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**CONTRIBUTIONS TO PALÆONTOLOGY**

**II**

**A PLIOCENE RODENT FAUNA FROM SMITHS  
VALLEY, NEVADA**

**BY ROBERT W. WILSON**

With two plates

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**Contribution No. 179**

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# A PLIOCENE RODENT FAUNA FROM SMITHS VALLEY, NEVADA

## INTRODUCTION

Tertiary mammalian remains were discovered by Chester Stock and E. L. Furlong several years ago in sedimentary beds exposed along the eastern side of Smiths Valley and south of Wilson Canyon, west-central Nevada. Since then field explorations have been conducted in the region, during the summers of 1931 and 1934, by the California Institute of Technology. At one locality near the western mouth of Wilson Canyon and about fifteen miles airline from Yerington, a small collection of rodent remains was obtained, the description of which is the purpose of the present paper.

Determination of Pliocene age for the deposits is afforded, chiefly, by the larger mammals in the fauna, especially the Equidæ. However, the rodent assemblage is suggestive of a similar age and indeed in one or two points indicates a stage of evolution approximating the Thousand Creek middle Pliocene fauna from northwestern Nevada.

The author wishes to acknowledge the kindness of the Museum of Paleontology, University of California, in loaning fossil rodent material from Fish Lake Valley and Thousand Creek deposits. The illustrations reproduced herein are from photographs which have been carefully retouched and arranged by Mr. John L. Ridgway.

## COMPARISON OF THE PLIOCENE RODENTS AND LAGOMORPHS OF SMITHS VALLEY AND THOUSAND CREEK

While the actual number of rodent specimens found at the Smiths Valley and Thousand Creek localities are not far different, the limited collecting area at the former locality has served perhaps to restrict the number of distinct types. Hence, comparison of the two faunas is handicapped by lack of similar rodent groups.

Among the sciuromorphs, the Smiths Valley aplodontid is too fragmentary to be of correlative value, except to indicate a Pliocene age for the fauna. *Citellus?* species possibly represents a stage of evolution comparable to *Citellus* species from Thousand Creek, but neither species is specifically determinable, and the dentition of the Sciuridæ is apparently too stable to be of much service in correlation. *Pliosacomys* may have a counterpart in the Thousand Creek co-type of *Cupidinimus magnus*, but the relation of the former to the latter can not be satisfactorily established on the basis of available Thousand Creek material. The Thousand Creek genera *Mylagaulus*, *Marmota*, *Dipoides* and *Diprionomys* are not represented in the Smiths Valley assemblage, but the absence of *Mylagaulus*, at least, is certainly fortuitous.

In the myomorph group, *Peromyscus* near *antiquus* is very close to, if not identical with, the Thousand Creek species. Neither *Pliozapus* nor any zapodid is represented in the Thousand Creek fauna.

The Smiths Valley leporid represents a smaller species of lagomorph than *Hypolagus vetus*, but this does not necessarily indicate a less advanced form, as small leporids are known from the upper Pliocene.

R. A. Stirton described and figured<sup>1</sup> two isolated beaver teeth as *Eucastor* cf. *lecontei* from beds seventeen miles south of Yerington, Nevada. In view of the fact that a more advanced member of the same phylum, namely *Dipoides*, is known from Thousand Creek, it should be pointed out that the fossil beaver locality is in another basin some distance to the east of the Smiths Valley locality, and may come from beds representing a different time stage.

It seems desirable to call attention to the fact that the Thousand Creek rodent assemblage, and to a lesser extent that from Smiths Valley, shows a predominance of sciuriform types characteristic of the North American Tertiary up to the upper Pliocene. In the upper Pliocene (cf. faunas of Grand View, Hagerman, Benson and Curtis), however, the myomorph group becomes for the first time an important element in the assemblage.

Comparative faunal lists of Smiths Valley and Thousand Creek are given below.

SMITHS VALLEY	THOUSAND CREEK
Rodentia	Rodentia
<i>Aplodontid</i> species	<i>Mylagaulus</i> cf. <i>monodon</i> Cope
	<i>Liodontia furlongi</i> Gazin
	<i>Marmota nevadensis</i> (Kellogg)
	<i>Marmota minor</i> (Kellogg)
<i>Citellus?</i> species	<i>Citellus</i> species
	<i>Dipoides</i> species
	<i>Diprionomys parvus</i> Kellogg
	<i>Cupidininus magnus</i> (Kellogg)
<i>Pliosaccomys dubius</i> n. gen. and sp.	
<i>Pliozapus solus</i> n. gen. and sp.	
<i>Peromyscus</i> near <i>antiquus</i> Kellogg	<i>Peromyscus antiquus</i> Kellogg
Lagomorpha	Lagomorpha
<i>Leporid</i> species	<i>Hypolagus vetus</i> (Kellogg)

## SYSTEMATIC DESCRIPTION OF SPECIES

### APLODONTIIDÆ

#### Aplodontid species

The outer half of a left P<sub>4</sub>, Calif. Inst. Tech. Coll. Vert. Pale. No. 1793, is referred to an aplodont rodent. The styles are prominent and acute. A slight and discontinuous coating of cement? is present on the tooth. No

<sup>1</sup> R. A. Stirton, Univ. Calif. Pub., Bull. Dept. Geol. Sci., Vol. 23, No. 13, 439, figs. 117-118, 1935.

indication of the presence of lakes is seen in the fragment preserved. In acuteness of outer styles, the Smiths Valley specimen resembles more closely Thousand Creek specimens of *Liodontia furlongi* than it does *L. alexandrae* from the Virgin Valley middle Miocene deposits. Apparently, no characters are present that would serve to distinguish our specimen from Thousand Creek aplodonts.

## SCIURIDÆ

### *Citellus?* species

A small sciurid species is represented principally by a right lower jaw without teeth, Calif. Inst. Tech. Coll. Vert. Pale. No. 1795, and a fragment of left ramus with M $\bar{2}$ , C.I.T. No. 1794 (Plate 1, fig. 5).

No. 1794 shows several characters which indicate its intermediate character between *Sciurus* and typical citellids, as for example *Citellus armatus*. Thus it may be allocated to the group of ground-squirrels with relatively unspecialized dentition, which includes *Callospermophilus* and *Citellus* (*Otospermophilus*).

M $\bar{2}$  has a basin which is rather compressed in fore and aft direction. The internal talonid rim appears to run to the metaconid without pronounced notch. Details are, however, obscured by the loss of the metaconid through breakage. The entoconid is not present as a distinct cusp, but is obscured by the curving posterior crest of the talonid. The protolophid is rather well developed, and in the existing stage of wear tends to form a pit-like enclosure.

No. 1794 does not agree in dentition with any of the Recent forms of ground-squirrel, but lack of adequate material makes comparison of little value. Absence of a distinct notch anterior to the entoconid, compression of the basin, and development of the protolophid may be characters tending to distinguish this form from related Recent ground-squirrels. Among Recent squirrels, however, the lack of a distinct notch is observed in some specimens of *Eutamias*, but other characters serve to distinguish the fossil from that genus.

*Otospermophilus gidleyi* from the Rattlesnake<sup>1</sup> may be distinguished by heavier jaw, slightly larger size, and possibly by a slightly less elevated posterior talonid rim than in No. 1794. Judging from the original description, the Rattlesnake species agrees with the Smiths Valley form in lack of a distinct internal notch in front of the entoconid, and in the relatively broad basins of the cheek-teeth. The species of *Citellus* from the Thousand Creek<sup>2</sup> does not have the comparable tooth present and the existing figure is not detailed enough for comparison. This specimen is smaller than No. 1794, but size difference is in part, at least, a function of position in the ramus.

Within the author's knowledge no fossil ground-squirrel known to occur earlier than those of the upper Pliocene or Pleistocene exhibits the typical ground-squirrel specializations in the dentition. Typical *Citellus* apparently does not arise until this stage of the Cenozoic.

<sup>1</sup> J. C. Merriam, C. Stock, and C. L. Moody, Carnegie Inst. Wash. Pub. No. 347, 68-69, figs. 23 a, b, 1925.

<sup>2</sup> Louise Kellogg, Univ. Calif. Pub., Bull. Dept. Geol., vol. 5, No. 29, pp. 427-428, fig. 8, 1910.

<i>Measurements (in millimeters)</i>		
	No. 1795	No. 1794
P $\bar{4}$ -M $\bar{3}$ , alveolar length.....	9.0 (a)	...
M $\bar{2}$ , antero-posterior diameter.....	...	2.1
M $\bar{2}$ , transverse diameter.....	...	2.5

(a) Approximate.

