A NEW MIOCENE MAMMALIAN FAUNA FROM THE CALIENTE MOUNTAINS, CALIFORNIA

by

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INTRODUCTION

Fossil mammalian remains from the Caliente Mountain region, San Luis Obispo County, California, were first found by John B. Stevens in 1928 in red beds associated with basalt flows near Padrones Spring. The material, fragments of a merycodont jaw, was presented to the California Institute at that time. The importance of the Caliente Mountain marine section is emphasized by Reed and Hollister[1] in their

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1 Reed, R.D. and Hollister, J.S., Structural Evolution of Southern California. Am. Assoc. Petrol. Geol., p. 80, 1936.

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discussion of the Caliente Miocene. As recognized by Reed and Hollister, "The great difference in facies of these beds permits the determination of the interrelation of mammalian, mollusk, and foraminiferal zones, a task that is not easy in many districts."[2] The present study was under-

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2 Reed, R.D. and Hollister, J.S., ibid., p. 82, 1936.

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taken, therefore, with a view to obtaining a mammalian fauna from the region and establishing its relationships to the Miocene molluscan and foraminiferal zones. It is hoped also that such a study might bring out more clearly the relationships of the invertebrate and vertebrate time scales for at least this stage of the Miocene.

The collection of the vertebrate remains forming the principal basis for the present discussion was made by the author during the fall, winter, and spring months of 1938-39. For the suggestion of this problem

and for much invaluable assistance and encouragement, the author is greatly indebted to Dr. Chester Stock. Mr. E.L. Furlong and Dr. R.W. Wilson have kindly tendered many helpful suggestions during the course of study. The author wishes to gratefully acknowledge the courtesy J.E.Eaton of Dr. U.S. Grant IV and Mr. Harry Allen of the University of California at Los Angeles and for their very kind permission to use valuable data obtained by them in the study of the fossil molluscan faunas obtained from this area. Dr. R.M. Kleinpell and Mr. W.D. Kleinpell furnished important data bearing on the correlation of the vertebrate fauna with known foraminiferal zones. The kind permission of Mr. Washburn to carry on field work within the boundaries of the Washburn Ranch, is greatly appreciated.

LOCATION AND OCCURRENCE

The area from which the fossil material was obtained lies on the northeast flank of the Caliente Mountains in San Luis Obispo County, California. Caliente ridge forms the western boundary of Carrizo Plain and overlooks the Cuyama River Valley to the southwest. The fossiliferous beds are exposed in badlands on the backslope of the dissected eastern limb of the main Caliente Mountain anticline. The fossil localities are distributed along the strike of the beds for some five miles northwest of a point one half mile southeast of Padrones Spring. These occurrences lie in sections 25, 26, and 27 in T. 11 N., R. 26 W. and in sections 31, and 32 in T. 11 N., R.25 W., McKittrick Quadrangle, California.

The strata containing the vertebrate fossils represent a series of highly colored sediments, associated with four or five basaltic flows, intercalated in Temblor Miocene marine sandstones. The fossil localities are scattered throughout the land-laid sediments and are closely associated with the basic extrusives. The highest stratigraphic position of the fossil vertebrates is between the main basalt flows and the "Upper Miocene" shale, below the main basalt and above the "triple" basalt, in compact, very fine grained siltstone with interbedded deposits of thick, coarse red sandstone occurs abundant merycoidodont remains. Fossil remains occur also in very compact, fine grained tan and red siltstones between the lower and middle and between the middle and upper members of the "triple" basalts. The next to lowest occurrence is in medium grained white sand, with interbedded greenish clay lenses, that lies some fifty feet below the lowest triple member of the basalt flow.

The fossil material, in all but the latter horizon, consists of isolated bones and teeth and its preservation is fragmentary. Only at one locality were mammalian remains found in fair abundance in the white sands and greenish clays. This site, C.I.T.Vert.Pale. Loc. No. 315, yielded a badly crushed merycoidodont skull and a number of isolated teeth and limb bones of merychippine horses. Limb elements are poorly preserved, and are water-worn and abraded. The tooth material is in a better state of preservation but individual teeth tend to break apart when removed from the matrix.

The lowest vertebrate horizon lies some fourteen hundred feet stratigraphically below the lower triple basalt horizon, locality No. 325. This horizon contained fragmentary bones and teeth referable to an immature merycoidodont, probably similar to Merychyus calimontanus n.sp.

MODE OF ACCUMULATION

Presence of fossil remains of land animals in the upper portion of a marine invertebrate-bearing sandstone series requires some discussion of the probable mode and site of deposition of the vertebrate material. As is shown on the aerial photograph, fig. , and stated in the stratigraphic discussion, the mammal-bearing horizons are associated with deposits containing remains of littoral marine organisms like Ostrea and Turritella. In all cases the mammals and invertebrates occur in separate beds, but frequently the deposits containing them lied immediately adjacent to one another. This relationship suggests an accumulation taking place under the influence of diastrophic movements and which brought about a rhythmic interfingering of non-marine and littoral marine strata. Along a given section line the stratigraphic sequence from bottom to top may include the following: oyster reef, mammal remains, basalt, mammal remains, basalt, oyster reef, basalt, mammalian remains, oyster reef, mammalian remains. Apparently during the period of this deposition rapid transgressions and regressions of the sea were taking place with extrusions of basaltic material accompanying the laying down of marine sands, silts, and clays. These variations and rapid changes in the depositional record are noteworthy in view of the proximity of the area to the San Andreas rift. The latter zone of faulting lies approximately four miles northeast of the fossil localities. Evidence of crustal movement in this area and their proximity to the San Andreas region suggest, at least, that the latter may have been active during this stage of the Miocene.

The fine sandy siltstones of reddish color, containing abundant

merycoidodont remains, may have been laid down as flood plain deposits or as aeolian loess. It seems likely that such silts and clays represent deposits formed by a slow flowing, aggrading stream. A similar type of deposition has been advocated by W. D. Matthew[3] in accounting for the en-

3 Matthew, W.D., Univ. Cali. Publ. Bull. Dept. Geol. Sci., vol. 22, p.23, 1932.

tombment and preservation of merycoidodont remains in the White River. The medium fine sand and greenish clay lenses as well as the coarse sandstones found in the Caliente section may represent stream channel deposits, although some of the coarse sands may be marine in origin in the light of their wide lateral extent. The proximity of oyster-bearing silts suggests that the flood plain silts and stream channel sands were deposited sufficiently close to the mouth of a stream to permit periodic interfingering of marine littoral accumulations.

The abraded and water worn state of the fossil limb elements in the sand a clay lenses supports the view of an existence of a stream channel, and similarly the scattered, but sometimes well preserved merycoidodont remains in the red silts suggests burial under flood plain conditions.

FAUNA OF THE CALIENTE RED-BEDS

The mammalian assemblage from the Caliente Mountains is incomplete, and consists entirely of herbivores. Further collecting doubtless will bring to light better material and give some representation of the carnivores. The following species are recognized.

Perissodactyla:

Rhinocerotid sp.

Hypohippus(?) sp.

Parahippus(?) sp.

Merychippus insignis carrizoensis n. sp.

Merychippus stevensi n. sp.

Artiodactyla:

Merychyus calimontanus n. sp.

Ticholeptus(?) sp.

Merycoidodont(?) sp. a

Merycoidodont sp. b

Camelid(?) sp.

Dromomeryx(?) sp.

Merycodus sp.

Chelonia:

Testudinate remains

ENVIRONMENT OF FAUNA

The environmental conditions which prevailed during the period of existence of the Caliente Miocene vertebrate fauna may perhaps be best understood as a result of study of the horses and merycoidodonts. The most common type of merychippine horse found in this horizon possesses very low-crowned and almost wholly uncemented teeth; a type of dentition ill-adapted to the gritty grasses of the open plains. Similarly, the anchitheriine horses, Parahippus and Hypohippus, with brachydont dentition and relatively broad feet were not typical plains dwellers. These forms

suggest a forest or glade environment and a humidity greater than that of the region as it is today. The least common merychippine horse in the fauna possesses teeth that are higher crowned, and more heavily cemented than in the common species Merychippus occurring here and hence indicates an adaption in the direction of grazing on open plains. The most advantageous set of environmental conditions for these types of horses might be found in a forested region with adjacent or interspersed grassland areas.

The rhinocerotid present in the fauna also possesses short-crowned teeth and likewise suggests wooded areas adjacent to grassy plains. Bode[4], calls attention to the fact that the modern species of rhinoceroses

4 Bode, F.D., Carnegie Inst. Wash. Pub., No. 435, p. 78, 1935.

feed on grasses and on the leaves of small trees and shrubs.

