

A New Species of *Merychippus*

By J. P. BUWALDA and G. E. LEWIS

A SHORTER CONTRIBUTION TO GENERAL GEOLOGY

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*Description of a new species of horse from
the middle Miocene, and descriptions of
three new geologic formations*



UNITED STATES DEPARTMENT OF THE INTERIOR

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A NEW SPECIES OF MERYCHIPPUS

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ABSTRACT

Merychippus tehachapiensis, a new species of middle Miocene horse, is described and named from the Kinnick formation of the Tehachapi Mountains, Calif. *M. tehachapiensis* is believed to be a reliable indicator of pre-Barstovian age in the Mojave Desert and nearby California areas because its morphology and stratigraphic position are similar to those of *M. primus* of the middle Miocene Sheep Creek local fauna in the Hemingford group of Nebraska.

Three new formations, the pre-middle Miocene Witnet, the middle Miocene Kinnick, and the late Miocene Bopesta are described and named.

INTRODUCTION

The senior author¹ published (1916) the preliminary description of a new species of *Merychippus* after collecting some of the material described in the present paper during the years 1914 and 1915. He named the fauna with which this *Merychippus* was associated the Phillips Ranch fauna, but did not name the new species. Twenty years after the first collection of this fauna was made, he also published (1934 and 1935, in abstract) a brief statement on the geology of the locality (UC locality 2577, equivalent to CIT locality 503²).

The University of California has made further collections at this and nearby localities, and in recent years Messrs. R. H. Tedford and R. L. Shultz, Jr., have collected considerable material for the California Institute of Technology. We are indebted to them and to the University for permission to describe the type and hypodigm material. The study of this and related material from other localities was carried out in Pasadena at the California Institute. Mr. David P. Willoughby prepared the illustrations.

The material described herein was collected from a single locality. Collections made by the U. S. Geological Survey from other areas in southern California in recent years have included this same new species of horse, whose occurrence will be described in forthcoming reports by the junior author.

WITNET, KINNICK, AND BOPESTA FORMATIONS IN TEHACHAPI MOUNTAINS, CALIFORNIA

WITNET FORMATION

This sedimentary formation is exposed chiefly along Cache Creek and lower Oil Canyon about 5 miles northeast of Monolith, Kern County, Calif., and is herein named from Witnet Ridge north of lower Oil Canyon. It consists mainly of alternate beds of coarse gray arkose, locally bouldery, and of dark sandy shale. It is probably of continental origin, and its thickness is more than 4,000 feet. It has yielded no fossils, but its age is probably early Tertiary and certainly pre-middle Miocene. The strata are steeply tilted and in part overturned. The formation crops out as a strip $\frac{1}{2}$ to $\frac{3}{4}$ mile wide and 4 miles long along Cache Creek and Oil Canyon. Neither the top nor the bottom of the formation is exposed; at the lower contact the granitic basement rocks are thrust over it, and the youngest beds are covered by gently dipping Miocene strata that overlie the upper part of the Witnet formation with strong angular unconformity.

Type section.—Lower Oil Canyon about 1 mile above its junction with Cache Creek; NW $\frac{1}{4}$ of Sec. 13, T32S, R34E, M D B and M, Mojave Quadrangle; Tehachapi Quadrangle.

Name Witnet formation first used by Buwalda (1934).

KINNICK FORMATION

The Kinnick formation is herein named from Kinnick Ridge, north of the confluence of Cache, Oil, and Sand Creeks. It consists mainly of stratified, green, basic volcanic tuffs, largely ash beds with some coarse agglomerates; the upper part consists of gray sandy shale with, locally, white freshwater diatomaceous beds and cherts. There are some basic lava flows. The thickness is not less than 1,500 feet. The formation is exposed over wide areas west of Cache Creek from Monolith northward for 6 or more miles. The strata are moderately deformed with dips generally not more than 30 degrees. The shales of the upper part contain the Phillips Ranch vertebrate local fauna of middle

¹ Professor Buwalda died August 19, 1954.

² CIT=California Institute of Technology; UC=University of California at Berkeley. Where not otherwise specified, numbers following these abbreviations are catalogue numbers.