## GEOMYIDÆ

*Pliosaccomys dubius*<sup>1</sup> n. gen. and sp.

*Holotype*—A right ramus with P $\bar{4}$ -M $\bar{3}$ , Calif. Inst. Tech. Coll. Vert. Pale., No. 1796 (Plate 2, figs. 2, 2a).

*Paratypes*—Fragmentary rostral portion of skull, Calif. Inst. Tech. Coll. Vert. Pale., No. 1797 (Plate 1, figs. 2, 2a). Palatal fragment bearing right P $\bar{4}$ -M $\bar{2}$  and left P $\bar{4}$ -M $\bar{1}$ , Calif. Inst. Tech. Coll. Vert. Pale., No. 1798 (Plate 1, fig. 4).

*Referred Material*—A number of maxillary fragments and rami with teeth in varying stages of wear.

*Locality*—Smiths Valley, Lyon County, Nevada. Locality 174, C.I.T.

### GENERIC AND SPECIFIC CHARACTERS

Jaw heavy. Dentition in contrast slender and tooth-row short. P $\bar{4}$ /4 composed of a double column. P $\bar{4}$  with posterior column forming a compressed ellipse in cross-section, anterior column becoming subcircular with wear; median union of anterior and posterior columns. Premolars not becoming similar to molars with wear, as in *Entoptychus* and *Pleurolicus*. Dentition hypsodont, apparently more so than in any known heteromyid from an horizon of similar age. Partial development of Y-pattern with subsequent formation of lakes in posterior and anterior lophes of upper and lower molars, respectively, at particular stage of wear.<sup>2</sup> Worn inferior molars almost rectangular, but slightly tapering toward lingual side. Enamel band on occlusal surface of teeth essentially continuous. Anterior faces of incisors flat and wide. Rostrum not arched. Palate sculptured. Zygomatic structure apparently as in Geomyidæ. Size approximately as in *Thomomys monticola mazama*; slightly larger than *Cupidinimus magnus* (Kellogg).

### DESCRIPTION

*Skull*—Available skull parts are limited to the palatal portion of the maxillaries and to a fragment of the rostral portion of a skull, No. 1797 (Plate 1, figs. 2, 2a). However, such portions of the skull as are in the collection furnish characters which indicate geomyid affinities for *Pliosaccomys*. The rostral region is relatively heavy without arching of the inferior border of the rostrum. The latter, however, is a distinctly heteromyid rather than geomyid character. The skull is molded around the roots of the incisors for added strength as in Geomyidæ generally, contrasting in

<sup>1</sup> The generic designation is not intended to imply a reinstatement of the name *Saccomys* Cuvier (equals *Heteromys*), but is chosen with reference to the old name *Saccomyidæ* Baird (equals *Geomyoidea*).

<sup>2</sup> A. E. Wood, Ann. Carnegie Mus., vol. 24, p. 168, 1935. "In the lower molars the . . . buccal movement of the protoconid toward the protostylid has made a deep fold between these two cusps, and caused a migration of the external cingulum to the anterior side of the tooth where it becomes an anterior cingulum. A result is to give the loph the shape of a Y, whence it is referred to as a Y-pattern."

this regard with the Heteromyidæ. The entrance to the infraorbital canal is protected from muscle pressure by countersinking in a sulcus. There is no evidence of a transverse canal extending through the rostrum. This last character appears to possess considerable importance in assigning *Pliosacomys* to the Geomyidæ.

According to Miller and Gidley,<sup>1</sup> in Recent Heteromyidæ the "orifice of [the] infraorbital canal [is] protected from muscle pressure by countersinking in a vacuity which extends transversely through [the] rostrum." In the Geomyidæ, its orifice is "protected from muscle pressure by countersinking in an oblique sulcus." Presence of a vacuity in a skull of *Perognathoides quartus* (U.C. No. 29639) from the Fish Lake Valley lower Pliocene beds, and in a skull of *Perognathus furlongi* (C.I.T. No. 35) from the Cuyama Valley upper Miocene beds, demonstrates that this character was already established prior to the Smiths Valley stage. The incisive foramina are long and narrow, somewhat larger than those in either Recent *Thomomys* or *Heteromys*. The premaxillaries appear to be fused to a single bone as in Recent Geomyidæ. The premaxillary-maxillary suture is slightly in advance of the sulcus of the infraorbital canal and considerable unbroken bone is present posterior to the suture. In *Heteromys* the suture is just in advance of the infraorbital vacuity. For this reason a small area farther back in which bone is missing from the lateral wall of the maxillary can not be interpreted as a vacuity. Moreover, bone is present between this point and the entrance to the infraorbital canal proper. At the point where breaking away of the bone occurs, the maxillary in Recent Geomyidæ is very thin. A second specimen, which consists of a fragment of maxillary and premaxillary, does not show a very decided sulcus but neither does it possess apparently a transverse canal. So little of this specimen exists that the apparent shallowness of the sulcus may be due, at least in part, to its fragmentary character. An examination of this fragment tends to show that the incomplete character of the maxillary in No. 1797 is due to breakage.

The most superior point reached by the incisors in their backward course is somewhat below the dorsal surface of the skull. In Heteromyidæ the incisors reach almost the roof of the rostrum. The former condition apparently strengthens the skull against pressure exerted by the incisors. The narrow palate is rather heavily sculptured, much more so than in Recent Heteromyidæ, and approaches in this character those found in the Geomyidæ. Narrowness of palate is another point of resemblance to the Geomyidæ. The palate in the Heteromyidæ is relatively wider. From what remains of the incisors, it may be conjectured that they were somewhat protruding, but the premaxillaries and nasals may have projected anteriorly farther than in Recent gophers.

*Upper Dentition*—The upper incisors are relatively wide in section and but slightly rounded. No definite grooving of the incisors can be observed.

The fourth upper premolar is a persistently double-columned tooth. In the paratype, the anterior column (protoloph) is triangular in cross-section and is the smaller of the two columns. The posterior column (metaloph) is subrescendent in outline and joins the protoloph toward the inner margin of the tooth. The tooth is divided into two columns by means of inner and outer re-entrant folds in the enamel. The inner fold is the more anterior and shallower of the two. No. 1800, a right maxillary with P<sub>4</sub>-M<sub>2</sub> (Plate 1, fig. 3), possesses P<sub>4</sub> in an unworn state. Details of construction are rather

<sup>1</sup> G. S. Miller and J. W. Gidley, Jour. Acad. Sci., vol. 7, No. 13, 433-434, 1918.

difficult to determine, but the protoloph may be composed of more than a single cusp. The metaloph is composed principally of two parts, the posterior portion is apparently made up of two cusps placed side by side (metacone and hypocone), which soon unite to form a single broad column. At the inner border and somewhat in advance of the metacone and hypocone is a crescentic cusp (entostyle) which connects the metaloph and protoloph. A cingular ridge forms the postero-internal border of the tooth, connecting with the entostyle in front and internally, and with the midpoint of the posterior border of the metacone-hypocone column behind. This pattern-stage prevails but a short time in the life of the individual. No. 1801, left maxillary with P<sub>4</sub>-M<sub>1</sub>, shows the occlusal pattern in old age in which the re-entrants are about equal in depth and are opposite each other. Both columns form compressed ellipses in cross-section with the metaloph the larger.

The type of P<sub>4</sub> present in Nos. 1800 and 1798 is superficially similar to that developed in *Liomys* and *Heteromys*, especially the latter. The chief points of difference, when *Pliosacomys* is compared to *Heteromys*, is in the attachment, immediately upon wear, of the entostyle to the protoloph in the former as well as in the more angulate, less-rounded appearance of the entostyle. P<sub>4</sub> of *Pliosacomys* exhibits strong resemblance to the comparable tooth in *Thomomys monticola* in the lingual attachment of the two columns and in the shape of the metaloph. Unfortunately, no unworn upper premolars of *Thomomys* are available for comparison.

