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**CONTRIBUTIONS TO PALEONTOLOGY**

**III**

**A NEW SPECIES OF DIPOIDES FROM THE  
PLIOCENE OF EASTERN OREGON**

**BY ROBERT W. WILSON**

With one plate and one text-figure

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

*Contribution No. 145*

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# A NEW SPECIES OF DIPOIDES FROM THE PLIOCENE OF EASTERN OREGON

## INTRODUCTION

Numerous remains of castoroid rodents from the Tertiary of North America have been referred to the Old World genus *Dipoides* Jaeger. Apparently, most of the material represents types generically distinct from *Dipoides*, and the genus is actually represented by very few specimens of fragmentary character. It is not the purpose of this paper, however, to present the distinguishing characters which separate the true *Dipoides* from other American beavers with simplified dental pattern, but to describe remains of a *Dipoides* species collected by California Institute of Technology field parties in Pliocene beds in the region of Rome, Oregon. R. A. Stirton, of the University of California, has made a study of the taxonomy and relationships of members of the beaver group and his report on the Castoridae is now in press.

### *Dipoides stirtoni* n. sp.

*Geological horizon and locality*—Pliocene lake beds exposed along the Crooked Creek drainage, tributary to the Owyhee River, 5 miles southwest of Rome, Malheur County, Oregon.

*Type specimen*—A left ramus with P4-M3, No. 1662, Calif Inst. Tech. Coll. Vert. Pale., Plate 1, figs. 10, 10a.

*Referred material*—Several fragmentary lower jaws, including two rami of immature individuals with the deciduous molar preserved; a fragment of maxillary with M1; numerous isolated upper and lower cheek-teeth and incisors; and a number of fragmentary skeletal elements.

*Specific characters*—Cheek-teeth prismatic. P4 with antero-internal fold well developed and extending to base of tooth. P4 with at least two external grooves extending to the base of the tooth, representing two enamel infolds as seen in occlusal view. M1 and M2 sub-equal. Molars relatively narrower than in *Dipoides majori* Schlosser. Size about as in *Dipoides* cf. *majori* from Ertemte and Olan Chorea, Mongolia. The species is named in honor of Mr. R. A. Stirton for his work on fossil beavers.

## DESCRIPTION OF MATERIAL

While numerous isolated cheek-teeth, representing the upper dentition, are available from the Rome area, the assignment of these teeth to a definite position in the maxillary is in most cases not possible. Even the fourth upper premolar, generally determined without much difficulty, does not seem to be clearly separable from the first molar. Moreover, in spite of the prismatic structure of the cheek-teeth accompanied by extreme hypsodonty, the dental pattern apparently undergoes considerable modification with wear, or there is considerable individual variation, which is not likely, or both. Hence, the following description of the upper dentition is necessarily subject to some doubt.

The fourth upper premolar is presumably the largest tooth in the superior grinding series. It is rather sharply curved backward and outward. Normally this tooth (Plate 1, fig. 5) possesses two external and one internal inflections of the enamel with corresponding grooves on the side, which extend to the base of the tooth. The antero-external and the internal inflections are adjacent and separated by a narrow isthmus of dentine. In rare cases, this isthmus is cut through and the antero-external and internal inflections are confluent (Plate 1, fig. 4). In young specimens (Plate 1, fig. 3) a third external inflection of the enamel, which is posterior to the other two, is present and appears as a fold in the posterior outwardly directed enamel loop. This fold is sometimes present with an accompanying groove on the side of the tooth which may or may not extend to the base, or without the groove, or as an isolated enamel islet. Apparently in P<sub>4</sub> of *D. stirtoni* at least two external folds of the enamel are always present and reduction to one external fold and one internal fold does not take place.

The first upper molar is smaller than the preceding tooth and probably less curved outward. In No. 1668 (Plate 1, fig. 2), a portion of the maxillary with apparently this tooth, a single external and an internal inflection of the enamel are present. This stage, however, seems to be present only after more or less wear. In another tooth, No. 1691 (Plate 1, fig. 6), identified as M<sub>1</sub> or M<sub>2</sub> and more probably the former, isolated lakes are shown, representing the first and third external inflections. Hence, at some stage of wear M<sub>1</sub> must have a pattern considerably like that of P<sub>4</sub>.

