A TERTIARY MAMMALIAN FAUNA FROM THE MINT CANYON FORMATION, SOUTHERN CALIFORNIA

by

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ILLUSTRATIONS

Introduction

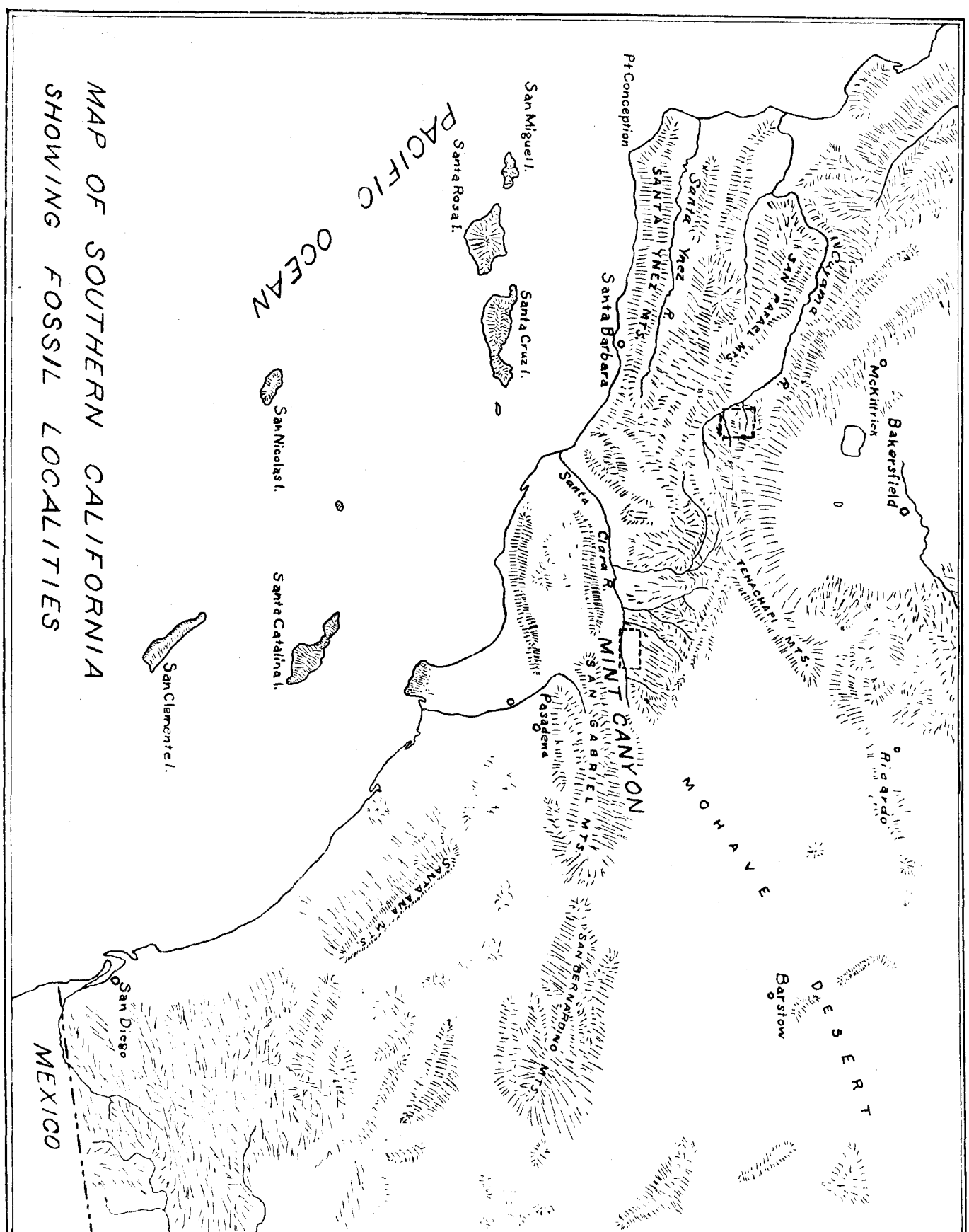
The Mint Canyon beds, typically exposed in Mint Canyon seven miles northeast of Saugus, California, were described by Dr. W. S. W. Kew in Bulletin 753 (1924) of the United States Geological Survey. In 1919 during the course of geologic mapping of this region by Dr. Kew, fossil vertebrate remains were found at several localities. The types represented in the collection were recorded in Kew's paper in a provisional list submitted by Dr. Chester Stock. However, no detailed study was made of this material. Further mammalian remains have been recently secured from the Mint Canyon formation by Mr. Thomas Clements during geologic study of the Tejon Quadrangle.

In view of the geologic position of the Mint Canyon beds, intercalated in a series of marine formations of the Pacific Coast marine province, the terrestrial fauna secured from these deposits is not only important in establishing the age of the Mint Canyon but also furnishes a basis for comparing the Tertiary record of this region with that of the Great Basin to the east. Opportunities to correlate the Tertiary marine record with the terrestrial record of the Great Basin and of the Great Plains on the basis of land vertebrates are of infrequent occurrence and warrant in the present instance a careful survey of the Mint Canyon fauna.

Acknowledgements

The writer wishes to acknowledge his indebtedness to Dr. Kew and Dr. Chester Stock for the collection of most of the material. He wishes to thank the Department of Paleontology of the University of California for kindly loaning the material for study. Likewise he expresses appreciation of the cooperation given by Mr. Clements. Especially does the writer wish to thank Dr. Stock for criticism and assistance during

Fig. 1.


