1899. Going north about ten miles the first camp was established on Barton Creek, where a thorough exploration of the surrounding country was made.

As reported by Cope and Cummins, the beds occupying the tops of the divides in this vicinity are true Miocene and, though of not great vertical thickness nor extensively exposed, are very rich in fossil remains. Several good fossils were found at this locality, the most important being a partial skeleton, in a splendid state of preservation, of *Mastodon*

productus (No. 10582, American Museum Collection) including the skull and lower jaws.

Leaving this locality the party returned to Clarendon, then going west about twenty-five miles to the head of Mulberry Cañon turned southeast about three miles and established a camp at the top of the bluffs a little to the west of the mouth of the cañon. It was at this locality that Cope and Cummins reported a new geological horizon which Cummins called the 'Goodnight Beds' and which Cope considered the same as the Paloduro beds, placing them, in time, between the Loup Fork (Miocene) and Blanco beds which are true Pliocene.

The party remained several days in this locality and the writer explored both sides of the cañon for its entire length, failing to find any evidences of a break in the stratigraphic continuity of the deposits on opposite sides of the cañon, as reported by Cummins.

From Mulberry Cañon the party traveled southeast, crossing the South Fork of Red River near the mouth of Mulberry Creek, continuing south to a point nearly due east of Silverton, the county-seat of Swisher County, turned west and ascended the steep and rugged escarpment to the top of the Staked Plains. Continuing west, passing the head of Rock Creek, a third camp was established at the head of Tule Cañon.

The deposits here and extending east to and beyond Rock Creek on the south side of the cañon, and for some distance along the north side of the cañon as well, are of Pleistocene formation. At the head of Tule Cañon was found a specimen of *Elephas imperator* (No. 10598, American Museum Collection), consisting of a complete fore limb, part of the fore foot, the lower jaw and upper teeth, besides a few vertebræ and ribs.

Returning to the head of Rock Creek, seven miles to the east of the Tule Cañon camp, the party established a fourth camp. At this locality was made the splendid find of fossil horse skeletons (*Equus scotti*) already described by the writer.¹

This practically ended the season's work, the party returning to Clarendon by the way of Canyon City at the head of

¹ Bull. Am. Mus. Nat. Hist., Vol. XIII, pp. 114-116; Vol. XIV, pp. 134-137.

Paloduro Cañon, then to Amarillo and back along the line of the railroad.

EXPEDITION OF 1900.

The writer was accompanied on the second expedition by Mr. Hans W. Zinsser, of Columbia University, who proved both a valuable assistant and agreeable companion.

A little preliminary work was done this year at the old locality north of Clarendon, but the main object of this expedition was to explore the eastern escarpment of the Staked Plains south from Silverton, and especially to examine the Blanco beds at Mount Blanco. Accordingly the party, leaving Clarendon July 26, 1900, started southwest, taking nearly the route followed the previous year as far as the main divide between Mulberry Creek and South Fork of Red River, then crossing the South Fork of Red River, several miles west of the crossing point of the previous year, ascended the steep escarpment to the top of the Staked Plains at a point nearly north of Silverton. Going east about fifteen miles to the point at which the party ascended the previous year, we turned south along the top of the escarpment, examining the bluffs for a distance of forty or fifty miles, then taking a southwest course across the Plains went direct to Mount Blanco.

The exposures at Mount Blanco are true Pliocene, and, though of small extent, are very rich in fossil remains. The specimens of most importance found at this locality were a nearly complete skull and lower jaws of *Dibelodon mirificus* (No. 10622, American Museum Collection), and, the following year, a partial skeleton of a Glyptodont consisting of a nearly complete carapace, tail pieces, pelvis, sacrum, lumbar and caudal vertebrae. This specimen has since been described by Professor Henry F. Osborn,¹ under the name *Glyptotherium texanum*, gen. et sp. nov.

On finishing the work at this place the party went directly north to the head of Rock Creek, where a second excavation was made in the bank or quarry, from which the horse skele-

¹ Bull. Am. Mus. Nat. Hist., Vol. XIX, 1903, pp. 491-494.

tons were taken the previous year, resulting in the finding of additional material of *Equus scotti* (Nos. 10628, 10629 and 10630, American Museum Collection).

Finishing up the season's work here the party again returned to Clarendon, practically by the same route followed the previous year.

EXPEDITION OF 1901.

The third expedition to the Staked Plains was made possible by the kind generosity of Mr. William C. Whitney, who donated a sum to the American Museum to be used, under the direction of Professor Henry F. Osborn, for the collecting and placing on exhibition of fossil horse material to illustrate the evolution of the horse in America. The object, therefore, of this last expedition was to make a more extended exploration of the Miocene and Pliocene exposures with the hope of obtaining some new material of the three-toed horses of these periods.

Accompanied by Mr. William Kendal as assistant and Mr. James Morton as cook and teamster, the writer left Clarendon July 1, going first to the old locality between Barton Creek and Salt Fork of Red River. Wishing to extend the explorations further to the north and east the party continued on north about five miles to the head of Petrified Cañon, camping there a few days, then turning east traveled down Whitefish Creek about twenty-five miles to Skillet Creek, making another camp at this place. At the head of Petrified Cañon were found the skulls and parts of skeletons of twelve three-toed horses. Unfortunately, however, the bones were badly crushed and broken and covered with a hard limestone concretion which is very difficult to remove without injury to the fossil.

On the divide east of Skillet Creek the writer obtained three important specimens, a skull and lower jaws of a Mastodon (No. 10673, American Museum Collection) of the *M. productus* type, both fore feet complete of a second individual (No. 10672, American Museum Collection) of the same species, and a skull with a few skeleton bones of the big dog *Dinocyon*

gidleyi (No. 10671, American Museum Collection) subsequently described by Dr. W. D. Matthew.¹

The creeks have cut deeply into the underlying strata of the Triassic in this locality, and erosion has entirely obliterated the Miocene deposits from many of the divides.

The deposits that remain in this vicinity differ greatly in character from the exposures along Barton Creek and to the west. They represent much more the appearance of the underlying red beds of the Triassic, from which the materials composing them are apparently derived.