The second upper molar has not been positively identified. A tooth, No. 1692 (Plate 1, fig. 9), tentatively determined as M<sub>2</sub>, shows a single external and internal inflection. In the young individual the occlusal pattern of the tooth may have had other inflections such as are shown in the first molar.

Several isolated grinding teeth have been tentatively identified as third upper molars. These teeth, Nos. 1687 to 1690, possess patterns unlike any others in the grinding series and agree to some extent with those in a *Dipoides* skull described by Young<sup>1</sup> from northern China. These teeth are curved backward but not noticeably outward. No. 1688 possesses an isolated lake corresponding to the first external inflection and two external folds corresponding to the second and third external inflections. These latter are confluent internally. The usual internal inflection is also present. This condition indicates the presence at an earlier stage of wear of three external and one internal inflections of the enamel. In No. 1687 (Plate 1, fig. 1), which shows a later stage of wear than No. 1688, the enamel lake has disappeared and the most posterior external inflection has become isolated from the outside giving a pattern somewhat like an inverted  $\cap$ . In still later stages of wear the tooth apparently assumes a pronounced sigmoidal pattern.

The superior incisors differ noticeably from those of *Castor* in more rounded anterior face. In the Recent beaver the incisors are flattened.

The lower jaw is relatively a little shorter and stouter than in *Castor* and possesses the following differences: (1) Angle with distinct descending portion; (2) area for muscle attachment at the symphysis extends posteriorly past chin and terminates about opposite the anterior portion of M<sub>1</sub>; (3) depression between alveolar border and coronoid greater than in *Castor*; and (4) termination of the incisor apparently somewhat higher in the jaw. Ad-

<sup>1</sup> Chung-Chien Young, Palæontologia Sinica, Series C, vol. 5, Fasc. 3, 11-13, Taf. 1, figs. 5, 5a, 1927.

ditional differences may exist, but the fragmentary character of the fossil remains make these characters difficult to determine.

The inferior incisors of *Dipoides*, like the superior, have rounded faces as opposed to the flattened incisors of *Castor*.

The fourth lower premolar (Plate 1, fig. 10a) is a large, rather straight tooth characterized by one large external inflection of the enamel and two internal inflections, the posterior one being the deeper. This pattern is very persistent for in only one of twenty-six specimens examined was there any indication of a change with wear. In this single specimen the occlusal surface of the tooth is normal, but the groove on the internal wall of the tooth, corresponding to the antero-internal inflection, extends down to a point about nine-tenths of the way from the wearing surface and stops. The base of the tooth shows a pattern in which the antero-internal inflection appears as an isolated lake.

The first lower molar (Plate 1, fig. 10a) is somewhat smaller than the premolar. The second molar (Plate 1, fig. 10a) is sub-equal in size to the first. Both teeth apparently invariably possess a single external and internal inflection of the enamel.

The last lower molar is somewhat narrower than the first two, but possesses about the same antero-posterior dimensions. It also invariably has one external and one internal inflection of the enamel. In addition, in some specimens, the anterior loop of enamel possesses a small re-entrant fold (Plate 1, fig. 10a). This fold apparently disappears with wear.

The cheek-teeth as a whole are characterized by extreme hypsodonty. At first it was believed that growth was from persistent pulps. However, in eighty-nine cheek-teeth examined, two (incidentally from the same individual) were found in which the bases of the teeth were closing. Very few cases were encountered in which the lateral grooves, representing the enamel folds in the occlusal pattern, did not extend to the base of the teeth. Since changes in tooth pattern by reduction of minor folds apparently took place, the termination of the minor lateral grooves short of the base of the tooth is probably more frequent than observed.

Two fragmentary right lower jaws, Nos. 1663 and 1664, carry the deciduous molar. These teeth are relatively short-crowned with distinct roots, and the lateral grooves are not so persistent as in the permanent teeth, thus tending toward an isolation of the inflections as lakes. Specimen No. 1663 (Plate 1, fig. 11) carries only DM<sub>4</sub>. This tooth is a reduced replica of the permanent premolar except that opposite the tip of the external inflection are three isolated lakes arranged in a line. Specimen No. 1664 has MI present in addition to DM<sub>4</sub>. The deciduous molar represents a stage of wear advanced over No. 1663, since the permanent premolar is present beneath the milk molar, which was not the case in the latter specimen. The enamel lakes opposite the tip of the external inflection are not present, but the antero-internal inflection is represented by an enamel lake.