The large number of merycoidodonts occurring in the fauna indicates an environment favorable to their widespread development. Matthew[5]

5 Matthew, W.D., Univ. Calif. Pub., Bull. Dept. Geol. Sci., vol. 22, p. 30, 1932.

concludes from the occurrences of merycoidodonts and from the dental and limb characteristics of these forms that they lived wholly in the open and had acquired a grazing habit. The light, long-limbed Merychyus stock in particular was well adjusted to life on the open plains. It is interesting to note that the fauna from the Merychippus Zone lacks any representation of the Merycoidodontidae, although some of the other faunal elements are comparable to those in the Caliente assemblage.

This might be taken also as evidence indicating that the fauna of the Merychippus Zone was not one dwelling typically on the plains.

The Caliente fauna regarded as a unit suggests prevalence of an open plains environment adjacent to the flood plain of some stream, with forested areas near at hand.

STAGE OF EVOLUTION OF FAUNA

The small horse, Merychippus insignis carrizoensis, is subspecifically related to Merychippus insignis primus of the Sheep Creek beds of Nebraska, and suggests a Middle Miocene age for the Caliente fauna. Furthermore, the close relationship of Merychippus stevensi to Merychippus isonesus of the Mascall in stage of evolution as exhibited by the dentition likewise suggests an age not later than upper Miocene. Although the actual number of specimens collected and referred to the Equidae is small, the relative abundance of teeth of one type of horse and the scarcity of those of another reflect to some degree the representation of these forms in the fauna. The prevalence of a small, primitive Merychippus and the presence of a large, more advanced Merychippus may be taken as evidence to indicate a stage slightly earlier than the Mascall and later than the Sheep Creek. M. isonesus is the common species in the Mascall, while the smaller and more primitive M. relictus and M. severus are not so abundantly represented. Exactly the reverse is the case with regard to primitive and more advanced equid species in the Caliente fauna. In the Sheep Creek fauna M. insignis primus appears to be somewhat more primitive than the Caliente subspecies. Hence, the Caliente fauna may be regarded as more advanced in the presence of this new subspecies as well as of the advanced form, Merychippus stevensi.

The two anchitheriine genera Hypohippus and Parahippus present in the Caliente assemblage are characteristic of the Middle Miocene, particularly in their association with large and small merychippine forms. The material referred to these two genera is too fragmentary to permit very detailed determinations of relationship. The species of Parahippus is smaller and apparently more primitive than P. brevidens or P. avus of the Mascall, and therefore would seem to indicate a stage somewhat earlier than the Mascall Miocene.

The rhinocerotid material is too fragmentary to serve as a basis in establishing faunal relationships.

Characters exhibited by the merycoidodont remains in the Caliente collection do not furnish a satisfactory basis in determining the stage of evolution of these mammals. However, the relative abundance of merycoidodonts in the Caliente fauna is noteworthy, especially in view of the fact that they appear to be more characteristic of the Middle than of the Upper Miocene.

Dromomeryx(?) sp. may represent a lower Middle or Upper Miocene age, but the association of this genus with anchitheriine and merychippine horses frequently occurs in Middle Miocene faunas.

Merycodus sp. seems to be more primitive than Merycodus cf. cerroensis (Frick) of the Avawatz and Merycodus negatus of the Barstow; hence a stage of evolution is suggested that is earlier than middle Upper Miocene.

RELATIONSHIPS OF FAUNA

Pacific Coast Province.- Among Miocene faunas of the Pacific Coast only that of the Merychippus Zone on Domengine Creek, North Coalinga

District, exhibits close relationship to the Caliente assemblage. There are no determinable species in common between these two faunas, although there is considerable agreement in the genera that are present. The Caliente species of horses are less advanced than Merychippus californicus and M. brevidontus, and the latter are related to the M. isonesus rather than to the M. insignis group. The Parahippus(?) sp. appears to be much less advanced than the Coalinga P. brevidens. Absence of merycoidodonts in the Coalinga assemblage may reflect the more advanced stage of the latter fauna or unfavorable environmental conditions for the presence of the mammals during the period of its existence. It appears probable that ecologic conditions were among the deciding factors mitigating against their representation. The rest of the fauna does not exhibit sufficient character on which to make any detailed statements of relationships.

Great Basin Province.- The Tertiary assemblages of the Great Basin province showing closest resemblance to the Caliente fauna are the Mascall, Skull Springs, and Virgin Valley faunas, all nearly related. The Mascall shows greatest resemblance to the Caliente fauna. Merychippus insignis carrizoensis n. subsp. is closely related in stage of evolution to M. severus, M. relictus, and M. insignis, although slightly more primitive. Merychippus stevensi n. sp. is comparable in stage of development to M. isonesus although certainly distinct specifically. Because of lack of sufficient material the comparison of the anchitheriine horses from the Caliente beds with those from the Mascall is difficult. However, Parahippus(?) sp. is smaller and apparently more primitive than P. avus or P. brevidens. The merycoidodont genera and

species are distinct and offer no basis for comparison, other than that they are abundant or represented in both faunas. The small camelid from the Caliente Miocene may resemble Miolabis, a genus occurring in the Mascall. The Caliente Dromomeryx(?) sp. is too poorly represented to give more than an indication of affinity with D. borealis of the Mascall.

Great Plains Province.- The most nearly related Miocene vertebrate fauna from the Great Plains Province is apparently the Sheep Creek[6]. This fauna is slightly less advanced than the Caliente

6 Matthew, W. D., Bull. Amer. Mus. Nat. Hist., vol. 50, art. 2, 1924.

assemblage, but possesses comparable forms. Presence of an advanced merychippine type, M. stevensi n. sp., in the Caliente fauna and absence of any comparable form in the Sheep Creek beds suggest that the former assemblage is more advanced than the Sheep Creek fauna. M. insignis carrizoensis n. subsp. is very closely related to the Sheep Creek form, the differences between them being only of subspecific value. The artiodactyl genera Merychyus and Merycodus occur in both assemblages. However, no specific comparisons can be made due to the incompleteness of the material and the inadequateness of publishes descriptions.

Atlantic Coast Province.- The only vertebrate fauna in this province comparable to that from the Caliente Mountains is the Upper Hawthorn of Florida.[7] This assemblage is somewhat like the Caliente

7 Simpson, G. G., Florida State Geol. Survey. Bull. No. 10, p. 14, 1932.

Fauna in state of preservation and in its constituency. The Upper Hawthorn is less advanced than both the Caliente and the Sheep Creek,

and its age is probably lower Middle Miocene. Merychippus gunteri of the Upper Hawthorn is more primitive than M. insignis primus and M. insignis carrizoensis n. subsp. although very similar to these forms in size and in characters of the dentition. M. stevensi n. sp. is much more advanced than any species of Merychippus from the Hawthorn horizon. The merycoidodonts cannot be compared directly because of their fragmentary character. Dromomeryx is present in both faunas, but again the materials do not permit adequate comparisons.

STRATIGRAPHIC POSITION OF THE CALIENTE MAMMALIAN FAUNA IN TERTIARY MARINE SERIES OF CALIFORNIA

General Stratigraphy of Caliente Range[8] -

8 Reed, R.D., and Hollister, J.S., Structural Evolution of Southern California, Am. Assoc. Petrol. Geol., 1936.

The oldest exposed strata in the core of the Caliente Mountain anticline are a series of sparsely fossiliferous black shales referred to the Oligocene. These shales may be Eocene or Lower Miocene, as the paleontologic evidence is not altogether satisfactory. Overlying this shale series is a thick accumulation of Lower Miocene marine shales and sandstones carrying Vaqueros fossils. These shales and sandstones grade upward into strata, dominantly marine sandstones, which carry Middle Miocene Temblor fossils. Above a thick transitional zone with representations of both Vaqueros and Temblor faunas are sandstones containing Middle and Upper Temblor molluscs. The upper portion of the Temblor becomes non-marine and yields a mammalian fauna from beds closely associated with several basaltic flows. This upper portion of the Middle Miocene section consists dominantly of red-beds and basalt flows, but

me interbedded marine sands are also present and these contain littoral marine molluscs.

Overlying the basalts and red-beds is a brown silty shale a few hundred feet thick. It is apparently non-marine, but no fossils were found. A thick series of coarse sands and silts make up the "Upper Miocene" strata at the top of the section, overlying the shale. No identifiable fossils have been recorded from these, although some unidentifiable bone fragments were found near its base by H. D. Curry and R. D. Reed[9]. Further search failed to bring to light additional material.

9 Reed, R.D., personal communication.

An Upper Miocene age for these deposits is suggested because of their position above the Temblor. However, they may be determined ultimately as of an age earlier than Upper Miocene.

The change in types of sediments and faunas in the Miocene section of Caliente Mountain has been recognized by Reed and Hollister[10].

10 Reed, R.D., and Hollister, J. S., op.cit. p. 82, 1936.

They state: "The Caliente Mountain section is marine in the Lower Miocene parts, littoral above lower Middle Miocene, and non-marine throughout the several thousand feet of beds belonging to the upper Middle and Upper Miocene. Toward the southeast Lower and lower Middle Miocene grade into littoral and then non-marine facies. Toward the northwest, on the other hand, all members become marine, and most of the Lower and Middle Miocene becomes foraminiferal, commonly siliceous, shale."

