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NEW MAMMALIAN FAUNAS FROM MIOCENE
SEDIMENTS NEAR TEHACHAPI PASS IN
THE SOUTHERN SIERRA NEVADA

A THESIS SUBMITTED IN PARTIAL SATISFACTION OF
THE REQUIREMENTS FOR THE DEGREE OF
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BY

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INTRODUCTION

During the past five years expeditions under the direction of the Department of Palaeontology of the University of California have made considerable collections of Tertiary mammalian fossils in formations near Barstow and at Ricardo, in the Mojave Desert. Mammalian material has also been obtained in sections containing marine formations in the Southern San Joaquin Valley, on the western or opposite side of the southern Sierra Nevada. Study of this material from the Mojave Desert and the San Joaquin Valley has yielded important information regarding the history of mammalian life in these regions. With the geologic data obtained it is being made the basis for a beginning in the correlation of events in the Tertiary palaeontologic and geologic history of the Great Basin and Pacific Coast provinces.

With a view to contributing to the solution of this general problem of Cenozoic correlation between the Great Basin and Pacific Coast

provinces, the writer examined an area of sedimentary deposits near Tehachapi Pass, in the southern Sierra Nevada. This area lies directly between the San Joaquin Valley and the Mojave Desert. Because of its position it seemed probable that its study would yield critical information bearing upon the question of correlation between the two provinces. Reconnaissance examinations by the writer in the winter of 1912 and in the summer of 1914 had, moreover, suggested the probability of the presence of mammalian fossils in the exposures of sedimentary strata in the Tehachapi area.

As the result of several weeks' work in the Tehachapi Pass region in November and December, 1914, two fossil faunas were secured at quite widely separated horizons. More material was obtained in June, 1915, in the collection of which the writer was ably assisted by Clarence L. Moody, James M. Douglas, and Edward Thacher.

Though the collections are not large, they are thought to contribute new information relating to the history of the Mammalia of western North America, and bearing on the geologic history of the southern Sierra Nevada and adjacent regions.

This paper is a summary statement of the composition and relationships of these faunas. Detailed descriptions of the faunas and a discussion of the geologic results are to follow.

OCCURRENCE

The Tertiary formations in which the mammalian faunas are found in the Tehachapi region are in part an extension of beds first brought to notice by Professor Andrew C. Lawson,¹ who described strata exposed in the vicinity of Monolith and lower Cache Creek, near Tehachapi Pass.

The formations are included in a section of volcanic and terrestrial materials extending over an area of seventy-five to eighty square miles or more of the summit region of the southern Sierra northeast of the town of Tehachapi. The total thickness of the formations is probably not less than four or five thousand feet. Constituting the group are basic lava flows, volcanic agglomerates, massive pumiceous tuffs, stratified ash beds, terrestrial sandstones, clays, cherts, and fanglomerates. The fossiliferous horizons are probably stratigraphically near the middle of the section. The whole succession of strata records recurrent volcanic activity, with intervening periods of subaerial and lacustral deposition. The angular fanglomeratic character of the coarser

¹ Univ. Calif. Publ., Bull. Dept. Geol., vol. 4, pp. 431-462, 1906.

sediments and the similarity of the finer beds to playa lake deposits strongly suggest that the climate was arid or semi-arid, rather than humid. The presence of palm leaves near the lower of the horizons at which mammalian remains were found does not conflict with this inference.

Since their deposition the series of deposits containing the faunas have been folded, with dips up to 30 degrees. The tilted strata have been in part cut away by erosion, and their deep dissection has afforded excellent opportunity for securing collections of the contained fossil remains. The fossils were obtained from badland surfaces, on which they lie where the matrix has been blown or washed away, and from rocky shelves on the bluffs in which the fossils were embedded.