Several teeth in the collections show patterns in early stages of wear (Plate 1, figs. 7, 7a, 8, 8a). The occlusal patterns seem to be characterized by three inflections from one side and one from the other, and are thus suggestive of the earlier and more primitive casteroids from which *Dipoides* is apparently to be derived. The minor folds which are later lost are represented on the walls of the teeth by lateral grooves which rarely extend very far down the sides.

Numerous fragmentary remains of the skeleton of *Dipoides* are present in the collection (fig. 1). Unfortunately most of the limb elements are in-

complete, so that important information relating to the ratios of the lengths of the various limb bones can not be obtained. However, the conclusion was reached that *Dipoides* is certainly not fossorial and, although most of the skeletal elements differ from those of *Castor* in varying degrees of detail, that the genus may be amphibious.

The vertebræ are very poorly preserved. None is flattened as are the tail vertebræ of *Castor*.

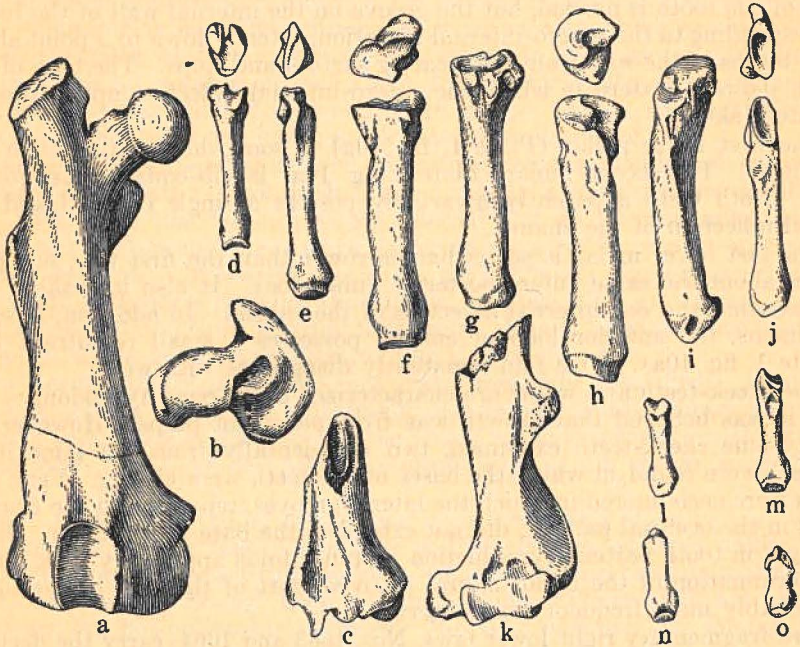


FIG. 1.—*Dipoides stirtoni* n. sp. Limb and foot elements, Nos. 1698 to 1705, 1707, 1715 to 1718 Calif. Inst. Tech. Vert. Pale. Coll., natural size. *a*, femur; *b*, proximal end of tibia; *c*, distal end of fused tibia and fibula; *d*, right metatarsal I; *e*, right metatarsal II; *f* and *g*, right metatarsal III; *h* and *i*, right metatarsal IV; *j*, left metatarsal V; *k*, distal fragment of humerus; *l*, right metacarpal II; *m*, left metacarpal III; *n*, right metacarpal IV; *o*, left metacarpal V.

Rome Pliocene, Malheur County, Oregon.

The humerus is essentially as in *Castor*, although smaller, as are all of the skeletal elements. The element agrees with that of *Castor* in lacking the entepicondylar foramen. The supinator ridge is not so well developed as in such fossorial forms as *Epigaulus*.

The ulna resembles very closely that of *Castor*. The proximal portion of the olecranon process, however, projects internally and the process is elongate transversely rather than in an anteroposterior direction. The element is much less massive than the ulna of *Epigaulus*. The proximal end of the radius is similar to that in *Castor*. The distal portion of the shaft is not so flattened as in the living genus, and the distal articular surface is noticeably concave.

