

Taxonomic Status of the Large Mole from the Echigo Plain, Central Japan, with Description of a New Species (Mammalia, Insectivora, Talpidae)

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Abstract A new species of the genus *Mogera* is described from the Echigo Plain in central Japan under the name of *Mogera etigo*. It is similar to *M. tokudae* from Sado Island in such primitive characters as vertebral formula and shape of muzzle pad, but is different from *M. tokudae* in much larger relative values of body and cranial dimensions, larger manus, and smaller upper and lower second premolars, the last feature of which seems to indicate relatively advanced stage of evolution.

It has been known that a large mole occurs in the Echigo Plain, Chûbu District, Honshu, Japan. ABE (1967) identified it with *Mogera tokudae* KURODA, 1940, from Sado Island, off central Honshu, on the basis of specimens obtained at Kameda, and Shibata in the Echigo Plain. TSUCHIYA and USUKI (1966) considered their *M. kobeae* with same reservation, while YH. and T. IMAIZUMI (1970) tentatively regarded it as *M. tokudae*.

We examined sixty-two specimens of the mole from fifteen populations in the Echigo Plain and forty-eight specimens of *M. tokudae* from three populations in Sado Island (Fig. 1, Table 1). As the result, we came to the conclusion that the former is not *M. tokudae* but an unknown species.

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Mogera etigo sp. nov.

[Japanese name: Echigo-mogura]

(Figs. 1–6)

Mogera kobeae: TSUCHIYA & USUKI, 1966, J. mamm. Soc. Japan, 2: 158.

Mogera tokudae: ABE, 1967, J. Fac. Agr. Hokkaido Univ., Sapporo, 55: 260. — YH. & T. IMAIZUMI, 1970, J. mamm. Soc. Japan, 5: 15. [Partim.]

Holotype. NSMT-M 29390, old male, study skin and skull, collected from Inugaeshi-shinden, Shirone-shi, Echigo Plain, Niigata Prefecture, Chûbu District,

