CONTRIBUTIONS TO PALÆONTOLOGY

VII

A MIOCENE MAMMALIAN FAUNA FROM SUCKER CREEK, SOUTHEASTERN OREGON

By David W. Scharf

With two plates and eleven text-figures

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INTRODUCTION

Sediments occurring along the lower course of Sucker Creek,[1] in eastern Malheur County, Oregon, have been correlated with the Payette formation of southwestern Idaho on the basis of fossil plant remains found in them. A fossil mammalian fauna, collected from the Sucker Creek beds by field parties of the California Institute, now makes possible a clearer understanding of the relationships between the Miocene mammalian stages found in the northern Great Basin Province and the Payette stage of southwestern Idaho. Because of its incompleteness, the Payette mammalian assemblage up to the present time has furnished no thoroughly satisfactory basis for comparison with similar faunas occurring farther to the west.

The Payette formation, occurring in the region drained by the lower course of the Snake River, was named by Waldemar Lindgren in 1898.[2] The flora has been described by F. H. Knowlton[3] and more recently by R. W. Chaney.[4] The age of the Payette has been determined chiefly by plant remains. In support of a Miocene age for this plant assemblage Chaney makes the following statement: "The position of the Payette formation, above basalt lavas, is in accord with the relation of the Miocene Mascall formation to the Columbia lavas in Oregon. Vertebrate remains collected from the Payette formation by Buwalda are referred by him to the Middle or Upper Miocene. There appears, therefore, to be an agreement between the evidence of the flora, the fauna and the stratigraphy in pointing toward the Miocene age of the Payette formation." [5]

Future geologic mapping may show that the Sucker Creek beds are an integral part of the Payette formation. That the Sucker Creek beds are directly related in age to the Payette is shown by the flora, and such comparisons as can be made between the fossil mammals obtained at Sucker Creek and those from the type section of the Payette are fully in accord with this view. Buwalda[6] reports the presence in the Payette beds of Idaho of a fauna which includes a mastodont, *Hypohippus*, a rhinocerotid, *Merycodus*, and a camelid.

Approximately forty miles west of the Sucker Creek deposits is the Skull Spring occurrence. The beds of that name have yielded a large

[1] On many maps this creek is called Succor Creek. Since the present spelling of the name is that recorded on recent road maps, it is adopted in this paper.
[2] W. Lindgren, 18th Ann. Report U. S. Geol. Surv., Pt. 3, 632–634, 1898.
[3] F. H. Knowlton, 18th Ann. Report U. S. Geol. Surv., Pt. 3, 721–744, 1898.
[4] R. W. Chaney, Amer. Jour. Sci., ser. 5, vol. 4, 214–222, 1922.
[5] R. W. Chaney, *ibid.*, 220, 1922.
[6] J. P. Buwalda, Science, n.s., vol. 60, 572–573, 1924.

and varied mammalian assemblage described by C. L. Gazin.[1] Gazin assigns a Middle Miocene age to the fauna, correlating it with the Mascall of north-central Oregon and with the Virgin Valley of northwestern Nevada. The sediments carrying the fossils were correlated with the Payette formation.

The more important collecting localities in the Sucker Creek beds occur approximately nine miles north of Rockville, Oregon, and

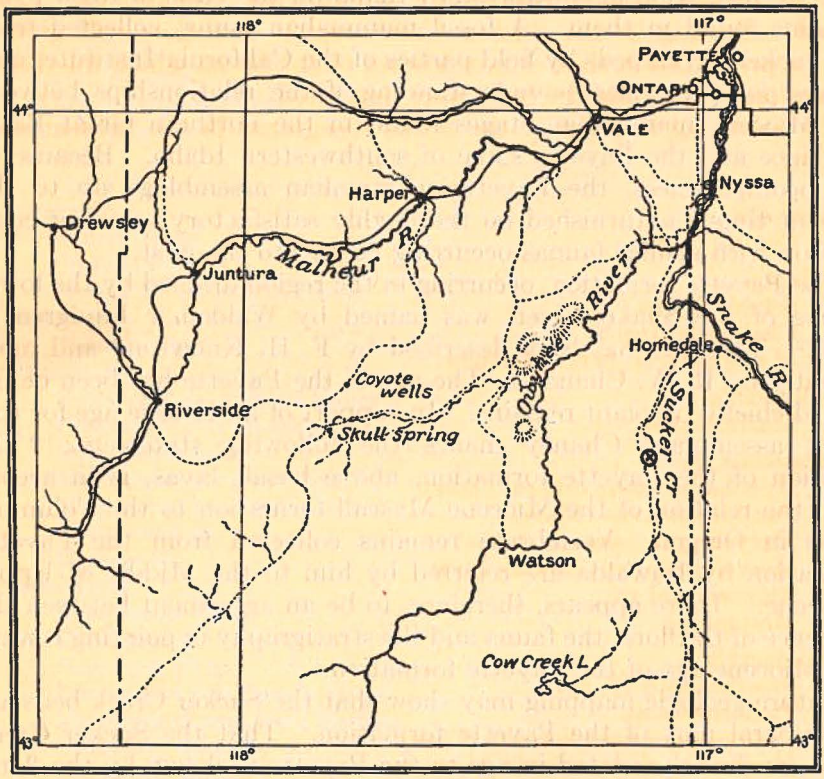


FIG. 1—Index map of portion of eastern Oregon and adjacent region of western Idaho, showing location (X) of Sucker Creek fossil vertebrate occurrence.

approximately five miles west of the Oregon-Idaho border. Location of the beds is shown on the accompanying map (fig. 1).

The beds carrying the fossils consist of fine- to medium-grained pyroclastics, varying from white to green and brown in color. Presence of fish vertebræ and of ostracod shells indicates deposition of at least a portion of the sediments in a body of water.

Fossil mammalian remains were first discovered in the Sucker Creek beds by Chester Stock and E. L. Furlong in 1927. The writer is

[1] C. L. Gazin, Carnegie Inst. Wash. Pub. No. 418, 37–86, 1932.

indebted to Dr. Stock for the opportunity to undertake this study and for kindly advice and criticism during its progress. The illustrations were prepared by Mr. John L. Ridgway.

SUCKER CREEK FAUNA

While the mammalian collections from Sucker Creek are rather fragmentary and incomplete, nevertheless sufficient material is available to permit certain reasonably trustworthy conclusions. Continued collecting in the Sucker Creek region doubtless will give a fuller representation than is now known of the fauna which inhabited the region at the time the beds were deposited.

The following is a list of the forms recognized in the present collection:

Carnivora
- Canid (?) sp.

Rodentia
- Sciurid (?) sp.
- Chalicomyid sp.
- Mylagaulus cf. lævis Matthew

Proboscidea
- Mastodont sp.

Perissodactyla
- Hypohippus near osborni Gidley
- Parahippus avus (Marsh)
- Merychippus isonesus (Cope)
- Merychippus brevidontus Bode
- Rhinocerotid sp.
- Moropus sp.

Artiodactyla
- Prosthennops (?) sp.
- Ticholeptus sp.
- Dromomeryx near borealis (Cope)
- Merycodus cf. nevadensis Merriam
- Camelid (?) sp. a
- Camelid (?) sp. b

ENVIRONMENT OF FAUNA

Although the vertebrate fossil record is fragmentary, certain suggestions are indicated as to the environmental conditions that prevailed in the region during the period of deposition of the Sucker Creek sediments. The brachydont ungulates represented by *Hypohippus*, *Parahippus*, *Moropus* and *Dromomeryx* were evidently browsing types and their presence suggests a glade or forest environment, with a humidity greater than that of the semiarid desert which characterizes the region today. On the other hand, the occurrence of hypsodont

grazing forms, as for example *Merychippus* and *Merycodus*, may well suggest an association of extensive grasslands with the forest areas.

