CONTRIBUTIONS TO PALÆONTOLOGY

V

# ANCHITHERIINE HORSES FROM THE MERYCHIPPUS ZONE OF THE NORTH COALINGA DISTRICT, CALIFORNIA

By Francis D. Bode

With five plates

[Preprinted from Carnegie Institution of Washington Publication No. 440, pages 43 to 58, November, 1933]

*Arch Graduate School of the Geological Sciences*
*California Institute of Technology*
*Pasadena, California*

*Contribution No.* 110

CONTRIBUTIONS TO PALÆONTOLOGY

V

# ANCHITHERIINE HORSES FROM THE MERYCHIPPUS ZONE OF THE NORTH COALINGA DISTRICT, CALIFORNIA

By Francis D. Bode

With five plates

[Issued November 1933]

CONTENTS

# ANCHITHERIINE HORSES FROM THE MERYCHIPPUS ZONE OF THE NORTH COALINGA DISTRICT, CALIFORNIA

## INTRODUCTION

Excavations by the California Institute of Technology in the Merychippus zone of the North Coalinga district, California, have added considerably to our knowledge of the Equidæ from this horizon. In addition to a large amount of material representing the genus *Merychippus*, the teeth of three genera of anchitheriine horses have been found. These teeth are of value in that they furnish additional information regarding the taxonomic position and geographic distribution of several of the middle Tertiary genera known from the Pacific Coast and Great Basin provinces.

The writer is indebted to the Department of Paleontology, University of California, for loan of comparative material, including type specimens, from the Barstow and Mascall formations. Dr. Walter Granger of the American Museum of Natural History has kindly permitted the writer to study and figure a specimen of *Archæohippus penultimus* Matthew from the Sheep Creek beds of western Nebraska. Dr. C. L. Gazin of the United States National Museum likewise has kindly permitted the description of a mandible found by him in Cajon Pass, California. The writer is indebted also to Dr. Chester Stock for his criticism given during the course of this study and for his aid in making comparisons of the described material from the Merychippus zone with types in the American Museum and elsewhere in the east. The illustrations reproduced in the plates are from photographs that have been accurately and carefully retouched by Mr. John L. Ridgway.

The material from the Merychippus zone was obtained in part from the type locality on Domengine Creek, north of Coalinga, where the original collections were made by the University of California which formed the basis of the important contribution published by J. C. Merriam[1] in 1915. The specimens were collected in the course of rather extensive excavations in a zone of sandstones and conglomerates 2 or 3 feet thick lying at the top of the middle Miocene "Temblor" section on Domengine Creek and immediately below the Miocene beds known as the "Big Blue." In addition, large collections of fossil remains were obtained at a new quarry-site along the strike of the beds one-fourth mile south of the type locality and at a position approximately 20 feet stratigraphically below the Temblor-Big Blue contact.

The material found at both localities consists for the most part of scattered teeth and limb elements. Some of the specimens have

[1] J. C. Merriam, Trans. Amer. Philos. Soc., n.s., vol. 22, pt. 3, 44 pp., 1915.

suffered considerably from abrasion, probably due to transportation by or movement in water.

## SYSTEM OF MEASUREMENTS

On superior cheek-teeth the anteroposterior diameter is the distance measured across the base of the crown from the middle of the faces of contact with the adjoining anterior and posterior teeth. The height of the crown is measured only on unworn specimens. It is the maximum distance from the base of the crown to the top of the paracone. The transverse diameter is measured across the base of the crown from the point of deepest indentation of the paracone wall to the farthest lingual projection of the protocone. In second premolars the transverse diameter is measured at the base of the crown from the point of deepest indentation of the metacone wall to the farthest lingual projection of the hypocone.

On inferior cheek-teeth the height of the crown, measured only on unworn teeth, is the maximum distance from the base of the crown to the top of the protoconid. The anteroposterior diameter is the greatest distance taken across the tooth from the anterior to the posterior side, including the entostylid. The transverse diameter is the minimum distance at the base of the crown from the farthest external projection of the protoconid to the lingual side of the tooth. On second premolars this diameter is taken in a similar manner across the tooth from the hypoconid.

## DESCRIPTION OF SPECIES

### Hypohippus sp.

This genus is represented in the collections from the Merychippus zone by an upper molar, No. 885, and three lower premolars, Nos. 886, 887 and 888, Calif. Inst. Tech. Coll. Vert. Pale., Plate 1, figures 6 to 9.

*Measurements (in millimeters)*

| | No. 885 $M\underline{1}$ | No. 886 $P\bar{2}$ | No. 887 $P\bar{4}$? | No. 888 $P\bar{3}$? |
|---|---|---|---|---|
| Anteroposterior diameter..... | 18.7 | 19.8 | 19.5 | 19.0 |
| Transverse diameter..... | 25.3 | 13.5 | 16.3 | 16.0 |

The superior molar is well worn. The anteroposterior diameter is less than that of any described species of *Hypohippus*. The transverse diameter is comparable to that found in *H. osborni*. The walls of the metaloph are simple with no indication of a crochet. The protoconule is smaller than the

protocone. An internal cingulum is absent. The hypostyle is relatively weak.

The lower premolars are slightly smaller than those for any described species of *Hypohippus*. These teeth are distinguished from *Parahippus* by the absence of an entostylid and of the groove on the inner wall of the metaconid-metastylid column. In Nos. 886 and 888 the anterior end of the posterior loph does not connect with the metaconid. A heavy external cingulum is present on two of the teeth but is absent on the third, No. 886.

The material is inadequate for more than a generic determination.

**Parahippus brevidens Marsh**

The genus *Parahippus* is represented in the collections of the California Institute from the Merychippus zone by approximately 20 well-preserved upper and lower cheek-teeth, Plate 1, figures 1 to 5 and 10 to 18.

The upper cheek-teeth are relatively high crowned and generally well cemented. An internal cingulum is absent. The external walls of the paracone and metacone are smooth with practically no indication of a median ridge. The protoloph is usually continuous and is bent almost at right angles between the protocone and protoconule. The protocone is conical in shape. The metaloph is attached to the ectoloph. One or more crochets are always present on the anterior side of the metaloph. The middle portion of this loph usually exhibits a number of ptychoid crenulations of the enamel on both anterior and posterior walls. The hypocone is ridge-shaped and essentially a continuation of the metaloph. The hypostyle is a strong cusp, triangular in cross-section, which encloses a small fossette. The third upper molar is considerably reduced in size and possesses a heavy coating of cement. The greatest transverse diameter in the superior cheek-tooth series probably occurs in P4, since teeth referable to the two posterior premolar positions are larger than any of the teeth identified as molars.