MAP OF SOUTHERN CALIFORNIA
SHOWING FOSSIL LOCALITIES
PACIFIC OCEAN
San Miguel I.
Santa Rosa I.
Santa Cruz I.
San Nicolas I.
Santa Catalina I.
San Clemente I.
Pt Conception
Santa Barbara
Santa Ynez R.
SANTA YNEZ MTS.
Santa Clara R.
SAN RAFAEL MTS.
McKittrick
Bakersfield
TEHACHAPI MTS.
MINT CANYON
SAN GABRIEL MTS.
Pasadena
Riverside
MOHAVE
DESERT
Barstow
SAN BERNARDINO MTS.
SANTA ANA MTS.
San Diego
MEXICO

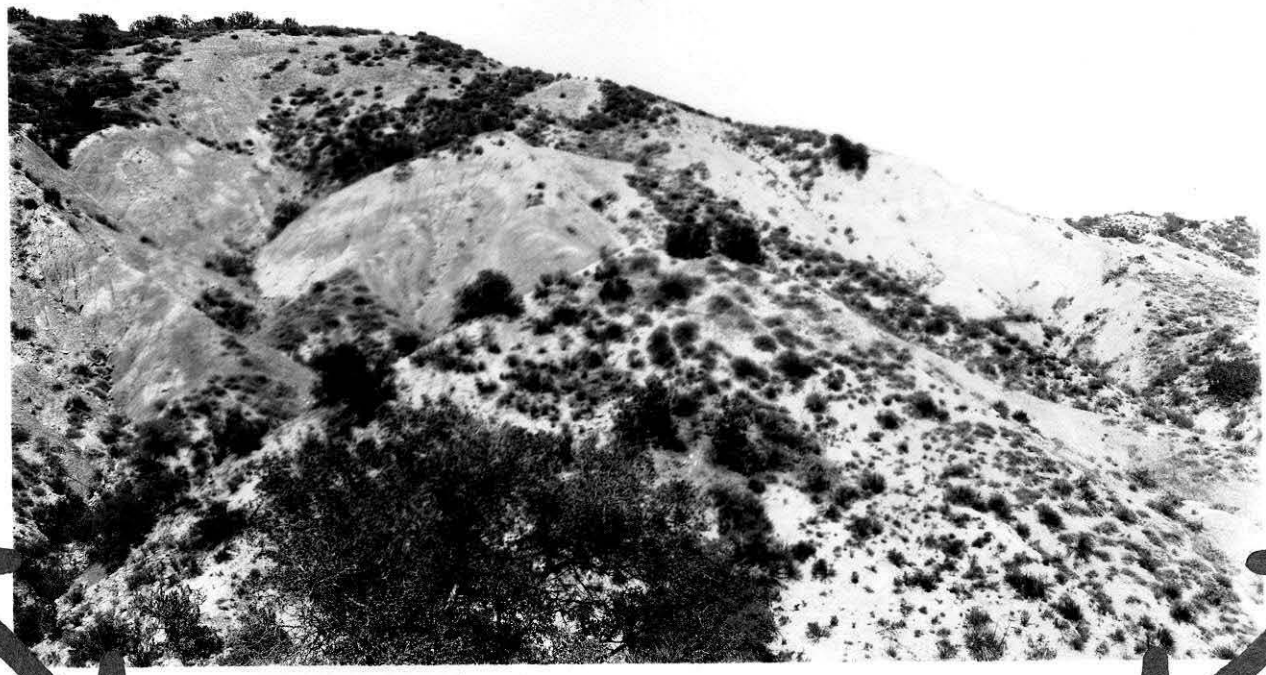


Fig. 2. Typical exposure of fossiliferous Mint Canyon formation from which the camel skull and many of the horse teeth were obtained. East of divide between Mint Canyon and Bouquet Canyon and four miles north of the Santa Clara Valley.

the course of this study.

Geography and Distribution

The fossiliferous Mint Canyon formation is exposed in an extensive are located in the northern part of the Fernando Quadrangle and in the southeastern part of the Tejon Quadrangle in Los Angeles County, California. These quadrangles embrace regions in the southeastern part of the Liebre Mountain-Sawmill Mountain district north of the Santa Clara Valley. The deposits are situated about equidistant from the Los Angeles basin and the Mohave Desert. Figure 1. shows the geographic position of the Mint Canyon horizon with reference to vertebrate horizons of comparable age in southern California. Most of the area, although extensively dissected, is so covered with brush and soil that the exposures are poor. Figure 2. shows one of the best outcrops and it is typical of the group from which fossils were obtained.

Geologic Features

The Mint Canyon formations overlies unconformably the Sespe? formation (upper Oligocene or lower Miocene)[1]. The beds tentatively assigned by Kew to the Sespe are not fossiliferous but have been correlated on the basis of lithology and stratigraphy. In the Fernando Quadrangle the formation consists largely of red and buff colored coarse sandstones and conglomerates, apparently terrestrial accumulations. The Mint Canyon formation itself is a few thousand feet thick. A closer estimation of thickness would require a large amount of detailed work on the series. The beds are locally deformed. In places they are faulted against a schistose basement complex. This is the case in the region

