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Western Chinese Arvicolines (Rodentia) Collected by the Sage Expedition

MARIE A. LAWRENCE[1]

ABSTRACT

The arvicoline rodents collected by the Sage West China Expedition (1934) to Sichuan are reported. The localities and measurements are given for *Eothenomys melanogaster melanogaster* and *Pitymys sikimensis irene*. A new species, *Microtus musseri*, is diagnosed, described, and compared with other members of the genus. The new species is closest morphologically and ecologically to *Microtus millicens* from which it differs in dentition, size, and pelage color.

INTRODUCTION

In the autumn of 1934, Dean and Ann Sage, William Sheldon, and T. Donald Carter collected mammals and birds in western China under the aegis of the American Museum of Natural History. The Sages sought the giant panda and takin, while Carter collected small mammals and birds. Published accounts emphasized the exotic terrain and the search for the panda (Sage, 1935; Carter, 1937; Sheldon, 1937, 1975). Sheldon (1975) provided an informal list of the mammals obtained. The only scientific report of the small mammals from this expedition is Musser and Chiu's note (1979) on *Rattus andersoni* and *Rattus excelsior*. In this paper, I report on the arvicoline rodents collected by the Sage West China Expedition and describe a new species of *Microtus* from western Sichuan.

Definitions and Measurements

The following terms are used in this paper:

Triangles: Those sections of a cheektooth composed of dentine outlined by enamel which are either buccal or lingual to the medial longitudinal axis of the alveolus. These sections are roughly triangular in shape and may be opposite or alternate (fig. 1A, 1B).

Open triangle: A triangle in which the enamel sheath does not meet in the medial longitudinal axis of the tooth and the dentine continues uninterrupted into the adjacent triangle (fig. 1B).

Closed triangle: A triangle in which the dentine section is discrete as the enamel boundaries meet in the median longitudinal axis of the tooth (fig. 1A).

Prism: An enamel enclosed dentine field

[1] Scientific Assistant, Department of Mammalogy, American Museum of Natural History.

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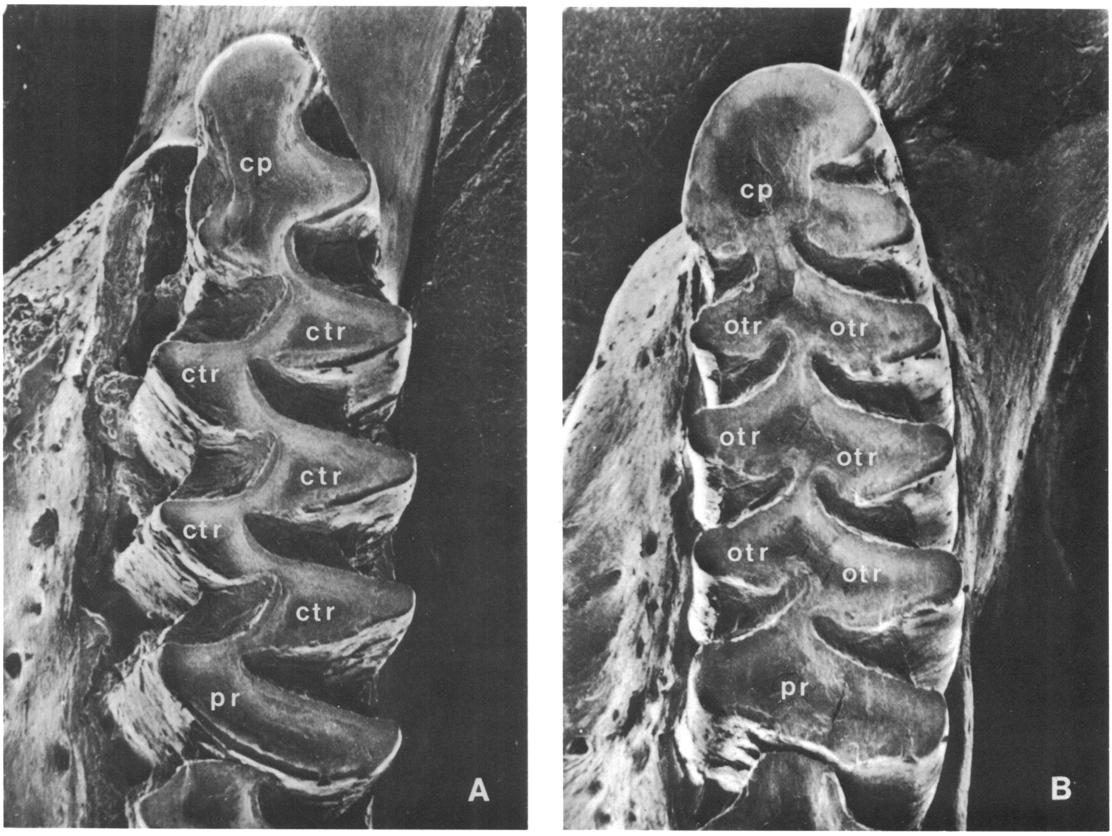

FIG. 1. First dentary teeth illustrating terms used in text. A. *Microtis agrestis* (AMNH 87097). B. *Eothenomys melanogaster* (AMNH 111546).
Abbreviations: cp, cap; ctr, closed triangle; otr, open triangle; pr, prism.

that extends across the median longitudinal axis of the tooth. Prisms may be triangular or crescentic in shape and are often at a slightly oblique angle to the axis of the tooth (figs. 1, 2).

Salient angle: The lateral projections of a triangle (closed or open) or a prism.

Cap: The anterior dentine field of the first lower cheektooth. It may be more or less complex as the descriptive terms that have been used for it suggest: crescent, trefoil, and mushroom (fig. 1A, 1B).

Heel: The posterior dentine field of the last upper cheektooth. The enamel outline is variable in shape. Some forms have been described as J-, C- or Y-shaped (fig. 2A, 2B).

I have avoided the term "loop" because it is applied in the arvicoline literature to structures as discrete as the cap, heel, and open triangle of the present paper. Such usage is imprecise and misleading.

The limits of measurements used are illustrated in figure 3.

Specimens examined are in the collection of the American Museum of Natural History (AMNH).

ACKNOWLEDGMENTS

Many people were helpful in the process of turning this bit of research into a published paper. I thank Ms. M. Danker and Ms. Paula Jenkins of the British Museum for supplying unpublished information about *Microtus millicens,* Messrs. Peter Goldberg and Jim Coxe for photographs, Robert J. Koestler for SEM photographs and Richard Sheryll for

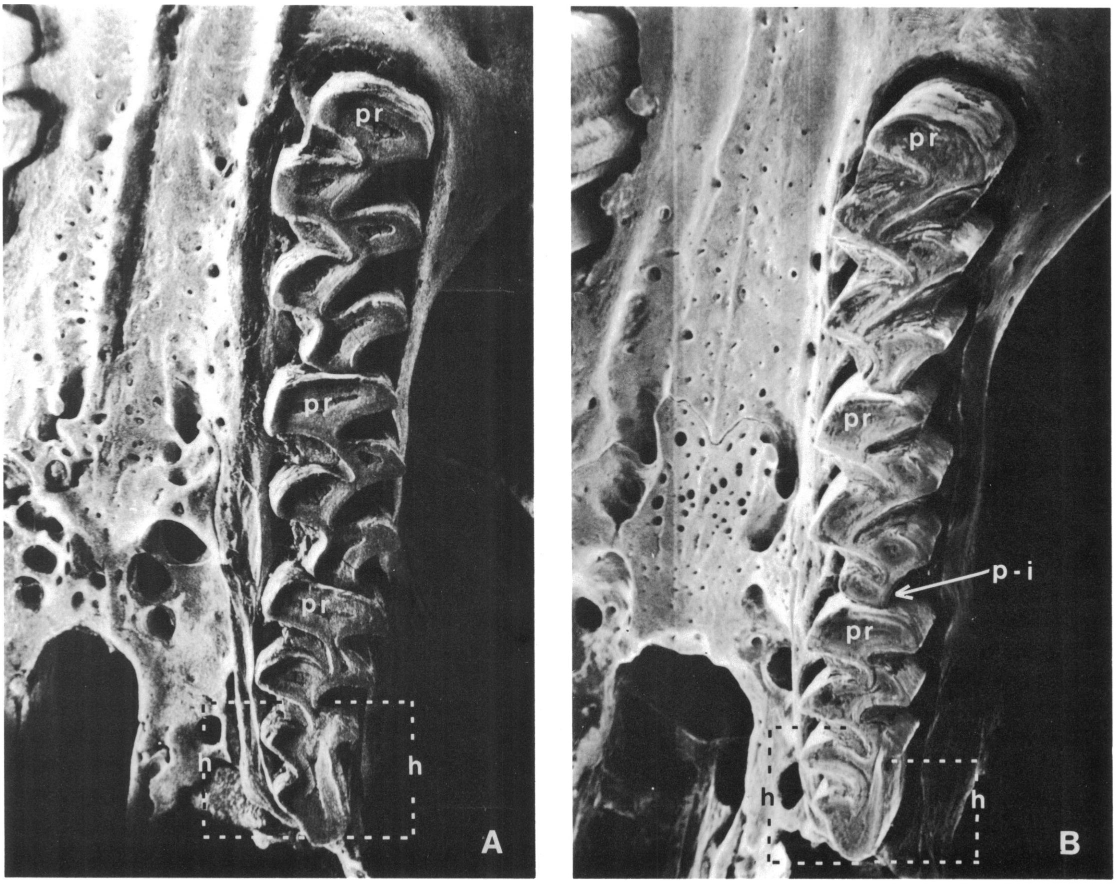

FIG. 2. Maxillary tooth rows illustrating terms used in text. A. *Microtus californicus eximius* (AMNH 124332). B. *Microtus agrestis* (AMNH 87097).
Abbreviations: h, heel; p-i, postero-internal triangle; pr, prism.

