

VIII

Mammalian Fauna from the Titus Canyon Formation, California

CHESTER STOCK

With three plates and four text figures

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INTRODUCTION

In 1935 Stock and Bode called attention to the occurrence near Death Valley, California, of lower Oligocene mammal-bearing deposits designated by them the Titus Canyon formation. Subsequently, Stock (1936) described titanotherium remains from this formation. Study of the remainder of the fauna was delayed because of the war. This investigation has now been completed. As a result the age of the Titus Canyon formation is defined within narrower limits of the lower Tertiary than has been done previously.

I am indebted to Dr. Robert W. Wilson for the study and identification of the rodent material.

TITUS CANYON FORMATION

The sedimentary deposits comprising the Titus Canyon formation represent an almost continuous belt exposed on the eastern flanks of the Grapevine and Funeral Mountains, California, from the vicinity of Grapevine Peak on the northwest to a point a short distance beyond Chloride Cliff on the southeast. Along its length the formation has been subjected to considerable faulting. It takes its name from a typical occurrence in Titus Canyon, near the now deserted mining camp of Leadfield, easternmost Inyo County, California. As shown by the series of columnar sections, reproduced in the original report on the Titus Canyon formation (Stock and Bode, 1935, p. 574), the deposits comprise quartzite conglomerates, sandstones, calcareous mudstones, algal limestone, and tuffaceous sandstones. The formation lies with marked unconformity on Paleozoic sediments. Overlying the Titus Canyon, likewise with discordance, are later Tertiary igneous and sedimentary rocks.

A persistent horizon seen in the measured columnar sections is the algal limestone. Beneath this occur all the localities where fossil vertebrate remains were collected by field parties of the California Institute of Technology. Attention should be directed to the two most important fossil sites, localities 253 and 254, because from them has come practically all the identifiable mammalian material.

AGE RELATIONS OF FAUNA

Mammalian remains are, on the whole, poorly preserved in the Titus Canyon formation. Even the large and solidly constructed skull of *Protitanops curryi*, described in a previous paper (Stock, 1936, pp. 656-661), shows in its distortion the result of earth movements that have affected the enclosing sediments, in this instance a maroon-colored calcareous mudstone. With the titanotherium skull was

associated some skeletal material representing the same individual. This likewise is imperfectly preserved. The remainder of the fauna is composed of incomplete or fragmentary parts, mostly of the skulls, lower jaws, and dentitions. For this reason it is not always possible to reach definite generic or specific identifications. The problem of adequate determination is also made difficult by the fact that the comparative material from related earlier geologic horizons is in a similar state of incompleteness. Study of the entire assemblage, however, does delineate more clearly than heretofore the relations of the fauna, and offers therefore an opportunity to reach a closer approximation of its age.

Following is a list of the mammals identified from the fossil collections obtained in the Titus Canyon formation:

Paramyine(?) sp.	Colodon sp.
Aplodontoid, spp. indet.	Eotrigonias(?) mortivallis, n. sp.
Canid sp.	Agriochoerus transmontanus, n. sp.
Meshippus, small sp.	Poabromylus(?) robustus, n. sp.
Protitanops curryi Stock	Leptomeryx blacki, n. sp.
Menodontine? titanothera	

A review of this assemblage clearly indicates relationship to that of the White River on the one hand and to that of the Duchesne on the other. *Colodon* and *Agriochoerus* supply a link with faunas from the White River. The paramyine (?) rodent, *Eotrigonias* (?), and *Poabromylus* (?) point to a relationship with the faunas from the Eocene. Characters more primitive than those of comparable forms in the White River are shown by *Protitanops*, *Leptomeryx*, and *Agriochoerus*. It is interesting to note that those forms tentatively ascribed to Eocene genera show definite progressive advance beyond these types. Unfortunately, the specimens referred to aplodontoid rodents and to a carnivore are too imperfectly known to be of significance. If the Duchesne is considered uppermost Eocene in age, and the Chadronian is lower Oligocene, the fauna from the Titus Canyon formation may be conveniently assigned to the basal Oligocene.

DESCRIPTION OF FAUNA

RODENTIA

The rodents are represented by scant and poorly preserved material. At least three types are to be recorded. Dr. R. W. Wilson has kindly examined this material and makes the following determinations and comments:

Paramyine(?) sp.

(Plate 1, figures 3, 3a)

The presence of a large species of rodent is indicated by a fragmentary left ramus with incomplete M_2 , C.I.T. no. 2035. The incomplete preservation of the specimen and lack of comparative material prevent a definite determination of the fossil. This specimen represents apparently a derivative of the *Leptomys* group of the paramyines or a new generic type.

The principal characters presented by no. 2035 are: (1) anterior margin of masseteric fossa apparently under anterior border of M_2 or posterior border of M_1 ; (2) incisor compressed, anterior face convex; (3) basin of M_2 reduced by somewhat internal position of mesoconid, and deep wrinkling of enamel floor of basin; (4) entoconid prominent; (5) molars apparently more compressed transversely than in *Ischyrotomus eugenei* Burke (1935, pp. 5-7, fig. 1); and (6) size large, approaching *I. eugenei*, but smaller than comparable material of the type of *Manitsha tanka* Simpson (1941) from the lower Brule.

Measurements (in millimeters) of C.I.T. no. 2035

M_2 , anteroposterior diameter.....	7.8
M_2 , transverse diameter (approximate).....	7.0
Depth of ramus beneath M_1	18.5

Aplodontoid, spp. indet.

A badly preserved skull without dentition except for right incisor and one heavily worn cheek tooth, C.I.T. no. 3554, is that of an unknown aplodontoid much smaller than no. 2035. The grinder lacks any pattern, and the specimen is indeterminate. It may possibly, however, represent some kind of cylindrodontine.

In addition to the above, a third rodent, larger than no. 3554 but still much smaller than no. 2035, is apparently represented by a poorly preserved maxillary tooth row, C.I.T. no. 3555. The dental pattern is basically paramyine in structure, but is not shown clearly enough for unequivocal reference to the Paramyinae.

All three rodent species from the Titus Canyon formation apparently are aplodontoids in the larger meaning of the term (i.e., equivalent to Protrogomorpha or primitive Sciuromorpha), but only no. 2035 warrants a more accurate determination.

CARNIVORA

Canid sp.