The scapula is incompletely represented. A few fragments of the anterior border are all that have been found. In most of the specimens the corocoid process seems more prominent than in *Castor*, but otherwise no differences were noted.

The manus of *Dipoides*, exclusive of the phalanges, is represented only by a poorly preserved scapho-lunar and the second, third, fourth and fifth metacarpals. Compared to the metacarpals of *Castor* those of the Pliocene genus apparently have less flattened, narrower heads and are somewhat larger, relative to the metatarsals. In *Dipoides* metacarpals II and IV are of nearly equal size. The second metacarpal is longer but the fourth is perhaps more robust. In the Recent beaver, metacarpal IV is both considerably longer and more robust than the second metapodial.

The remains of the pelvis are too fragmentary to be of any value. No differences were observed between the fossil genus and *Castor*.

The shaft of the femur of *Dipoides* is less flattened than in *Castor*, the third trochanter is placed higher on the shaft, the great trochanter overtops the head to a greater extent; and the neck is longer. The patellar surface is also deeper and narrower than in *Castor*.

The femoral articulations of the tibia are somewhat more convex antero-posteriorly than in the comparable element of *Castor*. In *Dipoides* the proximal tip of the cnemial crest is prominent and projects slightly outward. Hence, there is a wide notch between the external facet and the proximal tip of the cnemial crest. The outline of the articular surface of the distal end is more rectangular than in *Castor* and the posterior process of the tibial-tarsal articular surface is more internal in position. A prominent difference which distinguishes *Dipoides* from *Castor* lies in the distal fusion of the tibia and fibula in the former genus.

The pes of *Dipoides* is represented by a tarsus, complete except for the external and middle cuneiform; all five metatarsals; and most of the phalanges. In the calcaneum, the tuber calcis is relatively shorter than in *Castor*, the facet for articulation with the cuboid is at a more acute angle with the long axis of the bone, and the sustentacular facet is relatively short and parallel to the long axis of the calcaneum. The head of the astragalus is not so flattened transversely as in *Castor* and the neck is shorter. The trochlear surface in the Recent beaver is flatter than in *Dipoides*. The navicular is relatively broader than in *Castor*, and the astragalar surface is elongate transversely instead of more or less antero-posteriorly. The cuboid also is relatively broader than in *Castor*. The facet for articulation of Metatarsal IV is not as concave or as elongate, and the inner facets are more pronounced. The inner cuneiform of *Dipoides* is close to that of *Castor*, but the bone in the former does not narrow so rapidly toward the proximal side and is thus more rectangular.

The metatarsals of *Dipoides* seem to indicate a foot which was not so spreading as that of *Castor*. Moreover, these elements are not so well developed relative to the metacarpals as in the latter genus, indicating perhaps a less amphibious habit, if indeed it is to be assumed that *Dipoides* was semiaquatic. The metatarsals of *Dipoides* are not noticeably flattened distally, as seems to be the case in the pes of *Castor* examined. There are besides many differences of detail in which the metatarsals of the two genera differ. The phalanges of *Dipoides* are also not so flattened as in the Recent beaver.



## COMPARISONS WITH KNOWN SPECIES

At the present time only four species of this genus are known; *Dipoides problematicus*, *D. sigmodus*, *D. majori* and the present species. Species from the North American Tertiary such as *tortus*, *lecontei* and *curtus* apparently do not represent *Dipoides*. *D. problematicus*, the type species, and *D. sigmodus* are from the Tertiary of Europe, *D. majori* from Mongolia and China.

The type species, *Dipoides problematicus* from the Bohnerzen of Salmendingen,<sup>1</sup> is a smaller form than the Rome species. Illustrations of *D. problematicus* show teeth which are less prismatic than those of *D. stirtoni*, that is to say the teeth are narrower at the top than at the base. Moreover, in spite of the fact that the teeth figured by Schlosser are open at the base of the crown, he describes them in the text as possessing roots.<sup>2</sup> If many specimens of *D. problematicus* are rooted, this character seems to distinguish the type species from the New World form. As mentioned before, closure of the pulp cavities is rare in the Rome material, and even in the single individual in which this character is shown, no roots have formed. It is not very probable that all of the teeth studied are from young individuals.