No third molar is represented in the collection. The remaining two molars are so nearly alike, except that M<sub>1</sub> is slightly larger than M<sub>2</sub>, that the description of one will suffice. M<sub>1</sub> is bilophodont in early stages of wear, but is soon reduced to a single column by the union of the two lophs (metaloph and protoloph) at the lingual border. The intervening valley disappears and the occlusal pattern becomes rather rectangular with a re-entrant fold of more or less depth at the buccal border. In extreme wear the pattern is more elliptical, but the buccal inflection persists. No. 1800 possesses M<sub>1</sub> and M<sub>2</sub> in a relatively unworn state. In this specimen (Plate 1, fig. 3) it is seen that the anterior loph or protoloph, although rather compressed and linear, is made up of more than a single cusp. Judging from the faint swellings in the enamel, the protoloph may be composed of three distinct cusps as in the Geomyoidea generally. The posterior loph or metaloph is more crescentic and is rather similar to the posterior loph of the premolar. Two transversely placed cusps (metacone and hypocone) form the straighter portion of the metaloph. Posterior and median to these cusps a cingular ridge originates which forms the postero-internal border of the tooth. As this ridge curves forward it swells slightly into a cusp (entostyle), which with wear unites with the innermost of the three forward cusps, the protostyle. Moreover, the inner of the two posterior cusps (hypocone) also unites, with wear, to the more lingual part of the cingular ridge. Hence, the metaloph soon assumes a rather linear outline curving forward at its inner border to unite with the protoloph.

It should be mentioned that in the cheek-teeth, both upper and lower, the enamel forms a continuous band about the tooth. This is in decided contrast to Recent Geomyidæ in which the enamel is discontinuous and arranged in plates. Several rather worn specimens have minor interruptions of the enamel. These interruptions may have significance in indicating a trend toward the discontinuous plates of modern Geomyidæ, but

are too indefinite in character to have much weight attached to them in *Pliosacomys*.

Four maxillary specimens are present in the collection. It is with some doubt that they are assigned to a single species. No. 1799, a palatal fragment with left P<sub>4</sub>-M<sub>2</sub>, right P<sub>4</sub>-M<sub>1</sub> (Plate 1, fig. 8), differs from the paratype No. 1798 not only in smaller size but in character of tooth-pattern as well. However, the teeth are somewhat less worn and this fact may account for some of the apparent differences. If splitting of species were inaugurated on the basis of variation in tooth-pattern and rami of *Pliosacomys*, a number of species would have to be established within this genus. The entire rodent fauna described in the present paper was obtained from one exposure within a radius of 25 feet or less. It seems more reasonable to assume that all specimens of *Pliosacomys* represent a single species rather than that a number of closely allied species were preserved in this limited area.

*Ramus*—The ramus is relatively heavy and stout for the size of the dentition. The ridge for attachment of the masseter medialis muscle is short and generally not very well defined. The masseter lateralis ridge, however, is clearly indicated, at least as far back as the last molar. The ridge appears to be better developed than in *Heteromys*; less developed than in *Thomomys*. The ascending ramus has its origin opposite the penultimate molar. Valuable characters for distinguishing Recent Geomyidæ from Recent Heteromyidæ lie in the posterior portion of the ramus, notably in the character of the angle. Unfortunately, this region of the jaw is very imperfectly preserved in *Pliosacomys*, and little can be ascertained regarding its exact shape. The angle apparently was of more normal type than in Recent Geomyidæ, perhaps approaching that in *Entoptychus*. At any rate, it appears to have been more inferior in position than in Recent genera. The protuberance on the side of the ramus, marking the posterior termination of the incisor, was apparently extremely well developed, as in the Geomyidæ. This character is not especially noteworthy in the Heteromyidæ. Judging from the imperfectly preserved jaws, the plate of bone bearing the coronoid and condyle must have been rather high. Unfortunately, neither coronoid nor condyle is preserved in any of the specimens. The incisor terminates considerably in back of the dental foramen and somewhat above it.

*Lower Dentition*—The inferior incisor is relatively broad with flat anterior face. This character is seen in Recent gophers, but Recent pocket-mice have the enamel band rounded with the incisor as a whole more compressed. In *Dipodomys spectabilis* the anterior face of the lower incisor is flattened. However, it is not so flattened as in *Pliosacomys*, nor is the incisor relatively so broad.

As in the upper premolar, P<sub>4</sub> is persistently double-columned. The anterior column (protolophid) is sub-circular in cross-section. The posterior column (metalophid) is much compressed antero-posteriorly. The two lophs are joined at their mid-points, forming a modified X-pattern.<sup>1</sup> No. 1809, a left ramus with P<sub>4</sub>-M<sub>2</sub> (Plate 1, fig. 7), possesses an unworn fourth premolar. The metalophid appears to show traces of three cusps, metaconid, hypoconid, and an intermediate cusp. The protolophid is rather complex, but appears to be formed essentially of three cusps arranged in a trefoil. These cusps are apparently analogous, from lingual to buccal side,

<sup>1</sup> A. E. Wood, *op. cit.* 99, 1935.

to Wood's protoconid, anteroconid, and mesoconid.<sup>1</sup> The uneven surface of the unworn enamel indicates the presence of one or two anterior accessory cusps. With wear the trefoil runs together, becoming a simple, sub-circular column. One of the anterior re-entrant folds may persist for some time as a shallow inflection. The metalophid also possesses some irregularities in early stages of wear, but these do not persist for long. P4 does not seem to be particularly close in pattern to any heteromyid, except in the worn state where all traces of original pattern are lost. It is not at all close to *Heteromys* or to any of the heteromyines.

The first two lower molars are mirror images of M1 and M2, as is the case in so many rodents. However, since at least eight lower jaws of *Pliosacomys* are available, the change of occlusal pattern with wear is satisfactorily demonstrated. The teeth are bilophodont in the younger stages of wear, becoming monolophodont with age. The posterior loph (hypolophid) is narrow and linear. The number of cusps composing it can not be definitely determined, but there is some indication of a normal three-cusped loph (entoconid, hypoconid and hypostylid). The anterior loph (metalophid) is composed of two cusps, the metaconid and protoconid, with a cingular ridge originating in front and at the lingual side of the protoconid, forming the antero-external portion of the tooth (thus forming a partial Y-pattern). This ridge terminates in a small cusp, the protostylid. The valley intervening between the cingular ridge and the metalophid is rather shallow so that with wear the whole front half of the tooth soon unites to form a wedge-shaped loph with the point directed toward the lingual border. For a greater or less time the remnants of the intervening valley persist as an enamel islet. The valley between metalophid and hypolophid is shallow, so that with continued wear the two lophs unite at the buccal border. The occlusal pattern is then somewhat rectangular in section with an inflection of more or less depth on the lingual side. In old age all inflections disappear.

The third lower molar differs somewhat from the remaining two in possessing a more circular outline. It may also differ in that the external portion of the valley between the two lophs tends to remain as a re-entrant fold in the enamel, thus forming with the lingual fold the H-pattern described by Wood.<sup>2</sup>

The lower deciduous premolar is represented in the collection by No. 1810 (Plate 1, fig. 1), a fragment of jaw bearing this tooth. The tooth is brachydont and extended antero-posteriorly. It is apparently composed of an internal and external row of low cusps, four on a side, all more or less connected. A second jaw in the collection also bears this tooth in a worn state. Fortunately, all three permanent molars are present, so that no doubt exists in referring No. 1810 to *Pliosacomys*.

#### COMPARISONS

If *Pliosacomys* is to be assigned to the Geomyidæ, the dentition shows a striking amount of parallelism to the Heteromyidæ. A. E. Wood has recently published a careful and complete account of the evolution and relationships of the heteromyids.<sup>3</sup> In this publication, Wood has divided the group, following an earlier classification of Coues, into three subfamilies, namely Perognathinæ, Dipodomysinæ, and Heteromyinæ. Comparisons with

<sup>1</sup> A. E. Wood, *op. cit.* 79, fig. 1a, 1935.

<sup>2</sup> A. E. Wood, *op. cit.* 101, 1935.

<sup>3</sup> A. E. Wood, *op. cit.* 1935.

these subfamilies show that although *Pliosacomys* may resemble the members of a particular line in some respects, it disagrees quite radically in others. The following selected differences distinguish *Pliosacomys* from members of the various heteromyid subfamilies as these groups are defined by Wood.

*Distinguished from Perognathinae* by: Lophs of P<sub>4</sub> unite at lingual border; development of lakes in molars result from partial development of a Y-pattern in posterior and anterior lophs of upper and lower molars respectively; P<sub>4</sub> with more than four cusps; no development of H-pattern, with possible exception of M<sub>3</sub>, contrasting with progressive members of the Perognathinae.