(Plate 1, figures 1, 1a)

A small portion of a left ramus of a mandible with fragment of crown in M_2 , C.I.T. no. 3568, represents a slender-jawed canid. This specimen was collected at locality 254. The jaw is deeper than that in *Pseudocynodictis paterculus* (A.M.N.H. no. 9616-8) from the *Titanotherium* beds of Pipestone Springs, Montana, which is relatively as slender. *Pseudocynodictis temnodon* may have had a jaw comparable in depth. In no. 3568 the heel region in M_2 is large, but perhaps no more so than in *Pseudocynodictis*. The length of the heel is approximately equivalent to the antero-posterior diameter of the trigonid part of the tooth. The heel has a flat basin with the inner border forming a low rim which, however, may have been better developed than in *Pseudocynodictis*. The outer border was evidently higher, although it is not preserved in the California specimen. Small portions of the paraconid and metaconid are preserved, and a cingulum is present in front of the paraconid ridge. Although broken away to some extent, the paraconid appears to be higher in the Titus Canyon specimen than in *Pseudocynodictis*. An alveolus, oval in cross section, is situated behind M_2 , indicating that the third molar was reduced in size, and single-rooted, or at least with coalesced anterior and posterior roots.

The second lower molar is longer and narrower, the heel considerably longer than

in specimen M.C.Z. no. 2094, referred to the Miacidae and described by Schlaikjer (1935, pp. 77-78, fig. 3) as part of the type of *Miacis matthewi*. The latter comes from the Yoder formation, Goshen County, Wyoming, which is regarded by Schlaikjer as of basal Oligocene age.

Measurements (in millimeters) of C.I.T. no. 3568

M ₂ , length.....	7.1
M ₂ , length of heel.....	3.3
Depth of ramus behind M ₂	14.8
Thickness of ramus below M ₂	5.5

PERISSODACTYLA

Equidae

Mesohippus, small sp.

(Plate 2, figures 1, 1a, 3)

Horse material from the Titus Canyon formation is rare, the best-preserved specimens being a last lower molar and a calcaneum. The fossils represent the earliest stage in the evolutionary history of the Equidae thus far known from the region west of the Rocky Mountains. The individual is distinctly more primitive than the *Miohippus* types known from the John Day and from the Las Posas Hills Sespe.

Both the lower molar, no. 3562 (pl. 2, figs. 1, 1a) and the calcaneum, no. 3563 (pl. 2, fig. 3) represent a horse intermediate in size between *Epihippus* of the Uinta and *Mesohippus bairdii* of the White River. On the basis of the lower tooth, the size closely approaches that of *Epihippus (Duchesnehippus) intermedius*, described by Peterson (1931, pp. 66-68, fig. 4) from the Duchesne River beds, Utah. Unfortunately for our comparisons, Peterson's specimen lacks M₃, but the cheek-tooth series, P₂-M₂, is otherwise complete. In C.I.T. no. 3562 the height of crown is slightly greater than in Carnegie Mus. no. 11845 from the Duchesne River beds, but the difference is negligible. Though an anterior cingulum is present, this ledge is not continued on the outer base of the protoconid. The tip of the metaconid displays only a slight tendency to be bifid. In the illustration of *Epihippus intermedius* the lower teeth are shown to have both metaconid and metastylid. As a matter of fact, a metastylid is present also in the Bridger *Orohippus*, as pointed out to the writer by Dr. C. L. Gazin. The crown in the tooth from the Titus Canyon has undergone wear, as is shown by the enamel surface along the posterior side of the inner pillar.

Several lower teeth of a small species of *Mesohippus* from the Oligocene of Pipestone Springs, Montana, are available in the collections of the U. S. National Museum. M₃ from the Titus Canyon is slightly smaller than comparable teeth in the collection of the U. S. National Museum from the Montana locality, and the posterior lobe in no. 3562 is proportionately wider. Likewise, the crown of the tooth in no. 3562 is a trifle higher than in specimens from Pipestone Springs. The tooth from the Titus Canyon and those in the U. S. National Museum do not show a metastylid, whereas an incipient development of this cusp is seen in the paratype of *Mesohippus bairdii*. In the latter the heel in M₃ is directed inward more than in either the Titus Canyon specimen or U.S.N.M. no. 17838. This is shown by the greater angle which the lobe makes with the middle lobe in the latter two individuals than in *bairdii*.

Though the calcaneum is larger than the comparable tarsal element in *Epihippus*, it is definitely smaller than any calcaneum of *Mesohippus* available for comparison.

Comparative measurements (in millimeters)

	C.I.T. no. 3562	U.S.N.M. no. 17838	U.S.N.M. no. 17839	<i>M. bairdii</i> (paratype) U.S.N.M. no. 8632
M ₃ , anteroposterior diameter.....	13.2	14.2	13.5	15.2
M ₃ , greatest width, anterior lobe.....	6.6	6.7	6.7	8.2
M ₃ , width of heel.....	3.9	3.3	3.5	4.1
Calcaneum, C.I.T. no. 3563, greatest length 42.8; greatest width 16.1				

Brontotheriidae

Previously described by Stock (1936) from the Titus Canyon are two types of titanotheres. A restatement of their characters is as follows:

Protitanops curryi Stock

Type specimen. Skull and jaws, no. 1854, Calif. Inst. Tech. Vert. Pale. Coll.

Locality. Calif. Inst. Tech. Vert. Pale. Loc. 253. Lower red beds of Titus Canyon formation in canyon east of Thimble Peak, Grapevine Mountains, California.

Generic and specific characters. Upper incisors 2; teeth small, crowns oval and noncingulate. Canines less robust than in *Brontops*. Small diastema between canine and P¹. Premolars with well developed internal cingula, but no external cingula. Nasals long and broad. Horns larger than in *Protitanotherium*, oval in cross section, but with transverse diameter greater in relation to fore-and-aft diameter than in Uinta genus. Horns directed outward as well as upward. Dorsal surface of cranium narrow. Size large, intermediate between that of *Protitanotherium emarginatum* and that of *Brontops robustus*. This species is named for H. Donald Curry, discoverer of the first titanotheres in the lower Tertiary of the Grapevine Mountains.