Miocene age. The Kinnick formation lies with strong angular unconformity across the edges of the Witnet formation. It probably bears conformable relations to the overlying Bopesta formation.

Type section.—Base at unconformity north of the confluence of Cache, Oil and Sand creeks (SW corner of Sec. 11, T32S, R34E, M D B and M), thence northward through CIT locality 503 in saddle west of Hill 5,015, Mojave Quadrangle, in NW $\frac{1}{4}$ of Sec. 34, T31S, R34E, M D B and M.

Name Kinnick formation first used by Buwalda (1934).

BOPESTA FORMATION

The Bopesta formation is herein named from Bopesta Ridge, southwest of Cache Peak. It consists of tan and white, fine and coarse, quartzose sandstones containing some ash and volcanic debris, a few conglomeratic beds, and some gray sandy shale beds. The formation is exposed widely in conspicuous badlands areas east of upper Cache Creek 6 to 7 miles northeast of Monolith, Kern County, Calif., and extending under Cache Peak. The thickness is probably not less than 3,500 feet. The beds are moderately deformed, with dips as much as 30 degrees. The Cache Peak vertebrate local fauna, which occurs in the lower and middle part, is late Miocene in age. Probably conformable on the Kinnick formation but contrasts strongly with it as a mappable unit through its coarseness of materials. Overlain by basic lavas, probably unconformably.

Type section.—From near the confluence of Cache Creek and its East Fork (which heads on the south side of Cache Peak) in the NW $\frac{1}{4}$ of Sec. 1, T32S, R34E, M D B and M, to the north side of Cache Peak, which is in Sec. 20, T31S, R35E, M D B and M.

Name Bopesta formation first used by Buwalda (1934).

GEOLOGIC OCCURRENCE OF *MERYCHIPPUS* *TEHACHAPIENSIS*

The type and hypodigm material of *Merychippus tehachapiensis* was found in the Phillips Ranch local fauna of the Kinnick formation (CIT locality 503=UC locality 2577), in strata consisting mainly of gray shale and fine sandstone, both ashey, interbedded with chert and freshwater diatomite, with a maximum thickness of a few hundreds of feet.

The Bopesta formation which contains an upper Miocene vertebrate fauna (Cache Peak local fauna) overlies the Kinnick formation. Partly because of the sharp difference in lithology, which changes from the gray shale and well-stratified fine sandstone of the upper part of the Kinnick, that may represent playa deposits, to the coarse, poorly stratified tan and red sandstone and conglomerate of the Bopesta, but espe-

cially because of the supposed contrast in the merychippine species in the two formations, it was formerly believed that they represented lower and upper Miocene rocks, that middle Miocene rocks were missing, and that the Bopesta formation unconformably overlay the Kinnick. We now believe that at least the upper part of the Kinnick formation, which yields the Phillips Ranch local fauna, is of middle Miocene stratigraphic position.

Probably the stratigraphic range of *Merychippus tehachapiensis* and that of the larger merychippine species of the Bopesta overlap. The sedimentary section seems to be continuous, and the sandstone of the Bopesta formation conformably overlies shale of the Kinnick. Messrs. Tedford and Schultz reported the discovery of teeth of the larger merychippine species at the locality that yielded the type specimen of *M. tehachapiensis*, and of one specimen probably referable to *M. tehachapiensis* in the lower part of the coarse sandstone regarded as belonging to the Bopesta formation. Perhaps the different environments indicated by the dissimilar upper part of the Kinnick formation (shale, chert, and diatomite) and the Bopesta formation (sandstone and conglomerate), rather than the time interval, determined the change in the most numerous species of *Merychippus* occupying the region in Miocene time. However, only a few teeth of the larger, advanced species of *Merychippus* have been found in the Kinnick, and, excepting the specimen found near its base, *M. tehachapiensis* has not been reported from the Bopesta. Detailed study of structural features of adjoining parts of the Kinnick and Bopesta has not yielded evidence of an unconformity.

