

$$\int_0^K J_\mu(z \, dn \, u) sn^{2\nu-1} u \, cn^{2\rho-1} u \, dn^{1-\mu} u \, du = \sum_{n=0}^{\infty} k^{2n} \left(\frac{z}{2}\right)^n \frac{B(\nu + n, \rho)}{n! 2} J_{\mu+n}(z)$$

$$\int_0^1 J_\mu(zx) x^{\mu+1} \exp[1/2tz(1 - x^2)] dx = \sum_{n=0}^{\infty} t^n z^{-1} J_{\mu+n+1}(z)$$

$$\int_0^1 J_\mu(zx) x^{\mu+1} \exp[1/2t(1 - x^2)] dx = \sum_{n=0}^{\infty} t^n z^{-n-1} J_{\mu+n+1}(z).$$

In the first two expressions the Bessel functions of the first kind ( $J$ 's) may be replaced throughout by functions of the second kind ( $Y$ 's); and further, if the factor  $(-)^n$  in the summation involving  $J_{\mu-n}(z)$  be omitted the functions of the first kind may be replaced throughout by modified functions of the second kind ( $K$ 's). These equations, which hold for  $R(\nu), R(\rho) > 0$ , may be verified by replacing  $z \, dn \, u$  by  $\sqrt{z^2 - z^2 k^2 sn^2 u}$ , expanding the Bessel functions in the integrand, using Lommel's expansion, and integrating termwise.

The last two equations, which hold when  $R(\mu) > -1$  and which may be verified by using<sup>6</sup>

$$J_{\mu+n+1}(z) = \frac{z^{n+1}}{2^n n!} \int_0^1 J_\mu(zx) x^{\mu+1} (1 - x^2)^n dx,$$

have probably been noticed before. The analogous series  $\sum_{n=0}^{\infty} t^n z^n J_{n+\nu}(z)/n!$  has already been summed by W. Kapteyn<sup>7</sup> and some other Dutch mathematicians.

<sup>1</sup> S. O. Rice, "On Contour Integrals for the Product of Two Bessel Functions," *Quart. Jour. Math.*

<sup>2</sup> G. N. Watson, *Theory of Bessel Functions*, §5.21.

<sup>3</sup> *Ibid.*, §5.23.

<sup>4</sup> E. W. Barnes, *Trans. Roy. Soc. Lond.*, 206, Part XI, 295 (1906).

<sup>5</sup> G. H. Hardy, *Trans. Camb. Phil. Soc.*, 21, 13 (1908); W. McF. Orr, *Ibid.*, 17, 171 (1898); 19, 151 (1900).

<sup>6</sup> G. N. Watson, l. c., §12.11.

<sup>7</sup> W. Kapteyn, *Vraagstuk*, 132, Solutions by G. R. Boogaerdt't, S. C. van Veen and others. *Wiskundige Opgaven*, 14, 269-271 (1928).

*SIMIMYS, A NEW NAME TO REPLACE EUMYSOPS WILSON, PREOCCUPIED.—A CORRECTION*

BY ROBERT W. WILSON

A description of a new genus of cricetine-like rodent was published in the January, 1935, issue of the PROCEEDINGS of the National Academy of

Sciences. T. S. Palmer has kindly brought to my attention the fact that the name *Eumysops*, proposed for the genus, is preoccupied by *Eumysops* Ameghino 1888. Hence, the new name *Simimys* is proposed for *Eumysops* Wilson.

**Genus *Simimys*, new name**

1935. *Eumysops* Wilson, *Proc. Nat. Acad. Sci.*, Vol. 21, No. 1, 26-32, Jan., 1935.

(Not *Eumysops* Ameghino, *Lista de los Mamíf. Fós. de Monte Hermoso*, 5-6, June, 1888).

Type species—*Eumysops simplex* Wilson, *Proc. Nat. Acad. Sci.*, Vol. 21, No. 1, 26-28, plate 1, figure 1, 1935.

<sup>19</sup> Muller, H. J., *Amer. Nat.*, 56, 32 (1922).

