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Identification and Morphological Characteristics of *Clethrionomys rufocanus, Eothenomys shanseius, E. inez* and *E. eva* from the USSR, Mongolia, and Northern and Central China

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Abstract. Museum specimens of 236 red-backed voles from the southern part of the USSR, Mongolia, and the Provinces of Inner Mongolia, Hopei, Shansi, Shensi, Kansu, Chinghai, Hupeh, and Szechwan in China were compared with 69 specimens of *Clethrionomys rufocanus* from Finland. The distance from the most posterior edge of the upper 3rd molar (M3) to the most anterior point on the incisor (I-M3) correlated positively with ages determined by the developmental stages of molar roots in the year-round samples from Finland. In the samples from Finland and from eight localities in the USSR and Mongolia 46° N or more (Group A), most of the skulls measuring I-M3 = 14.6 mm or more did not have alveolar capsules to indicate root development. On the other hand, in the samples from 11 localities in northern China situated from 37° to 41°N, alveolar capsules indicating rootless molars were observed even in skulls where I-M3 = 14.6 mm or more. In the samples from 18 localities in central China from 31° to 39°N, all skulls had an I-M3 of 14.6 mm or less, and alveolar capsules were found even in adult females having prominent mammae on the skin. Adult animals larger than the smallest I-M3 class (0.3 mm interval) of the adult females in the respective localities are divided into two groups (Groups B and C) by the relation between I-M3 and interorbital width (IOW). Group B animals had larger I-M3 and smaller IOW, including the holotype of *Craseomys shanseius*, whereas those of Group C had smaller I-M3 and larger IOW. Group C specimens could be further divided into two groups (C-1 and C-2) based on the relation between I-M3 and tail length (TL). Given an increase in I-M3, specimens in Group C-1 had a shorter TL, including the holotypes of *Microtus* (*Eothenomys*) *inez* and *M.* (*E.*) *nux*, whereas those of Group C-2 had a longer TL, including the holotypes of *M.* (*Caryomys*) *eva, M.* (*Caryomys*) *alcinous*, and *Craseomys aquilus*. Group A specimens are identified as *Clethrionomys rufocanus* by the presence of roots and the age variation of molar patterns on M3, whereas, based on the absence of roots, Group B specimens are classified as *E. shanseius*, Group C-1 as *E. inez*, and Group C-2 as *E. eva*. The holotype of *M. inez jeholicus* with unworn M3 is a young specimen of *E. shanseius*. The distribution areas of these four species are determined and the demarcation line between *C. rufocanus* and *Eothenomys* is established by the Gobi Desert in Mongolia and Inner Mongolia. *E. shanseius* and *E. inez* are distributed sympatrically at Kolanchow, Shansi Province. Each habitat was reviewed.

Key words: *Clethrionomys rufocanus*; *Eothenomys shanseius*: *Eothenomys inez*; *Eothenomys eva*; Eastern Asia.

Except for *Clethrionomys rutilus*, classification of other red-backed voles (*Clethrionomys* and *Eothenomys*) from the Provinces of Inner Mongolia, Hopei, Shansi, Shensi, Kansu, Szechwan, and Hupeh in China has been very complicated. Following the description of seven new forms, three classifications have been proposed. Hinton (1926) lumped six forms into *Evotomys* (=*Clethrionomys*) *rufocanus*, excluding one form which was described after publication of his work. Allen (1940) designated the voles from Inner Mongolia, Hopei, and Shansi as *C. rufocanus*, and recognized two oriental voles as *Eothenomys inez* from Shansi and Shensi, and *E. eva* from Shansi, Shensi, Kansu, and Hupeh. Corbet (1978) recognized three oriental voles, *E. shanseius* from Hopei and Shansi, *E. inez* and *E. eva*.

Morphological variation and distribution of red-backed voles have never been clarified for northern and central China for three reasons. First, the preceding classifications have not been uniformly applied by other taxonomists (Ellerman, 1941; Tokuda, 1941; Ognev, 1950; Ellerman & Morrison-Scott, 1951; Shou, 1962; Gromov & Polyakov, 1977; Honacki *et al.*, 1982; Hu & Wang, 1984). Secondly, identification keys are very simple and only crude distribution maps are available (Corbet, 1978). Finally, many faunal studies recently published in China have neither mentioned the classification system adopted nor the identification method used (Li, 1965; Tan *et al.*, 1965; Zhao, 1978; Chen *et al.*, 1980; Zheng, 1982; Liu *et al.*, 1984; Zhang, 1984; Laing & Zhang, 1985; Zhang, 1987; Wang, 1990; Zheng & Zhang, 1990).

In the present paper, I compare external, cranial and molar characteristics of red-backed voles from the USSR, Mongolia, and northern and central China with those of *C. rufocanus* from Finland. I present more practical criteria to identify the voles in these regions and show the distributions of the species in detail.

Materials and Methods

A total of 305 specimens were examined: 69 specimens of *C. rufocanus* collected from Kilpisjarvi, Finland (69°03′N, 20°49′E) from February to November, 1983, by A. Kaikusalo; and 236 specimens of *Clethrionomys* and *Eothenomys* from the southern part of the USSR, Mongolia, and northern and southern China (the Provinces of Hopei, Shansi, Shensi, Kansu, Chinghai, Hupeh, and Szechwan) housed in the following institutions: the British Museum (Natural History) (BM), U. K.; the Museum of Comparative Zoology, Harvard University (MCZ), the American Museum of Natural Hisory (AMNH), the United States National Museum of Natural History (USNM), and the Field Museum of Natural History (FMNH), U. S. A.; the Institute of Zoology, Academia Sinica (ASZI), Beijing, and the Northwest Plateau Institute of Biology, Academia Sinica (ASNPIB), Sining, China; and the Yamashina Institute for Ornithology (YIO), Chiba, Japan.

The locality and reference numbers in Fig. 10, latitude, longitude, date collected, museum, and registration number of all specimens examined are listed in Appendix A. Latitude and longitude of the localities were determined from gazetteers in Zhuang (1983) and Su (1984). Appendix B includes remarks on the type localities of *Craseomys shanseius* Thomas, 1908 and *Caryomys aquilus* Allen, 1912. Some of these specimens were previously described and identified (Thomas, 1908a, b, 1909, 1910a, b, 1911a, b, c, d, 1912a, b ; Clark & Sowerby, 1912 ; Hollister, 1913 ; Allen, 1912, 1924, 1940 ; Hinton, 1926 ; Howell, 1929 ; Kuroda, 1939 ; Ellerman, 1941 ; Ellerman & Morrison-Scott, 1951 ; Tan *et al.*, 1965 ; Corbet, 1978).

Tail length (TL) was recorded from the skin label. The presence of mammae and the number of nipples were checked for female specimens. Incisor-3rd molar length (I-M3) and interorbital width (IOW) were measured on undamaged skulls to the nearest 0.1 mm with a dial caliper by the author. The I-M3 is the distance from the most anterior point on the incisor to the most posterior edge of the M3. The IOW is the shortest distance of the frontal bones between orbits. The condylobasal length (CBL) was not applied, because many skulls were damaged.

The disappearence of the M2 alveolar capsule was recorded for the skulls of *C. rufocanus* from Finland and all museum specimens (Prychodko, 1951 ; Koshkina, 1955). Three stages were recognized : a strong arched alveolar capsule ; an intermediate stage, in which the capsule is slightly swollen ; a capsule flattened and reduced to a straight line.

The age of skulls of *C. rufocanus* from Finland was determined according to the developmental stages of their molar roots following the criteria of Abe (1976). Six age classes were determined : I+II, III+IV, V, less than 33% of root ratio (VI), from 33 to 60% of root ratio (VII), and 61% or more of root ratio (VIII).

Adult museum specimens were determined as having a size greater than the smallest I-M3 class (0.3 mm interval) of females with the presence of mammae on the skin in the respective localities (Fig. 3).

Enamel patterns of occlusal surface on M1, M2, and M3 were drawn for museum specimens from close-up pictures of the molar rows (1.75×magnification) using a stereo microscope (SMZ-10) produced by Nikon at 6.6×magnification after the pictures were taken in the museum with an accessory close-up lens attached to an Olympus camera.

Enamel patterns on M3 were classified first into four types according to Abe (1982). Type 4+5 is complex with three reentrant angles on the buccal side ; type 6 has three salient angles on the buccal side, a short posterior loop, and a confluent dental isthmus between triangles ; Type 9 has three salient angles in which the internal posterior enamel lamella is straight to convex ; Type 7+8 has three salient angles on the buccal side with slightly concave internal posterior lamella, which Type 9 does not. Type 9 and Type 7+8 were further divided into Type 9′ and Type (7+8)′, respectively, in which a confluent dental isthmus between all triangles is present.

The occurrence of a small extra posterior-internal angle on M1 and M2 was also checked. The posterior-internal enamel lamella was classified based on the presence or absence of a prominent angle.