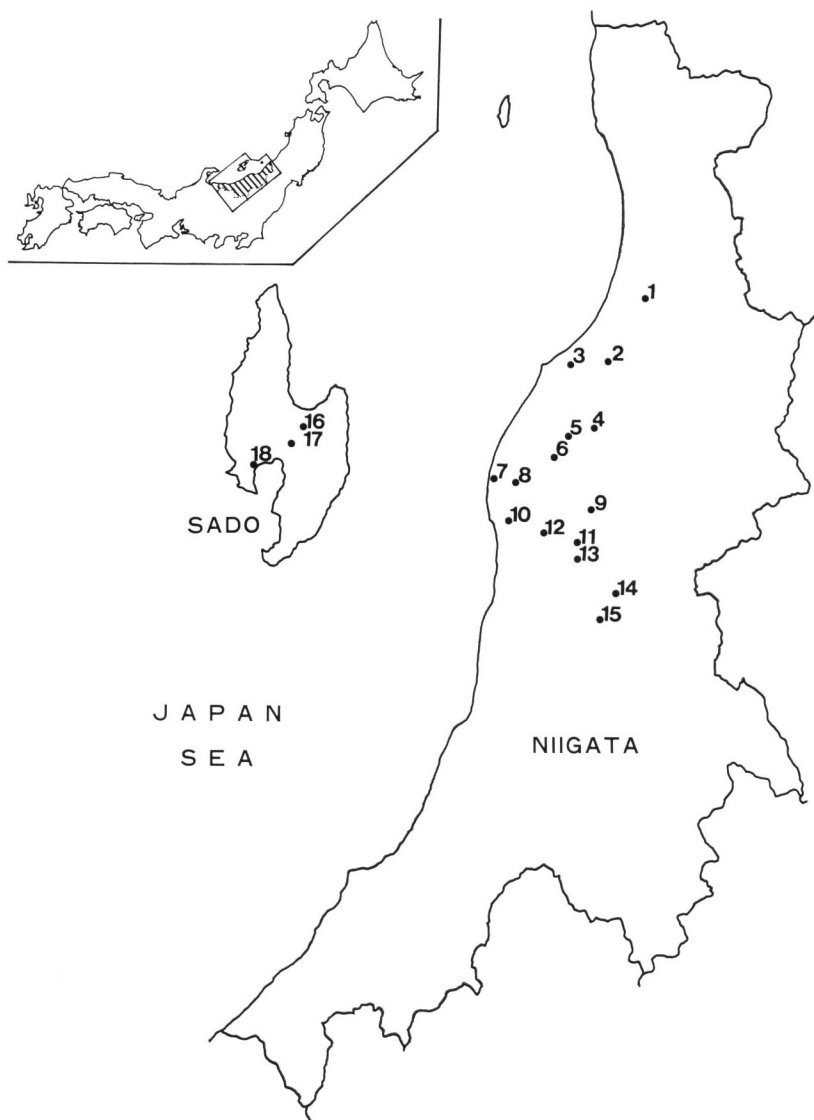


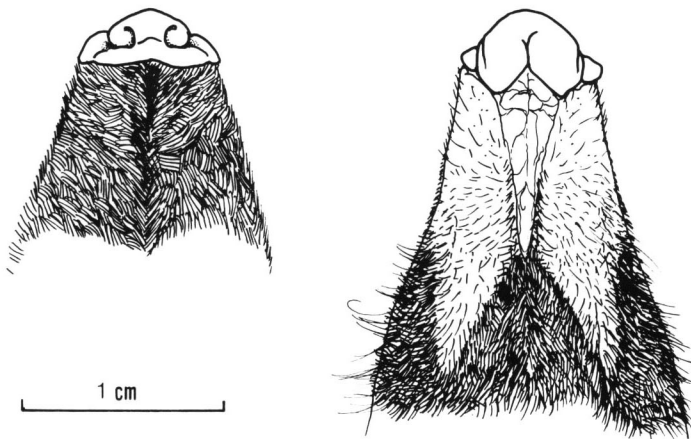
Fig. 1. Map showing the collecting sites of *Mogera etigo* sp. nov. and *Mogera tokudae*.

Honshu, Japan, by Mr. Eiichi Tanaka, August 1990. The holotype is preserved in the Mammal Section, Department of Zoology, National Science Museum, Tokyo.

Measurements of holotype (in mm). Head and body 172.0, tail 23.0, hind foot cum unguis 28.0, hind foot sine unguis 23.0, manus cum unguis 32, manus sine unguis 25, breadth of manus 25.5, body weight 167.1 g, greatest length of skull without i 42.36,

Table 1. Material examined of *Mogera etigo* sp. nov. from the Echigo Plain.

	Collecting sites	Collector	Number
1.	Kajikawa-mura, Kitakanbara-gun	Yoshiharu IMAIZUMI	1 ♂
2.	Haizuka, Toyosaka-shi	Ôyô Geological Corporation	2 ♂♂
3.	Nigorikawa, Niigata-shi	Ditto	2 ♂♂ 1 ♀
4.	Niitsu-shi	Yoshiharu IMAIZUMI	1 ♂
5.	Inugaeshi-shinden, Shirone-shi	Eiichi TANAKA	14 ♂♂ 16 ♀♀
6.	Ajikata-mura, Nishikanbara-gun	Yoshiharu IMAIZUMI	1 ♂ 1 ♀
7.	Mt. Kakuda, Nishikanbara-gun	Kimiyuki TSUCHIYA	1 ♂ 1 ♀
8.	Maki-chô, Nishikanbara-gun	Yoshiharu IMAIZUMI & Tadaaki IMAIZUMI	1 ♀
9.	Kamo-shi	Hideaki USUKI	1 ♀
10.	Yahiko-mura, Nishikanbara-gun	Yoshiharu IMAIZUMI	2 ♂♂ 1 ♀
11.	Honjôji, Sanjô-shi	Yoshiharu IMAIZUMI & Tadaaki IMAIZUMI	2 ♂♂ 1 ♀
12.	Dôukin, Tsubame-shi	Ôyô Geological Corporation	2 ♂♂ 3 ♀♀
13.	Sakae-mura, Minamikanbara-gun	Yoshiharu IMAIZUMI & Tadaaki IMAIZUMI	1 ♀
14.	Tochio-shi	Hideaki USUKI	2 ♂♂ 1 ♀
15.	Ichi-no-kai and Ôkawato Tochio-shi	Yoshiharu IMAIZUMI	2 ♂♂ 2 ♀♀

Fig. 2. Muzzle pad and naked patch of *Mogera etigo* sp. nov., NSMT-M 29606, ♀, from Dôukin, Tsubame-shi, Niigata Prefecture. Left, ventral aspect; Right, dorsal aspect.

condylobasal length without i 41.37, zygomatic width 15.56, mastoid width 19.79, depth of braincase 10.89, interorbital constriction 7.8, rostrum at canines 5.81, width across upper canines (crown) 5.56, length of auditory bulla 5.75, width across M2–M2 (alveoli) 11.52, length of C–M3 (crown) 16.68, upper tooth row (crown) 18.42, length of mandible 27.26, length of pl–m3 (crown) 14.89, lower tooth row (crown) 17.29.