*Dipoides sigmodus* is from the fluviatile marls under the Palace of Justice of Montpellier.<sup>3</sup> This species has a longer tooth row than *D. stirtoni* and P $\bar{4}$  and M $\bar{1}$  are sub-equal in size.<sup>4</sup> In P $\bar{4}$  of a ramus of *D. sigmodus* the antero-internal fold is represented as an isolated lake. However, in another specimen P $\bar{4}$  is normal.<sup>5</sup> This may indicate a greater tendency for the fourth lower premolar to be S-shaped than in *D. stirtoni*. In the Rome species, as mentioned previously, only a single specimen shows an isolated lake in place of a re-entrant fold, and this isolation occurs below the level of the present wearing surface of the tooth.

The type of *Dipoides majori* Schlosser is a unique lower jaw with M $\bar{1}$ -M $\bar{3}$  and alveolus for P $\bar{4}$ .<sup>6</sup> In view of the incompleteness of the type, comparisons with our species are difficult to make. In size it agrees with large representatives of *D. stirtoni*. The molar series increases in size from front to back, whereas in the Rome type M $\bar{1}$  and M $\bar{2}$  are sub-equal. The molars of *D. stirtoni* are on the average

<sup>1</sup> Max Schlosser, Geol. Pal. Abh., Neue Folge, Band 5, Helt 3, 21-23, Taf. 1, 1902.

<sup>2</sup> *Ibid.*, 21, 1902.

<sup>3</sup> Paul Gervais, Zool. et Pal. Françaises, Paris, 21-22, pl. 1 fig. 13, pl. 8, fig. 10b, 1859.

<sup>4</sup> I am indebted to R. A. Stirton of the University of California for important information concerning *D. sigmodus*. Mr. Stirton kindly permitted me to use his unpublished manuscript concerning the genus *Dipoides*.

<sup>5</sup> Paul Gervais, *loc. cit.*, pl. 1 fig. 13, pl. 8 fig. 10b, 1859.

<sup>6</sup> Max Schlosser, Abh. bayr. Ak., der Wiss., II, Cl. 22, Bd. 1, Abth., 40-42, Taf. II, figs. 14, 14a, 1903.

narrower than in the Chinese type. This is most noticeable in M1, least noticeable in M2. Schlosser subsequently described as *Dipoides* cf. *majori*<sup>1</sup> some isolated teeth and limb bones from Ertemte and Olan Chorea, Mongolia. This material apparently represents a type somewhat smaller than *D. majori* and nearly comparable in size to the average *D. stirtoni*. Schlosser believed that the Chinese form might represent an individual surpassing the average in size, and refrained from erecting a new species. Schlosser's description of the upper cheek-teeth agrees with that based on characters displayed by *D. stirtoni*, when variation due to wear is taken into consideration. His figures<sup>2</sup> do not appear to check his description but this may be due to an error in the figures.

Schlosser points out as a difference between *D. problematicus* and *D. majori* that the superior molars of the former "differ from those found at Ertemte and Olan Chorea by the separation of the median out fold from the inner fold by a thin bridge of dentine."<sup>3</sup> The only dentinal bridge that can be seen in the figures of *D. problematicus* is that formed by the first internal and external re-entrant angles. If this is the bridge referred to, the superior molars of *D. stirtoni*, possessing two external and one internal inflections of the enamel, agree to this extent with those of the European form and differ with those of the Asiatic type. Two specimens present in the Rome collections, however, show this bridge cut through. The fourth lower premolar of *Dipoides* cf. *majori* may differ from that of *D. stirtoni* in lacking the anterior internal inflection. A figure of P4 shows no inflection but a second figure does.<sup>4</sup> His text does not indicate very clearly which pattern is the most characteristic. Schlosser<sup>5</sup> figures a number of skeletal elements of *Dipoides* cf. *majori*. This material agrees with that from North America in size and in other characters as well. There are apparently minor differences to be noted, but actual comparison of material might serve to eliminate even these.

