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VOLUME XXI

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ABSTRACT

Three species of small voles are assigned to the genus *Ophiomys*. A study of three populations of *Ophiomys taylori* from successive stratigraphic horizons in the Late Cenozoic Glenns Ferry Formation of Idaho shows that there was a change in the occlusal pattern of M_1. The earliest (oldest) population had an M_1 with a dominant pattern of a posterior loop and three alternating triangles. The youngest population had an occlusal pattern consisting dominantly of four and five alternating triangles. *Ophiomys taylori* is considered to be the ancestral stock that gave rise to *O. parvus* in the later Grand View local fauna of Idaho.

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INTRODUCTION

IN THE SUMMER OF 1956, Hibbard was invited by Dwight W. Taylor of the United States Geological Survey to make a study of the small vertebrates of the Hagerman local fauna from Twin Falls County, west of Hagerman, Idaho.

The microtine *Cosomys primus* Wilson was found to be common in the lower part of the Glenns Ferry Formation (Malde and Powers, 1962) and absent at the higher stratigraphic level of the famous United States National Museum Horse Quarry (Gazin, 1936). *Cosomys* was replaced at this higher level in the fauna by a smaller and distinct microtine.

That summer collections were made from an elevation of 3,025 feet (DWT Locality 540) to an elevation of 3,295 feet (DWT Locality 431) in the area of the Horse Quarry. Another collection was made approximately 45 miles northwest of Hagerman and south of Hammett, in Owyhee County, Idaho, on the south side of the Snake River where a "promontory" is locally called Sand Point. At this locality isolated teeth of a microtine smaller than *Cosomys* were found, but no remains of *Cosomys*.

The material collected in 1956 was reported by Hibbard (1959). The small microtine taken at DWT Locality 431, at the stratigraphic level of the Horse Quarry and approximately one and one-eighth miles southwest of the quarry was described as *Nebraskomys? taylori*. It was assigned a possible Aftonian age. The species was based on the occlusal pattern of four M_1s that have since proven to be the dominant pattern of that population.

The four M_1s recovered at the Sand Point Locality in Owyhee County were described as *Pliophenacomys idahoensis* and it has been proven that the species was based on the dominant dental pattern of the M_1 of that population. This fauna was assigned a late Piocene age.

Malde and Powers (1962) made a detailed study of the Upper Cenozoic stratigraphy along the Snake River in the region where the fossils were collected and were able to show that the deposits containing the lower 400 feet of flood plain facies in the area of the Hagerman Horse Quarry were lower in the stratigraphic section than the deposits at Sand Point from which the fossils were recovered. They described the Glenns Ferry Formation which includes the Hagerman local fauna (late Pliocene), the Sand Point local fauna (late Pliocene), and the Grand View local fauna (early Pleistocene).

Since their study, Evernden, *et al.* (1964, p. 164) have dated a basalt within the Glenns Ferry Formation from Elmore County, Idaho, that is the same basalt as that found just northeast of and 60 feet below the

Horse Quarry in Twin Falls County. The basalt gave a potassium-argon date of 3.48 ± 0.27 million years old. They also dated a volcanic ash taken 90 feet below the basalt. It gave a potassium-argon date of 3.3 million years. Another volcanic ash taken 90 feet above the basalt gave a potassium-argon date of 3.2 million years. These dates, as well as the fauna, establish a late Pliocene age for this part of the Glenns Ferry Formation.

The collections made in the summers of 1962, 1964, 1965, and 1966 of these small microtines show that they belong to a distinct group which has a variable M_1 pattern. A study of four stratigraphically separated populations shows a phyletic trend from an M_1 with three alternating closed triangles to an M_1 with five alternating triangles in the Glenns Ferry Formation. These related forms have been placed in the new genus *Ophiomys*.

ACKNOWLEDGMENTS

We wish to thank the following for permission to study specimens under their care: C. Lewis Gazin and Clayton E. Ray, United States National Museum; Charles A. Repenning, United States Geological Survey; William A. Clemens, Museum of Natural History, University of Kansas; and J. Arnold Shotwell, Museum of Natural History, University of Oregon. We are indebted to Miklós Kretzoi of the Hungarian Geological Institute and Charles A. Repenning for discussions concerning their points of view regarding the development and relationships of various microtines.

Special credit is due The University of Michigan field parties, which made possible this series of specimens for study. Members of the 1962 party were John R. Bolt, G. Nelson Greene, Jerry G. Smith, and Richard J. Zakrzewski; the 1964 members were William G. Melton, Jr., Jack C. Schuster, and Richard J. Zakrzewski; the 1965 members were Philip R. Bjork, Kenneth E. Campbell, Jr., Toby Jewett, Gerald Larson, Richard L. Wilson, and Richard J. Zakrzewski; the 1966 members were Lynn S. Fichter, Robert A. Garwood, and William G. Melton, Jr.