Results

1. Variation of Clethrionomys rufocanus *from Finland*

In the large sample of *C. rufocanus* from Finland, I-M3 correlates positively with the six age classes defined by root development ($r=0.796$, $df=67$, $p<0.001$) and may be used as an approximate indicator of age (Fig. 1). The alveolar capsule disappears once I-M3 reaches 14.8 mm. Among the 16 skulls in the 13.0–14.7 mm I-M3 range, one skull has an intermediate capsule stage (6.2%); among the 10 skulls in the 14.8–15.0 mm I-M3 range, six skulls have an intermediate stage or lose the capsule (60.0%); and where I-M3=15.1 mm or more, all skulls lose the capsule. Root development (VI, VII and VIII age classes) is observed in three among four skulls without capsules in the 14.8–

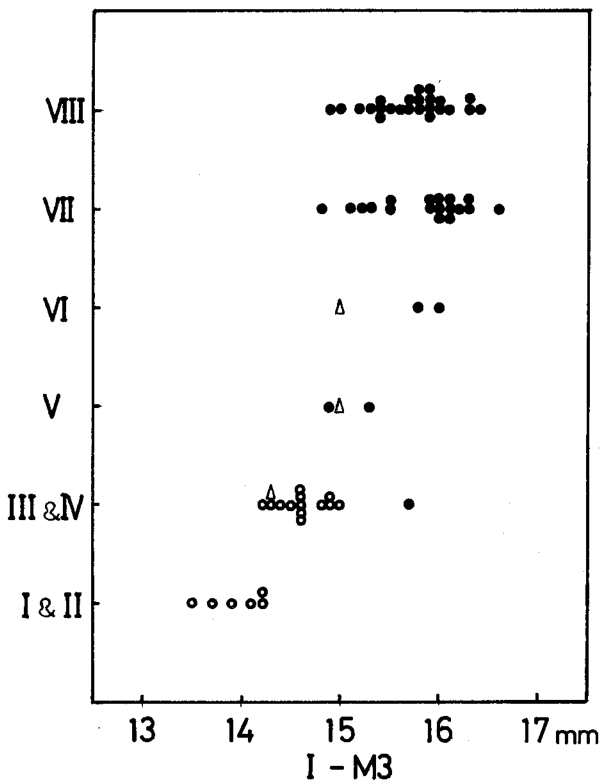

Fig. 1. Relationship between incisor-3rd molar length (I-M3), age classes (I–VIII), and development of alveolar capsule in *C. rufocanus* from Finland. Symbols: capsule present=open circle; capsule absent=closed circle; and intermediate stage=open triangle.

15.0 mm I-M3 range (75%), and in 41 of 43 skulls without capsules where I-M3=15.1 mm or more (95.3%). Consequently, the absence of the capsule is a good indicator for root development in skulls where I-M3=15.1 mm or more.

The disappearence of the alveolar capsule in relation to I-M3 is compared among the samples collected in different months (Fig. 2). In *C. glareolus*, the development of molar roots is known to be more retarded in the autumn-born cohort than in the spring or summer cohort (Lowe, 1971; Zejda, 1971). The capsule disappears in specimens collected in May where I-M3=14.6 mm or more, whereas the capsule is absent in specimens collected in July and September where I-M3=15.5 mm or more, which suggests a retardation of molar root formation. In the following comparison of capsule development, the absence of capsules indicating root development is specified in the skull classes where I-M3=14.6−15.2 mm or more, and the museum specimens are given in two collection periods: the first half of the year (January to June), and the second half of the year (July to December).

2. Variation of Specimens from the Southern Part of the USSR, Mongolia, and Northern and Eastern China

Plots of I-M3, the absence of alveolar capsule and the presence of mammae on the skin have been arranged from north to south for the museum specimens examined (Fig. 3). Fifty-two adult females with mammae on the skin are found among 230 specimens from Localities 1 to 37. Skulls from Localities 1 to 19 exhibit I-M3=14.6 mm or more, whereas those from Localities 20 to 37 have I-M3 of less than 14.6 mm. The absence of capsules indicating root development is found in skulls in which I-M3=14.6 mm or more; all such

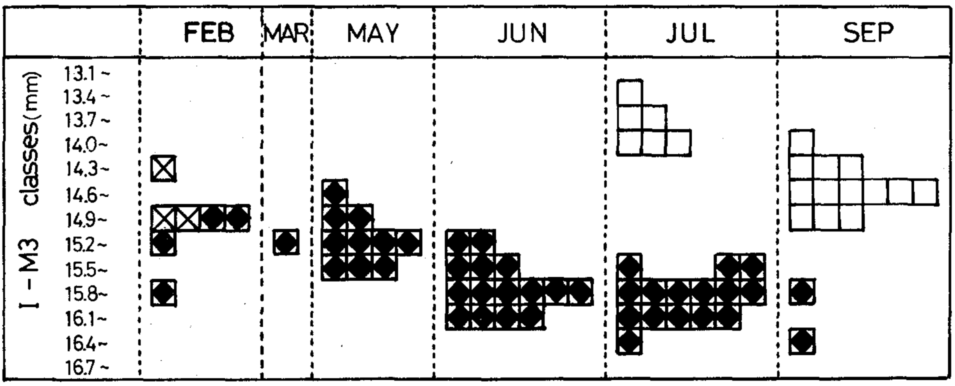

Fig. 2. Monthly variation of frequency distributions of incisor-3rd molar length (I-M3) with development of alveolar capsule in *C. rufocanus* from Finland. One square indicates one specimen. Symbols: capsule presest=open rectangle; capsule absent=small closed rhombus within a square; and intermediate stage=X-letter within a square.

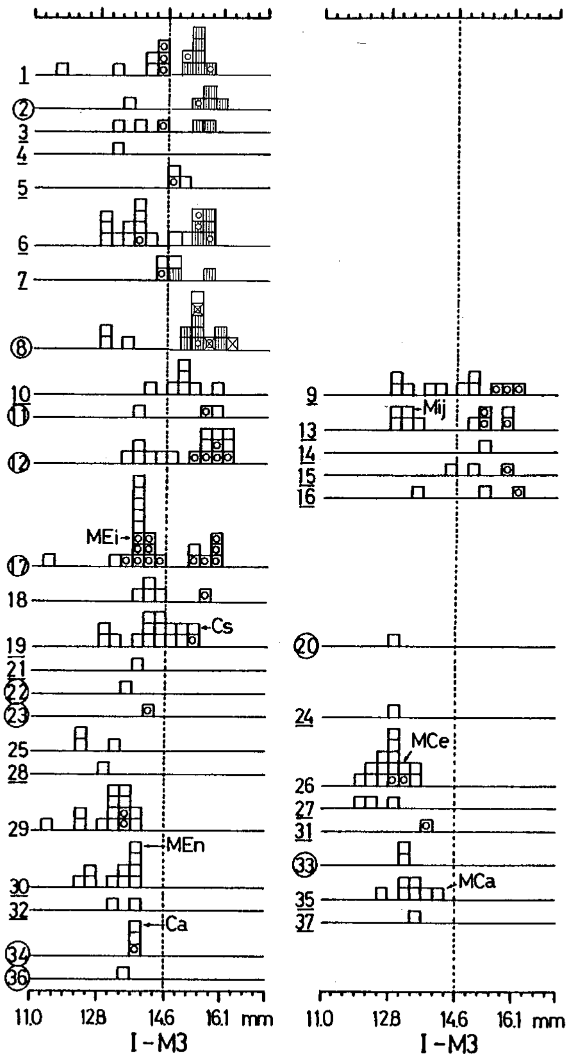

Fig. 3. Geographical variation of frequency distributions of incisor-3rd molar length (I-M3) with development of alveolar capsule in samples of red-backed voles from the USSR, Mongolia, and northern and central China. Some localities situated at the more western or eastern regions are arranged parallel to show the approximately similar longitude. Numbered localities (1−37) refer to Appendix A. A numbered locality with a circle indicates samples collected from January to June, while an underlined locality number indicates samples collected from July to December. An unmarked locality number indicates samples collected from January to December. The holotypes are abbreviated as follows: *Microtus inez jeholicus*＝Mij; *Microtus* (*Eothenomys*) *inez*＝MEi; *Craseomys shanseius*＝Cs; *Microtus* (*Caryomys*) *eva*＝MCe; *Microtus* (*Eothenomys*) *nux*＝MEn; *Microtus* (*Caryomys*) *alcinous*＝MCa; *Craseomys aquilus*＝Ca. The broken line indicates an I-M3 of 14.6 mm, from which the alveolar capsule has disappeared in *C. rufocanus* from Finland (Fig. 1). One square indicates one specimen. Symbols: capsule present＝vertical lines within a square; capsule absent＝open square; intermediate stage of the capsule＝X-letter within a square; and an adult female with prominent nipples on the skin＝open circle within a square.

specimens were collected from Localities 1 to 8. On the other hand, capsules indicating a lack of root development are observed in other skulls, including 34 skulls where I-M3=15.2 mm or more (Localities 9 to 19), and in 36 adult females with mammae (Localities 9 to 37). Thus, the populations from Localities 1 to 8 differ from those from Localities 9 to 37 with regard to the presence of alveolar capsules and will be referred to hereafter as Group A.

Aside from Group A, two other patterns of I-M3 and root development are found among specimens from Localities 9 to 37 (Fig. 3). One group is present in Localities 9 to 19 where animals have a long I-M3 of 14.6 mm or more, and the other type is found in Localities 20 to 37 where animals have a short I-M3 of less than 14.6 mm. Fig. 4 shows that adult animals from Localities 9 to 37 can be divided into two enclosures based on the relationship between I-M3 and IOW, though all specimens examined are not classified by this relationship.