<sup>20</sup> Stern, C., *Zeit. ind. Abst. Vererb.*, 41, 198 (1926).

<sup>21</sup> Sturtevant, A. H., *Carn. Inst. Wash. Publ.* 399, 1 (1929).

<sup>22</sup> Muller, H. J. (in press) (1934).

<sup>23</sup> Brink, R. A., *Amer. Nat.*, 66, 444 (1932).

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## CRICETINE-LIKE RODENTS FROM THE SESPE EOCENE OF CALIFORNIA

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Communicated November 30, 1934

*Introduction.*—The Sespe deposits of southern California have yielded several cricetine-like rodent specimens. Rodent types other than those related to *Paramys* and its allies are rarely found in the Eocene of the North American continent. Hence, these specimens are not only of interest from the standpoint of adding new types to the Eocene fauna, but also in that they may eventually aid in the solution of the difficult and complex problem of rodent differentiation.

### ***Eumysops simplex*, n. gen. and n. sp.**

*Type Specimen.*—Left ramus with  $M\bar{1}$ - $M\bar{3}$ , No. 1759 Calif. Inst. Tech. Vert. Pale., figure 1.

*Referred Specimens.*—Left ramus with  $M\bar{1}$ - $M\bar{2}$ , No. 1760 Calif. Inst. Tech. Vert. Pale.; left ramus with  $M\bar{2}$ - $M\bar{3}$ , No. 1778 C. I. T. Vert. Pale.

*Locality.*—Sespe Uppermost Eocene, north of Simi Valley, Ventura County, California; Locality 150 C. I. T. Vert. Pale.

*Generic Characters.*—No antero-median cusp on  $M\bar{1}$ . Heel of  $M\bar{3}$  not contracted posteriorly. Internal spur of hypostylid generally well developed. Protolophid uniting protoconid and metaconid; never disconnected from metaconid to form a pseudo-hypostylid spur as in posterior cheek-teeth of *Eumys*. Connection between hypostylid and protoconid weak, lacking in some specimens. No entoconid on  $M\bar{3}$ .

*Specific Characters.*—Metastylid somewhat less developed on  $M\bar{1}$  than in *Eumysops vetus*. Metastylid not present on  $M\bar{2}$ . Connection between hypostylid and protoconid generally less well developed than in *E. vetus*, sometimes lacking.

*Description.*—No. 1778 is the only specimen of *Eumysops* which shows much of the ramus. The masseteric fossa terminates under the first molar. The masseter lateralis ridge is relatively strong, the masseter medialis ridge relatively weak. The latter characters are present in *Eumys*

but are reversed in *Peromyscus*. A striking feature in the ramus seems to be presented by the long posterior extension of the condylar portion.

The trigonid in  $M\bar{1}$  of the genotype is composed of two subequal cusps, the protoconid and metaconid (see Figs. 1, 1a). These cusps are connected at their posterior borders by a crescentic loph, the protolophid. Running forward and inward from the protoconid is a short ridge apparently representing the upward extension of a short anterior cingulum. This ridge is the only trace of an antero-median cusp in the first lower molar. In the

referred specimen, No. 1760, the ridge is absent but a short anterior cingulum is present. Running back from the metaconid is a depressed ridge which terminates in a small metastylid. A large hypostylid is situated between protoconid and hypoconid. It does not connect anteriorly with the protoconid in the genotype. Greater tendency toward such union may be discerned in No. 1760, but in neither case is the connection strong as in *Eumys*. Internally the hypostylid throws off a spur, here termed the internal hypostylid spur, which curves slightly forward. A similar spur, but with less development, extends forward and outward from the external side. In No. 1760 the hypostylid presents a triangular wearing surface with the internal spur apparently absent or obliterated; the external spur extends almost to the margin of the tooth, and a rather indistinct connection exists with the base of the protoconid. The hypostylid is united posteriorly with the hypoconid. Hypoconid and entoconid are connected by a hypolophid. A strong hypoconulid ridge curves backward and inward from the hypoconid to form the posterior margin of the tooth.