The lower cheek-teeth are small and relatively light. A faint external cingulum is present. In unworn teeth the metaconid-metastylid column is defined by the internal groove in the upper half of the crown. An entostylid is but weakly developed. The amount of cement present is variable but is usually heavy in the protoconid-hypoconid valley. Cement is also present as a rule in the valleys on the lingual side of the tooth. The inner cusps are expanded at the base so that the entrance to the lingual valleys is narrowed. The enamel walls are smooth with no indication of striæ.

The ptychoid crenulations noted on the walls of the metaloph and the heavy coating of cement on most of the teeth serve to distinguish immediately the material referred to *Parahippus* from the Merychippus zone, from most of the recorded species of *Parahippus*.

The Coalinga specimens agree closely with teeth of *Parahippus crenidens* Scott in the development of the crochets and in the crenulations of the walls of the metaloph. They differ from those of *P. crenidens*, however, in their heavy coating of cement, less strongly developed ectoloph, shape of the protoloph, and in the presence of only a faint external cingulum on the lower teeth.

The deciduous teeth of *Parahippus cognatus* show progressive characters similar to those found in the permanent teeth from the Merychippus zone. This species can not be compared satisfactorily, however, since no deciduous teeth of *Parahippus* are available from the Temblor beds, north of Coalinga. Judging from the size of the milk-teeth in *P. cognatus* it seems probable that this species represents a much larger horse than that from the north

Coalinga horizon. Moreover, it appears to be safe to assume that the two forms are not conspecific.

A comparison with *Parahippus brevidens* Marsh from the Mascall beds in eastern Oregon fails to reveal any characters whereby the Coalinga specimens can be separated from this species. Two teeth referred to *P. brevidens* collected from the Mascall (Calif. Inst. Coll. Vert. Pale. Nos. 406 and 407) are almost identical with teeth from the Merychippus zone. As far as the writer is aware no lower cheek-teeth referable to *P. brevidens* have been described from the Mascall. It is interesting to note that the lower teeth of *Parahippus* from the Merychippus zone are quite distinct from those of *P. avus*, a second species recorded in the Mascall fauna. The lower cheek-teeth of *P. avus* are large and heavy with a strong external cingulum. The metaconid and metastylid are widely separated, the entostylid is a strong cusp, and the external walls of the inferior teeth are noticeably rugose. Thus additional evidence would seem to indicate that the two species from the Mascall are distinctly separable.

*Measurements (in millimeters)*

| Calif. Inst. Tech. Coll. | Height of crown | Anteroposterior diameter | Transverse diameter |
|---|---|---|---|
| P2, No. 1148 | ..... | *a*23.8 | 20.5 |
| P4?, No. 1147 | 15.6 | 19.8 | 22.1 |
| M1?, No. 1145 | 15.0 | 18.5 | 21.9 |
| M1?, No. 1144 | 14.8 | 16.8 | 21.7 |
| M2?, No. 1146 | 15.4 | 17.5 | 22.3 |
| M3, No. 1150 | 12.0 | 14.4 | *a*17.0 |
| M3, No. 1151 | ..... | 13.3 | ..... |
| P4, No. 1142 | ..... | 18.8 | 11.8 |
| M1, No. 1143 | ..... | 17.7 | 11.7 |
| M1?, No. 1141 | 17.6 | 17.2 | 11.5 |
| M3?, No. 1152 | ..... | 20.3 | 11.1 |
| P4, No. 406 | ..... | 18.7 | 22.9 |
| M3, No. 407 | 15.0 | 17.6 | 20.5 |

*a*, Approximate. Nos. 406 and 407 from Mascall middle Miocene, Oregon.

**Archæohippus mourningi (Merriam)**

*Archæohippus* is more abundantly represented by material in the collection from the Merychippus zone than either *Hypohippus* or *Parahippus*. The specimens comprise a lower jaw, No. 484, with P3–M3; a composite series of unassociated superior cheek-teeth, No. 881, with P4–M3; an unworn Dp3, No. 883; and in addition 20 superior and 15 inferior isolated molars and premolars; Plate 2, figures 1 to 5.

The superior cheek-teeth are brachydont though relatively high-crowned. The enamel is sometimes slightly rugose. An external cingulum is present on the paracone and metacone walls but does not connect across the mesostyle. A lingual cingulum is absent on most of the teeth but is faintly present on two specimens and distinct on a third. P1 is not represented in the collection. The premolars are larger than the molars. The greatest transverse diameter probably occurs in P4. M3 is reduced in size, the posterior wall of the tooth showing a marked transverse compression. All of the teeth are devoid of cement. A faint but distinct median ridge is present on the external wall of the paracone but is usually absent on the metacone. The

protoloph is rectilinear in outline. The protoconule is elongate and flattened with a straight, sharp, ridge-like appearance in unworn teeth. The protocone is distinctly conical in shape and is firmly attached to the protoloph. The anterior wall of the protoloph is deeply notched between protoconule and protocone and a prominent anterior cingulum extends across the notch, forming almost a small cusp in the center. The metaloph is always united with the ectoloph. The walls of the metaloph are smooth with no indication of a crochet, although in several teeth there are a few small plate-like projections which arise from the extreme antero-external end of the metaloph. The metaconule is a thin compressed ridge that curves slightly as the metaloph turns to join the ectoloph. The anterior wall of the metaloph is notched, giving the hypocone a conical appearance. The posterior wall of the metaloph is straight and unbroken. The hypostyle is large and triangular in shape. It is formed by an L-shaped crescent which is connected at its posterior end with a strongly developed portion of the postcingulum, inclosing a small triangular area.

The superior deciduous dentition is represented by Dp$\underline{3}$, No. 883. The parastyle is small and relatively feebly developed. The median ridge on the external wall of the paracone is strongly developed, giving this cusp a conical appearance. A distinct cingulum is present across the entire lingual side of the tooth. The height of the crown in this tooth is comparable to that found in teeth of the permanent dentition.