The conclusions as to the environment indicated by the Payette flora, derived by Chaney, are in accord with the evidence offered by the brachydont, browsing ungulates. Chaney considers the climate to have been similar to that of northern California and southwestern Oregon today. A forested region of some relief is indicated, with oaks as the dominant form on the slopes, while the lake or stream borders were swampy.[1]

AGE AND RELATIONSHIPS OF FAUNA

In the light of the known Tertiary faunal stages for western North America the assemblage from Sucker Creek is certainly of Miocene age. Presence of the species *Merychippus isonesus*, *Dromomeryx* near *borealis*, and *Mylagaulus* cf. *lævis*, found in Middle Miocene faunas elsewhere, would seem to suggest a nearly comparable age for the Sucker Creek assemblage. *Hypohippus*, *Parahippus* and *Moropus* are unfortunately too incomplete for specific determination, but may be indicative likewise of this stage.

The mammalian assemblage most closely related to the Sucker Creek fauna in time and in geographic position is that reported from the region of Skull Spring by Gazin.[2] The similarity between the two faunas is at once apparent from a comparison of the faunal lists given below:

Sucker Creek	Skull Spring
Carnivora	Carnivora
	Tomarctus cf. brevirostris Cope
	Euoplocyon (?) sp.
Canid (?) sp.	Canid (?) sp.
	Amphicyon sinapius Matthew
	Amphicyon cf. frendens Matthew
	cf. Pliocyon medius Matthew
	Hemicyon n. sp.
	Martes (Tomictis) gazini Hall
Rodentia	Rodentia
Sciurid (?) sp.	Sciurus malheurensis Gazin
	Sciurus tephrus Gazin
	Citellus longirostris Gazin
	Liodontia alexandræ (Furlong)
Mylagaulus cf. lævis Matthew	Mylagaulus cf. lævis Matthew
	Diprionomys (?) oregonensis Gazin
Chalicomyid sp.	

[1] R. W. Chaney, *op. cit.*, 221–222, 1922.
[2] C. L. Gazin, *op. cit.*, 37–86, 1932.

Sucker Creek	Skull Spring
Proboscidea	Proboscidea
Mastodont sp.	Mastodont sp.
Perissodactyla	Perissodactyla
Hypohippus near osborni Gidley	Hypohippus sp.
Parahippus avus (Marsh)	Parahippus near coloradensis Gidley
Merychippus isonesus (Cope)	Merychippus isonesus (Cope)
Merychippus brevidontus Bode	
Rhinocerotid sp.	Rhinocerotid sp.
Moropus sp.	Chalicothere (?) sp.
	Tapirid sp.
Artiodactyla	Artiodactyla
Prosthennops (?) sp.	Platygonus (?) sp.
Ticholeptus sp.	Ticholeptus (?) sp.
Dromomeryx near borealis (Cope)	Dromomeryx near borealis (Cope)
	Blastomeryx (?) sp.
Merycodus cf. nevadensis Merriam	Merycodus sp. a
	Merycodus sp. b
Camelid (?) sp. a	
Camelid (?) sp. b	

Many of the forms recognized in the Sucker Creek fauna are represented likewise in the Skull Spring assemblage by either identical or closely related types. It appears entirely possible that the Sucker Creek faunal stage is a near, if not a direct, chronologic equivalent of that described from Skull Spring, although the deposits in which the former occurs may represent a longer period of accumulation than that recorded by the beds containing the latter horizon. Gazin has pointed out the close resemblance between the Skull Spring fauna and the assemblages known from the Mascall and the Virgin Valley. As in the case of the Skull Spring assemblage, that from Sucker Creek shows a slightly greater resemblance to the Virgin Valley fauna than to the Mascall fauna, and this is especially noticeable in a comparison of the ungulates. Similarity of types is also seen when comparison is made with the fauna from the Pawnee Creek beds of Colorado and with that of the Lower Snake Creek beds of Nebraska.

SYSTEMATIC DESCRIPTION

Carnivora

Canid (?) sp.

Remains of carnivora in the fauna consist chiefly of jaw and limb fragments too incomplete to indicate definite family relationships. One specimen, an $M\underline{1}$, No. 1771, C. I. T. Coll. Vert. Pale. (Plate 1, fig. 4), is complete, however, and may represent a member of the Canidæ, although it appears to be distinct from any known genus of that family. The tooth is semi-quadrate in shape with broad heel. It is extremely low-crowned, the cusps barely rising above the general level of the occlusal surface. The paracone and metacone are placed well in from the outer edge, which is marked by a distinct cingulum. A faint anteroposterior ridge runs through the paracone and metacone. A low ridge curves forward and outward around the protocone. A weak protoconule attached to the protocone is likewise connected with the paracone by a faint ridge. The protocone lies entirely in the anterior half of the tooth. A metaconule is present at the postero-external end of the hypocone ridge.

Measurements (in millimeters)

Anteroposterior diameter	9.3
Transverse diameter	10.5

Rodentia

Sciurid (?) sp.

A fragmentary ramus without teeth, No. 1779 C. I. T. Coll., suggests a sciurid type, but the determination is by no means certain. Four quadrate cheek-teeth were apparently present as in the Sciuridæ, and the ramus is somewhat heavier and more massive than that in modern representatives of that family.

Chalicomyid sp.

A single tooth fragment, No. 1773 C. I. T. Coll. Vert. Pale. (Plate 1, fig. 2), suggests the presence of a member of the Chalicomyidæ. The specimen unfortunately does not provide a basis for a more definite determination.

Mylagaulus cf. lævis Matthew

A single mylagaulid tooth, No. 1042 C. I. T. Coll. Vert. Pale. (Plate 1, figs. 3, 3a), an upper fourth premolar, is practically identical in size and in structure with specimens from Skull Spring, referred by Gazin[1] to *Mylagaulus* cf. *lævis* Matthew. Five enamel lakes are present on the occlusal surface, although six or seven may have been present originally. The anterior lake has a bifurcate front border and appears to have been formed by the union of two lakes. In the postero-external lake the posterior border is bifurcate and this structure appears also to be the result of a union of two lakes. The external lake is quite small and elliptical in shape, while the others are elongate anteroposteriorly.

A fragment of a right ramus, No. 1774 (Plate 1, fig. 1), bears $M\bar{2}$ and $M\bar{3}$ and the posterior portion of $P\bar{4}$. The posterior molars are simple cylindrical teeth. $M\bar{2}$ possesses four enamel lakes while three lakes are present in $M\bar{3}$.

[1] C. L. Gazin, *ibid.*, 69–71, 1932.

Measurements of teeth (in millimeters)

	$P\frac{4}{4}$ No. 1042 C.I.T.	$M\frac{2}{2}$ No. 1774 C.I.T.	$M\frac{3}{3}$ No. 1774 C.I.T.
Anteroposterior diameter	8.2	3.8	2.4
Transverse diameter	5.3	3.4	2.4

Proboscidea

Mastodont sp.

Fragments of teeth and incomplete limb elements are recognized as belonging to a mastodont type, but the specimens are not sufficiently complete to permit a more detailed determination.