[1] Kew, W. S. W., U.S.G.S. Bull. 753, p. 52, 1924

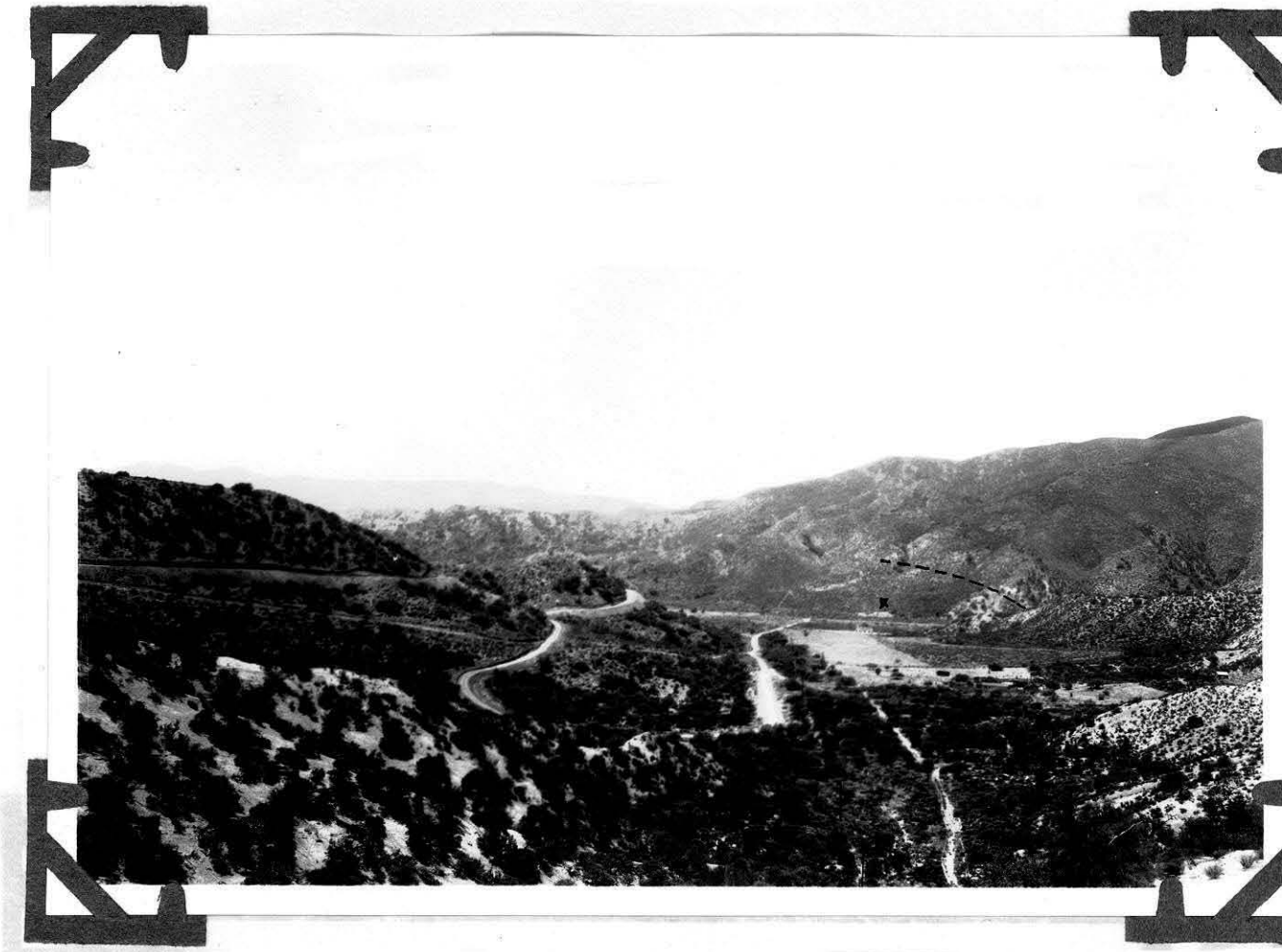


Fig. 3. View looking west from point near contact of the Mint Canyon formation and the basement complex east of Mint Canyon. Valley in foreground parallel to contact.

Small isolated exposure in right center of photograph is the Parahippus locality.

Fig. 4. View looking southeast from divide between Dry Canyon and Haskell Canyon. one mile south of contact with the basement, showing a portion of the Quaternary terrace gravels near left center lying on truncated Mint Canyon beds. The exposure on the extreme right shows Modelo? sandstones dipping to the south.

shown by Figure 3.

Overlying this series unconformably is the Modelo? formation (upper Miocene?).[1] The buff and brown colored sandstones and shales of this series are marine in origin. Figure 4. includes some beds assigned to this formation. The few invertebrate fossils found in some of the beds point to an upper Miocene age. Mr. Clements has recently obtained a varied faunal assemblage from localities in the Tejon Quadrangle and is at present engaged in studying it. This study may lead to a closer determination of age. Correlation on the basis of invertebrate material with other California marine horizons will have considerable importance in assisting in the determination of the upper age limit of the Mint Canyon series.

Along the contact with the basement complex and apparently in the lower strata of the Mint Canyon formation, the coloration is dominantly red. The fossiliferous horizons occur in fine grained, silty members. They are ferruginous and contain numerous rounded quartz pebbles. Exposures of these beds in Mint Canyon and near San Francisquito Canyon have yielded teeth of Parahippus sp. and Merychippus californicus.

Toward the south and ascending in the series gray beds become predominant. They vary from coarse sandstones and conglomerates to lenticular silt layers with intercalated fine grained, colored beds of distinctly sub-aerial origin. The gray beds are extensive and apparently are lacustrine deposits. Some of the interbedded silts contain abundant tests of fresh water gastropods belonging to the species Paludestrina imitator Pilsbry (identification by Dr. G. D. Hanna). Occasionally mammalian remains are associated with them.

Figure 5. shows a section of these gray beds truncated by a Quaternary level of the Santa Clara Valley. Figure 4. indicates the

[1] Kew, W. S. W., U.S.G.S. Bull. 753, p. 68, 1924

Fig. 5. View looking west from knoll on west side of Mint Canyon highway and four miles north of the mouth of Mint Canyon. Gray beds near the skyline dipping gently southward belong to the Mint Canyon formation and are truncated by the Quaternary valley level.

position of Quaternary terrace gravels with respect to the Mint Canyon formation. The terrace gravels are dark brown in color and are apparently flood plain deposits. As yet no vertebrate fossils have been found in them.