These stratigraphic relations have made possible the correlation of foraminiferal, molluscan, and mammalian faunas of the Miocene occurring in the Caliente Mountain area. This has been accomplished principally by the use of persistent basalt flows that were found to serve as convenient marker beds. Discussion of individual sections will bring out in detail the relationships of these faunal facies to one another.

Padrones Spring and Jerd Spring Area.- The red-beds and basalt flows of this area show the greatest structural complexity of the entire region. As shown on the aerial photograph of this area, Plate , there are two principal basalt flows, the Main Basalt and the Lower Basalt. The former consists of two or three individual flows separated by clastic tuff and breccia. The total thickness of the flows is approximately one hundred feet. This group of flows forms the resistant stratum behind which are eroded the small basin-like badlands of Jerd Spring and Padrones Spring. Above the Main Basalt is exposed some seven hundred feet of coarse red, massive sandstones and interbedded red siltstones. These beds dip under the alluvium of the valley floor to the northeast. Southward along the strike the contact of these beds with the white and reddish coarse sandstones of "Upper Miocene" age is exposed. A thick section of the latter sediments is seen in the area reaching from the Main basalt to the San Andreas Rift. Southeast of JerdSpring are numerous basalt flows and poorly dissected red-beds.

The only fossil vertebrate, Merycodus sp., found in beds overlying the basalt occurs some three hundred feet above the upper contact of the Main Basalt, locality No. 170 C.I.T.

Below the Main Basalt at Jerd and Padrones Springs is a series of coarse red sandstones, green tuffaceous beds, and chocolate and tan silt-

stones in which occur remains of Merychyus calimontanus and a rhinocerotid at localities No. 313 and No. 312. These strata are folded, the folding having been sufficiently intense to produce reverse dips of the Main Basalt. To the southwest almost vertical dips of the basalt can be found in places, but these return to the normal 45° N.E. east and west of this area. Below these sandstones and silts exposed in the badlands of Padrones Spring are several unmapped basalt flows that may be the southeastward continuation of the Triple Basalts of the Cliff Gap and Wells Ranch areas.

Approximately 2500 feet below the Main Basalt is the Lower Basalt forming the southern boundary of the undissected area in back of Padrones Spring. This flow is approximately fifty feet thick and does not extend laterally into the Cliff Gap area, although this horizon may be traced into that section by means of a massive white sandstone bed that continues to the west after the basalt has thinned and disappeared. One hundred feet below the Lower Basalt is the locality of the lowest occurring identifiable vertebrate remains, locality No. 325. The material found here consists of teeth and limb fragments of an immature merycoidodont. This form is probably different from the Merychyus described from Jerd and Padrones Springs, but the material is too scrappy to permit positive identification. Unidentifiable fragments of bone were also found two hundred feet farther down in the section at locality No. 325P. It appears from the position of these lowermost fossil localities that they belong in the middle Temblor or in the older marine invertebrate horizons. If this is actually the case a faunal difference may exist between the vertebrates found in the sediments associated with the Main Basalt and the types occurring this far down in the section. The fossil material

available does not give evidence of a difference due to its fragmentary character and scant representation. Until such time as this might be shown to be the case all the fossil vertebrates occurring in a stratigraphic thickness of 3500 feet are regarded as belonging to a unit fauna.

The only invertebrate fossil found in this area is a fragment of a Turritella from the Padrones Spring badlands. J. E. Eaton[11] reports

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11 Eaton, J.E., personal communication.

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the presence of a zone containing Turritella carrisaensis in this area.

Cliff Gap Area.- West along the strike of the basalt flows from the Jerd Spring and Padrones Spring is the Cliff Gap area, plate This region yielded the most important mammalian fossil material and also demonstrated the close association of fossil vertebrates and invertebrates. The Main Basalt persists and continues westward into the Wells Ranch area. Overlying the Main Basalt are 1300 feet of coarse red sandstones that yielded no fossils. Above these red beds are unfossiliferous brown shale and a coarse sandstone and silt series which may be Upper Miocene in age. These sediments are involved in the partly overturned Wells syncline.

Below the Main Basalt are coarse red sandstones that outcrop in the Padrones Spring area; but interbedded with their lower portion and underlying them is a series of three or four thin basalt flows, named the Triple Basalts by Allen and Anderson[12], in the Wells Ranch

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12 Allen, H.B., and Anderson, I., Unpublished Thesis, Department of Geology, Univ. of Cal. at Los Angeles. A Stratigraphic Study of the Caliente Mountains Miocene, San Luis Obispo County, California. June, 1938.

Figure shows the columnar sections in the four critical

areas and attempts to correlate the several basalt flows.

Three hundred feet of coarse red sandstones occur between the Main Basalt and the Upper Triple Basalt. No vertebrate fossils were obtained from these sediments, although they represent the equivalent of the sandstones containing Merychyus and rhinocerotid of the Padrones Spring badlands. The Upper Triple Basalt underlying these sandstones is discontinuous, but becomes continuous farther to the west. The flow in this area averages about forty feet in thickness. Below the Upper Triple are 150 feet of red sandstones, and red and buff siltstones. Seventy feet above the underlying Sub-upper Triple Basalt occur remains of Hypohippus(?) sp. at locality No. 323. Thirty-five feet above this basalt flow and 1800 feet west along the strike, in a buff siltstone, occur remains of Merychippus stevensi, Parahippus sp., and limb elements referred to Hypohippus(?) sp. Twenty-five feet above a subsidiary member of the Middle Triple Basalt and below locality No. 323 is an oyster reef carrying an unidentified species of oyster.

The Sub-upper Triple Basalt appears to have a much weathered "pillow" structure. The outer surfaces of the "pillows" appear to have been chilled and are semi-vitreous. Limonite and gypsum veinlets fill numerous fractures in the basalt. The structure and appearance of this section in the vicinity of the subsidiary member of the Middle Triple contrasts strongly with the very vesicular, dense black, and relatively unweathered basalts of the other flows. The characters of this flow suggest that it was laid down in the presence of water vapor, if not sub-aqueously. Its presence so close stratigraphically to the oyster reef is suggestive. This basalt flow is from twenty to fifty feet thick

and extends laterally for approximately 3700 feet, dying out to the east and west of this locality.

Below the subsidiary member of the Middle Triple Basalt are 120 feet of sandstones and silts, which overlie the Middle Triple Basalt. Near the Middle Triple occurs another oyster reef characterized by a species of oyster which appears to be identical with that found in the upper reef. The underlying Middle Triple Basalt is about sixty feet thick. Below this basalt are 140 feet of tan and red siltstones and a few massive beds of sandstone. A few fragmentary remains of merycoidodonts were found in the red silts.

The Lower Triple Basalt flow underlying these sediments is fifty feet thick. Below this flow is an uninterrupted series of sandstones and shales that change downward in the section from reddish to yellow and buff color. The red beds become less numerous, although they continue to occur down in the section for several thousand feet. Below these deposits are found sediments containing marine Temblor and Vaqueros fossils. Fifty feet below the Lower Triple are fossil localities No. 315, and No. 324. No. 315 yielded the major part of the Merychippus material as well as the poorly preserved skull of the merycoidodont, Ticholeptus(?) sp. At approximately the same stratigraphic level 4000 feet west along the strike is locality No. 324, which yielded several teeth referred to Merycoidodont sp., and Promerycx(?) sp. One hundred and fifty feet below this horizon is another persistent oyster reef, and the oysters found here are again similar to those of the upper reefs.

1300 feet below the Lower Triple Basalt is a massive buff sandstone bed that marks the lateral extension of the horizon of the

Lower Basalt flow of the Padrones Spring and Jerd Spring area. No vertebrates were found this low in the section. It appears probable that the sediments adjacent to this horizon changed from non-marine to marine along the strike from the Padrones Spring section to the Cliff Gap section. Tracing this lowest of the vertebrate horizons from Padrones Spring to nearly the Wells Ranch enables one to establish the position of the horizon with respect to the invertebrate zones of the Wells Ranch section.

Locality No. 324 is the westernmost of the vertebrate occurrences, although the Main and Triple Basalt series of flows continues farther westward. The reddish colored sediments also continue westward into the Wells Ranch area, but invertebrate faunas replace the vertebrate assemblages.

Wells Ranch area.- The Wells Ranch section of the Basalt series lies six miles northwest along the strike of the Basalts from the Cliff Gap section. The following data concerning the stratigraphy and paleontology of this area are derived from a thesis by Allen and Anderson[13]

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13 Allen, H.B., and Anderson, I., op. cit., 1938.

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and from personal discussions with Dr. U. S. Grant IV and Mr. Harry Allen. A portion of the Wells Ranch columnar section, fig. , is reproduced here with the kind permission of Mr. J. E. Eaton, Dr. Grant and Mr. Allen. This section shows the stratigraphic relationships of the basalt flows and the sediments containing the upper and middle Tembler invertebrate zones.