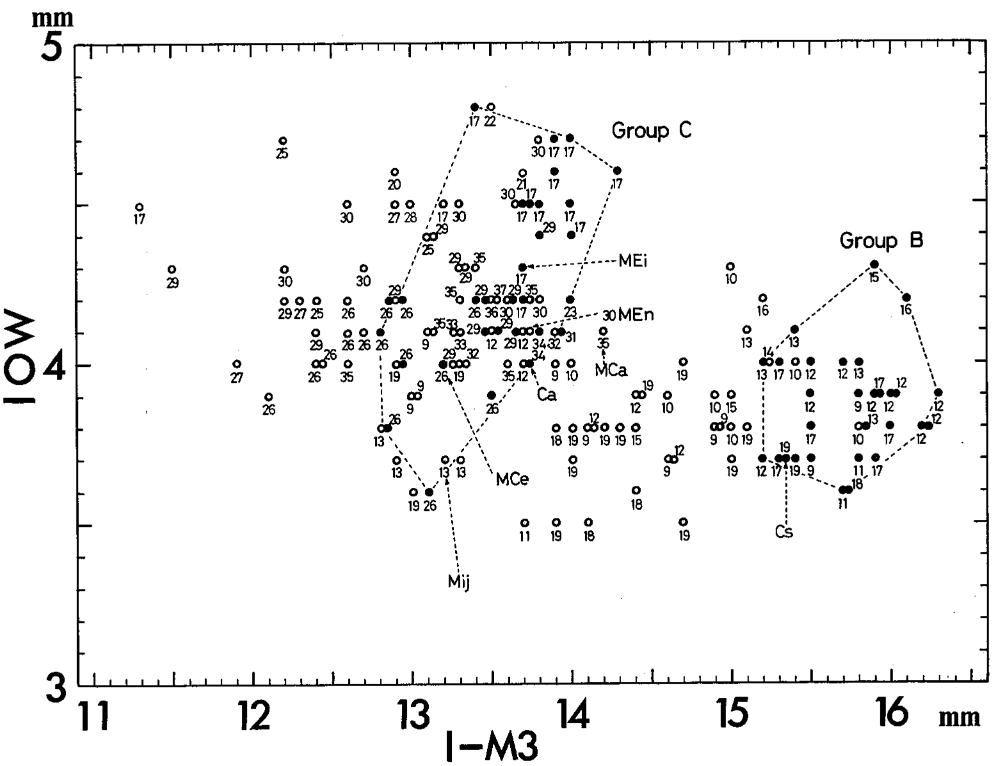

Fig. 4. Relationship between incisor-3rd molar length (I-M3) and interorbital width (IOW) in samples of red-backed voles from Localities 9 to 37. No specimen is given in Locality 24 because of IOW being damaged. Adult animals enclosed by broken lines are classified as Groups B and C. For numbered localities (10−34), see Appendix A, and for abbreviations of the holotypes, see Fig. 3. Symbols: adult individual=closed circle; individual other than adults=open circle.

Hereafter skulls with long I-M3 and narrow IOW are referred to as Group B, and those with short I-M3 as Group C. Group B consists of adult animals collected from Localities 9 to 19, excluding Localities 10 and 14. Group C is composed of adult animals collected from Localities 17, 23, 26, 29, 31 and 34. Adult animals from Locality 17 (Kolanchow population) belong to both Group B and Group C. In spite of not being classified as adult females due to a lack of mammae on the skin, specimens from Localities 10 and 14, and from Localities 21, 25, 30, 32, 33 and 35–37 were classified as being in Groups B and C, respectively, because they are enclosed in either area and separated from each other. Also, specimens from Localities 20, 22, 27 and 28 are placed in Group C because they are located near the enclosure of Group C.

Group C can be further divided into two groups (C-1 and C-2) by the relationship between I-M3 and TL (Fig. 5). With the increase in length of I-M3, Group C-2 specimens from Localities 24, 26, 27, 29, and 31–36 have a longer TL than those of Group C-1 from Localities 17, 20–23, 25, 28 and 30. Although one skull with short I-M3 (Locality 24 ; Fig. 3) is not plotted in Fig. 4 because the frontal is broken and the IOW is not available, it has a longer tail in comparison to I-M3 and is classified as being in Group C-2 (Fig. 5). One specimen with the missing tail and short I-M3 (Locality 37 ; Fig. 3) is not illustrated in Fig. 5, but entered in Group C-2 because of the resemblance of the molar pattern on the M$\underline{3}$ to that of the holotype of *Microtus* (*Caryomys*) *alcinous* (m in Fig. 8).

The following four holotypes are plotted as adult animals: *Craseomys shanseius* (BM 8. 8. 7. 85) in Group B (Fig. 4), *M.* (*E.*) *inez* (BM 9. 1. 1. 188) in Group C (Fig. 4) and in Group C-1 (Fig. 5), and *M.* (*C.*) *eva* (BM 11. 2. 1. 223) and *Craseomys aquilus* (MCZ 7190) in Group C (Fig. 4) and in Group C-2 (Fig. 5). On the other hand, the following three holotypes are not shown as adult animals. *M.* (*E.*) *nux* (BM 10. 5. 2. 79 ; Locality 30) and the series from the same locality are placed in the adult section of Group C (Fig. 4) and then in Group C-1 (Fig. 5). Because the holotype of *M.* (*C.*) *alcinous* (BM 11. 9. 8. 136 ; Locality 35) is located near the enclosure of Group C and the series from the same locality are enclosed in the adult section of Group C (Fig. 4), the holotype is classified first as Group C and then Group C-2 (Fig. 5). *M. inez jeholicus* (YIO 857 ; Locality 13) is categorized as a young specimen because the skull has unworn M$\underline{3}$s on both sides. The holotype was collected together with adult specimens classified as Group B (Fig. 4), and the holotype is subsequently considered to be in Group B.

Some further characteristics are exhibited after classifying specimens as Groups A, B, C-1, and C-2. According to the frequency histograms of TL (Fig. 6), Groups A and B do not show a cline, though the eastern specimens of Group B (Localities 9, 13, 14, and 16) have a slightly longer TL than the western specimens of the same group (Localities 10–12 and 17–19). The southern form of Group C-1 (Locality 30) has a slightly longer tail. Group C-2 specimens have a longer TL than those of other groups, and Group C-2 specimens having a TL of more than 41 mm show a cline increasing from north to south.

Regarding enamel patterns of occlusal surface on M3 (Fig. 7), Group A skulls with short I-M3 are of Type 6; skulls with long I-M3 are of Types 7+8 and 9 (a, b, and c in Fig. 8); and the complex form of Type 4+5 appears in small numbers independent of I-M3 (6/66=9.1%; d in Fig. 8). In Group B, almost all large-sized skulls are of Types 7+8 and 9 (51/81=63.0%; e and f in Fig. 8), and small-sized skulls are of Type 6, as found in Group A. Type 4+5, however, occurs more frequently in Group B (11/81=13.6%) than in Group A specimens, and seven skulls have a confluent dentine isthmus between all triangles: one is of Type (7+8)′ and six are of Type 9′ (g in Fig. 8). In Group C-1, Type 7+8 predominates (19/33=57.6%; i and j in Fig. 8), followed by Type 4+5 (12/33=36.4%; h in Fig. 8), and an absence of Type 9 specimens. In Group C-2, on the contrary, the Type 9 is the most common (35/50=70.0%; k, l, and m in Fig. 8), followed by Type 7+8 (11/50=22.0%), and very few Type 4+5 specimens (3/50=6.0%). The enamel pattern of Group C-1 (h, i, and j in Fig. 8) shows a slightly longer posterior loop than that of Group C-2 (k, l, and m in Fig. 8).

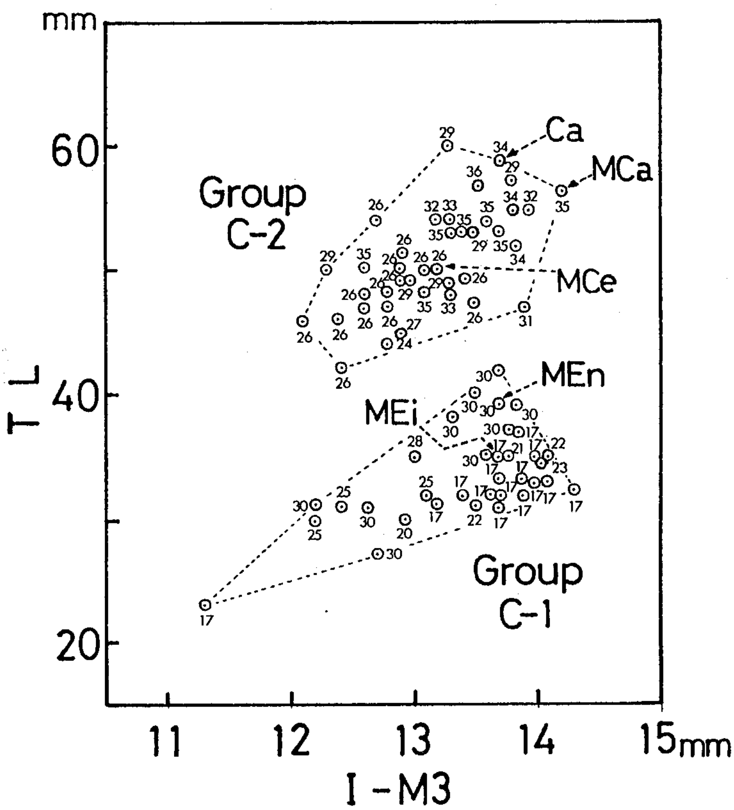

Fig. 5. Relationship between incisor-3rd molar length (I-M3) and tail length (TL) in samples of red-backed voles from Localities 17 and 20 to 37. For numbered localities (17−37), see Appendix A, and for abbreviations of the holotypes, see Fig. 3.