A hypothetical reconstruction of conditions during the period of accumulation of the Mint Canyon series is naturally fallible but certain observations seem justified. The faunal assemblage although meagre is a group adapted apparently to semi-arid conditions. Relationship of the fauna to the Barstow fauna as suggested by the presence of Merychippus intermontanus indicates a possibility of freer communication with the Mohave Desert than exists today. Faulting and folding have been active in the region in Recent times. This late Cenozoic deformation is largely responsible for the high relief of the present topography. A number of streams including San Francisquito Creek find their sources on the north side of the topographic divide between the Mohave Desert and the Santa Clara Valley. In Figure 1. these relationships are roughly shown by the sketch map. The streams appear to be antecedent. Thus open avenues of connection probably existed in the late Tertiary and possibly as early as the Miocene. However, some regions of high relief must have partially enclosed the area in order to supply the coarser sediments.

Nature of the Paleontologic Material

The mode of deposition of the Mint Canyon beds was not favorable to burial of skeletal parts in association. Teeth occurring at particular localities were scattered and sometimes weathered before burial. The fossiliferous horizons are infrequent in occurrence in the series. Good specimens are exceedingly rare; a series of horse teeth and the anterior portion of a camel skull being among the better specimens discovered.

Among the skeletal materials found are isolated vertebrae, carpal and tarsal bones of horse, and certain artiodactyl limb elements.

Mint Canyon Fauna

The vertebrate fauna is represented by the following forms:

Equidae

Parahippus, sp.

Merychippus californicus Merriam

Merychippus intermontanus Merriam

Protohippus?, sp.

Camelidae

Miolabis californicus, n. sp.

Antilocapridae

Merycodus?, sp.

Large antelopine form

Rodentia

Archeolagus?, sp. or Hypolagus?, sp.

Proboscidea

Tetrabelodon?, sp.

Aves

Avian remains

Testudinata

Testudo, sp.

Description of Fauna

PARAHIPPUS, sp.

Although the material upon which this genus was recognized is not available for study at the present time, identification was made by Dr. Chester Stock.[1] The teeth are brachydont and have very little cement.

[1] U.S.G.S. Bull. 753, p. 54

MERYCHIPPUS CALIFORNICUS Merriam

The tooth upon which the recognition of this species is based is a superior right molar two or three showing a slight amount of wear (No. 18, Calif. Inst. Coll.). Its height is almost twice as great as its antero-posterior diameter. The coating of cement is rather light. Curvature of the crown is moderate. The transverse diameter diminishes very pronouncedly toward the grinding surface. In size it is comparable to M. californicus from the Temblor of the north Coalinga district and is slightly smaller than M. sumani from the Mohave Desert Barstow. Plate I. Figure 1. illustrates its proportions.

The protocone occupies an almost median position on the inner side of the grinding surface. It is a flattened oval in cross-section and judging from both form and position along the inside of the crown it is separated from the protoconule up to an advanced stage of wear. Plication of the fossettes is moderate and approximates that in both M. californicus and M. isonesus. However, the post-fossette is open posteriorly to the base of the crown. The interior wall of the post-fossette forms the exterior wall of the hypocone. A similar condition is sometimes found in M^2 of M. sumani and in other merychippine forms. A small anteriorly directed pli cahallin is present.

Measurements of No. 18

Antero-posterior diameter (10 mm. above base)	18.1 mm.
Transverse " " "	15.0
Antero-posterior diameter (at base of crown)	18.2
Transverse " " " "	18.7

Comparative Measurements

	M. californicus (Mint Canyon, No. 18)	M. californicus (type M^3, No. 21246)	M. sumani (type, No. 21422)
Antero-posterior diameter	18.1	17.7	19.7
Transverse "	15.0	15.2	15.5
Height	31.0	29.5	32.8

M. isonesus from the Mascall is less advanced than the Mint Canyon form. M. sumani from the Barstow has a protocone tending to become circular, a heavier coat of cement, and the tooth as a whole tends to be somewhat larger. With M. californicus the Mint Canyon specimen shows close agreement and is therefore referred to that species.

MERYCHIPPUS INTERMONTANUS Merriam

A much worn upper premolar two (No. 30042, Univ. Calif. Coll.), a fragmentary upper premolar four, and well worn lower premolars two and three (No. 30041, Univ. Calif.) are referred to this species. Some incisors (No. 30043, U.C.) and a canine (No. 30044, U.C.) from the same locality (No. 3555 U.C. Coll. Loc.) are apparently also to be referred to the same form. Plate I. Figures 2-5.

P_{-}^{2} shows a rather light coating of cement but this may not be a general feature for the lower teeth considered as pertaining to the species are heavily cemented. The fossettes open into one another and communicate with the outside through a valley between the protocone and hypocone. The fossette borders are simple. This type of pattern has been produced in several merychippine forms and several protohippine forms. Merychippus sejunctus (Cope) from the Pawnee Creek formation of northeastern Colorado and Protohippus perditus (Leidy) from the Niobrara River formation of

Nebraska are similar. The tooth from the Mint Canyon beds is much larger than it is in the type species of the former and somewhat larger than in the latter. Merychippus intermontanus Merriam from the Barstow Miocene of the Mohave Desert is similar in pattern but somewhat smaller in size.

The major portion of a tooth which may be upper premolar four is assigned to this species. It is a large tooth and comparable in size to teeth of the two Barstow forms, Merychippus intermontanus and Merychippus calamarius stylodontus. The protocone is strongly united to the protoconule, a character which seemingly indicates a relationship with M. intermontanus since in M. calamarius stylodontus the protocone is often separate from the protoconule until the crown is reduced to a height measurement less than the width. The hypocone is not prominent and is attached very solidly to the metaconule. A small pli caballin is present.