The Main Basalt is 150 feet thick in this area, and the overlying red beds have thinned some 300 feet from the thickness near Cliff Gap.

The sediments underlying the Main Basalt are three times as thick as those in the Cliff Gap area. These deposits have not yielded any vertebrate or invertebrate fossils. The Triple Basalts retain the same thickness that they possess to the southeast, although the intercalated sediments are thicker in this section. Yellow and buff sandstones are dominant in the Triple Basalts with the red beds more or less restricted to the section above the Upper Triple and below the "Upper Miocene" shale.

One vertebrate fossil, a portion of a lower horse tooth, was found by Dr. U.S. Grant below the Main Basalt near Leaning House Gap. This tooth belongs to an advanced Pliohippus or possibly an Equus-like form. It is an extremely high and straight-crowned tooth, and much larger than the largest Merychippus teeth occurring in the sediments in the Cliff Gap area. It cannot have been derived from the red-beds associated with the Basalts and the Temblor invertebrates. Most probably it came from Late Tertiary or Quaternary terrace deposits that cover portions of the area adjacent to Leaning House Gap.

As is shown in the columnar sections in fig. , the identity of the Triple and Main Basalts in the Wells Ranch and Cliff Gap areas enables a striking correlation to be made between the sediments with the invertebrates in the former area and that with the vertebrates of the latter area. The position of Hypohippus(?) sp., Merychippus stevensi, and Parahippus(?) sp. is stratigraphically equivalent to the upper zone of the Upper Temblor as recognized by Grant and Allen. Similarly Merychippus stevensi, Merychippus insignis carrizoensis, Ticholeptus(?) sp., Mery-

coidodont sp. a, and Dromomeryx(?) sp. are stratigraphically equivalent to the underlying zone of the Upper Temblor. As expressed earlier, in the section on the Relationships and Stage of Evolution of the Fauna, the vertebrates suggest a middle Miocene age, intermediate between Mascall and Sheep Creek, The correlation chart fig. , shows the excellence of the correspondence of the age of these sediments associated with the basalts, as given independently by the invertebrate and vertebrate assemblages.

By tracing the previously mentioned buff sandstone bed, the horizon of the Lower Basalt of the Padrones and Jerd Springs section appears to be stratigraphically close to the base of the lowest zone of the Wells Ranch area as shown in the columnar sections, fig. . This would indicate that the Lower Basalt horizon and the Merycoidodont sp. b of locality No. 325 are probably the correlative of the Middle Temblor. The nature of the merycoidodont material from this horizon does not permit determination of its relationship to merycoidodonts found in sediments associated with the Triple and Main Basalts.

Washburn Ranch Area.- This area lies five miles northwest of the Wells Ranch section and thirteen miles northwest of Padrones Spring and Jerd Spring. The Main and Triple Basalt flows are well exposed in the Wells Ranch section, but one mile northwest of Black Rock Ridge, near the mouth of Midway Canyon, the Main Basalt thins and disappears below the valley alluvium. The Upper Triple Basalt continues northwesterly into the Washburn Ranch section, but its companion flows, the Middle and Lower Triple Basalts, thin out and disappear in the vicinity of Midway Canyon.

In this distance along the strike of the Upper Triple Basalt from the Wells Ranch section into this area, the red beds below the Upper Triple Basalt are replaced by white and buff sandstones and calcareous shales. Above the basalt some few tens of feet of red beds persist along the strike into this area.

It becomes evident therefore that an easily recognizable stratigraphic unit, the Upper Triple Basalt, fig. , can be traced for ten miles from the vertebrate occurrences of the Cliff Gap area, through the section containing invertebrate fossils in the Wells Ranch area, into the Washburn Ranch region, where foraminiferal shales occur. Thus the marker basalt flow permits a stratigraphic correlation of the beds containing molluscan, vertebrate and foraminiferal assemblages in this portion of the Caliente Mountain Miocene.

Several years ago R.M.Kleinpell, W.D. Kleinpell, and J.S. Hollister[14]

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[14] Kleinpell, R.M., Miocene Stratigraphy of California. Am. Assoc. Petrol. Geol., p. 73, 1938.

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collected a Gould shale foraminiferal fauna in a calcareous shale east of Sulphur Spring Creek. The locality, No. 1772, L.S.J.U., lies on the Washburn Ranch property in the near vicinity of the Upper Triple Basalt. On the aerial photograph of this area, plate , the Upper Triple Basalt is seen to be exposed along the flanks of the ridges that lie immediately southwest of the valley under cultivation, south and west of the Washburn Ranch house. The small alluviated valley lies in the trough

of a syncline, and the Upper Triple Basalt curves back around the northern nose of the structure and is exposed immediately southwest of the ranch house as well as along the northeast rim of the valley. The nose of the syncline lies approximately one mile northwest of Sulphur Spring Creek.

From the locality description and information furnished by W.D. Kleinpell one may judge that the location where the foraminiferal fauna was collected occurs in the valley now under cultivation. However, it is possible to give a maximum figure of 600 feet, the stratigraphic distance which separates this foraminiferal horizon from the Upper Triple Basalt lying above it.

The chart showing the columnar sections, fig. , presents graphically the stratigraphic correlations between the various areas as based principally on the basalt flows. Thus it seems to be demonstrated that the Upper Relizian foraminifera are stratigraphic equivalents of at least the beds of the upper portion of the Upper Temblor containing invertebrates and of the strata containing Hypohippus(?) sp., Parahippus(?) sp., and Merychippus stevensi n. sp.

AGE OF CALIENTE FAUNA

On the basis of the fauna as a whole and of the stage of evolution of its various constitutents, this assemblage is Middle Miocene in age and presumably intermediate between the Mascall and Sheep Creek vertebrate stages. The stratigraphic correlation of this fauna with Upper Temblor invertebrates and Upper Relizian foraminifera places these vertebrates rather accurately in the invertebrate time scale of the California Miocene. This vertebrate fauna may be considered as belonging to the time stages represented by the lower portion of the Upper Relizian stage and the

upper portion of the Lower Relizian. Thus, the deposits containing the fauna are doubtless to be correlated with the Gould Shale and upper Temblor.

Discovery of the Caliente Miocene vertebrates in a stratigraphic section containing marine invertebrate faunas necessitates a slight revision of our views regarding the position of related vertebrate assemblages for western North America.

The Merychippus Zone of the North Coalinga district, according to F.D. Bode and R. M. Kleinpell, probably lies stratigraphically in beds immediately above the Temblor, as this term is employed in the type section. Its position is definitely above beds representing the uppermost zone of the Upper Relizian, and within beds included in the Lower Luisian stage of the marine Miocene of California. The Caliente deposits, as described in detail in the previous section, are equivalent to the Upper Temblor, of the type section, and possibly also to the lower portion of the Upper Relizian stage. This places the Merychippus Zone above the Caliente Beds by at least the stratal unit represented by the Upper Relizian.

The Mascall, Skull Springs, and Virgin Valley faunas are regarded by Bode as older than the Merychippus Zone, and by the writer as younger than the Caliente assemblage. The Mascall and related faunas are therefore intermediate in time between the two Californian assemblages. The suggestion is therefore made that the Mascall, Skull Springs and Virgin Valley faunal stages belong to the period of time when the Gould Shale and Upper Relizian

fauna were accumulating in Miocene. The Sheep Creek is certainly older than either the Mascall or Caliente and is probably the equivalent of the lower Middle Miocene as determined in the invertebrate sequence of the California Tertiary. The correlation chart, fig. , is in part based upon observations by F.D. Bode, R.M. Kleinpell, and G.G. Simpson.

SYSTEMATIC DESCRIPTION OF FAUNA

EQUIDAE

Four species have been recognized among the Equidae, and these are distributed among the genera Hypohippus, Parahippus and Merychippus. The material consists of some twenty-seven isolated teeth, one fragment of a lower jaw bearing three teeth, one series of three upper molars, and several isolated limb elements. These specimens, with exception of the jaw fragment, are not particularly well preserved and do not include any deciduous teeth. Despite poor preservation and small representation of teeth it is readily seen that there are two species of Merychippus in the fauna, distinguished by differences in size and in crown height of teeth.

Merychippus insignis carrizoensis n. subsp.

Type specimen.- M^1, M^2 and M^3 in fragment of left maxillary, No. 2552, Calif. Inst. Tech. Coll., Caliente Mountains, San Luis Obispo County, California.

Paratypes.- P^4, No. 2560; P_3, No. 2558; $\overline{M^3}$, No. 2570; $\overline{P^4}$, No. 2575; Calif. Inst. Tech. Coll., Caliente Mountains, San Luis Obispo County, California.

