

Finding *Euroscaptor mizura* (Mammalia: Insectivora) and Its Nest from under *Hebeloma radicosum* (Fungi: Agaricales) in Ashiu, Kyoto, with Data of Possible Contiguous Occurrences of Three Talpine Species in This Region

Naohiko SAGARA, Shuji KOBAYASHI, Hidetoshi OTA,

Toyoaki ITSUBO and Hiroaki OKABE

ABSTRACT We examined nests and other traces of moles in Ashiu, Kyoto, beneath fruit bodies of a mushroom species, *Hebeloma radicosum*, which grows on the underground latrines of small mammals. We also attempted to catch animals at nesting sites which were detected through the fungal fruiting. As a result, an adult specimen of a talpine mole species, *Euroscaptor mizura*, was collected together with its nest. This is the first record of *E. mizura* from Ashiu region. Also, this is the first report of the nest of *E. mizura*, of the mushroom-mole nest association in *H. radicosum* and *E. mizura*, and of the capture of a mole at the nesting site under indication of the fungus. Morphological features of the animal and structure of the nest are described. This finding further revealed a contiguousness in the distribution of three talpine species, *E. mizura*, *Mogera wogura* and *Mogera kobeae* in Ashiu.

KEY WORDS *Euroscaptor mizura*/ *Hebeloma radicosum*/ nest/ capture/ *Mogera wogura*/ *Mogera kobeae*/ distribution

Introduction

The mushroom species, *Hebeloma radicosum* (Fr.) Ricken has been found to grow and fruit on deserted latrines of moles and shrew moles near their nests (Sagara, 1978, 1980; Sagara *et al.*, 1981). In the course of verifying this phenomenon in Ashiu, the northeastern part of Kyoto Prefecture, we came to suspect the occurrence of a talpine species, *Euroscaptor mizura* (Günther), a species previously unrecorded from this region (Fig. 1). This suspicion first arose in 1981 from examination of mammalian hairs left in the nest which had been excavated from under the fruit bodies of *H. radicosum*. Since then, three more nests containing similar hairs have been obtained in the Ashiu region (Sagara, unpublished). Eventually, we captured a live specimen of *E. mizura* at one of these nest sites in 1987.

In this paper, we report the method of capture and describe the specimen and the nest of the mole. We also note some evidences for the unusual, closely neighbouring or intermixed occurrences of the three talpine mole species, *E. mizura*, *Mogera wogura* (Temminck) (*sensu* Abe, 1967) and *Mogera kobeae* Thomas in Ashiu.