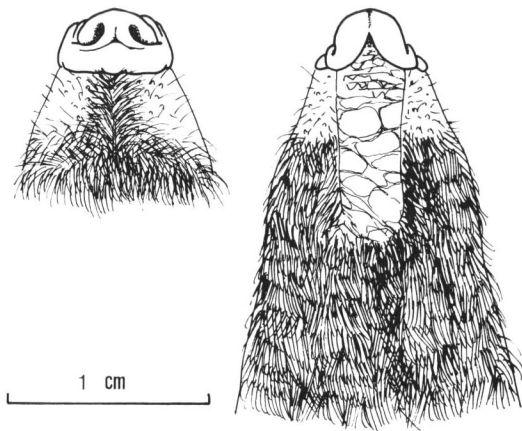


Fig. 3. Muzzle pad and naked patch of *Mogera kobeeae*, NSMT-M 28175, ♂, from Nishi-ku, Fukuoka-shi, Fukuoka Prefecture. Left, ventral aspect; Right, dorsal aspect.

Table 2. Variation of external, cranial and dental measurements of *Mogera etigo* sp. nov. from the Echigo Plain and coefficient differences between *M. etigo* and *M. tokudae*.

	N	M	SD	CD	Non overlap %
Head and Body	62	160.3	±8.61	0.64	74
Tail	62	26.5	±2.95	0.06	70
Hind foot (cu)	62	27.2	±1.07	1.48	93
Manus (cu)	62	30.0	±1.34	1.71	96
Greatest length of skull	50	41.41	±0.71	1.69	95
Zygomatic width	53	15.07	±0.37	1.04	85
Mastoid width	53	19.34	±0.48	1.14	87
C-C	55	5.15	±0.25	1.28	90
M2-M2	55	11.17	±0.37	1.39	92
C-M3	53	16.24	±0.40	1.96	98
Mandible	57	26.54	±0.73	1.05	85
p1-m3	57	14.73	±0.34	1.28	90

Specimens examined. See Table 1 and Fig. 1.

Diagnosis. Similar to *Mogera tokudae* KURODA, 1940, from Sado Island in general aspects such as the shape of naked muzzle patch and upper incisor row, large meatus, vertebral formula, etc., but much larger in relative sizes of body parts and cranial dimensions, with relatively large manus cum unguis, more than 70% of the greatest length of skull. Mean value of manus cum unguis 30.0 mm, and that of the greatest length of skull 41.4 mm.

Description. External characters: The largest species of the Japanese moles of the genus *Mogera*; on average HB 160.3 (N=62), T and T% 26.5 and 16.5% (N=62),