The drawings were made by Alice R. Ballard (A.R.B.); Richard L. Wilson (R.L.W.); and Michael O. Woodburne (M.O.W.).

Financial support to Hibbard for the field work during the summer of 1962 was provided by the National Science Foundation (Project G-19458); for the field work during the summers of 1964–1966, and for the line drawings by Alice R. Ballard, was provided by NSF (Project G.B.-1528).

The manuscript was critically read by Dr. Chester A. Arnold and Dr. Robert V. Kesling.

Ophiomys, gen. nov.

Genotype.—*Mimomys? parvus* Wilson, 1933, Carnegie Inst. Wash. Publ., No. 440, pp. 128–132, Fig. 6a. Specimen No. 1369 CIT, now in the Los Angeles County Museum of Natural History.

Referred species:

Pliophenacomys meadensis Hibbard, 1956, Pap. Mich. Acad. Sci., Arts, and Letters, 41 (1955), pp. 187–191, Figs. 14A-E, G-I, K-M.

Nebraskomys? taylori Hibbard, 1959, Pap. Mich. Acad. Sci., Arts, and Letters, 44 (1958), pp. 12–15, Figs. 3A-C.

Pliophenacomys idahoensis Hibbard, 1959, Pap. Mich. Acad. Sci., Arts, and Letters, 44 (1958), pp. 15–19, Figs. 4A-I.

Generic diagnosis.—A microtine rodent with rooted teeth which lack cement and labial dentine tracts, with no enamel pit or pits on M^3. The M_1 consists of a posterior loop with three to five alternating triangles and an anterior loop. The alternating triangles are not as closed as in *Pliophenacomys*. The fourth and fifth triangles are confluent and open broadly into the anterior loop. The prism fold occurs on some of the M_1s with three alternating triangles. The enamel pit occurs chiefly on those M_1s with three alternating triangles. A few of the M_1s with four alternating triangles possess enamel pits. The apices of the lingual re-entrant angles of the lower molars are constricted and are generally directed forward. M^1 is three rooted, M^2 with three or two roots, and M^3 with two roots.

Ophiomys is distinguished from *Pliophenacomys* by a more ventrally placed mental foramen and the posterior shape of M^3 (Fig. 1A). Both *Ogmodontomys* Hibbard (1941) and *Pliophenacomys* Hibbard (1938) have the apices of the lingual re-entrant angles of the lower molars perpendicular or nearly perpendicular to the long axis of the occlusal surface (see Fig. 1M). This character also distinguishes these two genera from *Cosomys* Wilson (1932). The enamel pits reported on the M^3 of *Ogmodontomys* by Zakrzewski (1967), from Locality 3 of the Rexroad fauna, are found only on immature or very young adult specimens and disappear immediately with wear. One adult M^3 from the Fox Canyon local fauna has a deep enamel pit. This tooth is one of 75 M^3s from Fox Canyon.

Cosomys is distinguished from *Ophiomys* by the presence of three alternating triangles on the M_1. Approximately 80 per cent of the *Cosomys*

M_1s have a prism fold and 70 per cent an enamel pit. The prism fold and enamel pits on M_1 occur only in *Ophiomys taylori* and not on the M_1 of other species assigned to *Ophiomys*. Approximately 16 per cent of the M_1s of *O. taylori* have a prism fold and 59 per cent of the M_1s have an enamel pit.

Nebraskomys Hibbard (1957) is a small microtine rodent in which the first and second alternating triangles of M_1, M_2, and M_3 are confluent. The first and second triangles of M_2 are nearly opposite. It is considered as ancestral to *Atopomys* Patton (1965).

Cseria Kretzoi (1959) is considered to include *C. gracilis* (the genotype) and *Mimomys stehlini* Kormos and probably other species described as *Mimomys* that lack cement but have a deep enamel pit on the anterior loop of the M_1 and one or two deep enamel pits on M^3. M_1 has a posterior loop, three alternating triangles, and an anterior loop.

The genus *Mimomys* Forsyth Major (1902) is distinguished by the presence of rooted molars with *cement* in the re-entrant angles. M_1 has a posterior loop, three alternating triangles, and an anterior loop.

Ophiomys parvus (Wilson)

(Figs. 1N, R)

Mimomys? parvus Wilson, 1933, Carnegie Inst. Wash. Publ., No. 440: pp. 128–132, Figs. 5 and 6.

Pliophenacomys parvus (Wilson); Hibbard, 1950, Univ. Mich. Mus. Paleo., Contrib., 8(6): pp. 155–157.

Pliomys parvus (Wilson) non Hibbard; Kretzoi, 1955, Acta Geol., 3(4): p. 354.

Pliophenacomys parvus (Wilson); Hibbard, 1959, Pap. Mich. Acad. Sci., Arts, and Letters, 44 (1958): pp. 22–25, Figs. 4J-K.

