

**Article XXXII.—NOTES ON PALEOCENE AND LOWER  
EOCENE MAMMAL HORIZONS OF NORTHERN NEW MEXICO  
AND SOUTHERN COLORADO.**

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PLATES XCVII AND XCVIII.

The purpose of the present short paper is to indicate some of the results of the Eocene exploration conducted by the writer, with the assistance of Mr. George Olsen, in the San Juan Basin in 1916. It is hoped that the following notes may be of some aid to future Eocene collecting in this region and possibly also to detailed geologic plotting.

Three separate localities were examined, viz.: the Torrejon of Angel Peak, lying south of the San Juan River; the Torrejon of the Animas Valley, between Aztec and Cedar Hill; a set of later beds in Colorado, lying north of the Denver and Rio Grande Railway, between Los Piños and Piedra Rivers.

The American Museum expedition of 1913 visited nearly all of the Paleocene localities of the San Juan Basin from which fossils had previously been obtained, made extensive collections and summarized the stratigraphic results in a paper published the following year.<sup>1</sup>

These localities are all on the south side of the San Juan River and extend in a long line from the vicinity of Ojo Alamo eastward to the Puerco River below Cuba. Exposures lying to the north near the San Juan and in the Animas Valley were known to be Paleocene but for lack of time were not examined that year.

*The Angel Peak Region.*

The exposures at Angel Peak are in the form of a gigantic crater cut out of a fairly level grass-covered plain to a depth of several hundred feet and with a diameter of three to four miles. Angel Peak itself, which is merely an irregular-shaped residual mass of Eocene shales and sandstones, rises from the eastern wall of this crater. The drainage of this great badland basin is northward into the San Juan through a rough steep-walled valley

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<sup>1</sup> Sinclair, W. J., and Granger, Walter, 'Paleocene Deposits of the San Juan Basin, N. Mex.' Bull. Amer. Mus. Nat. Hist., Vol. XXXIII, pp. 297-316, 1914.

known as Coots Cañon. The region was worked from a spring on the rim on Sec. 3, T. 27 N., R. 11 W. The beds present a generally grayish appearance with occasional reddish bands, not unlike Puerco and Torrejon exposures further to the south. They are mostly shales with some heavy layers of sandstones which, toward the center of the basin, have assisted in the formation of low mesas. Because of limited time and the great extent and extreme roughness of the exposures in this basin not more than half the area was examined but Torrejon fossils were found in fair abundance although in an unusually poor state of preservation. The characteristic fossil levels of the typical Torrejon were absent and the bones were found on various horizons from near the base of the beds in the center of the basin to within 150 feet of the top along the western wall. Some of the localities as noted on field labels are: "1 mile west of Angel Peak," "2 miles west of Angel Peak", and "Sec. 26, T. 27 N., R. 11 W." (along western rim). Further to the north at the head of a deep draw which puts into Coots Cañon from the west some better preserved fossils were found on Sec. 3, T. 27 N., R. 11 W. Among the specimens obtained from these various localities are the following:

<i>Tetraclænodon</i>	<i>Protogonodon</i> sp. nov.
<i>Mioclænus turgidus</i>	<i>Tricentes</i>
<i>Periptychus rhabdodon</i>	<i>Deltatherium</i>
<i>Anisonchus sectorius</i>	<i>Psittacotherium</i>

These, with one exception, are characteristic Torrejon forms. *Protogonodon* is a Puerco genus, not previously known from the Torrejon, but the present specimen is not of a Puerco species and shows the advancement of tooth structure to be expected in the transition from the lower to the upper horizon. Without question, then, the lower two-thirds of the exposures of the Angel Peak basin is Torrejon formation. The uppermost 100 to 150 feet, although unfossiliferous where examined, may also be Torrejon but the beds have much the appearance of the upper beds of the Ojo Alamo section, which are soft yellowish sandstones referred to the Wasatch. The exposures for three miles down Coots Cañon were examined and found barren. These beds are lower than any exposed in the basin and take on more the appearance of the Puerco of Ojo Alamo. The writer is of the opinion that they are Puerco from the fact that they underlie beds of known Torrejon age and are above the Cretaceous. If they are Torrejon it would make a much greater thickness for that formation in this locality than it has anywhere to the southward. No unconformities were observed either above or below the fossiliferous zone.