Finishing the work at this locality the party made a second visit to the Blanco beds at Mount Blanco. Except for a few days of fruitless search in the vicinity of the mouth of Tule Cañon, the remainder of the time was occupied in a second careful examination of the deposits at this place and in exploring Blanco Cañon to its mouth. The most important specimens found on this second trip to Mount Blanco were the *Glyptodon* specimen referred to above and a new species of *Platygonus*, since described by the writer² (*Platygonus texanus*, No. 10702, American Museum Collection).

Returning to Clarendon, practically by the route taken the year before in going from Clarendon to Mount Blanco, the three years' work in northwestern Texas was at an end.

GEOLOGICAL NOTES.

Professor W. F. Cummins, in the very complete and interesting reports of his explorations in northwestern Texas,³ has so fully, and, for the most part, accurately described the general geological character and stratigraphy of the Staked Plains, that an attempt at any such extensive and detailed description here would be an unnecessary repetition of much of Cummins's work. Cope⁴ has given detailed descriptions of the fossils, taken from various localities, apparently verifying Cummins's determination of the various beds. It is, therefore, the inten-

¹ Bull. Am. Mus. Nat. Hist., Vol. XVI, 1902, pp. 129-136.

² Bull. Am. Mus. Nat. Hist., Vol. XIX, 1903, p. 478.

³ Geol. Surv. Texas, 3rd Ann. Rep., 1891 (1892), pp. 129-200; 4th Ann. Rep. 1892 (1893), pp. 179-238.

⁴ Geol. Surv. Texas, 4th Ann. Rep., 1892 (1893), pp. 11-87. Proc. Acad. Nat. Sci. Phila., Vol. XLV, 1894, pp. 63-68.

tion of the writer to discuss, in some detail, only the more important localities with the purpose of correcting some obvious errors made by Cummins, both in the distribution and correlation of these beds, and to present briefly some of the writer's observations and conclusions which are at variance with those of both Cope and Cummins. These conclusions are briefly as follows:

- (1) The fossil-bearing formations are fluviatile, not lacustrine, in origin.
- (2) The Blanco has a limited distribution.
- (3) The Goodnight (Paloduro) Beds are not a valid division.
- (4) The principal deposits forming the Staked Plains are of the Miocene epoch but older than the Loup Fork stage.
- (5) The fossil-bearing beds in the locality north of Clarendon and at Mulberry Cañon correspond in age with the Loup Fork formation, as shown by the fossils.

PLEISTOCENE.

*Rock Creek Beds*¹ = *Sheridan (Equus) Beds*.

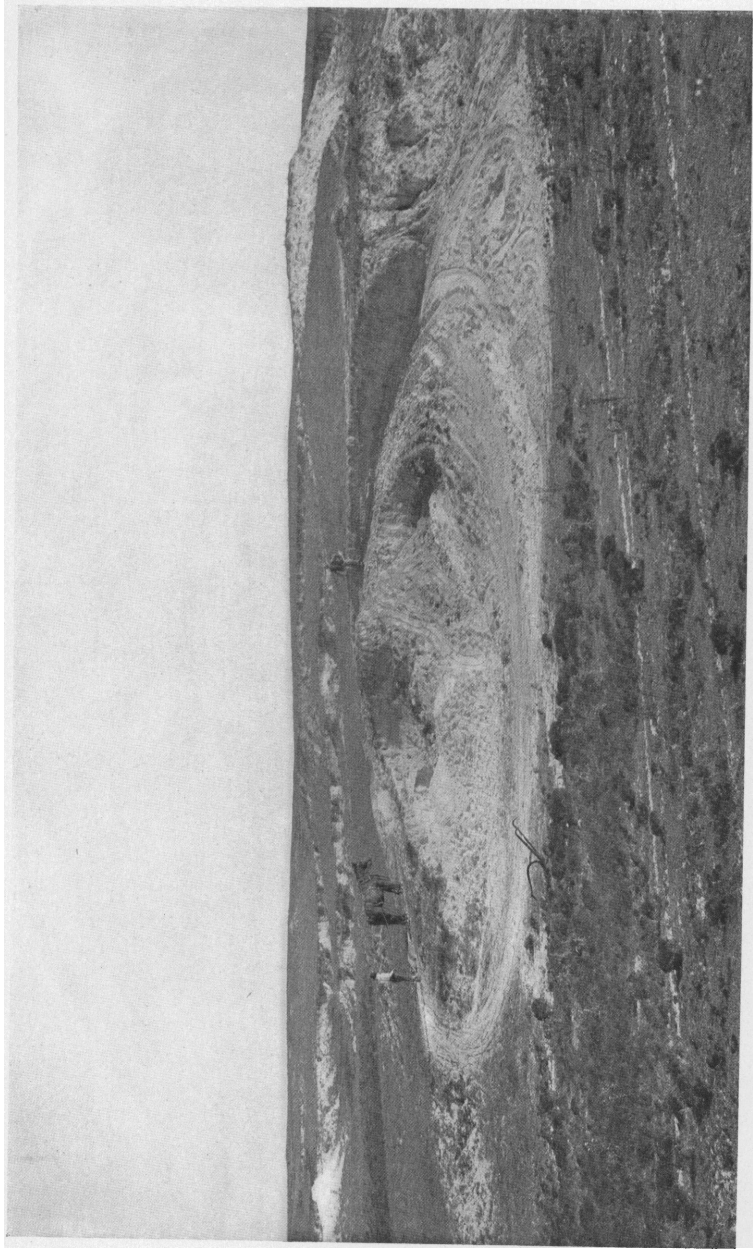
The Sheridan or Equus division of the Pleistocene beds, as reported by Cummins, are extensively exposed, especially along the south side of Tule Cañon and at the head and on both sides of Rock Creek, a small tributary emptying into Tule Cañon from the south.

Cummins's section of Tule Cañon, taken near the head, is as follows:

6. Fine white sand.....	25 feet
5. Coarse sand, with pebbles.....	20 "
4. Bluish clay.....	15 "
3. Coarse sand.....	30 "
2. Reddish clay.....	60 "
1. Triassic sandstone.....	20 "

The upper four strata of this section (Nos. 3-6) belong to the Pleistocene age. But the section is representative of these beds only in a general way. Other sections taken at different

¹ Local name proposed by the writer



PLEISTOCENE EXPOSURES, AT HEAD OF ROCK CREEK, SWISHER CO., TEXAS.