Horizon and type locality.—Upper part of Glenns Ferry Formation, early Pleistocene, Grand View local fauna, from the NE¼, Sec. 15, T.4S, R.2E., southeast side of Jackass Butte, Owyhee County, Idaho.

Diagnosis.—M_1 has five alternating triangles. The fourth and fifth are confluent and open widely into the anterior loop. The dentine on the anterolabial side of the anterior loop extends well above the base of the anterolabial re-entrant angle. M_1 will develop an interrupted enamel pattern at an earlier stage of wear on the occlusal surface than in *O. meadensis*.

Since 1956, isolated teeth of this vole have been recovered from five localities (other than the type locality) along the southwest and west side of Jackass Butte, in Owyhee County, Idaho.

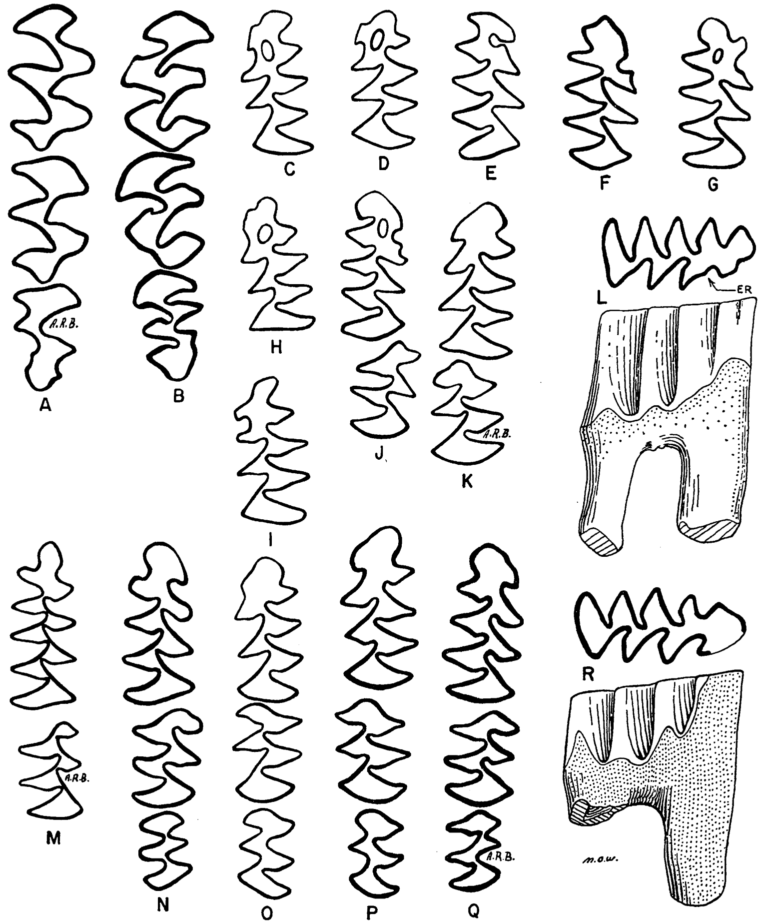

FIG. 1. *Ophiomys* and *Pliophenacomys:* A, *Pliophenacomys primaevus,* occlusal view. UMMP V55338 right M^1 -M^3. B-K, *Ophiomys taylori* occlusal views. B, UMMP V55072, left M^1 -M^3; C, UMMP V53289, left M_1; D, UMMP V55268, left M_1; E, UMMP V55311, right M_1; F, UMMP V55313, right M_1; G, UMMP V55314, right M_1; H, UMMP V55303, left M_1; I, UMMP V55301, left M_1; J, UMMP V55030, right M_1 -M_2; K, UMMP V55300, left M_1 -M_2; L, *O. taylori* labial and occlusal views, USNM 21872 (holotype of *Pliophenacomys idahoensis*), right M_1; M, *Pliophenacomys primaevus,* occlusal view KU 3905, holotype, left M_1 -M_2; N, *Ophiomys parvus,* occlusal view, UMMP V49601, right M_1 -M_3; O-Q, *O. taylori,* occlusal views; O, UMMP V55304, left M_1 -M_3; P, UMMP V55203, left M_1 -M_3; Q, UMMP V55203, right M_1 -M_3; R, *O. parvus* labial and occlusal views, USNM 21877, RM_1. All views $\times$ 8.

Ophiomys parvus is distinguished from *O. meadensis* (Hibbard) by its slightly narrower molars with thinner enamel walls and narrower labial re-entrant angles. The enamel is uniform in thickness. *Ophiomys parvus* is more advanced than *O. meadensis* as shown by the higher dentine tracts on the labial side of M_1 (Fig. 1R). The fourth and fifth alternating triangles of M_1 are confluent in both species.