*Distinguished from Dipodomysinae* by: Lophs of P<sub>4</sub> unite at lingual border; partial development of Y-pattern in molars with subsequent formation of lakes; P<sub>4</sub> apparently more than five-cusped; H-pattern not developed in lower molars except possibly in M<sub>3</sub>; pattern of cheek-teeth apparently somewhat more deeply impressed on tooth-crown.

*Distinguished from Heteromyinae* by: Lophs of P<sub>4</sub> never unite at buccal side; P<sub>4</sub> with modified X-pattern (at least protolophid unites with median portion of metalophid).

Characters in the skull and ramus of *Pliosacomys* already discussed, appear to distinguish the genus from the Heteromyidae as a whole.

One species of heteromyid, *Cupidinimus magnus* (Kellogg) (equals *Diprionomys magnus* Kellogg)<sup>1</sup> is rather close to the Smiths Valley form. *Cupidinimus magnus* is based on two specimens, established as type and cotype by Louise Kellogg. The type, U.C. No. 12567 is a lower jaw with P<sub>4</sub>-M<sub>2</sub>. M<sub>2</sub> in No. 12567 is definitely wider than M<sub>1</sub>. In *Pliosacomys* M<sub>1</sub> and M<sub>2</sub> are subequal in width. Other differences are, in *Pliosacomys*: the lateral folds of M<sub>1</sub> and M<sub>2</sub> do not extend downward as far as in No. 12567; mental foramen larger and more superior in position; ramus may be relatively more heavy; and masseter muscle scar probably better defined and less horizontal. The cotype of *C. magnus*, U.C. No. 12568, is a fragment of ramus with P<sub>4</sub>. It shows the same general type of premolar construction that occurs in *Pliosacomys*, the incisor has a flat anterior face (relatively rare in heteromyids) and the masseter muscle scar is of the same type of construction as in our genus. The Smiths Valley genus differs in perhaps slightly larger size than No. 12568; mental foramen probably somewhat more superior in position; and perhaps in somewhat different pattern of P<sub>4</sub>. With regard to this last character, *Pliosacomys* seems to possess a slightly more complicated pattern at the same stage of wear, although a more worn specimen of the genus may be quite similar. Nos. 12567 and 12568 presumably represent the same species, although because of the fragmentary nature of the material this can not be absolutely demonstrated. If the two are to be assigned to a single species, they differ from *Pliosacomys* chiefly in the molar teeth, as outlined above. A specimen from San Pedro Valley, referred by Wood to *C. magnus*, consisting of P<sub>4</sub>-M<sub>1</sub> with associated upper incisors, is clearly not related to our genus.<sup>2</sup> It is possible that apparent similarity of the cotype of *Cupidinimus magnus* to *Pliosacomys* results largely from the incompleteness of the former specimen.

Comparison of *Pliosacomys* with fossil types known to be related to the geomyids is limited by lack of material. This dearth or absence of material is especially noteworthy for that long period of time which inter-

<sup>1</sup> Louise Kellogg, Univ. Calif. Pub., Bull. Dept. Geol., vol. 5, No. 29, 434-435, fig. 18, 1910.

<sup>2</sup> A. E. Wood, *op. cit.* 146-148, 1935.

vened between the lower Miocene and upper Pliocene. The earliest forms which have been referred to the Geomyidæ are *Entoptychus* and *Pleurolicus* from the John Day and related formations. These genera have been grouped by Miller and Gidley as a subfamily, Entoptychinæ, of the Geomyidæ.<sup>1</sup> Limited comparative material at hand makes many comparisons difficult or impractical. *Entoptychus* is an extremely specialized genus for this stage in the history of the gophers. It is distinguished from *Pliosacomys* by many characters in the skull, rami and dentition, as well as by a wide separation in time. Selected differences are as follows: In *Entoptychus* (1) cheek-teeth with persistent? growth, (2) P4/4 assume a molar-pattern on wear, (3) cheek-teeth tend to form lakes between lophs, and (4) inferior border of rostrum arched. *Pleurolicus*, judging from the description of the genus by Cope<sup>2</sup> and by Matthew,<sup>3</sup> is similar to *Entoptychus*, except that the former possesses rooted cheek-teeth. As in *Entoptychus*, the premolars of *Pleurolicus* wear to a pattern much like that of the molars. In view of the fundamental difference in premolar pattern and the early specialization of *Entoptychus*, the group does not seem to be related to either the Smiths Valley genus or to other known Geomyinæ. The upper Pliocene and Pleistocene gophers all differ widely from *Pliosacomys* in the differentiation of the enamel of the cheek-teeth into discontinuous bands, the persistent growth of the cheek-teeth, and in many other characters as well. A few specimens are known from the middle and later Tertiary and have been referred to Recent genera. These forms presumably differ widely from *Pliosacomys*.

#### RELATIONSHIPS

Virtually all workers stress the close connection between the Heteromyidæ and the Geomyidæ. As a matter of fact, many of the striking differences between the two families are traceable directly to differences in habits of life. The Smiths Valley specimens confirm this view and, indeed, very strongly suggest not only a close relationship, but also a descent of the gophers from the pocket-mice, or at least a descent from a common ancestor whose resemblance to pocket-mice would be indicated by an absence of fossorial characters as well as by tooth pattern. This corresponds to a view expressed many years ago by W. B. Scott.<sup>4</sup>

The exact relationships of *Pliosacomys* are rather puzzling. In many of its characters the genus stands structurally between the Heteromyidæ and the Recent Geomyidæ. However, its late appearance in the fossil record indicates that probably it should be considered as only a persistently primitive and aberrant geomyid, but exhibiting perhaps a stage similar to that passed through by the main line of the gophers (Geomyinæ) in their evolution toward Recent types.

A. E. Wood has shown that the Heteromyinæ and the Perognathinæ (plus Dipodomynæ) were apparently distinct by lower Miocene (Harrison) time. The evidence, however, is based on relatively poor material. Since *Pliosacomys* combines characters of both groups, the line it represents presumably would also have been distinct by that time. At any rate, the presence of the Entoptychinæ in the John Day and Harrison stages shows that this branch of the Geomyidæ was differentiated. The middle Oligocene rodent *Heliscomys* is regarded by Wood as the "starting point for the

<sup>1</sup> G. S. Miller and J. W. Gidley, Jour. Wash. Acad. Sci., vol. 8, No. 13, 433-434, 1918.

<sup>2</sup> E. D. Cope, Report U. S. Geol. Surv. Terr., vol. 3, Bk. 1, 866-867, 1884.

<sup>3</sup> W. D. Matthew, Bull. Amer. Mus. Nat. Hist., vol. 23, Art. 9, 211-212, 1907.

<sup>4</sup> W. B. Scott, Proc. Acad. Nat. Sci. Phila., 284, 1895.

evolution of the later Heteromyidæ." He states: "It is possible that *Heliscomys* is the common ancestor of the Heteromyidæ and Geomyidæ, but the gap between it and the earliest geomyids is so great and the time so short as to make this virtually impossible. It is almost certain, however, that *Heliscomys*, as far as dental development is concerned, is structurally ancestral to the geomyids."<sup>1</sup> There is certainly no character in *Pliosacomys* which would suggest that this genus and the Geomyinæ were differentiated from the heteromyids before the middle Oligocene. If anything, the genus suggests by the parallelism displayed in the cheek-dentition a somewhat later separation. It is possible that the Entoptychinæ, in view of the precocious specialization along certain lines in *Entoptychus*, represents the first branching-off of the gophers from the central stock and the Geomyinæ a somewhat later one. No unworn teeth of *Entoptychus* are available for comparison, so that the degree of relationship of this form to the early heteromyids, *Pliosacomys*, or to other geomyids, as evidenced by dental structure, could not be investigated.

Records of Geomyinæ before the upper Pliocene are extremely rare. W. D. Matthew mentions the presence of *Thomomys* in the Deep River and Nebraska Miocene stages in a chart accompanying his paper on the affinities of the Ischyromyidæ.<sup>2</sup> I am not familiar with any papers by Matthew or by other authors containing more specific statements concerning these forms. H. J. Cook and M. C. Cook, in a paper entitled "Faunal Lists of the Tertiary Vertebrata of Nebraska and Adjacent Areas,"<sup>3</sup> list *Thomomys* species as coming from the lower Snake Creek. A record of an existing genus in a stage as early as the Deep River is very unusual. If these determinations prove correct, *Pliosacomys* has little to do with the main line of the Geomyidæ. Marsh established a new species, *Geomys bisulcatus*,<sup>4</sup> for a specimen from "Pliocene strata, near Camp Thomas, on the Loup Fork river." The incisors are double-grooved and the molars are close to those in *Geomys bursarius*. H. J. Cook and M. C. Cook, in their paper cited above, list *G. bisulcatus* as questionably present in the Fort Niobrara (upper Miocene) and the lower Snake Creek. From the Snake Creek Pliocene, Matthew describes a rodent jaw, without teeth, which he first referred to *Geomys*<sup>5</sup> and later apparently to *Thomomys*.<sup>6</sup> H. J. Cook and M. C. Cook list both genera as occurring in the upper Snake Creek fauna. The Pliocene records are not so confusing as the Miocene occurrences, but confirm the view that *Pliosacomys* is not the lineal ancestor of any of the modern gophers. As stated previously, the upper Pliocene and Pleistocene geomyids are clearly advanced types, closely related to Recent forms and not closely allied to the Smiths Valley genus.