In the middle foreground is seen the quarry from which were taken six partial skeletons of *Eryuus scotti*.

points show great variations in details of character and in the relative thickness of the different strata. No. 1 belongs to the Triassic, which apparently underlies the whole of the Staked Plains. No. 2 of the section, designated by Cummins as "Reddish clay," is probably of Miocene age, as will be shown later. Unfortunately no characteristic fossil remains have been found in this stratum to fix definitely its geological position. However, it is older than the Sheridan beds, as are also the strata which bound them on the north and south. The Sheridan beds are unconformable with those of this older formation and apparently mark the course of an ancient stream which, after scooping out a channel or narrow valley in the older formation, refilled it again in Pleistocene times.

Fig. 1, page 625, is a diagrammatic cross-section across Tule Cañon near its head.

There is nothing in the character of the deposits to indicate beds of lake formation. On the contrary, the distribution of the beds, which are nowhere very wide but extend several miles east to the edge of the Plains, indicates, rather, an alluvial origin. The sharp cross-bedding of sand, gravel, and clay, which the writer observed at certain points in the formation, and the peculiar distribution of the coarser gravels, all indicate the depositions of a river or smaller stream rather than those of a lake. A further indication of an alluvial derivation of these beds is that the fauna represented consists wholly of land forms, and some of the bones show weather checking. The wind, carrying large quantities of fine sand and dust from the surrounding plains, may also have played a very important part in forming these deposits.

Following is a list of species from the beds at Tule Cañon, as given by Cope¹:

TESTUDINATA.	DIPLARTHRA.
<i>Testudo hexagonata</i> Cope,	<i>Equus excelsus</i> Leidy,
" <i>laticaudata</i> Cope.	" <i>semiplicatus</i> Cope,
EDENTATA.	" <i>tau</i> Owen,
<i>Myiodon</i> ? <i>sodalis</i> Cope.	" <i>major</i> Dekay, ³
PROBOSCIDA.	<i>Holomeniscus sulcatus</i> Cope,
<i>Elephas primigenius</i> Blum. ²	" <i>macrocephalus</i> Cope.

¹ Rep. Geol. Surv. Texas, 1892 (1893), p. 87.

² *Elephas primigenius*, probably *E. imperator*.

³ *Equus major* = *E. complicatus*

The following additional species were taken from these beds by the American Museum party:

Elephas imperator,

Platygonus sp. ind.

Equus scotti,

Large carnivore, gen. et sp. ind.

PLIOCENE.

Blanco Beds.

The Blanco beds have been correctly referred to the Pliocene age, as is shown by the peculiar fauna they contain; Cummins has, however, given them a much wider distribution than is evident from a close study of the formations in that region. He says of these beds¹: "This formation constitutes the eastern scarp of the Staked Plains from the Double Mountain Fork of the Brazos River on the south to Paloduro Canyon on the north."

Cope also reported exposures of these beds northeast of Miami, Roberts County, Texas, more than one hundred and fifty miles to the north of Mount Blanco. His identification was founded on some fossil horse teeth which he referred to *Equus cumminsii* Cope. This species, as has been shown by the writer in a former paper,² is not referable to the genus *Equus*, and is indistinguishable at present from some species of the Loup Fork *Protophippus*, hence the correctness of Cope's identification of Blanco beds at Miami is, at least, doubtful.

Cummins was probably led to error by including in his section of the Blanco beds strata properly belonging to beds of an older age.

Cummins's sections of the Blanco beds, taken at two different localities, are as follows³:

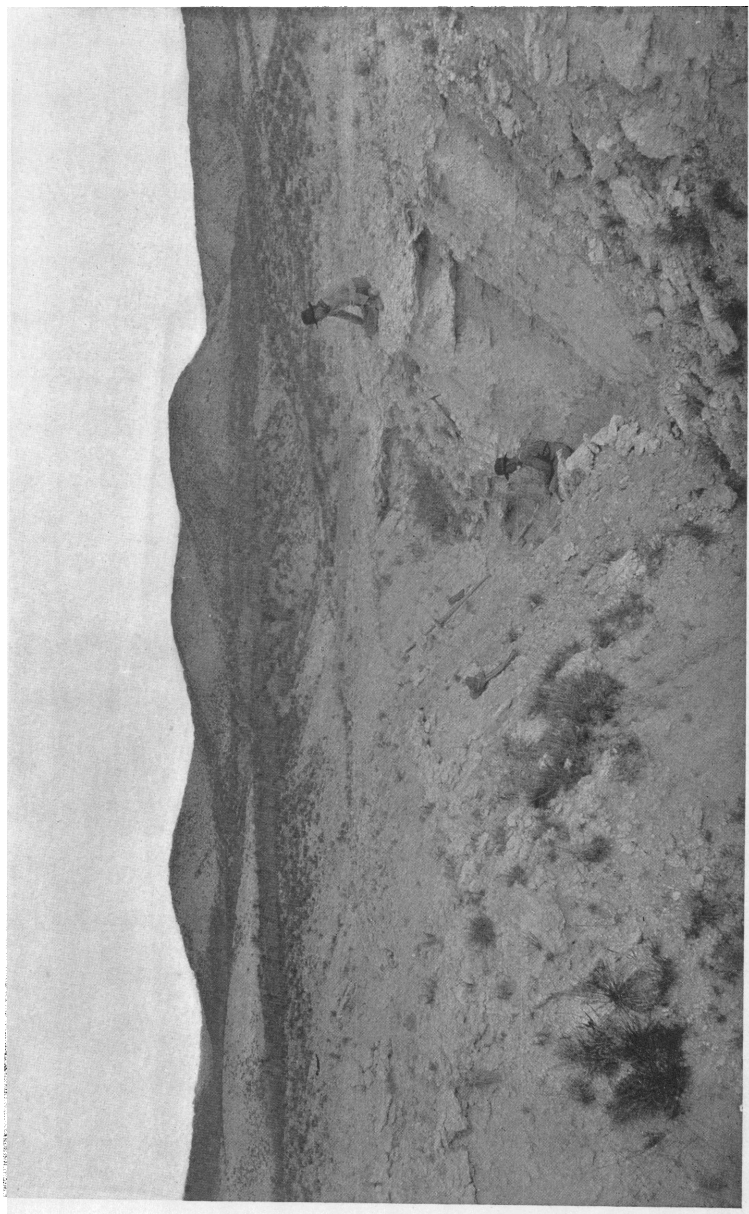
At Mount Blanco.