Subspecific characters.- Height of crown slightly less than in Merychippus insignis primus (Osborn) and greater than in M. gunteri Simpson. Size close to that of M. insignis primus. Protocone attached firmly to protoconule almost immediately after wear is initiated. Teeth with very thin coat of cement. Pre-fossette exhibits two or three plications with one quarter wear, while post-fossette is rarely plicated. Lower cheek-teeth with moderately complex enamel folds. Poorly cemented, but more so than in the uppers. Distinct separation of metastylid on molars.

This species is represented in the collection by twelve upper teeth, and ten lower teeth, all quite similar in their characters and showing very little variation.

The principal characters are the small size, short crown, attachment of protocone, and lack of any great amount of cement. The cross-sectional area is comparable in size to that of M. primus. The posterior enamel border of the pre-fossettes may have as many as six plications in little worn teeth and the anterior border of the post-fossette may have as many as four plications, although the latter number occurs but rarely. In general the plications are more numerous and better developed in the pre-fossette, but all plications become very faint when the tooth is worn half way down. The pre-fossette is closed in all specimens after slight wear has taken place. A single pli-caballin is present in all specimens.

The deposit of cement is very light externally and ligually, and appears restricted to areas of invagination of the enamel. The external styles are prominant and the crown is strongly curved. The curvature appears to be particularly evident in the upper third of the crown. A permanent and strong attachment of protocone and protoconule is seen shortly after wear has taken place. The metaconule-hypocone and the protoconule-protocone are distinctly loph-like in unworn teeth.

The height of the inferior cheek-teeth is very similar to that of the uppers. They are a trifle smaller in size than those of M. primus. The lowers are somewhat more heavily cemented than the uppers, but the amount of cement present is variable. The metaconid-metastylid column is well developed and the separation between the two extends well down toward the base of the crown. The metaconid-metastylid column of $\underline{P2}$, No. 2581 (fig.), possesses no internal groove except at the extreme tip. The enamel pattern in these teeth is somewhat more complicated than in those of M. primus, but it becomes simple in type when the tooth is worn more than one-third of its height.

Comparisons.- Merychippus i. carrizoensis is very close to the type of Merychippus brevidontus Bode in size of tooth crown, but the teeth of the former are shorter crowned. The most striking differences lie in the complexity of the enamel pattern, heavy cementation, and in the detached protocone of M. brevidontus. This latter species is distinctly more advanced and certainly specifically different from the Caliente form. The lower teeth of the Coalinga species are somewhat higher crowned and more complicated in

character of enamel pattern than M. i. carrizoensis. The metaconid-metastylid column is better developed in the former and the internal gutter more clearly defined. Moreover, protoconid and hypoconid exhibit a small fold projecting internally from their inner walls, a character which is not present in specimens from the Caliente region.

M. californicus Merriam is not closely related to the Caliente species. The former is much larger and higher crowned, and upper cheek-teeth possess an isolated protocone. Cementation is also very much heavier in M. californicus.

The teeth of M. relictus are slightly higher crowned, possess more complicated fossette borders, heavier cement than the Caliente species. In upper cheek-teeth of Cope's species the protocone is an isolated cusp and remains so even in teeth that are very well worn. M. insignis carrizoensis resembles M. relictus in the crown-sectional area of the crowns of cheek-teeth.

In the teeth of M. isonesus Cope the crowns are much higher, with isolated protocone and heavier cement. The lowers of this species are similar in pattern to those of the Caliente form, but the latter are smaller and lower crowned.

Among species recorded from Tertiary deposits of Eastern North america the small Caliente Merychippus is probably most closely related to M. insignis primus (Osborn) of the Sheep Creek Middle Miocene.[15]

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15 Matthew, W.D., Bull Amer. Mus. Nat. Hist., Vol. L, art.II, p. 162, 1924.

Comparison with topotypic material in the American Museum collections suggests that the Californian material represents a subspecies of Merychippus insignis Leidy, and is distinguished from M. insignis primus only in small details. The height of crown of unworn specimens from the Caliente Miocene is somewhat less than in teeth of M. primus and amounts to ten percent on the average. A thinner deposit of cement is present in the Caliente specimens, but this substance may have been worn away to some extent in the process of transportation and burial. Both types show practically the same degree of complexity in development of the fossette borders and have the pli-caballin present in upper cheek-teeth. The union of protocone and protoconule takes place at almost exactly the same place in the height of the crown, and the isthmus is of comparable width in these subspecies. Likewise, the cross-sectional areas of the crowns of the cheek-teeth at equivalent stages of wear are very similar. The lingual border of protocone and hypocone in M. i. primus is flattened somewhat, but the difference between this form and the Caliente subspecies is not striking.

The characters of the lower teeth of the two subspecies are also similar. Crown height and the amount of cement are less in the Caliente specimens, but the enamel patterns of the two forms are strictly comparable. The stage of development of the metaconid-metastylid column is almost identical. The lower cheek-teeth of M. insignis carrizoensis appear to be smaller in overall size. The difference in the size of the premolars and molars in specimens of M. insignis primus is observable also in the teeth of M. insignis carrizoensis. Thus, the latter species appears

to be slightly less advanced than M. insignis primus, although individual specimens are sometimes difficult to distinguish from the latter except for the presence of less cement.

Merychippus gunteri Simpson of the Hawthorn Middle Miocene[16] is

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[16] Simpson, G.G., Bull. Amer. Mus. Nat. Hist., vol. LIX, art. III, p.163, 1930.

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also close to the Caliente subspecies. Simpson[17] suggests that M. gunteri is a member of the Merychippus insignis group, and that the Florida species is somewhat more advanced than Merychippus insignis primus. The latter

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[17] Simpson, G.G., op. cit., p. 165, 1930.

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statement is difficult to understand in view of the fact that M. gunteri is described as having shorter crowned teeth that are smaller in size, and possesses a more complex enamel pattern than in M. i. primus.

From the descriptions and illustrations it appears that the teeth of M. gunteri are slightly shorter crowned than those of the Caliente form, although they are close in crown size. The similarity in complexity of fossette borders and in early union of protocone and protoconule are further characters in common. A simple pli-caballin is present in both forms, and judging from the illustrations, the cement on the teeth of the Florida species appears to be almost as slight as on those of M. insignis carrizoensis. The lower teeth are very similar in their enamel patterns. The overall dimensions of the lower teeth of M. gunteri appear to be greater than in the Caliente form. One character seen in both the California and

Florida species is the feeble separation of the metastylid in $\overline{P2}$, although it is distinct in other teeth.

The Hawthorn species is probably more primitive than M. insignis carrizoensis, and may be comparable to the primitive merychippine type from the Phillips Ranch horizon of California. Osborn[18] quotes Merriam with regard to similarity which exists between lower teeth of this species,

[18] Osborn, H.F., Mem. Amer. Mus. Nat. Hist. N.S., vol.II, p. 108, 1918.

described by Sellards, to specimens from the Phillips Ranch horizon.

M. gunteri is more primitive than the Caliente species, although the latter is not far removed in stage of advancement of its characters. M. insignis carrizoensis possesses characters which appear to place it between M. insignis primus and M. gunteri. The California species is certainly most closely related to these forms and hence is designated as a new subspecies of M. insignis Leidy.

(1) Merychippus insignis carrizoensis n. subsp.
(2) Merychippus gunteri Simpson
(3) Merychippus insignis primus (Osborn)
(4) Merychippus brevidontus Bode
(5) Merychippus californicus Merriam

Measurements (in millimeters)

Superior Dentition:	(1) C.I.T. No.	(2) F.S.G.S. V-4959	(3) A.M.N.H. 1893	(4) C.I.T. No.	(5) C.I.T. No.1405
$\overline{P2}$, anteroposterior diameter..(2553)	21		20.0 (1421)	22.2	21.4
transverse diameter. . . .	16.5		16.8	18.7	18.6
$\overline{P3}$, anteroposterior diameter..(2558)	16.8		16. (1414)	19.8	21.7
transverse diameter. . . .	19.5		19.1	22.	21
$\overline{P4}$, anteroposterior diameter..(2560)	16.9		15.5 (1413)	18	21
transverse diameter. . . .	18.8		19.4	19.7	21.4
$\overline{M1}$, anteroposterior diameter..(2552)	16.6		15 (1409)	18	18.8
transverse diameter. . . .	18		19	19	20
$\overline{M2}$, anteroposterior diameter..(2552)	16	14.5	15.8 (1408)	18	19
transverse diamter	19.5	20	19.2	21	20

Measurements (in millimeters) contin.