The history of the Geomyidæ, taking the earlier identifications and assignments at their maximum worth, a gratuitous assumption at best, might seem to cast doubt on the recognition of *Pliosacomys* as a geomyid. A possible alternative explanation of the relationships of *Pliosacomys* lies in the view that this genus is a heteromyid with geomyid specializations. However, this view does not have much in its favor. As mentioned previously, if the Heteromyinæ and Perognathinæ (plus Dipodomycinæ) were separate as far back as the lower Miocene, then the line of development

<sup>1</sup> A. E. Wood, *op. cit.* 82-83, 1935.

<sup>2</sup> W. D. Matthew, Bull. Amer. Mus. Nat. Hist., vol. 28, Art. 6, 67, fig. 19, 1910.

<sup>3</sup> H. J. Cook and M. C. Cook, Nebr. Geol. Surv., Paper No. 5, 49, 1933.

<sup>4</sup> O. C. Marsh, Amer. Jour. Sci., Third Ser., vol. 2, Art. 17, 121-122, 1871.

<sup>5</sup> W. D. Matthew, Bull. Amer. Mus. Nat. Hist., vol. 26, Art. 27, 382-383, 1909.

<sup>6</sup> *Loc. cit.*, vol. 50, Art. 2, 68, 1924.

represented by *Pliosacomys* was without much doubt also distinct at that time. Moreover, unless the perforate character of the rostrum is acquired more than once, this feature during the lower Miocene was present in all heteromyids which eventually gave rise to Recent types. Indeed, it is safe to say that the common ancestor of all the recognized heteromyid groups must also have possessed this character. The *Pliosacomys* line, on the other hand, is distinguished by an imperforate rostrum and the source of the several phyletic developments would consequently be still further removed in time, namely, to a position not very remote from that occupied by the common ancestor for both the Geomyidæ and Heteromyidæ. In other words, the *Pliosacomys* line becomes geomyid virtually by definition. It must be admitted that the above reasoning is tenuous, but is perhaps as justifiable as an alternative explanation. As a matter of fact, the dental characters of *Pliosacomys* which sometimes parallel those of one, sometimes those of another, of the heteromyid subfamilies are themselves in favor of geomyid affinities. Direct evidence is seen in the definite geomyid characters of skull and jaws, already discussed, with perhaps the chief negative or heteromyid character presented by the unarched rostrum.

A careful review of all fossil geomyid material would undoubtedly shed light on the evolution of the gophers. At present even figures of late Miocene and early Pliocene Geomyinæ are not available.

A little additional evidence, which throws some light on the characters in the cheek-dentition of *Pliosacomys*, is furnished by the unworn teeth of Recent gophers. C. Hart Merriam figured the relatively unworn teeth of *Geomys*. A figure of a ramus of this genus<sup>1</sup> with relatively unworn cheek-teeth shows that in the unworn state, and for a short time after wear has started, the enamel continuously surrounds the dentine. An M1 and M2 also show patterns not unlike those developed in *Pliosacomys*. M2, in which the tooth is still divided into two lophs, possesses a metalophid which is wedge-shaped, and a narrow hypolophid, very much like that in the corresponding tooth in *Pliosacomys*. Another figure of Merriam's, that of *Heterogeomys*,<sup>2</sup> shows a decided H-pattern in the lower molars, a characteristic not of *Pliosacomys*, but of the Dipodomyinæ. A milk molar of *Geomys*,<sup>3</sup> although badly worn, resembles *Pliosacomys* in relatively great antero-posterior diameter, but this is a character common to both heteromyid and geomyid milk teeth. An unworn P4 of *Thomomys* from the Carpinteria asphalt deposits of upper Pleistocene age, although apparently differing in several points, is as much like the unworn P4 of *Pliosacomys*, as that tooth in the latter genus is like any known heteromyid premolar.

#### CONCLUSIONS

*Pliosacomys* is best assigned to the family Geomyidæ and subfamily Geomyinæ. Many of its characters indicate the close relationship of the Geomyidæ to the Heteromyidæ. The genus can not be directly ancestral to any existing gopher, but, in cheek-tooth characters at least, may show a structural stage through which the Geomyinæ have passed.

<sup>1</sup> C. H. Merriam, U. S. Dept. Agric., North Amer. Fauna, No. 8, 252, pl. 16, fig. 4, 1895.

<sup>2</sup> C. H. Merriam, *op. cit.* 252, pl. 16, fig. 2, 1895.

<sup>3</sup> *Op. cit.* 252, pl. 16, fig. 2, 1895.

## Measurements (in millimeters)

	<i>Pliosaccomys dubius</i>	
	No. 1794	No. 1798
Length of diastema between I and P <sub>4</sub> .....	10.6	...
Width of palate between P <sub>4</sub> .....	...	2.3
I, antero-posterior diameter.....	1.8	...
I, transverse diameter.....	1.9	...
Alveolar length, P <sub>4</sub> -M <sub>2</sub> , inclusive.....	...	5.0 (a)
P <sub>4</sub> , antero-posterior diameter (occlusal surface).....	...	1.7
P <sub>4</sub> , transverse diameter.....	...	1.8
M <sub>1</sub> , antero-posterior diameter.....	...	1.1
M <sub>1</sub> , transverse diameter.....	...	1.7
M <sub>2</sub> , antero-posterior diameter.....	...	1.0
M <sub>2</sub> , transverse diameter.....	...	1.7
(a) equals approximate.		
		No. 1796
Depth of jaw below P <sub>4</sub> .....		5.1
Alveolar length P <sub>4</sub> -M <sub>3</sub> , inclusive.....		6.1
P <sub>4</sub> , antero-posterior diameter (occlusal surface).....		1.3
P <sub>4</sub> , transverse diameter.....		1.3
M <sub>1</sub> , antero-posterior diameter.....		1.2
M <sub>1</sub> , transverse diameter.....		1.6
M <sub>2</sub> , antero-posterior diameter.....		1.1
M <sub>2</sub> , transverse diameter.....		1.7
M <sub>3</sub> , antero-posterior diameter.....		1.1
M <sub>3</sub> , transverse diameter.....		1.5
I, antero-posterior diameter (average of three specimens).....		1.6
I, transverse diameter (average of three specimens).....		1.4
Alveolar length P <sub>4</sub> -M <sub>3</sub> inclusive (average of four specimens).....		5.8

## ZAPODIDÆ

*Pliozapus solus* n. gen. and sp.

*Genotype*—A right ramus with M<sub>1</sub>-M<sub>3</sub>, Calif. Inst. Tech. Coll. Vert. Pale., No. 1811 (Plate 2, figs. 4, 4a).

*Locality*—Smiths Valley, Nevada. Locality 174, C.I.T.

## GENERIC AND SPECIFIC CHARACTERS

I,  $\bar{0}$ ,  $\bar{0}$ ,  $\bar{3}$ . Molar teeth broad, crowns brachydont? Enamel folds not crowded. Anteroconid absent in M<sub>1</sub>. Rudimentary protolophid in M<sub>2</sub>. Protoconid and hypoconid rounded, not angulate as in Recent Zapodinae. Metalophid gives off spur which encloses a small lake. Protoconid in M<sub>1</sub> unites with protoconid-hypoconid ridge with moderate wear. Protoconid-hypoconid ridge relatively more antero-posterior in position than in Recent genera of Zapodinae. Angle of ramus much as in *Zapus*, condylar notch high. Size about as in *Zapus hudsonius*, but cheek-teeth relatively heavier.