Young has described a skull of *Dipoides* from north China as *D. majori*.<sup>6</sup> In this specimen the superior cheek-teeth possess only a single external and internal inflection. Of the described species of *Dipoides*, the Asiatic species *D. majori* and its referred material is perhaps closest to *D. stirtoni*. However, the proportions of the lower molars appear to be slightly different, and in addition *D. majori* is

<sup>1</sup> Max Schlosser, *Palæontologia Sinica*, Series C, vol. 1, Fasc. 1, 27-30, pl. II, figs. 11, 29-41, 1924.

<sup>2</sup> Max Schlosser, *ibid.*, pl. II, figs. 29a, 31, 1924.

<sup>3</sup> *Ibid.*, 28, 1924.

<sup>4</sup> *Ibid.*, pl. II, figs. 30, 32, 1924.

<sup>5</sup> *Ibid.*, pl. II, figs. 11, 34-41, 1924.

<sup>6</sup> Chung-Chien Young, *loc. cit.*, 1927.

probably to be distinguished, as suggested in the above comparisons, by a tendency to develop a simpler pattern in the cheek-teeth. The development of a less complex pattern would indicate a more advanced species. In any event, the geographic separation serves to lessen the possibility of specific identity.

#### COMPARISONS WITH CLOSELY RELATED AMERICAN FORMS

Two additional localities in the Tertiary of western North America have furnished *Dipoides* material which appears to be related to that of *D. stirtoni*. Louise Kellogg has described a  $P\bar{4}$  and  $M\bar{1}$  of *Dipoides* from Thousand Creek, Nevada, as *Dipoides*, sp. probably new.<sup>1</sup> The Thousand Creek specimens may possibly represent *Dipoides stirtoni*, although with the present incomplete remains it is impossible to determine this. In the Rattlesnake collections of the California Institute of Technology from eastern Oregon are two fragmentary rami,

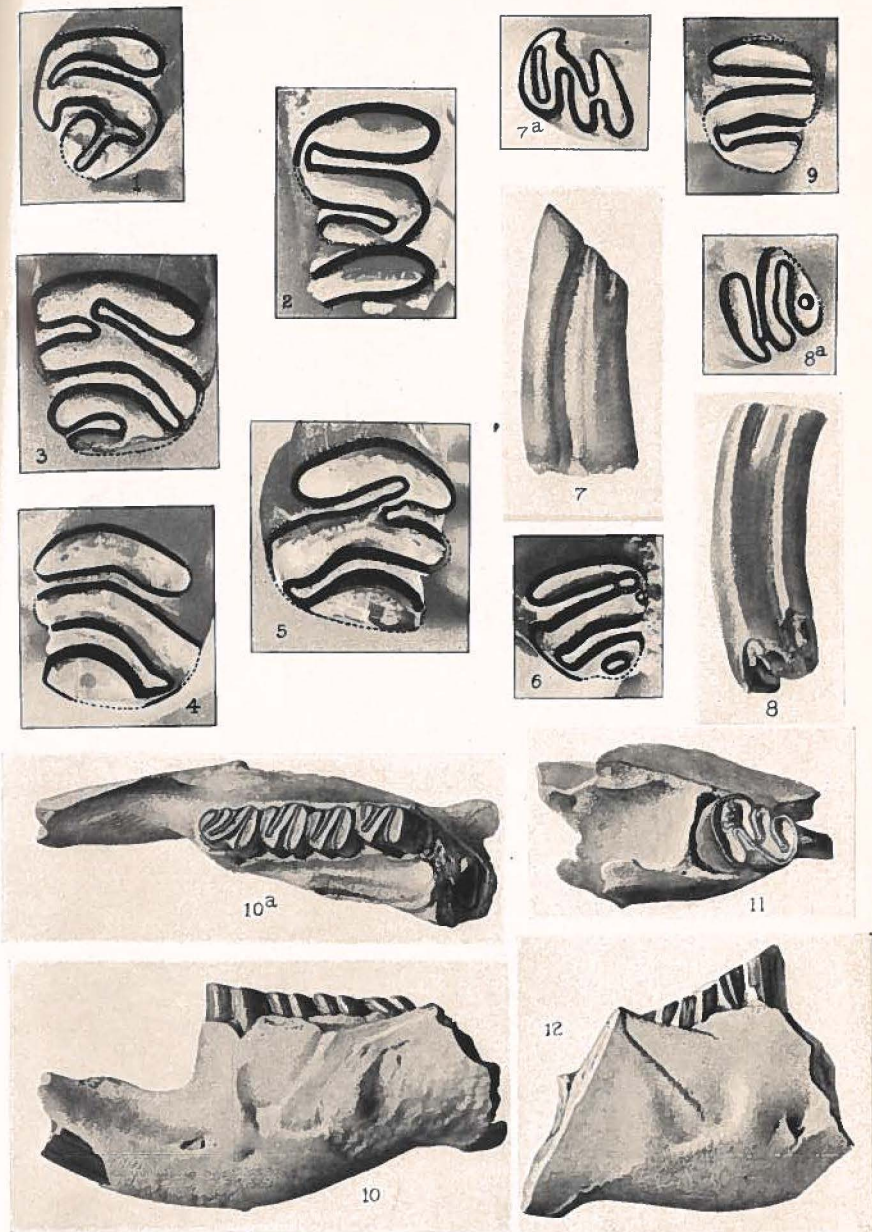
TABLE 1—Table of measurements (in millimeters)