The two localities from which the faunas were collected are situated about three miles apart. The lower fauna was found in sandstones, containing chert layers, about nine miles northeast of the town of Tehachapi, and one mile northeast of Phillips Ranch, which is on Sand Creek, a tributary of Cache Creek. This assemblage may be known as the Phillips Ranch fauna. The second or younger fauna occurs in coarse sandstones and fine fanglomerates exposed along the south fork of upper Cache Creek, about three and one-half miles east of Phillips Ranch. This upper mammal-bearing horizon passes under Cache Peak on the divide between Cache Creek and Jawbone Cañon. This will be known as the Cache Peak fauna. Strata of an estimated thickness of five hundred feet separate the horizons of the Phillips Ranch and Cache Peak faunas. It is quite possible that an unconformity occurs in the section between the two faunas; evidence suggesting an erosion interval was noted in upper Oil Canyon, a tributary of Cache Creek from the south.

The Phillips Ranch fauna was obtained at a single locality extending only a few hundred feet along the outcrop of the beds and through but fifty or seventy-five feet of the strata. The Cache Peak material was collected from exposures distributed over an area perhaps two miles long and extending through several hundred feet of beds.

PHILLIPS RANCH FAUNA

The collection from the lower horizon near Phillips Ranch includes the following forms:

Merychippus, n. sp.
Camelid, large
Camelid, small
Moropus, sp.

Merycodus? sp.
Carnivore, indet.
Canid, indet.
Felid, indet.

The horses of the Phillips Ranch fauna are of a type in or near the genus *Merychippus*, but possibly represent a new subgenus of that group less advanced in tooth structure than typical *Merychippus*. They are represented by upper and lower cheek-teeth and by a number of limb bones. The upper cheek-teeth are short hypsodont, the height being about equal to or a little greater than the transverse diameter in well worn teeth. The teeth are small, those in the middle of the series ranging from 15.6 to 17.1 mm. in anteroposterior diameter and from about 15 to 16.4 mm. transverse diameter. Height of worn teeth on the outer side is 15 to 18 mm., on inner side 10.2 to 12.2 mm. They are relatively narrow transversely compared with the teeth of typical species of *Merychippus*. The outer and inner faces are not approximately parallel as in strictly prismatic teeth, but approach each other somewhat toward the summits of the teeth. The crowns are slightly curved. They are well cemented, but the cement covering is not heavy. The outer faces of paracone and metacone are flat or have a very faint median rib. The mesostyle is prominent, narrow, and may be of nearly equal width from base to summit of tooth, or may flare slightly at the base. The protoconule and metaconule are slightly larger than protocone and hypocone. The protoconule is slightly crescentic and is broadly connected with the oval protocone. The metaloph is completely connected with ectoloph, but is usually not connected with protoloph because of imperfect development of the posterior horn of the protoconule. The fossettes are well cemented, with one or two crinkles in the enamel borders. The prefossette is usually open on the median or inner border between protoloph and metaloph. The post-fossette is sometimes closed and sometimes open between hypocone and hypostyle.

The upper cheek-teeth are more advanced than those of *Parahippus* and the other genera of the Anchitheriinae in the greater height of the crowns and in their prismatic form, in their strong cementation, in the relatively large size of protoconule and metaconule compared with protocone and hypocone, and in the tendency to close the fossettes. They are relatively primitive compared with described forms of *Merychippus* in their small size, shorter crowns, subequality in size of protocone and protoconule, in the imperfect development of the posterior horn of the protoconule, and in the general openness of the fossettes on the inner side.

The characters are in a measure those assigned by Gidley² to hypothetical genera of a group "C" of division "Anchitheriinae

² Gidley, J. W., Bull. Am. Mus. Nat. Hist., vol. 23, p. 868, 1907.

Leidy": "Inner conules (pr and hy) smaller than median conules (pl and ml), protoconule semi-crescentic; partially or completely united with the metaloph; . . ."

The lower cheek-teeth of this equid form are all of one type, characterized by being distinctly hypsodont, and well cemented. Their length is approximately one to one and one-half times their antero-posterior diameter. The metaconid-metastylid column is well developed. The marked groove between the metaconid and metastylid persists nearly to the base of the tooth. The lower cheek-teeth seem in some respects more advanced than the upper, but certainly represent the same form, as the upper and lower teeth of the same individual have been found together.