$M\bar{2}$  is the largest tooth of the cheek-tooth series. This tooth is quite

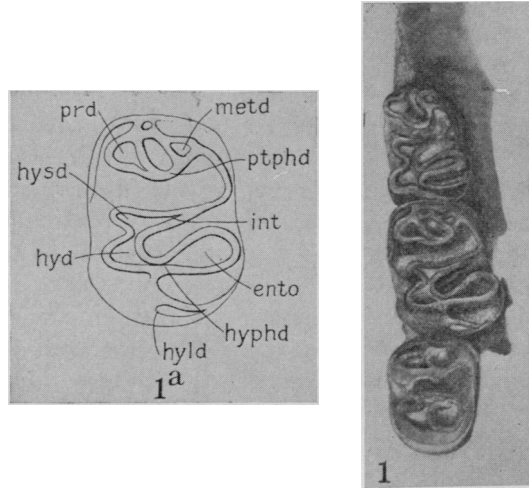


PLATE 1

Figure 1.—*Eumysops simplex*, n. gen. and sp. Genotype specimen, No. 1759; approximately  $\times 12$ .

Figure 1a.—Diagrammatic figure of *Eumysops* molar, greatly enlarged. *Ento*, entoconid; *hyd*, hypoconid; *hylld*, hypoconulid ridge; *hyphd*, hypolophid; *hysd*, hypostylid; *int*, internal spur of hypostylid; *metd*, metaconid; *prd*, protoconid; *ptphd*, protolophid.

Calif. Inst. Tech. Vert. Pale. Coll. Sespe Uppermost Eocene, California.

similar to  $M\bar{1}$  in general plan except that it is larger; the principal anterior cusps are set farther apart; there is no trace of a metastylid; the hypostylid is more of a loph than a cusp with much greater development of the spurs, especially the internal one; and the anterior cusps are united by means of a small anterior ridge in addition to the posterior connection. This ridge in the type is formed chiefly by what appears to be a small cusp. In the referred specimen, No. 1760, only an enamel ridge is evident. No anterior connection apparently exists in No. 1778. The ridge in this specimen unites with the cingulum. No. 1760 differs somewhat from the type in character of the hypostylid. In the former specimen the hypostylid retains a more cusp-like shape. A slight indication of a metastylid is evident in No. 1778. The hypostylid is cusp-like, and the internal spur is hardly more developed than in  $M\bar{1}$  of No. 1759.

$M\bar{3}$  narrows gradually toward the posterior end. The protoconid and metaconid are connected by the protolophid. A small ridge runs from the protoconid to join the anterior cingulum and forms a weak connection internally with the metaconid. The talonid consists of a hypoconid with strong posterior ridge curving around the border of the tooth and extending well forward on the inner side. An entoconid is absent. The hypostylid is well developed with spurs extending inward and outward. The external spur shows a weak connection with the protoconid. Details of this tooth are somewhat obscured by wear. In No. 1778, no anterior connection of protoconid and metaconid can be discerned unless this is established by the cingulum. The hypostylid-protoconid connection is somewhat stronger than in the type.

#### *Eumysops vetus*, n. sp.

*Type Specimen*.—Right ramus with  $M\bar{1}$ - $M\bar{3}$ , No. 1761 Calif. Inst. Tech. Vert. Pale.

*Referred Specimen*.—Badly damaged left ramus with  $M\bar{1}$ - $M\bar{3}$ , No. 1762 Calif. Inst. Tech. Vert. Pale.

*Locality*.—Sespe Upper Eocene, north of Simi Valley, Ventura County, California; Locality 207 C. I. T. Vert. Pale.

*Specific Characters*.—Metastylid a distinct cusp in  $M\bar{1}$  and  $M\bar{2}$ . Hypostylid and protoconid weakly united.