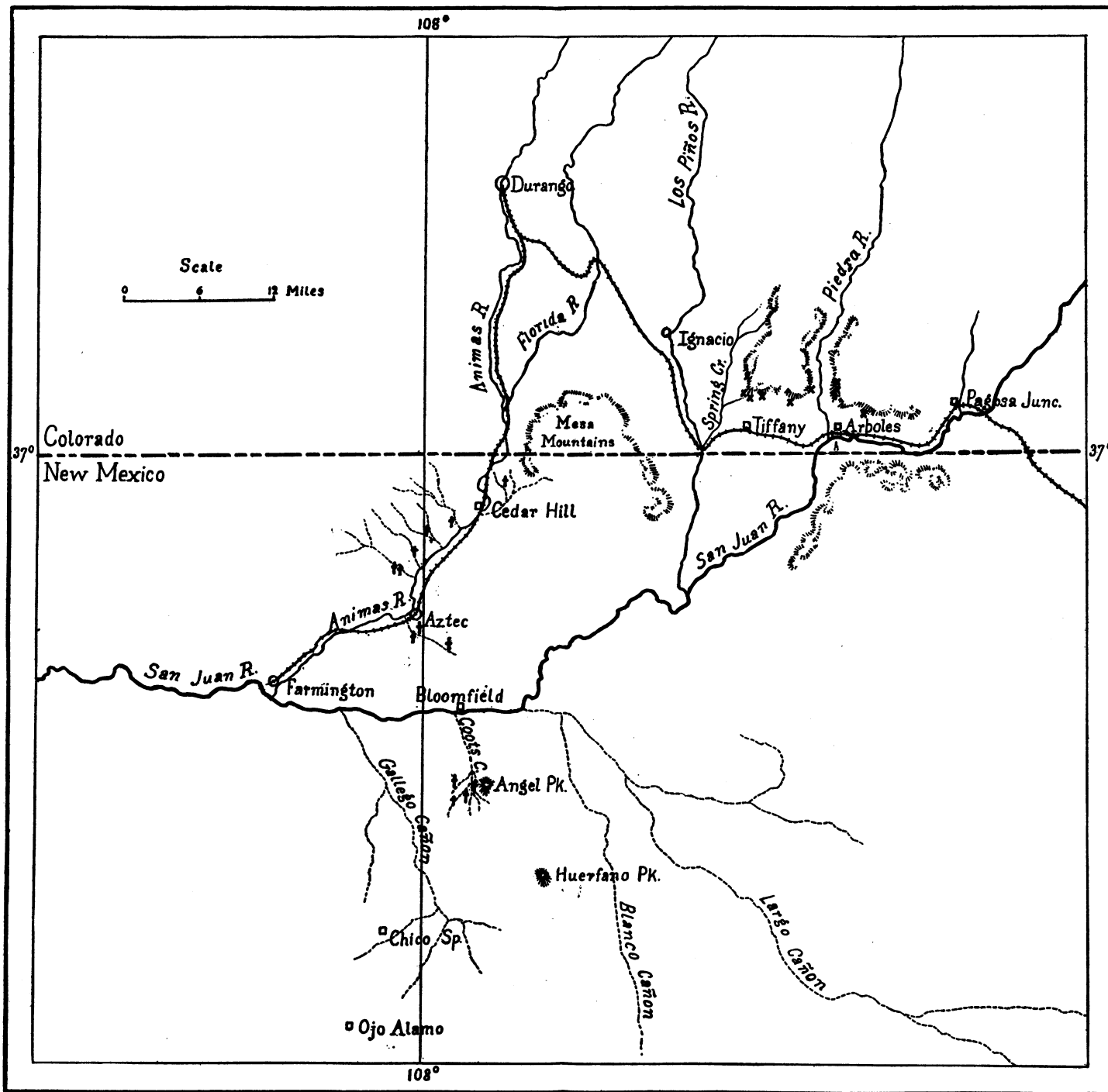


Fig. 1. Sketch Map of a portion of the San Juan Basin showing sections examined in 1916. † indicates localities from which Torrejon fossils were obtained, × those in which Tiffany beds fossils were found.