Study Area and Method

1. Locality.

Kami-tani, Ashiu (Kyoto University Ashiu Experimental Forest), Miyama-cho,

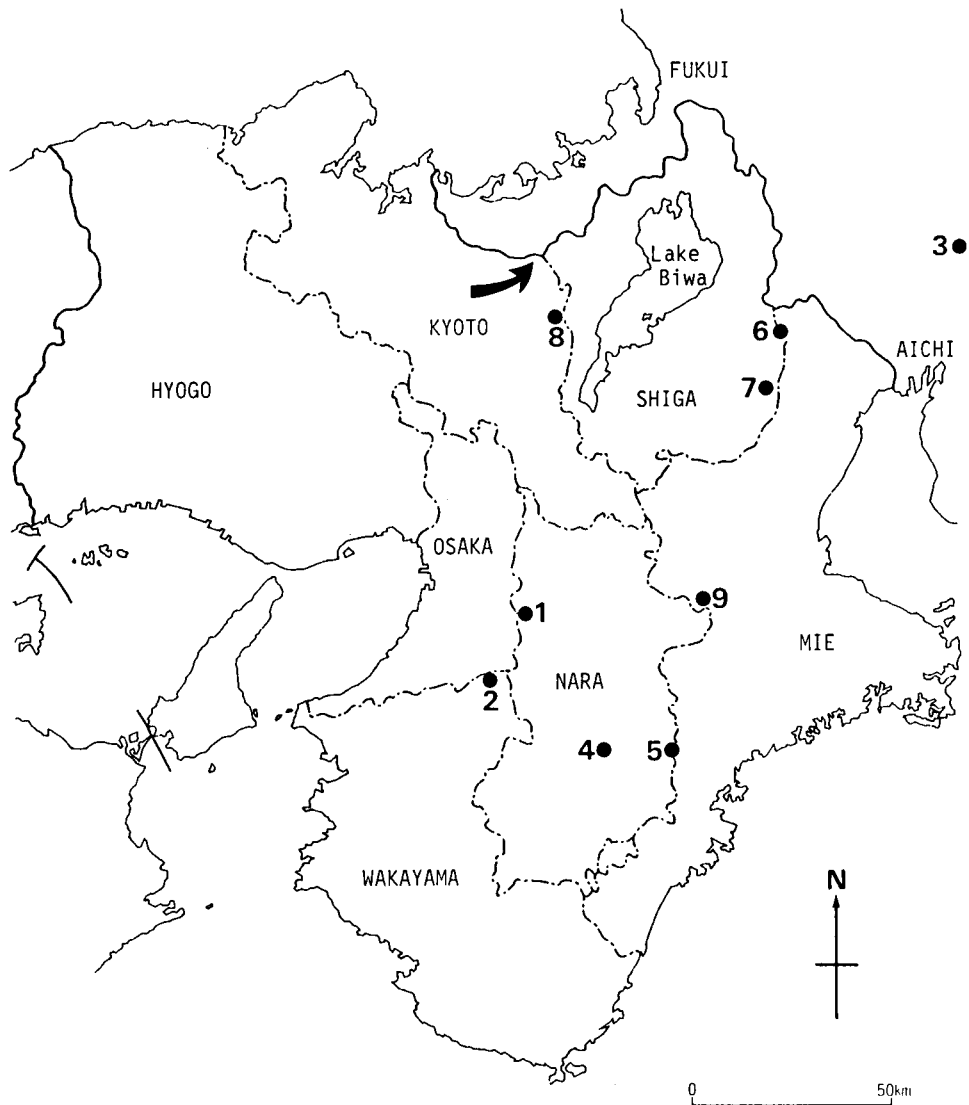


Fig. 1. Map of Kinki District and adjacent areas showing the localities where *Euroscaptor mizura* has been recorded. Arrow indicates the location of Ashiu reported in this paper. 1, Mt. Nijyo-zan, Taima-cho, Kita-katsuragi-gun, Nara Prefecture (Taruno, 1978). 2, Neko-dani, Hashimoto City, Wakayama Prefecture (Taruno, 1978). 3, Inuyama National Forest, Inuyama City, Aichi Prefecture (Kimura & Hirose, 1982). 4, Mt. Misen in Ohmine Mountain Range, Tenkawa-mura, Yoshino-gun, Nara Prefecture (Shimizu, 1984). 5, Mt. Ohdaigahara, Kami-kitayama-mura, Yoshino-gun, Nara Prefecture (Shimizu, 1984). 6, Mt. Oike-dake in Suzuka Mountain Range, Eigenji-cho, Kanzaki-gun, Shiga Prefecture (Shimizu, 1985). 7, Mt. Amagoi in Suzuka Mountain Range, Eigenji-cho, Kanzaki-gun, Shiga Prefecture (Teranishi & Shimizu, 1985). 8, Haccho-daira, Sakyo-ku, Kyoto City, Kyoto Prefecture (Kobayashi & Ueda, 1986). 9, Kurabone-toge, Misugi-mura, Ichishi-gun, Mie Prefecture (Shimizu, 1988).

Kitakuwada-gun, Kyoto Prefecture: the montane region bordering on Fukui Prefecture to the north and on Shiga Prefecture to the east (Figs 1, 2). The sampling spot is located at the foot of a hill slope near the stream of Kami-tani Valley, the head of the Yura-gawa River (Fig. 3); latitude $35^{\circ}20'46''$ N, longitude $135^{\circ}44'58''$ E; altitude 665 m. Ground inclination at the spot was *ca* 40° SSW.