SYSTEMATIC DESCRIPTION

Family EQUIDAE Gray, 1821

Subfamily EQUINAE Steinmann and Döderlein, 1890

Genus *MERYCHIPPUS* Leidy, 1857

Merychippus tehachapiensis, new species

Figures 12-16

Type.—Fragment of right maxilla with P⁴ and M¹, and associated right P², all only moderately worn; CIT 4919 from CIT locality 503 (fig. 12).

Hypodigm material.—Associated left M¹, M², and M³, CIT 4920 from CIT locality 503 (fig. 13); left M¹ and M², CIT 4921 from locality 503; fragmentary rami with left P₃, P₄, M₁, M₂, M₃ and right P₃, P₄, M₁, M₂, UC 11817 from UC locality 2577 (fig. 14); fragmentary ramus with right P₂ and P₃, UC 21688 from UC locality 2577 (fig. 15); left M₃, UC 21685 from UC locality 2577 (fig. 13); and additional specimens from CIT locality 503 (=UC locality 2577).

Stratigraphic position.—Kinnick formation, middle Miocene of Hemingfordian age.

Locality.—Phillips Ranch, north half of Sec. 34, T31S, R34E, Kern County, California (U. S. Army Corps of Engineers Map of Tehachapi Quadrangle, coordinates 1266.8—1359.4).

Diagnosis.—The diameters and heights of the crowns of the cheek teeth are about 85 to 90 percent those of the type of *Merychippus primus* (Osborn) (see Osborn, 1918), with similar enamel pattern and other morphologic features, except that the upper premolars tend to be somewhat narrower in proportion to their length than in *M. primus*. The cheek teeth are further advanced morphologically beyond *Parahippus* but, individually and in series, are about the same length as in *M. gunteri* Simpson; however, they tend to be proportionally narrower and with crowns as much as 50 percent higher than the highest reported for *M. gunteri*. The morphologically similar cheek teeth range from somewhat smaller to about the same size in plan, but from 10 to 15 percent higher-crowned, and with protocone further forward than in *M. carrizoensis* Dougherty. The cheek teeth are about one-quarter smaller, and lower crowned than in *M. stevensi* Dougherty.

The elliptical protocone is broadly connected to the protoconule a very short distance from the apex of the unworn protocone in protohippine fashion. The permanent cheek teeth have a relatively thin coating of cement. The fossettes of the permanent cheek teeth are lined but not at all filled with cement. The post-protoconal valley is more nearly filled with cement than the fossettes, and usually communicates with the pre-fossette where the crochet fails to touch or fuse with

the protocone for about the apical half of the unworn crown height. Many of the permanent upper cheek teeth have well-wrinkled fossette walls in early stages of wear, with the usual progressive simplification in the increasingly advanced stages of wear; many have a single, or even double, pli caballin, either incipient or well-developed. However, the degree of enamel complication is far from constant. The milk molars are very thinly and incompletely covered with cement, and are slightly larger but otherwise very similar to those of *M. insignis* Leidy.

The senior author's original description and comparisons (1916, p. 78-79, 82-83) are amended and supplemented by the present diagnosis. The table below indicates the sizes of the figured specimens.

STRATIGRAPHIC SIGNIFICANCE

The senior author's descriptions of the geologic occurrence of *Merychippus tehachapiensis* in the Tehachapi Mountains (Buwalda, 1916, 1934, 1935, and this report) indicate that this rather primitive species was outlived by the larger and more advanced species of *Merychippus* found in the Cache Peak local fauna of that region.

The junior author's recent studies of specimens collected from the Mojave Desert in the Barstow, Calif., area by the U. S. Geological survey establish the presence of *Merychippus tehachapiensis* in Miocene rocks of that region. Probably *M. tehachapiensis* and certain other species of fossil vertebrates found in the

Specimen	Measurements in millimeters			Stage of wear
	Length	Width	Crown height	
CIT 4919 P ²	18.9	14.2	16.0	Medium.
P ⁴	15.7	16.9	16.0	Early medium.
M ¹	15.7	17.5	13.9	Medium.
CIT 4920 M ¹	15.8	17.1	¹ 14.0	Advanced medium.
M ²	15.0	16.5	16.5	Medium.
M ³	14.2	15.7	20.0	Earliest slight.
UC 11817 P ₃	16.8	9.6	20.5	Early medium.
P ₄	14.8	9.6	20.5	Early medium.
M ₁	16.1	9.0	-----	Medium.
M ₂	16.3	7.7	-----	Slight.
P ₃ -M ₂	65.0	-----	-----	
UC 21688 P ₂	15.8	8.9	-----	Slight.
UC 21685 M ₃	19.7	7.5	23.0	Slight.