*The Lower Animas Valley.*

At the mouth of the Animas River the surface rocks are of Cretaceous age. The great bluff of the San Juan River opposite Farmington is, according to C. M. Bauer,<sup>1</sup> made up chiefly of the Kirtland shale with the contained Farmington sandstone member, the bluff being capped by sandstones and shales referred to the Wasatch.

On the geologic map of the paper cited (pl. lxiv) Bauer has indicated the rocks of the south side of the San Juan for two or three miles below the mouth of Gallego Cañon and an equal distance above it as being Wasatch, apparently a continuation of the rocks capping the bluff opposite Farmington. Although the writer has never examined the beds along the San Juan at this point he is inclined to believe from their appearance and from a knowledge of the beds to the north and east that the lowermost of them, at least, are Paleocene. David Baldwin probably prospected this section in the early eighties and although he did not record anything from the mouth of Gallego he did obtain Torrejon fossils from further up the San Juan as well as from the Animas Valley to the north. Such records of Baldwin's as there are of fossils from the northern exposures of the Paleocene are as follows:

<i>Neoplagiulax molestus</i> . Type.	"North side San Juan River", 1886.
<i>Mioclenus turgidus</i> (3159)	"Rio San Juan."
" <i>opisthacus</i> . Type.	"Rio San Juan", 1882.
<i>Deltatherium fundamini</i> s. Type.	"Mouth of Canon Largo."
<i>Hemithlæus baldwini</i> . Type.	"Rio San Juan."
<i>Periptychus carinidens</i> . Type.	"Mouth of Cañon Largo."
" <i>rhabdodon</i> var. <i>fissus</i> (362a)	"S. side San Juan River."
<i>Pantolambda cavirictus</i> . Type.	"Ute Reserve near Durango, N. M.", 1883.
"Various Teeth."	"N. side San Juan on Animas."
Humerus	"West side Animas."

These are all Torrejon forms. The specimens from the mouth of Largo Cañon are spoken of as coming from "below the Cañon Largo sandstones" (?basal Wasatch ss.) and judging from Baldwin's letters were from near the base of the exposures. The type of *Pantolambda cavirictus* is probably from the Animas Valley, near the Colorado-New Mexico line. The other localities given are too indefinite to be of much value.

The examination of the Animas Valley last season was begun about a mile below Aztec on the east side of the valley. In travelling up the Animas from Farmington one gradually passes out of the Cretaceous and near

<sup>1</sup> Bauer, Clyde Max, 'Stratigraphy of a part of the Chaco River Valley,' U. S. G. S. Prof. Paper 98-P., pp. 271-278, 1916.

Aztec the first good exposures of the overlying Paleocene shales are seen. The first fossils were obtained from the long draw through which the Aztec-Bloomfield road passes, at a point a few hundred yards south of the forks of the road and about one and one-half miles south of the Aztec station. A section taken at this point is as follows:

Soft buff-colored sandstones.....	43 feet
Deep weathering, olive-colored shales.....	22
White sandstones, buff in places and with brown nodules.....	25
Olive-colored shales with numerous brown nodular masses (mammals from upper part).....	60+
	<hr/>
	150+

The following Torrejon mammals were obtained from the lower element of this section: *Plagiaulacid* (?*Ptilodus*), *Clænodon*, *Tetracleænodon*, *Tricentes*, ?*Protoselene*, indet. *Oxycænid*. From the head of this same draw at a somewhat higher level and from a local reddish stratum similar in appearance to the fossiliferous layers of the typical Torrejon were obtained jaws of *Periptychus rhabdodon* and *Deltatherium fundamini*. Other exposures both to north and south of this draw failed to yield fossils.