Perissodactyla

Hypohippus near osborni Gidley

An unworn complete $M\frac{3}{3}$, No. 1769 (plate 2, figs. 4, 4a), and the posterior portion of an upper cheek-tooth, No. 1048 (fig. 2), represent the genus *Hypohippus*. The specimens are so strikingly similar to teeth from the Virgin Valley beds described by Merriam[1] as *Hypohippus* near *osborni*, that Merriam's discussion of the affinities of the Virgin Valley form holds equally well for the Sucker Creek specimens. It may be noted, however, that in No. 1769 a groove running part way down the lingual side of the metaconid is faintly suggested and a tiny tubercle is present at the entrance to the postero-internal valley.

FIG. 2—*Hypohippus* near *osborni* Gidley. Fragment of upper cheek tooth, No. 1048, occlusal view; x1.0. Calif. Inst. Tech. Coll. Sucker Creek, Miocene, Oregon.

Measurements (in millimeters)

$M\frac{3}{3}$, No. 1769, anteroposterior diameter	23.5
$M\frac{3}{3}$, No. 1769, transverse diameter	12.5

Parahippus avus (Marsh)

A number of lower cheek-teeth, Nos. 442 (fig. 3b), 443–445, 1045 (fig. 3a), and 1046 C. I. T. Coll. Vert. Pale., are referred to the species *Parahippus avus* (Marsh) recorded from the Mascall formation of north-central Oregon.[2] The teeth are featured by very strong external cingula and by the presence of cement in the valleys. $M\frac{3}{3}$, No. 1046, possesses a very heavy deposit of cement but has only a weak cingulum. A very low cingular cuspule is present at the base of the external median valley in all of the specimens. The inner walls of the protoconid and hypoconid show a slight crenulation of the enamel and this becomes less distinct with wear. Tiny cuspules may be present at the bases of the interior valleys,

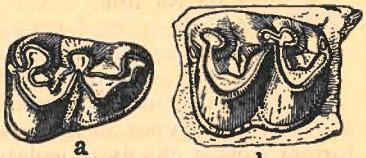


FIG. 3—*Parahippus avus* (Marsh). *a*, $P\frac{2}{2}$, No. 1045, occlusal view; *b*, $P\frac{3}{3}$ or $P\frac{4}{4}$, No. 442, occlusal view; x1.0. Calif. Inst. Tech. Coll. Sucker Creek Miocene, Oregon.

[1] J. C. Merriam, Univ. Calif. Pub., Bull. Dept. Geol., vol. 6, 257–261, figs. 25–27, 1911.
[2] H. F. Osborn, Mem. Amer. Mus. Nat. Hist., vol. 2, pt. 1, 87, 88, 1918.

attached to the walls of the metaconid and metastylid. The entostylid is a well-developed pillar, rising from the posterior cingulum. Its summit in a little-worn tooth is somewhat lower than that of the entoconid. The metaconid and metastylid are separated by a groove which is distinct for a distance extending approximately half-way to the base of the crown. The metaconid sends a long narrow projection into the antero-interior valley. In one specimen, No. 445, this projection is represented by a separate antero-posteriorly elongated style and there is a prominent buttress on the anterior wall of the protoconid loph. The floors of the interior valleys are situated somewhat above the base of the crown and the valleys are consequently rather shallow in vertical depth, becoming reduced by wear to mere notches. The external valley extends well into the crown throughout all stages of wear.

The Sucker Creek form shows advance over the type found at Skull Spring[1] in greater height of crown, slightly larger size, presence of cement and of a heavy continuous external cingulum. Moreover, the teeth from the Sucker Creek deposits are marked by regular horizontal striations, while in the Skull Spring specimen the surface is irregularly rugose in a vertical direction.

Lower teeth of *P. brevidens* (Marsh) in the collections of the California Institute from the Merychippus zone of the North Coalinga region, California, do not have a strong external cingulum and are of somewhat smaller size. The lower teeth of *P. crenidens* (Scott)[2] are slightly smaller in antero-posterior diameter and the metaconid does not project into the antero-interior valley. In *P. pawniensis* Gidley[3] the metaconid and metastylid are not so distinctly separated as in the Sucker Creek form.

A very close resemblance is seen to exist between the Sucker Creek specimens and a tooth described by Merriam[4] as *Parahippus* cf. *avus* from the Middle Miocene Virgin Valley beds of Nevada.

Only a fragmentary cheek-tooth, No. 1775 (Plate 2, fig. 5), is present of the upper dentition of *Parahippus*. It exhibits no characters to separate it from any of the several species of *Parahippus*.

Measurements of teeth (in millimeters)

	Anteroposterior diameter	Greatest transverse diameter (at base)
$P\bar{2}$, No. 1045	19.9	13.0
$P\bar{4}$(?), No. 442	19.5	15.6
$M\bar{1}$(?), No. 443	20.0	14.6
$M\bar{2}$(?), No. 444	19.3	13.1
$M\bar{3}$, No. 1046	21.5	11.6

Merychippus Leidy

Remains of merychippine horses are more numerous than those of the anchitheriine types in the collections from the Sucker Creek beds. The former consist chiefly of isolated upper and lower cheek-teeth, but an incomplete mandible and several limb elements are also present.

F. D. Bode,[5] in a study of a large number of merychippine teeth from the Merychippus zone of the North Coalinga region, found that the majority of

[1] C. L. Gazin, Carnegie Inst. Wash. Pub. No. 418, 77, 78, fig. 10c, 1932.
[2] H. F. Osborn, *op. cit.*, 90–92, fig. 67, 1918.
[3] J. W. Gidley, Bull. Amer. Mus. Nat. Hist., vol. 23, 932, 1907; H. F. Osborn, Mem. Amer. Mus. Nat. Hist., vol. 2, pt. 1, 92–93, 1918.
[4] J. C. Merriam, Univ. Calif. Pub., Bull. Dept. Geol., vol. 6, 261–262, fig. 29, 1911.
[5] F. D. Bode, Carnegie Inst. Wash. Pub. No. 453, art. V, 39–63, 1934.

the teeth from this horizon exhibit the characters of *Merychippus californicus* Merriam. However, a number of variants were recognized by Bode which approach in their characters those of other described species of *Merychippus*, and in addition one group was established as specifically distinct from all known forms.

Similar variation is found among the *Merychippus* teeth in the Sucker Creek collection, although diversity of type is expressed to a lesser extent than in the Coalinga fauna, due in part at least to the much smaller number of specimens available. A majority of the teeth possess the characters of a single species. A second form can also be distinguished and variants are present which approach still other species of *Merychippus*.

Merychippus isonesus (Cope)

The predominating form in the Sucker Creek assemblage exhibits the characters of *Merychippus isonesus*. The upper teeth have curved crowns of moderate length and are heavily cemented. Protocone and hypocone are sub-equal in size and round-oval in shape, with the hypocone slightly more flattened than the protocone. Both protocone and hypocone are discrete cusps during the first stages of wear, with spurs projecting toward protoconule and metaconule, respectively. The hypocone connects with the metaconule at an early stage of wear, while the protocone remains distinct until the tooth is a little more than half-worn. The fossettes are wide and are open at the anterior and posterior ends of the tooth in unworn specimens, but the union of protoconule and metaloph is complete except in $P\overline{2}$. The fossettes become completely closed in an early stage of wear. A pli-caballin, pli-protoconule and pli-hypostyle are usually present though not always developed to the same extent in each specimen. The parastyle and mesostyle are prominent, the mesostyle especially so in the premolars.

As the teeth advance in stage of wear, the protocone becomes rounder in cross-section and the prominence of the projecting spur is decreased. The isthmus connecting hypocone and metaconule, at first narrow, becomes almost as wide as the hypocone itself at a stage of wear marked by a union of protocone and protoconule. With increased wear the fossettes become narrower and the enamel plications tend to disappear. In very advanced wear the protocone and hypocone coalesce, converting the post-protoconal valley into a small enamel-enclosed lake.