*Description*.—This species is close to *Eumysops simplex*. The metastylid of *E. vetus* is a distinct cusp in  $M\bar{1}$  and  $M\bar{2}$ . The internal spur of the hypostylid joins the metastylid in  $M\bar{2}$ , sometimes in  $M\bar{1}$ . The hypostylid unites with the protoconid on the external side of the latter cusp in  $M\bar{1}$  and  $M\bar{2}$ , more toward the median line in  $M\bar{3}$ . However, the strong median connection present in  $M\bar{2}$  and  $M\bar{3}$  of *Eumys* is lacking. The connection of hypostylid to hypoconid is less well developed in *E. vetus* than in *E. simplex*. This is most marked in  $M\bar{1}$ . In No. 1761 the hypo-

stylid in  $M\bar{2}$  and  $M\bar{3}$  is quite loph-like. The characters of the hypostylid may be due in part to wear or preservation of the specimen.

### ***Eumysops* cf. *vetus* Wilson**

*Specimen*.—A small fragment of left ramus with  $M\bar{1}$ , No. 1763 Calif. Inst. Tech. Vert. Pale.

*Locality*.—Sespe Upper Eocene, north of Simi Valley, Ventura County, California; Locality 202 C. I. T. Vert. Pale.

*Description*.—It is doubtful to which species of *Eumysops* the 202 specimen should be allocated. In character of metastylid specimen 1763 appears to be intermediate between *E. simplex* and *E. vetus*. In degree of hypostylid-hypoconid union No. 1763 most closely resembles No. 1760. On the basis of stratigraphic position, No. 1763 should be closer to *E. vetus*.

*Comparisons and Relationships*.—*Eumysops* shows a number of characters which serve to distinguish it from the White River genus *Eumys*. The most striking difference is the absence of an antero-median cusp on the first lower molar. In *Eumys* this cusp is well developed and not much less prominent and robust than the principal cusps. *Eumysops* never has more than faint indication of this cusp.  $M\bar{1}$  of the Sespe genus is further distinguished by presence of a metastylid and by a somewhat more external position of the hypostylid. The internal hypostylid spur of  $M\bar{2}$  is generally much better developed in *Eumysops*. There is no tendency toward disconnection of protolephid and metaconid with formation of a pseudo-hypostylid spur as is the case in at least the posterior molars of *Eumys*. The hypostylid is only weakly, if at all, connected with the protoconid. In *Eumys* a fairly strong median connection exists between these two cusps. Lastly, in  $M\bar{1}$  and  $M\bar{2}$  of the Sespe genus no connection exists between hypostylid and hypolephid. In *Eumys* the loph uniting the posterior cusps forms a more anterior connection between hypoconid and entoconid than in our genus, and unites with the posterior part of the hypostylid. Schaub<sup>1</sup> apparently believes that the hypolephid ("hypoconidhinterarm") of *Eumys* has become disconnected, has disappeared, and that a new anterior connection ("nachjochkante") has arisen. If the hypolephid of *Eumysops* is really the "hypoconidhinterarm," a profound difference exists between *Eumys* and the Sespe genus in the origin of the loph uniting the posterior cusps in  $M\bar{1}$  and  $M\bar{2}$ . As stated previously,  $M\bar{3}$  of *Eumysops* narrows gradually toward the posterior end and the posterior half is not contracted as in *Eumys*. The protolephid in  $M\bar{3}$  of *Eumysops* is similar to that of  $M\bar{2}$  and thus differs from the corresponding tooth of *Eumys*, which shows perhaps an even greater tendency to form a pseudo-hypostylid spur than in  $M\bar{2}$ . The hypostylid in  $M\bar{3}$  of the Sespe genus is rather weakly united to the protoconid by the external hypostylid spur. However, the union of the two cusps in No. 1778 is

somewhat stronger than in the genotype. In *Eumys* the median connection of the hypostylid with protoconid is strong. The cheek-teeth in *Eumysops* are lower crowned than in the White River genus.