The most extensive exposures of the lower Animas Valley are to be found on the west side from about three miles north of Aztec northward to Cedar Hill. Several great draws coming down from the high divide between the Animas and La Plata Rivers put into the Animas here and the sides are weathered out into unusually rough badlands. These draws, beginning with the southernmost, are called Bohannon, Tucker, Kiffin and Leper Cañons. The beds exposed here are grayish shales and buff sandstones which to the northward, especially in Leper Cañon, alternate with strata of red and purplish shales. On the upper levels the sandstone layers become thicker and near the top of the divide they predominate over the shales. A total thickness of not less than 1000 feet is represented here. The upper levels, which are presumably Wasatch, were examined in several places but found barren of fossils. In the lower gray shales, however, a small collection of rather poorly preserved Torrejon mammals was secured. Fossils were found in each of the draws and were not confined to distinct horizons although always in the gray shales and limited in each case to the lower 300 feet of the exposures. One small "pocket" on the south side of Bohannon Draw, about one and one-half miles above its mouth, was fairly rich and furnished about one-half of all the material collected in this section. Among the forms obtained from this area along the west side of the Animas are the following:

<i>Periptychus rhabdodon</i>	<i>Tricentes</i>
<i>Mioclænus turgidus</i>	<i>Didymictis haydenianus</i>
<i>Tetraclænodon</i>	<i>Clænodon</i>
<i>Mixodectes</i>	<i>Deltatherium</i>
<i>Pentacodon</i>	

The last set of exposures of the Animas Valley to be examined lay on the east side of the river near Cedar Hill. Here near the head of a long draw which puts into the Animas at the Cedar Hill bridge were obtained a fragmentary skull of *Pantolambda cavirictis* and a jaw of *Tetraclænodon*. These were from an elevation of between 200 and 300 feet above the river and apparently from a higher level than any of the fossils found further down the valley. Above Cedar Hill the valley narrows up rather abruptly and although there are small exposures of the lower levels here and there they were not examined.

It is evident from the collection made that the lower 300 feet of the beds exposed along the Animas from Aztec to Cedar Hill belong to the Torrejon formation. Lithologically these beds are not dissimilar to the Torrejon of the southern area, although the two sharply defined horizons of the type locality are missing on the Animas. At Aztec the country is low and the beds apparently do not reach above the Torrejon, but at Cedar Hill and along the heads of the big draws on the west side of the river between Aztec and Cedar Hill the passage up into the Wasatch is undoubtedly made but the line of contact was not determined.

While the Animas fauna is distinctly Torrejon it is difficult to correlate it with that of either the upper or lower horizons of the typical Torrejon. There is, in fact, no very great distinction, so far as known at present, between the two horizons, nor could any great difference be expected since the two levels are separated by only 100 feet of supposedly continuous sedimentation. *Deltatherium* is confined to the lower level where it is common. *Pantolambda* seems to occur only on the upper level and certain species common to both horizons are relatively much more abundant in one than in the other. For instance *Mioclænus turgidus* is rare in the upper level while in the lower it is about the most common form. On the whole it may be said that, aside from the Cedar Hill specimens, the Animas fauna is rather closer to that of the lower horizon of the type locality. The *Pantolambda cavirictis*, from Cedar Hill, is distinctly an upper beds form and it seems probable that the entire vertical range of the Torrejon formation is represented here.

Whether or not the Puerco underlies the Torrejon along the Animas the writer is not able to say. At Aztec there are at least 100 feet of Paleo-

cene shales and soft sandstones underlying the lowest stratum in which Torrejon fossils were found, and these may belong to the Puerco. Above Cedar Hill, near the mouth of the Florida River, the beds, which are nearly horizontal further south, are slightly uptilted and levels apparently lower than any exposed between Aztec and Cedar Hill are brought to the surface. These are alternating sandstones and light gray shales. One of the best exposures of these lower beds was observed along the bank of the Florida about two miles above its mouth but no fossils were found in it; these also may be Puerco but in the absence of fossils it could not be determined definitely. The valley of the Animas above the Florida was not visited and the contact between the Paleocene and the Animas formation was not noted.