12. Soil.....	8 feet
11. Hard limestone.....	2 "
10. Sandstone.....	3 "
9. Stalactitic limestone.....	4 "
8. Calcareous sandstone.....	4 "
7. White sandy clay.....	30 "
6. White diatomaceous earth.....	4 "
5. Packsand.....	20 "

¹ Geol. Surv. Texas, 4th Ann. Rep., 1892 (1893), p. 201.

² Bull. Am. Mus. Nat. Hist., Vol. XIV, pp. 126, 127.

³ Geol. Surv. Texas, 4th Ann. Rep., 1892 (1893), pp. 200, 201.



BLANCO BEDS.

One half-mile south west of Mount Blanco.

- 4. White diatomaceous earth..... 8 feet
- 3. Green sandy clay..... 30 "
- 2. Red clay..... 2 "
- 1. Reddish clay..... 30 "

Three miles north of the old town of Docum, in Dickens County:

- 5. White sandy clay..... 6 feet
- 4. White diatomaceous earth..... 3 "
- 3. Purple clay..... 3 "
- 2. White diatomaceous earth..... 4 "
- 1. Reddish sandy clay..... 150 "

These sections are valuable only in giving the approximate thickness and general character of the deposits. No. 1, of both sections, is wrongly included in the Blanco series, as are also Nos. 9, 10 and 11 of the section taken near Mount Blanco. These strata belong probably to the Miocene age and are apparently continuous with the beds they so much resemble at Tule Cañon and other portions of the Staked Plains.

A complete section of this older formation is represented by Cummins's section taken "one fourth of a mile northwest of H. C. Smith's ranch and one mile north of Mount Blanco":

- 3. Limestone..... 2 feet
- 2. Stalactitic limestone..... 10 "
- 1. Red clay (same as No. 1 of previous section) ¹... 30 "

The diagrammatic section, Fig. 2, page 626, taken by the writer across Blanco Cañon and through the Blanco beds, shows both of Cummins's sections taken near Mount Blanco and illustrates their relations to each other.

It is thus seen that the Blanco beds, at Mount Blanco, like the Rock Creek beds, apparently occupy a comparatively narrow valley or basin formed for their deposition by ancient erosion of the older beds. Like the Rock Creek beds also they extend a long distance in one direction, being traceable south-eastward for fifteen or twenty miles to the edge of the Plains. Though the deposits differ in character from those of the Rock Creek beds and the fauna indicates an earlier age, here, as at Tule Canoñ, there is a total absence of any proof of a lake origin for these beds and many evidences of river or stream deposition.

¹ Cummins refers to the section taken near Mount Blanco and given above.

SHERIDAN BEDS

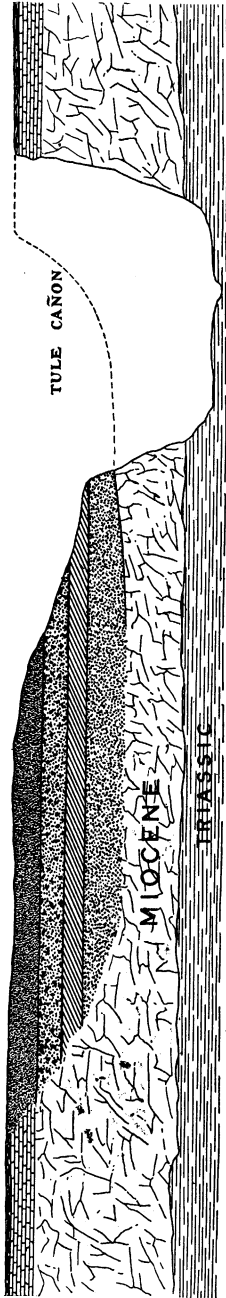


Fig. 1. Diagrammatic section across Tule Cañon near its head, showing position of Rock Creek (Sheridan) beds and underlying strata. Vertical scale about 1 in. to 150 ft.; horizontal scale about 3 in. to 1 mile.

BLANCO BEDS

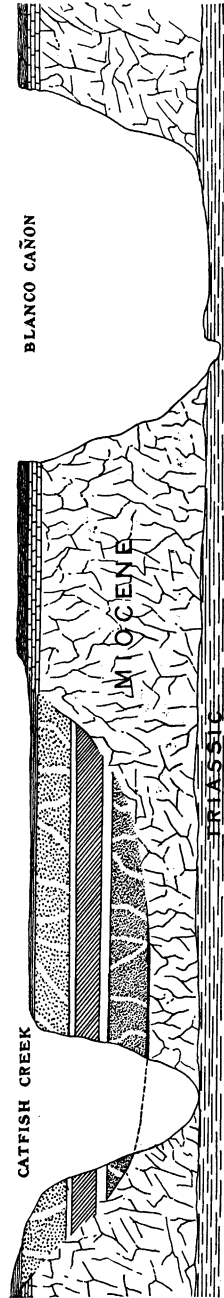


Fig. 2. Diagrammatic section across Blanco Cañon at Mount Blanco, showing position of Blanco beds and underlying strata. Vertical scale about 1 in. to 150 ft.; horizontal scale about 3 in. to 1 mile.

The occasional beds of diatomaceous earth are easily accounted for by supposing that there were in this ancient valley occasional ponds filled with clear water, enduring for various periods of time, partially or totally isolated from the stream that ran through the valley, such as exist at the present time in the West, especially in the Sand-hills country of northern Nebraska and southern South Dakota. The diatomaceous deposits are for the most part quite impure and contain great quantities of remains of rushes and pond grasses, indicating that these ponds were never of any great depth and probably occasionally received an overflow from the stream in times of freshet.