The teeth from Sucker Creek are shorter-crowned and slightly less curved than teeth of *Merychippus californicus*. Furthermore, the protocone in *M. isonesus* does not usually project quite so far inward beyond the hypocone as is the case in the Coalinga species.

The lower cheek-teeth are moderately long-crowned and heavily cemented. Comparison of the lower cheek-teeth of *M. isonesus* with those of *M. californicus* reveals the following differences: (1) In *M. isonesus* the crowns are shorter and the convexity of the external walls of the protoconid and hypoconid is more pronounced than in *M. californicus;* (2) The anterior horn of the hypoconid loph joins the posterior horn of the protoconid loph at a later stage of wear in *M. isonesus* than in *M. californicus;* (3) In the lower premolars of *M. isonesus* the anterior horn of the hypoconid loph usually joins the posterior horn of the protoconid loph immediately adjacent to the metaconid-metastylid column or it may join directly with the metastylid, producing a very deep external median valley. In *M. californicus*, on the other hand, the union is usually established about half-way between the external and internal sides of the tooth, producing a much shallower external median valley.

The differences noted under (1) appear to be constant, whereas those indicated in (2) and (3) are evidently subject to variation and are not always trustworthy characters of value in distinguishing these two species.

The lower canines in the incomplete mandibular specimen, No. 1059, are small and incisiform and are placed immediately adjacent to $I\overline{3}$. The size of the alveolus for $I\overline{3}$ indicates that this tooth was somewhat larger than the canine.

In the milk teeth of *M. isonesus* from Sucker Creek the protocone and hypocone are conical and the principal axis of the latter cusp runs diagonally across the tooth. As noted by Bode,[1] these characters readily distinguish the milk teeth of *M. isonesus* from those of *M. californicus*. In the latter, the teeth have longer crowns, are well-cemented, and the protocone and hypocone are cylindrical with the principal axis of the hypocone oriented in an anteroposterior direction.

$M\underline{3}$, No. 437 (fig. 4h), is typical of a form whose characters suggest *Merychippus sumani*. The protocone is elongated anteroposteriorly and this cusp remains separate to the base of the crown. The tooth is considerably larger than teeth of average size referred to *M. isonesus*.

Measurements of teeth (in millimeters)

	Antero-posterior diameter	Greatest transverse diameter (exclusive of cement)	Height of crown of unworn specimens
$P\underline{2}$, No. 1049	21.6	15.8	
$P\underline{3}$, No. 1050	19.7	17.2	
$P\underline{4}$, No. 1051	18.9	18.0	
$M\underline{2}$, No. 1053	18.5	17.0	
$M\underline{3}$, No. 1054	17.6	16.3	*a*20.0
$M\underline{3}$, No. 437	21.3	19.0	
$P\overline{2}$, No. 1057	18.4	8.8	
$P\overline{3}$, No. 1057	17.8	10.5	
$P\overline{3}$ or $P\overline{4}$, No. 1052	19.5	*a*10.5	
$M\overline{1}$, No. 1055	18.5	*a*8.5	*a*30.0
$M\overline{2}$, No. 1056	*a*18.1	*a*8.5	*a*30.0
$M\overline{3}$, No. 1058	*a*22.7	*a*7.0	
$P\overline{2}$–$M\overline{3}$, No. 1059	106.4		
$Dp\underline{2}$, No. 441	23.4	14.9	
$Dp\underline{3}$, No. 440	19.7	15.8	
$Dp\underline{4}$(?), No. 439	19.1	16.6	
$Dp\overline{2}$, No. 1047	*a*22.5	12.0	

a, approximate.

Merychippus brevidontus Bode

Three teeth, Nos. 1123, 1124 and 1770, C. I. T. Coll. Vert. Pale. (Plate 2, figs. 1–3a), exhibit the complexity of enamel pattern coupled with shortness of crown which is characteristic of this species as described from the Merychippus zone of California.

In view of the association of this form with a progressive species of *Parahippus* as noted by Bode for the latter horizon, it is well to indicate a similar association in the Sucker Creek fauna.

[1] F. D. Bode, *op. cit.*, 45, pl. 2, figs. 2 and 3, 1934.

Measurements of teeth (in millimeters)

	$M\underline{2}$ No. 1770 C.I.T.	$M\underline{2}$(?) No. 1123 C.I.T.	$P\bar{2}$ No. 1124 C.I.T.
Anteroposterior diameter	18.5	18.9	20.1
Transverse diameter	17.7	.....	11.7

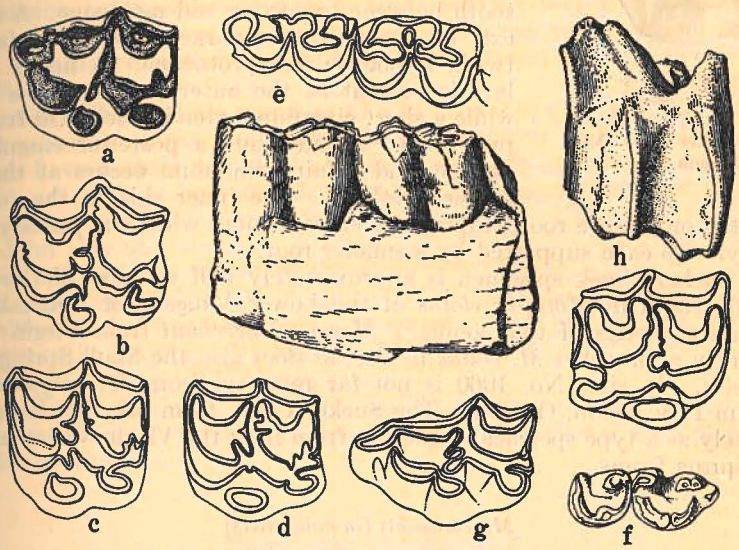


FIG. 4—*Merychippus isonesus* (Cope). *a*, $P\underline{2}$, No. 1049, occlusal view; *b*, $P\underline{3}$, No. 1050, occlusal view; *c*, $P\underline{4}$, No. 1051, occlusal view; *d*, $M\underline{2}$, No. 1053, occlusal view; *e*, $P\bar{2}$ and $P\bar{3}$, No. 1057, lateral and occlusal views; *f*, $M\bar{1}$, No. 1055, occlusal view; *g*, $Dp\underline{2}$, No. 441, occlusal view; *h*, $M\underline{3}$, No. 437, lateral and occlusal views showing type of tooth associated with typical *M. isonesus* and which closely resembles *M. sumani;* x1.0. Calif. Inst. Tech. Coll. Sucker Creek Miocene, Oregon.

Rhinocerotid sp.

Fragments of teeth and of limb elements indicate the presence of a rhinocerotid in the fauna, but a generic determination of the form is not possible on the basis of available material. The fragments suggest a type with relatively long-crowned teeth.

Moropus sp.