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THE VOLES

From September 22 to December 10, 1934, the expedition explored that part of Sichuan bounded on the east by the Min River and on the west by longitude 103°15′. The southern limit was 31°15′ and the northern extent was 31°30′. Collections were made on the east-west trending ridges of the Qionglai shan, from 5000 to 12,000 feet (1525 to 3660 m.). Wilson (1913) divided western China into altitudinal phytogeographic zones: *cool temperature belt*—5000 to 10,000 feet (1525 to 3050 m.); *temperate alpine belt*—10,000 to 11,500 feet (3050 to 3507.5 m.); and *alpine belt*—11,500 to 16,000 feet (3507.5 to 4880 m.). The *cool temperature belt* is characterized by deciduous, flowering trees and shrubs, conifers, and many tall growing herbs. The dominant plant is rhododendron, which becomes abundant above 8000 feet (2440 m.). The *temperate alpine belt* is mostly a moorland of dwarf, small-leaved rhododendrons, scrublike shrubs, and thickets of bamboo. "Where the nature of the

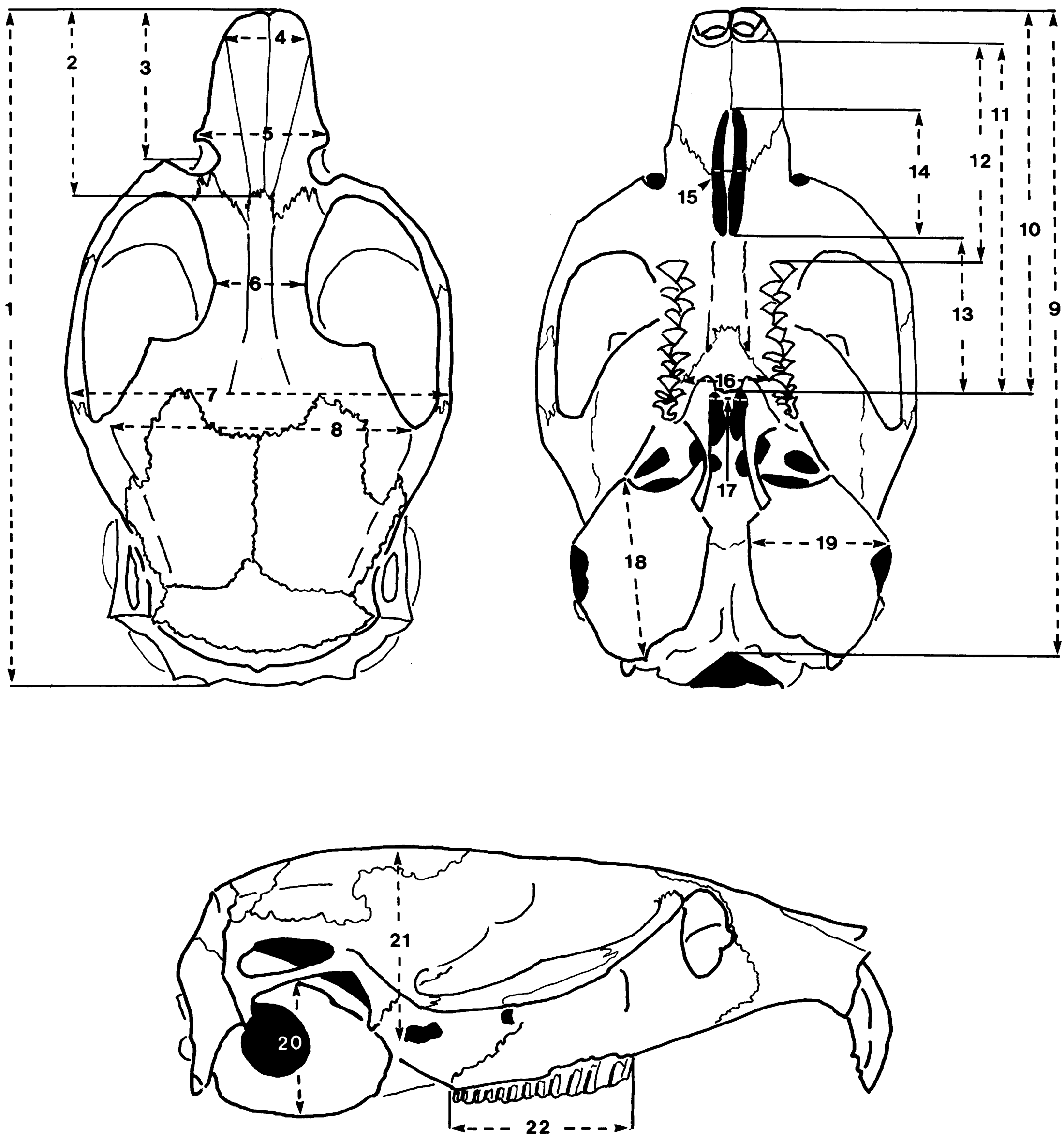

FIG. 3. Views of *Microtus pennsylvanicus* illustrating limits of measurements. 1. Greatest length of skull. 2. Nasal length. 3. Rostrum length. 4. Nasal breadth. 5. Rostrum breadth. 6. Least breadth of anterior frontals ("inter-orbital" breadth). 7. Zygomatic breadth. 8. Braincase breadth. 9. Basilar length. 10. Palatal length. 11. Palatilar length. 12. Diastema length. 13. Palatal bridge length. 14. Incisive foramina length. 15. Incisive foramina breadth. 16. Palatal breadth at M^3. 17. Mesopterygoid fossa breadth. 18. Bulla length. 19. Bulla breadth. 20. Bulla height. 21. Braincase height. 22. Alveolar length M^1–M^3.

country admits, magnificent forests occur of larch, spruce and hemlock" (Wilson, 1913, p. 8). The tree limit varies according to slope and rainfall and may be from 10,500 to 14,500 feet (3202.5 to 4422.5 m.). The *alpine belt* is characterized by a wealth of herbs;

lousewort, ragwort, and gentians are dominant. The Sage expedition collected in these three zones.

Arvicolines were taken at Qionglai shan (Chen Lliang shan of the specimen labels), 30 miles west of Wenquan at 9000 feet (2745 m.) 9500 feet (2897.5 m.), 11,000 feet (3355 m.) and 12,000 feet (3660 m.) in September and October; Mao Mo Gou in November and December at 7600 feet (2318 m.); Caobo, Cheng Gou Creek at 5000 feet (1525 m.) in October; and Cheng Wei, Cheng Gou Creek from 7000 to 10,000 feet (2135 to 3050 m.) in October, November, and December.

Three species of voles were taken: Two short-tailed forms, *Eothenomys melanogaster melanogaster* and *Pitymys sikimensis irene,* and a long-tailed form described in this paper. *Eothenomys melanogaster* was collected from 5000 to 10,000 feet (1525 to 3050 m.). The long-tailed vole was found from 7600 to 12,000 feet (2318 to 3660 m.) and *Pitymys sikimensis irene* from 9500 to 12,000 feet (2897.5 to 3660 m.).

Eothenomys melanogaster melanogaster,
Milne-Edwards, 1872

REFERRED SPECIMENS: Caobo, Cheng Gou Creek at 5000 feet (1525 m.): AMNH 111542–111544, 111546, 111547.

Cheng Wei, Cheng Gou Creek from 7000 to 10,000 feet (2135 to 3050 m.): AMNH 111545, 111548–111552, 111554–111562, 111567–111568.

All *Eothenomys* were collected in Wilson's *cool temperature belt* where rhododendron is dominant and deciduous trees and shrubs, conifers, and tall-growing herbs are present.

The animals have a velvety black-brown dorsal and gray ventral pelage. In body size, skull conformation, and skull characters, as well as occlusal pattern (figs. 4, 5), they conform to the descriptions of the species by Milne-Edwards (1871) and Allen (1940). Measurements (table 1) are within the range of variation for the species.

Pitymys sikimensis irene
(Hodgson, 1849)

REFERRED SPECIMENS: Qionglai shan, 30 miles (48.2 km.) west of Wenquan, 9500 feet (2897.5 m.): AMNH 111414, 111415, 111417–111425, 111429–111439, 111446–111450, 111467–111469, 111471, 111477–111479, 111486–111490, 111492, 111499, 111501–111505, 111507.

Qionglai shan, 30 miles (48.2 km.) west of Wenquan, 10,000 feet (3050 m.): AMNH 111440, 111537.

Qionglai shan, 30 miles (48.2 km.) west of Wenquan, 11,000 feet (3355 m.): AMNH 111411–111443, 111453–111460, 111538, 111867.

Qionglai shan, 30 miles (48.2 km.) west of Wenquan, 12,000 feet (3660 m.): AMNH 111462, 111470, 111472–111474, 111476, 111480–111485, 111494–111496, 111498.

These sites extend from Wilson's *cool temperature belt* into the "alpine belt." The vegetation described by Wilson is moorland with dwarf, small-leaved rhododendron, scrublike shrubs and thickets of bamboo, with occasional stands of larch, spruce, and hemlock. Sheldon (1975) described alpine Qionglai shan as "grassy meadows on steep slopes, cliffs with an infinite variety of herbs."