The inferior cheek-teeth are uncemented. The crowns of the molars and premolars are usually smooth, although the external walls are sometimes marked by a series of thin horizontal lines. In the lower jaw (No. 484) P$\overline{4}$ and P$\overline{3}$ are larger than the molars, with the greatest transverse diameter of the series occurring on the posterior portion of P$\overline{4}$. An external cingulum is present on the teeth of No. 484. An internal cingulum is only faintly defined on a few of the teeth. With the exception of the posterior side of M$\overline{3}$, an anterior and a posterior cingulum is present on all of the inferior teeth. The metaconid and metastylid are separated at the summit of the crown but become connected at an early stage of wear. The entostylid is well developed but does not stand so high as the entoconid in unworn teeth. There is usually a distinct median ridge on the inner walls of the protoconid and hypoconid. A single P$\overline{1}$, C.I.T. No. 1223, shows that this tooth was two-rooted with a simple, thin, almost trenchant crown. In M$\overline{3}$ the entostylid is a distinct conical cusp smaller than the hypoconid and connected with the entoconid-hypoconid wall by a thin plate-like projection. A small additional cusp is present near the base on the lingual side between the entoconid and entostylid.

The *Archæohippus* material from the Merychippus zone represents a more advanced type than *A. ultimus* (Cope) from the Mascall. In *A. ultimus* the hypostyle is a single cusp formed only by a strengthening of the postcingulum. In the Coalinga form this cusp is triangular in shape and incloses a small fossette. The type of *A. ultimus* shows that in this species M$\underline{3}$ is unreduced. Several third upper molars collected from the Merychippus zone show that in the Coalinga form M$\underline{3}$ is noticeably reduced. The protocone and hypocone are smaller in the Mascall form. Unlike the cusps in the Coalinga species they do not widen sufficiently at the base to obstruct the entrance to the valley between protoloph and metaloph. The median external rib on the paracone wall is much more distinct in *A. ultimus*. None of the teeth from the Merychippus zone exhibits an internal cingulum comparable to the heavy cingulum present on the paratype from the Mascall. The height of the crown of the cheek-teeth in *A. ultimus* is comparable to that found in advanced

forms of *Miohippus*. In extreme height of crown the Coalinga specimens appear precocious for an anchitheriine horse with such small teeth.

With the exception of the height of crown the lower cheek-teeth of *A. mourningi* and *A. ultimus* are quite similar.

The teeth of *Archæohippus penultimus* Matthew compare closely in structure with those belonging to the species from the Merychippus zone. In the Coalinga specimens the parastyle and mesostyle are more strongly developed. The median external rib on the paracone wall is more noticeable in *A. penultimus*. The valley between the protoloph and metaloph is slightly wider than in specimens from the Merychippus zone. The enamel pattern of the upper cheek-teeth is essentially similar in these two species. In the lower cheek-teeth the separation of the metaconid-metastylid column is slightly more in evidence in the Coalinga specimens.

The structural characters seen in the cheek-teeth suggest that the two forms are very closely related. In view of present uncertainty as to their geologic time relations and their wide geographical separation it seems advisable to recognize *A. mourningi* and *A. penultimus* as specifically distinct on the basis of the characters outlined above.

The teeth from the Merychippus zone agree with the type and paratype of *Archæohippus mourningi* (Merriam) from the Barstow in almost every particular. In the type, M1 is practically inseparable from molars assigned to the same position from the Merychippus zone. The principal difference is presented by the absence of an external cingulum on the premolars of the paratype. However, the presence or absence of an external cingulum appears to be a variable character and thus of slight diagnostic value. In the collection of 21 isolated lower cheek-teeth of *Archæohippus* from the Merychippus zone the external cingulum is absent in 8 teeth, faint to indistinct in 7, and distinct in only 6. The lower jaw from the Barstow is slightly larger than No. 484 from the Coalinga locality. The difference in size may well be within the limits of individual variation as several teeth from the north Coalinga district exceed the Barstow paratype in size.

*Measurements (in millimeters)*

| Calif. Inst. Tech. Coll. | Height of crown | Anteroposterior diameter | Transverse diameter |
|---|---|---|---|
| No. 881:[1] | | | |
| P4 | 12.1 | 13.1 | 15.3 |
| M1 | ..... | 12.3 | 15.6 |
| M2 | 10.2 | 11.2 | 14.6 |
| M3 | 9.7 | 10.2 | 13.0 |
| M3, No. 884 | 9.5 | 14.0 | 8.2 |
| Dp3, No. 883 | 8.6 | 11.0 | 10.6 |
| M3, No. 882 | ..... | 12.7 | 10.3 |
| Ramus, No. 484:[2] | | | |
| P3 | 9.2 | 13.0 | 9.0 |
| P4 | 10.2 | 12.5 | 9.7 |
| M1 | ..... | 11.8 | 9.2 |
| M2 | ..... | 12.0 | 8.9 |
| M3 | 10.0 | 13.9 | 8.3 |

[1] Teeth listed under this number are not all of one individual.

[2] Length from anterior end of P3 to posterior end of M3, 65.9.
Depth of ramus below middle of M1 normal to inferior border, 21.9.
Width of ramus below middle of M1 (thickness), 8.0.

## PREVIOUSLY DESCRIBED OR NEW MATERIAL REFERRED OR RELATED TO ARCHÆOHIPPUS

Most of the material referred to *Archæohippus* from Miocene horizons in North America has been described but not figured. Since the original descriptions of the three species of *Archæohippus*, new material has come to light which better illustrates the characters of the genus.

Opportunity is taken, therefore, to review particularly the dental characters of previously described specimens and to consider also the new material on which to base a more complete definition of the genus than has been attempted heretofore.

### Archæohippus ultimus (Cope)

*Genotype*—The anterior portion of a skull with a nearly complete dentition, No. 8174 Amer. Mus. Coll., described by Gidley[1] from Mascall beds on Cottonwood Creek, Oregon.

*Paratype*—Several isolated teeth; one an upper molar, No. 1689 Univ. Calif. Coll., described by Gidley[2] from Mascall beds, and figured by Merriam[3] and by Osborn.[4]

*Referred specimens*—An unworn lower molar, No. 3059 Univ. Calif. Coll.; an unworn lower premolar, Calif. Inst. Coll. No. 424, and a much worn inferior molar, No. 31987 Univ. Calif. Coll.; Plate 3, figures 1-4. All specimens from the Mascall deposits.