One right jaw (UMMP V49411) of *Ophiomys parvus* with M_1 and M_2 has the articular process. The occlusal length of M_1 and M_2 is 4.0 mm. The capsular process for the base of the incisor is better developed than in the holotype of *O. meadensis* of comparable age. Only a right jaw (UMMP V49601) was taken that contained M_1-M_3 (Fig. 1N). The occlusal length of M_1-M_3 is 5.5 mm.

The isolated M^1s have three roots. The lingual root is not so well developed as in *Ophiomys taylori*. There are 46 M^2s. One right M^2 has three roots, the others and the M^3 have only two roots.

It is evident that the *Ophiomys taylori* stock gave rise to *O. parvus*. Further collecting should produce faunas that are intermediate in age between the Sand Point local fauna and the Grand View local fauna.

Ophiomys meadensis (Hibbard)

Pliophenacomys meadensis Hibbard, 1956, Pap. Mich. Acad. Sci., Arts, and Letters, 41 (1955): pp. 164–167 and 187–191, Figs. 6A–G, 14A–E, G–H, K–M.

Holotype.—UMMP V32019, a nearly complete left lower jaw, with only M_3 missing.

Horizon and type locality.—Lower Pleistocene (Aftonian), Ballard Formation, Big Springs Ranch, Locality UM-K2-53, SE¼, Sec. 23, T.32S., R.29W., Meade County, Kansas.

Diagnosis.—*Ophiomys meadensis* is slightly larger than the other species in the genus. It is intermediate between *O. taylori* and *O. parvus* in the development of the capsular process for the incisor. M_1 consists of 5 triangles. The fourth and fifth triangles are confluent and open widely into the anterior loop. For specific differences see *O. parvus*.

All isolated M^1s from the Sanders local fauna have three roots. The lingual root is the same size as in *Ophiomys parvus*. Among the M^1s from the Dixon local fauna, two have the lingual root fused with the large anterior root.

There are 14 M^2s from the Sanders local fauna, four have three roots and the others have two roots. There are 24 M^2s from the Dixon local fauna, six have three roots and the remaining 18 have two roots. All M^3s are two rooted.

The right M_1 (Fig. 6F, Hibbard, 1956, p. 166) is not *Ophiomys meadensis*. It is the tooth of an undescribed microtine, with higher crowned teeth, possessing dentine tracts. The alternating triangles are more closed than in *O. meadensis* and the fourth and fifth are not confluent.

It is not known where or when the stock that gave rise to *Ophiomys meadensis* branched off from the *O. taylori* stock.

Ophiomys taylori (Hibbard)

(Figs. 1B–L, O–Q; 2A–C)

Nebraskomys? taylori Hibbard, 1959, Pap. Mich. Acad. Sci., Arts, and Letters, 44 (1958): pp. 12–15, Figs. 3A–C.

Pliophenacomys idahoensis Hibbard, 1959, Pap. Mich. Acad. Sci., Arts, and Letters, 44 (1958): pp. 15–19, Figs. 4A–I.

Nebraskomys? taylori Hibbard; Taylor, 1966, Malacologia, 4(1): p. 75.

Holotype.—No. 21832 USNM, (Fig. 2A) part of right lower jaw with incisor, M_1–M_3.

Horizon and type locality.—Glenns Ferry Formation, Hagerman local fauna, Upper Pliocene. United States Geological Survey (USGS). Cenozoic locality 19216 (DWT 431), NE¼, Sec. 20, T.7S., R.13E., Twin Falls County, Idaho (see Hibbard, 1959, p. 4).

Diagnosis.—*Ophiomys taylori* is a small vole. It is larger than *Nebraskomys mcgrewi* Hibbard and smaller than *Cosomys primus* Wilson. The capsular process for the reception of the incisor is poorly developed. The occlusal pattern of the M_1 is highly variable. There are no dentine tracts developed on the M_1.

The localities from which specimens of *Ophiomys taylori* have been recovered from the Glenns Ferry Formation in Idaho are listed from oldest to youngest. The fossils are in the United States National Museum (USNM); and The University of Michigan Museum of Paleontology (UMMP).

Locality UM-Ida. 3–65, elevation 3,110′, Twin Falls County.—A left M_1 of *Ophiomys taylori* was taken at this locality in association with numerous teeth of *Cosomys*. This occurrence is the lowest in the Glenns Ferry Formation. The tooth is that of a young adult. It lacks the prism fold (Fig. 1C). A shallow enamel pit is present in the anterior loop. Only the second lingual re-entrant angle curves forward. It has an occlusal length of 2.4 mm. and a width of 1.2 mm.

Locality UM-Ida. 2–65, elevation 3,280′–3,300′, Twin Falls County. —A left M_1, two right M^1s and a right M^3 of *Ophiomys taylori* were recovered in association with many *Cosomys* teeth. The M_1 lacks the prism fold. An enamel pit is present and the anterior loop is trilobed (Fig. 1D). The occlusal length is 2.3 mm. and the width is 1.1 mm. The three lingual re-entrant angles curve forward at their apices. The M^3 is two rooted.