	C. I. T. No. 1662 Rome, Ore.	C. I. T. No. 1665 Rome, Ore.	C. I. T. No. 1666 Rome, Ore.	C. I. T. No. 1667 Rome, Ore.
Length of lower tooth row . . . . .	20.3	21.8	22.0	...
$P\bar{4}$ , anteroposterior diameter . . . . .	6.0	6.5	6.5	6.4
$P\bar{4}$ , transverse diameter . . . . .	4.7	4.8	5.2	5.1
$M\bar{1}$ , anteroposterior diameter . . . . .	4.8	5.2	4.8	5.6
$M\bar{1}$ , transverse diameter . . . . .	4.9	4.7	5.1	4.9
$M\bar{2}$ , anteroposterior diameter . . . . .	4.8	5.2	4.7	5.8
$M\bar{2}$ , transverse diameter . . . . .	4.8	4.6	5.0	4.9
$M\bar{3}$ , anteroposterior diameter . . . . .	5.1	4.8	5.3	...
$M\bar{3}$ , transverse diameter . . . . .	4.3	4.2	4.3	...
Length of diastema between I and $P\bar{1}$ . . .	a18.2	...	a17.7	...

a, approximate.

a left lower jaw with  $P\bar{4}$ ,  $M\bar{2}$ , and  $M\bar{3}$ , No. 1339 C.I.T. Coll. Vert. Pale., and a right lower jaw with  $M\bar{1}$ , No. 1340 C.I.T. Coll. Vert. Pale. *Dipoides stirtoni* apparently is to be distinguished from these specimens by the possession of a deeper, more massive ramus, and possibly by more hypsodont dentition. It might be mentioned in this connection that the type of *D. stirtoni* selected, although the most perfectly preserved specimen in the Rome collection, is somewhat below average in size.

<sup>1</sup> Louise Kellogg, Univ. Calif. Publ., Bull. Dept. Geol., vol. 5, No. 29, 431, fig. 14, 1910.



*Dipoides stirtoni* n. sp.

Fig. 1, M3?, No. 1687; fig. 2, fragmentary right maxillary with M1. and incomplete M2, No. 1668; fig. 3, P4, No. 1695; fig. 4, P4, No. 1697; fig. 5, P4, No. 1696; fig. 6, M1?, No. 1691; figs. 7, 7a, little-worn cheek-tooth, No. 1693; fig. 7, lateral view, fig. 7a, occlusal view; figs. 8, 8a, little-worn cheek-tooth, No. 1694; fig. 8, lateral view; fig. 8a, occlusal view; fig. 9, M2?, No. 1692. All figures approximately x 4.

Figs. 10, 10a, left ramus with P4-M3, type specimen, No. 1662, approximately x 1.33; fig. 11, fragmentary right ramus with DM4, No. 1663, approximately x 2.66; fig. 12, fragmentary right ramus with P4-M2, No. 1667, x 1.33.

Calif. Inst. Tech. Coll. Vert. Pale.

Pliocene, Rome, Malheur County, Oregon.