Following is the list of species, as reported and determined by Cope from the Blanco beds¹ and also as reported and determined by the American Museum Expeditions:

<i>Cope.</i>	<i>American Museum.</i>
TESTUDINATA.	TESTUDINATA.
<i>Testudo turgida</i> Cope,	<i>Testudo campester.</i>
" <i>pertenuis</i> Cope.	
AVES.	EDENTATA.
<i>Crecooides osbornii</i> Schuf.	<i>Glyptotherium texanum,</i>
EDENTATA.	<i>Megalonyx</i> sp.,
<i>Megalonyx leptostoma</i> Cope.	<i>Mylodon</i> sp.
CARNIVORA.	CARNIVORA.
<i>Canimartes cumminsi</i> Cope,	<i>Amphicyon</i> (? <i>Borophagus</i>).
<i>Borophagus diversidens</i> Cope,	
<i>Felis hillanus</i> Cope.	PROBOSCIDA.
PROBOSCIDA.	<i>Dibelodon mirificus,</i>
<i>Tetrabelodon shepardii</i> Leidy,	" <i>tropicus.</i>
<i>Dibelodon humboldtii</i> Cuvier,	
" <i>tropicus</i> Cope,	PERISSODACTYLA.
" <i>præcursor</i> Cope.	<i>Neohipparion</i> sp.,
DIPLARTHRA.	<i>Pliohippus simplicidens.</i>
<i>Equus simplicidens</i> Cope, ²	
" <i>cumminsi</i> Cope, ²	ARTIODACTYLA.
" <i>minutus</i> Cope, ²	<i>Platygonus bicalcaratus,</i>
<i>Platygonus bicalcaratus</i> Cope,	" <i>texanus,</i>
<i>Pliachaenia spatula</i> Cope.	<i>Pliachaenia spatula,</i>
Total number of species, 16.	" sp.

¹ Rep. Geol. Surv. Texas, 1893, p. 73.

² *Equus simplicidens* = *Pliohippus simplicidens*; *Equus cumminsi* = *Protohippus* sp.?, and *Equus minutus* = *Protohippus* sp.? See Bull. Am. Mus. Nat. Hist., Vol. XIV, pp. 123-128 and p. 140.

MIOCENE.

(?) *Goodnight (Paloduro) Beds.*

In 1893 Cummins proposed a new horizon, the Goodnight beds, placing it, in time, between the Loup Fork and Blanco divisions. In thus placing these beds he says: "I do this on both stratigraphic and palæontologic grounds. In making a stratigraphic section of the country, I found that the Goodnight fossil beds were above the conglomerate bed of the Loup Fork section made at Clarendon, the Clarendon beds being near the base of the Tertiary and below the conglomerate, while the beds at Goodnight were nearly at the top of the plains."

Following are Cummins's sections taken at the typical locality on opposite sides of Mulberry Cañon near its mouth:

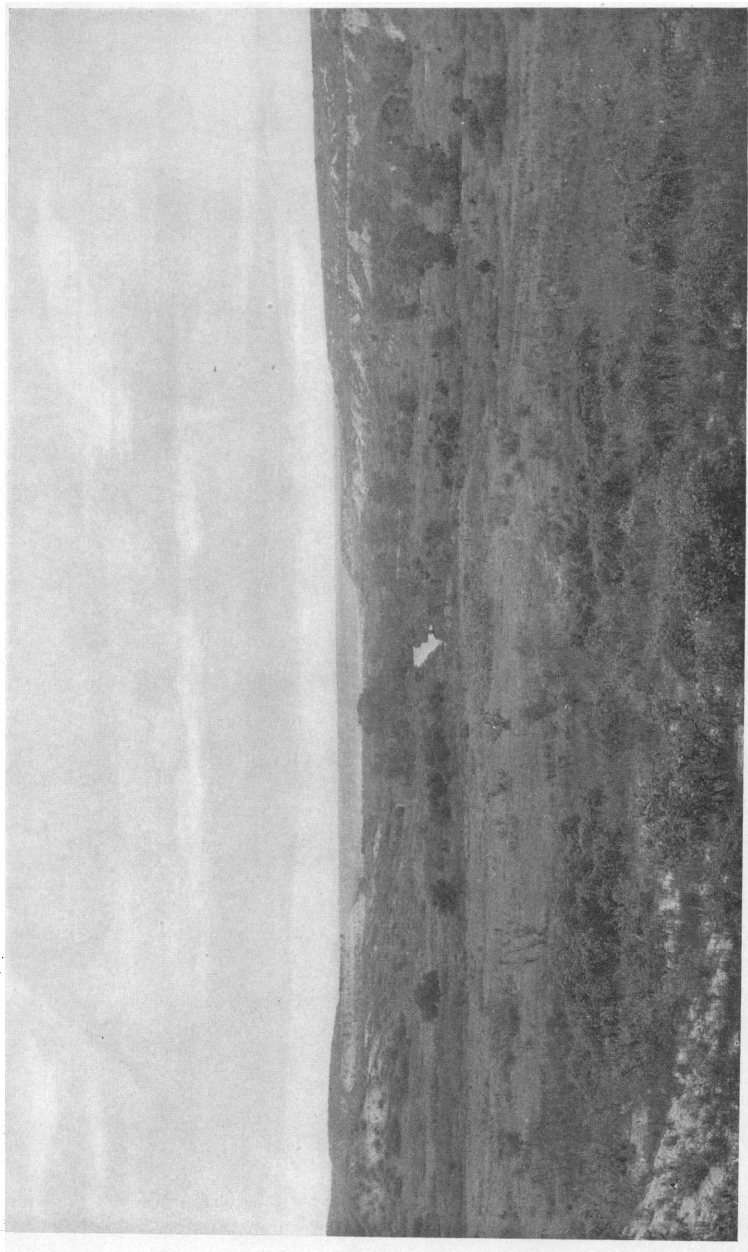
North Side.

1. White sandy clay, concretionary.....	60 feet
2. Sandy clay.....	40 "
3. Reddish sandy clay.....	25 "
4. Conglomerate, cross-bedded.....	20 "
5. Red clay, to the base.....	80 "
	225 feet

South Side, about one mile from the preceding section.