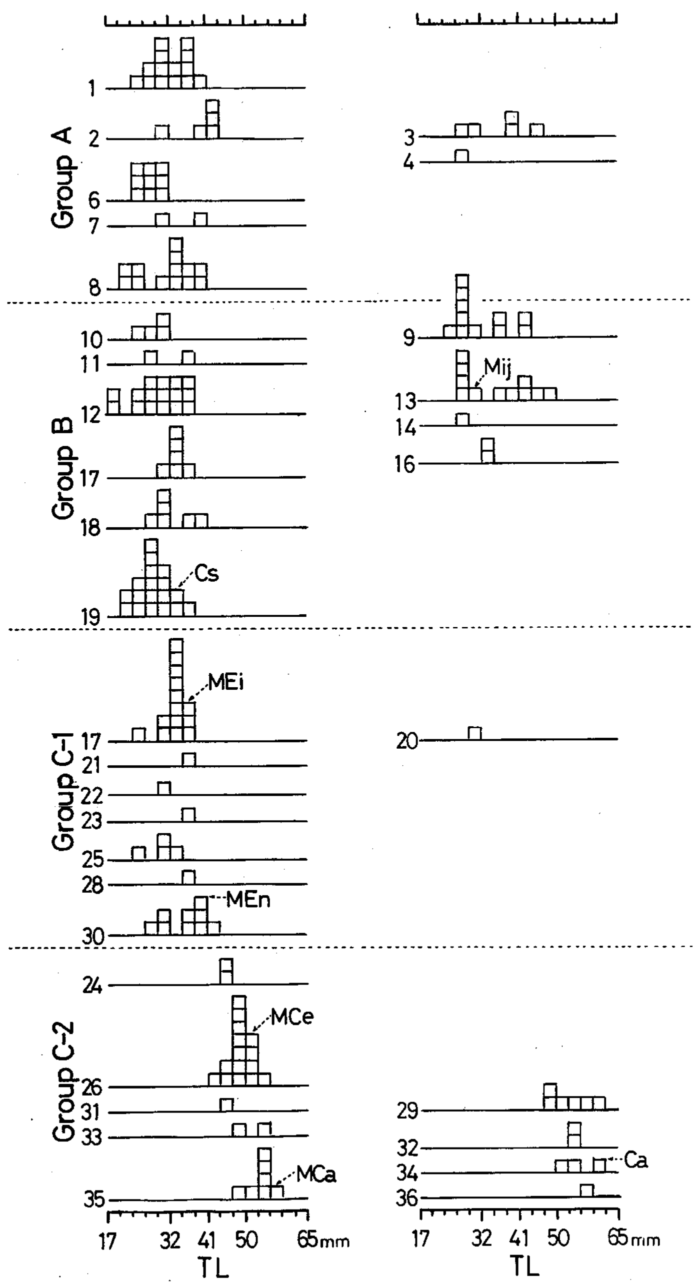

Fig. 6. Geographical variation of frequency distributions of tail length (TL) in samples of red-backed voles from the USSR, Mongolia, and northern and central China. For numbered localities (1—37), see Appendix A, and for abbreviations of the holotypes, see Fig. 3. Groups A, B, C-1, and C-2 are classified in the text.

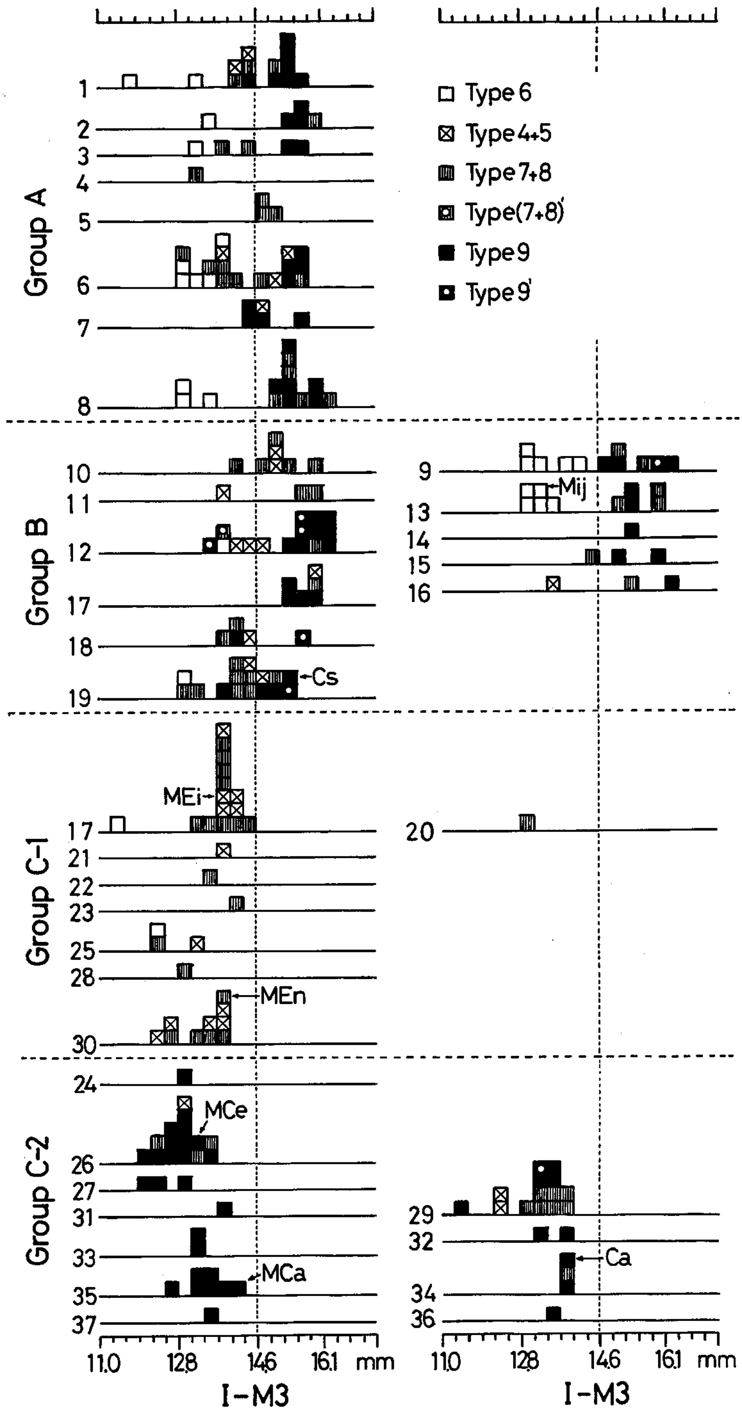

Fig. 7. Geographical variation of frequency distributions in the patterns of 3rd molar in relation to I-M3 in samples of red-backed voles from the USSR, Mongolia, and northern and central China.