Menodontine? titanotheres

A poorly preserved facial portion of a skull, C.I.T. no. 2007, from C.I.T. Loc. 255, represents a titanotheres which is apparently distinct from *Protitanops curryi*. This specimen occurred in the lower red beds of the Titus Canyon formation, exposed in the west fork of Titus Canyon, Grapevine Mountains, California. Its stratigraphic position is therefore similar to that of *Protitanops curryi*.

This specimen is smaller than the type of *P. curryi*. At least one molar crown is fairly well preserved. The transverse diameter of the crown, in relation to the anteroposterior diameter, is less in this tooth than in the comparable tooth of *Protitanops*. A faint external cingulum can be discerned on the molars. The premolars (P²-P⁴) are distinctly larger than the comparable teeth in *Protitanops*. As in the latter, the teeth have strong internal cingula, but they likewise have very faint external cingula. In P² a low crest marks the position of the deuterocone and tetracoccone. The two inner cusps are distinct in P³ and P⁴. In these teeth the deuterocone is situated well back of the anterior border of the tooth, leaving a distinct shelf in front. The external surfaces of the two outer cusps in P² and P³ are convex and ribbed.

Little is left of the horns, but they appear to have a round or rudely triangular cross section.

Relationship of no. 2007 to the menodontine titanotheres among the White River Brontotheriidae is suggested particularly by the elongate molars and to some extent also by the basal cross section of the horn.

Helaletidae

Colodon sp.

(Plate 2, figures 4, 4a)

Fossil tapir remains are poorly preserved, and are represented principally by C.I.T. no. 3567, a fragment of the right ramus of a mandible with molar teeth. This specimen was found at C.I.T. Loc. 255 in the lower red beds of the Titus Canyon formation, exposed in the west fork of Titus Canyon, Grapevine Mountains, California. Unfortunately, crowns of the cheek teeth are damaged and only small parts of the enamel surface remain.

Comparisons. In no. 3567 the molars are smaller than the comparable teeth in the paratype of *Colodon dakotensis*, A.M.N.H. no. 1213, from the *Metamynodon* beds of the White River. They are, however, larger than the molar teeth in A.M.N.H. no. 658, referred to *C. occidentalis*. In the reduced character of the heel, no. 3567 differs from the Uinta genus *Isectolophus* and resembles members of the Helaletidae. The size of the heel in M_3 is variable in *Colodon*, as judged from 3 specimens in the American Museum collections (nos. 658, 1213, and 9779). In no. 658 the heel consists of a single tubercle having a median position on the posterior border. In no. 9779 the heel is not so prominent as in no. 658, but is wider transversely. In no. 1213 of *Colodon dakotensis* the heel in M_3 has a distinctly more posterior projection than in the previously mentioned specimens.

Comparative measurements (in millimeters)

	<i>Colodon</i> sp., C.I.T. no. 3567	<i>C.</i> <i>dakotensis</i> , paratype, A.M.N.H. no. 1213	<i>C.</i> <i>occidentalis</i> , A.M.N.H. no. 658	<i>Colodon</i> sp., A.M.N.H. no. 9779	<i>C.</i> <i>occidentalis</i> , P.U. no. 13595
Length along middle line anterior end of M_1 to posterior end of M_3	50.4	....	47.7*	46.6	48.8
Length along middle line anterior end of M_2 to posterior end of M_3	36.9	44.7	34.8*	34.3	35.5
M_1 , anteroposterior diameter through middle.....	13.0	....	12.8	12.3	12.9
M_2 , anteroposterior diameter through middle.....	14.8	20.1	15.0	14.7	15.0
M_3 , anteroposterior diameter through middle.....	21.1	24.3	19†	19.3	20.5
M_3 , transverse width across posterior lobe.....	12.2	13.6	12.1	12.3	12.9
M_3 , length of heel.....	4.0	4.5	3.8	2.9	3.7

* M_3 not completely erupted.

†Approximate.

In the specimen from the Titus Canyon formation, the heel has a backward extent nearly, if not entirely, equal to that in A.M.N.H. no. 1213. Its outer posterior margin has been broken away. The enamel of the heel is worn into two distinct facets,

separated by a furrow, and these facets tend to emphasize the division of the wearing surface into two parts. The heel in no. 3567 appears, therefore, to be broader than in comparable teeth of White River species, and to this extent may indicate that the former type is more primitive than the latter. The depth of the jaw agrees with that in A.M.N.H. no. 9779. The Titus Canyon specimen is more massive than Princeton Univ. Coll. no. 13595, identified as *C. occidentalis* and from the *Titanotherium* beds of South Dakota. No. 3567 is, however, shallower than no. 13595.

Rhinocerotidae

The rhinoceros material from the Titus Canyon formation was originally regarded as representing the Hyracodontidae. A further acquaintance with the material makes it obvious that the specimens do not represent hyracodonts, but belong to an early member of the true rhinoceroses. This evidently represents a new type, which may be designated as follows:

Eotrigonias(?) *mortivallis*, n. sp.

(Plate 2, figures 2, 2a; text figures 1-4)

Type specimen. Fragment of left ramus, no. 3564, Calif. Inst. Tech. Vert. Pale. Coll.

Cotype. Metatarsal II and metatarsal IV, no. 3565, Calif. Inst. Tech. Vert. Pale. Coll.