2. Vegetation.

The area belongs to the beech zone, but this particular spot was predominantly occupied by *Quercus serrata* Murray, mixed with *Quercus mongolica* Fischer et Turcz. var *grosseserrata* (Bl.) Rehder et Wilson, *Betula grossa* Sieb. et Zucc., *Styrax obassia* Sieb. et Zucc., *Acer* spp., *Fagus crenata* Blume, and some other trees.

3. Method of Capture.

As was mentioned previously, the presence of fruit bodies of *H. radicosum* on the ground indicates the presence of a mole's nest under the ground. This mushroom was found at the spot shown in Fig. 2 (Point 3), Fig. 3 and Fig. 4 (left arrowhead) on 27 Oct. 1982, where we collected mole nests from under the ground on 26 May 1983 and again on 19 June 1983. The soil was replaced after each excavation. The nests collected were presumed to be those of *E. mizura* by investigating the characteristics of hairs within (Sagara, unpublished). In the third digging on 27 July 1983, a nest was not found, but the mushroom came out there again on 7 Oct. 1987 (Fig. 4, right arrowhead).

On the other hand, we often observed, in the course of excavating mole's nests, that the moles once fled from the sites hit by our digging returned there while the work was suspended and silence was maintained. Taking these data and experiences into consideration, we excavated the nest beneath the mushroom on 9 Oct. 1987, and waited for the mole to return. The equipments to be used to capture the mole were a pick-ax, chloroform or tube traps, depending upon the situation.

4. Other Approaches.

We have attempted to obtain *E. mizura* specimens in Ashiu since 1982 by using various kinds of traps (snap traps, pit falls and tube traps) and by collecting dead animals found on roads (DOR). These attempts were not successful, but we obtained specimens of other mole species, *M. wogura* and *M. kobeae*. These two mole species were identified by Dr Hisashi Abe of Hokkaido University. We also examined burrows of moles in Ashiu, and recognized three diameter classes (Kobayashi, unpublished). The finding of *E. mizura* by the method described above confirmed that they correspond to the three talpine species. Some of these data are presented in this paper to discuss the distribution of the moles.