*Measurements (in millimeters)*

| | Height of crown | Anteroposterior diameter | Transverse diameter |
|---|---|---|---|
| Type No. 8174 Amer. Mus. Coll.:* | | | |
| $P\frac{2}{}$ | ..... | 14.5 | 14.1 |
| $P\frac{3}{}$ | ..... | 12.4 | 15.7 |
| $P\frac{4}{}$ | ..... | 13.1 | 15.8 |
| $M\frac{1}{}$ | ..... | *a*10.8 | *a*14.6 |
| $M\frac{2}{}$ | ..... | *a*11.0 | *a*14.9 |
| $M\frac{3}{}$ | ..... | *a*11.0 | *a*14.1 |
| Paratype: | | | |
| $M\frac{3}{}$?, No. 1689 U. C. Coll | 8.8 | 11.1† | 14.2† |
| Molar: | | | |
| No. 3059 U. C. Coll | 9.0 | 12.6 | 7.8 |
| Premolar: | | | |
| No. 424, C.I.T. Coll | 10.3 | 13.5 | 9.5 |
| Molar: | | | |
| No. 31987, U. C. Coll | ..... | 11.5 | 8.3 |

* Length from anterior end of $P\frac{1}{}$ to posterior end of $M\frac{3}{}$, 78.2.
Length from anterior end of $P\frac{1}{}$ to posterior end of $P\frac{4}{}$, 45.5.

† These measurements differ from those given by Merriam, due to the use of a slightly different system of measurements.

*a*, Approximate.

[1] J. W. Gidley, Bull. Amer. Mus. Nat. Hist., vol. 22, 385–388, 1906.
[2] J. W. Gidley, *ibid.*
[3] J. C. Merriam, Univ. Calif. Publ., Bull. Dept. Geol., vol. 7, 428, fig. 4, 1913, and vol. 11, 476, fig. 35, 1919.
[4] H. F. Osborn, Mem. Amer. Mus. Nat. Hist., vol. 2, pt. 1, 213, fig. 173 (4), 1918.

In the type skull the enamel pattern of the teeth is in large measure obliterated by wear. The development of an internal cingulum is variable. The basal ledge is well defined on the entire lingual side of P2. It is absent on the lingual side in P3 to M1. A cingulum is present at the base of the protocone only in M2 and M3. A well-developed cingulum is present on the walls of the paracone and metacone but does not extend across the base of the mesostyle. The valley opening between the protoloph and metaloph is not constricted at the lingual entrance as in *Archæohippus mourningi.*

The lower teeth are slightly smaller than those of *A. mourningi* and of *A. penultimus.* The worn tooth, No. 31987, from the Mascall has a strong internal cingulum as well as external cingulum. An external cingulum is present around the protoconid but is absent on the hypoconid in No. 424. The protoconid and hypoconid of No. 3059 U. C. Coll. have no cingula. No trace of a separation of the metaconid-metastylid exists in the tooth, No. 31987, because of the extreme wear of the crown. The separation is but faintly defined in No. 3059, but it occupies the upper one-third of the crown in No. 424. The walls of the crowns are slightly rugose. All of the teeth are devoid of cement.

**Archæohippus penultimus Matthew**

*Type*—Fragment of a lower jaw with P3–M1, No. 18950 Amer. Mus. Coll.

*Paratype*—An isolated lower molar No. 18951 Amer. Mus. Coll. Both the type and paratype were described by Matthew[1] from the Sheep Creek beds in Stonehouse Quarry draw, Sioux County, Nebraska.

In the type jaw fragment, the three teeth have been considerably worn. This wear has obliterated all trace of the original separation of the metaconid-metastylid column. The paratype is more moderately worn and retains a slight indication of the gutter separating the metaconid from the metastylid. In both the type and paratype an external cingulum is absent.

Since the above material was collected, the American Museum has obtained additional material from the lower Sheep Creek beds in Aphelops Draw at the Snake Creek quarries. The specimens include a rather complete palate with Dp1–Dp4 and M1, No. 21534 Amer. Mus. Coll. and a well-preserved mandible, probably of the same individual, with Dp2–Dp4 and M1, No. 21532 Amer. Mus. Coll., Plate 4, figures 1-2. This material has been referred by Matthew to *Archæohippus penultimus.*

In the palate a deep restricted preorbital fossa is very well shown. The enamel on the walls of the teeth is smooth. A faint external cingulum is present at the base of the paracone and metacone, but is interrupted by the mesostyle. An internal cingulum is present on Dp2 only. In Dp2 the parastyle is large and well developed and slightly larger than the paracone, which is conical in shape. P1? is a large tooth and appears to have roots which are fused. A median ridge is present on the wall of the paracone in all of the teeth, but it is sometimes faint or indistinct. The parastyle and mesostyle are weakly developed when compared with the comparable styles in *A. ultimus* and in *A. mourningi.* The protoloph is unbroken and rectilinear in outline. It is sharply constricted between the protocone and protoconule. The metaloph is a thin ridge which flares posteriorly to produce the hypocone. There is no indication of a crochet on any of the teeth. The metaconule can not be distinguished from the metaloph. In the milk teeth the protoconule is approximately as large as the protocone. The protocone and hypocone are conical in shape and are set far apart so that the

[1] W. D. Matthew, Bull. Amer. Mus. Nat. Hist., vol. 50, 158, 1924.

valley opening between them is not constricted. The hypostyle is a well-developed cusp, triangular in shape and inclosing a small fossette. All of the teeth are uncemented.

In common with other members of the Anchitheriinæ, the inferior deciduous teeth of No. 21532 exhibit a greater degree of separation of the metaconid-metastylid than do the permanent teeth. In the milk teeth of this specimen a groove occupies the upper half of the height of the crown, while the separation exists only in the upper fourth of the permanent molar. A cingulum is present on all of the inferior teeth on the anterior and external sides of the protoconid. In the milk teeth a well-developed ledge is present between the protoconid and hypoconid. An external cingulum is present only on the hypoconid of Dp$\bar{2}$. In Dp$\bar{2}$ the paraconid and protoconid are of equal size. The paraconid is situated in front of and only slightly interior to the antero-external cusp. The metaconid is placed almost directly inside of the protoconid, so that the anterior loph in this tooth forms almost a right angle. The valley between the protoconid and hypoconid slopes downward and to the rear, while its position is almost vertical in the deciduous teeth posterior to the second. The alveolus for Dp$\bar{1}$ indicates that this tooth was single-rooted. All of the teeth are uncemented. The walls of the deciduous teeth are slightly rugose, while the walls of M$\bar{1}$ are smooth. The symphyseal region of the jaw is thin and delicate and flattened horizontally.