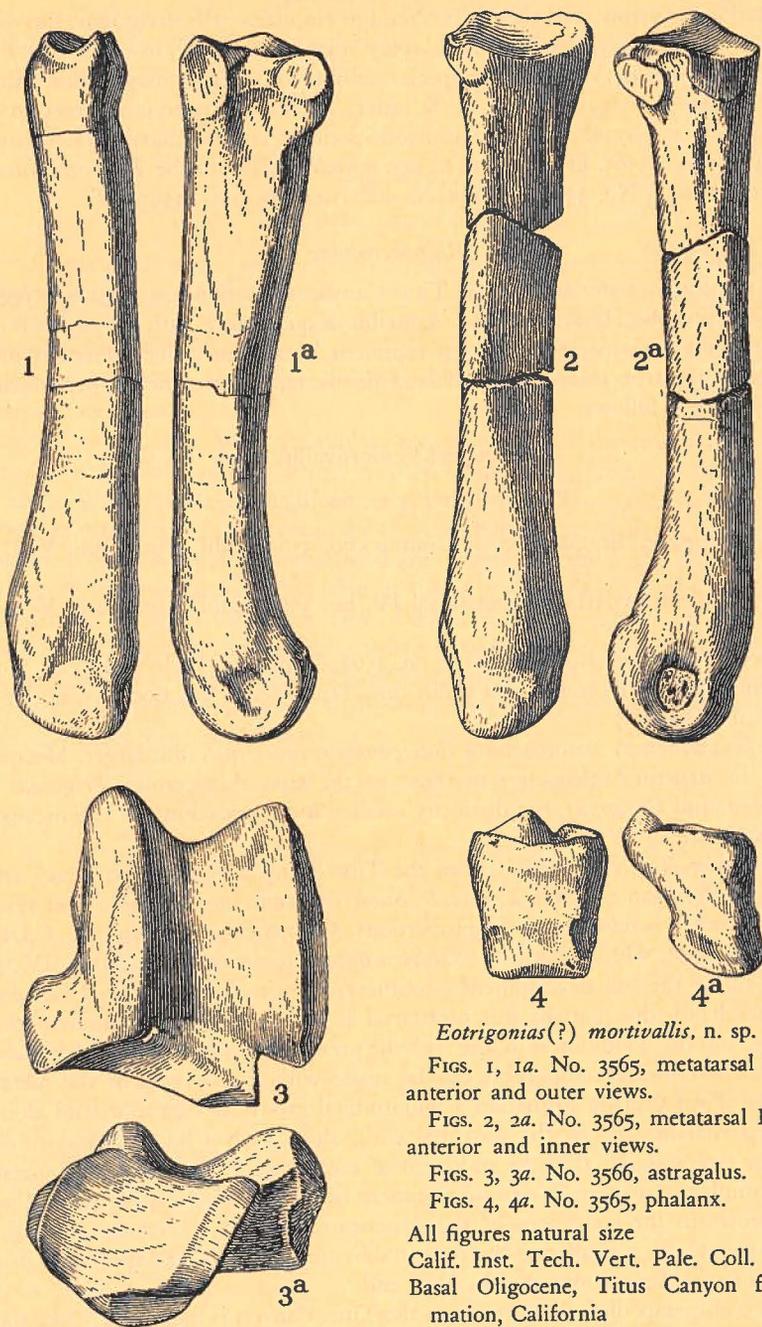
Referred specimen. Left astragalus, no. 3566, Calif. Inst. Tech. Vert. Pale. Coll.

All these specimens come from Calif. Inst. Tech. Vert. Pale. Loc. 254, in the Titus Canyon formation.

Specific characters. Approaching *Eotrigonias rhinocerinus*, but larger. Metapodials similar in structural characters to those of the true rhinoceroses *Trigonias*, *Subhyracodon*, and *Caenopus*, but distinctly smaller and approaching in size metapodials of *Hyrachyus*.

Description. The metapodials from the Titus Canyon (figs. 1, 1a, 2, 2a) are distinctly smaller than those of *Trigonias*, *Subhyracodon*, and *Caenopus*, but resemble those of *Subhyracodon* in their proportions. Comparing, for example, C.I.T. no. 3565 with A.M.N.H. no. 536 of *Subhyracodon occidentalis*, metatarsal IV in the former shows the full development (stoutness) seen in the latter. In *Hyracodon*, on the other hand, the shaft of this metatarsal is more compressed (thinner) than in no. 3565, and this condition is in line with the presumed cursorial habits of *Hyracodon*. A somewhat similar comparison can be made with *Hyrachyus*. In the metatarsal from the Titus Canyon formation a longitudinal groove is seen to extend along the anteroexternal face below the proximal end, which with a linear concavity on the posterior face suggests that the rudiment of metatarsal V has fused with metatarsal IV. A similar suggestion is seen in specimens of metatarsal IV of the true Oligocene rhinoceroses in the collections of the American Museum of Natural History. The second metatarsal is similar to the comparable metapodial in *Subhyracodon* in structure and in the flaring inward of its distal end.

In size of metapodials the form from the Titus Canyon is more nearly like some of the species of *Hyrachyus* than like species of the true rhinoceroses. In detail, however, the metapodials show more similarity to the latter than to the former. For example, in metatarsal IV of *Hyrachyus*, A.M.N.H. no. 12674 from the Bridger, the outward flare of the distal half is similar to that in the Titus Canyon specimen, but the element



Eotrigonias(?) mortivallis, n. sp.

FIGS. 1, 1a. No. 3565, metatarsal II, anterior and outer views.

FIGS. 2, 2a. No. 3565, metatarsal IV, anterior and inner views.

FIGS. 3, 3a. No. 3566, astragalus.

FIGS. 4, 4a. No. 3565, phalanx.

All figures natural size

Calif. Inst. Tech. Vert. Pale. Coll.

Basal Oligocene, Titus Canyon formation, California

is longer and its shaft is more compressed. This is especially noticeable in the upper half of the element. The same characteristic differences are seen in metatarsal II of no. 12674 as compared with the Titus Canyon specimen.

The astragalus (figs. 3, 3a), though also distinctly smaller, likewise shows considerable resemblance to that of the true rhinoceroses. In comparison with the astragalus of *S. occidentalis*, the distal surface for the navicular in no. 3566 is deeper dorsoventrally, but otherwise there is considerable resemblance between the specimen from the Titus Canyon and the astragalus of *S. occidentalis*. No long neck is present in the astragalus, in which both the Titus Canyon form and *Subhyracodon* differ from *Hyrachyus* and *Hyracodon*. There is likewise no lip on the outer side of the outer convexity of the trochlea.

The only basis of comparison between the Titus Canyon individual and *Eotrigonias* is that furnished by the lower dentition, more specifically the lower molars of *E. rhinocerinus*, figured by Wood (1927, pl. 4, fig. 19). Wood states that these teeth are similar to those of the Oligocene true rhinoceroses. He likewise points out that the posterior cingulum in M_3 is reduced to very small proportions. The lower teeth in the Titus Canyon specimen correspond in size to those of *Eotrigonias*. M_2 , the only tooth completely preserved, lacks the external cingulum. M_3 likewise seems to be without an external cingulum. Unfortunately, the last molar has not been entirely erupted, and the posterior part of the tooth is not preserved.