### *The Ignacio Region.*

Along the eastern border of the Ignacio quadrangle in southern Colorado there arises abruptly to a height of over 2000 feet above the broad valley of Los Piños River a great mass of Tertiary sediment. This formation is continued to the eastward to within a few miles of Pagosa Junction where the sharply upturned edges are seen resting on the Cretaceous. To the north it reaches nearly to the State highway between Bayfield and Pagosa Springs. It is the northern edge of the great area of Lower Eocene which extends southward to the Nacimiento Mountains and the heads of the Puerco and Chaco tributaries, Torrejon, Escavada and other arroyos. It is deeply dissected by the Piedra and San Juan Rivers and is separated from the Mesa Mountains to the southwest by a great stretch of open country drained by Los Piños River. The area near Ignacio has been studied and measured for the Government Survey by J. H. Gardner and his section taken there has been published by W. T. Lee.<sup>1</sup> The beds are referred by Gardner to the Wasatch and his section shows a total thickness of 2275 feet of reddish, brownish, yellowish, tan-colored, purplish and gray shales and gray and tan-colored sandstones. The shales are predominant in the lower part of the section, the sandstones becoming more frequent and massive toward the top. The beds, in the Ignacio region, lie nearly horizontal; they overlap the Torrejon and Puerco and rest on the Animas formation, according to Gardner, with unconformity not perceptible. This sediment is pretty well masked by a dense growth of cedars, piñons, scrub-oak and pines but here and there are scars on the steep slopes where the surface seems to have slipped off leaving exposed the bright variegated

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<sup>1</sup> Lee, W. T. "Stratigraphy of the Coal Fields of Northern Central New Mexico." *Bull. Geol. Soc. Amer.*, Vol. 23, p. 584, 1912.



shales which at a distance have a pale reddish effect. The largest of these exposures are perhaps half a square mile in area but most of them are of only a few acres. J. W. Gidley, of the National Museum, who accompanied Gardner when he made his studies (1909) succeeded in obtaining from the lower part of the beds a small but interesting mammalian fauna. While the upper part of the beds are, without much question, of the same age as the fossiliferous Wasatch of the Gallina region, 75 miles to the southeast, the lower beds containing the fauna discovered by Gidley cannot properly be correlated, on a faunal basis, with any part of the Gallina Wasatch.

A brief report by Mr. Gidley on this collection has recently been published.<sup>1</sup> In this he states that the fauna appears to be intermediate between the Fort Union and the Wasatch and lists the following forms: *Coryphodon* sp. indet., a phenacodont intermediate between *Phenacodus* and *Euprotogonia*, *Hemiacodon* (?sp. nov.), *Nothodectes* sp., miscellaneous teeth apparently belonging to species of the Clark Fork beds.

Three years ago when the writer was in the San Juan Basin Mr. Gidley kindly volunteered information regarding these mammal-bearing beds but lack of time prevented an examination of them that season. Last summer, however, the party spent nearly a month in a thorough prospecting of the horizon. Practically all of the exposures, from their western limit near Ignacio eastward to a point two or three miles east of the Piedra River, were gone over with great care and with the result that a small collection was secured which fully substantiates Gidley's contention that the fauna is intermediate between the Torrejon (Fort Union) and the Wasatch. The fossils were in every case from the lower beds, a vertical range of not over 300 feet, and, with one exception, were from the shales. A few of the specimens came from the Piedra Valley and several from directly north of Allison, but by far the richest locality was at the extreme western end of the hills on Sec. 20, T. 33 N., R. 6 W. This is the locality reported by Gidley as the one from which he got his collection. Even in the richest pockets, however, fossils were not abundant and it was only by going over the ground with the greatest care that the collection was secured. The material obtained may be divided into two classes: first, such specimens as were found isolated, in most cases already weathered out, and second, an aggregation of remains of small mammals found in a mass of soft uniform gray shale which was imbedded in a stratum of mottled purplish and brownish clay. This gray shale mass was irregular in shape and less than half a cubic yard in bulk, although probably considerably reduced by erosion, and having all the appearance of being the filling of a fissure formed in the mottled clay.

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<sup>1</sup> Wegemann, Carrol H. "Wasatch Fossils in So-called Fort Union Beds of the Powder River Basin, Wyoming." U. S. G. S., Prof. Paper No. 108 D, pp. 57-60, 1917 (Report by J. W. Gidley on 59).