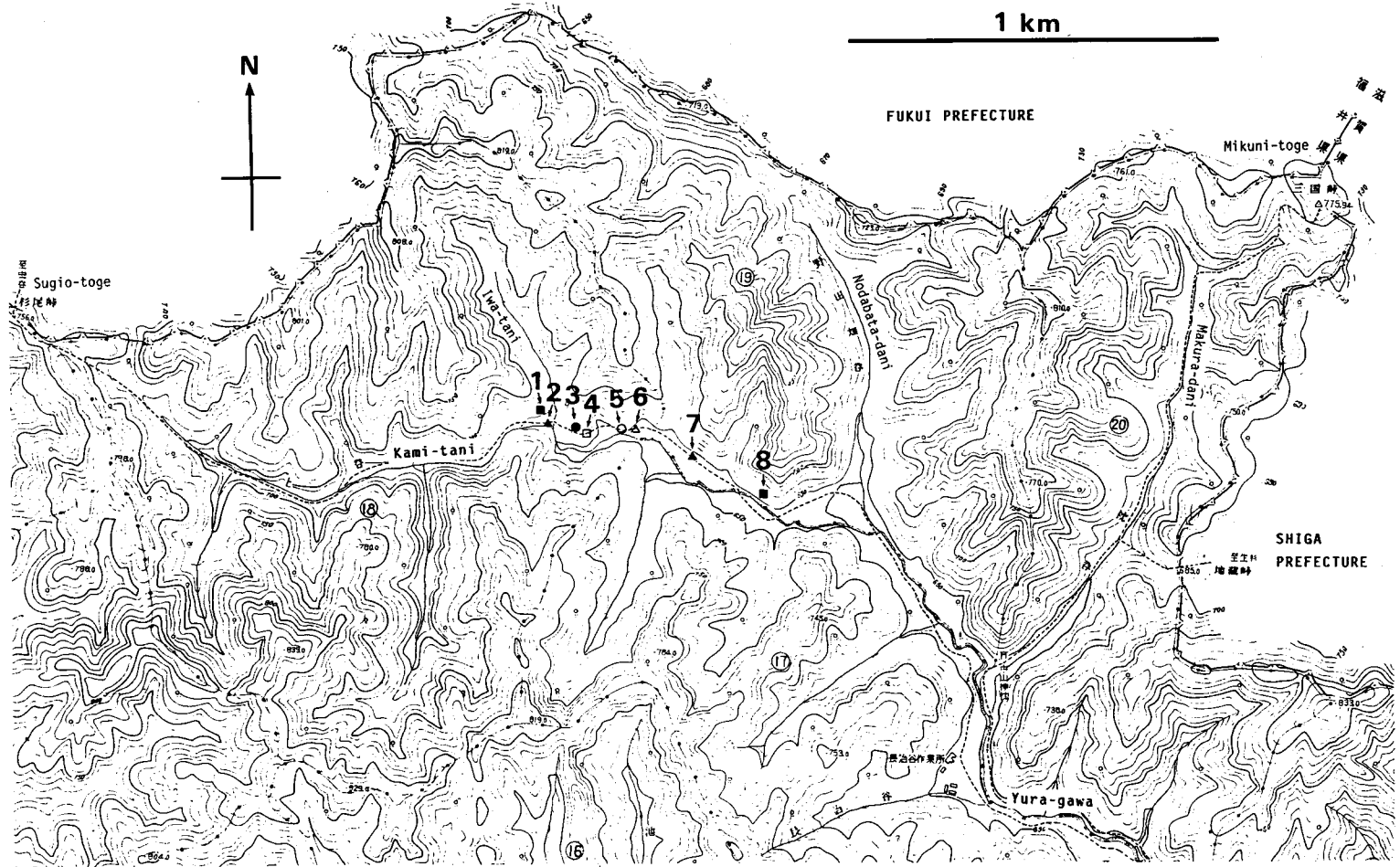


Fig. 2. Map of Kami-tani Valley in Ashiu, Kyoto, showing the points at which occurrences of mole species were observed. 1, *Mogera kobeae* nest and specimens obtained on 9 Oct. 1984 (Sagara, unpublished). 2, *Mogera wogura* specimen trapped on 5 Nov. 1987 (Fig. 9, centre). 3, *Euroscaptor mizura* nest and specimen obtained on 9 Oct. 1987 (described in this paper). 4, *Mogera kobeae* burrows, 64–70 × 50–60 mm diam, observed on 4 Nov. 1987. 5, *Euroscaptor mizura* burrows, 29–33 × 25–30 mm diam, observed on 5 Nov. 1987. 6, *Mogera wogura* burrows, 40–47 × 34–35 mm diam, observed on 5 Nov. 1987. 7, *Mogera wogura* specimen trapped on 4 Dec. 1984. 8, *Mogera kobeae* specimen trapped on 4 Dec. 1984 (Fig. 9, right). Encircled numbers indicate divisions in the experimental forest.