1. Concretionary yellow limestone.....	4 feet
2. Yellowish clay, with small concretions.....	12 "
3. Concretionary limestone.....	3 "
4. Yellowish sandy clay.....	40 "
5. Hard stalactite limestone, breaking into conchoidal fracture.....	3 "
6. Yellowish sandy clay, with small concretions, less concretionary at base.....	80 "
7. Bright red clay.....	40 "
8. Soft dark red sandstone.....	20 "
9. Soft limestone.....	4 "
10. Red clay, with white spots.....	20 "
	226 feet

A careful study of this region has compelled the writer to disagree with Mr. Cummins both as to the correctness of his



MULBERRY CAÑON.

Showing horizontal position and continuity of strata on opposite sides of the Cañon.

observations and in his interpretation of the strata in this locality. The writer could find no warrant for making any separation of the beds at Mulberry Cañon, either on stratigraphic or palæontologic grounds.

Briefly, Cummins's stratigraphic grounds for separating the Goodnight beds from the Loup Fork division are as follows: (1) That the Loup Fork beds in the vicinity of Clarendon were overlaid by the heavy cross-bedded conglomerate layer which underlies the upper series of strata at Mulberry Cañon. (2) That there is a marked difference in his two sections taken on opposite sides of Mulberry Cañon. He says of these sections: "It will be apparent upon examination of these two sections that there is a marked difference between them. The heavy bed of conglomerate on the north side of the canyon, No. 4 of the section, does not occur on the south side, nor was there any gravel on that side to show that the conglomerate bed had ever been there."

This statement is incorrect, for the writer found an abundance of gravel on both sides of the cañon and had no trouble in tracing the conglomerate layer (No. 4 of Cummins's section) across to the south side of the cañon where it is exposed in two localities, showing a maximum thickness of at least fifteen feet. This bed of conglomerate and sand is nowhere of great width, hence it does not appear in every section on either side of the cañon. The writer also found this coarse conglomerate bed appearing again in the Clarendon locality, resting directly on the eroded surface of the Triassic and *underlying* the Miocene beds, but not overlaying them, as reported by Cummins. There are scattered patches of loose gravel partially covering the Miocene deposits in the vicinity, but it is superficially distributed and nowhere can be said to be in its original bed of deposition. It was probably this frequent occurrence of loose gravel which led Cummins to believe that the conglomerate bed had overlaid the Miocene in this locality.

Cummins's two sections taken at Mulberry Cañon are misleading, for no two sections, even though taken on the same side of the cañon, agree in detail. There is, therefore, no such real difference in the two sides of the cañon as these sections

apparently show. The main divisions of either section are traceable around the head of the cañon and are continuous with corresponding strata of similar character on the opposite side.

From the foregoing facts it seems evident that Cummins's separation of the Goodnight beds on stratigraphic grounds is scarcely admissible.

Cummins's palæontologic grounds for the separation of these beds is based on Cope's determination of the small collection of fragmentary fossils taken from the vicinity of Mulberry Cañon on the south side.

Cope's determination of these fossils is as follows ¹:

<i>Aphelops</i> sp.,	<i>Hippidium interpolatum</i> Cope,
<i>Protohippus lenticularis</i> Cope,	“ ? <i>spectans</i> Cope,
<i>Protohippus</i> sp.,	<i>Equus eurystylus</i> Cope,
“ ? <i>perditis</i> Leidy,	“ ? <i>simplicidens</i> Cope.

In referring to this list Cope ² stated that two of these genera are characteristic of the Loup Fork beds, but are not known to extend higher; that *Equus*, on the contrary, had never been found in the Loup Fork formation; and that *Hippidium* was of uncertain horizon. Of the species Cope said “the three which are identifiable are new to science.”

As shown by the writer in a former paper ³ *E. simplicidens* Cope and *E. eurystylus* Cope can not be referred to the genus *Equus*, but on the contrary are distinctly Miocene in character and only referable to Miocene genera. *Hippidium* is probably an exclusively South American genus, and the species referred to it by Cope are probably referable to the genus *Protohippus*. The three species from the Mulberry Cañon locality which Cope considered identifiable are as follows: *Protohippus lenticularis* Cope, *Hippidium interpolatum* Cope, and *Equus eurystylus* Cope.

The first of these species is, perhaps, authentic, but it is referable to the genus *Neohipparion* ⁴ and not to *Protohippus*.

¹ Geol. Surv. Texas, 4th Ann. Rep., 1892 (1893), p. 45.

² Geol. Surv. Texas, 4th Ann. Rep., 1899 (1892), p. 45.

³ Bull. Am. Mus. Nat. Hist., Vol. XIV, 1901, pp. 123-126.

⁴ The genus *Hipparion* was founded on an European type, though many American species have since been referred to it. The writer, however, has separated generically the American group from the Old World *Hipparion*, giving to the American group the name *Neohipparion*. (Bull. Am. Mus. Nat. Hist., Vol. XIX, p. 467.)

MULBERRY CAÑON

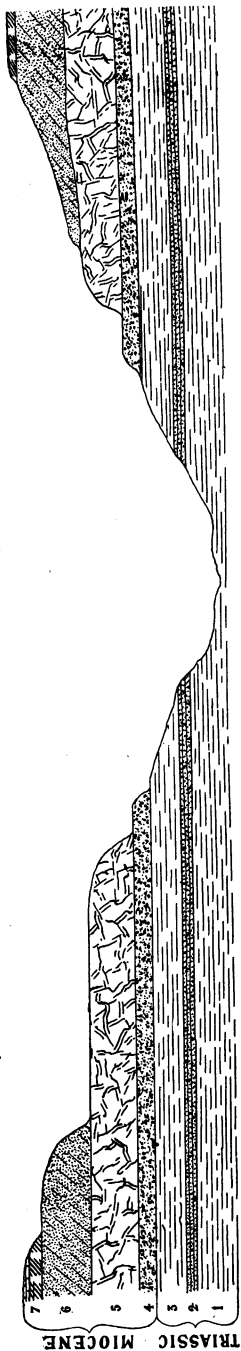


Fig. 3. Diagrammatic section across Mulberry Cañon near its mouth, showing position of Panhandle (Lower or Middle Miocene) beds and the underlying strata. Vertical scale about 1 in. to 250 ft.; horizontal scale about 2 in. to 1 mile.