The material of the first group comprises the following forms:

<i>Periptychus</i> , sp. nov.	? <i>Chriacus</i>
Phenacodonts, 3 species	<i>Nothodectes</i> sp.
? <i>Dissacus</i>	

The *Periptychus* shows the reduced premolars of *P. carinidens* and the elongated molars of *P. rhabdodon*. The three species of phenacodonts are indicated by their size; the largest of these is unquestionably referable to the genus *Phenacodus* since all three upper molars possess well developed mesostyles. It is about as large as *P. intermedius*. The other two species are represented by lower teeth only and cannot be referred positively to either *Phenacodus* or *Tetracænodon*. The smaller one is equal to *T. minor* in size and the other is intermediate between that and *T. puercensis*. A single premolar tooth is referred doubtfully to *Dissacus* but it cannot be distinguished from one of the smaller species of *Pachyaena*. A single worn upper molar agrees fairly well with *Chriacus*. *Nothodectes* is represented by an  $m_3$  and fragments of jaws without teeth.

It is from the small gray shale "pocket" though that by far the most important material was obtained. There is here preserved, apparently, a fair representation of the small mammal fauna of that locality. The process of working out the extremely delicate material from the matrix, which was taken up in sections, has only begun but already several new and interesting forms have shown up. The first of these, a bat (*Zanycteris*) has already been described by Dr. W. D. Matthew and descriptions of the other forms will follow at intervals. Not only are fragmentary skulls and jaws preserved but there is a considerable amount of disorganized skeleton material, all in a fair state of preservation. The fossils are rather evenly distributed through the matrix and not confined to one level. The occurrence of so many small forms in this deposit and the absence of any of the larger ones suggests that they may be the remains of animals brought into a fissure by a small predatory mammal. The exact location of this deposit is in a small low-lying exposure of brownish and purplish shales of three or four acres in extent lying three-fourths of a mile northeast of the Mason schoolhouse on Sec. 20, T. 33 N., R. 6 W. (See Plate XCVIII.) The deposit will be referred to in future papers as the Mason quarry or Mason pocket.

Of the fauna of this Mason quarry *Nothodectes* seems to be the most common form and is represented by skeleton material as well as broken skulls and jaws. Besides this there is the bat *Zanycteris*; a tiny marsupial; small plagiaulacids of probably two genera; a genus possibly belonging to the Tarsiidæ; one or two genera of insectivores, and a few bird and lizard

bones. Doubtless other things will come to light as the preparation work advances.

To those familiar with our Eocene mammalian faunas the position of this one as intermediate between the Torrejon and Wasatch<sup>1</sup> is manifest. *Periptychus* has not been found before above the Torrejon and *Phenacodus* has not been found as low as the Torrejon. *Chriacus*, a common Torrejon genus runs through to the Wasatch<sup>2</sup> and the same applies to *Dissacus*. *Coryphodon*, reported by Gidley, is a common Lower Eocene genus, rare in the Clark Fork and absent from the Torrejon. *Nothodectes* has been known only from the type which comes from the Clark Fork. Plagiolacids are more suggestive of the Torrejon but one large form runs through to the base of the Wasatch (Sand Coulee beds). The "*Hemiacodon*" of Gidley's list would, the writer feels, in the presence of more complete material, prove to be something else since *Hemiacodon* is a Middle Eocene (Upper Bridger) genus.

The closest correlation of these beds seems to be with the Clark Fork beds of Wyoming. The predominance of phenacodonts, the presence of *Nothodectes* and the general intermingling of Paleocene and Lower Eocene genera are points of resemblance. The Clark Fork beds immediately underlie the lowest *Eohippus*-bearing levels of the Wasatch in the Bighorn Basin, and these Colorado beds seem to occupy about the same stratigraphic position. Although no fossils have been found in the overlying beds of the Ignacio region, yet the lower beds fauna is certainly older than the lower fossiliferous levels of the Gallina region which contain a typical Wasatch fauna.

This Colorado horizon should be specially designated and the writer suggests the name **Tiffany Beds**, after the station of Tiffany on the Denver and Rio Grande Railway, four miles south of the Mason schoolhouse. Possibly the vertical range of the fauna characterizing these beds is greater than 300 feet but the formation is not cut through to its base at the Mason schoolhouse or at any other points where fossils were found, and the levels above 300 feet, probably because of the precipitous nature of the exposures, have not yielded fossils.