In one specimen (no. 21692) lower milk teeth are present in the jaw with the permanent teeth. The deciduous teeth are of the short-crowned type and bear a thin cement layer.

With the horse teeth are three astragali and scattered limb bones representing small forms. One of the three astragali is much smaller than the others and possibly represents a type distinct from that indicated by the other material.

The camels of the Phillips Ranch fauna are known from cheek-teeth, an astragalus, a distal portion of a radius, a distal portion of a tibia, and by a number of foot bones. The material probably does not permit of specific determination, but difference in the size of the teeth suggests that a large and a small species of camel are present.

Moropus is indicated in the assemblage of species by a portion of a lower jaw containing three premolars and a molar, all little worn. Compared with *Moropus elatus* Marsh, the teeth in this jaw are considerably smaller and are relatively narrower transversely.

An incomplete calcaneum closely resembles that of the antelope-like *Merycodus*.

A toothless carnivore jaw represents a small form which is probably not generically determinable.

A part of a lower jaw, probably of a canid, and a portion of a tooth, apparently a felid, likewise do not admit of exact identification.

The evidence as to age of the Phillips Ranch fauna is furnished principally by the horse material. The *Merychippus* is possibly so primitive that it should be set off as a new subgenus. *Merychippus* is usually held to range from middle Miocene to early Pliocene. It appears that this faunal stage is not younger than middle Miocene and may represent a somewhat earlier stage of that period.

CACHE PEAK FAUNA

The Cache Peak fauna includes the following forms:

Merychippus, n. sp., *a*

Merychippus, n. sp., *b*

Hypohippus, sp.

Camelid, sp., *a*

Camelid, sp., *b*

Merycochoerus (?), sp.

Dromomeryx, sp.

Merycodus, sp.

Felid, sp.

Of the three forms of horses only one is represented by sufficient material to make possible a full study. Of this type there were obtained a nearly complete skull (no. 22254, Univ. Calif. Loc. 2735) with complete upper cheek dentition, a complete femur, complete metapodial region with lateral elements and phalangeal series, and the extremities of a number of other limb bones. No lower teeth of this individual were found.

The notable characters of the dentition of this specimen are as follows: Upper cheek-teeth short hypsodont and well cemented. Mesostyle strongly developed. Protocone flat oval in cross-section and slightly smaller than the protoconule, distinctly connected with the protoconule in every tooth in the skull. Protoconule and metaconule not notably crescentic. Postfossette closed in all the teeth; prefossette closed on the inner or median side in seven of the twelve teeth.

Several other upper cheek-teeth from the Cache Peak horizon, some unworn, are of the same type as those of no. 22254, and exhibit no new characters. In the course of wear the protocone of these teeth would be disconnected from the protoconule until approximately the upper half of the tooth had been worn away.

Several lower cheek-teeth in the collections, presumably representing the form seen in no. 22254, are also quite heavily cemented.

The type of horse represented by these upper and lower cheek-teeth is certainly to be characterized as a species of *Merychippus* as this group is at present defined, and is not one of the most primitive members of the group.

The second form of horse in the Cache Peak fauna is known only by parts of three upper cheek-teeth, two of which fortunately exhibit the protocone-protoconule relation. These teeth are badly worn, but the crowns appear to have been rather short hypsodont, well cemented, and somewhat curved. The most notable feature is the fact that the protocone as shown in no. 21693 is widely disconnected from the protoconule to the very base of the tooth, and that it is short oval in cross-section. The protoconule in this specimen is distinctly larger than

the protocone, is markedly crescentic in outline, and is connected with the metaloph. The last three characters are among those which set off the *Merychippus* group from the earlier horses. So far as can be judged from the scanty material, this form should be included within the genus *Merychippus*, but the disconnected protocone indicates that it probably lies within that division of the genus leading toward the *Hipparion* stock rather than within the division which probably gave rise to *Protohippus*, *Pliohippus*, and other forms with connected protocone.

The *Hypohippus* material consists of three upper cheek-teeth. The advanced state of wear will probably not permit the safe reference of the form represented by the teeth to any of the described species of *Hypohippus*.