Locality UM-Ida. 1a-65, elevation 3,260′, Twin Falls County.—Nineteen left and 15 right lower jaws with M_1 or more molars, and 7 left and 7 right isolated M_1s as well as other isolated teeth including 9 M^2s and 2 M^3s of *Ophiomys taylori* were recovered at this locality in association with 2 *Cosomys* jaws with teeth, and 3 right and 3 left isolated M_1s.

There are 3 immature M_1s of *Ophiomys taylori,* one possesses an enamel pit and a prism fold. The other two possess the enamel pit and an enamel ridge (ER), (Fig. 1L). Eight of the 9 young adult M_1s have the enamel pit but none have either prism fold or enamel ridge.

The following variations are found among the 19 adult M_1s: 8 possess the enamel pit with no prism fold (Fig. 1C, D, H), one has only a prism fold (Fig. 1F), two contain both of these characters, and one specimen the enamel pit and the enamel ridge. The remainder have none of these characters. Two specimens considered to be old adults still retain a trace of the enamel ridge.

Thirty-five of the 48 M_1s have a posterior loop, 3 alternating triangles and an anterior loop with a shallow fourth lingual re-entrant angle (Fig. 10). Thirteen of the 48 M_1s have a distinctive fourth triangle (Fig. 1L) and one, UMMP V55300, has 5 alternating triangles (Fig. 1K). The trilobed pattern of the anterior loop occurs in 10 of the M_1s (Fig. 1I).

There are 2 left and 3 right lower jaws with M_1-M_3, (Fig. 10). The occlusal lengths range in size from 5.3 to 5.9 mm., average of 5.7 mm. There are 13 left and 12 right lower jaws with M_1-M_2. Measurements of occlusal lengths range from 3.7 to 4.4 mm., average of 4.1 mm. Eighteen M_1s, 3 of which are in jaws, range from 2.1 to 2.6 mm., average of 2.4 mm.

The M^3s are two rooted. Six of the 9 M^2s are 3 rooted, one is two rooted, one has a large anterior root with a tiny root behind, and the base of the other tooth is broken.

Locality: United States National Museum Horse Quarry, elevation 3,290′, Twin Falls, County.—Recovered from this quarry were a left jaw with M_1-M_3; a right jaw with M_1-M_2, and 4 isolated teeth, including one M^2 of *Ophiomys taylori.* The right M_1 has a prism fold and an enamel pit (Fig. 1J). The occlusal length is 2.6 mm. and the width is 1.2 mm. The left M_1 is broken. The M^2 is two rooted. *Cosomys* is not known from this locality.

Locality: USGS Cenozoic Locality 19216 (DWT 431) elevation 3,295′, Twin Falls, County—Nineteen left and 17 right lower jaws containing M_1 or more teeth, 13 left and 9 right isolated M_1s, a left maxillary with M^1-M^3 (UMMP V55072, Fig. 1B), and 3 left and 2 right isolated M^2s, as well as addititional isolated teeth were recovered from this locality. No *Cosomys* were present.

In the above collection there is one right M_1 from an immature individual with an enamel pit and ridge. There are 7 left and 9 right M_1s of young adults. Two of these teeth possess an enamel pit and prism fold, one an enamel pit and ridge, 8 only an enamel pit and one with only a prism fold.

Nineteen left and 13 right M_1s represent teeth of adult individuals. Six of these teeth have both an enamel pit and an enamel ridge, 9 have only an enamel pit (Fig. 1C). A young adult M_1, UMMP V55311, shows the pit in the process of formation (Fig. 1E). Five M_1s possess only prism folds (Fig. 1F) and one has only an enamel ridge (Fig. 1L). The above characters were not observed on the remaining adults and old adult teeth.

Fourteen of the above M_1s have a posterior loop, four alternating triangles and an anterior loop. None of these teeth possess the prism fold. Twenty-four of the M_1s have a trilobed pattern.

The occlusal length of M_1-M_3 in four jaws range from 5.7 to 5.8 mm., average 5.76 mm. The length of M_1-M_2 in 26 jaws range from 3.75 to 4.5 mm., average of 4.1 mm. The length of 27 M_1s range from 2.3 to 2.8 mm., average of 2.6 mm.

Four of the M^2s were 3 rooted. The other was two rooted.

Localities: USGS Cenozoic Localities 19128 (DWT 406) and 19129 (DWT 407) elevation 2,600′ to 2,690′, Owyhee County, Idaho.—Taken at the site of the Sand Point local fauna (Hibbard, 1959, p. 5) were two left and two right jaws with M_1-M_2 or M_1, 9 left and 6 right isolated M_1s and 3 isolated M^2s of *Ophiomys taylori*. No *Cosomys* were present.