		(1)	(2)	(3)	(4)		(5)
M3, anteroposterior diameter..	(2552)	14.3	14.5	16	(1423)	18.5	19

Inferior Dentition:

			V-4962				488
P2, anteroposterior diameter..	(2581)			15.3			18.7
transverse diameter. . . .		9.1		9.6			9.7
P3, anteroposterior diameter..	(2573)	15.6	17	15.5			18.7
transverse diameter. . . .		10.1	12	11.3			10.8
P4, anteroposterior diameter..	(2577)	15.7	17	15.6	(1491)	19.2	19
transverse diameter. . . .		10.3	12.5	11.2		11.5	11
M1, anteroposterior diameter..	(2578)	15	16	14.5	(1426)	18	16.8
transverse diameter. . . .		9.7	11.5	10.3		10.7	9
M2, anteroposterior diamter..	(2576)	14.4	17	15.0	(1430)	18.6	18.5
transverse diameter. . . .		8.9	11	9.7		10	8.7
M3, anteroposterior diameter..	(2570)	16		19			20.6
transverse diameter. . . .		7.2		8.1			7.8

Merychippus stevensi n. sp.

Type specimen.- M1 or M2, No. 2582 Calif. Inst. Tech. Vert. Pale. Coll.

Paratypes.- DP3, slightly worn, No. 2562; M1, well worn, No.2555; M3, No. 2571; and lower cheek tooth, No. 2572.

Specific characters.- One third larger and cheek-teeth with higher crowns than in M. insignis carrizoensis. Height and size of crown comparable to that in M. isonesus. Fossette borders of upper cheek-teeth less complicated than in M. californicus. Protocone attached firmly to the protoconule and this union is seen immediately after wear has begun. I take pleasure in naming this species for John B. Stevens, geologist of the Associated Oil Company of California.

This species is represented by eight upper teeth, two fragmentary lowers, and an ungual phalanx of the median digit. Some variation in characters is exhibited by the teeth but all specimens are distinct from those referred to M. insignis carrizoensis.

Description.- The specimens referred to M. stevensi are all considerably larger and higher crowned than those of the small Merychippus in the fauna. As in the smaller species the protocone is attached, and in this character the teeth differ from those of the Miocene species M. isonesus and M. californicus. The dimensions of the tooth crown are on the average almost exactly those of M. isonesus. The enamel pattern of the occlusal surface shows slight complication. Usually three to five plications of the fossette border are seen in half worn teeth. The pli-caballin is simple and single. The amount of cement present is variable, but it is quite heavily deposited on well preserved teeth.

The inferior cheek-teeth are represented only by two fragments. a broken $\underline{M3}$ appears to be much higher crowned and larger than the lowers of M. insignis carrizoensis. The other fragment possesses a moderately complex enamel pattern that is similar to that in M. californicus.

One specimen, probably a milk tooth of this Caliente form, No. 2562, C.I.T., is similar to milk premolars of M. isonesus. No. 2562 is hypsodont with protocone and hypocone tending to form pillars as in deciduous teeth of M. californicus.

M. stevensi possesses cheek-teeth that are from a quarter to a fifth shorter crowned than in M. californicus, although the areas of their occlusal surfaces and their dimensions are closely similar in these forms. Cement forms a much thicker substance in teeth of the former, although as Bode[16] has pointed out, this character is highly variable and doubtful

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[16] Bode, F.D., Carnegie Inst. Wash. Pub. No. 435, p. 53, 1934.

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diagnostic value in many cases. The fossettes in upper cheek-teeth of

M. stevensi have less complicated borders; and the pre-fossettes appear to be closed in all specimens. The latter feature contrasts with that of M. californicus, for in the species from the Merychippus Zone seventy percent of the premolars have the pre-fossette open until the crowns are half worn. The Caliente species differs markedly from M. californicus in very early attachment of the protocone. M. stevensi is certainly distinct from and less advanced than M. californicus.

M. insignis primus possesses distinctly lower crowned teeth and is a smaller type, although in the relation of protocone to protoconule it shows considerable resemblance to M. stevensi.

On the basis of the comparisons which have been made, Merychippus stevensi is probably close to M. isonesus in stage of evolution and is less advanced than M. californicus. No described species is strictly comparable to the Caliente form and hence, although the specimens are few in number, it seems desirable to recognize it as a distinct type.

HEIGHT OF CROWN OF CHEEK-TEETH IN MERYCHIPPINE SPECIES
(Measurements of unworn upper teeth in mm.)

HORIZON	SPECIES	MAXIMUM	MEAN	MINIMUM
Sheep Creek	Merychippus insignis primus (Osborn)	22		16
Caliente	Merychippus insignis carrizoensis n. subsp.	23		16
	Merychippus stevensi n. sp.	33		28
Mascall*	Merychippus isonesus Cope	34	29	26
Coalinga*	Merychippus californicus Merriam	42	34	29
Barstow*	Merychippus sumani Merriam or Merychippus intermontanus Merriam	46	36	32

* Measurements after Bode, 1934.

Measurements of unworn or slightly worn topotypic specimens.

Parahippus(?) sp.

Occurring in the same horizon with the type of Merychippus stevensi, at locality No. 322, Calif. Inst. Tech. Vert. Pale., is a fragmentary left ramus of a small anchitheriine horse, No. C.I.T., which retains $\overline{P4}$, $\overline{M1}$, and $\overline{M2}$. The teeth are moderately worn, and are very well preserved.

The jaw is deep, much more so than that in Archaeohippus mourningi. In this respect the specimen appears to belong to the Parahippus group. Cement appears to be completely lacking, but a thin deposit in the lingual valleys may represent a slight amount of this substance. F. D. Bode[20] cites the following list of characters distinguishing Archaeohippus from Parahippus: " (1). Complete absence of a crochet, (2). constant thin a straight alignment of protoloph and metaloph, (3). precocious development of crown-height relative to small size of tooth, (4). complete absence of cement, and (5). peculiar and characteristic development of the pre-orbital fossae as shown in A. ultimus and A. penultimus." One additional character stated by Bode, may be of value, namely "the maximum transverse diameter for the cheek tooth series occurs in $\overline{P4}$, an advance beyond the position in which this measurement is found in typical members of the anchitheriine group."[21] It is unfortunate that this group in the Caliente fauna, is represented only by lower teeth. Under these circumstances the characters useful in determining the relationships of the Caliente species are limited to the presence or absence of cement, position

[20] Bode, F.D., Carnegie Inst. Wash. Pub., No. 440, p.56, 1933.

[21] Bode, F.D., op. cit., p. 57, 1933.

of maximum transverse tooth diameter in jaw, and to general size and proportions of jaw and teeth.

The apparent absence of cement in No. suggests a relationship with Archaeohippus, but the robustness and depth of the jaw, when compared with that of Archaeohippus mourningi, suggests a larger, heavier Parahippus - like form. Lack of cement seems to feature several species of Parahippus, as for example P. agrestis. Some specimens of P. leonensis also show this character. If correctly referred to Parahippus, the species from Caliente Mountain is certainly smaller than most species listed by Schlaikjer[22] in his discussion of the genus. This species appears to be

[22] Schlaikjer, E.M., Bull. Mus. Comp. Zool., Harvard., vol.LXXX,No.5, 1937.

smaller than P. tyleri and P. leonensis, and is probably larger than P. pristinus. The Caliente species may represent a dwarf from or the survival of a primitive type.

$\overline{P4}$ is larger and more robust than the molars. All teeth possess faint external cinguli, and internal cinguli are limited to the anterior and posterior faces of each tooth. The metaconid and metastylid are separated slightly at the top of the crown, but the separation disappears on the lower half of the tooth. The entoconid and entostylid appear to be well developed.

Measurement (in millimeters)

	Parahippus(?) sp. No. C.I.T.
$\overline{P4}$, anteroposterior diameter.	14.0
transverse diameter.	10.8
$\overline{M1}$, anteroposterior diameter.	13.0
transverse diameter	9.2
$\overline{M2}$, anteroposterior diameter.	13.0
transverse diameter.	9.

Hypohippus (?), sp.

The greater portion of a tibia with associated astragalus, No. 2551, C.I.T. appears to represent this anchitheriine genus. These elements were found at locality No. 323, approximately fifty feet stratigraphically above a horizon containing Merychippus and Parahippus. The tibia lacks the proximal end including the cnemial crest, although the rest of the specimen is well preserved with the astragalus in articulation. The elements belong to a very large heavy-limbed equid. The only figured or measured tibia of Hypohippus available for comparison is that of Hypohippus (Drymohippus) nevadensis[23] from the Cedar Mountain beds of Nevada. No. 2551 is very similar in its proportions to the latter but is smaller in some of its measurements.

[23] Merriam, J.C., Univ. Calif. Publ., Bull. Dept. Geol., vol.9, No.13, 1916.

Measurements (in Millimeters)

	Hypohippus(?), sp. No.2551 C.I.T.
Tibia:	
length (approximate).	400.
greatest transverse diameter of distal end	73
Astragalus:	
greatest transverse diameter.	57
greatest height of articular surface with the tibia	60.

Rhinocerotid, sp.

Presence of a rhinocerotid in the fauna is indicated by several fragments of teeth, Nos. and C.I.T. Coll. Vert. Pale. The available material suggests a type with relatively small, short-crowned teeth.

MERYCOIDODONTIDAE

Merychyus calimontanus n. sp.