T. Donald Carter, who collected the voles, noted in his field catalog on October 1, 1934, 30 miles (48.2 km.) west of Wenquan, Qionglai shan, that "there are evidently two different forms of vole being found at the higher altitudes. The trap lines descend for about 1000 feet from camp and both forms are taken along that line." Another note, October 5–6, 1934, 30 miles (48.2 km.) west of Wenquan, Qionglai shan, adds, "The short-tailed vole is evidently a much more grass-living vole than the long-tailed, as practically all taken from the timber line to the basins at the mountain top—about 13,000 feet—are taken at the entrances of burrows and runways in the grass." The short-tailed vole collected at this locality is referred to *Pitymys sikimensis irene* on the basis of enamel pattern of cheekteeth, body size, color, and texture of pelage. All of these characters are within the limits of the species given by Gruber (1969) and Allen (1940). Measurements are listed in table 2.

On October 5–6, 1934, 30 miles (48.2 km.) west of Wenquan, Qionglai shan, Carter noted further that "The long-tailed vole is taken about the rocks and cliffs." That vole is described below.

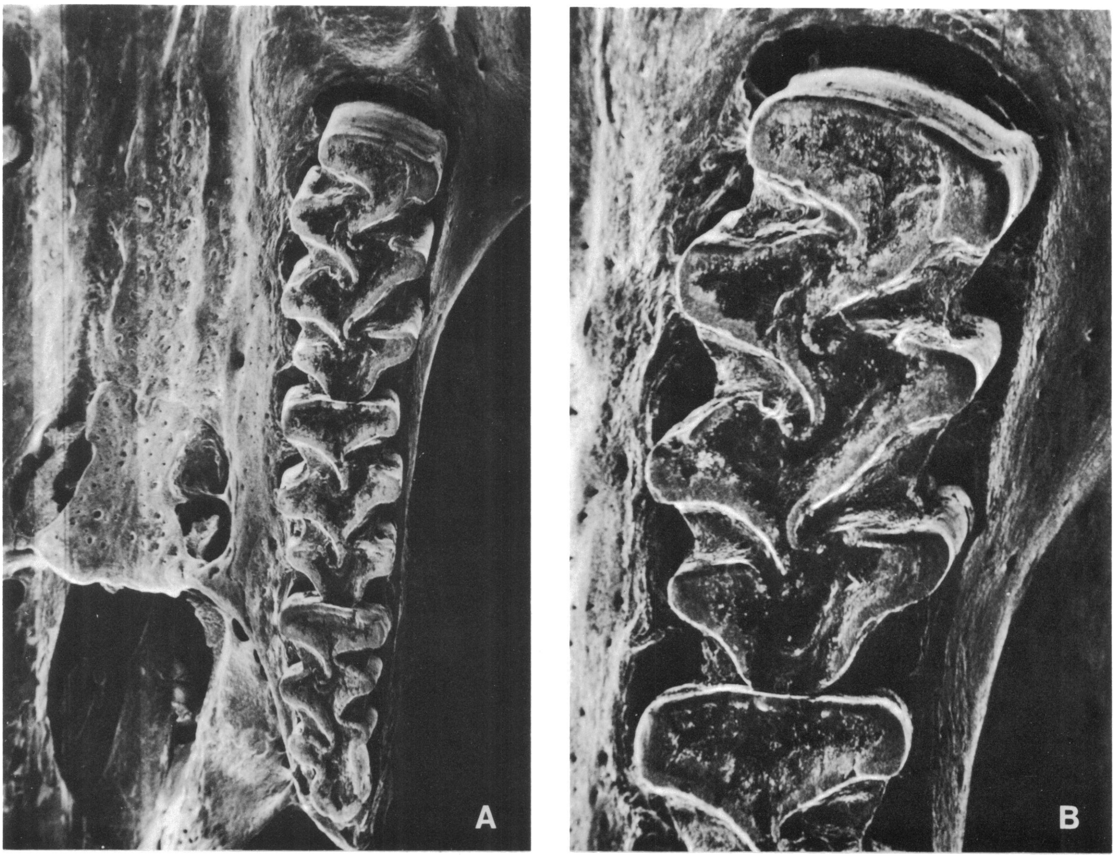

FIG. 4. Occlusal views of maxillary teeth of *Eothenomys melanogaster melanogaster* (AMNH 111546). A. Left maxillary tooth row (length M^1–M^3 = 5.7 mm.) and posterior palate. B. First maxillary tooth (length, 2.2 mm.).

Microtus musseri, new species

HOLOTYPE: Skin, cranium, and dentaries of an adult male, AMNH 111533. The left bulla and left parietal bone are slightly damaged. T. Donald Carter collector (original field number C-784) October 3, 1934 at 9000 feet [2745 m.]), Qionglai shan, 30 miles (48.2 km.) west of Wenquan, Sichuan, The Peoples Republic of China. (The label transliterates the locality as "Chen Lliang Shan range, 30 miles west of Wenchuan.")

REFERRED SPECIMENS: Qionglai shan ("Chen Lliang Shan range"), 30 miles (48.2 km.) west of Wenquan, 9000 feet (2745 m.): AMNH 111523.

Qionglai shan, 30 miles (48.2 km.) west of Wenquan, 9500 feet (2897.5 m.): AMNH 111508, 111509, 111511, 111512, 111514, 111515, 111517–111519, 111527–111529, 111531, 111532, 111569, 111570, 111573, 111575–111578, 111580–111584, 111587.

Qionglai shan, 30 miles (48.2 km.) west of Wenquan, 10,000 feet (3050 m): AMNH 111522, 111524, 111536.

Qionglai shan, 30 miles (48.2 km.) west of Wenquan, 11,000 feet (3355 m.): AMNH 111530, 111539, 111540.

Qionglai shan, 30 miles (48.2 km.) west of Wenquan, 12,000 feet (3660 m.): AMNH 111586.

Cheng Gou Forks, 30 miles (48.2 km.) west of Wenquan, 7600 feet (2318 m.): AMNH 111588, 111589.

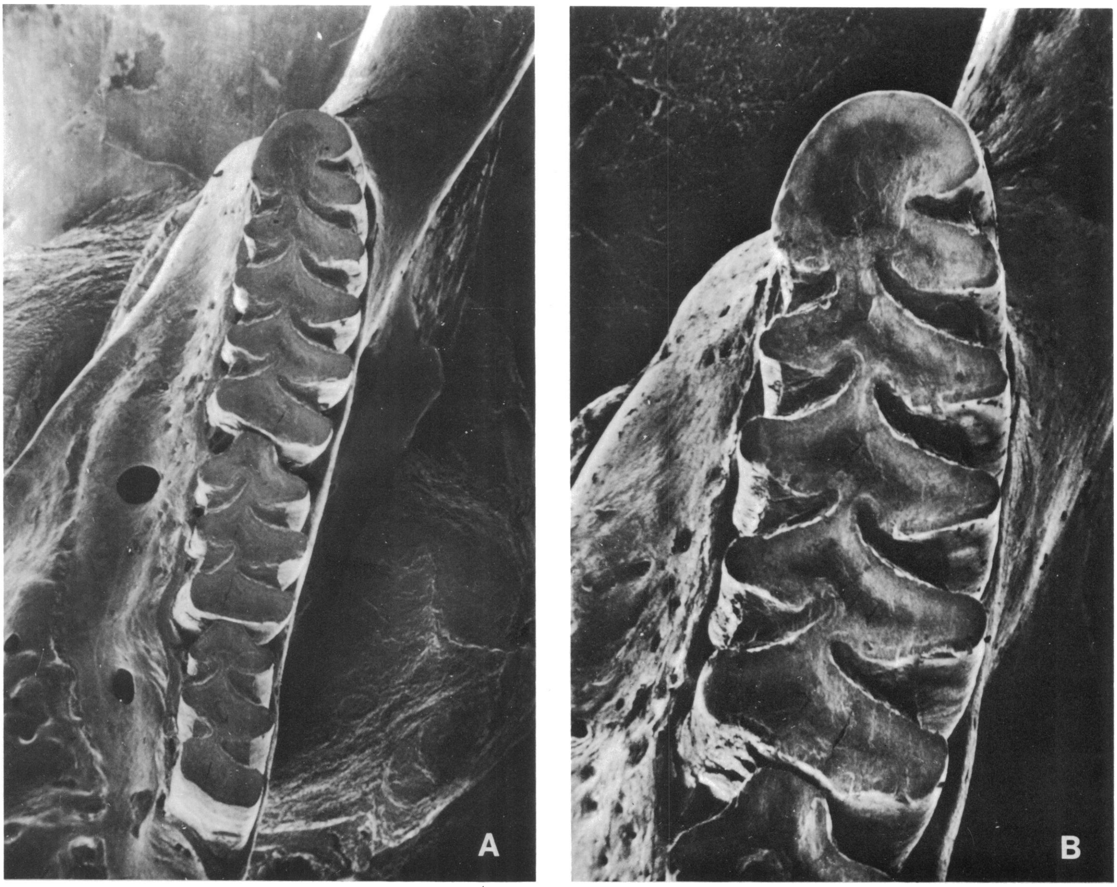

FIG. 5. Occlusal views of lower cheekteeth of *Eothenomys melanogaster melanogaster* (AMNH 111546). A. Left lower tooth row (length M_1–M_3 = 5.7 mm.). B. First lower cheektooth (length, 2.6 mm.).

Cheng Wei, Cheng Gou Creek, 25 miles (40.2 km.) west of Wenquan, 7000 feet to 10,000 feet (2135 to 3050 m.): AMNH 111590–111592.

Mao Mo Gou, 30 miles (48.2 km.) west of Wenquan, 8600 feet (2623 m.): AMNH 111593–111597.

Specimens 111518, 111587, 111588, 111591, and 111593 are skins only.

DISTRIBUTION: All the localities are in the Qionglai shan, western Sichuan, Peoples Republic of China from altitude 7000 feet (2135 m.) to 12,000 feet (3660 m.).