¹ Estimated.

Barstow area are characteristic of a stratigraphic position below that of the typical upper Miocene fauna of the Barstow formation as that formation and its fauna are generally understood.

Merychippus tehachapiensis, although notably smaller and having lower-crowned cheek teeth, is a good structural ancestor for *M. intermontanus*, the typical Barstow horse, as shown in figure 16. These are demonstrable differences in stage of evolution of two different species of the same genus in the same area. The specific diagnosis pointed out the morphologic similarity of *M. tehachapiensis* to *M. primus* and *M. carrizoensis*. This evidence seems to warrant acceptance of *M. tehachapiensis* as a fossil that is diagnostic of middle Miocene stratigraphic position about equiva-

lent to that of the Hemingfordian Sheep Creek local fauna, with a stratigraphic position well below that of the typical Barstow fauna.

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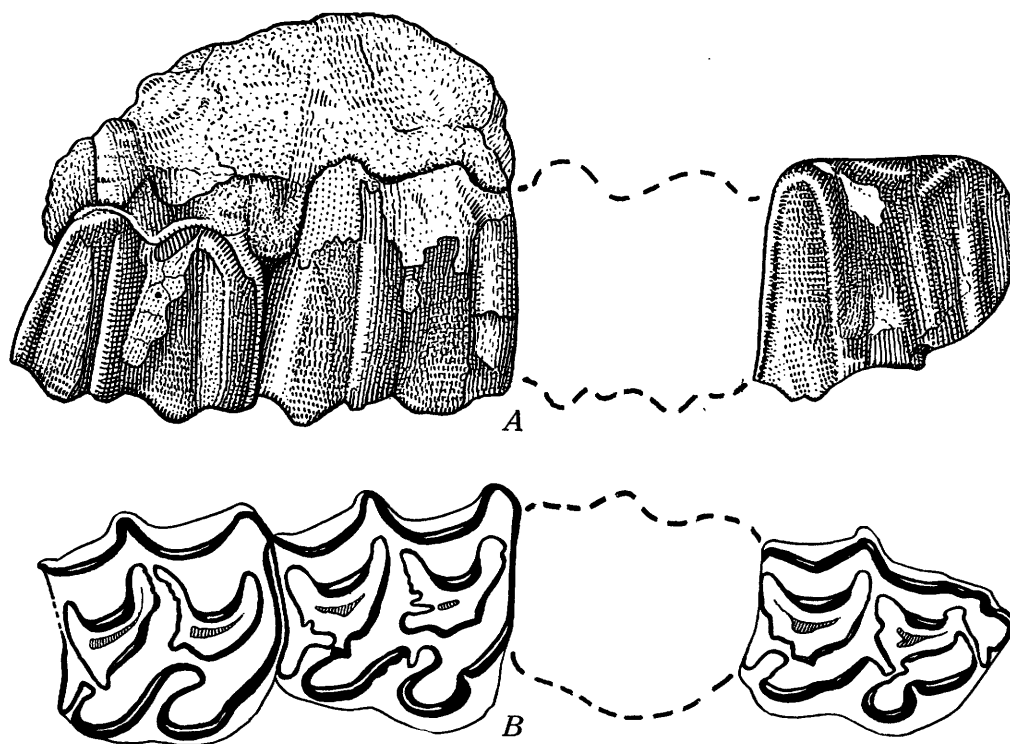


FIGURE 12. *Merychippus tehachapiensis* Buwalda and Lewis, n. sp., $\times 2$. Type: A, buccal and B, occlusal views of fragment of right maxilla with P^4 and M^1 , and associated right P^2 , CIT⁴4919 from CIT locality 503.