## DESCRIPTION

The ramus of *Pliozapus* (Plate 2, fig. 4) is similar to that in Recent *Zapus* in general proportions, in so far as these may be judged from the imperfect specimen at hand. The important posterior region of the jaw is sufficiently preserved to show that the angle is essentially as in *Zapus*.

The jaw is readily distinguished from cricetine forms by the character of the angle which is a broad flattened plate, much inflected, its inferior border sharply keeled by the presence of the masseter lateralis ridge. The latter is strong and continuous from the angle up to and on the side of the ramus,

giving almost an hystricine appearance to the jaw. The ramus further differs from that of cricetine forms by possessing a notch between angle and condyle, which is U-shaped and superior in position.

The masseter muscle scar terminates about opposite the mid-point of M1. The fragmentary nature of the jaw makes it impossible to determine the presence or absence of a foramen between M3 and the ascending ramus. Such a foramen is not present in *Zapus* but is, in some members at least, of the Sicistinæ.

The compressed incisor has a convex anterior face. It is not noticeably different in character or in point of origin from that in *Zapus*.

The cheek-teeth, three in number, are relatively broad with brachydont? crowns. The exact height of crown is difficult to ascertain. The fact that the cheek-teeth are, in their present stage of wear, very short-crowned and the pattern is still rather clear points toward a rather brachydont type. M1 and M3 are three-rooted, the intermediate molar is four-rooted.

The grinding teeth (Plate 2, fig. 4a) are rather worn, so that details of tooth-pattern are in certain instances somewhat obscured. M2 is relatively broad for a zapodid tooth, in general proportions it is somewhat like the corresponding tooth in *Sicista*. It is, however, longer than wide. The tooth-crown is essentially quadritubercular. The two inner cusps are smaller but apparently higher than the outer pair. Moreover, the inner cusps, set somewhat in advance of the outer, are compressed into loph and the inner cusps themselves are obscured. These four cusps apparently represent the protoconid, metaconid, hypoconid, and entoconid. A small cusp is situated in front of the protoconid and metaconid and somewhat toward the external margin of the tooth. This cusp corresponds in position to the paraconid of other orders, but the paraconid is usually lost in rodents. Its place is sometimes taken by a cingular cusp. Schaub, in his work on the fossil Sicistinæ, has referred to this cusp as a paraconid.<sup>1</sup> In the present paper Wood's term, anteroconid,<sup>2</sup> will be used. The metaconid, protoconid, and anteroconid are united by a transverse loph, in the present case at least, best termed the metalophid. The hypoconid is worn into a large flat cusp, with a strong hypoconulid ridge forming the posterior margin of the tooth. The protoconid and hypoconid are united by an antero-posterior and somewhat oblique ridge, the protoconid-hypoconid ridge. A small metastylid just posterior to the metaconid is compressed into an oblique loph which joins externally with the protoconid-hypoconid ridge. Apparently, a short protolophid is present as a small spur given off internally from the protoconid. Moreover, the metalophid also gives off a spur, which projects posteriorly to join the metastylid loph and encloses a small crescentic lake. The entoconid is united to the posterior portion of the protoconid-hypoconid ridge by a strong entolophid, which more or less obscures the cusped nature of the entoconid.

The first molar is so worn that for the most part the original loph and intervening valleys are confluent. The tooth narrows somewhat toward its anterior end. M1 lacks an anteroconid, and apparently this feature is not due to wear. The valley between metaconid and metastylid is reduced to a tiny notch. However, a small lake occupies a position similar to that in M2. The pattern of the posterior half of the tooth is obscured by breakage as well as by wear. A small median lake apparently represents the remnant of the valley between entolophid and hypoconulid ridge.

<sup>1</sup> S. Schaub, *Eclogæ geol. Helvetiæ*, 23, p. 622, 1930.

<sup>2</sup> A. E. Wood, *op. cit.* 79, fig. 1a, 1935.

M $\bar{3}$  is considerably reduced with regard to length. The anteroconid, if originally present, has been obliterated by wear. A lake corresponding to the lake in M $\bar{2}$  is present, as well as a second, antero-internal one which apparently represents the fusion of the metalophid and anterior cingulum. A point of difference between the last molar and the anterior two is seen in the metastylid which joins with the entoconid, and, moreover, lacks the oblique loph which in M $\bar{1}$  and M $\bar{2}$  joins this cusplule with the protoconid-hypoconid ridge. This character may be due to individual variation for in a mandible of *Eozapus*, available for comparison, the metastylid loph appears to be present on one side and absent on the other.

#### COMPARISONS AND RELATIONSHIPS

It seems clear that *Pliozapus solus* should be placed in the Zapodidae as that family is defined by Miller and Gidley. The Zapodidae, according to those authors, includes three subfamilies, namely, the extinct European Theridomyinae, the Eurasiatic Sicistinae, and the Asiatic and North American Zapodinae.<sup>1</sup> The various views of authors on the systematic position of the theridomyids do not concern us in the present paper, since *Pliozapus* clearly does not belong in this group. The Theridomyinae have large functional fourth premolars, became extinct in the Miocene, and are limited apparently in their distribution to the Old World. It is also clear that *Pliozapus* is much closer to at least some members of the Zapodinae than to the Sicistinae, and should be placed in the former subfamily.

North American fossil Dipodoidea, other than Pleistocene types, are limited to the Uinta *Protoptychus*<sup>2</sup> and to the John Day *Paciculus*.<sup>3</sup> Very little is known about the systematic position of either of these two genera. *Protoptychus* has been referred to the Dipodidae by Miller and Gidley, but these authors note the possible reference of this type to the Theridomyinae. A. E. Wood has suggested that the genus may represent an "aberrant and sterile offshoot of the Ischyromidae."<sup>4</sup> The only known specimen is a skull, so that comparisons with *Pliozapus* can not be made, except that, as inferred from the upper dental series, a functional P $\bar{4}$  must have been present. It may be presumed from the characters displayed by the upper dentition that the lower dentition was quite unlike that in *Pliozapus*. The John Day *Paciculus* has been placed in the Dipodidae by Hay.<sup>5</sup> Cope's figures of the lower jaws are not good enough to permit many general comparisons and no detailed ones.<sup>6</sup> *Paciculus* is much larger than the form from Smiths Valley and the proportions of the teeth are different. Judging from the fact that P $\bar{4}$  has already disappeared, *Paciculus* was probably an early specialization, certainly not closely related to the later zapodids.

*Sicista*, *Eozapus*, *Zapus* and *Napæozapus* comprise the Recent genera of the Zapodidae. The first belongs to the subfamily Sicistinae, the last three to the Zapodinae. Although the rami of *Zapus* and *Pliozapus* agree rather closely, so far as known, the cheek-dentition of the North American Recent zapodids, *Napæozapus* and *Zapus* are in sharp contrast to that of the Tertiary form. *Pliozapus* has broader, more brachydont teeth with decidedly less-modified patterns and broader reentrant folds. As a matter of fact, the cusps have been so completely converted into folds in the

<sup>1</sup> G. S. Miller and J. W. Gidley, *op. cit.* 422-443, 1918.

<sup>2</sup> W. B. Scott, *op. cit.* 269-286, 1895.

<sup>3</sup> E. D. Cope, Proc. Amer. Philos. Soc., 18, 370, 1879 (1880).

<sup>4</sup> A. E. Wood, *op. cit.* 239, 1935.

<sup>5</sup> O. P. Hay, Carnegie Inst. Wash. Pub. No. 390, vol. 2, 911, 1930.

<sup>6</sup> E. D. Cope, *op. cit.* pl. 66, fig. 32, 1884.

former genera that their differentiation would be extremely difficult to interpret were it not for the comparisons made available by *Pliozapus*. Using the terminology employed in the description of *Pliozapus*, the following additional differences among others may be mentioned: (1) protoconid-hypoconid ridge not present in *Zapus*, except when a connection is formed through wear, (2) entoconid and protoconid connected directly by a long crest in *Zapus*, in *Pliozapus* the two are not connected except by means of protoconid-hypoconid ridge, (3) anterior portion of  $M\bar{2}$  in *Zapus* disconnected from protoconid and metaconid in early stages of wear, and (4) hypoconulid ridge apparently double in *Zapus*.

The enamel pattern of *Napæozapus* is essentially similar to that in *Zapus*, but  $P\bar{4}$  is missing and there are minor differences as well.