Type specimen.- No. 2543 Calif. Inst. Tech. Coll., palate with dentition but lacking the right upper incisor teeth, and associated limb fragments.

Referred specimens.- No. 2545 Calif. Inst. Tech. Coll., fragmentary left maxillary with P4, and M1 to M3 inclusive. No. 2544, a fragmentary left ramus with $\overline{P4}$, and $\overline{M1}$ to $\overline{M3}$ inclusive. No. 2546, palate with deciduous teeth and P4 - M3.

Specific characters.- Size larger than M. elegans and very close to that of M. harrisonensis. The anterior premolars are less reduced and crowded than in M. elegans. Posterior transverse spur projecting inward from principal cusp of P3 not connected with the inner border of the crown. Premolars slanting posteriorly more so than in M. harrisonensis and less so than in M. elegans.

Description and comparison.- The author is indebted to Dr. Chester Stock for his notes on the types of M. elegans, and M. arenarum.

The Caliente species is slightly larger than M. elegans, No. 120 U.S.N.M. The basic patterns of the premolars in the two species are very similar,

but significant differences are present in P3 and P2. P2 possesses a shorter anterior oblique spur; and the middle transverse spur is directed posteriorly rather than inward and slightly foreward as in No. 120.

The occlusal surface of P3 in No. 120 is slightly broader for its length than in M. calimontanus . The most important character appears to be exhibited by the posterior transverse inner spur of the principal cusp in P3. In M. elegans this spur meets the inner border of the tooth and forms two basins on the internal side. In M. calimontanus the spur does not reach the inner border of the crown, and the anterior basin is not closed. The spur does not seem to connect with the inner border until the tooth is very well worn. The premolars of M.elegans are smaller with respect to the size of the molars than in M. calimontanus. The premolar-molar index of M. elegans is 0.71, and that of M. calimontanus is 0.76.

M. arenarum No. 8146 A.M.N.H. from the Upper Harrison, is very similar in size to M. calimontanus. The premolars and molars of this specimen have greater length than those of M. arenarum, although their width is very nearly the same. The premolar indices are 0.76 and 0.72 respectively.

P4 of M. calimontanus lacks the well developed internal cingulum of No. 8146. P4 and P3 are not so long crowned as are the comparable teeth in the Californian species.

As in M. elegans, the posterior internal oblique spur from the principal cusp extends to the inner border of the crown. This type of spur appears to occur in other species of Merychyus insofar as this can be determined from the illustrations in Thorpe's Monograph.[24] The specimens

[24] Thorpe, M.R., Mem. Peabody Mus. Nat. Hist., vol. III, part IV, 1937.

from Caliente Mountain thus differ from these species in the absence of a connection between this spur and the internal wall of the crown of P3.

The paratypic lower dentition No. 2544 C.I.T. Coll. Vert. Pale. possesses the typical $\overline{P4}$ of Merychyus, as figured by Loomis[25]. The $\overline{P4}$ of this

[25] Loomis, F.B., Bull. Amer. Mus. Nat. Hist., vol. II, art. 1, 1924.

specimen is almost exactly similar to that in the type of the genus. The lower molars tend to be somewhat squarer than those of M. elegans and M. arenarum.

Merychyus harrisonensis, of the lower Harrison, is slightly larger in overall length of dentition, but is very close in size of individual teeth. The premolar-molar index of the former is 0.77, and the premolars appear to be slightly smaller although less crowded and less reduced anteriorly than those of M. calimontanus. Thorpe[26] considers M. harrisonensis the most primitive form of the genus Merychyus. M. calimontanus has more

[26] Thorpe, M.R., op. cit., vol. III, pt. 4, 1937.

advanced features than the lower Harrison form, and less advanced features than M. elegans of the Upper Miocene (?). The stage of evolution of the Californian species suggests a Middle Miocene age.

Associated with the type palate, No. 2543, are fragments of both hind limbs. The distal end of a left femur, the proximal endsof the left

and right tibiae, both astragali and calcanei and several metatarsals and phalanges are preserved. The metatarsals are quite long and slender, and the shaft of the tibia is narrow and elongate. The measurements given in the table emphasize the delicate character of the limb elements of M. calimontanus. The proportions of the hind limbs of this specimen are strictly comparable to those of the smaller Merychyus elegans minimus. Comparison with the proportions of Promerycochoerus vantasselensis demonstrates the differences between the long-limbed, light forms, and the short-limbed, heavy types. In the latter genus and species the calcaneum is longer than metatarsal IV, while in the former metatarsal IV is one-third longer than the calcaneum. Similarly the metatarsals of P. vantasselensis are one-third broader than those of M. calimontanus, although the metatarsals are very similar in size.

A fragmentary palate of M. calimontanus, No. 2546, bearing deciduous premolars occurred at the same stratigraphic level several tens of feet east of the occurrence of the type adult palate. $Dp\frac{3}{3}$ $Dp\frac{4}{4}$, and $M\frac{1}{1}$ are preserved on both sides. $Dp\frac{3}{3}$ is short crowned with moderately prominent external styles. In its front portion the tooth possesses anterior and antero-internal basins which are flattened and compressed as in the permanent premolars, but the posterior portion of the tooth appears to have the simple crescent and pillar of a molar. $Dp\frac{4}{4}$ is short crowned with prominent external styles. It is molariform with double crescents and pillars. $M\frac{1}{1}$ is longer crowned than the deciduous teeth and possesses very strong external styles.

Measurements (in millimeters)

	M. arenarum Cope	*M. elegans* Leidy		*M. calimontanus* n. sp.			
	No. 8146	No. 120	No. 121	No. 2543		No. 2545	
	A.M.N.H.	A.M.N.H.		C.I.T.			
Superior dentition:							
Length, anterior end of C to posterior end of M^3 ------		86	88.7	92.2			
Length, anterior end of P^1 to posterior end of M^3 ------		76.4	77.4	81.9			
Length, anterior end of P^3 to posterior end of M^3 ------	63.1			65			
P^1, greatest oblique length ---		6.9	7.6	8.6			
P^1, width normal to length ----		4.3	4.6	5.2			
P^2, length along outer side ---		8.2	8.4	8.6			
P^2, greatest width ----------		7.2	6.4	7.3			
P^3, length along outer side ---	9.3	8.9	8.7	10.2			
P^3, greatest width ----------	9.3	8.7	7.8	9.2			
P^4, length along outer side ---	8.8	8.9	8.1	9		9	
P^4, greatest width ----------	12	10.7	9.5	11.8		11.9	
M^1, length along outer side ---	12.3	12.9	11.7	12.6	a	13.7	
M^1, greatest width ----------	13.3	13.8	12.5	13.6		13	
M^2, length along outer side ---	15.6	a 15.2	16	17.5	a	16.9	
M^2, greatest width ----------	14.9	14.8	15.1	15.2	a	15.8	
M^3, length along outer side ---	19	20.5	22.2	19.2		20.5	
M^3, greatest width ----------	15.6	17.3	15.5	16.6		15.8	
C, transverse width ----------		7.7	7.2	8.2			
Inferior dentition:							
Length, anterior end of P_4 to posterior end of M_3 ------	60.7			No. 2544 61			
P_4, length along inner side ---	12.4	10.8	10.7	11.4			
P_4, greatest width ----------	9.5	7.8	7	8.3			
M_1, length along inner side ---	12.2	11.8	11.1	11.4			
M_1, greatest width ----------	9.5	8.7	8.7	9.5			
M_2, length along inner side ---	14.3	14.5	14.3	14.4			
M_2, greatest width ----------	10.9	9.9	10.7	11.1			
M_3, length along inner side ---	23		24.1	25.8			
M_3, greatest width ----------	10.3		10	a 10.6			

a, Approximate

1, Measurements from Thorpe, 1937.

M. harrisonensis Peterson[1]

No. 1341
C.M.
95
82
8
4
10
7
9.5
8
8.6
11.5
12
13.5
15
15
20
16.1
8

Measurements (in millimeters)

	M. calimontanus C.I.T. No. 2543	P. vantaselensis[1] C.M. No. 1230	M. elegans minimus[2] C.M. No. 1439
Femur, greatest transverse diameter of condyles	29.1		
Tibia, greatest transverse diameter of proximal end	31.3	53	24*
Calcaneum, greatest length	45.6	78	33*
Astragalus, greatest length	26.4	42	18*
Astragalus, greatest transverse diameter	16.2	27	12*
Metatarsal IV, greatest length	62.5	65*	50
Metatarsal IV, transverse diameter of distal end	10.1	16*	7*
Digit IV, length of first phalanx	22.3		13*

* Measurements from illustration.

1 Peterson, O.A., Ann. Carn. Musc., vol. IX, fig. 40, p. 213, 1914.

2 Loomis, F.B., Bull. Geol. Soc. Amer., vol. 44, pt. 4, p. 726, 1933.

Ticholeptus(?) sp.