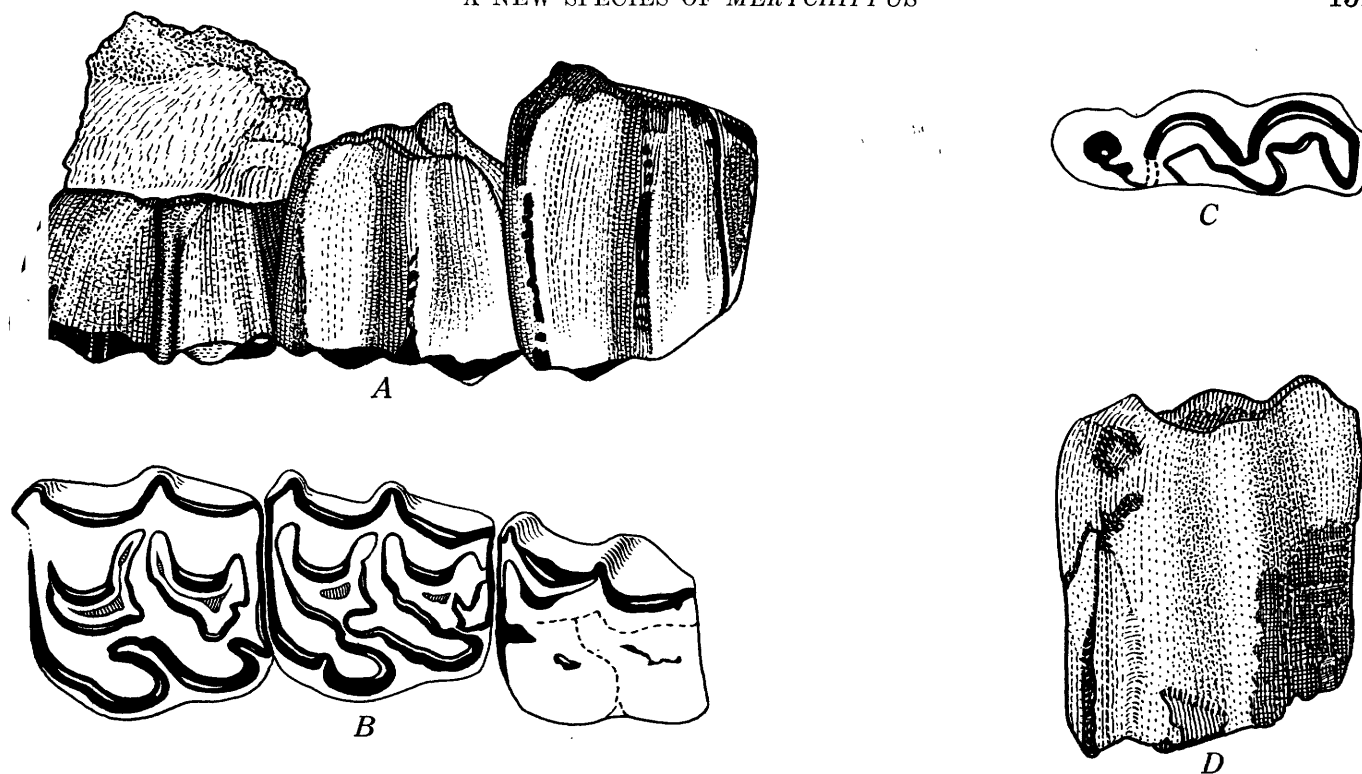


FIGURE 13. *Merychippus tehachapiensis* Buwalda and Lewis, n. sp., $\times 2$. A, buccal and B, occlusal views of associated left M¹, M², and M³, CIT 4920 from CIT locality 503; C, occlusal and D, lingual views of left M₃, UC 21685 from UC locality 2577