The question arises as to whether these Tiffany beds and the apparently equivalent Clark Fork beds of Wyoming are to be considered as Paleocene or Lower Eocene. Dr. Matthew is inclined, on the basis of fauna only, to consider them as the top of the Paleocene while the writer at present feels

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<sup>1</sup> The term "Wasatch" is here used in the generally accepted palæontological sense, comprising such beds as contain *Eohippus* and its associated forms, which include lemuroids, rodents and artiodactyls.

<sup>2</sup> Found in the Gallina district only.

that they may more consistently be placed as the base of the Lower Eocene. The Tiffany beds have been treated in Gardner's section as a part of a stratigraphic unit referred to the Wasatch and hence are to be considered as Lower Eocene. The writer is not able to differentiate these beds, stratigraphically from the overlying beds, yet the fact remains that the fauna is distinctly more primitive than that which is commonly known as Wasatch and, considering both those forms which are present and those which are conspicuous by absence, it actually resembles the Torrejon more than the Wasatch.

In the Bighorn basin the sequence of Eocene beds is as follows:

Lost Cabin  
Lysite <sup>1</sup>  
Gray Bull  
Sand Coulee  
Clark Fork

No certain stratigraphic unconformity has been detected in this Wyoming series but a big faunal break occurs between the Clark Fork and the Sand Coulee beds. Four modern orders of mammals — Primates, Perissodactyls, Artiodactyls and Rodents — which are absent in the Clark Fork make a sudden appearance as common fossils in the Sand Coulee beds. These four orders <sup>2</sup> are also unrepresented in the Tiffany beds and yet they are common on the lowest fossil levels of the Gallina Wasatch and would also very probably be found in the middle and upper levels of the series in the Ignacio region if the beds there were more advantageously exposed.

It would be easier to explain this sudden advent of entirely new types of mammals if unconformities were found above the Clark Fork and above the Tiffany beds. Sinclair and Granger have noted a probable unconformity <sup>3</sup> on the western side of McCulloch Peak, in the Bighorn, immediately above beds similar in appearance to the typical Clark Fork. In the Clark Fork basin no unconformity has been detected although, because of changes in the fauna, its existence has been suspected. Similarly one might expect a stratigraphic break above the Tiffany beds. Should the existence of such unconformities ever be established this would seem to the writer to be the place to draw the line between the Lower Eocene and the Paleocene.

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<sup>1</sup> The Knight formation of the type locality of the Wasatch appears to be the equivalent of the Lysite or the upper Gray Bull.

<sup>2</sup> The Primates are included on the assumption that *Nothodectes* and a peculiar form suggesting some of the Tarsiidae are not actually referable to this order.

<sup>3</sup> Bull. Amer. Mus. Nat. Hist., Vol. XXXI, Art. V, p. 59, 1912.



Fig. 1. Looking eastward across the Animas Valley at Cedar Hill. The Mesa Mountains, in the background, show exposures of Torrejon at their base.

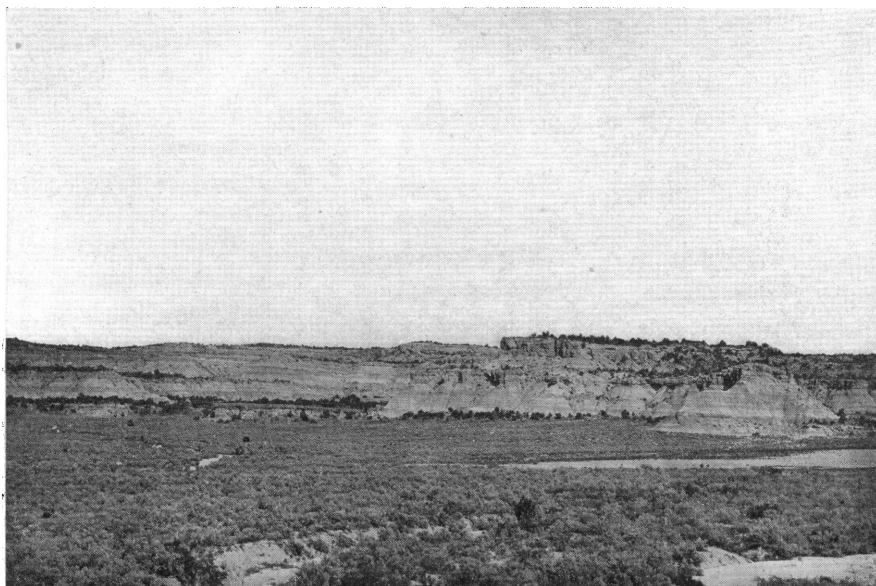


Fig. 2. Torrejon beds at mouth of Leper Cañon, west side of the Animas Valley just below Cedar Hill. The sandstones of the upper levels in the background are probably Wasatch.