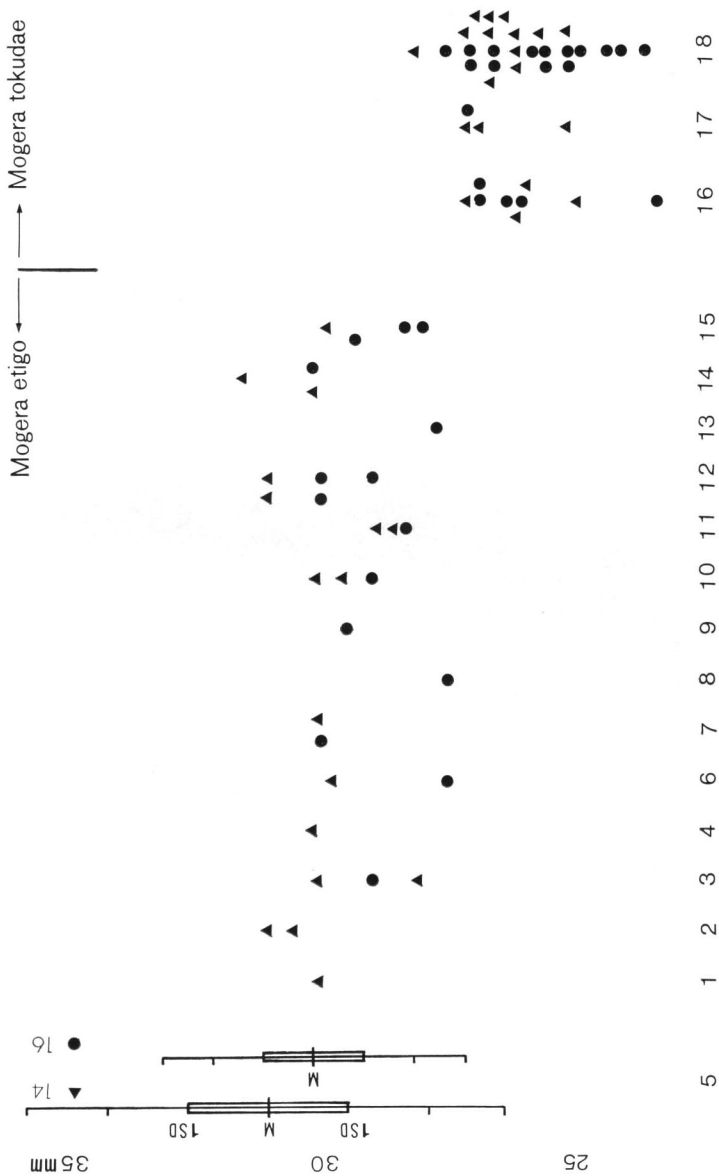


Fig. 4. Differences in the length of manus cum unguis between *Mogera etigo* and *M. tokudae*. Scatter diagram, showing mean values of the lengths of manus cum unguis in Shirone-shi and individual measurements of the same length in the other populations examined. The numbers indicate population numbers examined. M, mean value; SD, standard deviation; triangle mark, male; circular mark, female.



Fig. 5. Skull of *Mogera etigo* sp. nov., holotype, NSMT-M 29390, old male. — A, Dorsal aspect of cranium. B, ventral aspect of cranium. C, lateral aspect of skull.

HF (cu) 27.2 (N=62), HF (su) 23.1 (N=62), Manus (cu) 30.0 (N=62) (in mm), BWt. 136 g (N=62) (Table 2).

Muzzle pad well developed, with loosely convex anterior margin, and sharply concave posterior margin in dorsal aspect, naked patch on upper surface of muzzle behind muzzle pad wrinkled along median line, lozenge-shaped in outline (Fig. 2); eye

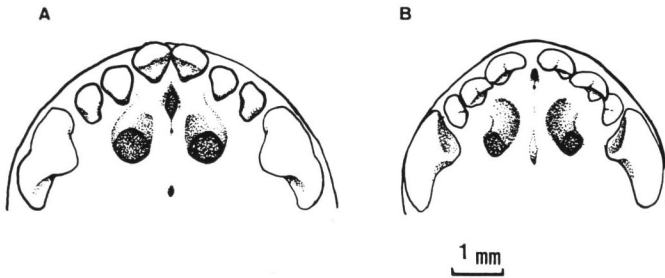


Fig. 6. Incisive foramen and anterior palatine foramina. — A, *Mogera etigo* sp. nov., holotype, NSMT-M 29390, old male. B, *Mogera tokudae*, NSMT-M 16457, adult male, from Sawane, Ikari, Sawada-machi, Sado Island.

and meatus of ear large, the latter 5 mm on an average; forefeet and nail large, but rather narrow, tail long, thickened, as long as hind foot in general. Dorsal fur long, 5–10 mm in length, dark greyish brown in colour, proximal portions of hairs dark grey, ventral fur shorter than the dorsal and slightly paler, ventral hairs not much smeared by secretion of sebaceous gland.

Skull and teeth: Skull long and massive; on average GLS 41.41 (N=50), ZYG 15.07 (N=53), MAST 19.34 (N=53), ROST 5.58 (N=51), C-C 5.15 (N=55), M2-M2 11.17 (N=55), C-M3 16.23 (N=53), Mand 26.54 (N=57), pm1-m3 14.73 (N=57), M1 3.31 (N=54) (in mm).