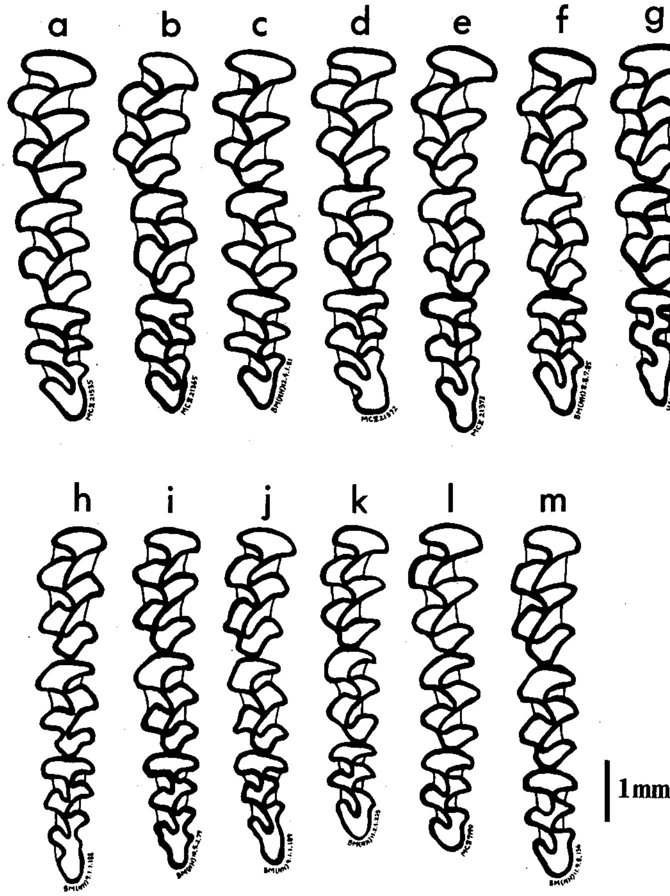

Fig. 8. Enamel patterns of upper molars in Groups A (a−c), B (d−g), C-1 (h−j), and C-2 (k−m). The alveolar capsule is absent in a−c, but present in d−m. a, MCZ 21535 (Locality 7, CBL=25.1 mm, and I-M3=14.8 mm) with simplex form on M3 (Type 9); b, MCZ 21365 (Locality 6, CBL=25.9 mm, and I-M3=15.3 mm) with simplex form on M3 (Type 9); c, BM(NH) 12. 4. 1. 81 (Locality 2, CBL=26.6 mm, and I-M3=15.7 mm) with simplex form on M3 (Type 9); d, MCZ 21372 (Locality 10, CBL=24.9 mm, and I-M3=15.0 mm) with complex form on M3 (Type 4+5); e, MCZ 21373 (Locality 10, CBL=25.5 mm, and I-M3=15.4 mm) with simplex form on M3 (Type 7+8); f, BM(NH) 8. 8. 7. 85 (the holotype of *Craseomys shanseius*, Locality 19, CBL=25.7 mm, and I-M3=15.3 mm) with simplex form on M3 (Type 9); g, USNM 155055 (Locality 19, CBL=26.7 mm, and I-M3=15.4 mm) with confluent dental spaces of simplex form on M3 (Type 9′); h, BM(NH) 9. 1. 1. 188 (the holotype of *Microtus* (*Eothenomys*) *inez*, Locality 17, CBL=23.0 mm, and I-M3=13.7 mm) with complex form on M3 (Type 4+5); i, BM(NH) 10. 5. 2. 79 (the holotype of *Microtus* (*Eothenomys*) *nux*, Locality 30, CBL=23.4 mm, and I-M3=13.7 mm) with simplex form on M3 (Type 7+8); j, BM(NH) 9. 1. 1. 189 (Locality 17, CBL=23.7 mm, and I-M3=14.0 mm) with simplex form on M3 (Type 7+8); k, BM(NH) 11. 2. 1. 223 (the holotype of *Microtus* (*Caryomys*) *eva*, Locality 26, CBL=22.8 mm, and I-M3=13.2 mm) with simplex form on M3 (Type 9); l, MCZ 7190 (the holotype of *Craseomys aquilus*, Locality 34, CBL=23.4 mm, and I-M3=13.7 mm) with simplex form on M3 (Type 9); m, BM(NH) 11. 9. 8. 136 (the holotype of *Microtus* (*Caryomys*) *alcinous*, Locality 35, CBL=23.4 mm, and I-M3=14.2 mm) with simplex form on M3 (Type 9).

The occurrence of a small extra posterior-internal angle on M1 and M2 (Fig. 9) is higher in Group C-1 (M1, 18/33=54.5% ; M2, 19/33=57.6%) than in Group C-2 (M1, 8/50=16.0% : M2, 7/50=14.0%) specimens.

The number of nipples on the museum skins was found to be four pairs on Groups A and B specimens, and two pairs on those of Groups C-1 and C-2.

3. *Taxonomic Conclusion*

There is a sharp contrast in the presence or absence of alveolar capsules between specimens in Group A and those in Groups B, C-1 and C-2 (Fig. 3). In Group A, the absence of alveolar capsules, indicating rooted molars, begins to develop from I-M3=14.6 mm, Type 6 molar pattern appears in short I-M3, and the simplex form of Types 7+8 and 9 appears in long I-M3 (Fig. 7). These characteristics are the same as described for *C. rufocanus* from Finland and from northeastern China and northern Korea (Kaneko, 1990). I consider Group A specimens to be examples of *Clethrionomys rufocanus*.

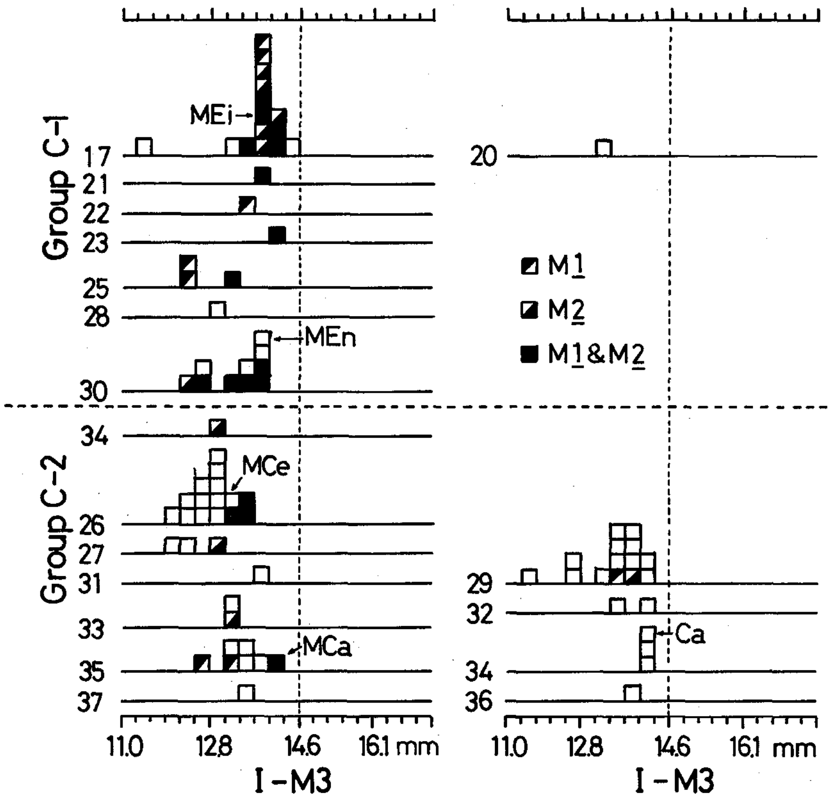

Fig. 9. Geographical variation of frequency distributions of the occurrence of a small postero-internal angle on M1 and M2 in samples in Groups C-1 and C-2.

Specimens of Groups B, C-1 and C-2, in contrast, are allocated to *Eothenomys*. All have a palatal shelf construction like *Clethrionomys* but lack root development even in old age, as indicated by the presence of capsules in adult specimens. Also, the molar reentrant folds are narrower than those of *Alticola*, which has little cement in the folds. This combination of traits conforms to the generic diagnosis of *Eothenomys* (Hinton, 1926; Ellerman, 1941; Corbet, 1978).

Group B specimens differ in some characteristics of molar pattern, TL, and IOW (Figs. 4, 6, and 7) from those of *Eothenomys regulus* in Korea (Kaneko, 1990). For example, the complex form of Type 4+5 in $M\underline{3}$ is less common in Group B (11/81=13.6%) than in *regulus* (69/97=71.1%); the simplex form of Types 7+8 and 9 is more frequent in Group B (51/81=63.0%) than in *regulus* (23/97=23.7%); TL is slightly shorter in adult specimens of Group B ($N=26$, $\bar{X}\pm SD=35.7\pm4.8$ mm, range=28−47 mm) than in those of *regulus* ($N=29$, $\bar{X}\pm SD=45.0\pm2.6$ mm, range=40−49 mm); and IOW is slightly narrower in adult specimens of Group B ($N=29$, $\bar{X}\pm SD=3.86\pm0.17$ mm, range=3.6−4.3 mm) than in those of *regulus* ($N=29$, $\bar{X}\pm SD=4.23\pm0.19$ mm, range=3.8−4.6 mm). The holotypes of *Craseomys shanseius* Thomas, 1908 and *Microtus inez jeholicus* Kuroda, 1939 both exhibit traits of Group B. I therefore recognize Group B specimens as *Eothenomys shanseius* and consider the name *M. inez jeholicus* Kuroda, 1939 to be a junior synonym of *E. shanseius* (Thomas, 1908).

The holotypes of *M.* (*E.*) *inez* Thomas, 1908 and *M.* (*E.*) *nux* Thomas, 1910 are classified as members of Group C-1 and appear to be conspecific. Group C-1 specimens are here designated as *Eothenomys inez*, with the name *M.* (*E.*) *nux* Thomas, 1910 as a junior synonym.

Group C-2 specimens can be allocated as *Eothenomys eva* because the holotypes of *M.* (*C.*) *eva* Thomas, 1911, *M.* (*C.*) *alcinous* Thomas, 1912, and *Craseomys aquilus* Allen, 1912 are classified as Group C-2 and conspecific. The names *M.* (*Caryomys*) *alcinous* Thomas, 1911 and *Craseomys aquilus* Allen, 1912 are junior synonyms of *Eothenomys eva* (Thomas, 1911).

The localities of the examined specimens of *C. rufocanus, E. shanseius, E. inez*, and *E. eva* are illustrated in Fig. 10.