*Measurements (in millimeters)*

| Amer. Mus. Coll. | Height of crown | Anteroposterior diameter | Transverse diameter |
|---|---|---|---|
| Paratype: | | | |
| Inferior molar | | | |
| No. 18951 | ..... | 12.8 | 8.5 |
| Palate* | | | |
| No. 21534 | | | |
| P$\underline{1}$ | ..... | 10.5 | 6.5 |
| Dp$\underline{2}$ | ..... | 15.9 | 12.5 |
| Dp$\underline{3}$ | ..... | 13.5 | 12.8 |
| Dp$\underline{4}$ | ..... | 13.9 | 13.2 |
| M$\underline{1}$ | 11.7 | 13.1 | 14.8 |
| Mandible* | | | |
| No. 21532 | | | |
| Dp$\bar{2}$ | ..... | 16.4 | 8.3 |
| Dp$\bar{3}$ | ..... | 13.7 | 9.3 |
| Dp$\bar{4}$ | ..... | 14.1 | 9.5 |
| M$\bar{1}$ | 10.5 | 14.4 | 9.3 |

Length from anterior end of P$\underline{1}$ to posterior end of M$\underline{1}$, 60.2.
Length from incisor alveolar border to posterior border of vertical ramus, 166.8.
Length of tooth row Dp$\bar{2}$–M$\bar{1}$ inclusive, 58.3.
Depth below middle of M$\bar{1}$, normal to inferior border, 23.3.
Width below middle of M$\bar{1}$ (thickness), 13.2.
Height from inferior border to tip of coronoid process, 85.2.
* Measurements taken on right side of mandible and palate.

**Archæohippus mourningi (Merriam)**

*Type*—Portion of a maxillary with Dp$\underline{3}$–Dp$\underline{4}$ and M$\underline{1}$, No. 19840 Univ. Calif. Coll., Plate 3, figure 5.

*Paratype*—Portion of a ramus with dentition representing P$\bar{2}$–M$\bar{2}$, No. 19764 Univ. Calif. Coll., plate 3, figure 6. Both the type and paratype were

described by Merriam[1] from the Barstow upper Miocene, Mohave Desert, California.

The full description of these specimens by Merriam requires little addition, except that the alveolus for $P\underline{1}$ shows that this tooth was two-rooted. The species was referred provisionally to the genus *Parahippus* and was assigned later to the genus *Archæohippus* by Osborn.[2] The material discovered in the quarries of the Merychippus zone substantiates Osborn's determination.

*Measurements* (in millimeters)*

| Univ. Calif. Coll. | Height of crown | Anteroposterior diameter | Transverse diameter |
|---|---|---|---|
| Type: | | | |
| Maxillary | | | |
| No. 19840 | | | |
| $Dp\underline{3}$ | ..... | 12.4 | 13.5 |
| $Dp\underline{4}$ | ..... | 12.8 | ..... |
| $M\underline{1}$ | ..... | 13.0 | ..... |
| Paratype: | | | |
| Ramus | | | |
| No. 19764 | | | |
| $P\underline{4}$ | 9.5 | 14.1 | 10.5 |
| $M\underline{1}$ | ..... | 13.6 | 8.8 |
| $M\underline{2}$ | ..... | *a*13.1 | 8.5 |

Length from anterior end of root of $P\underline{2}$ to posterior end of $M\underline{2}$, 74.0.

*a*, Approximate.

* Difference between these measurements and those given by Merriam may be due to slightly different systems of measurements.

In addition to the occurrences of *A. mourningi* in the Barstow and in the Merychippus zone, this species is now known from a third locality in California.

The major portion of a mandible with the lower dentition lacking only $M\underline{2}$ and $M\underline{3}$ on the left side, No. 12244 U. S. Nat. Mus. Coll., collected by Dr. C. L. Gazin in Miocene beds of Cajon Pass, San Bernardino County, California, is here referred to *Archæohippus mourningi*. This specimen is shown on Plate 5. Dr. Gazin has kindly furnished the following description of the locality:

"The specimen was found in place in the southeast wall of the 2d railroad cut southwest of Alray. Alray is a small station at the intersection of the upbound track of the Santa Fe R. R. and the state highway in the upper part of Cajon Pass. The occurrence of this form along with the lower teeth of a larger merychippine form was just a few feet from a derail switch signal. The beds at this horizon are rather brightly colored, principally reddish brown and green. Although the *Archæohippus* jaw was found in the coarser red beds, both the reddish and greenish horizons exhibit bone fragments at other localities. Referring to the Hespina Quadrangle, the locality is in the W part of NW¼ sec. 26, T 3 N, R 6 W, S. B. B. & M."

The characters of the cheek-teeth in No. 12244 have been in large measure destroyed by wear. A very faint notch on the crowns of $M\underline{2}$ and $M\underline{3}$ of the

[1] J. C. Merriam, *op. cit.*, 427–434, 1913.

[2] H. F. Osborn, *op. cit.*, 1918.

right side indicates that a separation of the metaconid-metastylid column probably existed at an earlier stage of wear. There is no indication of an external cingulum on any of the teeth. The entostylid of $M\bar{3}$ is conical in shape and is similar to that found in third lower molars of *Archæohippus mourningi* from the Merychippus zone. The greatest transverse diameter for the cheek-tooth series obtains across the posterior portion of $P\bar{4}$. The paraconid of $P\bar{2}$ is placed anteriorly to the metaconid rather than to the protoconid as in $Dp\bar{2}$ of *A. penultimus*. The protoconid-hypoconid valley has the primitive backward slope. $P\bar{1}$ is double-rooted. The crown forms a single ridge and is almost trenchant in aspect. This tooth is almost identical with a first premolar assigned to *A. mourningi* from north Coalinga. The symphyseal region of the jaw is larger and heavier than that found in the referred specimen of *A. penultimus*, but this difference may be due to the much greater age of the individual represented by No. 12244. The enamel walls of the teeth are smooth. All of the teeth are uncemented.