It becomes apparent that the Titus Canyon material represents a true rhinoceros, distinctly smaller than the typical *Trigonias*, *Subhyracodon*, and *Caenopus*. The nearest approach in size is evidently to *Eotrigonias* Wood. Wood has described two species of this genus, namely, the genoholotype, *E. rhinocerinus* from the Uinta Basin, and *E. petersoni* from the "middle" Washakie, Wyoming. When better known, the rhinoceros from the Titus Canyon may come to be regarded as generically distinct from *Eotrigonias*. It represents an interesting connecting link between the true rhinoceroses of the upper Eocene and those of the lower Oligocene.

Measurements (in millimeters) of Eotrigonias(?) mortivallis

Fragment of ramus, C.I.T. no. 3564:

M_2 , length at occlusal surface.....	15.1
M_2 , greatest width.....	11.8
Depth of jaw at posterior end of M_2	32.0
Width of jaw opposite anterior half of M_3	17.6

Astragalus, C.I.T. no. 3566:

Greatest length.....	40.2
Width.....	40.0

Metatarsal II, C.I.T. no. 3565:

Length.....	95.2
Anteroposterior diameter of proximal end.....	20.4
Transverse diameter of proximal end.....	12.3
Greatest width of distal end of shaft.....	17.8

Metatarsal IV, C.I.T. no. 3565:

Length.....	93.0
Anteroposterior diameter of proximal end.....	18.5
Transverse diameter of proximal end.....	19.0
Transverse diameter of distal end.....	16.6

ARTIODACTYLA

Agriochoceridae

Several individuals of *Agriochocerus* occur in the collection from the Titus Canyon formation, giving the impression that the genus was more abundantly represented

than any other kind of mammal found fossil in these deposits. A single species is represented by the material, which is designated as follows:

Agriochœrus transmontanus, n. sp.

(Plate 3)

Type specimen. Part of right maxillary with P²-M¹, no. 3558, Calif. Inst. Tech. Vert. Pale. Coll.

Paratype. Fragment of left maxillary with P⁴-M², no. 3556, Calif. Inst. Tech. Vert. Pale. Coll.

Locality. Calif. Inst. Tech. Vert. Pale. Loc. 254. Titus Canyon formation.

Specific characters. Size slightly larger than *Agriochœrus minimus* Douglass, no. 709 Carnegie Mus. Coll. from the lower Oligocene of Montana. No cuspule present on posterior side of P⁴ in back of principal internal cusp and lingual to metacone. Molars broader in anteroposterior diameter than in no. 709.

Description. This is a small species of *Agriochœrus*, resembling *A. minimus* in size, but slightly larger. Like the latter, the species from the Titus Canyon is considerably smaller than species of *Agriochœrus* from the Brule and from the John Day. In the presence of two distinct cusps on the outer side of the tooth crown in P⁴, the type is definitely more advanced than *Mesagriochœrus* and is like *Agriochœrus*. In all specimens of *Agriochœrus* that were available for examination, including that of *A. minimus*, P⁴ shows a well developed cuspule in back of the principal internal cusp. In all the specimens of *A. transmontanus*, the internal cusp is large, and trihedral in shape, with a flat external face. The ridge formed by the intersection of the external face with the posterior face of the principal internal cusp extends to the posterior cingulum. Here the latter is slightly expanded; this expansion of the basal ledge shows to best advantage in a third specimen available, C.I.T. no. 3557, but still falls far short of forming a distinct cuspule as in *A. minimus*. Although not perfectly preserved, the upper molars appear to have individually an anteroposterior diameter greater in relation to transverse measurement of tooth crown in *A. transmontanus* than in *A. minimus*. Protoconules are present in the molar teeth. An imperfect part of a skull, C.I.T. no. 3572, is illustrated on plate 3, figures 3, 3a. Referred also to *A. transmontanus* is a mandibular fragment with the remains of the three molars, C.I.T. no. 3559. In this specimen the length of the lower teeth, anterior end of M₁ to posterior end of M₃, is approximately 37.4 mm.

Measurements (in millimeters) of upper teeth of A. transmontanus

	Type specimen, C.I.T. no. 3558	Paratype, C.I.T. no. 3556
Length, anterior end of P ² to posterior end of M ¹	37.4	....
Length, anterior end of P ⁴ to posterior end of M ².....	....	26.3
P ² , anteroposterior diameter.....	9.0	....
P ² , transverse diameter.....	4.0	....
P ³ , anteroposterior diameter.....	9.0	....
P ³ , transverse diameter.....	7.0	....
P ⁴ , anteroposterior diameter.....	9.6	....
P ⁴ , transverse diameter (approximate).....	10.7	....
M ¹ , anteroposterior diameter through middle (approximate) ..	10.0	....

*Hypertragulidae**Poabromylus*(?) *robustus*, n. sp.

(Plate 1, figures 4, 4a)

One of the unexpected relationships to be established as a result of comparison of the mammals from the Titus Canyon formation with those from the Duchesne is that indicated by an artiodactyl jaw tentatively referred to *Poabromylus*. The type of the genus (*Poabromylus kayi*) was described by Peterson (1931, pp. 75-78, fig. 12) from the upper beds of the Duchesne (Lapoint substage) in the Uinta Basin, Utah. *Poabromylus* was later discussed and refigured by Scott (1945, pp. 227-228, pl. 1, figs. 4, 4a). The genotypic specimen, no. 11753 Carnegie Mus. Coll., is an incomplete left ramus of the mandible with P_3 - M_3 . By a curious coincidence, essentially the same kind of material represents the new specific type from the Titus Canyon, except that in the latter the crown of M_1 is missing, and a part of the crown of P_2 is present.

Type specimen. Part of left ramus with P_2 - M_1 , no. 3569, Calif. Inst. Tech. Vert. Pale. Coll.

Locality. Calif. Inst. Tech. Vert. Pale. Loc. 254. Titus Canyon formation.

Specific characters. Larger and more robust than type of *P. kayi*. Structure of crown in P_4 similar to that in the Duchesne species, but front half of tooth noticeably thicker transversely and tapering toward forward end more abruptly than in the latter. Posteroexternal corner of tooth strongly defined by a buttress or wrinkle of the enamel. Immediately in front of this the outer enamel surface is depressed, this depressed area being situated at the posteroexternal base of the principal cusp.