Discussion

To justify comparison of museum specimens with *Clethrionomys rufocanus* from Finland, I will review the classification history of red-backed voles (*Clethrionomys* and *Eothenomys*) from northern and central China, with the exception of *C. rutilus*. Six species and one subspecies of the red-backed voles have been described: *Craseomys shanseius* Thomas, 1908; *Microtus* (*Eothenomys*) *inez* Thomas, 1908; *M.* (*E.*) *nux* Thomas, 1910; *M.* (*Caryomys*) *eva* Thomas, 1911; *M.* (*C.*) *alcinous* Thomas, 1912; *Craseomys aquilus* Allen, 1912; and *M. inez jeholicus* Kuroda, 1939. Several faunal studies (Thomas, 1909, 1910b, 1911b, c, 1912a; Clark & Sowerby, 1912) classified specimens under the scientific names mentioned above, except for Allen (1924), who used some of the

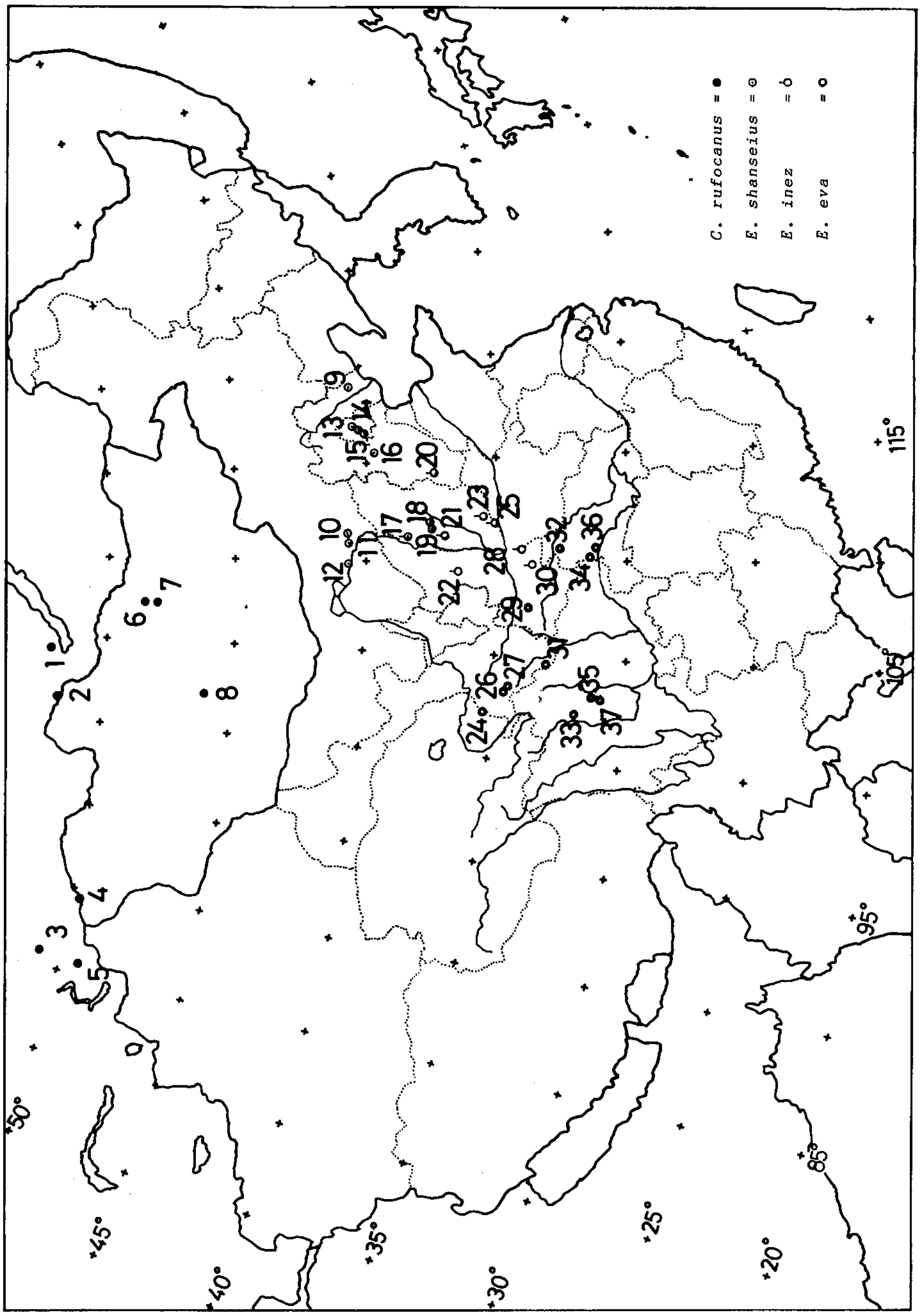

Fig. 10. Localities of *C. rufocanus* (A), *E. shanseius* (B), *E. inez* (C-1), and *E. eva* (C-2) identified in the present study. For numbered localities (1−37), see Appendix A. At Locality 17, both species of *E. shanseius* and *E. inez* were collected.

same names but identified certain specimens from northern China as *Evotomys* (=*Clethrionomys*) *rufocanus* without comment.

In his famous monograph of Microtinae (=Arvicolinae), Hinton (1926) lumped these six forms (*M. inez jeholicus* Kuroda, 1939 is excluded because the description was published at a later date) into one subspecies of *Evotomys rufocanus*. Hinton (1926) stated that some of the morphological differences described for these types are the result of age variation and many taxonomists adopted his classification (Ellerman, 1941; Tokuda, 1941; Ognev, 1950; Ellerman & Morrison-Scott, 1951; Shou, 1962; Gromov & Polyakov, 1977).

Like Hinton (1926), Howell (1929) and Allen (1940) classified the red-backed vole from Hopei and Shansi Provinces in China as *Clethrionomys rufocanus* because the skull of *C. rufocanus shanseius* is apparently identical to that of *C. rufocanus* (Allen, 1940). However, their classification differed from Hinton (1926) for voles from the Provinces of Shansi, Shensi, Kansu, Szechwan, and Hupeh in China. Howell (1929) retained one vole of *M.* (*Caryomys*) *inez*, whereas Allen (1940) separated both *E. inez* and *E. eva* from *C. rufocanus* based on fur coloration, tail length and molar occlusal pattern.

Corbet (1978) later revised the classification of *Eothenomys*, and recognized *E. shanseius, E. inez*, and *E. eva* from *C. rufocanus* because of the absence rooted molars even in older specimens. Honacki *et al.* (1982) followed the classification of Corbet (1978).

In summary, these different classifications were based on whether or not the red-backed vole of northern and central China possesses molar roots in adult specimens. In this paper, skull size where molar roots appear in *C. rufocanus* from Finland was used to identify museum specimens of the *C. rufocanus* group. The absence of alveolar capsules indicating root development appears in skulls with I-M3 greater than 15.2 mm in *C. rufocanus* from Finland (Figs. 1 and 2). In the measurement table in Hinton (1926), the dental length (=I-M3) for one skull was given as 14.4 mm with closing cement spaces on M$\underline{2}$ among five specimens from Lapland, Norway, and Sweden, whereas four skulls with a dental length of more than 15.4 mm had roots on M$\underline{2}$. The above observations accord with my estimation that the absence of capsules indicating root development in *C. rufocanus* begins in skulls with an I-M3 more than 15.2 mm.

The holotypes of *shanseius, inez, aquilus*, and *eva* are adult specimens that have capsules indicating a lack of roots (Fig. 3). Although the holotypes of *nux* and *alcinous* do not confirm as adult animals due to a lack of female specimens with mammae in Localities 30 and 35, these two holotypes correspond to the adult section of Group C in the size of I-M3 and IOW (Fig. 4), and the patterns on M$\underline{3}$ are similar between the holotypes of *nux* and *inez*, and the same between the holotypes of *alcinous, eva*, and *aquilus* (Fig. 8). Furthermore, all 164 specimens examined from Localities 9 to 37 lack roots, even in skulls with I-M3 more than 15.2 mm, including 36 adult females with prominent mammae (Fig. 3). Consequently, the above forms without roots are considered adult specimens rather than immature ones, and the generic allocation of *shanseius, inez*, and *eva* is *Eothenomys* (Allen, 1940 ; Corbet, 1978 ; Honacki *et al*., 1982), not *Clethrionomys* (Hinton, 1926 ; Allen, 1940).

The holotype of *Microtus inez jeholicus* is a young *E. shanseius*. Although Allen (1940) provisionally followed Kuroda's (1939) identification, he questioned the longer hind foot (17−21 mm) for *jeholicus* compared to *E. inez* (16 mm). Corbet (1978) and Honacki *et al*. (1982) expressed the same doubts. A large hind foot is possible in *E. shanseius* ; for example, the hind feet measure 20−21 mm in the series of *E. shanseius* from Kweihwa Cheng (Locality 10).

In describing *Microtus* (*E.*) *inez* and *M.* (*E.*) *nux*, Thomas (1909 ; 1910b) mentioned that the pattern on M1 and M2 has a tendency to develop a small extra postero-internal angle, which is very different from the large extra angle in *E. melanogaster*. On the other hand, Thomas (1911b) noted that the additional angles are reduced to a minute size and scarcely perceptible in *M.* (*C.*) *eva*, but not in *M.* (*C.*) *alcinous*. Allen (1940) referred to the presence of the angle in *E. eva eva*, but did not mention it in *E. eva alcinous*. The postero-internal angle is sometimes present in *E. inez* and *E. eva*, but the frequency of the occurrence is greater in *inez* than in *eva* and does not suggest any geographical difference (Fig. 9).

This study refines the distribution range in eastern Asia for *C. rufocanus*. The southern limit of the range in China was reported differently by Allen (1940), Corbet (1978), and Honacki *et al*. (1982), though my taxonomic conclusion supports their classification. Allen (1940) showed the distribution as the Provinces of Shansei and Hopei, because he considered *E. shanseius* as a member of *C. rufocanus*. Corbet (1978) noted the southern limit as the southern Ural, Altai, Manchuria and Korea, and excluded Mongolia, whereas Honacki *et al*. (1978) included Mongolia. Fig. 10 indicates that the southern limit lies 45° N in Mongolia, which accords with the figure of Mallon (1985). Thus, the currently understood limit of *C. rufocanus* lies at approximately 45°N in Mongolia, and 40°N in Korea and northeastern China (Manchuria ; Kaneko, 1990), and 41.5°N in the southern part of Hokkaido, Japan (Ota, 1984).