*Measurements of No. 12244 U. S. N. M. (in millimeters)*

| | Anteroposterior diameter | | Transverse diameter | |
|---|---|---|---|---|
| | Right | Left | Right | Left |
| $P\bar{1}$ | 9.8 | 9.9 | 3.9 | 3.9 |
| $P\bar{2}$ | 13.2 | 12.8 | 7.5 | 7.9 |
| $P\bar{3}$ | 11.1 | 11.7 | 7.6 | 8.2 |
| $P\bar{4}$ | 11.5 | 11.4 | 8.8 | 9.3 |
| $M\bar{1}$ | 10.9 | 11.8 | 9.0 | 9.5 |
| $M\bar{2}$ | 11.8 | ..... | 9.0 | ..... |
| $M\bar{3}$ | 14.0 | ..... | 7.7 | ..... |

Length from incisor alveolar border to posterior side of $M\bar{3}$, 124.7.
Length of tooth row $P\bar{1}$–$M\bar{3}$ inclusive, 83.9.

**Parahippus sp.**

A portion of a left ramus with $Dp\bar{3}$–$\bar{4}$ and $P\bar{3}$–$\bar{4}$, No. 23852 Univ. Calif. Coll., described by Maxson[1] as *Parahippus?* (*Archæohippus*) near *mourningi* Merriam from the Mint Canyon beds, California, is here referred to *Parahippus* sp. The specimen presents few diagnostic characters. The separation of the metaconid-metastylid column in the permanent teeth is less than that which one would expect to find in a parahippine form from the upper Miocene. The teeth are considerably larger than those of any known species

*Measurements of No. 23852 Univ. Calif. Coll. (in millimeters)*

| | Height of crown | Anteroposterior diameter | Transverse diameter |
|---|---|---|---|
| $Dp\bar{3}$ | ..... | 15.7 | ..... |
| $Dp\bar{4}$ | ..... | 17.7 | ..... |
| $P\bar{3}$ | 15.7 | 16.8 | 10.7 |
| $P\bar{4}$ | 15.8 | 16.7 | 11.2 |

[1] J. H. Maxson, Carnegie Inst. Wash. Pub. No. 404, 91–92, fig. 5, a-d, 1930.

of *Archæohippus*. A calcareous deposit in the lingual valleys of $P\bar{3}$–$\bar{4}$ may represent cement. If this is the case, the specimen undoubtedly belongs to the genus *Parahippus*. An appearance of better material is desirable before the relationships of this form are more accurately defined.

### Material Referred by Matthew[1] to Archæohippus from the Pawnee Creek Beds at Cedar Creek, Colorado

This specimen is a fragment of a left ramus with $M\bar{2}$ and $M\bar{3}$, No. 6305 Amer. Mus. Coll. $M\bar{2}$ is moderately worn. With the exception of a slight amount of wear on the paraconid-protoconid ridge, $M\bar{3}$ is unworn. This form is larger than any described species of *Archæohippus*. The metaconid is pointed with no indication of a metastylid. With the exception of an antero-external basal ridge on $M\bar{3}$, there is no indication of an external cingulum. The entostylid is loph-like and not conical as in *Archæohippus*.

This specimen differs from *Archæohippus* in greater size, in the absence of any separation of the metaconid-metastylid column, and in the loph-like development of the entostylid of $M\bar{3}$. These differences are sufficient to indicate that No. 6305 differs generically from *Archæohippus*. Possibly No. 6305 belongs to *Hypohippus*.

*Measurements of No. 6305 (in millimeters)*

| | Anteroposterior diameter | Transverse diameter |
|---|---|---|
| $M\bar{2}$ | 13.8 | 9.7 |
| $M\bar{3}$ | 19.5 | 9.5 |

Length from anterior end of $M\bar{2}$ to posterior end of $M\bar{3}$, 33.3.
Thickness of ramus below $M\bar{2}$, 13.3.

## GENERIC STATUS OF ARCHÆOHIPPUS

Matthew[2] is inclined to regard *Archæohippus* as a sub-genus under the genus *Parahippus* for the following reasons:

1. Teeth in these two forms have in common:
   - *a.* Rugosity of enamel walls.
   - *b.* Broken protoloph.
   - *c.* Separate protocone.
   - *d.* Similar separation of the metaconid-metastylid column.
   - *e.* Unreduced $M\frac{3}{3}$.
2. Metatarsal like that of small *Parahippi* and of *Merychippus primus* in that the inner cuneiform has no footing on its head, while in *Anchitherium*, *Kalobatippus*, *Hypohippus*, *Equus*, *Pliohippus*, and in the European hipparions the metatarsal has a well-developed facet for the inner cuneiform.

[1] W. D. Matthew, *op. cit.*, 1924.
[2] Amer. Mus. Novit. No. 540, 1932.

3. The shafts of the lateral metatarsals are reduced about as in *Parahippus pristinus*, rather less than in *Merychippus primus*, and the cross-section of the shaft is round-oval as in the protohippine horses generally (including *Parahippus*) in contra-distinction to the anchitheriine horses in which it retains the flat form of *Mesohippus*.
4. The phalanges are moderately elongated as in *Parahippus* and the protohippine horses, in contrast to the very short wide and flattened phalanges of the anchitheriine horses (including *Mesohippus*).

The *Archæohippus* material obtained in the Merychippus zone, together with additional specimens now available from other localities, establish more clearly the true taxonomic position of this genus. While the teeth of *Archæohippus* possess several characters common also to *Parahippus*, the three species of the former genus present a number of closely related characters sufficient to keep these forms in a distinct group. *Archæohippus* differs from *Parahippus* in the following characters: (1) Complete absence of a crochet, (2) constant thin and 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 preorbital fossa as shown in *A. ultimus* and in *A. penultimus*.