Recent *Eozapus* from China is much closer to *Pliozapus* than is either of the two North American genera. It differs from the latter and agrees with the former (A) in not having the enamel folds crowded, (B) in possessing a protoconid-hypoconid ridge, (C) protoconid and entoconid connected only by means of this ridge, (D) anterior portion of  $M\bar{2}$  connected with posterior portion, and (E) in presence of a single hypoconulid ridge. *Pliozapus* differs from *Eozapus* in (A) presence of broader cheek-teeth, (B) presence of spurs on lophs which tend to enclose enamel lakes, (C) principal outer cusps less angulate, (D) probable less height of crown, (E) a short protolophid in  $M\bar{2}$ , (F) the metastylid loph of  $M\bar{2}$  slants forward instead of being transverse or sloping slightly backward, (G) protoconid-hypoconid ridge of  $M\bar{1}$  more antero-posterior, and lastly (H) in a possible better connection between trigonid and talonid in  $M\bar{1}$ .

The Recent Eurasiatic sicistid, *Sicista*, also makes a closer approach to *Pliozapus*, with regard to dental pattern, than do *Zapus* and *Napæozapus*. *Pliozapus* is distinguished from *Sicista* by: more oblique direction of protoconid-hypoconid ridge, anterior termination of this ridge at buccal portion of protoconid rather than between protoconid and metaconid as in *Sicista*; cusps more compressed into lophs; cheek-teeth somewhat broader; greater development of metastylid; greater development of hypoconulid ridge; protoconid and metaconid of  $M\bar{1}$  are more nearly opposed; absence of anteroconid in  $M\bar{1}$ ; angle a larger plate with condylar notch higher; and masseter lateralis ridge much better developed.

*Plesiosminthus* and *Heterosminthus*, fossil sicistids from the European Oligocene and the Asiatic Pontian, respectively,<sup>1</sup> possess the anteroconid in  $M\bar{1}$  weakly developed, and in this respect come closer to *Pliozapus* than does *Sicista*. However, *Heterosminthus* is quite unlike the North American genus in greater reduction, in the former, of the elements of  $M\bar{3}$ , combined with a much less advanced  $M\bar{1}$  and  $M\bar{2}$ . *Plesiosminthus* may be a more suitable ancestor for *Pliozapus* than *Heterosminthus*, but the wide geologic separation, lack of comparative material, and incomplete *Pliozapus* remains make comparisons of little value. It is sufficient to state that the two are generically quite distinct.

*Pliozapus solus* clearly falls into the Zapodinae. The genus stands, in a sense, ancestral to the structurally progressive series *Eozapus*, *Zapus*, and *Napæozapus*. Actually, *P. solus* can not be ancestral to *Eozapus* since it appears to have certain features, as for example the development of spurs on certain of the lophs, that are probably progressive characters. However, *Pliozapus* is closer to *Eozapus* than to any other genus, either living or extinct. This relationship demonstrates again the close connection between

<sup>1</sup>S. Schaub, *op. cit.* 1930.

certain Asiatic and New World groups of mammals from Pliocene time onward. If speculation may be permitted, it seems most likely that North America, in view of the relations of *Pliozapus* to existing genera, was the seat of evolution of the Zapodinae. The ancestry of *Pliozapus solus* must, for the present, remain in doubt.

*Comparative measurements (in millimeters)*

	<i>Pliozapus solus</i> No. 1811 C.I.T. Smiths Valley	<i>Eozapus s. vicinus</i> Smithsonian No. 240762 Recent China	<i>Sicista flava</i> Smithsonian No. 173808 Recent Kashmir	<i>Zapus h. hudsonius</i> Dickey Coll. No. 17078 Recent On- tario, Canada
Length of M $\bar{1}$ -M $\bar{3}$ inclusive.....	3.9	3.5	3.1	3.4
M $\bar{1}$ , antero-posterior diameter.....	1.4	1.3	1.2	1.4
M $\bar{1}$ , transverse diameter.....	1.1	.9	.8	.7
M $\bar{2}$ , antero-posterior diameter.....	1.4	1.3	1.1	1.3
M $\bar{2}$ , transverse diameter.....	1.2	1.0	.9	.9
M $\bar{3}$ , antero-posterior diameter.....	1.1	1.0	.9	.7
M $\bar{3}$ , transverse diameter.....	1.0	.8	.7	.6

## CRICETIDAE

### *Peromyscus near antiquus* Kellogg

A left ramus with M $\bar{1}$ -M $\bar{3}$ , Calif. Inst. Tech. Coll. Vert. Pale., No. 1812 (Plate 2, figs. 3, 3a), of a cricetid rodent is very close to the Thousand Creek species, *Peromyscus antiquus*.<sup>1</sup> The dentition of the Smiths Valley form has the same proportions and length of tooth-row, but is somewhat less worn. M $\bar{1}$  and M $\bar{2}$  of No. 1812 are so close to the comparable teeth of the type of *P. antiquus* that difference in wear would account for any dissimilarities. However, the posterior cusp of M $\bar{3}$  (hypoconid plus entoconid) is more compressed in an oblique direction than in *P. antiquus*. Moreover, the internal valley in the latter tooth is somewhat dammed at its mouth in the type, and this is not the case in No. 1812. These last two characters may not be due entirely to wear or individual variation. The ramus of No. 1812 seems deeper and heavier than that of *P. antiquus*, but the incomplete inferior border of the ramus in the type specimen possibly accounts for some of this difference.

Other species of *Peromyscus* appear to be quite distinct from the Smiths Valley form. *P. brachygnathus*, *P. minimus* and *Eligmodontia arizonae* from the San Pedro Valley beds, Arizona,<sup>2</sup> are all much smaller than *P. near antiquus*, and have a more reduced M $\bar{3}$ . *P. dentalis* (Fish Lake Valley beds) and *P. longidens* (Barstow beds) are smaller and have less hypsodont teeth.<sup>3</sup> The various specimens referred to existing species or closely related forms are smaller than *P. near antiquus*, and tend to have more reduced third molars. Lastly, *P. loxodon* from the upper Miocene of New Mexico<sup>4</sup> is somewhat smaller. Apparently from Cope's description it differs also in having the molars more nearly subequal and shorter crowned.

<sup>1</sup> Louise Kellogg, *op. cit.* 432-433, fig. 16, 1910.

<sup>2</sup> J. W. Gidley, U. S. Geol. Surv., Prof. Paper 131, 124-125, 1922.

<sup>3</sup> E. R. Hall, Univ. Calif. Pub., Bull. Dept. Geol. Sci., vol. 19, Nos. 12, 13, 306-307, figs. 15-17, and page 315, figs. 5-7, 1930.

<sup>4</sup> E. D. Cope, U. S. Geol. Surv., West 110th Mer., vol. 4, 300-301, pl. 69, fig. 15, 1877.

The reference of the Smiths Valley form to *Peromyscus* follows the procedure adopted by various authors in describing extinct species of *Peromyscus*. If it were practical to employ, in dealing with fossil forms, the fine distinctions made in splitting Recent North American cricetids, several distinct genera doubtless would be established.

*Measurements (in millimeters)*

	<i>Peromyscus near antiquus</i>
	C.I.T. No. 1812
	Smiths Valley
Depth of ramus below M $\bar{1}$ .....	4.1
Length of M $\bar{1}$ -M $\bar{3}$ inclusive.....	5.6
M $\bar{1}$ , antero-posterior diameter.....	2.1
M $\bar{1}$ , transverse diameter.....	1.3
M $\bar{2}$ , antero-posterior diameter.....	1.8
M $\bar{2}$ , transverse diameter.....	1.4
M $\bar{3}$ , antero-posterior diameter.....	1.6
M $\bar{3}$ , transverse diameter.....	1.2

## LAGOMORPHA

### Leporid species

A single left lower grinding tooth indicates the presence of a leporid. The tooth is smaller than comparable toptype material of *Hypolagus vetus* (Kellogg). However, the specimen agrees rather closely in size with Pliocene remains obtained near Rome, Oregon, tentatively determined as representing *Hypolagus*. Characters other than size would be difficult to establish in the present instance. Several skeletal elements in the Smiths Valley collection also represent the Leporidae.