The two lower premolars (see Plate I. Figure 3.) have the simple pattern shown in M. sejunctus and in M. intermontanus after considerable wear. They are much larger than the corresponding teeth of M. sejunctus and are heavily cemented. The metaconid-metastylid column in $P_{\overline{2}}$ is narrow and closely united to the base of the crown. The entoconid is obliquely truncated.

Comparative Measurements

$P_{\overline{2}}$ No. 30042 U.C.	M. intermontanus (Mint Canyon)	M. intermontanus (type)	M.c.stylodontus (type)
Antero-posterior diameter	32.1	a27	28.9
Transverse "	24.2		24.2
Height	29.0	30 (P^{3})	

Note: "a" indicates that the measurement is approximate.

	M. intermontanus (Mint Canyon)	M. intermontanus	M.c.stylodontus
P^4?			
Antero-posterior diameter	a30	23.4	23.4
Transverse "	a25	24.8	23.8
Height	29		
P_2 No. 30041 U.C.			
Antero-posterior diameter	21.3	21.2	a18.5
Transverse "	15.0		
P_3 No. 30041 U.C.			
Antero-posterior diameter	21.0	20.4	18.9
Transverse "	17.0	14.2	

It would appear possible on the basis of size and agreement of characters noted in the dentition to assign the Mint Canyon form to the species Merychippus intermontanus. The similarity of this Great Basin form to the Great Plains species M. sejunctus and Protohippus perditus is quite interesting. Matthew (1915) regards the former as pointing toward the latter type. M. intermontanus from the Barstow and also the slightly larger form from the Mint Canyon may be associated with the protohippine stem in which case it is possible that they descended from a form similar to M. sejunctus. The Mint Canyon Merychippus intermontanus appproaches very closely the genus Protohippus and possibly should be referred to it.

PROTOHIPPUS?, sp.

A fourth distinct type of equine yielded by the Mint Canyon series is represented by three and possibly four lower cheek teeth (No.30041 U.C.). The specimens are apparently worn and considerably weathered. The teeth are definitely hypsodont and the crowns are heavily cemented. See Plate I. Fig. 6.

In many respects these teeth indicate affinity with Hipparion. In size and in some features of the enamel pattern the Mint Canyon form closely resembles Merychippus eohipparion Osborn from the Pawnee Creek beds of northeastern Colorado. The metaconid is well separated from the metastylid in $P\frac{}{2}$. The metaconid-metastylid pillars are widely separated but the groove does not flatten out near the base of the crown as in M. eohipparion. This may be regarded as an advanced character.

Other characters serve to distinguish these teeth from those of Merychippus. In cross-section they exceed the most advanced merychippine types. In one of the teeth the metaconid-metastylid groove is broad and not so sharply indented as is usually the case in Merychippus. The enamel pattern of the crown differs from that of the large Barstow forms.

The pattern of the grinding surface shows some remarkable similarities to that of Hipparion condoni Merriam from the Ellensburg formation of southern Washington. The antero-posterior diameter of the metaconid-metastylid column is even greater than that of H. condoni and is comparable to that of other species of Hipparion. Valleys adjacent to the metaconid-metastylid column are compressed and emphasize its large proportions. On the protoconid of each tooth is a prominent antero-external ridge as in H. condoni. Flattening of the exterior margins of protoconid and hypoconid is not so marked as in H. condoni and in other species of Hipparion. The metaconid-metastylid groove although broad is still somewhat more sharply demarcated in the Mint Canyon specimen than in H. condoni. The entostylid and entoconid are compressed and are not separated as in the Ellensburg type. The entoconid has developed an anterior lobe, an unusual character in Merychippus, but it is not so fully rounded as in Hipparion. Moreover, the length of the crowns does not seem as great (taking into consideration wear) as in Hipparion.

From Pliohippus the Mint Canyon form differs both in size and in the marked development of an entero-external fold in the lower teeth. Characters of the teeth are in a general way accordant with those of Protohippus. Within this genus, however, no specific determination can be made because the material is too scanty.

Measurements of No. 30041 U.C.

	$P\frac{}{3}$?	$P\frac{}{4}$?	$M\frac{}{1}$?
Antero-posterior diameter	23.9	26	22.4
Transverse "	15.3	11.6	11.6
Antero-posterior diameter metaconid-metastylid column	13.2	14.2	14.2
Height	24.5	24.5	18.4

MIOLABIS CALIFORNICUS sp. nov.

The type material for this species consists of the greater part of the anterior portion of a skull (spec. No. 30046, U.C. Coll. Loc. 3568). This specimen is illustrated in Plates II. and III. The cranial portion is missing as is also the anterior portion of the premaxilla. Crowns of incisors, canines, and some cheek teeth are not present but those of the premolar-molar series on both sides so supplement each other as to offer a complete series for study. Some fracturing of the skull has taken place, but it does not involve serious deformation.

The presence of two upper incisors separates the individual from the genus Procamelus in which the second upper incisor is lost. Cope noted a tendency in Procamelus to retain this incisor during the youthful stage. Superior molar one of the Mint Canyon camel is well worn and indicates an adult stage.