Description. Aside from larger size and distinctive differences noted for the fourth premolar, considerable resemblance prevails between no. 3569 and no. 11753 from the Duchesne. The curvature of the jaws is similar. No evidence exists in either specimen of the presence of a tooth immediately, or for a distance of at least 5 mm., in front of P_2 . On the crown of P_3 in both species the outer crest which extends backward from the principal cusp swings inward along the posterior margin of the tooth but does not reach the inner side of the tooth. From the principal cusp extends also a much shorter inner crest or spur that outlines with the outer posterior crest a valley whose broad exit is at the posterointernal corner of the tooth. The inner face of the principal cusp in P_3 extends beyond that of the inner posterior spur, and is therefore separated from the latter by a groove more clearly evident in no. 3569 than in no. 11753.

The molars are likewise similar in the two specimens, although the enamel surfaces of these teeth (and of the premolars as well) are more markedly crinkled in the material from the Titus Canyon. No basal ledge occurs between the outer anterior and posterior crescents in M_2 in no. 3569 as in no. 11753. The posterior lobe of M_3 is remarkably similar in the two forms. The enamel loop is not completed on the inner side of the tooth where the lobe connects with the inner posterior crescent. Instead, in each instance, the enamel is bent into the crown of the tooth and toward the outer side.

As was indicated before, the greatest contrast in the dentition between the type from the Titus Canyon and that from the Duchesne is in P_4 , although fundamental resemblance remains. Thus, extending inward from the principal cusp is a crest which curves forward. The crest in no. 3569, however, is far more prominent than that in no. 11753, and because of this it outlines, with the inner face of the principal cusp, a

much more pronounced pocket or groove on the inner face of the tooth. Unfortunately, the anterior end of P_4 is not preserved, but it is evident that the tooth did not taper to the anterior end so gradually in no. 3569 as in no. 11753. The structure of the heel in P_4 is essentially the same in both species, except for the modifications of the outer posterior enamel surface already noted under the specific characters of *Poabromylus*(?) *robustus*. A notch occurs between the crest on the posterior margin of the tooth and the crest on the inner side of the heel in no. 3569. Into the deep basin of the heel extends a short spur from the posterior side of the crest that projects to the inner side of the tooth from the principal cusp.

The crown of P_2 in no. 3569 is not completely preserved, but enough remains to indicate that the inner posterior crest extending backward from the principal cusp is shorter than that in P_3 . Consequently, the valley outlined by this crest and the outer posterior crest is much smaller in P_2 than in P_3 .

A mental foramen is present approximately below the middle of P_2 .

Measurements (in millimeters) of C.I.T. no. 3569

Depth of lower jaw (normal to inferior border) between P_2 and P_4	11.9
Thickness of lower jaw below M_2	11.0
Length, anterior end of P_2 to posterior end of M_3	59.5
P_2 , length (approximate).....	6.0
P_3 , length.....	8.2
P_3 , width.....	3.3
P_4 , length (approximate).....	8.4
P_4 , width across principal cusp.....	4.7
P_4 , width along posterior margin of heel.....	5.0
M_2 , length.....	11.3
M_2 , width.....	8.0
M_3 , greatest length.....	16.2
M_3 , greatest width.....	9.1

Relationships. It becomes clearly evident from the comparisons that the species from the Titus Canyon is closely related to *Poabromylus kayi*, but is a larger and more progressive type. It appears reasonable to assume that were these forms known by complete materials, a sufficient number of characters would be found to separate the two generically.

Peterson referred *Poabromylus* to the Camelidae. This author stated that the genus was distinctly more advanced than *Eotylopus reedi* from the lower Oligocene, and that it could not be regarded as having a position intermediate between *Protylopus* and *Poebrotherium*. Peterson stated furthermore that "from present evidence *Poabromylus* certainly stands closer to *Poebrotherium* than to *Protylopus*." There appears to be no particular resemblance between *P.*(?) *robustus* and the true camels of the lower Oligocene. On the other hand, this species seems to show closer resemblance to the leptotragulines. To be sure, in *Leptotragulus* P_4 does not have the construction of crown seen in *Poabromylus*, and this is evident also in *Leptotragulus perfectus* from Pipestone Springs, Montana. P_2 and P_3 in no. 3569 from the Titus Canyon are somewhat similar to comparable teeth in *Leptotragulus*. There may likewise be similarity between the two forms in the construction of the last molar. In contrast with the early descriptions of the leptotragulines by Scott and Osborn, and Matthew, who referred these forms to the Camelidae, the group is now placed by Simpson (1945, p. 151) with the Archaeomerycinae under the Hypertragulidae.

Leptomeryx blacki, n. sp.

(Plate 1, figures 2, 2a)

Type specimen. Fragmentary ramus with molar teeth, no. 3560, Calif. Inst. Tech. Vert. Pale. Coll.

Paratype. Fragment of ramus with molars and P_4 , no. 3561, Calif. Inst. Tech. Vert. Pale. Coll.

Locality. Calif. Inst. Tech. Vert. Pale. Loc. 254. Titus Canyon formation, lower red beds exposed in west fork of Titus Canyon, Grapevine Mountains, California.

Specific characters. Smaller than known species of *Leptomeryx* and slightly larger than *Leptomeryx? minutus*. No diastema between P_1 and P_2 . Species named for Mr. Harold A. Black.

Description. This little artiodactyl is known principally by two ramal fragments. Both the type specimen and the paratype represent animals distinctly smaller than *Leptomeryx evansi*. *Leptomeryx? minutus* described by Peterson from the Duchesne River basal Oligocene is a still smaller form. Nos. 3560, 3561 are smaller than *L. yoderi* Schlaikjer. A notable feature in no. 3561 from the Titus Canyon formation is the absence of a diastema between the alveolus for P_1 and that for P_2 . In all specimens of *Leptomeryx* examined, a diastema is present between the first two lower premolars. It would appear from the size of the alveolus that P_1 in the present species was a larger tooth than in the species described from the White River and Pipestone Springs. As in *Leptomeryx*, the anterior mental foramen lies below the socket for P_1 .