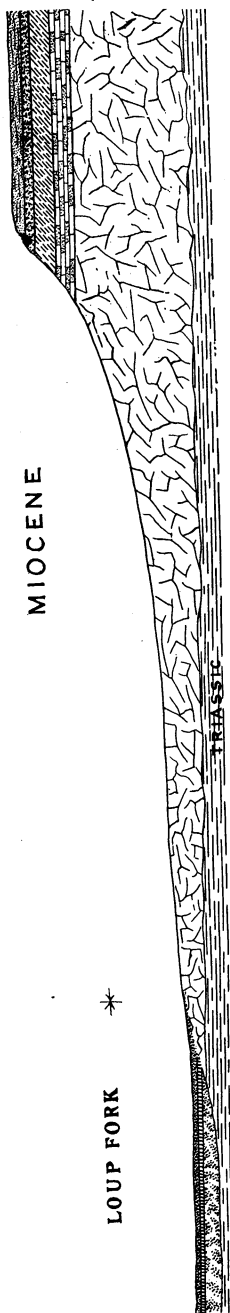


Fig. 4. Diagrammatic section of the Clarendon locality, showing position of Clarendon (Loup Fork) beds and Panhandle (Middle or Lower Miocene) beds, extending west to the top of the Staked Plains. Vertical scale about 1 in. to 300 ft.; horizontal scale about 1 in. to 1 mile.

The species does not indicate a later phase than the Upper Miocene, for the writer found, in the Clarendon locality, several specimens, including a skull with complete dentition, which are indistinguishable from *Protohippus lenticularis* Cope. The second species, as already mentioned, is indistinguishable from some species of *Protohippus*. The third species of this group, *Hipparion eurystylus* Cope, was founded on lower teeth and is not distinguishable from specimens found in the Clarendon locality. It is quite possible that Cope's type of this species represents the lower dentition of *Neohipparion lenticularis*, with which it corresponds in size.

Thus it will be seen that the palæontological evidence at hand not only fails to prove a new horizon for the so-called Goodnight beds, but, on the contrary, seems to prove conclusively that they are identical in age with the beds in the vicinity of Clarendon, which Cope recognized as Loup Fork (Upper Miocene) deposits.

There is little doubt, then, that there is no break at Mulberry Cañon, either in strata or fauna. Hence the Goodnight beds, as a new horizon, should be abandoned.

UPPER MIOCENE.

Clarendon Beds: "Loup Fork" Stage.

The deposits at the locality north of Clarendon belong undoubtedly to the Miocene epoch. The fauna indicates a close relationship with the Loup Fork formation.

This locality is east of the Staked Plains proper, but connected with them through long, low divides. The fossil-bearing strata do not, however, follow these divides back to the Plains, and is it impossible to say, owing to so much of the country in that direction being covered by recent deposits which are now more or less grass-covered, whether they extended any great distance to the westward or not. The

¹ Local name proposed by the writer. The name Loup Fork was first proposed as a formation name, and its subsequent extended use has given rise to so much confusion that it seems better not to employ it in the sense of a time division, but to limit its use to the formation occurring in the Loup River, Niobrara, and White River valleys for which it was originally used. The Clarendon beds are of approximately the same age as the Loup Fork beds, as judged by the known fauna, but cannot be regarded as a part of the same terrane, and they differ considerably in structure and composition.



HEAD OF PETRIED CANON.

Showing excavation in Clarendon Beds from which were taken several skulls and partial skeletons of three-toed horses.

exposures, however, show an extensive distribution to the northeast.

Here again, as at Tule Cañon and Mount Blanco, the peculiar formation of the deposits indicates, though in a somewhat different manner, an alluvial origin. Though distributed over a wider area in every direction there are running through these beds several narrow channels of sandy clay. The main body of the beds consists for the most part of cross-bedded sands and sandstones intermixing more or less and cross-bedding with the clays. These channels all take a direction nearly east and west, or approximately the same as that of the streams draining the country at the present time. Some of them are traceable for long distances. It is in these peculiar beds of sandy clays that all the fossils of this region occur.

Cummins's section of the Clarendon locality is as follows:

1. Whitish sandy clay.....	20 feet
2. Sandy clay, with many rounded siliceous pebbles of different sizes.....	20 "
3. Yellowish sand.....	40 "
4. Indurated white sand.....	40 "
5. Yellow sandy clay, with the sand more or less predominating in places. In places the sand is hardened, while in others the clay is more or less concretionary.....	250 "
6. Alternating beds of bluish clay and white sand (Loup Fork).....	30 "
	400 feet

Cummins has here placed the Loup Fork formation at the very bottom of this section of 400 feet of deposits. A careful study of this region, however, does not warrant such a disposition of this stratum. In reality this stratum (No. 6) belongs properly at the top of the above section, and the explanation is simple. Nowhere is bed No. 6 overlaid by any of the upper strata of the section; hence to obtain this section Cummins probably included the beds west to the top of the plains, and because No. 6 was at a lower level concluded that it ran under the beds to the west. This, however, is erroneous. The writer found several places where this fossil-bearing stratum lies unconformably on the eroded surface of

beds resembling the lower portion of the beds to the west which Cummins identified as probably Goodnight beds. It seems certain, therefore, that the beds to the west are older than the fossil-bearing strata under discussion. This apparent inconsistency in level is due to the heavy erosion of the older beds before the Upper Miocene deposits were laid down.