Matthew's objections to the generic status of *Archæohippus* appear to be somewhat overstressed. The rugosity of the enamel walls of a tooth has no diagnostic value whatsoever since this surface feature is found in teeth of practically all anchitheriine horses and also in the milk teeth of *Merychippus*. In all the upper teeth examined, the protoloph is usually sharply constricted between the protoconule and the protocone, but not one specimen has been found in which the protocone has been actually separated from the anterior transverse loph. The separation of the metaconid-metastylid column in *Archæohippus* is less than that found in contemporaneous species of *Parahippus*. Three specimens representing the third upper molar of *Archæohippus mourningi* collected in the Merychippus zone show that this tooth in the former species is distinctly reduced. Thus the genus, while primitive in many respects, presents certain characters in which it exhibits a progressive development. Lastly, the maximum transverse diameter for the cheek-tooth series occurs in $P\frac{4}{4}$, an advance beyond the position in which this measurement is found in typical members of the anchitheriine group.

A facet on the metatarsal for the inner cuneiform occurs in so many members of the Equidæ, as observed by Matthew, that it appears to have no generic value. The shape of the metatarsal shaft

and of the phalanges, based on a young individual whose milk teeth are but slightly worn, are hardly characters of generic importance.

In view of the differences enumerated above it seems to the writer that *Archæohippus* may well be retained as a genus distinct from *Parahippus*.

PLATE 1

FIGS. 1–5a.—*Parahippus brevidens* Marsh. Fig. 1, $M\overline{3}$, No. 1152; fig. 2, $M\overline{1}$?, No. 1143; fig. 3 $Dp\overline{3}$, No. 1149; fig. 4, $M\overline{1}$?, No. 1141; fig. 5, $P\overline{4}$, No. 1142. Merychippus Zone, California.

FIGS. 6–9.—*Hypohippus* sp. Fig. 6, $P\overline{2}$, No. 886; fig. 7, $P\overline{4}$?, No. 887; fig. 8, $M\underline{1}$, No. 885 fig. 9, $P\overline{3}$, No. 888. Merychippus Zone, California.

FIGS. 10–18.—*Parahippus brevidens* Marsh. Fig. 10, $M\underline{3}$, No. 1150; fig. 11, $M\underline{3}$, No. 1161; fig. 12, $P\underline{4}$, No. 406; fig. 13, $M\underline{3}$, No. 407; fig. 14, $P\underline{2}$, No. 1148; fig. 15, $M\underline{1}$?, No. 1145; fig. 16, $M\underline{1}$?, No. 1144; fig. 17, $P\underline{4}$, No. 1147; fig. 18, $M\underline{2}$?, No. 1146.

Nos. 1144, 1145, 1146, 1147, 1148, 1150, and 1161 from Merychippus Zone; Nos. 406 and 407 from Mascall middle Miocene, Oregon. All figures natural size. Calif. Inst. Tech. Coll.


1a


2


3


1


6a


5a


4a


6


5


4


7a


7


11


8


9


10


12


13


14


15


16


17


18

PLATE 2

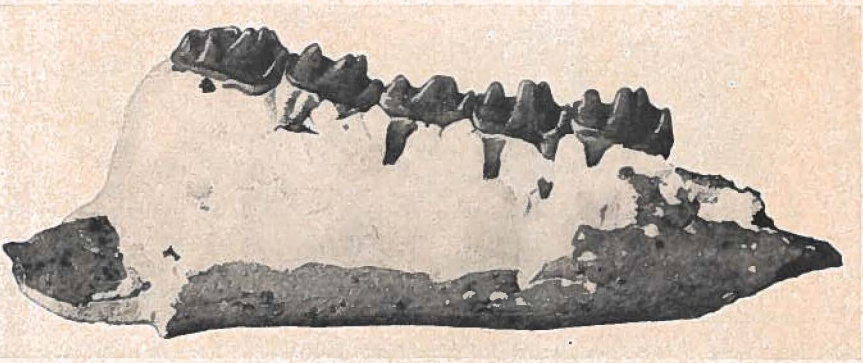
FIGS. 1–5.—*Archæohippus mourningi* (Merriam). Fig. 1, composite series $P\underline{4}$–$M\underline{3}$, No. 881; fig. 2, $M\underline{3}$, No. 884; fig. 3, $Dp\underline{3}$, No. 883; fig. 4, $M\underline{3}$, No. 882; fig. 5, left ramus with $P\underline{3}$–$M\underline{3}$, No. 484. Merychippus Zone, California. All figures natural size. Calif. Inst. Tech. Coll.

1

2

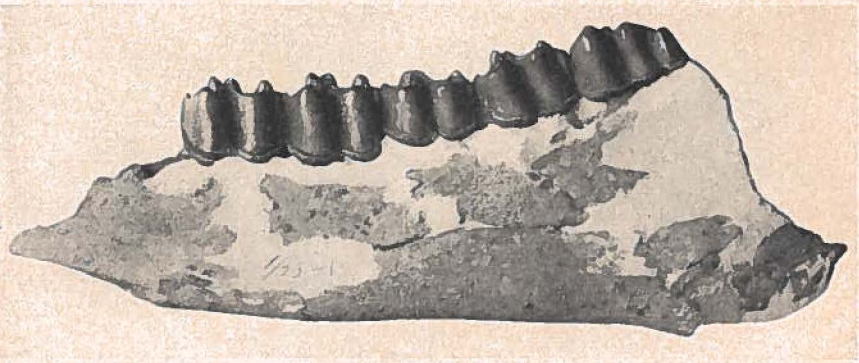
3

4



5

5a



5b

## Plate 3

Figs. 1–4.—*Archæohippus ultimus* (Cope). Fig. 1, inferior molar, No. 3059; fig. 2, inferior molar, No. 424; fig. 3, inferior molar, No. 31987; fig. 4, $M\underline{3}$, paratype, No. 1689. Mascall middle Miocene, Oregon.

Figs. 5–6.—*Archæohippus mourningi* (Merriam). Fig. 5, type, portion of maxillary with $Dp\underline{3}$–$Dp\underline{4}$ and $M\underline{1}$, No. 19340; fig. 6, paratype, portion of ramus with dentition representing $P\underline{2}$–$M\underline{2}$, No. 19764. Barstow upper Miocene, California.

Nos. 3059, 1689, 19340, 31987, and 19764 from Univ. Calif. Coll.; No. 424 from Calif. Inst. Tech. Coll. All figures natural size.