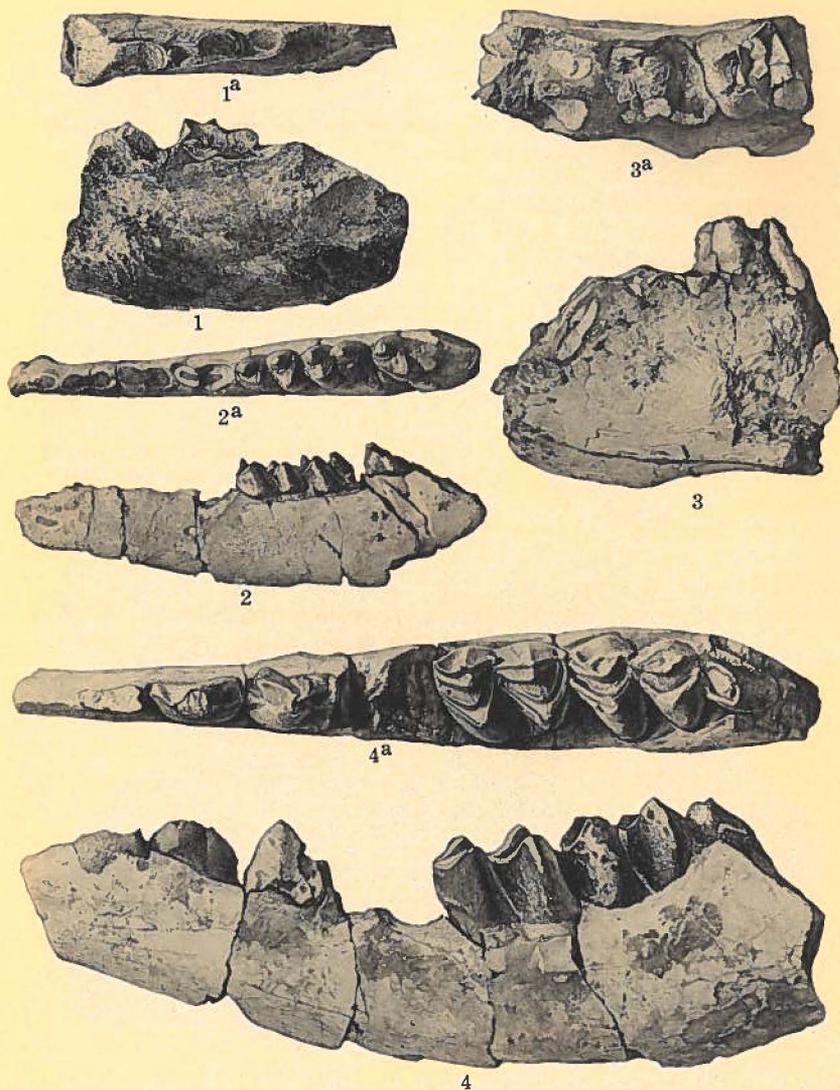
The cheek teeth are smaller than in known species of *Leptomeryx*, and the surface of the enamel in individual teeth is not so crinkled. The pattern of the occlusal surface of P_4 in no. 3561 resembles that seen in *Leptomeryx*. The tooth has a shorter crown and the anterior style is trihedral in shape and low. The crest extending backward from the principal cusp carries a short spur which projects backward and into the posterior basin. Several specimens of *Leptomeryx evansi* in the collections of the U. S. National Museum from the Chadron show the spur in P_4 . P_4 in no. 3561 differs from the comparable tooth in the *Leptomeryx? minutus* described by Peterson (1934, p. 386, fig. 6) from the Duchesne River beds, in the possession of characters seen in typical *Leptomeryx*. According to Peterson's description and figure, the principal cusp and adjacent inner cusp in P_4 are separate, not connected by a cross-crest as in the White River, Pipestone Springs, or Titus Canyon specimens. It is doubtful whether Peterson's specimen belongs to the genus *Leptomeryx*.

Measurements (in millimeters) of Leptomeryx blacki

	Type specimen, C.I.T. no. 3560	Paratype, C.I.T. no. 3561
Depth of ramus at posterior end of P_1 alveolus.....	5.5	...
Depth of ramus at posterior end of M_1	7.9	...
Thickness of ramus below M_1	4.2	...
M_1 , anteroposterior diameter.....	5.4	4.9
M_1 , transverse diameter.....	3.7	3.5
P_4 , anteroposterior diameter.....	...	5.0
P_4 , transverse diameter.....	...	2.4

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FIGS. 1, 1a. Canid sp. Fragment of mandible with M2, no. 3568, lateral and dorsal views.

FIGS. 2, 2a. *Leptomeryx blacki*, n. sp. Type specimen, left ramus of mandible with molar teeth, no. 3560, lateral and occlusal views.

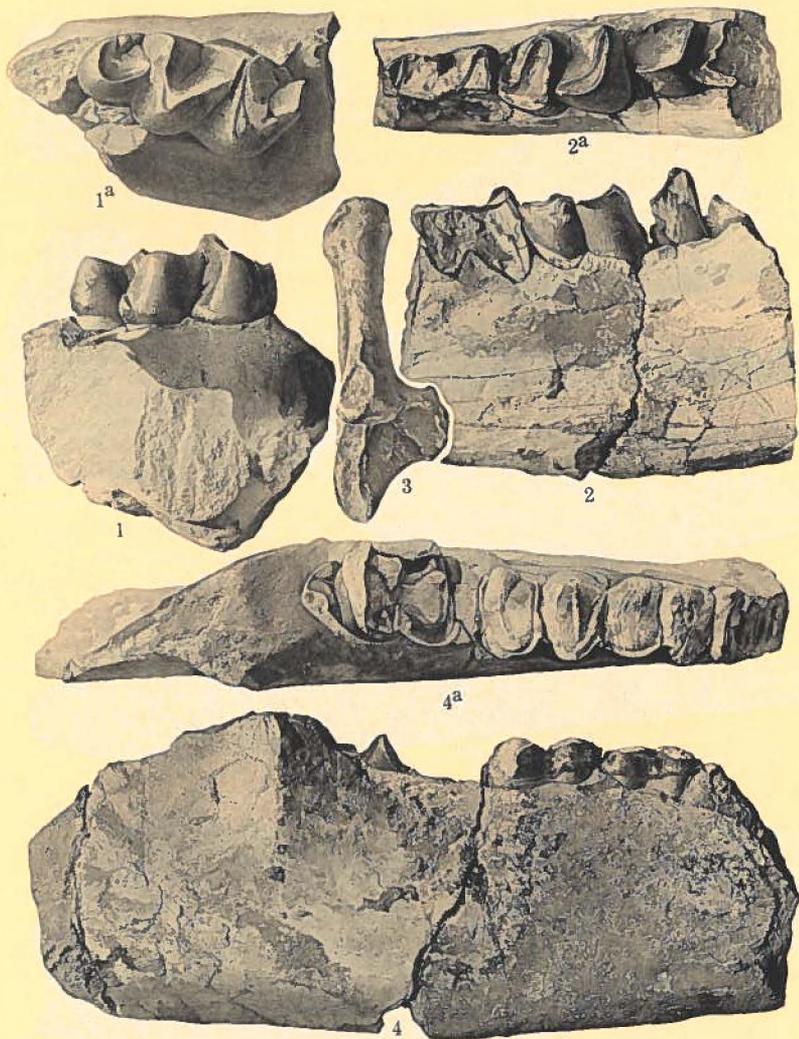
FIGS. 3, 3a. *Paramyine*(?) sp. Left ramus with incomplete M2, no. 2035, lateral and occlusal views.