*Measurements (in millimeters)*

Antero-posterior diameter.....	2.5
Transverse diameter.....	2.5

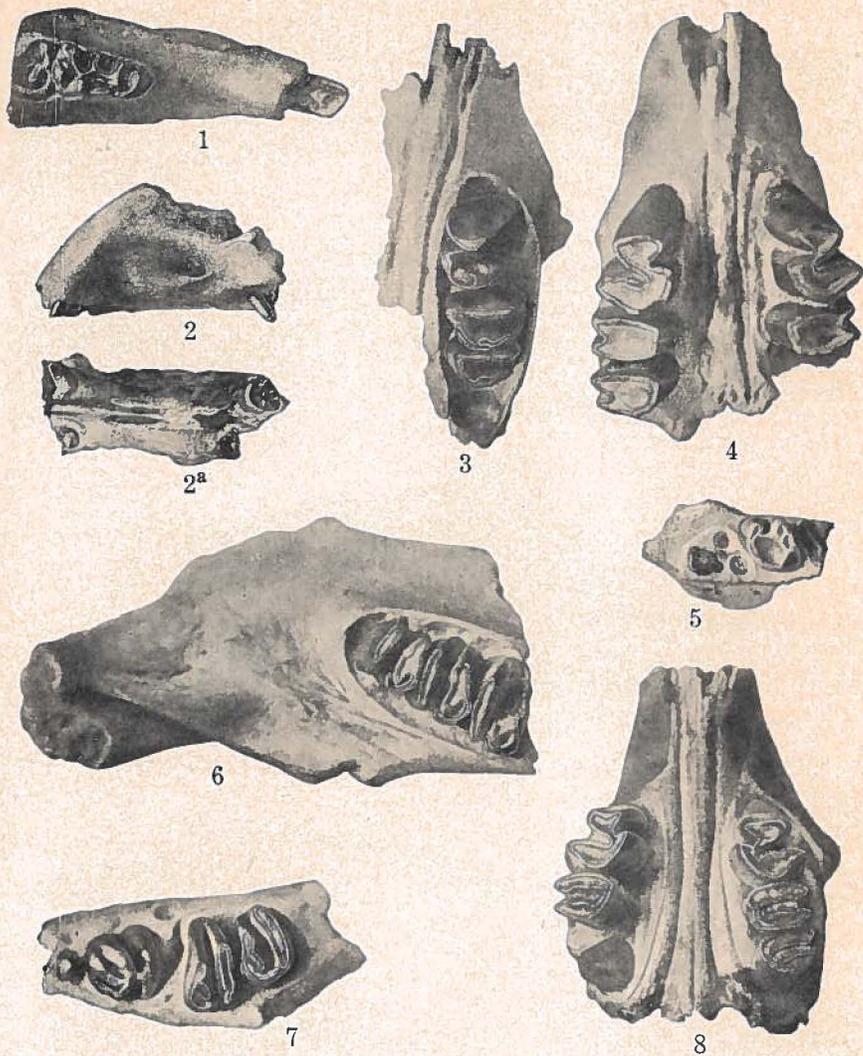
*Pliosacomys dubius* n. gen. and n. sp.

FIG. 1—Fragmentary right ramus with  $DM_4$ ; No. 1810; X6.

FIGS. 2, 2a—Rostral portion of skull, paratype specimen; No. 1797; X2. Fig. 2, lateral view; fig. 2a, ventral view (reversed).

FIG. 3—Right maxillary (reversed) with  $P_4$ – $M_2$ ; No. 1800; X6.

FIG. 4—Maxillary with right  $P_4$ – $M_2$ , left  $P_4$ – $M_1$ , paratype specimen; No. 1798; X6.

FIG. 6—Fragmentary right ramus with  $M_1$ – $M_3$ ; No. 1803; X6.

FIG. 7—Fragmentary left ramus with unworn  $P_4$ ,  $M_1$ – $M_2$ ; No. 1809; X6.

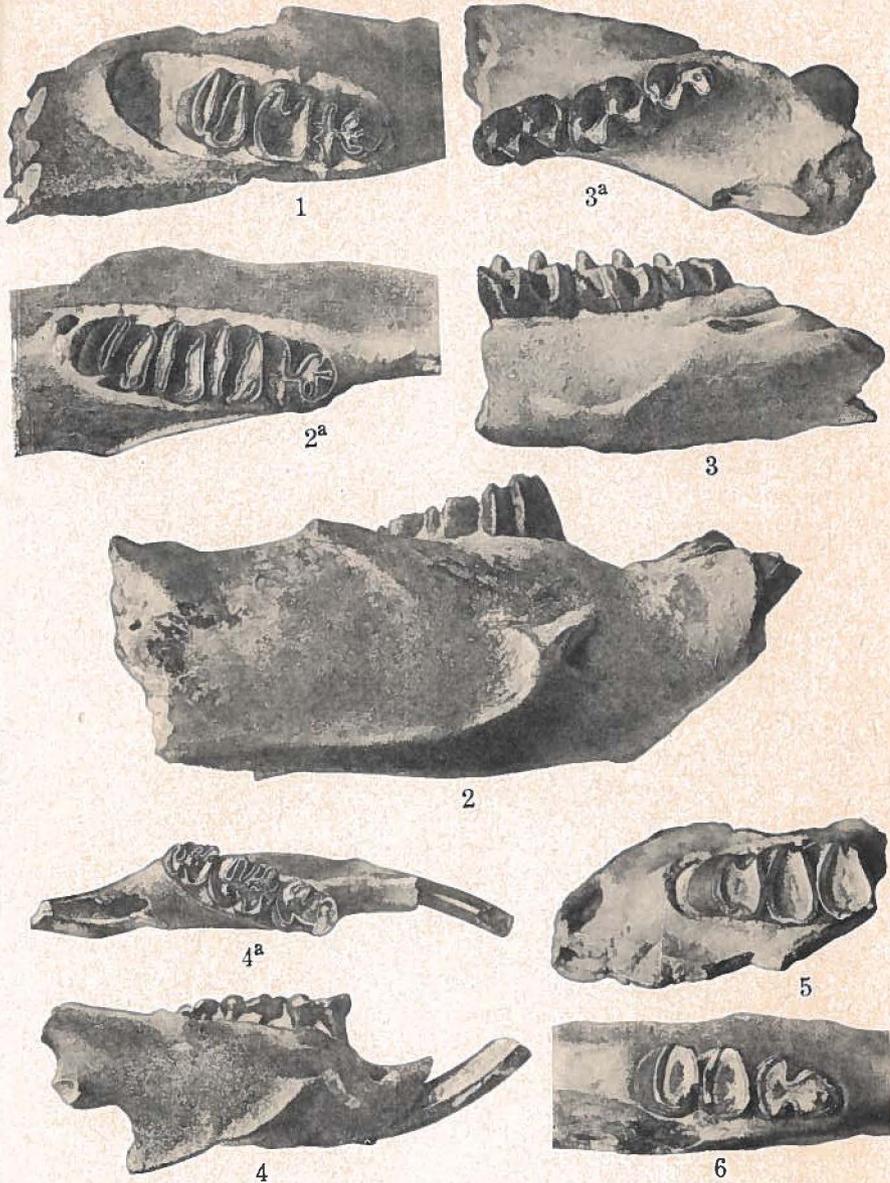
FIG. 8—Maxillary with right  $P_4$ – $M_1$ , left  $P_4$ – $M_2$ ; No. 1799; X6.

*Citellus?* species

FIG. 5—Fragmentary left ramus with  $M_2$ ; No. 1794; X3.

Sizes of all figures approximate.

Calif. Inst. Tech. Coll. Vert. Pale. Pliocene, Smiths Valley, Lyon County, Nevada.



*Pliosaccomys dubius* n. gen. and n. sp.

FIG. 1—Right ramus with P $\bar{4}$ –M $\bar{2}$ ; No. 1802; X6.

FIGS. 2, 2a—Right ramus with P $\bar{4}$ –M $\bar{3}$ , genotype specimen; No. 1796; X6. Fig. 2, lateral view; fig. 2a, occlusal view.

FIG. 5—Fragmentary right ramus with M $\bar{1}$ –M $\bar{3}$ ; No. 1806; X6.

FIG. 6—Right ramus with P $\bar{4}$ –M $\bar{2}$ ; No. 1804; X6.

*Peromyscus* near *antiquus* Kellogg

FIGS. 3, 3a—Left ramus with M $\bar{1}$ –M $\bar{3}$ ; No. 1812; X6. 3, lateral view; 3a, occlusal view.

*Pliozapus solus* n. gen. and n. sp.

FIGS. 4, 4a—Right ramus with M $\bar{1}$ –M $\bar{3}$ , genotype specimen; No. 1811; X6. Fig. 4, lateral view; fig. 4a, occlusal view.

Sizes of all figures approximate.

Calif. Inst. Tech. Coll. Vert. Pale. Pliocene, Smiths Valley, Lyon County, Nevada.