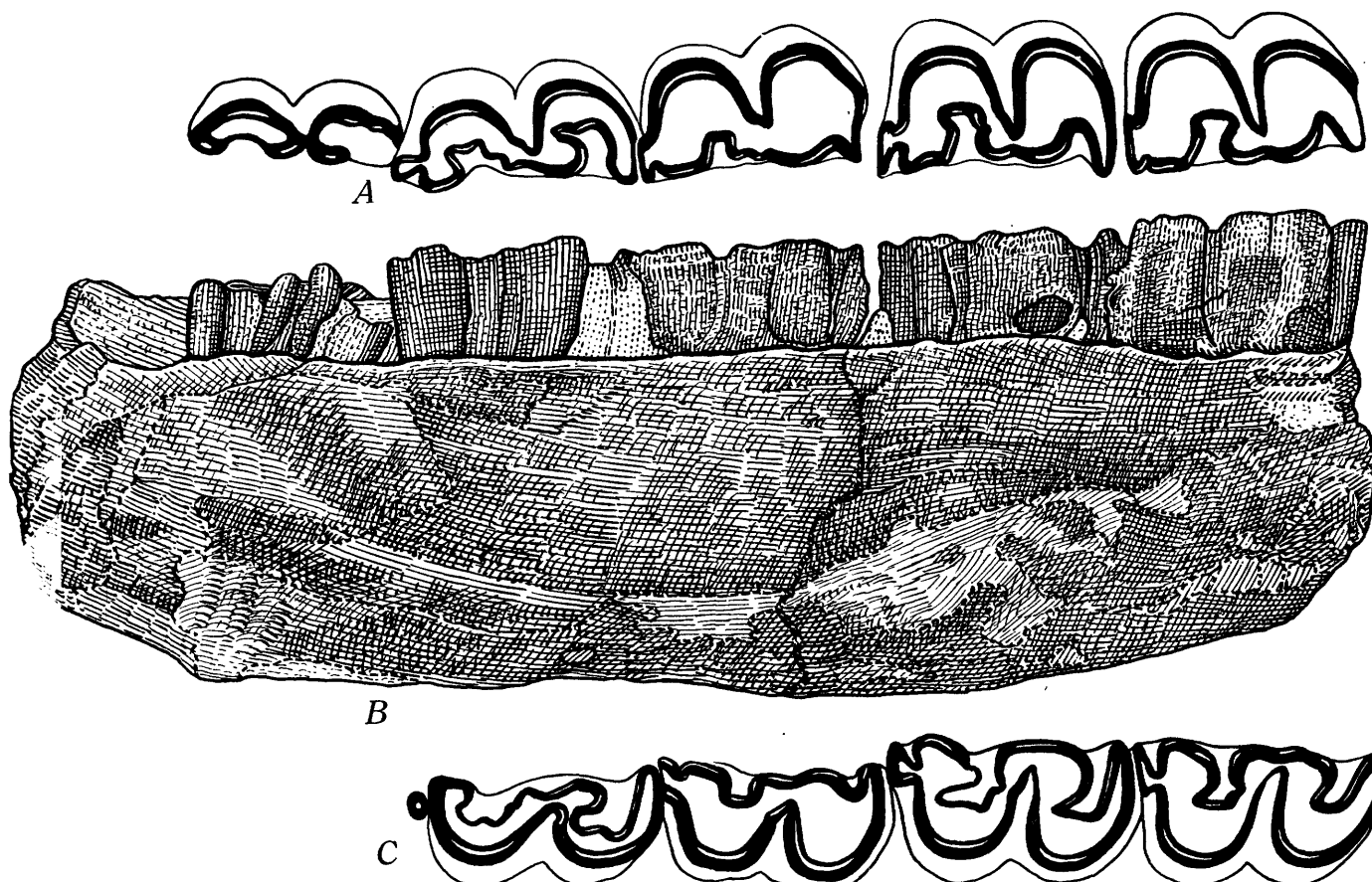


FIGURE 14. *Merychippus tehachapiensis* Buwalda and Lewis, n. sp., $\times 2$. A, occlusal view of cheek teeth and B, lingual view of fragment of left ramus with P₃, P₄, M₁, M₂, and partly erupted M₃; C, occlusal view of cheek teeth of fragment of right ramus with P₃, P₄, M₁, and M₂; UC 11817 from UC locality 2577.