ETYMOLOGY: This vole is named for Dr. Guy G. Musser, Archbold Curator in the Department of Mammalogy, American Museum of Natural History, in recognition of his work on Asian Muridae and in appreciation of the encouragement he has given me to study rodents.

DIAGNOSIS: *Microtus musseri* is a medium-sized vole, dark brown above and pale buff below, that is distinguished from all other *Microtus* (as used by Corbett and Hill, 1980, excluding *Pitymys*), by the following combination of characters: tail 60 percent length of head and body; skull unridged in adults, its profile flattened dorsally and with inflated bullae extending below the occusal plane of the cheektooth; first two upper cheekteeth each have a large postero-internal open triangle; first lower cheektooth with four closed

TABLE 1
Measurements (in Millimeters) of Skins, Skulls, and Teeth in Samples of *Eothanomys melanogaster melanogaster* from Qionglai shan, Western Sichuan
(The mean plus or minus one standard deviation, observed range in parentheses, and number of specimens listed.)

Measurement	Males Adults[a]	Females Adults[b]	Juveniles[c]
Length of head and body	98.8 ± 6.7 (88–108) 8	100.8 ± 8.4 (90–109) 6	93.1 ± 3.8 (89–97) 7
Length of tail	35.0 ± 1.8 (33–38) 8	34.5 ± 1.5 (33–37) 6	32.8 ± 1.7 (31–36) 7
Length of hind foot	15.8 ± 1.3 (14–17) 8	17.3 ± .8 (17–19) 6	16.2 ± .4 (16–17) 7
Greatest length of skull	23.6 ± 1.0 (22.5–25.9) 7	24.1 ± .4 (23.5–24.5) 4	22.5 ± .5 (22.0–23.5) 5
Basilar length	21.1 ± 1.1 (19.9–22.4) 7	21.1 ± .5 (20.3–21.7) 4	20.1 ± .9 (18.9–20.6) 4
Zygomatic breadth	14.0 ± .6 (13.6–14.4) 7	14.0 ± .4 (13.6–14.4) 3	13.5 ± .1 (13.4–13.7) 3
Interorbital breadth	4.2 ± .1 (4.0–4.5) 7	4.3 ± .1 (4.1–4.5) 4	4.2 ± .1 (4.0–4.5) 6
Length of rostrum	5.1 ± .3 (4.5–5.5) 7	5.6 ± .3 (5.2–6.0) 4	4.8 ± .2 (4.3–5.2) 7
Breadth of rostrum	4.9 ± .1 (4.7–5.2) 7	4.9 ± .1 (4.7–5.1) 4	4.6 ± .2 (4.3–4.9) 7
Length of nasals	6.0 ± .3 (5.6–6.7) 7	6.5 ± .2 (6.2–6.9) 4	5.8 ± .1 (5.6–6.2) 7
Breadth of nasals	2.7 ± .2 (2.5–3.1) 7	2.9 ± .1 (2.7–3.0) 4	2.6 ± .0 (2.6–2.7) 7
Height of braincase	6.6 ± .5 (5.9–7.6) 7	6.1 ± .3 (5.8–6.5) 4	6.0 ± .3 (5.6–6.6) 6
Breadth of braincase	11.0 ± .3 (10.6–11.5) 7	11.1 ± .2 (10.9–11.4) 4	10.5 ± .1 (10.3–10.7) 6
Length of diastema	6.5 ± .4 (6.1–7.4) 7	6.6 ± .2 (6.3–6.9) 4	6.2 ± .2 (5.9–6.6) 7
Palatilar length	11.3 ± .4 (10.9–12.0) 7	11.3 ± .3 (10.9–11.8) 4	10.6 ± .2 (10.3–11.0) 7
Palatal length	12.7 ± .3 (12.3–13.5) 7	12.6 ± .2 (12.4–12.9) 4	12.0 ± .3 (11.6–12.6) 7
Length of incisive foramina	3.8 ± .2 (3.6–4.2) 7	3.9 ± .2 (3.8–4.2) 4	3.5 ± .1 (3.3–3.8) 7
Length of palatal bridge	5.2 ± .1 (5.1–5.5) 7	5.2 ± .2 (5.0–5.5) 4	5.0 ± .2 (4.7–5.4) 7
Breadth of palatal bridge at M^3	3.0 ± .2 (2.8–3.4) 6	3.0 ± .1 (2.9–3.3) 4	2.8 ± .1 (2.6–3.0) 7
Breadth of mesopterygoid fossa	1.2 ± .0 (1.2–1.4) 7	1.2 ± .0 (1.1–1.3) 4	1.1 ± .0 (1.1–1.2) 5
Length of bulla	5.5 ± .2 (5.1–6.0) 7	4.1 ± .3 (3.8–4.5) 4	5.1 ± .2 (4.8–5.3) 5
Breadth of bulla	4.2 ± .3 (3.8–4.9) 7	4.1 ± .3 (3.8–4.5) 4	3.9 ± .1 (3.8–4.2) 5
Height of bulla	3.9 ± .4 (3.4–4.6) 6	4.4 ± .1 (4.2–4.6) 4	3.5 ± .2 (3.1–3.7) 5
Alveolar length of M^{1-3}	5.7 ± .1 (5.6–6.0) 7	5.8 ± .2 (5.5–6.1) 4	5.5 ± .1 (5.3–5.8) 7

[a] AMNH 111542, 111546, 111548, 111551, 111558–111560, 111567.
[b] AMNH 111543–111545, 111547, 111556, 111562.
[c] AMNH 111549–111550, 111552, 111554–111555, 111561, 111568.

triangles in front of the posterior prism, fifth and sixth triangles confluent with anterior cap; second lower cheektooth with posterior prism, a pair of closed triangles and an anterior pair of open triangles; mammae eight; plantar pads five or six.

DESCRIPTION: *Microtus musseri* is a medium-sized vole (table 3) with a tail 60 percent the length of head and body. The ears are rounded and just visible above the soft, deep fur. The fur is dark brown, Van Dyke 221 (Smithe, 1981); dorsal hair is 12 mm. long, dark slate at the base with black and ochraceous tips. The chin, throat, and venter are slate, washed with pale buff, and appear silvery in some lights. The color of the dorsum and venter shade into each other without a clear line of demarcation. The tail is bicolored in adults, sparse white hairs below and dark brown above. Two of the 42 skins have tails with white tips. Juveniles have dark brown tails. The feet are sparsely covered with white hairs and appear buffy. The vibrissae are fine and more than 20 mm. long.

Viewed dorsally, adult skulls have a smooth, rounded braincase without temporal, frontal, or nuchal ridges. The anterior constriction of the frontals ("interorbital region") is relatively broad. The braincase is longer than the combined length of the frontal constriction and the rostrum. Weak postorbital tubercules give the cranium the appearance of a shouldered flask. In profile, the skull appears flat, as the rostrum is minimally

TABLE 2

Measurements (in Millimeters) of Skins, Skulls, and Teeth in Samples of *Pitymys sikimensis irene* from Qionglai shan, Western Sichuan

(The mean plus or minus one standard deviation, observed range in parentheses, and number of specimens listed.)