Chalicotheres are represented in this collection by a single tooth, a right $M\underline{2}$, No. 1060 C. I. T. Coll. Vert. Pale. (fig. 5), which agrees in character of crown with the description of teeth of *Moropus* given by Holland and Peterson.[1] The tooth is unworn and well preserved. It is semiquadrate in shape with parastyle placed farther forward than the antero-internal corner of the tooth. The ectoloph is sharply inflected, having a W-shape, with prominent parastyle and mesostyle. A faint rib is present on the outer wall

[1] W. J. Holland and O. A. Peterson, Mem. Carnegie Mus., vol. 3, 245–247, 1914.

of the paracone. The outer walls of the paracone and metacone slant inward at an angle of approximately 45 degrees. The crest of the ectoloph is sharp. A small sharp tubercle lies adjacent to the inner wall of the paracone. The protocone is isolated, the protoloph being cut through by the anterior exit of the valley between protocone and paracone. A short sharp crest curves inward and forward from the summit of the protocone. A low sharp crest extending inward from the metacone ends in the hypocone. A deep V-shaped valley extends forward from the posterior end of the tooth between hypocone and metacone. A second exit of the protocone-paracone valley exists between hypocone and protocone. A heavy cingulum is present at the anterior end of the tooth, while a short cingulum extends backward from the protocone. In addition, a posterior cingulum is present and a faint cingulum occurs at the base of the ectoloph. The inner side of the tooth is supported on a large root, elliptical in cross-section, while the parastyle and mesostyle are each supported by a smaller root.

FIG. 5—*Moropus* sp. M2, No. 1060, occlusal view; x1.0. Calif. Inst. Tech. Coll. Sucker Creek, Miocene, Oregon.

The Sucker Creek specimen is approximately half the size of the corresponding tooth in *Moropus elatus* of the Lower Miocene of Nebraska, the best-known species of that genus.[1] *Moropus merriami* from Virgin Valley apparently approaches *M. elatus* in size, as does also the Skull Spring chalicothere(?). In size, No. 1060 is not far removed from *M. oregonensis* of the John Day region, Oregon. The Sucker Creek form may be determined ultimately as a type specifically distinct from both the Virgin Valley and the Skull Spring forms.

Measurements (in millimeters)

	Moropus, sp. No. 1060 C.I.T.	*M. elatus* No. 2103 Car. Mus.
M2, anteroposterior diameter.....	25.4	56.0
M2, transverse diameter.....	21.0	41.0

Artiodactyla

Prosthennops(?) sp.

The peccaries are represented by a single M3, No. 1061 C. I. T. Coll. Vert. Pale. (fig. 6). Four principal cusps are present and are arranged in a rectangle slightly longer antero-posteriorly than transversely. The two anterior cusps are somewhat stouter and stand slightly higher than the posterior pair The heel is about one-third the length of the entire tooth and displays four small cusps, sub-equal in size. A smaller cuspule is present on each side of the last cusp on the heel. The tooth unfortunately presents no characters on which a definite generic determination can be made. It can be readily separated from *Platygonus* by the conical shape of the cusps and an absence

[1] W. J. Holland and O. A. Peterson, *ibid.*, 222–226, 1914.

of cross-crests. It is distinguished from *Desmathyus* by an absence of a cingulum. In a comparison between third lower molars of *Perchœrus* from the White River and John Day Oligocene and those of *Prosthennops* from the Rattlesnake and Thousand Creek Pliocene, it was observed that the principal cusps in the later genus are stouter and crowd each other, occupying relatively more of the occlusal surface than in the earlier genus. In the earlier form the cusps are distinctly separated by open valleys. In these characters the Sucker Creek specimen approaches *Prosthennops*, but remains intermediate between that genus and *Perchœrus*.

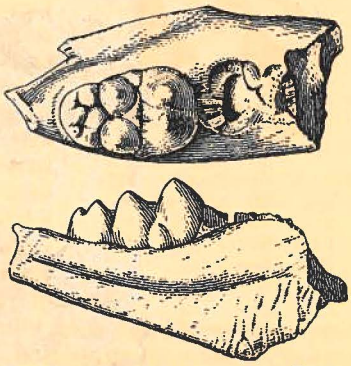


FIG. 6—*Prosthennops* (?) sp. $M\bar{3}$, No. 1061, lateral and occlusal views; x1.0. Calif. Inst. Tech. Coll. Sucker Creek Miocene, Oregon.

The peculiar character of the heel of No. 1061 may or may not have taxonomic importance. The number and size of accessory tubercles on the molars of Recent peccaries have been observed to be highly variable. A type of heel similar to that in No. 1061 is seen in *Perchœrus trichænus* of the John Day and serves to distinguish this species from *P. pristinus* of the same horizon.[1] A specimen of *Prosthennops* in the California Institute collections from the Rattlesnake Pliocene, although notably larger, has an arrangement of cusps on the heel of $M\bar{3}$ very similar to that in the Sucker Creek specimen. *Prosthennops longirostris* Thorpe from the Pliocene of Oregon has also a large number of tubercles on the heel of $M.\bar{3}$

Measurements (in millimeters)

Anteroposterior diameter	17.5
Transverse diameter	10.0

Ticholeptus sp.

Oreodont material in the Sucker Creek collection is sufficient to permit generic identification of the form represented, but a definite specific determination is not warranted.

Nos. 1062, 1064 and 1728 (fig. 7) are fragments of jaws bearing upper and lower teeth which, when compared with *Ticholeptus petersoni* Loomis[2] from the Lower Harrison beds of Wyoming, show close agreement in all essential details of tooth pattern but differ slightly in size. The lower jaw fragments are slightly larger than *T. petersoni*, but the upper teeth in No. 1728 are slightly smaller than the comparable teeth in that species. Also, in No. 1728, $M\underline{1}$ and $M\underline{2}$ have small median inner cuspules, $M\underline{3}$ a prominent cuspule and in addition a smaller cuspule at the base of the posterior inner crescent. These tubercles do not appear on the molars of the specimen of *T. petersoni* available for comparison. However, sufficient similarity is evident on which a reference of the Sucker Creek form to the genus *Ticholeptus* may be made.

[1] H. S. Pearson, Bull. Amer. Mus. Nat. Hist., vol. 48, 95, 1923.
[2] F. B. Loomis, Amer. Jour. Sci., ser. 5, vol. 6, 222–228, 1923.

The two oreodont teeth from Skull Spring, referred by Gazin[1] to *Ticholeptus*(?) sp., show considerable resemblance in size and in pattern to corresponding teeth of *T. petersoni* and would appear to be in fact indistinguishable from that species.

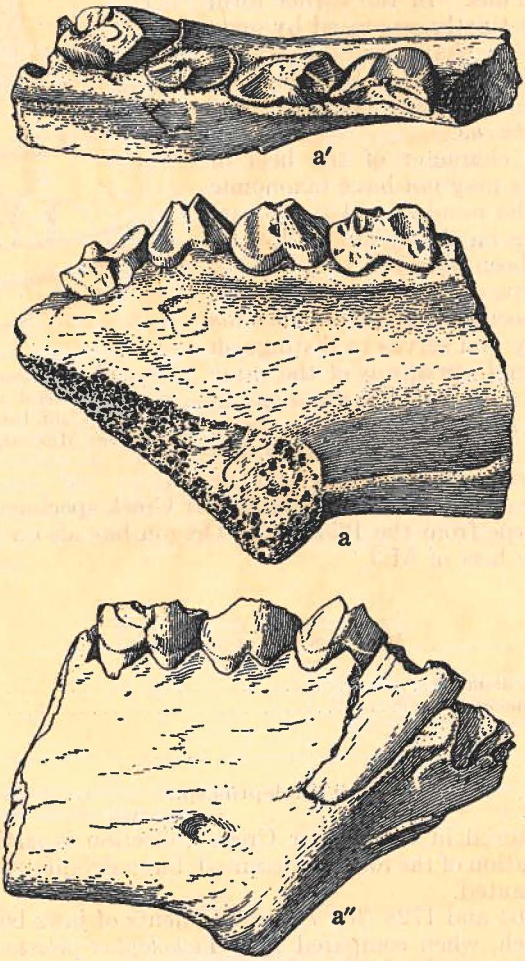


FIG. 7—*Ticholeptus* sp. *a*, Fragment of right ramus with $P\bar{1}$–$P\bar{4}$, No. 1062, lateral and occlusal views; x1.0. Calif. Inst. Tech. Coll. Sucker Creek Miocene, Oregon.