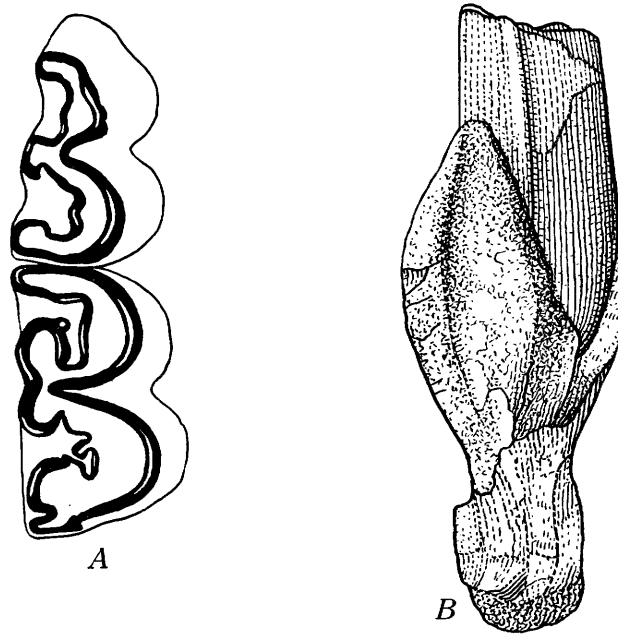


FIGURE 15. *Merychippus tehachapiensis* Buwalda and Lewis, n. sp., $\times 2$. A, occlusal view and B, view of posterior end of fragment of right ramus with P_2 and P_3 , UC 21688 from UC locality 2577.

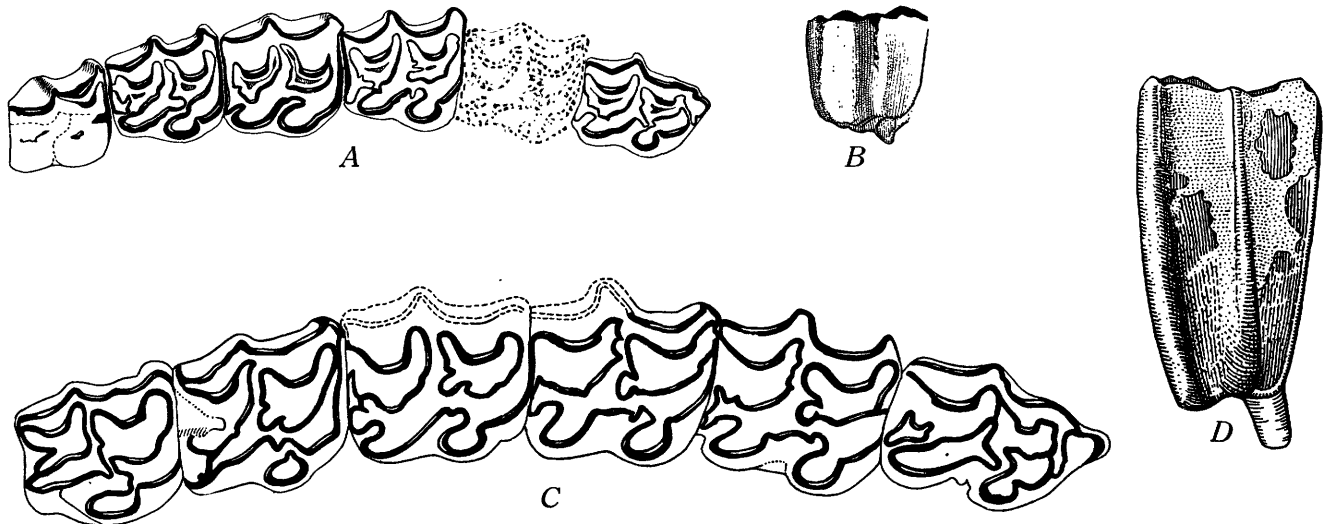


FIGURE 16. *Merychippus tehachapiensis* Buwalda and Lewis, n. sp., natural size. Restoration of right upper dental arcade with A, occlusal view of the series P^2 - M^3 , and B, buccal view of right M^3 , based on CIT 4919 and 4920; for comparison with *M. intermontanus* below.

Merychippus intermontanus Merriam, natural size. Restoration of right upper dental arcade with C, occlusal view of the series P^2 - M^3 , and D, buccal view of right M^2 ; after Merriam, based on UC 21399 and 21400.