The collection from the Cache Peak horizon includes a considerable amount of camel material, consisting of imperfect limb bones, with a few parts of teeth. The remains indicate the presence of at least two forms. Fragmentary teeth and some of the limb bones represent a species near *Procamelus*. Certain of the other parts, such as a crushed proximal extremity of a metapodial and two imperfect astragali, represent a camel decidedly larger than the first species mentioned.

Of the two teeth indicating the presence of an oreodont in the fauna one is presumably *Merycochoerus*; the other may be generically distinct.

The antelope-like *Dromomeryx* is represented in the Cache Peak fauna by two lower teeth. While it is not desirable to attempt a specific determination with such scanty material, the characters of the genus are well shown in the accessory median tubercle, the accessory anterior ridge developed from the cingulum, and in the roughened surface of the enamel. The "Palaeomeryx fold" on the anterior external crescent is shown on one of the teeth. *Dromomeryx* has been reported from middle Miocene to early Pliocene.

The fragmentary *Merycodus* material indicates a small species of that genus. This form may be the same as that occurring in the Barstow fauna.

A felid is known in the fauna by the distal portion of a metacarpal or metatarsal.

RELATIONSHIPS OF THE FAUNAS

A comparison of the Phillips Ranch and Cache Peak faunas must at present be based largely upon the horses represented in the two

collections. *Moropus* occurs only in the former fauna, while *Merychoerus*(?) and *Dromomeryx* are found only in the latter, but the collections are not sufficiently large to make the absence of a form from one fauna and its presence in the other significant. *Merycodus* is present in the collections from both localities, but the material is too scanty to allow an accurate comparison.

Of the horses, the species from the Phillips Ranch horizon has much smaller and much more primitive cheek-teeth than either of the forms in the Cache Peak fauna. The horse astragali from the Phillips Ranch horizon are all of a smaller type, while there are in the collections from the upper horizon astragali of a larger type as well.

The evidence of the camel material is not emphatic, but the larger size of most of the camel teeth and foot parts in the Cache Peak fauna tends to confirm the view that this assemblage represents a more advanced stage.

The Phillips Ranch fauna is quite certainly considerably older and less advanced than the assemblage from the Cache Peak horizon.

In considering the relations of the Phillips Ranch and Cache Peak faunas to other groups it seems desirable to compare them with faunas known from neighboring areas. In the Mojave Desert the Ricardo fauna, known from considerable collections to be of approximately lower Pliocene age, occurs about twenty miles to the northeast; the Barstow fauna, also well represented by material and of approximately upper Miocene age, is found about eighty miles to the east. In the southern San Joaquin Valley on the opposite side of the southern Sierra a meager collection obtained in the Tejon Hills is of approximately very late Miocene or lower Pliocene age.

The species of *Merychippus* found in the Phillips Ranch fauna is very different from any species found in the Barstow upper Miocene collection, being much more primitive. The camels do not permit of an exact comparison because of scantiness of the Phillips Ranch material, but they appear to be different. The species of *Merycodus* may be the same as that from Barstow, but with the material at hand a certain determination cannot be made.

The horse material from Phillips Ranch resembles still less any of the horses found in the Ricardo fauna, being much more primitive. It is likewise less advanced than the horse species obtained in the Tejon Hills in the southern San Joaquin Valley.

The Phillips Ranch fauna certainly represents a stage of evolutionary development much earlier than the Barstow, Ricardo and Tejon Hills faunas.

The horses of the Phillips Ranch fauna appear more primitive than those of either the Mascall or the Virgin Valley. They may be of a middle Miocene stage, but older than the stage of either the Mascall or the Virgin Valley. The lower, or Phillips Ranch horizon, appears to represent the oldest stage in the development of mammalian life above the Oligocene known thus far in the region west of the Wasatch.