Measurement	Males	Females	Males	Females
	Adults[a]	Adults[b]	Juveniles[c]	Juveniles[d]
Length of head and body	91.3 ± 7.5 (81–108) 22	89.2 ± 6.4 (80–103) 31	73.4 ± 5.8 (65–86) 11	72.9 ± 7.0 (60–89) 12
Length of tail	28.4 ± 3.1 (23–36) 21	25.9 ± 2.4 (22–29) 31	25.8 ± 2.6 (22–30) 11	23.5 ± 3.7 (17–29) 12
Length of hind foot	16.8 ± .8 (16–19) 22	16.5 ± .5 (15–17) 31	16.1 ± .7 (15–17) 11	15.9 ± .7 (15–17) 13
Greatest length of skull	20.8 ± .6 (19.6–21.5) 13	20.6 ± .4 (19.9–21.5) 14	20.2 ± .8 (19.3–20.2) 4	20.0 ± .6 (19.3–21.0) 7
Basilar length	19.1 ± .9 (17.9–20.3) 13	18.7 ± .5 (17.7–19.7) 16	17.7 ± .9 (16.3–18.9) 7	17.2 ± .9 (15.6–18.3) 9
Zygomatic breadth	12.6 ± .5 (12.0–13.4) 5	12.5 ± .4 (11.8–12.9) 6	—	11.9 ± .3 (11.6–12.2) 3
Interorbital breadth	3.3 ± .1 (3.0–3.8) 18	3.3 ± .1 (3.0–3.6) 24	3.3 ± .1 (3.1–3.6) 8	3.3 ± .1 (3.1–3.6) 11
Length of rostrum	4.9 ± .3 (4.4–5.3) 19	4.7 ± .3 (4.1–5.4) 26	4.6 ± .2 (4.3–5.0) 7	4.5 ± .3 (3.9–5.1) 9
Breadth of rostrum	4.1 ± .2 (3.8–4.7) 19	4.1 ± .1 (3.9–4.6) 26	3.9 ± .1 (3.8–4.3) 9	3.9 ± .2 (3.6–4.2) 10
Length of nasals	6.1 ± .3 (5.6–6.8) 19	6.0 ± .3 (5.2–6.7) 26	5.6 ± .4 (5.2–6.5) 8	5.5 ± .3 (4.8–5.9) 9
Breadth of nasals	2.5 ± .1 (2.2–2.7) 19	2.4 ± .1 (2.2–2.7) 26	2.3 ± .1 (2.2–2.6) 6	2.3 ± .1 (2.0–2.6) 9
Height of braincase	5.9 ± .4 (5.4–6.7) 10	6.0 ± .2 (5.5–6.3) 11	5.6 ± .2 (5.3–5.8) 4	5.7 ± .1 (5.5–5.8) 4
Breadth of braincase	10.4 ± .2 (10.0–10.9) 17	10.3 ± .2 (9.9–10.7) 19	10.2 ± .2 (9.9–10.6) 6	9.9 ± 1.1 (9.7–10.8) 10
Length of diastema	6.3 ± .3 (5.7–6.9) 18	6.2 ± .2 (5.7–6.6) 26	5.9 ± .5 (5.1–6.7) 9	5.7 ± .3 (5.3–6.2) 10
Palatilar length	11.2 ± .4 (10.8–12.1) 19	11.1 ± .3 (10.5–11.8) 26	10.6 ± .6 (9.8–11.6) 8	10.4 ± .5 (9.6–11.1) 10
Palatal length	12.5 ± .4 (11.6–13.5) 19	12.4 ± .4 (11.6–13.0) 26	11.7 ± .8 (10.2–12.8) 8	11.7 ± .6 (10.8–12.7) 10
Length of incisive foramina	3.8 ± .2 (3.3–4.2) 19	3.8 ± .2 (3.2–4.1) 26	3.6 ± .3 (3.2–4.1) 9	3.4 ± .2 (3.1–3.9) 10
Breadth of incisive foramina	1.1 ± .0 (1.0–1.3) 18	1.1 ± .1 (0.9–1.3) 26	1.0 ± .1 (0.9–1.2) 8	1.0 ± .9 (0.9–1.2) 10
Length of palatal bridge	5.3 ± .3 (4.7–6.0) 20	5.3 ± .2 (4.9–5.7) 27	5.0 ± .3 (4.5–5.7) 10	5.0 ± .3 (4.6–5.6) 10
Breadth of palatal bridge at M^3	2.4 ± .2 (2.2–2.9) 20	2.4 ± .1 (2.1–2.9) 27	2.4 ± .2 (2.1–2.9) 11	2.3 ± .1 (2.1–2.6) 11
Breadth of mesopterygoid fossa	1.0 ± .1 (0.7–1.2) 17	1.0 ± .1 (0.8–1.3) 18	1.0 ± .1 (0.8–1.1) 7	1.0 ± .0 (0.9–1.1) 7
Length of bulla	4.9 ± .2 (4.4–5.4) 17	4.8 ± .3 (4.4–5.5) 16	4.6 ± .4 (4.0–5.1) 8	4.4 ± .3 (3.9–4.9) 8
Breadth of bulla	3.9 ± .4 (3.5–4.7) 17	3.9 ± .4 (3.4–4.7) 16	3.7 ± .4 (3.3–4.5) 8	3.5 ± .4 (3.0–4.5) 8
Height of bulla	4.1 ± .4 (3.4–5.1) 12	3.8 ± .4 (3.2–4.8) 15	4.0 ± .1 (3.7–4.3) 7	3.8 ± .2 (3.5–4.1) 7
Alveolar length of M^{1-3}	5.0 ± .2 (4.8–5.4) 20	5.0 ± .3 (4.7–5.9) 26	4.7 ± .3 (4.1–5.3) 10	4.7 ± .1 (4.5–5.0) 10

[a] AMNH 111414, 111417, 111420, 111422–111423, 111432, 111435, 111439, 111453, 111460, 111468, 111476, 111481, 111487, 111492, 111495–111496, 111501, 111503, 111505, 111537, 111867.

[b] AMNH 111415, 111418–111419, 111425, 111429–111430, 111434, 111437–111438, 111440–111443, 111447–111448, 111454, 111459, 111462, 111467, 111470, 111472, 111477, 111482–111484, 111486, 111488, 111494, 111498–111499, 111538.

[c] AMNH 111421, 111431, 111433, 111456–111457, 111469, 111471, 111473–111474, 111502, 111504.

[d] AMNH 111424, 111436, 111446, 111449–111450, 111455, 111458, 111461, 111478–111480, 111485, 111507.

TABLE 3

Measurements (in Millimeters) of Skins, Skulls, and Teeth in Samples of *Microtus musseri* from Qionglai shan, Western Sichuan

(The mean plus or minus one standard deviation, observed range in parentheses, and number of specimens listed.)

Measurement	Males		Females	
	Holotype[a]	Adults[b]	Adults[c]	Juveniles[d]
Length of head and body	111	105.0 ± 9.0 (92–129) 20	102.9 ± 11.0 (90–117) 19	87.2 ± 8.2 (73–97) 8
Length of tail	64	60.6 ± 3.7 (53–69) 20	58.3 ± 8.9 (47–70) 19	51.1 ± 3.4 (44–55) 8
Length of hind foot	22	21.2 ± 1.0 (19–23) 20	21.0 ± 1.0 (18–23) 19	20.8 ± 1.8 (17–23) 8
Greatest length of skull	26.8	26.0 ± .9 (24.5–27.4) 12	25.6 ± .3 (24.7–26.3) 13	24.3 ± .9 (23.5–25.5) 5
Basilar length	23.8	23.3 ± .6 (21.9–24.3) 10	22.6 ± .7 (21.6–23.7) 12	21.0 ± 1.1 (20.0–22.2) 4
Zygomatic breadth	15.4	14.8 ± .4 (14.1–15.4) 8	14.5 ± .4 (13.6–15.3) 10	13.8 ± .4 (13.4–14.3) 3
Interorbital breadth	3.7	3.9 ± .2 (3.5–4.1) 18	4.0 ± .2 (3.7–4.5) 16	4.0 ± .1 (3.8–4.2) 7
Length of rostrum	5.3	5.7 ± .4 (5.1–6.4) 17	5.7 ± .2 (5.1–6.1) 16	5.3 ± .4 (4.6–5.7) 5
Breadth of rostrum	4.8	4.7 ± .2 (4.5–5.1) 18	4.7 ± .1 (4.4–5.1) 16	4.4 ± .1 (4.2–4.7) 7
Length of nasals	7.5	7.2 ± .3 (6.5–7.9) 17	6.9 ± .3 (6.1–7.6) 16	6.3 ± .4 (5.7–6.9) 5
Breadth of nasals	3.0	2.8 ± .1 (2.5–3.1) 18	2.7 ± .2 (2.1–3.1) 16	2.7 ± .0 (2.7–2.8) 6
Height of braincase	6.2	6.5 ± .2 (6.0–7.0) 13	6.9 ± .2 (6.6–7.4) 12	6.9 ± .0 (6.9–7.1) 4
Breadth of braincase	12.3	12.1 ± .4 (11.1–12.7) 15	12.3 ± .2 (11.9–12.8) 14	11.9 ± .2 (11.7–12.3) 6
Length of diastema	8.0	7.6 ± .3 (7.1–8.3) 18	7.5 ± .1 (7.3–8.0) 16	6.8 ± .6 (5.5–7.5) 7
Palatilar length	13.5	12.9 ± .5 (12.1–13.9) 18	12.8 ± .3 (12.2–13.5) 16	11.9 ± 1.0 (10.1–12.9) 6
Palatal length	15.0	14.4 ± .6 (13.4–15.4) 18	14.3 ± .4 (13.5–15.0) 16	13.2 ± 1.1 (11.2–14.4) 6
Length of incisive foramina	5.3	4.9 ± .2 (4.4–5.3) 18	4.9 ± .2 (4.5–5.2) 16	4.4 ± .4 (3.7–5.0) 7
Breadth of incisive foramina	1.0	1.0 ± .0 (0.9–1.1) 18	1.0 ± .0 (.8–1.2) 16	1.0 ± .1 (0.8–1.2) 7
Length of palatal bridge	5.7	5.5 ± .2 (5.1–6.1) 18	5.5 ± .2 (5.0–5.9) 16	5.3 ± .2 (4.8–5.6) 7
Breadth of palatal bridge at M^3	2.9	2.8 ± .1 (2.5–3.2) 17	2.8 ± .1 (2.5–3.1) 16	2.7 ± .1 (2.5–2.9) 8
Breadth of mesopterygoid fossa	1.4	1.2 ± .1 (1.1–1.4) 16	1.2 ± .1 (1.0–1.4) 16	1.1 ± .1 (1.0–1.4) 6
Length of bulla	6.5	6.5 ± .3 (5.9–7.0) 12	6.5 ± .2 (5.9–7.0) 14	5.8 ± .3 (5.5–6.3) 5
Breadth of bulla	4.8	4.6 ± .2 (4.1–4.9) 12	4.7 ± .1 (4.5–4.9) 14	4.3 ± .2 (4.0–4.6) 5
Height of bulla	5.6	5.4 ± .2 (4.8–5.9) 12	5.2 ± .3 (4.9–5.7) 13	4.9 ± .4 (4.3–5.4) 5
Alveolar length of M^{1-3}	6.3	6.1 ± .3 (5.6–6.7) 18	6.0 ± .2 (5.5–6.5) 16	5.6 ± .3 (4.9–6.2) 8
Depth of bulla below toothrow	1.4	1.2 ± .1 (1.0–1.6) 10	1.0 ± .0 (1.0–1.1) 10	1.1 ± .2 (0.8–1.4) 4

[a] AMNH 111533.

[b] AMNH 111512, 111515, 111517, 111522–111523, 111529, 111532–111533, 111570, 111573, 111575–111576, 111583, 111586–111587, 111589, 111593–111596.

[c] AMNH 111508, 111514, 111518–111519, 111525, 111527, 111530–111531, 111539, 111569, 111577–111578, 111580–111581, 111584, 111588, 111590–111591, 111597.

[d] AMNH 111509, 111511, 111524, 111528, 111536, 111540, 111582, 111592.