Three of the M_1s have only an enamel pit. Prism folds are present on 3 of the teeth which lack enamel pits (Fig. 1F). One of these is a young adult and the other two are adults. Eight of the M_1s, which include the four specimens figured by Hibbard (1959, Figs. 4A–D), have the enamel ridge, 4 of these also possess enamel pits. Figure 1L is of the holotype of *Pliophenacomys idahoensis*.

Eleven of the teeth possess 4 alternating triangles, one has 5. Nine of the M_1s are considered to be trilobed, (Fig. 1G).

The occlusal length of M_1-M_2 in the two jaws are 4.2 and 4.5 mm. The occlusal length of the 8 right and 9 left M_1s range from 2.4 to 2.7 mm., average of 2.5 mm. One of the M^2s is 3 rooted, one is immature and the other is broken.

Locality: USGS Cenozoic Locality 20475 (DWT T57–50). elevation 2,730′, Elmore County, Idaho.—Two associated lower jaws (UMMP V55203) of an adult *Ophiomys taylori* were found at the type locality of *Prodipodomys idahoensis* Hibbard in the summer of 1965 by Philip R. Bjork. Both of the M_1s have 5 triangles (Fig. 1P–Q). There is no enamel pit or prism fold. The occlusal length of the right M_1-M_3 is 5.7 mm., that of the left M_1-M_3 is 5.75 mm. Only one other specimen was recovered from the Glenns Ferry Formation in the Hagerman area with an M_1 pattern like this. This pattern occurred in a left jaw with M_1-M_2 (Fig. 1K) from Locality UM-Ida. 1a–65.

Discussion.—The palate (Figs. 2B–C) of *Ophiomys taylori* is similar to *Cosomys primus* in the development of the lateral palatal grooves. The anterior portion of the grooves is vertical with respect to the maxillary walls, as in *Ogmodontomys sawrockensis* but not so deep. In *O. sawrockensis* however, this vertical character continues posteriorly through the entire palate; while in *Ophiomys taylori* and *Cosomys primus* the maxillary walls which form the border of these grooves begin to slope outward and upward toward the alveolar plane from a position near the posterior palatine foramina. This feature is characteristic of *Ogmodontomys poaphagus*. A similar condition of the grooves is found in *Pliophenacomys primaevus,* but they are shallower than in *Ophiomys*.

The incisive foramina appear to be slightly more anterior in *Ogmodontomys* and *Pliophenacomys* than in *Ophiomys*. In *Cosomys* the position of the foramina varies, some being more anterior and others slightly more posterior than in *Ophiomys*.

The variations in the position of the incisive foramina in *Cosomys* are due to the difference in age. The posterior limit becoming more anteriorly situated with age, a feature found to occur in some species of Recent microtines (Quay, 1954).

The position of the posterior palatine foramina is slightly more posterior in *Ophiomys*. The anterior edge of the palatine bone reaches a position at a line drawn between the mid points of the anterior roots of the M^2. In the other genera the palatine reaches at least to the posterior root of the M^1. *Ophiomys* is smaller than any of the other genera in which the palates were compared.

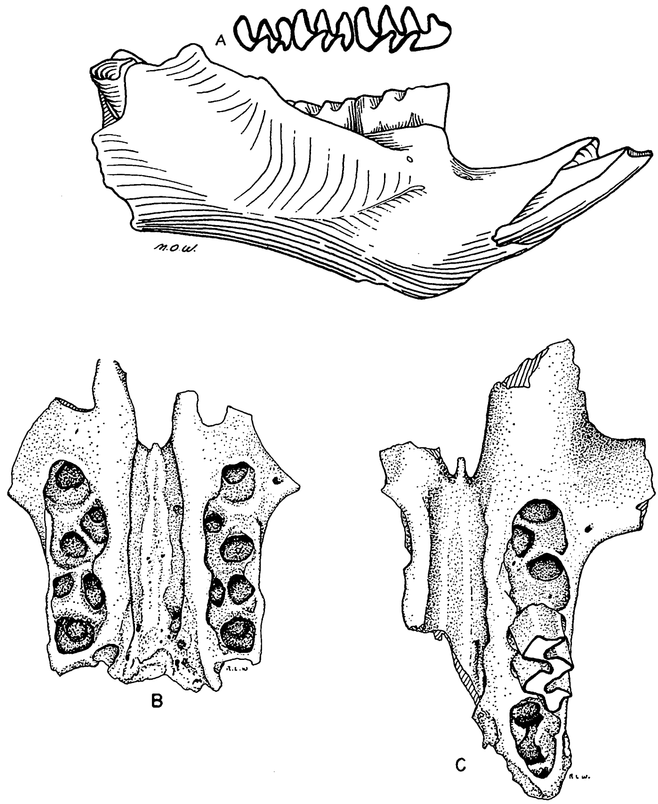

FIG. 2. *Ophiomys taylori:* A, USNM 21832, holotype, right jaw, M_1 –M_3, labial and occlusal views, × 5. B, UMMP V55306, maxillary with alveoli for left M^1 –M^2 and right M^1 -M^2; C, UMMP V53569, maxillary with left M^2 and alveoli for left M^1 and M^3.
Occlusal views, × 6.