FIGS. 4, 4a. *Poabromylus*(?) *robustus*, n. sp. Type specimen, left ramus of mandible with cheek teeth, no. 3569, lateral and occlusal views.

All figures $\times 1.5$

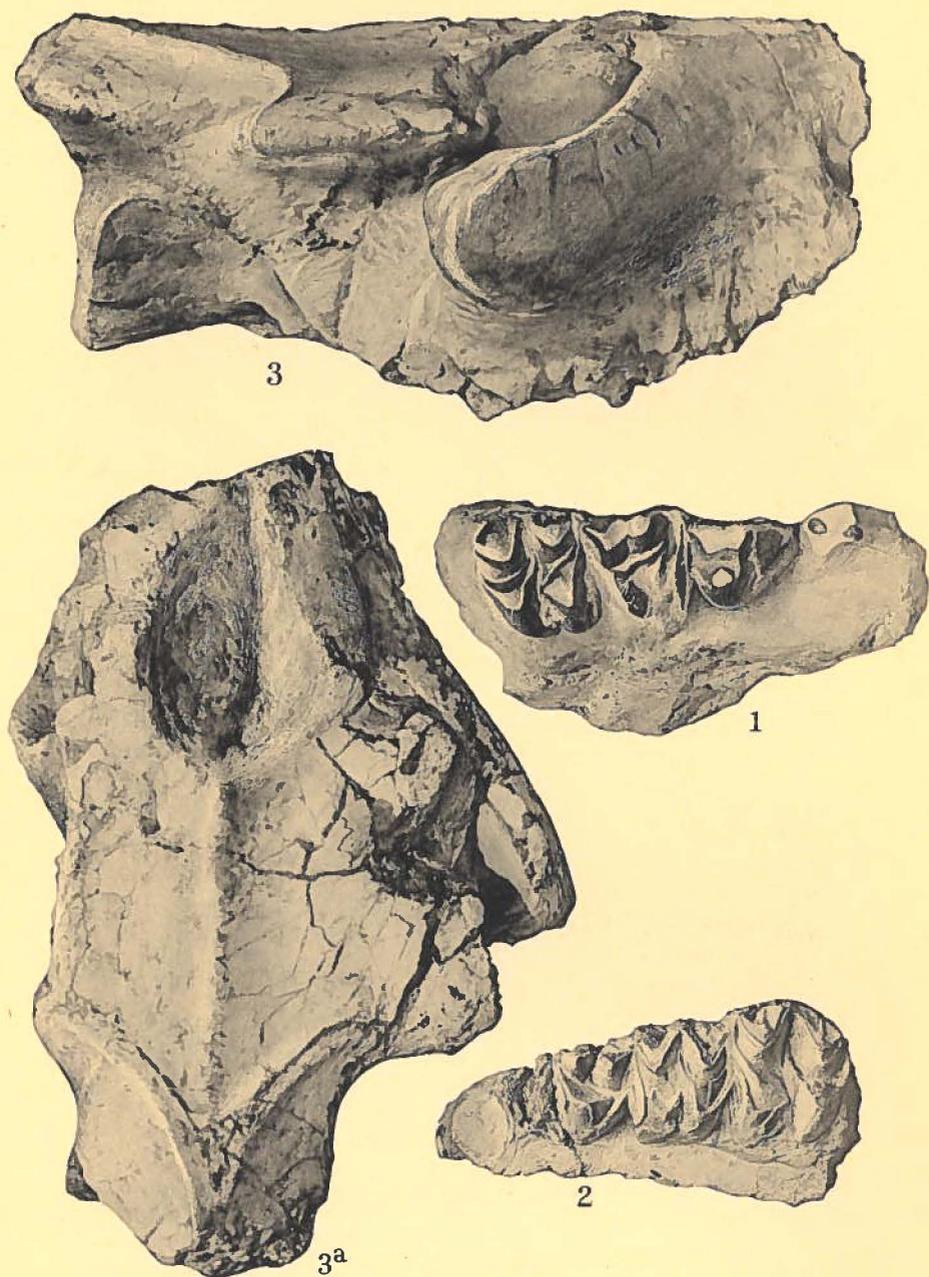
Calif. Inst. Tech. Vert. Pale. Coll.

Basal Oligocene, Titus Canyon formation, California



FIGS. 1, 1a. *Mesohippus*, small sp. Right M3, no. 3562, lateral and occlusal views.
 FIGS. 2, 2a. *Eotrigonias(?) mortivallis*, n. sp. Type specimen, fragment of left ramus
 of mandible with molar teeth, no. 3564, lateral and occlusal views.
 FIG. 3. *Mesohippus*, small sp. Right calcaneum, no. 3563, dorsal view.
 FIGS. 4, 4a. *Colodon* sp. Incomplete right ramus of mandible with cheek teeth, no.
 3567, lateral and occlusal views.

Figures 1, 1a, $\times 2$; figures 2-4a natural size
 Calif. Inst. Tech. Vert. Pale. Coll.
 Basal Oligocene, Titus Canyon formation, California



Agriochocerus transmontanus, n. sp.

FIG. 1. Type specimen, right maxillary with P²-M¹, no. 3558, occlusal view.

FIG. 2. Paratype, left maxillary with P⁴-M², no. 3556, occlusal view.

FIGS. 3, 3a. Skull fragment, no. 3572, lateral and dorsal views.

All figures × 1.5

Calif. Inst. Tech. Vert. Pale. Coll.

Basal Oligocene, Titus Canyon formation, California