The region of the skull forward of the premolar-molar series tends to be uniformly narrow transversely and relatively high above the orbit. The height of the facial region is a primitive character. I_{-}^{2} is definitely shown to be present by a root of considerable size. Although the portion of the premaxilla in front of I_{-}^{2} is lacking it seems quite possible that a small I_{-}^{1} was present. The root shows I_{-}^{3} to be a large tooth. A short diastema separates I_{-}^{3} from the slightly smaller canine behind it. A long diastema separates C_{-}^{1} from P_{-}^{1}. The latter is definitely and strongly two-rooted, a character which Wortman used to differentiate Cope's genus "Gomphotherium" from Protolabis. Matthew subsequently regarded the former genus as insufficiently differentiated from Leidy's genus Protomeryx. A short diastema separates P_{-}^{1} from P_{-}^{2}. The premolars have undergone great reduction from the stage represented by Poëbrotherium from the White River Oligocene and a noticeable reduction from Paratylopus from the John Day. This reduction is nearly the same as in Protolabis but less than in Procamelus. M_{-}^{1} is subquadrate in form while M_{-}^{2} and M_{-}^{3} tend to be elongate. The dentition as a whole is sub-hypsodont.

The small size, facial proportions, retention of incisors, more quadrate outline of molars, and less hypsodont dentition separate the specimen from Procamelus and later forms. Assigning it to Protolabis, Miolabis, or Paratylopus is more difficult. Miolabis transmontanus from the Mascall of central Oregon is very closely related to the species.

Protolabis is on the whole more advanced in the line of cameloid evolution. Incisors are much reduced and are even absent in a specimen from the upper horizon of the Loup Fork beds doubtfully referred to P. angustidens. Premolars are much reduced and P_{-}^{1} is absent in one species, P. montanus.

Protolabis heterodontus although similar in shape is much larger. P_{-}^{4} is subquadrate while the molars are shorter transversely and longer. Likewise as Wortman pointed out P_{-}^{1} is definitely a single-rooted tooth

except in Miolabis (Protolabis) transmontanus (Cope).

Protolabis montanus is nearly identical in size with Miolabis transmontanus but is larger than M. californicus. The advance of Protolabis over Miolabis is shown by (a) the single-rooted condition of $P\frac{1}{-}$, (b) the greater length of molars in proportion to their breadth and (c) the hypsodonty of the dental series as opposed to brachydonty in Miolabis.

Matthew regarded Miolabis transmontanus as not well separated from Paratylopus (Gomphotherium) (Cope). Wortman says, "The only valid distinction between Protolabis transmontanus and Gomphotherium cameloides is seen in the marked reduction of the second superior premolar in the former, and as this is in the direct line of modification leading to the Loup Fork Procamelus, I have thought best to regard it as of generic rank, especially until the question of coossification of metapodials is definitely settled."[1] The dental series $P\frac{2}{-}$ to $M\frac{3}{-}$ is nearly equal to that of Paratylopus cameloides from the upper John Day in size and is somewhat larger than that in Paratylopus sternbergi. In these forms $P\frac{2}{-}$ is slightly reduced from that in the White River genus Poëbrotherium. $P\frac{2}{-}$ in the Mint Canyon form is considerably reduced. The diastema between $I\frac{3}{-}$ and C in the John Day species is intermediate in length between Poëbrotherium and Miolabis californicus. The foregoing considerations differentiate the Mint Canyon form from Paratylopus.

With Miolabis transmontanus it exhibits striking affinity. In size it is but slightly smaller. The premaxilla is but slightly reduced. Reduction of incisors seems comparable. As mentioned previously $P\frac{1}{-}$ is two-rooted. Reduction of the first and second premolars is not quite so pronounced but comparable. The teeth are sub-hypsodont and approach the brachydont condition found in M. transmontanus. In view of such close relationship the Mint Canyon form may be assigned to the genus Miolabis.

[1] Wortman, J. L., Am. Mus. Bull. Vol. X, Art. VII, p. 122, 1898

From Miolabis transmontanus, however, it differs in some important details The dentition seems more primitive. The dental series is shorter. Reduction of premolars is not quite so marked. Premolar one is more strongly two-rooted for in M. transmontanus the roots are separate only at the extremities. The premolar series is not directed inward at an angle from the molar series but both form a comparatively straight chain. In M. transmontanus the premolar-molar ratio shows a relatively greater development of molars than is the case in the new species. Perhaps the most important differences are in the diastemata. Although the skull itself is smaller the diastemata behind $I^{\frac{3}{-}}$ and $C^{\frac{1}{-}}$ respectively are longer than those in M. transmontanus. On the other hand, the diastema between $P^{\frac{1}{-}}$ and $P^{\frac{2}{-}}$ is much shorter (approx. 15mm).

These distinctions are regarded as sufficient to separate the Mint Canyon form from hitherto defined species. For this type the name Miolabis californicus is suggested.

Comparative Measurements

	M. transmontanus	M. californicus (No. 30046 U.C.)	Auchenia llama
Length of skull	a300 mm.	a250 mm [1]	280 mm.
Width behind orbit	a100		142
Dentition I to $M^{\frac{3}{-}}$	257	a147	172
Length $P^{\frac{2}{-}}$ to $M^{\frac{3}{-}}$	92	79	70
Length $P^{\frac{2}{-}}$ to $P^{\frac{4}{-}}$	35	31	17
Length $M^{\frac{1}{-}}$ to $M^{\frac{3}{-}}$	57	48	53
Diastema $I^{\frac{3}{-}}$ to $C^{\frac{1}{-}}$	6	9	17
Diastema $C^{\frac{1}{-}}$ to $P^{\frac{1}{-}}$	11	13	
Diastema $P^{\frac{1}{-}}$ to $P^{\frac{2}{-}}$	20	a5	43

[1] Measurement computed from proportion of skull relative to skull of Protolabis montanus.

	M. transmontanus	M. californicus
Width P^3 (greatest)	7.5	7
Length	14	11.5
Width of M^2	18	15.0
Length	18	17.5
Width of M^3	19	14.5
Length	22	17.5

MERYCODUS?, sp.