The M^1 of *Ophiomys taylori* is 3 rooted; the median or lingual root is not as well developed for the size of the tooth as is the lingual root of *Cosomys* or *Ogmodontomys*. However, the lingual root is better developed in the species *Ophiomys taylori* than in the other species of the genus. The root is not as thin as the lingual root in *O. parvus* nor is there any evidence of fusion of the lingual and anterior root as seen in a few specimens of *O. meadensis* from the Dixon local fauna.

The M^2 can be either 3 or 2 rooted. In the 15 known M^2s, 3 or 20 per cent were 2 rooted. A sample of similar size with other members of the genus gives about 72 per cent for *Ophiomys meadensis* and 95 per cent for *O. parvus*. The M^3 is 2 rooted.

The capsular process for the reception of the incisor is poorly developed, however, the process becomes more robust with age. In specimens of equivalent age, the capsular process is better developed in *Ophiomys taylori* than in *Pliopotamys minor* (Wilson), but not as well developed as in *Cosomys primus* Wilson. The base of the incisor is dorsal to the dental foramen.

The M_1 of *Ophiomys taylori* is highly variable in its occlusal pattern. The M_1 varies from 3 to 5 triangles. The enamel pit is present on 60 per cent of the specimens. The prism fold is found on 16 per cent of the specimens. An intermediate stage in the loss of the prism fold is shown by the presence of an enamel ridge on 17 per cent of the specimens in the position where the fold would normally form.

With the loss of the prism fold and if the apex of the third lingual re-entrant angle trends toward a meeting with the third labial re-entrant angle, a fourth triangle becomes isolated. Also present is a fourth lingual re-entrant angle, which varies in depth. If the fourth lingual and third labial re-entrant angles are shallow they are lost with wear and the anterior loop takes on a rounded appearance. If these two re-entrant angles incise deeply, a pattern of five triangles will appear.

Through time there is a reduction in the occurrence of the enamel pit on M_1 and an increase in the percentage of forms with four triangles. This is observed in the sample from the Sand Point local fauna where 39 per cent of the population had the enamel pit and 61 per cent of the specimens had 4 triangles. At Locality DWT 431 and Locality UM-Ida. 1a–65, the enamel pit was found in 60 per cent of the M_1s, while 29 per cent of the M_1s from Locality DWT 431 and 41 per cent from Locality UM-Ida. 1a–65 had 4 triangles. Locality UM-Ida. 1a–65 may be slightly younger than Locality DWT 431 because of the higher percentage of the M_1s possessing 4 triangles. *Cosomys* is rare at Locality UM-Ida. 1a–65 and absent at Locality DWT 431. The presence of *Cosomys* at Locality UM-Ida. 1a–65 may be an ecologic factor rather than one of time.

Additional material is needed from the Sand Point local fauna to determine the exact relationship of the population of *Ophiomys taylori* which existed there. There does not seem to be any change in the occlusal length or hypsodonty within the specimens between the Hagerman localities and those found at Sand Point. However, the Sand Point population appears transitional to *O. parvus,* because of the high percentage of forms with 4 triangles. More specimens may show that this population warrants the subspecific rank of *O. taylori idahoensis*. The variations in the M_1 of *O. taylori* and *O. parvus* are summarized in Table I.

A pair of associated jaws is known from the locality in Elmore County. They have 5 triangles. Whether 5 triangles are a rare or dominant condition in this population will only be known when more specimens are recovered.

TABLE I

SUMMARY OF VARIATION IN M_1s OF *Ophiomys taylori* and *O. parvus*

Character	Hagerman Locality DWT 431 N*	%	Hagerman Locality UM–Ida. la–65 N*	%	Sand Point Localities DWT 406–407 N*	%	Grand View Localities ALL N*	%
Number of M_1s	47*	—	35*	—	18	—	102	—
Three triangles	33	70.2	20	57.2	6	33.3	0	—
Four triangles	14	29.8	14	40	11	61.2	1	0.9
Five triangles	0	—	1	2.8	1	5.5	101	99.1
Enamel pits	30	64	21	60	7	39	0	—
Prism folds	8	17	4	11.4	3	16.7	0	—
Enamel ridges	9	19	5	14.2	7	39	0	—
Three lobed	24	51	10	28.6	9	50	0	—

* Total does not include all specimens of old age. N = number of M_1s.

THE RELATIONSHIP OF SOME NORTH AMERICAN MICROTINES

Since the ancestry of the microtines is unknown it is impossible to state whether they had their origin in North America or in Eurasia. It is far more logical to assume that once the generalized stocks reached both continents, adaptive radiation and evolution proceeded in both regions. There is no evidence for the assumption that every time a new form is discovered, there has been a new invasion from some other continent, unless it is supported by unquestionable fossil evidence.