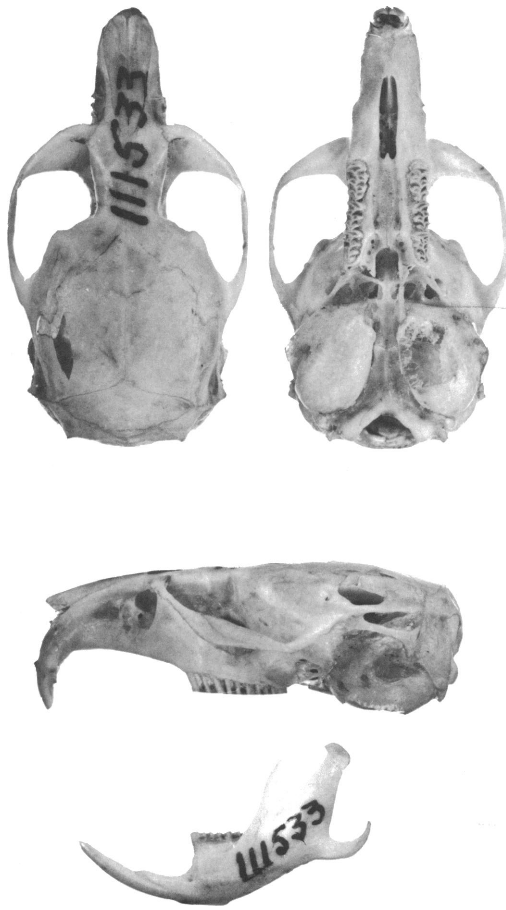

FIG. 6. Holotype of *Microtus musseri* (AMNH 111533). Views of cranium and left dentary approximately ×2. See table 3 for measurements.

downcurved (fig. 6). The large inflated bullae are internally lined with trabeculae and extend below the cheekteeth when the skull is placed with the occlusal surface of the teeth on a horizontal plane. The posterior part of the palate has a broad median ridge defined by shallow lateral pits. The distal ends of the pits are even with the anterior prism of the last upper cheektooth; proximally, they taper to an end on the palatal bone as it descends to join the ventral wings of the basisphenoid in the formation of the hamular processes. This proximal termination is medial to the end of the alveolus of the last upper cheektooth. The incisive foramina are constricted posteriorly as in Anderson's (1959) type 5.

The mandible has a gracile appearance. The coronoid process is slender and either even with or scarcely higher than the condylar process. The ascending ramus slants caudad at an angle of 30°. The angular process is inflected laterally, the bone is concave medially and has strong muscle ridges on its medial borders. Dorsal and ventral masseteric crests are visible but not prominent. In lateral view, the erupted incisor appears unusually long as the buccal side of the alveolus is deeply excavated. The lower incisors are obovate in cross section.

The upper cheekteeth are distinctive. The anterior two have fully developed postero-internal triangles. The first upper cheektooth has an anterior prism, three alternating closed triangles and a posterior external triangle that is confluent with a postero-internal triangle almost equal in size. The second maxillary tooth has an anterior prism, two closed triangles, and an external triangle that is confluent with a well-developed postero-internal triangle. The last maxillary tooth is variable. It usually (33 out of 42 skulls) consists of an anterior prism followed by three alternating closed triangles, one buccal and two lingual; it terminates in a reversed J-shaped heel, thereby forming three external and four internal salient angles (fig. 7). In nine specimens, there are only two closed triangles, the third being open and confluent with the heel. The angular pattern of the variants is three buccal and three lingual salient angles. The upper incisors are orthodont, ungrooved and the enamel is orange.

The enamel of the lower incisors is pale yellow. The first lower cheektooth is also variable. The usual pattern (34 of 42 skulls) is a posterior prism, four alternating closed triangles with the fifth and sixth triangles open and confluent with the anterior cap. There is a lingual salient angle on the anterior cap making a pattern of four buccal and five lingual salient angles for this tooth. The salient angles are consistent throughout the series of 42 skulls, but in eight specimens, only two of the triangles in front of the posterior

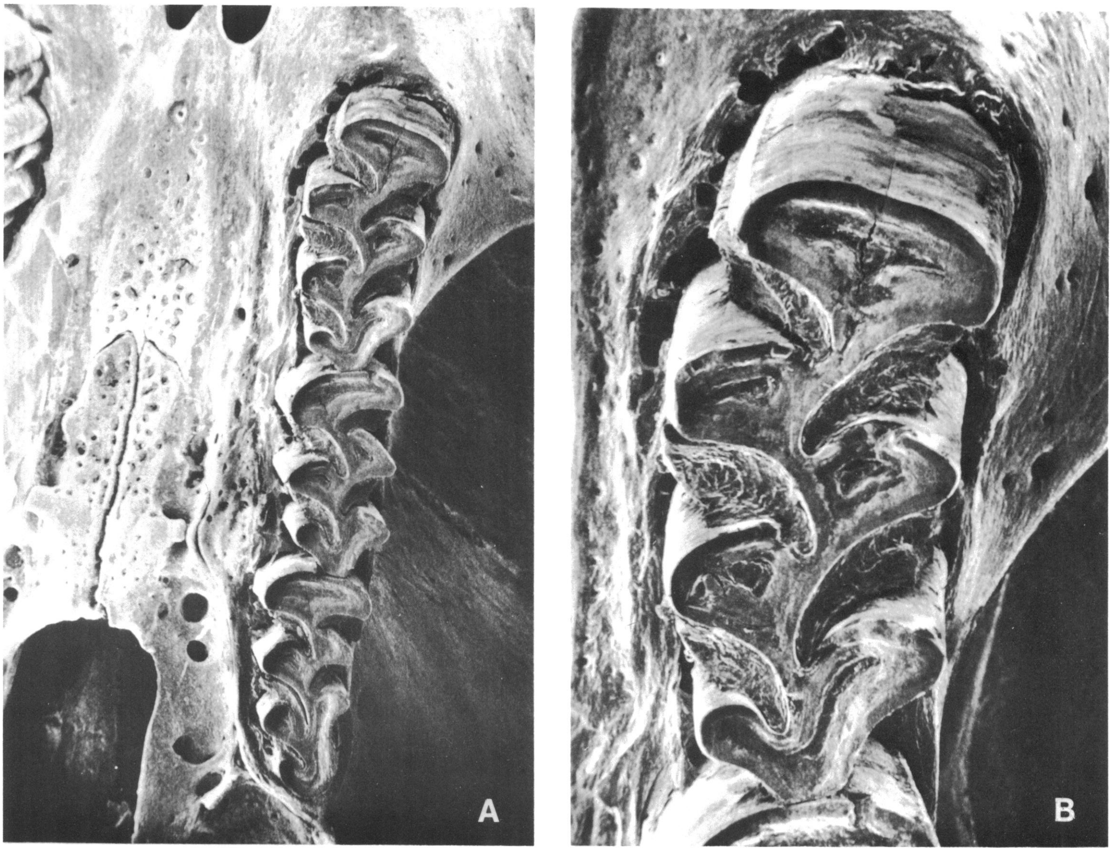

FIG. 7. Occlusal views of maxillary teeth of *Microtus musseri* (AMNH 111533). A. Left maxillary tooth row (length, 6.0 mm.) and posterior palate. B. First maxillary tooth (length, 2.2 mm.).

prism are closed. A pair of confluent triangles and a pair of closed alternating triangles in front of the transverse prism form the occlusal pattern of the second lower cheektooth. This tooth has three buccal and three lingual salient angles. The last lower tooth could also be described as having three buccal and three salient angles. However, the angular pattern is achieved by three graduated prisms set oblique to the axis of the alveolus (fig. 8). The largest prism is at the rear of the tooth and the buccal angles are smaller than the lingual.

COMPARISONS: *Microtus musseri* is compared with the genera *Eothenomys* and *Pitymys* with which it was found. It is then contrasted with members of the genus *Microtus* and the subgenus *Chionomys* to establish its specific placement.

Microtus musseri possesses derived characters not shared by any member of the genus *Eothenomys.* These traits are trabeculae lining the auditory bullae, and a median ridge on the posterior hard palate, produced by lateral pits on the palatal shelf and eight mammae.

The new vole does share the derived skull characters with the genera *Pitymys* and *Microtus.* Auditory trabeculae are variable in the genus *Pitymys* and its members have four to six mammae. *Microtus musseri* can also be distinguished from all members of the genus *Pitymys* by the lower dentition. The first lower cheektooth of *Pitymys* has only three closed triangles in front of the posterior prism. This is a diagnostic character for the genus. *Microtus musseri* has four closed tri-