It is interesting to note furthermore that a specimen in the collections of the California Institute from the Mascall Miocene of the John Day basin demonstrates for the first time the presence of *Ticholeptus* in that horizon. In this specimen, No. 1730 (fig. 8), a lower jaw fragment with $P\bar{4}$ and $M\bar{1}$, the anterior crest is bifurcate, a feature which Loomis[2] regards as characteris-

[1] C. L. Gazin, Carnegie Inst. Wash. Pub. No. 418, pp. 81–82, figs. 15, a and b, 1932.
[2] F. B. Loomis, Bull. Amer. Mus. Nat. Hist., vol. 51, 12, 1924.

tic of *Ticholeptus* and *Metoreodon*. However, the pillar-like cusp on the median crest is not enlarged and does not extend so far forward as in *Metoreodon*, nor is the posterior portion of the tooth reduced as in that genus. No. 1730 is slightly smaller than the corresponding part in *T. petersoni* and the

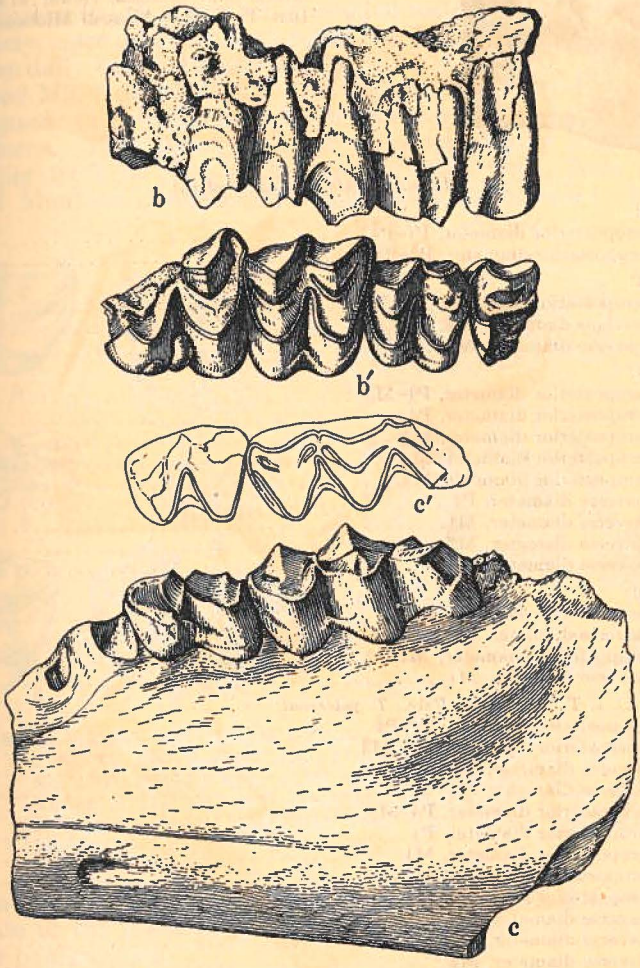


FIG. 7—*Ticholeptus* sp. *b*, Fragment of right maxillary with $P\frac{4}{}$–$M\frac{3}{}$, No. 1728, lateral and occlusal views; *c*, fragment of left ramus with $M\frac{2}{}$ and $M\frac{3}{}$, No. 1064, lateral and occlusal views; x1.0. Calif Inst. Tech. Coll. Sucker Creek Miocene, Oregon.

pillar-like cusp on the median crest is not so enlarged. Close resemblance to the Mascall specimen in this respect and in size is exhibited by a lower fourth premolar, No. 389, from Skull Spring. Nos. 389 and 1730 may belong to a species distinct from that represented by Nos. 387, 388, from Skull Spring.

FIG. 8—*Ticholeptus* sp. $P\bar{4}$ and $M\bar{1}$, No. 1730, lateral and occlusal views; x1.0. Calif. Inst. Tech. Coll. Mascall Miocene, Oregon.

Measurements (in millimeters)

No. 1062:	
Anteroposterior diameter, $P\bar{1}$–$P\bar{4}$	50.1
Anteroposterior diameter, $P\bar{2}$–$P\bar{4}$	39.0
No. 1064:	
Anteroposterior diameter, $M\bar{2}$–$M\bar{3}$	46.6
Transverse diameter, $M\bar{2}$	11.6
Transverse diameter, $M\bar{3}$	11.9
No. 1728:	
Anteroposterior diameter, $P\underline{4}$–$M\underline{3}$	*a*61.
Anteroposterior diameter, $P\underline{4}$	10.1
Anteroposterior diameter, $M\underline{1}$	*a*14.7
Anteroposterior diameter, $M\underline{2}$	17.8
Anteroposterior diameter, $M\underline{3}$	*a*23.4
Transverse diameter, $P\underline{4}$	*a*12.8
Transverse diameter, $M\underline{1}$	13.7
Transverse diameter, $M\underline{2}$	15.1
Transverse diameter, $M\underline{3}$	*a*16.2
No. 1730:	
Anteroposterior diameter, $P\bar{4}$	12.8
Transverse diameter, $P\bar{4}$	9.6
Anteroposterior diameter, $M\bar{1}$	13.0
Transverse diameter, $M\bar{1}$	9.1
No. 1527 C. I. T. Coll. Vert. Pale., *T. petersoni:*	
Anteroposterior diameter, $P\bar{2}$–$P\bar{4}$	34.5
Anteroposterior diameter, $M\bar{2}$–$M\bar{3}$	42.3
Transverse diameter, $M\underline{2}$	11.2
Transverse diameter, $M\underline{3}$	11.7
Anteroposterior diameter, $P\underline{4}$–$M\underline{3}$	64.0
Anteroposterior diameter, $P\underline{4}$	10.9
Anteroposterior diameter, $M\underline{1}$	15.5
Anteroposterior diameter, $M\underline{2}$	19.7
Anteroposterior diameter, $M\underline{3}$	23.0
Transverse diameter, $P\underline{4}$	13.0
Transverse diameter, $M\underline{1}$	16.4
Transverse diameter, $M\underline{2}$	17.3
Transverse diameter, $M\underline{3}$	18.3

Merychyus (?) sp.

A single tooth, No. 1063 (Plate 1, figs. 7, 7a), may belong to the genus *Merychyus*. The anterior crest is simple and a pillar-like cusp projects forward slightly at the point of union of the median crest with the posterior crescent. The posterior basin is completely enclosed and a posterior intermediate crest is suggested. This specimen resembles $P\bar{4}$ of *Merychyus*, as illustrated by Loomis.[1]

[1] F. B. Loomis, *op. cit.*, 13, fig. 7, 1924.

Measurements (in millimeters)

Anteroposterior diameter	12.9
Transverse diameter	8.4

Dromomeryx near borealis (Cope)

A species of *Dromomeryx* close to or identical with *Dromomeryx borealis* (Cope) is represented by a number of isolated teeth and a few limb elements. Unfortunately, specimens of horn-cores, on which the description of the species is partially based, are not present.