There has been considerable evolution of thought since the first discovery of fossil microtines with rooted teeth. The first were assigned to the living genera *Phenacomys* and *Evotomys* (= *Clethrionomys*), until Nehring (1898) named the genus *Dolomys*. Forsyth Major (1902) named the genus *Mimomys* for all of those voles with rooted molars which are distinct from *Evotomys*, *Phenacomys* and *Dolomys*. This assignment of voles with rooted teeth to the genus *Mimomys* has dominated the thinking of many students of fossil microtines.

There are definite trends in microtine evolution (Hibbard, 1964). These trends, or some of them, are observed in many lines of microtines which produced parallel dental patterns in different lineages. Therefore, a careful study of all microtines is needed to determine their true relationship where the fossil record is known. It should be clearly kept in mind that the recovery of more fossils may destroy some of our cherished ideas of relationships. A more accurate correlation of faunas between Eurasia and North America can be made on the morphological grade of the microtines than upon supposed identical generic status of a species where the history of the group is unknown.

The earliest microtine known from North America that can be considered as an ancestral stock for some lines of later microtines is *Prosomys mimus* Shotwell from the Hemphillian (Middle Pliocene) McKay Reservoir local fauna of Oregon. So far there is no evidence that it gave rise to later forms. The next oldest species is *Ogmodontomys sawrockensis* Hibbard from the late Hemphillian Saw Rock Canyon local fauna of Kansas. It is not known where this stock developed or from what, but it appears that a related species of *O. sawrockensis* gave rise to *Ophiomys*. The ancestral *Ogmodontomys* could have developed in Eurasia, but there is no fossil evidence, or an early form of *Ogmodontomys* which gave rise to the genus *Cseria* could have invaded Eurasia. In all of the fossil microtines from North America, only one adult M^3 has been observed with a deep enamel pit. This tooth is from the Fox Canyon local fauna (Zakrzewski, 1967) and has been considered as a variant of *Ogmodontomys p. transitionalis*. It is one of 75 M^3s. The others did not possess an enamel pit. It appears that the Upper Pliocene microtines had a parallel development in Eurasia and North America.

Ogmodontomys p. transitionalis is considered to have given rise to *Ogmodontomys p. poaphagus* of the Rexroad local fauna which lived on into the later Deer Park local fauna of Kansas and the Sand Draw local fauna of Nebraska. In the upper part of the Rexroad Formation above the Rexroad fauna there has been recovered a tooth of *Ogmodontomys* that shows the development of dentine tracts. It is not known whether this represents a more advanced stock or a variation within a population of *Ogmodontomys p. poaphagus* (Zakrzewski, 1967).

Cosomys is believed to have been derived from *Ogmodontomys*. This stock is thought to have branched off during Fox Canyon time from *O. p. transitionalis* or just prior to it from a form intermediate between *O. sawrockensis* and *O. p. transitionalis*. *Cosomys* is closer to *Ogmodontomys p. transitionalis* in size and closure of the alternating triangles. Although the frequency of enamel pits and constricted re-entrant angles in the M_1 and two rooted M^3s is low in *O. p. transitionalis*, there is no reason why these characters could not become dominant in the *Cosomys* branch. A detailed study of *Cosomys* is now in progress.

The ancestors of *Pliophenacomys, Nebraskomys,* and *Pliopotamys* are unknown. *Pliophenacomys* is advanced over *Ogmodontomys* in that it has five or more distinct alternating triangles on M_1. Furthermore the enamel around the base of the molars is more recessed so that an interrupted enamel pattern occurs earlier in old adults of *Pliophenacomys* than on the occlusal surface of *Ogmodontomys.*

Pliopotamys gave rise to *Ondatra* but faunas of intermediate age have not been found that show the beginning of the development of the interrupted enamel pattern.

SUMMARY

Three species of a small vole as defined on the pattern of M_1 and M^3 are considered to comprise the genus *Ophiomys. O. taylori* is found in the upper 200′ of beds in the Glenns Ferry Formation in the area of the Hagerman Horse Quarry and is a member of the Hagerman local fauna and the Sand Point local fauna of late Pliocene age. *O. parvus* is known from the early Pleistocene Grand View local fauna of Idaho from near the top of the Glenns Ferry Formation. *O. meadensis* is found in the Dixon and Sanders local faunas from Kansas of early Pleistocene age.

Ophiomys taylori is the most variable of the group having from three to five triangles, some prism folds, enamel ridges and enamel pits. A reduction of these characteristics and a trend toward five triangles can be demonstrated in this species through time.

It appears that *Ophiomys parvus* developed from *O. taylori.* When or where *O. meadensis* branched off from the *O. taylori* stock is not known.

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