Zygomatic width narrower than mastoid width; rostrum rather narrow, sagittal crest weak; anterior naris comparatively large, quadrate in outline, its total breadth about 3.0 mm, its posterior end lying at the posterior level of upper canine; ante-orbital foramen wide and shallow, its posterior end lying at the mid-level of upper second molar (M2); ante-orbital bridge between the foramen and orbit short and thick; palate generally wider than that of *tokudae*, incisive foramen and anterior palatine foramina well developed, larger than those in *tokudae*; auditory bulla rather inflated and circular in shape, its antero-posterior length about 5.2 mm, auditory meatus large and semicircular, its antero-posterior dimension about 4.3 mm, slightly shorter than that of auditory bulla. Mandible with rather weak coronoidal process, its masseteric fossa well developed.

Upper incisors arrange in a reversed V-shape, third incisor the smallest, its crown area almost half of first incisor; second upper premolar (PM 2) the smallest of upper premolars and about half of third upper premolar in antero-posterior diameter, instead of about two-thirds in *tokudae*; upper molars large, metacone of first molar larger than paracone in crown area; lower incisors subequal in breadth, second lower premolar (pm 2) smaller than third premolar (pm 3), its antero-posterior diameter about two-thirds of the latter, first lower and second molars subequal in crown area.

Dentition: $13/2 \text{ CI}/1 \text{ PM}4/4 \text{ M}3/3=42$. Vertebral formula: C. 7, T. 13, L. 6, S. 6, C. 13. Mammae 10.

Discussion

Relationship between M. etigo and M. tokudae. TOKUDA (1933) first recorded *M. wogura* ssp. from Sado Island; later KURODA (1940) examined a specimen from Sado Island, and named it *M. wogura tokudae*. IMAIZUMI (1970 a) treated it as *Mogera kobeae tokudae* based on a series from Sado, as the skulls is decidedly larger than that of typical *wogura* and similar to that of *M. kobeae*. On the other hand, ABE (1967) stated that the Sado form belonged neither to *M. kobeae* nor to *M. wogura*, but to a distinct speices, *M. tokudae*. YOSHIYUKI (1986) made a comparative study between twenty-two skeletons of *M. tokudae* from Niibo-mura and Sawada-machi in Sado and those of *M. wogura*, *M. minor*, *M. kobeae* and *Euroscaptor mizura*. This has revealed that the vertebral formula of *M. tokudae* (7,13,6,6,13) is similar to that of *Euroscaptor mizura*, which is the smallest and undoubtedly the most primitive species of the Japanese true moles. The vertebral formula of *etigo* seems to indicate that this species belongs to the group of *M. tokudae* and *E. mizura*, not to the group of *M. kobeae* and *M. minor* (vertebral formula: 7, 14, 5, 6, 12).

Mogera tokudae and *M. etigo* differ from *Euroscaptor mizura* (= *Mogera mizura*) in lacking the third lower incisor and distinctly larger sizes of body, skull and teeth. They seem to belong to the same group, as they are more primitive than the rest of the Japanese members of *Mogera* in rather long tail, longer fur, larger meatus and V-like upper incisive row. However, *M. tokudae* and *M. etigo* are easily distinguished from each other by external, cranial and dental measurements as shown by coefficient of difference (CD) (Table 2).

Non-overlap percent between *M. tokudae* and *M. etigo* are more than 90%, that is, 93% in HF (cu), 96% in Manus (cu), 95% in GLS, 98% in C-M3, 90% in C-C, 90% in p1-m3, 92% in M2-M2, and also, the second upper and lower premolars of *M. etigo* are distinctly smaller than those of *M. tokudae*, showing an advanced stage of evolution.

IMAIZUMI (1970 b) recognized three groups of local populations in the Japanese forms of the genus *Mogera* excluding *M. tokudae*. These groups were well defined by clinal variation of the greatest skull length. The clines became clearly recognized when correlative relations were calculated between mean value of the skull length in small local populations and local temperature indices (X), the latter of which were obtained by adding altitude in meter $\times 0.4/100$ to latitude of collecting sites. The three groups of local populations representing clines corresponded to the taxa of *minor*, *wogura* and *kobeae* inclusive of *kiusiuana* and could be expressed by a formula, $Y_c = a + bX$, as follows; $27.18 + 0.15 X$ in *minor*, $27.65 + 0.22 X$ in *wogura*, $16.86 + 0.61 X$ in *kobeae*. Intermediate populations were not observed among them. As all the local populations belonging to the same cline have in common the values of *a* and *b* of the formula, the difference in the size of skull between the northern and southern distributional areas may not be essential. For this reason, he regarded a population belonging to a cline as distinct species. This inference can also be strengthened by the fact that the three