$P\underline{2}$, $P\underline{4}$ and $M\underline{2}$, Nos. 1066, 1067 and 1068, C. I. T. Coll. Vert. Pale. (figs. 9a, b, c), appear to be indistinguishable from corresponding teeth in Cope's type specimens. They likewise appear to be specifically inseparable from corresponding teeth of No. 1542, Carnegie Mus. Coll., from the Upper Miocene of Montana, assigned by Douglass to *D. borealis*.[1] However, a

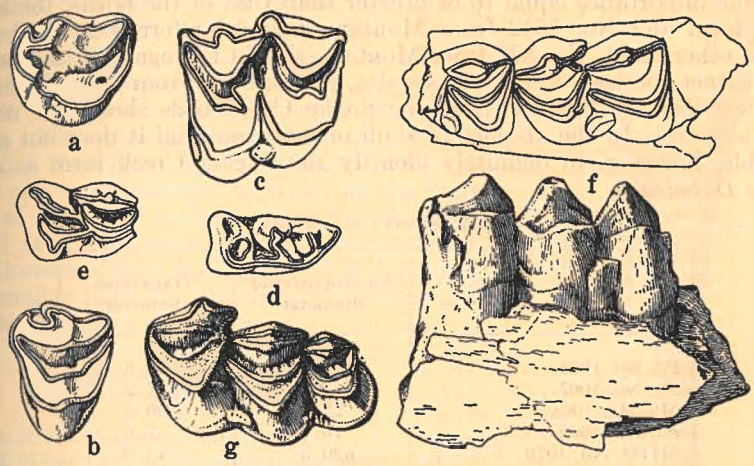


FIG. 9—*Dromomeryx* near *borealis* (Cope). *a*, $P\underline{2}$, No. 1066, occlusal view; *b*, $P\underline{4}$, No. 1067, occlusal view; *c*, $M\underline{2}$, No. 1068, occlusal view; *d*, $P\overline{3}$, No. 1069, occlusal view; *e*, $P\overline{4}$, No. 1729, occlusal view; *f*, $M\overline{2}$ and portion of $M\overline{1}$, No. 1071, lateral and occlusal views; *g*, $M\overline{3}$, No. 1072, occlusal view; x1.0. Calif. Inst. Tech. Coll. Sucker Creek Miocene, Oregon.

comparison of the lower molars from Sucker Creek with illustrations given by Douglass of the lower dentition of *D. borealis* reveals some differences which may be significant.

In the Sucker Creek specimens the antero-external crescent, after moderate wear, unites with the postero-internal crescent. A small enamel process is also present, extending postero-externally from a point near the posterior end of the antero-internal crescent to the point of union of the antero-external and postero-internal crescents.

The illustration of the lower teeth of *D. borealis* given by Douglass, shows the union of antero-external and postero-internal crescents occurring in the much-worn $M\overline{1}$ but not in $M\overline{2}$ and $M\overline{3}$. Moreover, there appears to be no trace of the small enamel process described above. $M\overline{3}$ of the Montana form, in fact, shows the most marked difference from the comparable

[1] E. Douglass, Ann. Carnegie Mus., vol. 5, plate 63, figs. 1 and 3, 1909.

tooth in the Sucker Creek species. In the former, a strong union takes place between the anterior ends of the internal and external crescents of the second lobe. Furthermore, the posterior lobe in No. 1072 from Sucker Creek (fig. 9g) appears to be rotated inward and away from the second lobe more than in the Montana specimen.

The lower teeth of *D. borealis* illustrated by Douglass are those of No. 827 Carnegie Mus. Coll. The upper dentition associated with this series is also figured. The upper teeth of No. 827 differ principally from those in another specimen, No. 1542 Carnegie Mus. Coll., in absence of accessory spurs on the wings of the internal crescents of the molars. Douglass assigned both No. 827 and No. 1542 to the species *D. borealis*, because of similarities noted in the characters of skull and horn in these types.

It is possible that the lower teeth associated with the type of upper dentition present in No. 1542 and in Cope's specimens resembled more closely the Sucker Creek material than does No. 827. If the dental characters have a specific importance equal to or greater than that of the horns, the Sucker Creek form and No. 1542 from Montana may be referred to *D. borealis*. On the other hand, No. 827 from Montana should be regarded as belonging to a distinct species. On this basis also, the material from Skull Spring and that described by Sinclair[1] from the Snake Creek beds should be referred to *D. borealis*. In the absence of skull or horn material it does not appear desirable, however, to definitely identify the Sucker Creek form as of the species *D. borealis*.

Measurements (in millimeters)

	Anteroposterior diameter	Transverse diameter
$P\frac{2}{2}$, No. 1066	16.3	14.6
$P\frac{4}{4}$, No. 1067	14.0	17.2
$M\frac{2}{2}$, No. 1068	22.2	20.5
$P\frac{3}{3}$, No. 1069	16.6	7.6
$M\frac{1}{1}$(?), No. 1070	*a*20.5	13.0
$M\frac{2}{2}$, No. 1071	21.8	13.5
$M\frac{3}{3}$, No. 1072	.....	13.5

a, approximate.

Merycodus cf. nevadensis Merriam

Merycodont remains consist of a fragmentary horn, No. 1073 C. I. T. Coll. Vert. Pale. (fig. 10), and two lower jaw fragments, No. 1074, bearing an $M\frac{2}{2}$, and No. 1772, bearing an $M\frac{3}{3}$ (Plate 1, figs. 5–6b). These specimens indicate a rather small form of *Merycodus*, possibly close to *M. nevadensis* Merriam,[2] from the Virgin Valley beds of Nevada.

The anterior tine of the horn and the base of the beam are missing in No. 1073. Judging from the depth of the nutrient canals, this specimen represents a fully adult individual. It is decidedly more slender than specimens in the large series of horns of *Merycodus loxocerus* Furlong,[3] representing individuals in various stages of growth from the Upper Miocene of Nevada. In *M. loxocerus* the beam, relative to the length of the tines, is considerably elongated and individual horns may be more slender than those of *M. furcatus*.

[1] W. J. Sinclair, Proc. Amer. Philos. Soc., vol. 54, 94–95, 1915.
[2] J. C. Merriam, Univ. Calif. Pub., Bull. Dept. Geol., vol. 6, 284–285, 1911.
[3] E. L. Furlong, Carnegie Inst. Wash. Pub. No. 453, 1–10, 1934.

The beam is slightly convex toward the front. Cross-sections of the beam are shown in figure 10.

The teeth represent young adult individuals and resemble closely in size comparable teeth in *M. loxocerus*, *M. nevadensis* and in a species of *Merycodus* recorded from Skull Spring.[1] The anterior crests are flanked by prominent styles at each end. The posterior crest of M$\bar{2}$ possesses also a strong posterior style. Both crests have strong median ribs on their lingual surfaces. The crescents are not so harply ridged as in *M. loxocerus* and have a rounded appearance. A median cuspule is present between the outer crescents of M$\bar{2}$. It is not shown in M$\bar{3}$, but the crown of this tooth has not fully emerged. M$\bar{2}$ has no trace of a vertical fold on the anterior face, but a suggestion of a fold is seen in M$\bar{3}$. In size of teeth, smallness of third lobe in M$\bar{3}$, and in slenderness of horn, the Sucker Creek form resembles *Merycodus nevadensis* more closely than it does any other known merycodont species. The present species may be identical with that from Skull Spring which it resembles in size and in prominence of styles on the inner crests of the lower molars. In latter character as well as in the more rounded crescents and in slenderness of horn, it differs from *M. loxocerus*. It is smaller than *M. furcatus*, *M. necatus* and *M. osborni*.

FIG. 10—*Merycodus* cf. *nevadensis* Merriam. Fragment of left horn-core, No. 1073, outer view; *a* and *b*, cross-sections; x1.0. Calif. Inst. Tech. Coll. Sucker Creek Miocene, Oregon.