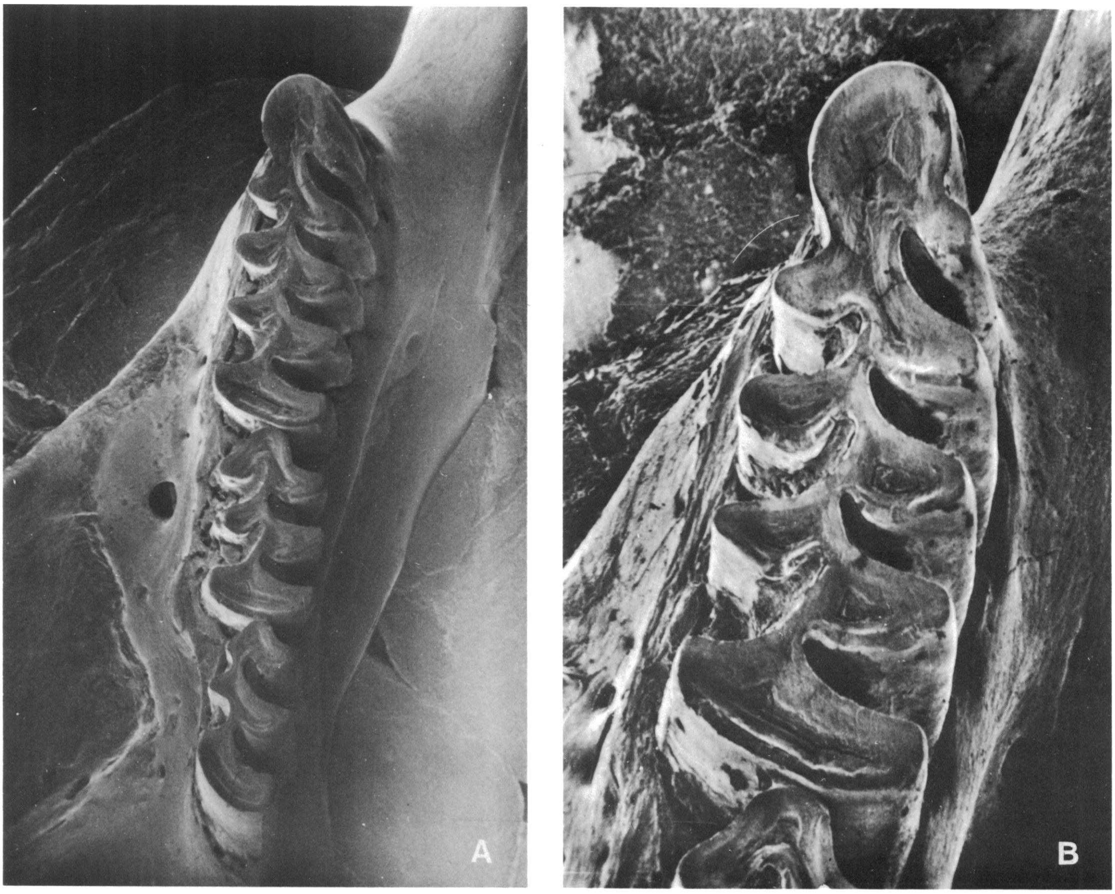

FIG. 8. Occulsal views of lower cheekteeth of *Microtus musseri* (AMNH 111533). A. Left lower tooth row (length, 6.0 mm.). B. First lower cheektooth (length, 2.9 mm.).

angles anterior to the posterior prism. Some species of *Pitymys* (*quasiator, multiplex,* and *shelkovnikovi*) have a postero-internal triangle on the second upper cheektooth and many forms demonstrate a slight tendency in that direction, for example *majori, bavaricus,* and *tatricus.* No species of *Pitymys* that I have examined or can find in the literature has a postero-internal triangle on the first upper cheektooth as does *M. musseri.*

The four closed triangles on the first lower cheektooth also distinguish *M. musseri* from most species of *Microtus.* This character is shared with *M. nivalis, M. gud,* and *M. roberti* of the subgenus *Chionomys* as well as with *M. oeconomus* and *M. millicens.*

Microtus oeconomus: This vole differs from *Microtus musseri* in its robust, strongly ridged skull, the shape and placement of the palatal pits and its upper dentition. *Microtus oeconomus* skulls have prominent anterior frontal and temporal ridges in mature specimens and the dorsal profile of the skull in lateral view is convex. The palatal pits are shaped like teardrops, the broadest and deepest portions medial to the anterior prism of the last maxillary tooth. The narrow end of the pit rarely extends posterior to the heel of the tooth. In many forms the pits excavate the palatal bone laterad rather than dorsad.

The upper dentition of *M. oeconomus* does not have postero-internal triangles on the first two upper cheekteeth. Jorga (1974) and Ruprecht (1967) did report a different variation in the enamel pattern of the second maxillary tooth; the second closed triangle after the anterior prism tends to divide. The last maxillary tooth, while variable, usually has four salient angles on both the buccal and lingual sides. It is consistently a more complex tooth than that of *M. musseri.*

Although the first lower cheektooth of *M. oeconomus* has four closed triangles in front of the posterior prism, as does *M. musseri,* this tooth is readily distinguishable between the two species. The anterior cap in *M. oeconomus* is crescentic in form and rarely has even a suggestion of an angle on the buccal side. There are only three buccal salient angles on the first lower cheektooth of *M. oeconomus. Microtus musseri* has four salient angles on the buccal side of the first lower cheektooth, as the sixth triangle is confluent with the anterior cap. Jorga (1974) illustrated examples of variation in this tooth in *M. oeconomus.* In his examples, the number of closed triangles varied from three to five, but the number of buccal salient angles remained three. My examination of the series of subspecies (*popofensis, suntaricus, unalascensis koreni, ratticeps,* and *limnophilus*), in the collections at the American Museum of Natural History and specimens of *M. oeconomus malcolmi* from the Philadelphia Academy of Science, found the range and limit of variation of this tooth to be the same as Jorga reported for *M. oeconomus* from Germany.

Microtus nivalis: Microtus musseri differs from *M. nivalis* and all its subspecies in pelage color, vibrissae length, and dentition. The Chinese voles are dark brown dorsally, pale buff ventrally, with vibrissae about 20 mm. long. *Microtus nivalis* has vibrissae from 30 to 50 mm. long; dorsal pelage that is gray tinged with brown or grayish brown. No member of the species has a first upper cheektooth with a postero-internal triangle. Some populations of some subspecies have a small postero-internal triangle on the second upper cheektooth as a variant (Buszko, 1974). *Microtus musseri* is consistent throughout the series of 42 skulls, in having a large well-defined postero-internal triangle on each of the first two upper cheekteeth.

Microtus nivalis usually has a first lower cheektooth with five closed triangles in front of the posterior prism, and an anterior cap of such shape that the tooth has only three outer (buccal) salient angles and five inner (lingual) salient angles. Forms with four closed triangles in front of the posterior prism are regarded as variants. Buszko (1974) and Kowalski (1957) have reported considerable variation in the first lower cheektooth in *M. nivalis* from the Carpathians and the Tatras. Kowalski illustrated examples from the collections of the Polish Academy of Sciences, Cracow, in which the closed triangles of this tooth varied from three to five. He also noted that they often varied in number between the left and right side of the same animal. Miller (1912) illustrated *M. nivalis aquitanius* with four closed triangles on the first lower cheektooth, but Bree (1961) and Niethammer (1964) have illustrated examples with five, which suggests that the same variation is present in western European forms of *Microtus nivalis* from the Pyrenees.

The anterior pair of confluent triangles on the second lower cheektooth of *M. musseri* is another trait that distinguishes its dentition from that of *M. nivalis.* The second lower cheektooth of *M. nivalis* has four alternating closed triangles in front of the posterior prism.

Microtus musseri cannot be identified with *M. nivalis* because of differences in dentition, pelage, and vibrissae. However, both *M. musseri* and *M. nivalis* are "weak skull" forms with flat skulls on which temporal, nuchal, and anterior frontal ridges are not apparent and both have long tails.

The snow voles, *Microtus nivalis,* are montane forms from the Pyrenees, Apennines, Alps, Tyrol, Carpathians, Caucasus, and the mountains of Asia Minor. Miller (1912), Kowalski (1957) and Ognev (1950) have all reported them as associated with rocky places or as burrowing among stones in alpine or subalpine habitats.

Microtus gud: While *Microtus gud* has a first lower cheektooth with four closed triangles in front of the posterior prism, it is easily distinguished from *Microtus musseri* by its size and upper dentition. Ognev (1950) lists the range of condylobasal length for *Microtus gud* in the USSR as 25.0 to 29.2 mm. Spitzenberger (1971) published the range for Anatolian forms as 28.7 to 30.2 mm. The range of condylobasal length of

Microtus musseri is 21.6 to 24.3 mm. *Microtus gud* does not have postero-internal triangles on the first two upper cheekteeth and the third upper cheektooth is complex with three or four closed triangles between the anterior prism and a complex elongated heel. This conformation produces four or five salient angles buccally and four salient angles lingually. A further dental difference between *M. gud* and *M. musseri* is the enamel pattern of the second lower cheektooth. *M. gud,* like *M. nivalis* has a second lower cheektooth with four alternating closed triangles in front of the posterior prism. The pattern for that tooth of *M. musseri* is a pair of confluent triangles followed by a pair of alternating closed triangles in front of the posterior prism.

Like *M. nivalis, Microtus gud* is a form reported as burrowing among rocks at high altitudes. It is also a species without apparent muscle ridges on the skulls of adults. Only the nominate subspecies develops a ridge on the anterior frontals in very old specimens (Ognev, 1950).

Microtus roberti: This arvicoline differs from *M. musseri* in the same characters as *M. gud*: lack of postero-internal triangles on the first two upper cheekteeth, complex third upper cheektooth, four closed triangles in front of the posterior prism on the second lower cheektooth and large size. The condylobasal length of the type is 27 mm. (Thomas, 1906). Ognev (1950) reported 54 specimens from Transcaucasia, the Caucasus and the Black Sea coast with a condylobasal range of 31.0 to 32.3 mm. This is approximately 8 to 9 mm. larger than *M. musseri* (table 3).

Microtus millicens: This vole is known only from the series of six specimens described and named by Oldfield Thomas in 1912. It is a species with a flat unridged skull and a tail more than 50 percent of the length of the head and body. It is distinguished from *Microtus musseri* by characters of dentition, size, and pelage. According to the original description and diagnosis (Thomas, 1912), they differ in the form of the first and third maxillary teeth. The first upper cheektooth of *M. millicens* lacks the postero-internal triangle that is present in *M. musseri.* The second maxillary tooth is similar in the two species, both having a large postero-internal triangle. The third maxillary teeth differ. *Microtus millicens* is described as having a pair of confluent triangles between the anterior prism and the U-shaped heel, forming three buccal and three lingual angles. The last upper cheektooth of *M. musseri* has three alternating closed triangles between the anterior prism and the reversed J-shaped heel, forming three buccal and four lingual salient angles.