1a

2a

3a

1

2

3

4

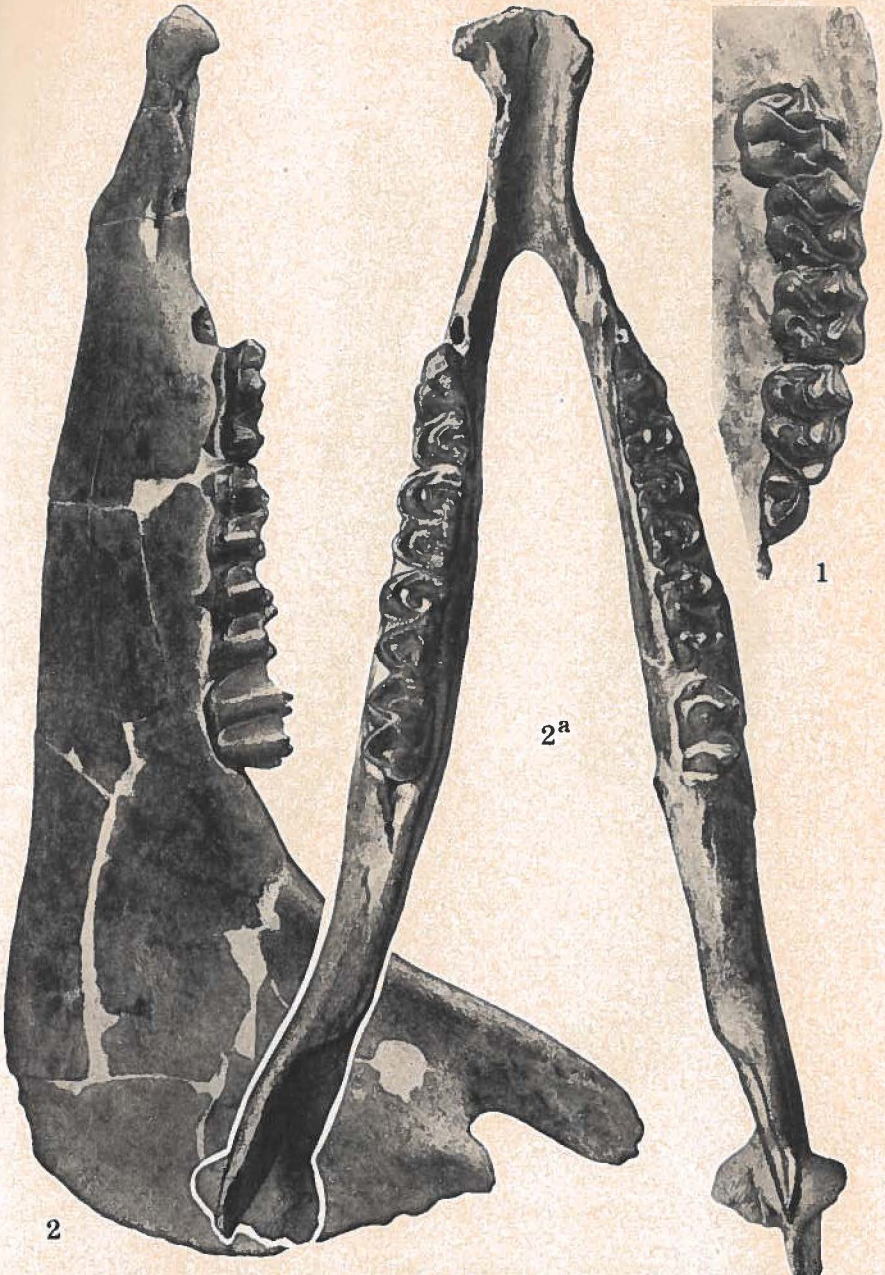
5

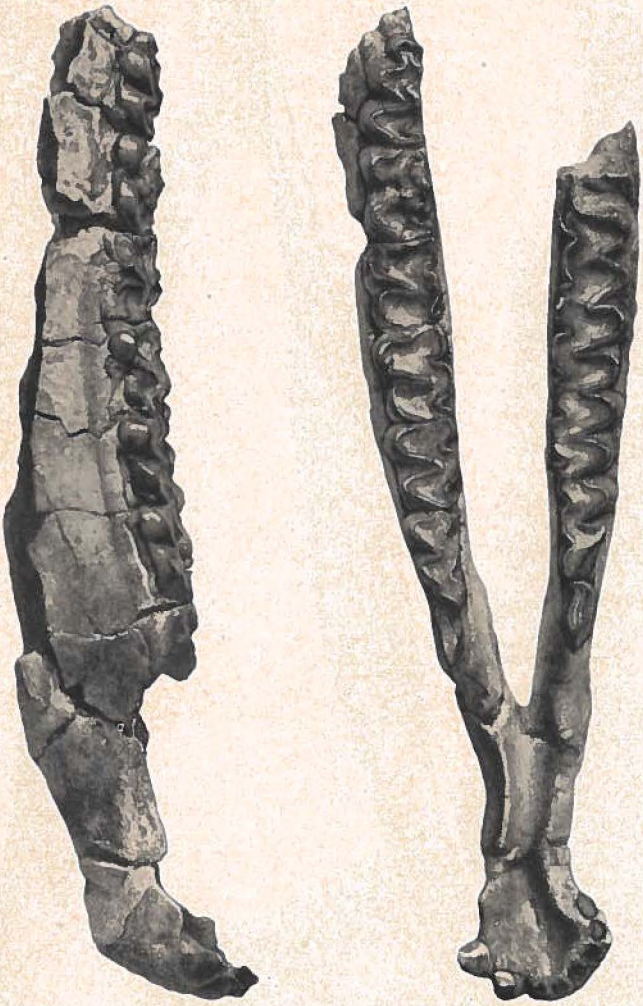
6a

6

PLATE 4

*Archæohippus penultimus* Matthew. Fig. 1, palate, Amer. Mus. No. 21534. Figs. 2-2a, mandible, Amer. Mus. No. 21532; lateral and superior views; natural size. Lower Sheep Creek beds in Aphelops Draw, Sioux County, Nebraska.


1
2a
2



*Archæohippus mourningi* (Merriam). Mandible, U. S. Nat. Mus. No. 12244; lateral and superior views; natural size. The symphyseal end has been displaced upward in this specimen. Miocene beds in Cajon Pass, San Bernardino County, California.