Measurements (in millimeters)

Length of tine above bifurcation	50.1
Length of beam below bifurcation (incomplete)	58.5
M$\bar{2}$, anteroposterior diameter	8.3
M$\bar{2}$, greatest transverse diameter	4.6
M$\bar{3}$, anteroposterior diameter at alveolar border	10.5
M$\bar{3}$, greatest transverse diameter	4.7

Camelid (?) sp. a

A lower jaw fragment, No. 1065 (fig. 11), with M$\bar{1}$ and partially emerged M$\bar{2}$, resembles the corresponding part of a lower jaw of *Paratylopus cameloides* (Wortman) from the Upper John Day, but differs in somewhat larger size and in slightly greater hypsodonty. No. 1065 compares favorably in size with *Miolabis transmontanus* (Cope) and may belong to a form closely related to this species.

The teeth have prominent median and posterior pillars on their lingual surfaces. The antero-internal corner of M$\bar{1}$ is missing and the same portion of M$\bar{2}$ is not sufficiently exposed to show whether or not anterior pillars were present. M$\bar{1}$ has a median outer cuspule. The base of M$\bar{2}$ is not visible. M$\bar{1}$ has an anterior cingulum from the lingual end of which a slight vertical

[1] C. L. Gazin, Carnegie Inst. Wash. Pub. No. 418, 85, 1932.

enamel fold is developed. An incipient development of this feature is seen in $M\underline{2}$.

Measurements (in millimeters)

$M\underline{1}$, anteroposterior diameter	14.5
$M\underline{1}$, transverse diameter	9.1
$M\underline{2}$, anteroposterior diameter	17.2
$M\underline{2}$, transverse diameter	9.0
Depth of jaw below $M\underline{2}$	*a*26.9

a, approximate.

Camelid (?) sp. b

A number of foot and limb elements, including an unciform co-ossified with a portion of the vestigial fifth digit, a patella and a pisiform, suggest a camelid larger than that previously recorded. These specimens may show some resemblance in size to *Alticamelus* or *Megatylopus*.

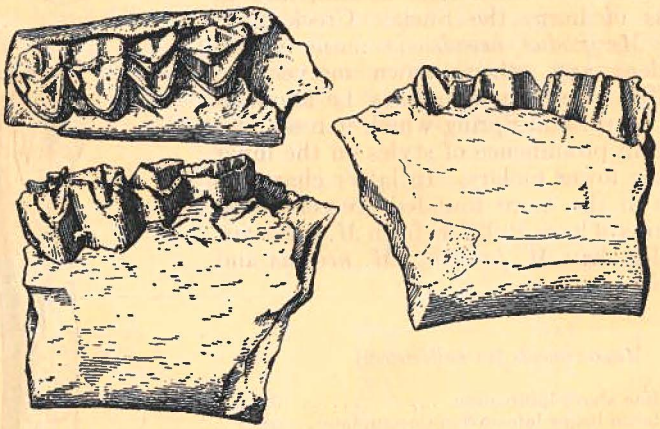


FIG. 11—*Camelid* (?) sp. a. $M\underline{1}$ and $M\underline{2}$, No. 1065, lateral and occlusal views; x1.0. Calif. Inst. Tech. Coll. Sucker Creek Miocene, Oregon.

Mylagaulus cf. *lævis* Matthew

FIG. 1—Fragment of right ramus bearing $M\bar{2}$, $M\bar{3}$ and portion of $P\bar{4}$, No. 1774, occlusal view; x4.
FIGS. 3, 3*a*—$P\underline{4}$, No. 1042, occlusal and inner views; x3.

Chalicomyid sp.

FIG. 2—Upper cheek tooth, No. 1773, occlusal view; x4.

Canid (?) sp.

FIG. 4—$M\underline{1}$, No. 1771, occlusal view; x2.

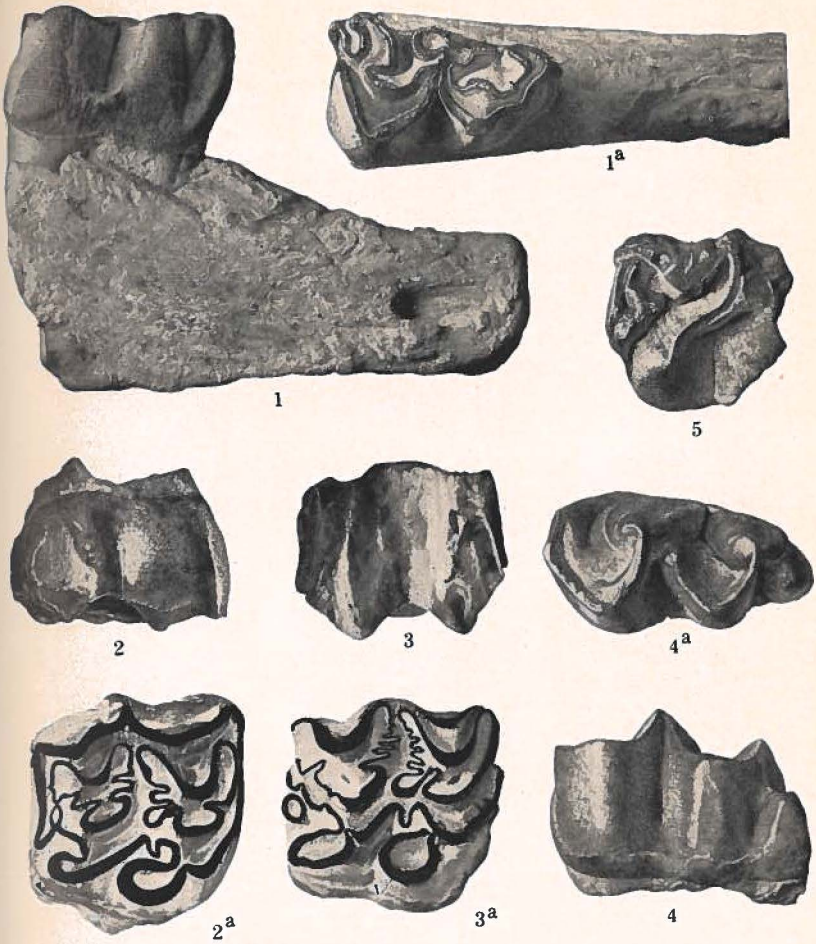
Merycodus cf. *nevadensis* Merriam

FIGS. 5, 5*a*, 5*b*—$M\bar{3}$, No. 1772, lateral and occlusal views; x1.5.
FIGS. 6, 6*a*, 6*b*—$M\bar{2}$, No. 1074, lateral and occlusal views; x1.5.

Merychyus (?) sp.

FIGS. 7, 7*a*—$P\bar{4}$, No. 1063, lateral and occlusal views; x3.

Calif. Inst. Tech. Coll. Sucker Creek Miocene, Oregon.



Merychippus brevidontus Bode

FIGS. 1, 1*a*—P$\underline{2}$, No. 1124, lateral and occlusal views; x1.5.
FIGS. 2, 2*a*—M$\underline{2}$, No. 1770, lateral and occlusal views; x1.5.
FIGS. 3, 3*a*—M$\underline{2}$(?), No. 1123, lateral and occlusal views; x1.5.

Hypohippus near *osborni* Gidley

FIGS. 4, 4*a*—M$\underline{3}$, No. 1769, lateral and occlusal views; x1.5.

Parahippus sp.

FIG. 5—Upper cheek tooth, No. 1775, occlusal view; x1.5.

Calif. Inst. Tech. Coll. Sucker Creek Miocene, Oregon.