The Cache Peak fauna has been stated to be more advanced than that from near Phillips Ranch. The *Hypohippus* of the Cache Peak assemblage is probably specifically distinct from that found at Barstow. The complete skull with dentition representing *Merychippus* differs somewhat in the details of the facial region and in its dentition from *Merychippus calamarius*, a common form at Barstow, but appears to be quite near that species. The Hipparion-like horse teeth of the Cache Peak fauna have the protocone more distinctly separated than it is in the nearest allied type in the Barstow fauna; this wide separation is probably an advanced character. On the other hand, the Barstow fauna contains horses which have longer and heavier lower molars than any found in the Cache Peak assemblage.

The *Dromomeryx* teeth from the Cache Peak horizon seem considerably shorter and less advanced than the form found at Barstow. The *Merycodus* cannot be compared satisfactorily. The *Merycochoerus* form may be different, but the material is too fragmentary to permit a certain comparison.

Comparing the Cache Peak with the Ricardo, no form is known to be common to the two faunas, although the *Merycodus* may be the same. The horses in the lower part of the Ricardo section are mainly very advanced types of *Pliohippus* and *Hipparion*.

The horses obtained in the Cache Peak horizon are all different from those so far known from the Tejon Hills, and probably represent a stage somewhat older.

The Cache Peak fauna is probably considerably older than the Ricardo, probably somewhat older than the Tejon Hills, but probably does not differ greatly in age from the Barstow.

The Cache Peak fauna represents a stage in advance of that found at Phillips Ranch. The Cache Peak fauna may be late middle Miocene or upper Miocene; it may furnish a transition stage between the Phillips Ranch and the Barstow faunas, but it is much nearer to the Barstow than to the Phillips Ranch.

GEOLOGIC SIGNIFICANCE OF THE FAUNAS

The faunas, consisting as they do in large part of horses, camels, and antelope-like forms, point to a plains or open valley environment in this region in middle Miocene time.

The deposits in which the faunas occur are of types which suggest that they were laid down under subaerial conditions as waste slope and playa lake deposits; the evidence for this view is corroborated by the occurrence of the mammalian remains, which are usually scattered and frequently much gnawed by rodents. The angularity of the coarser terrestrial deposits precludes their fluvial origin, and the lack of classification and bedding in the fine materials militates against their being in any large measure of truly lacustrine origin. The faunas and the formations in which they occur thus indicate that the climate was one of semi-aridity or aridity. Fossil wood and palm leaves at one or more horizons probably do not negative this view.

The age of the faunas being established as approximately middle and upper Miocene respectively, stratigraphic relations indicate that important crustal movements occurred in this region between Jurassic and middle Miocene time and in post-middle-Miocene time.

The movements subsequent to the Jurassic and antecedent to the middle Miocene are indicated by the relation of the mammal-bearing group to a succession of sediments which lie with marked unconformity below these strata and rest unconformably on the plutonic rocks of presumable Jurassic age. This lower sedimentary series, which is well exposed along lower Oil Cañon, has been deformed to the extent that the strata attain a vertical position over much of the area in which they are exposed. It is not improbable that deformative movements affected the territory immediately previously to the deposition of the mammal-bearing group, inasmuch as the topography on which these beds were laid down was one of some relief and indicates active erosion immediately preceding their deposition.

The crustal movements subsequent to middle Miocene time in the Tehachapi Pass region are evidenced by the folding which the mammal-bearing group has suffered since its deposition; dips of twenty to thirty degrees are common in the strata. Following this folding, erosion cut away no small part of the total mass of the accumulated sediments and probably produced on the region a land surface of gentle relief. The latest diastrophic event was the faulting along the southeastern base of the present range, by which the mountain area was displaced

vertically 2500 to 3000 feet with respect to the adjacent Mojave Desert area. This zone of displacement fractured the strata containing the middle Miocene mammalian remains, so that if there were no other basis for determining the date of the great displacement which gave the southern Sierra Nevada its present orographic features, the lower limit in time would be defined by the upper Miocene age of the younger of the two faunas. This would indicate that the faulting occurred in late Miocene or post-Miocene time. This fact is of interest when it is recalled that some geologists have set earlier dates for the faulting by which the northern Sierra Nevada attained its present elevation above the Great Basin.

Transmitted April 9, 1915.

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