A badly crushed skull and lower jaws of this merycoidodont, No. 2550 C.I.T. Coll. Vert. Pale., was found at locality 315 in association with remains of a merychippine horse. Although lacking only the anterior portion of skull and jaws and the extreme posterior end of the skull, this specimen has suffered so badly from crushing that exact measurements and comparisons cannot be made. A certain amount of calcareous in filtration of the specimen has likewise obscured somewhat the character of the dentition. Hence, only a tentative generic determination can be recorded.

The skull is long and deep, its length falling within that of known species of Ticholeptus and is well above that of Merychyus. The species of the Merrycochoerus line are on the other hand considerably larger and more robust. The nasals appear to be long. The brain case is narrow, relatively high, and short. The orbits are small and nearly circular in outline. The zygomatic processes of the jugal appear to be thin, and in all probability the zygomatic arches were slender. A small facial vacuity lies immediately anterior to the orbits. A larger depression occurs farther forward in the left maxillary, but from itsposition and the character of its borders may be judged to result from crushing.

In the lower jaw the coronoid process is short and thin, and the condyle is robust. The angle is worn away, but the jaw is essentially complete in depth below $\underline{M3}$.

The superior dentition is badly crushed except for $\underline{M3}$. The anterior premolars are absent and $\underline{P3}$ and $\underline{P4}$ are only partly preserved. The length

of the superior molar series lies between that of Ticholeptus brachymelis Douglass and that of Ticholeptus rusticus (Leidy)[2]. The diameter of

[2] Thorpe, M.R., op. cit., vol. III, pt. IV, p. 287, 1937.

M3 are greater in No. 2550 than in the former species, and smaller than those of the latter.

The dimensions of the lower molars are quite close to those of T. rusticus.

The characters of the Caliente specimen are not those of any described middle Tertiary oreodont, although it must be conceded that the structural features are so poorly exhibited as to obviate the possibility of recognizing this form as a new species. The probable presence of slender zygomatic arches, the long, high and narrow skull, and the size suggest that the specimen belongs to the genus Ticholeptus. However, without the characters of the premolars, this determination is still open to question. The proportions of the specimen appear to be between those of T. brachymelis and those of a T. rusticus.

Measurements (in millimeters)

	Ticholeptus(?) sp. No. 2500 C.I.T.	*T. brachymelis** No. 9731 A.M.N.H.	*T. rusticus** No. 19-104 A.M.N.H.
Skull			
Maximum length	a 265	257	270
Postorbital constriction diameter	a 40	40	52.5
Orbit, anteroposterior diameter	a 28	28	40
Orbit, vertical diameter	a 29	a 30	42
Depth of ramus below M3	a 46	45	52.5
Dentition			
Superior molar series	a 64	60	66.4
$M\overline{3}$, anteroposterior diameter	26	26.5	29.5
$M\overline{3}$, transverse diameter	a 18	23.5	22.1
Inferior molar series	a 66	64	66.4
$M\overline{1}$, anteroposterior diameter	a 14	16	14.7
$M\overline{1}$, transverse diameter	a 13	—	12.6
$M\overline{2}$, anteroposterior diameter	21.5	18	21.1
$M\overline{2}$, transverse diameter	15.5	—	15.2
$M\overline{3}$, anteroposterior diameter	32.5	29	32.6
$M\overline{3}$, transverse diameter	a 15	—	14.7

a. Approximate.

*. Measurements from Thorpe, 1937

Merycoidodont, sp. a

A single lower second molar in a jaw fragment, No. 2548 C.I.T. Coll. Vert. Pale., has merycoidodont characters. The crown is moderately well worn, and tends toward hypsodonty. It is larger than comparable teeth of Ticholeptus described by Thorpe[28]. The size and proportions of the tooth lie within the range of teeth of Merycochoerus, and are close to those of $\bar{M}2$ of Merycochoerus buwaldi Merriam.

[28] Thorpe, M.R., op. cit., vol. III, pt. IV, p. 237, 1937.

Measurements (in millimeters)

$\bar{M}2$, anteroposterior diameter	23.5
$\bar{M}2$, transverse diameter	17.2

Merycoidodont, sp. b

A single lower left $\bar{M}1$, No. 2587 C.I.T., several incomplete limb elements, a symphyseal portion of a mandible, and several broken caniniform teeth are referred to this form. The material is from locality No. 325 Calif. Inst. Tech. Coll. Vert. Pale., and is stratigraphically the lowest vertebrate occurrence. $\bar{M}1$ is very similar to the comparable tooth in specimen of Merychyus calimontanus. Its stratigraphic position is approximately 2400 feet below that of M. calimontanus.

Camelidae

Camelid(?) gen. et sp. indet.

Two small astragali No. 2588 and No. , are closely similar in size and proportions to camelid astragali in the collections from the Merychippus Zone. The latter have been referred tentatively to Miolabis.

Cervidae

Dromomeryx(?), sp.

A portion of a lower molar, No. 2549 C.I.T. Coll. Vert Pale., resembles very closely $\overline{M2}$ of Dromomeryx borealis[24]. The tooth is low crowned with rugose enamel on the external pillars. The forward internal crescent overlaps the anterior portion of the posterior crescent. A cuspule, oval crown-section, lies between the two external crescents. The anterior crescent is well worn and shows only a trace of the "paleomaryx-fold."

[24] Douglass, E., Ann. Carn. Mus. vol. IV, p. 468, 1909.

An incomplete astragalus, No. 2568 C.I.T., from locality No. 215, Calif. Inst. Tech. Coll. Vert. Pale., may be referrable to this genus. Comparison with merycoidodont and Camelid astragali reveal several differences. This specimen tends to be wider transversely and lacks the peculiar twist seen in the upper half of merycoidodont astragali. Differences from camelid astragali are less apparent, although the robustness of the specimen contrasts with the slender elongate astragali of Middle Miocene camelids.

ANTILOCAPRIIDAE

Merycodus sp.

This form is known by fragments of several lower jaws with broken teeth, and by one nearly complete left lower jaw. The latter material represents the first vertebrate material collected in the Caliente area, and was found by John B. Stevens in red sandstone approximately 250 feet above the main basalt flow at Padrones Spring. It is the only fossil vertebrate obtained thus far in beds above the main basalt.

Specimen No. 642 C.I.T. is a nearly complete left ramus with $\overline{P2}$, $\overline{P4}$, and $\overline{M1}$-$\overline{M3}$. The pattern of the crown of the premolars can not be distinguished and several teeth are broken. The teeth appear to be moderately hypsodont. When compared with an advanced merycodont, Merycodus cf cerroensis (Frick), No. 1997 C.I.T., from the Avawatz Mountains,[70] a number of differences are readily observable. The premolars are much less reduced with respect to the molars, and the post-symphyseal diastema is relatively shorter. As a long diastema and reduced premolars are considered to be progressive characters, the individual from Caliente Mountain is much less advanced than the Avawatz species. The Caliente specimen is more robust than M. cf. cerroensis, but its overall length is very much as in the latter. The Avawatz form possesses a more slender ramus with much longer post-symphyseal diastema.

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[70] Henshaw, P.C., A Tertiary Mammalian Fauna from the Avawatz Mountains, San Bernardino County, California. Carn. Inst. Wash. pub. No. 514, I, p. , 1939.

Illustrations of jaws of M. negatus from the Barstow Miocene of

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[21] Furlong, E.L., Univ. Cal. Bull. Dept. Geol. Sci., vol. 17, pl. 25, 1927.

California, as well as measurements taken from these illustrations indicate that Furlong's material is intermediate between the Caliente and Avawatz merycodonts in length of diastema, reduction of premolars, and robustness of jaw. M. negatus is much closer to M. cf. cerroensis, but has a shorter diastema and a more robust jaw.

Measurements (in millimeters) and Ratios

	Merycodus sp. No. 692, C.I.T.	Merycodus negatus* No. 26781, U.C.	M. cf. cerroensis No. 1997, C.I.T.
Length from mental foramen to posterior end of M3	86	8.45	83.8
Length of diastema from anterior end of mental foramen to anterior end of P2	21.3	33	36
Depth of jaw below P2	13.2	15	11.4
Depth of jaw below M3	22	17	17.8
$\frac{\text{M3 anteroposterior diameter}}{\text{Postsymphyseal diastema}}$ ratio	0.75	0.6	0.48
$\frac{\text{M1 - M3}}{\text{P2 - P4}}$ ratio	a 1.3	a 1.8	2.3
M1-M3, total length	36	33	36
M1, long diameter	7.5	7.5	8.9
M1, greatest transverse diameter	5.3		3.3
M2, long diameter	9.7	9.7	11.4
M2, greatest transverse diameter	5.7		5.9
M3, long diameter	16.6	16	17.3
M3, greatest transverse diameter	5.9		4.7

*, Measurements from Illustration, Furlong, E.L., op. cit., pl. 25, 1927.

a, Approximate.