It is beyond the scope of this paper to make extensive comparisons with European cricetids. However, comparisons made with these forms by means of Schaub's beautifully illustrated monograph<sup>2</sup> show that *Eumysops* is quite distinct and, applying Schaub's views on the cricetine molar, more primitive in several respects. The stratigraphic position of *Eumysops* would tend to confirm the latter statement. *Paracricetodon* and *Cricetodon* are European cricetids which may be compared to *Eumysops*. In none of the types illustrated by Schaub is the protolophid strongly united with the metaconid in all three molars as in *Eumysops*. The nearest approach to this condition in the European forms is found in *Paracricetodon cadurcense* and *spectabile*.<sup>3</sup> However, in  $M\bar{3}$  of these forms the protolophid is somewhat detached from the metaconid, at least in certain individuals. The antero-median cusp of  $M\bar{1}$  is generally well developed in the European cricetids but in several species such as *P. spectabile* and *P. cadurcense*, it is variably developed and some specimens apparently show virtually the same condition as in our form.

A major difference between *Eumysops* and European cricetids may lie in the development of the hypolophid. This crest in the Sespe genus is posterior in position as compared to a similar ridge seen in cricetids from later horizons. If this loph represents the "hypoconidhinterarm," it is much better developed than in any other known cricetid, and *Eumysops* would not possess a "nachjochkante" in the sense of Schaub at all.<sup>4</sup> There is no other spur or loph which might be interpreted as a "hypoconidhinterarm." In addition to the characters mentioned above, *Paracricetodon* has generally no open valley between metaconid and entoconid, but a ridge formed by the antero-posterior extension of the two internal cusps bounds the internal margin of the tooth. In *Eumysops*, a sharp valley is present between metaconid and entoconid. Lastly,  $M\bar{3}$  of *Eumysops* is not noticeably elongate as in *Paracricetodon* and does not bear an entoconid as in the latter genus or, indeed, as in most species of *Cricetodon*. Presumably in this character *Eumysops* is more advanced than the early European cricetids. Presence in  $M\bar{2}$  of most specimens of *Eumysops* of a minor connection between protoconid and metaconid, which is anterior to the protolophid, is apparently also an advance beyond at least one European type, *P. cadurcense*. The latter species shows only a very weak connection, but in most European cricetids the ridge is as strong as or stronger than in our form. Of the many species of *Cricetodon* from the Quercy, *C. gergovianum* seems superficially to resemble *Eumysops* most closely. However, Schaub states that this species is not a primitive type. It is to be distinguished by (1) presence of an antero-

median cusp in  $M\bar{1}$ ; (2) protolophid not united with metaconid in  $M\bar{2}$  and  $M\bar{3}$ ; (3) a well developed union of hypostylid with protoconid in  $M\bar{2}$  and  $M\bar{3}$ ; and (4) no trace of hypolophid. On the other hand, it is the only Quercy species which lacks an entoconid.

According to Schaub<sup>5</sup> the oldest cricetid recognized previously is *Cricetodon schaubii*<sup>6</sup> from the Sannoisian of China. This form is based on two isolated lower cheek-teeth,  $M\bar{2}$  and  $M\bar{3}$ , of which the former is the type. The type is distinguished from ours by its short internal hypostylid spur, and somewhat free protolophid.  $M\bar{3}$  has a well developed entoconid.

Only two genera of rodents in the Eocene of North America, other than the present one, cannot be referred to the *Ischyromidæ* of Matthew. *Protophychus* Scott<sup>7</sup> is quite evidently not related to the present genus. *Pareumys* Peterson<sup>8</sup> was referred to the Muridæ by Peterson, who apparently considered it to be related to *Eumys*. I do not think the genus is murine, and it is quite possibly an ancestor to *Cylindrodon*. It is clearly not related to *Eumysops*.

The phylogenetic position of *Eumysops* is uncertain. Remains of the genus are limited to fragmentary lower jaws, and in absence of any knowledge of the zygomasseteric region of the skull a discussion of the position of the Sespe genus is obviously limited to structural details of tooth pattern which, as far as the present state of our knowledge goes, may or may not be significant from a phylogenetic standpoint. *Eumysops* possesses several characters that may be regarded as very primitive and that serve to indicate the genus to be one of the most primitive of cricetine-like forms. However, absence of an entoconid in  $M\bar{3}$  marks an advance for *Eumysops* beyond *Paracricetodon* and most early species of *Cricetodon*. *Eumysops* may be ancestral to *Eumys*. As a matter of fact, the Sespe genus is closer to *Paracricetodon* and *Cricetodon* in many characters, but this may be due to a rather rapid advance made by *Eumys* along certain specialized lines. The absence of an entoconid in  $M\bar{3}$  seems to preclude ancestry to European genera.