The following species have been reported from the Clarendon locality:

REPORTED AND IDENTIFIED BY COPE.	OBTAINED AND IDENTIFIED BY THE AMERICAN MUSEUM EXPEDITIONS.
<i>Aphelops fossiger</i> Cope,	<i>Mastodon productus</i> ,
<i>Protohippus perditis</i> Leidy,	“ sp.
“ <i>parvulus</i> Marsh,	<i>Dinocyon gidleyi</i> ,
“ <i>fossulatus</i> Cope (sp. nov.),	“ <i>mæandrinus</i> ,
<i>Protohippus mirabilis</i> Leidy ¹ ,	<i>Machærodus</i> sp.,
“ <i>placidus</i> Leidy,	<i>Teleoceras</i> sp.,
<i>Hippotherium</i> ² <i>affine</i> Leidy,	<i>Hipparion</i> ³ <i>lenticularis</i> ,
“ <i>occidentale</i> Leidy,	“ <i>occidentalis</i> ,
<i>Procamelus robustus</i> Leidy,	“ sp.,
“ <i>gracilis</i> Leidy,	<i>Protohippus perditis</i> ?
“ <i>leptognathus</i> Cope (sp. nov.),	“ sp.,
<i>Blastomeryx gemmifer</i> Cope,	<i>Pliohippus</i> ? sp. nov.
<i>Tetrabelodon serridens</i> ? Cope.	<i>Procamelus</i> sp.,
	<i>Pliauchænia</i> sp.

MIDDLE OR LOWER MIOCENE.

*Panhandle Beds.*⁴

As to the age of these older beds it is difficult to say, owing to the present lack of palæontologic evidence, just where they should be placed. It is probable, however, that they are Lower or Middle Miocene.

Some lower teeth of *Merycochærus* and a lower tooth of *Procamelus* taken from these beds by the writer prove them to be not older than the Lower Miocene.

Though differing somewhat in detail in the different localities, these older beds in the vicinity of Clarendon, at Mulberry Cañon, at Mount Blanco, and at Tule Cañon and Rock

¹*Protohippus mirabilis* = *Merychippus mirabilis*.

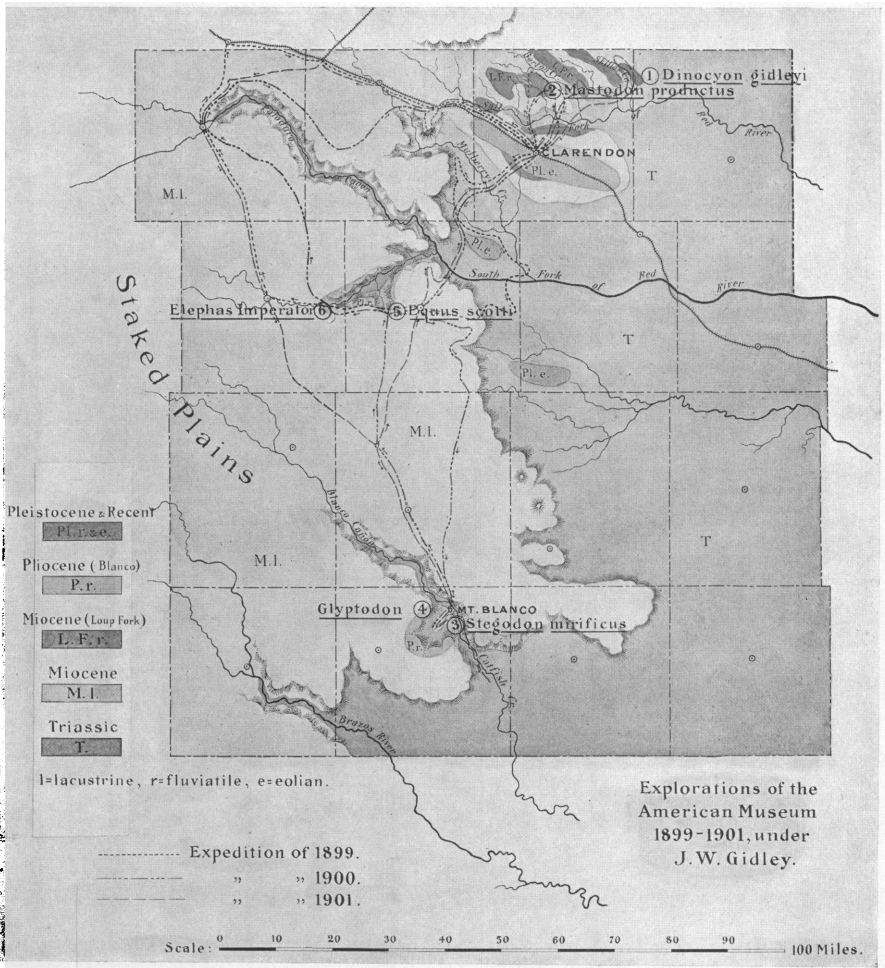
²*Hippotherium* = *Neohipparion*.

³*Hipparion* = *Neohipparion*.

⁴Local name proposed by the writer.



MAP OF TEXAS.
Showing area of Explorations.



- Pleistocene = Rock Creek Beds.
- Pliocene = Blanco Beds.
- Miocene (Loup Fork) = Clarendon Beds.
- Miocene = Panhandle Beds.

Creek are evidently of the same age. They closely resemble each other in a general way, and the formations are traceable from one locality to another around the irregular escarpment of the Plains. Numerous wells dotting the Staked Plains show everywhere the existence of these beds. They are of nearly uniform thickness, and form practically the whole area of the Staked Plains.

SUMMARY.

Following is a summary of the conclusions reached by the writer from this study of the formations of northwestern Texas:

(1) There has been no great disturbance or change of level in the region of the Staked Plains since the close of the Triassic, hence the strata of the Triassic which underlie this whole region are for the most part nearly horizontal, and the country at the beginning of the Miocene was comparatively level.

(2) The Panhandle (Lower or Middle Miocene) beds were comparatively evenly distributed over the vast area now occupied by the Staked Plains and in addition extended westward to the Rocky Mountains in New Mexico, and spread out to the eastward over a much greater territory than they now occupy. These deposits seem to be, at least partially, lacustrine in origin.

(3) All the formations of the Staked Plains that are of more recent date than the Lower or Middle Miocene are represented by comparatively small areas, and are fluvial, or æolian and fluvial, in origin. These later depositions are represented by the Clarendon beds in the vicinity of Clarendon, the Blanco Beds at Mount Blanco, and the Rock Creek beds at Tule Cañon and Rock Creek.