On the basis of the specimens examined and literature references, the habitats of *C. rufocanus* may be summarized as follows. The edge of the forest following along the northern edge of Mongolia is composed of mixed forests such as larches, firs and pines, as well as oaks and birches (Allen, 1940). Tapucha (Locality 13) contains a forest of nut pines (*Pinus cembra* ; Hollister, 1913). Hence, the habitats of *C. rufocanus* are mixed or coniferous forests, which are the same as those in Manchuria (Kaneko, 1990).

An unsolved problem concerns the identification of one specimen (BM 8. 8. 8. 83=original No. 1625) collected from the Chiao Cheng Shan (Locality 19) in December, 1907. I have not listed in Appendix A ; however, Thomas (1908b) identified the specimen as *Craseomys shanseius*. Its capsules have almost disappeared and the molars are about to form roots. Hinton (1926) mentioned that this specimen has rooted molars and an imperfect skull with a dental length of 15.4 mm suggesting a CBL of approximately 25.8 mm. He classified all the voles including this specimen from northern and central China as *Clethrionomys rufocanus*. My examination of this specimen confirms the development of roots and I-M3=15.4 mm. This specimen and *C. rufocanus* from Finland, therefore, have the same I-M3 size, which suggests the absence of alveolar capsules indicating root development (Fig. 1). However, identification of this specimen as *C. rufocanus* should be suspended until we can obtain more samples of *C. rufocanus* from the same district, especially because Locality 19 is isolated from the range of *C. rufocanus* given here.

Regarding the red-backed vole from Hopei Province, Thomas (1908b) identified one specimen (BM 8. 8. 7. 81=original No. 1549) from the Imperial Tombs (Locality 15) as *Craseomys regulus*. Allen (1924, 1940) recognized all five specimens collected from that locality as *Evotomys* (or *Clethrionomys*) *rufocanus shanseius*, and Hinton (1926) agreed. Kuroda (1939) identified large-sized voles from Altolian (Locality 9) and Mt. Mulei (Locality 13) as *C. rufocanus regulus*, and smaller voles collected from the same localities as a new subspecies of *Microtus inez jeholicus*, which are identified here as *E. shanseius*. Corbet (1978) and Honacki *et al*. (1982) described *E. regulus* as existing in Hopei Province and *E. shanseius* as possibly present in Hopei. In the present taxonomic conclusion, *E. regulus* and *E. shanseius* differ in tail length, interorbital width, and crown wear patterns on M_3, and the museum specimens from Hopei Province are identified as *E. shanseius*. The demarcation line between the species of *regulus* and *shanseius* may be the Liao-he Pingyuan River located in northeastern China.

Habitats of *E. shanseius*, based on the specimens examined and literature references, include bushes at the foot of a talus-slide in the Imperial Tombs (Locality 15; Thomas, 1908b), brush-covered valley-bottoms at the Chiao Cheng Shan (Locality 19; Thomas, 1908b), large rocks in or near dense spruce or larch woods, and overgrown gullies and canyons in Kolanchow (Locality 17; Thomas, 1909). This vole feeds upon leaves of young plants growing among rocks under which it burrows (Locality 19; Clark & Sowerby, 1912). *E. shanseius* apparently prefers rocky areas, as does *E. regulus* (Kaneko, 1990).

According to Allen (1940), Corbet (1978) and Honacki *et al*. (1982), the distribution of *E. inez* is the Provinces of Shansei and Shensi and extends to Hopei Province (=Nekka or Jehol). Apparently Hopei Province was mentioned as Kuroda (1939) referred to it in his description of *M. inez jeholicus*. However, because *jeholicus* is identified here as *E. shanseius*, the distribution of *E. inez* is now confined to the Provinces of Shansi and Shensi. *E. shanseius* and *E. inez* occur sympatrically in Kolanchow (Locality 17; Fig. 4), which confirms the description by Thomas (1909), who noted that the former is much less common than the latter.

The following are the habitats described previously and now identified as those of *E. inez*. The species was commonly found in the bottoms of certain narrow, wooded and overgrown gullies, in burrows in the soft soil beneath bush in Kolanchow (Locality 17; Thomas, 1909), and in the lower regions of well-vegetated loess ravines in Yen-an-fu (Locality 22; Clark & Sowerby, 1912).

The geographic range for *E. eva* has been cited as the Provinces of Kansu, Hupeh, and Szechwan (Corbet, 1978) or the Provinces of Kansu, Hupeh, Szechwan, and Shensi (Allen, 1940; Honacki *et al.*, 1982), because Allen (1940) examined specimens from the Tai-pei-shan, Shensi Province (Locality 29). I confirmed Allen's identification in this study, and thus the distribution includes Shensi Province. With keys for identification, Hu and Wang (1984) reported that *E. eva* appears at Zoige Xian (33°12′N, 102°54′E), Pingwu Xian (32°24′N, 104°30′E) and Heishu Xian (32°06′N, 103°06′E), Szechwan Province, which are located in the range of *E. eva* (Fig. 10). The demarcation between *E. inez* and *eva* is not clear. The two species were collected in the Qingling and Daba Shan Mountains, Shensi Province (Zheng, 1982; Wang, 1990), and the southern part of Kansu Province (Zheng & Zhang, 1990). However, because their identifications have not been verified, further studies should be carried out in these districts.

The distribution of *C. rufocanus* is separated from that of the three species of *Eothenomys* by the Gobi Desert. The range of these three *Eothenomys* indicates that they occur mostly in the southeastern border of the Palaearctic Region in China (Editorial Committee of China Natural Geography in Academia Sinica, 1979) except for *E. eva*, which can be found along into the northern border (Hupeh Province) of the Oriental Region.

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Appendix A

Specimens Examined

Locality numbers used in this study (see Fig. 10), locality, latitude and longitude, month and year collected, museum, and registration number of all specimens examined are listed below from north to south. Locality numbers 1–8 refer to *Clethrionomys rufocanus*, numbers 9–16, 17 (selected specimens), 18 and 19 to *Eothenomys shanseius*, numbers 17 (selected specimens), 20–23, 25, 28 and 30 to *E. inez*, and numbers 24, 26, 27, 29 and 31–37 to *E. eva*.

1. Leestvineechnoya, Irkutsk, USSR ; approximately 52°10′N, 104°12′E ; July, 1914 ; BM 14. 11. 1. 78–81, 14. 11. 1. 83–86, 15. 3. 9. 35–40.
2. Syansk Mts., 100 miles W of Lake Baikal, USSR ; 51°42′N, 102°09′E ; June, 1910 ; BM 12. 4. 1. 79–83.
3. Tapucha, Altai, USSR ; approximately 51°04′N, 85°37′E ; August, 1912 ; USNM 175454–56, 175458, MCZ 14322.
4. Tchegan–Burgazi Pass, Altai, USSR ; 49°38′N, 89°26′E ; July, 1912 ; USNM 175453.
5. Katon–Karagai, Bukhtarmo River, Altai, USSR ; 49°10′N, 85°38′E ; November, 1927 ; BM 28. 6. 19. 41/August, 1930 ; BM 28. 6. 19. 40, 28. 6. 19. 42.
6. 45 miles NE of Urga (=Ulan Bator), Mongolia ; 48°21′N, 107°34′E ; July, 1919 ; AMNH 46232, FMNH 30525–26, MCZ 21364, 21370/August, 1919 ; BM 29. 3. 17. 145, USNM 259911–12, AMNH 46047, 46049, 46237, FMNH 30524, 30528–30, 30532, 30534–35, MCZ 21365.
7. 15 miles NE of Urga (=Ulan Bator), Mongolia ; 48°03′N, 107°08′E ; September, 1919 ; AMNH 46305, 46314, MCZ 21368–69, 21535.
8. Sain Noin Khan (=Uyanga), Mongolia ; 46°17′N, 102°12′E ; June, 1922 ; AMNH 57483–84, 57488, 57491, 57496, 57500–01, 57503–06, FMNH 30537, MCZ 21366–67.
9. Altorian (=near Sandaoheize), Hopei Province, China : 40°48′N, 119°00′E : October, 1935 ; YIO 862–66, 890–95.
10. Kweihwa Cheng (=Hohhot Shi), Inner Mongolia, China ; 40°48′N, 111°42′E ; November, 1919 ; AMNH 45429, 45436 (the skin is housed in FMNH as

33719), FMNH 33717–18, MCZ 21372–74/December, 1921; AMNH 56344.