Nothing has been said thus far concerning possible relationships of the Sespe genus to rodents other than cricetine types. These should not be overlooked in view of the primitive character of *Eumysops*. Certain European Oligocene representatives of the Sicistinæ are peculiarly close in molar structure to the Cricetinaæ. This similarity in the two groups is most troublesome in dealing with the lower dentition. As a matter of fact, a number of specimens of fossil rodents were first referred to the Cricetidæ, apparently incorrectly, and more recently transferred to the Sicistinæ.<sup>9</sup> *Eumysops* shows some characters which may be characteristic of the Oligocene Sicistinæ. Two of most importance are: (1) great development of the internal hypostylid spur to reach the internal border of the



tooth in  $M\bar{2}$ ; and (2) obliquely place hypostylid ridge when such a ridge exists as in No. 1761 from locality 207. It should be mentioned, however, that in No. 1778 the internal hypostylid spur is rather short, and the weak connection between protoconid and hypostylid is more or less antero-posterior.

Representatives of the Sicistinae are at present limited in their distribution to Eurasia. No definite fossil record of this group has yet been recorded on this continent, although both *Protoptychus* and *Paciculus* have been referred to the Dipodoidea. The Recent *Zapus* of North America and an undescribed zapodid from the Pliocene of Nevada in the California Institute collections further indicate that the Zapodidae may have been present in North America throughout most of Tertiary time. On the other hand, the Cricetidae are definitely known from Oligocene to Recent in North America. In absence of any conclusive evidence to the contrary, it is perhaps best to place *Eumysops* in the Cricetidae.

<sup>1</sup> Schaub, S., *Abh. schweiz. palaeontol. Ges.*, **45**, 6, 83, 99-100, Fig. 1 (1925).

<sup>2</sup> Schaub, S., *Ibid.*, 1-110, pls. I-V (1925).

<sup>3</sup> Schaub, S., *Ibid.*, 54-58, 60-61, pl. II, Figs. 12, 14 (1925).

<sup>4</sup> Although the "hypoconidhinterarm" has disappeared in *Eumys*, it is still present in a number of early European cricetids. It is usually represented by a spur extending inward from the hypoconid. Its greatest development in European forms is in *Paracricetodon cadurcense* in which it reaches the base of the entoconid.

<sup>5</sup> Schaub, S., *Eclogæ geol. Helvetiæ*, **23**, 631 (1930).

<sup>6</sup> Zdansky, O., *Pale. Sinica*, Ser. C, **2**, Fasc. 2, 10-12, pl. 1, Figs. 5-6 (1930).

<sup>7</sup> Scott, W. B., *Proc. Acad. Nat. Sci. Phila.*, 269-286 (1895).

<sup>8</sup> Peterson, O. A., *Ann. Carnegie Mus.*, **12**, 66, Fig. 7 (1919).

<sup>9</sup> Schaub, S., loc. cit., 616-617, 627-629 (1930).

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## FUNDAMENTAL GEODETIC SURVEYS IN THE UNITED STATES NEARING COMPLETION

BY WILLIAM BOWIE

DIVISION OF GEODESY, U. S. COAST AND GEODETIC SURVEY

Read before the Academy, Monday, November 19, 1934

Geodetic surveys have been carried on in the United States by the United States Coast and Geodetic Survey, the several branches of the Corps of Engineers of the United States Army, the United States Geological Survey and a few private organizations for many years, but it is only during the past few decades that these surveys have been extended rapidly. The greater part of these surveys have been made by the Coast and Geodetic Survey, which was organized in 1807 and started field operations in 1816.