Recognition of this form in the Mint Canyon series is based upon a portion of a horn core. The specimen represents a section of the shaft immediately below the bifurcation as is shown by a flattening of the surface and by divergence of the nutrient canals. These are distinct and numerous and indicate the presence during life of a covering integument. The small size of the form is shown by the proportions of the core. The antero-posterior diameter is 11.7 mm.: the transverse diameter is 16.3 mm.

ANTILOCAPRID?

An enamel fragment 35 mm. in length indicates the presence of a large antelopine form. Ilingoceros and Sphenophalos are forms which might have teeth of comparable size.

ARCHEOLAGUS?, sp. or HYPOLAGUS?, sp.

A number of lower molariform teeth of a lagomorph have been collected in the Mint Canyon series but no complete material has been obtained. Dice (1917) distinguishes members of the lagomorph group from one another by certain structural features seen in lower premolar three. Unfortunately no representative of this tooth appears in the collection.

The teeth are smaller and have much less cement than is the case with Lepus. In size they are comparable to those of either Archeolagus or Hypolagus. There is little cement on any of the teeth, a character which resembles Archeolagus.

The lower molariform teeth have reentrant angles which extend almost across them. An upper molariform tooth has a reentrant angle extending little over half way across the crown with finely crenulated margins. This tooth is similar to those in Hypolagus. Another upper molariform tooth has a reentrant angle extending half way across the crown but possessing smooth margins. Exterior to the outer end of the reentrant angle is an isolated loop of enamel, a primitive feature. These characters do not serve to identify the genus to which the Mint Canyon specimen should be assigned.

MASTODON REMAINS

No complete teeth could be assembled from the fragments collected hence the arrangement of the individual tubercles could not be determined. The size is accordant with Tetrabelodon. The enamel thickness averages 6 mm.

AVIAN REMAINS

A proximal portion of a claw possessing a bony prominence on the inferior surface is the sole indication of the presence of birds. It is narrow transversely and deep vertically.

TESTUDINATE REMAINS

These include portions of carapace and plastron as well as a portion of a limb bone. Proportions are quite large. It exceeds Testudo mohavense from the Barstow in size. The carapace is 4 cm. thick at the middle.

Faunal Relationships

The Mint Canyon series is one of the southernmost of the California Tertiary vertebrate horizons lying within the Pacific Coast marine province. Situated immediately south of the Mohave Desert area it is perhaps not surprising to find a relationship between the Barstow and Mint Canyon faunas.

In both the Virgin Valley and Barstow occurrences anchitheriine horses accompany the more progressive types. This association is found also in the Mint Canyon fauna. That the more primitive types of horses continued to exist in the upper Miocene and lower Pliocene is shown by the fossil record at several localities in the Great Basin.

The protohippine forms of both the Barstow and the Mint Canyon are approximately at the same evolutionary stage. Merychippus intermontanus is difficult to separate generically from Protohippus. In the milk dentition of the Barstow form as well as in the permanent dentition characters closely resemble those of Protohippus. This lack of definite distinction was noted by Dr. J. C. Merriam in his discussion of the Barstow horses.

The smaller form assigned to Merychippus californicus is more advanced than M. isonesus of the Mascall and more primitive than M. sumani of the Barstow. It appears specifically identical with the type recorded from the Temblor Miocene of the north Coalinga region. Merriam's work on the Merychippus fauna of this horizon indicates that the zone represents the faunal stage of Turritella ocoyana and the stratigraphic stage of the "Temblor" beds of F. M. Anderson. On the basis of the stage of evolution of the mammals evidenced by types from the Great Basin province the age of the Coalinga occurrence would be considered more recent than on the basis of percentage of marine molluscan species characterizing this horizon.

This lack of adjustment may be due in part to a depression of the Tertiary invertebrate time scale and in part to an elevation of the corresponding vertebrate scale. Should it become possible to ascertain accurately the age of the so-called Modelo from a molluscan fauna, a partial adjustment of the time scales of the Pacific Coast marine province and the Great Basin province might be attempted since forms similar to those in each of these provinces are coexistent at the Mint Canyon stage.

A vertebrate occurrence to the east of Cuyama Valley, recently investigated and partially described by Mr. C. L. Gazin, seems to be more recent than the Mint Canyon. It is also located in the Pacific Coast marine province. (See Fig. 1. in which it is blocked out to the northwest of the Mint Canyon occurrence.) Stratigraphically it overlies the Modelo and underlies the Santa Margarita formation.[1] Providing the identification of the Santa Clara Valley Modelo? is confirmed, there is reason to believe that a time interval represented by a period of marien deposition separates the Mint Canyon and Cuyama vertebrate faunas.

Judging from the rather fragmentary material which represents the Barstow Camelidae, these forms are larger and possibly more advanced than Miolabis from the Mint Canyon. Protolabis montanus Douglas from the Loup Fork beds of Colorado and Procamelus occidentalis Leidy from the Santa Fe beds of New Mexico are likewise some what larger but show some similarity in structure. Miolabis transmontanus (Cope) from the Mascall of Oregon very closely resembles the Mint Canyon species. Deducing definite time differences from the above mentioned cameloid relationships is not justifiable for there is a strong possibility that the tylopod stock is polyphyletic.

[1] Identification of formations by W. A. English
U.S.G.S. Bull. 621, 191-215, 1916

The Mint Canyon fauna presumably occupies a position between the Mascall and the Coalinga (Temblor or Topanga) faunal stages of the Miocene on the one hand and the Barstow on the other. This position would indicate apparently an upper middle Miocene or lower upper Miocene age. Several considerations lead the writer to favor an upper middle Miocene age for the Mint Canyon formation.