populations are undoubtedly different from one another in relative times of distributional expansion in the past as is clearly seen in the patterns of their geographical distribution. Besides, *kobeae* and *minor* are sympatric in the Hiwa area, Hiroshima Prefecture, which suggests that the two species are specifically different. Accordingly, the difference in the relative value of skull length, namely in the mean value of skull length of a local population in a zone of the same temperature index, may suggest difference at the species level, at least in the group of *Mogera*.

All the Sado and Echigo populations examined are distributed between 37° and 38° in latitude, or within one latitude, and vertically their ranges are lower than 100 m in altitude. These facts mean that they are not different in the temperature index, as clearly shown by the same average yearly temperature, 13.1°C, observed at Aikawa in Sado and Niigata in the Echigo Plain from 1951 to 1980 (RIKA NENPYÔ, 1990).

Occurrence of statistically distinct larger and smaller forms in a region of the same temperature index seems to indicate that they belong to two different clines, which suggests that they are different species. The smaller form in relative value is *M. tokudae* and the larger one *M. etigo*.

Relationship between M. etigo and M. kobeae. Geographical variation of *M. kobeae* is remarkable, the largest specimens being found in the Ina population of Nagano Prefecture, Chûbu District, Honshu. The mean value of the greatest length of skull in *M. etigo* is contained in the range of that of Ina population of *Mogera kobeae*. However, *M. etigo* differs from *M. kobeae* in the following characters. Numbers of thoracic, lumbar and caudal vertebrae of the former are different from those of the latter, which has 14 thoracic, 5 lumbar, 6 sacral and 12 caudal vertebrae, namely, thorax with 14 ribs instead of 13, lumbar and caudal vertebrae with lesser number of bones. The muzzle pad is well developed in *M. etigo*, and the shape of naked muzzle patch behind the muzzle pad is lozenge-shaped in *etigo*, while in *kobeae*, the muzzle pad is small with large rectangular naked area (Figs. 2-3). In *M. kobeae*, the upper incisors are arranged in a semicircle instead of V-shape. Therefore, there remains little doubt about the specific independency of *M. etigo*, even though the dimension of the greatest length of skull in the Ina population, which is at the northern periphery of distribution of *M. kobeae*, is contained in the range of the former.

References

- ABE, H., 1967. Classification and biology of Japanese Insectivora (Mammalia). 1. Studies on variation and classification. *J. Fac. Agr. Hokkaido Univ.*, **55**: 192-265, pls. 1-2.
- IMAIZUMI, YH., & T. IMAIZUMI, 1970. Interspecific relationship in two mole species in the plains of Niigata, Honshu. *J. mamm. Soc. Japan*, **5**: 15-18. (In Japanese with English summary.)
- IMAIZUMI, Y., 1970 a. The Handbook of Japanese Land Mammals, Vol. I. xxx+350 pp. Tokyo, Shin-shichô-sha. (In Japanese.)
- 1970 b. Land mammals of the Tsushima Islands, Japan. *Mem. natn. Sci. Mus., Tokyo*, (3): 159-176. (In Japanese with English summary.)
- KURODA, N., 1940. A Monograph of Japanese Mammals Exclusive of Sirenia and Cetacea. 311 pp.,

- 48 pls. Sanseido, Tokyo and Osaka. (In Japanese.)
- RIKA NENPYÔ (NAT. ASTRONOM. OBSERV.), 1990. Chronological Scientific Tables. 20+1032 pp. Tokyo, Maruzen. (In Japanese.)
- TOKUDA, M., 1933. Preliminary notes on some small mammals from Sado Island. *Annot. zool. japon.*, **14**: 238–241.
- TSUCHIYA, K., & H. USUKI, 1966. An abnormal record of mammal formula of a Japanese mole. *J. mamm. Soc. Japan*, **2**: 158. (In Japanese.)
- YOSHIYUKI, M., 1986. The phylogenetic status of *Mogera tokudae* KURODA, 1940 on the basis of body skeletons. *Mem. natn. Sci. Mus., Tokyo*, (19): 203–213. (In Japanese with English summary.)