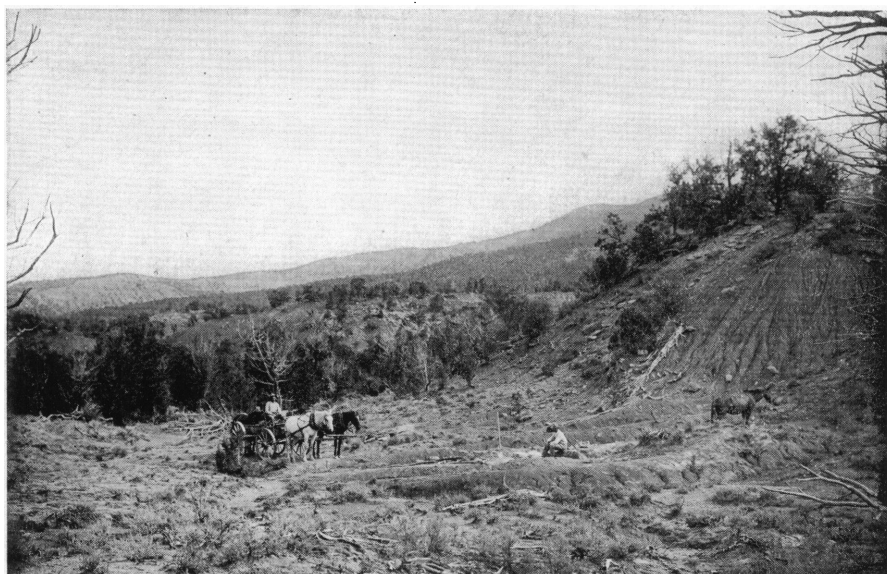


Fig. 1. Small exposure of the Tiffany beds about three-fourths of a mile northeast of the Mason schoolhouse, Sec. 20. T. 33 N., R. 6 W., Colorado, looking northeast. Man is seated on the edge of the excavation from which small mammals were obtained.

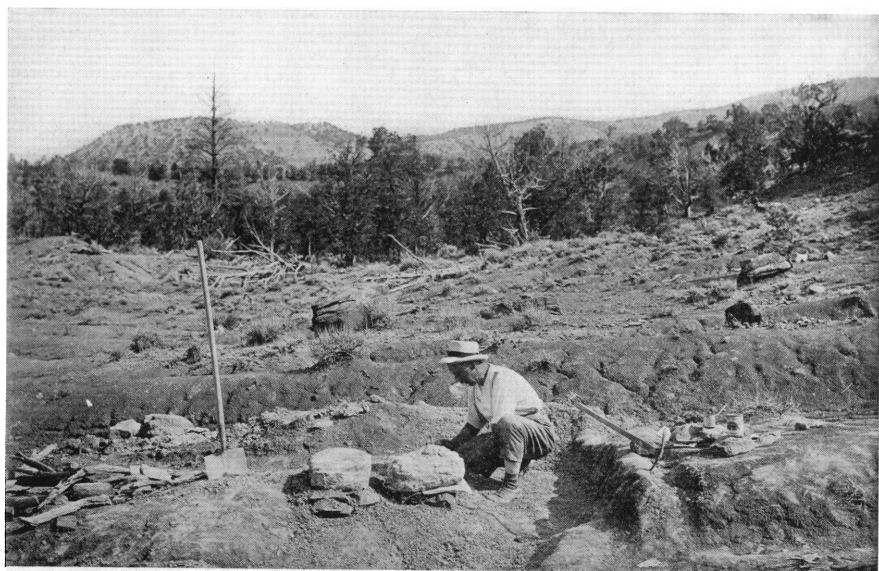


Fig. 2. Closer view of the small mammal quarry shown in Fig. 1, looking directly north. Two of the sections of matrix containing the fossils are shown ready for removal.