In both species, the third maxillary tooth varies, but they are also unlike in the variant forms. Examinations of the original series of *M. millicens* by Paula Jenkins of the British Museum reveals that in four of the six specimens the two triangles between the anterior prism and the heel are closed. The type, B.M.11.9.8.105, is one of these four. In the remaining two specimens, the triangles after the anterior prism are open as described in Thomas's diagnosis, but there is a third closed internal triangle, making a pattern of three buccal and four lingual angles. All the specimens of *Microtus musseri* have a third internal triangle and all have two closed triangles immediately after the anterior prism. In nine specimens of *M. musseri,* the third internal triangle is open and confluent with the heel.

The lower dentition of both species is the same. They share the character of four closed triangles between the posterior prism and the anterior cap in the first lower cheektooth and on the second lower cheektooth an anterior pair of confluent triangles.

Although there is some size overlap in the samples of the two populations, *Microtus musseri* is significantly larger than *Microtus millicens* in length of head and body, tail, hind foot, skull and palate. It is also significantly wider in zygomatic breadth. There is not a significant difference between the basilar lengths of the two species (table 4).

The pelage of *Microtus musseri* resembles that of *M. millicens* in length, texture, and dorsal color. However, the two species differ in color of venter, underside of tail, and fore and hind feet. The venter of *Microtus millicens* is paler than that of *M. musseri* and the underside of the tail and the feet of *M. millicens* are white. The ventral surface of the tail and the feet of *M. musseri* are buff.

TABLE 4
Measurements (in Millimeters) of *Microtus musseri* and *Microtus millicens* from Sichuan[a]

	Microtus musseri	P[b]	*Microtus millicens*
Length of head and body	104.02 ± 9.99, 39 100.82–107.22 (90–129)	.01–.001	89.83–4.66, 6 86.03–93.63 (83–95)
Length of tail	59.5 ± 6.81, 39 57.35–61.71 (47–70)	.01–.001	50.8 ± 2.78, 6 48.57–53.09 (46–53)
Length of hind foot	21.15 ± 1.03, 39 20.83–21.47 (18–23)	<.001	18.33 ± .25, 6 18.13–18.53 (18–18.5)
Occipitonasal length	25.83 ± .76, 25 25.53–26.0 (24.5–27.4)	<.001	24.38 ± .36, 6 24.10–24.66 (23.7–24.7)
Condylobasal length	22.96 ± .77, 22 22.64–23.28 (21.6–24.3)	.4	22.70 ± .35, 6 22.42–22.98 (22.0–23.0)
Palatal length	14.37 ± .53, 34 14.19–14.55 (13.4–15.4)	.01–.001	13.56 ± .27, 6 13.34–13.78 (13.2–14.0)
Zygomatic breadth	14.71 ± .47, 18 14.49–14.93 (13.6–15.4)	<.001	13.31 ± .36, 6 13.03–13.59 (12.9–13.8)
Alveolar length of M^{1-3}	6.14 ± .30, 34 6.04–6.24 (5.5–6.7)	<.001	5.65 ± .10, 6 5.57–5.73 (5.5–5.8)

[a] Measurements in millimeters in the following order: the mean, standard deviation, size of sample after the comma, plus and minus twice the standard error of the mean and in parentheses the observed range.
[b] P values are the probabilities that the means of the samples are drawn from the same population.

The differences in dentition, size, and pelage make it impossible to place these two animals in the same species. It should be noted that the localities where *Microtus musseri* was taken are approximately 35 miles southwest of Wei-choe, the collecting locality of *Microtus millicens.* The Cheh-shieh shan separates them.

Although *M. musseri* cannot be referred to any of the species of *Microtus* having a first lower cheektooth with five closed triangles in front of the posterior prism, some of these species have been described as having postero-internal triangles on one or both of the first two maxillary teeth: *M. agrestis, M. clarkei, M. socialis, M. pennsylvanicus, M. breweri, M. montanus,* and *M. californicus eximius.* This so-called *agrestis* angle is usually small compared with the other enamel triangles on the same tooth. Its presence is variable in *M. montanus* and *M. californicus eximius,* but consistent in *M. pennsylvanicus* and *M. breweri* among the New World forms. In the Palearctic, it is variable in its presence in *M. socialis,* but consistent in *M. clarkei* and *M. agrestis.*

A postero-internal angle on the first maxillary tooth appears in *M. agrestis agrestis* from Scandinavia, *M. agrestis exul, M. agrestis ognevi, M. mongolicus, M. socialis paradoxus,* and *M. pennsylvanicus terranovae.* In all these forms except *M. agrestis exul,* its presence is variable, and the loop is small to tiny compared with the other enamel triangles on the tooth (Ursin, 1949; Reichstein and Reise, 1965; Corbet, 1975).

Microtus musseri, from the mountains of western Szechuan, cannot be referred to any species of *Microtus* previously described, because of its unique combination of characters. Its lower dentition excludes it from any of the forms with more than four closed triangles on the first lower cheektooth. Its upper dentition, size, and pelage distinguish it from those species with four closed triangles on the first lower cheektooth. Of this last group of voles, *M. millicens* shares most characters with *M. musseri.* Both animals have flattened, unridged skulls, tails more than 50 percent the length of head and body, long, loose dorsal pelage, a postero-internal triangle on the second upper cheektooth, four closed enamel triangles on the first lower cheektooth, and an anterior pair of open triangles on the second lower cheektooth. Both animals were trapped in the subalpine and alpine zones of the mountains of western Sichuan. *Microtus millicens* is smaller than *M. musseri,* has paler ventral fur and white fore and hind feet as well as white ventral tail. It lacks the postero-internal triangle on the first maxillary tooth and usually has only a pair of closed triangles after the anterior prism on the last maxillary tooth; when a third triangle is present, the anterior two are confluent. *M. musseri* has the postero-internal triangle on the first maxillary tooth and usually has three closed triangles after the anterior prism on the last maxillary tooth.

DISCUSSION

The skull of *M. musseri* is morphologically closer to that of *M. millicens* than to any other known arvicoline. If you assume that increasing elaboration of cutting edges of the teeth (von Koenigswald, 1980), extreme hypsodonty with accompanying rootlessness and palatal changes, and spongy tissue in the bullae are derived characters, then a progression can be posed for the derivation of *M. musseri* and *M. millicens* from an animal with morphology like *Clethrionomys rufocanus* through morphological forms like *Eothenomys eva. Clethrionomys rufocanus* has long loose fur, four mammae, rounded brain case, unridged skull, straight posterior palatal shelf without a median ridge, rooted teeth in very old age, upper occlusal pattern of anterior prism and four alternating closed triangles for the first tooth, anterior prism and three alternating closed triangles for the second and anterior prism, two alternating closed triangles before the Y-shaped heel for the third, a first lower cheektooth with four closed triangles in front of the posterior prism, and second lower cheektooth with an anterior pair of confluent triangles followed by a pair of closed triangles and a posterior prism (1). Some variants of *C. rufocanus* have three or four closed triangles between the anterior prism and heel of the last maxillary tooth. *Eothenomys eva* shares all of the characters of *Clethrionomys rufocanus* but has rootless dentition throughout life (2). Variants of the third maxillary tooth of *E. eva* may have none, or one triangle between anterior prism and heel. There are always three buccal and three lingual salient angles on this tooth in both *C. rufocanus* and *E. eva. Microtus millicens* shares the skull conformation and lower occlusal pattern of *Clethrionomys rufocanus* and *Eothenomys eva.* However, it has eight mammae, trabeculae lining the bullae and a posterior palate with lateral pits, separated by a median ridge, on the palatal shelf (3). This group of derived characters is shared by all members of the genus *Microtus. Microtus millicens* and *Microtus musseri* differ from most of the members of the genus *Microtus* because they retain the primitive lower toothrow occlusal pattern shared with *C. rufocanus* and *E. eva.* They share the derived character of a second maxillary tooth which is elaborated by a large postero-internal triangle. *Microtus musseri* alone has the derived characters of a postero-internal triangle on the first maxillary tooth and a third closed triangle between the anterior prism and the heel on the lingual side of the last maxillary tooth.

In assessing the phylogenetic position of *Microtus musseri* and *Microtus millicens,* it should not be overlooked that they may be part of an older fauna. *Microtus musseri* was collected at the same localities and altitudes as *Uropsilus soricipes, Sorex cylindricauda cylindricauda, Blarinella quadricauda, Niviventer andersoni, Niviventer excelsior, Rhinopithecus roxellanae,* and *Ailuropoda melanoleuca* and on the same trap lines as *Pitymys sikimensis irene. Uropsilus soricipes* and *Sorex cylindricauda cylindricauda* were taken at the same altitudes at Wei-choe as *Microtus millicens* (Thomas, 1911). All these animals are peculiar to the western highlands of Sichuan (Musser and Chiu, 1979). We may be sampling, with *M. musseri, M. millicens,* and *Pitymys sikimensis irene,* part of an early arvicoline fauna that has been able to survive in the special alpine and subalpine conditions of western Sichuan.

It is von Koenigswald's (1980) hypothesis that as the arvicolines evolved they have become more and more efficient as grass eaters, hence the lengthening of the cutting edges of the tooth enamel. It is not certain that *M. musseri, M. millicens,* and forms with similar dental and skull characters such as the European members of the subgenus *Chionomys* are primarily grass eaters. The complex of masticatory musculature and dental patterns observed in these forms may be as adaptive for processing vegetation other than grass as the muscular–dental complex of more derived microtines is adaptive for siliceous grasses (Guthrie, 1965). If this is true, then the unridged skull and relatively open occlusal pattern are a functional complex and should be studied from that point of view.

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