References

Horses

Merriam, J. C., Univ. Calif. Bull. Dept. Geol., Vol. 11, No. 5 pp. 479-505, 1919

Merriam, J. C., Trans. Am. Phil. Soc. N.S. Vol. XXII, Part III, pp. 7-11, 1915

Osborn, H. F., Memoirs of Am. Mus. N.S. Vol. II, Pt. I

Camels

Matthew, W. D., Mem. of Am. Mus. Vol. I, Pt. VII, pp. 20-39, 1901

Cope, E. D., U.S.G.&G.S. of Terr., Vol. 5, No. 1, p. 67

Wortman, J. D., Am. Mus. Bull. 10, pp. 93-142, 1898

Matthew, W. D., Am. Mus. Bull. Vol. 38, Art. VII, pp. 216-17

Cope and Matthew, Am. Mus. Monograph Series No. 2, Pl. 153 & 154

Report U. S. Geog. Sur. W. 100th Meridian, pp. 325-46, 1877

Rodents

Dice, L. R., Univ. Calif. Bull. Dept. Geol., Vol. 10, No. 12, pp. 179-83

Kellogg, L., Univ. Calif. Bull. Dept. Geol., Vol. 5, No. 29, pp. 411-37, 1910

Explanation of Plates

All Natural Size

Plate I.

Fig. 1 a. and 1 b. Merychippus californicus Merriam. Upper molar. No. 18, Calif. Inst. Coll.

Fig. 1 a. Outside view and occlusal view.

Fig. 1 b. Posterior view.

Fig. 2. Merychippus intermontanus Merriam. Upper premolar two. No. 30042, Univ. Calif. Coll. Outside and occlusal views.

Fig. 3. Merychippus intermontanus Merriam. Lower premolars two and three. No. 30041, U.C. Coll. Outside and occlusal views.

Fig. 4. Merychippus intermontanus Merriam. Incisor No. 30043, U.C.

Fig. 5. Merychippus intermontanus Merriam. Canine No. 30044, U.C.

Fig. 6. Protohippus?, sp. No. 30041, U.C., Outside and occlusal views.

Plate II.

Right side of skull of Miolabis californicus. No. 30046, U.C.

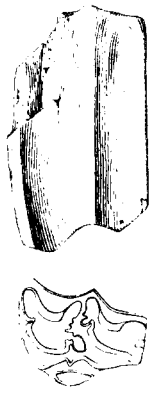
Plate III.

Palatal view of skull of Miolabis californicus. sp. nov. No. 30046, Univ. Calif. Coll.

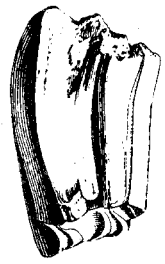
All drawings by John L. Ridgway.

Plate I.

6.



1a.



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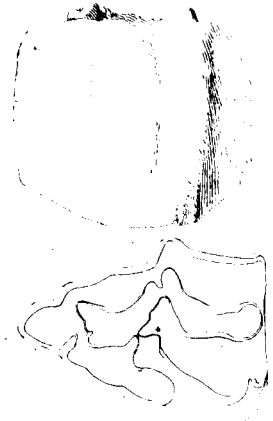

2.

3.

4.

5.

Plate II.

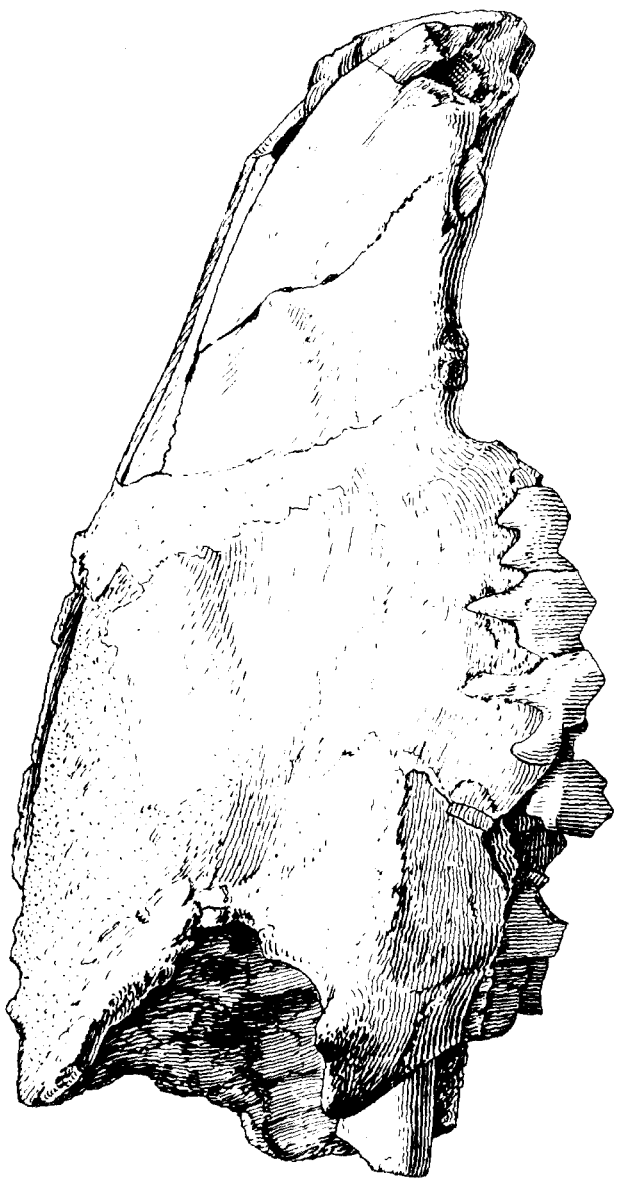

Plate III.