11. Mts. 30 miles W of Kweihwa Cheng (=Hohhot Shi), Inner Mongolia, China; 40°48′N, 111°07′E; May, 1912; USNM 175527–28, AMNH 36896.
12. Mt. Wula Shan, Inner Mongolia, China; 40°42′N, 109°24′E; June, 1978; ASZI 21962–78.
13. Mt. Mulei (=Mt. Wuling Shan), Hopei Province, China; 40°36′N, 117°30′E; September, 1935; YIO 857 (the holotype of *Microtus inez jeholicus* Kuroda, 1939), 858–61, 884–89.
14. Xinglong Xian, Hopei Province, China; 40°24′N, 117°30′E; September, 1976; ASZI 26643.
15. Imperial Tombs (=Qing Dongling), Beijing, China; 40°06′N, 117°36′E; September, 1907; BM 8. 8. 7. 81/December, 1921; AMNH 56349/January, 1922; AMNH 56347.
16. Shijiayan, Beijing, China; 39°48′N, 115°36′E; September, 1970; ASZI 24956/September, 1987; ASZI field numbers=K5703–04 (the registration numbers are unknown).
17. Mts. 12 miles NW of Kolanchow (=Kelan Xian), Shansi Province, China; 38°50′N, 111°25′E; May, 1908; BM 9. 1. 1. 188 (the holotype of *Microtus* (*Eothenomys*) *inez* Thomas, 1908), 9. 1. 1. 187, 9. 1. 1. 189–90/June, 1908; BM 9. 1. 1. 181–86, 9. 1. 1. 191–201. The registration numbers BM 9. 1. 1. 196–201 refer to *E. shanseius*, and the other numbers to *E. inez*.
18. Mt. 50 miles NW of Taiyuan-fu (=Taiyuan Shi), Shansi Province, China; 38°23′N, 111°55′E: December, 1909; USNM 172591–92, 172594–95/January, 1910; USNM 172596.
19. Chao Cheng Shan (=Mt. Gandi Shan or Mt. Nanyan Shan), Shansi Province, China; 37°54′N, 111°30′E; November, 1907; BM 8. 8. 7. 82, 8. 8. 7. 89–91/December, 1907; BM 8. 8. 7. 85 (the holotype of *Craseomys shanseius* Thomas, 1908), 8. 8. 7. 84, 8. 8. 7. 86–88, 8. 8. 7. 92–93/October, 1908; USNM 155050–55. Restriction of the type locality of *Craseomys shanseius* is explained in Appendix B.
20. Zanhuang Xian, Hopei Province, China; 37°36′N, 114°24′E; June, 1963; ASZI 23270.
21. Guanshang, Shansi Province, China; 37°12′N, 111°12′E; July, 1960; ASZI 16857.
22. 12 miles S of Yen-an-fu (=Yan'an Shi), Shensi Province, China; 36°25′N, 109°30′E; January, 1909; USNM 155049.
23. Qinshui Xian, Shansi Province, China; 35°42′N, 112°12′E; May, 1962; ASZI 19488.
24. Near Guru, Chinghai Province, China; 35°36′N, 102°36′E; July, 1983; ASNPIB 88021, 88023.
25. Yuanqu Xian, Shansi Province, China; 35°18′N, 111°36′E; June, 1962; ASZI 19490, 19492/July, 1962; ASZI 19489, 19491.
26. Tauchow (=Lintan Xian), Kansu Province, China; 34°42′N, 103°24′E: April, 1910; BM 11. 2. 1. 223 (the holotype of *Microtus* (*Caryomys*) *eva*

Thomas, 1911), 11. 2. 1. 224–26/April, 1911; FMNH 19082–83/September, 1911; BM 12. 8. 5. 49–51, 12. 8. 5. 54–56, 12. 8. 5. 59/October, 1911; BM 12. 8. 5. 52–53.

27. Choni (=Jone Xian), Kansu Province, China; 34°36′N, 103°36′E; September, 1925; MCZ 24464/October, 1926; MCZ 24200–01.
28. Lonan Hsien (=Luonan Xian), Shensi Province, China; 34°06′N, 111°06′E; December, 1909; BM 10. 5. 2. 87.
29. Tai-pei-shan (=Mt. Taibai Shan), Shensi Province, China; 33°54′N, 107° 42′E; January, 1910; BM 11. 6. 1. 55/September, 1921; AMNH 56380 (the skin is housed in MCZ as 21294), 56383, FMNH 39391/October, 1921; AMNH 56369, 56371, 56373, 56375, 56377–78, 56379 (the skin is housed in MCZ as 21295), 56381–82, FMNH 39392.
30. Shang-chou District (=Shang Xian), Shensi Province, China; 33°54′N, 109° 54′E; November, 1909; BM 10. 5. 2. 79 (the holotype of *Microtus* (*Eothenomys*) *nux* Thomas, 1910), 10. 5. 2. 75, 10. 5. 2. 81–82, 10. 5. 2. 84–86, USNM 171967–69.
31. Wen Xian, Kansu Province, China; 32°54′N, 104′42°E; August, 1987; ASZI field number=K5684 (the registration number is unknown).
32. Fang Hsien (=Fang Xian), Hupeh Province, China; 32°06°N, 110′42°E; December, 1907; MCZ 7191, 7194.
33. Barkam Xian, Szechwan Province, China; 31°54′N, 102°30′E; June, 1961; ASZI 20824–25.
34. Showlungtan, Hupeh Province, China; approximately 31°36′N, 110°06′E; May, 1907; MCZ 7190 (the holotype of *Craseomys aquilus* Allen, 1912), 7196, BM 13. 9. 13. 10. Restriction of the type locality of *Craseomys aquilus* is explained in Appendix B.
35. Weichoe (=Wenchuan Xian), Szechwan Province, China; 31°24′N, 103°30′ E; November, 1910; BM 11. 9. 8. 136 (the holotype of *Microtus* (*Caryomys*) *alcinous* Thomas, 1911), 11. 9. 8. 128, 11. 9. 8. 130, 11. 9. 8. 133–34, 11. 9. 8. 137–38.
36. Wansonshan (=Mt. Wantiao Shan), Hupeh Province, China; 31°12′N, 110° 30′E; June, 1907; MCZ 7189.
37. Goan Shid Dwe (=near Guan Xian), Szechwan Province, China; 31°00′N, 103°36′E; August, 1934; FMNH 45760.

Appendix B

Fixing the Type Locality of Craseomys shanseius *Thomas, 1908 and* Caryomys aquilus *Allen, 1912*

1. *Craseomys shanseius* Thomas, 1908 (BM 8. 8. 7. 85; Locality 19)

The type locality has been given as "100 miles N. W. of Tai-Yuen-Fu, Shansi (8000′), China" (Thomas, 1908b; Hinton, 1926; Allen, 1940; Ellerman & Morrison-Scott, 1951; Corbet, 1978; Honacki *et al*., 1982). However, Malcom P. Anderson, who collected the type specimen on December 4, 1907 (Thomas, 1908b), noted that "On 17th November I began work at Chao-Cheng-Shan, a mountain of 10,000 ft altitude situated about 100 miles west-north-west of Tai-Yuen-Fu" and "remained in this place till December 6th, 1907" (Thomas, 1908b). Therefore, I judge "100 miles N. W. of Tai-Yuen-Fu" to be "Chao-Cheng-Shan".

According to Anderson (1920), "Chao-Cheng-Shang" is a group of three summits, the highest of which is called "Mo-er-shan". The description can be confirmed from his picture (Anderson, 1920). The exact location of "Chao-Cheng-Shan" or "Mo-er-Shan", however, has never been restricted until now, because current Chinese maps and atlases do not refer to these localities. Clark and Sowerby (1912) collected six specimens of *Craseomys shanseius* (USNM 155050-55), and noted that specimen No. 41 (=now USNM 155055) was caught on the summit of Mo-erh-shan and the type specimen was collected from the same district. On the skin label of the specimen (USNM 155055), there is a note in pencil as "Essentially a topotype". Thus, I found Mt. Mo-erh-shan (about 37°55′N, 111°30′E ; alt. 9296 ft=2789 m) on the route map of the Clark expedition (Clark & Sowerby, 1912).

Next, I identified the current place name of Mt. Mo-er(h)-shan as Mt. Guandi Shan or Mt. Nanyanshan (37°54′N, 111°30′E, alt. 2831 m ; Altas Publication Company, 1979 ; Zhuang, 1983). Their equivalence accords with the latitude, longitude and altitude of the mountain, the running direction of the river, and the name of nearby towns.

2. *Craseomys aquilus* Allen, 1912 (MCZ 7190 ; Locality 34)

The type locality has been given as "Showlungtan, Hupeh, China" (Allen, 1912, 1940 ; Hinton, 1926 ; Ellerman & Morrison-Scott, 1951). "Showlungtan" was marked on a handwritten map housed in the MCZ, which was drawn by Walter R. Zappey, the collecter of this holotype. Current Chinese atlases, however, do not refer to "Showlungtan" or "Haso-lung-tang", which was noted by Wilson (1913) who went to Hupeh with Mr. Zappey. The Location of Mt. Wantiao Shan (=Mt. Wansonshan : Allen, 1912 or Mt. Wanchaoshan : Wilson, 1913) and the running direction of the Jiudaoling He River, one of the branches of the Han Shui River, accord on both Zappey's map and the Hupeh Province map (scale=1 : 1,100,000 ; Altas Publication Company, 1982). On the other hand, the location of Hsienshan Hsien (=Xingshan Xian) and the running direction of the Chang Jiang and Xiang Xi Rivers are different on both maps. Because the location of Zappey's "Showlungtan" coincides approximately with that of Hongping on the Province map, I restrict "Showlungtan" to approximately 31°36′N and 110°06′E using the location of Hongping given by the Atlas Publication Company (1979).