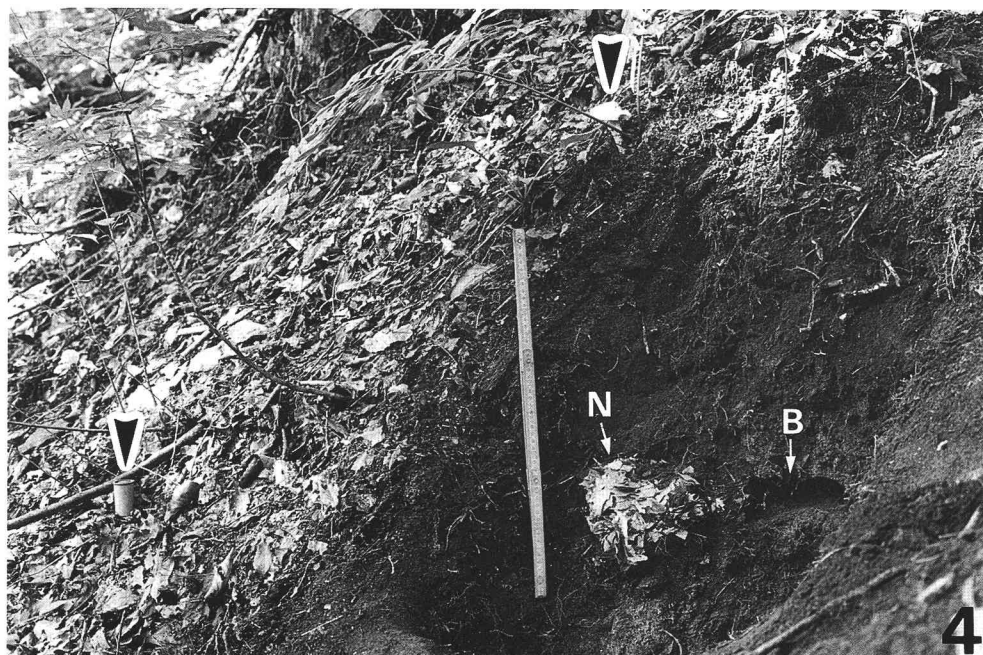


Fig. 3. A general view of the spot in Kami-tani where *Euroscaptor mizura* was captured. The man at the centre is indicating the point where *Hebeloma radicosum* was found on 27 Oct. 1982. Photograph taken on 4 Nov. 1982.

Fig. 4. The spot where *Euroscaptor mizura* was captured. Arrowheads: Fruit bodies of *Hebeloma radicosum* observed in 1982 (left) and in 1987 (right). N: Nest of *E. mizura* excavated under the fruit body of 1987. B: Burrow of *E. mizura*. The scale 50 cm long. Photograph taken on 9 Oct. 1987.

Results

1. Capturing and Making a Specimen.

The mole returned to its nest site, and loudly sniffed when it reached the wall of the dug hole. At this moment, we turned up the soil containing the mole with the pick-ax and captured it alive.

We kept the mole in captivity until 3 Dec. 1987, when we fixed it with 3.7 % formaldehyde for two days, and preserved it in 70 % ethanol thereafter. The specimen was deposited in the mammalian collection of the first author's laboratory.

2. Measurements, External Characteristics and Identification.

The body weight of the mole was 25 g when it was measured *ca* 5 hrs after capture; the mole had not been fed before measuring. The pelage was nearly black (Fig. 6).

The measurements of the animal after the 55 days' captivity were as follows. Body weight 27.7 g; head and body length 91.8 mm; tail length 23.6 mm; hand length 13.0 mm (s. u.), hand width 12.6 mm; foot length 13.4 mm. The ratio of the tail length to the head and body length was 25.7 %.

Nails stretched out abnormally during the captivity (compare Fig. 6 with Fig. 9 [left]). The muzzle had a triangularly naked portion on the upper side (Fig. 7). The third lower incisors were observed (Fig. 8).

The above data agree well with the descriptions for *E. mizura* by previous authors (Imaizumi, 1960; Abe, 1967).

3. Nest and Burrows.

The nest (Fig. 4, N) was subspherical, 18 cm diam and 15 cm ht, and was composed of fallen leaves of the broad-leaved trees growing nearby (Fig. 5). Those leaves had been used without being shredded. There was only a single entrance to the nest cavity. The burrows around the nest were 40×35 , 37×33 , 40×35 and 40×26 mm diam.

4. Occurrence of Three Mole Species in Ashiu.

The above finding, together with the results of trapping and the observations of burrows, revealed that the three talpine species, *E. mizura*, *M. wogura* and *M. kobeae* occur in the region of Kami-tani (Fig. 9), and that their habitats are very closely situated with each other (Fig. 2).

In addition, evidences for the occurrence of more than one mole species at one spot have been obtained from the neighbouring areas within Ashiu as follows. A specimen of *M. wogura* was captured when it was passing in the soil only about 50 cm away from a nest of *E. mizura* (Sagara, unpublished). Likewise, burrows of *M. wogura* were found only about 50 cm away from a nest of *M. kobeae* (Sagara, unpublished). A

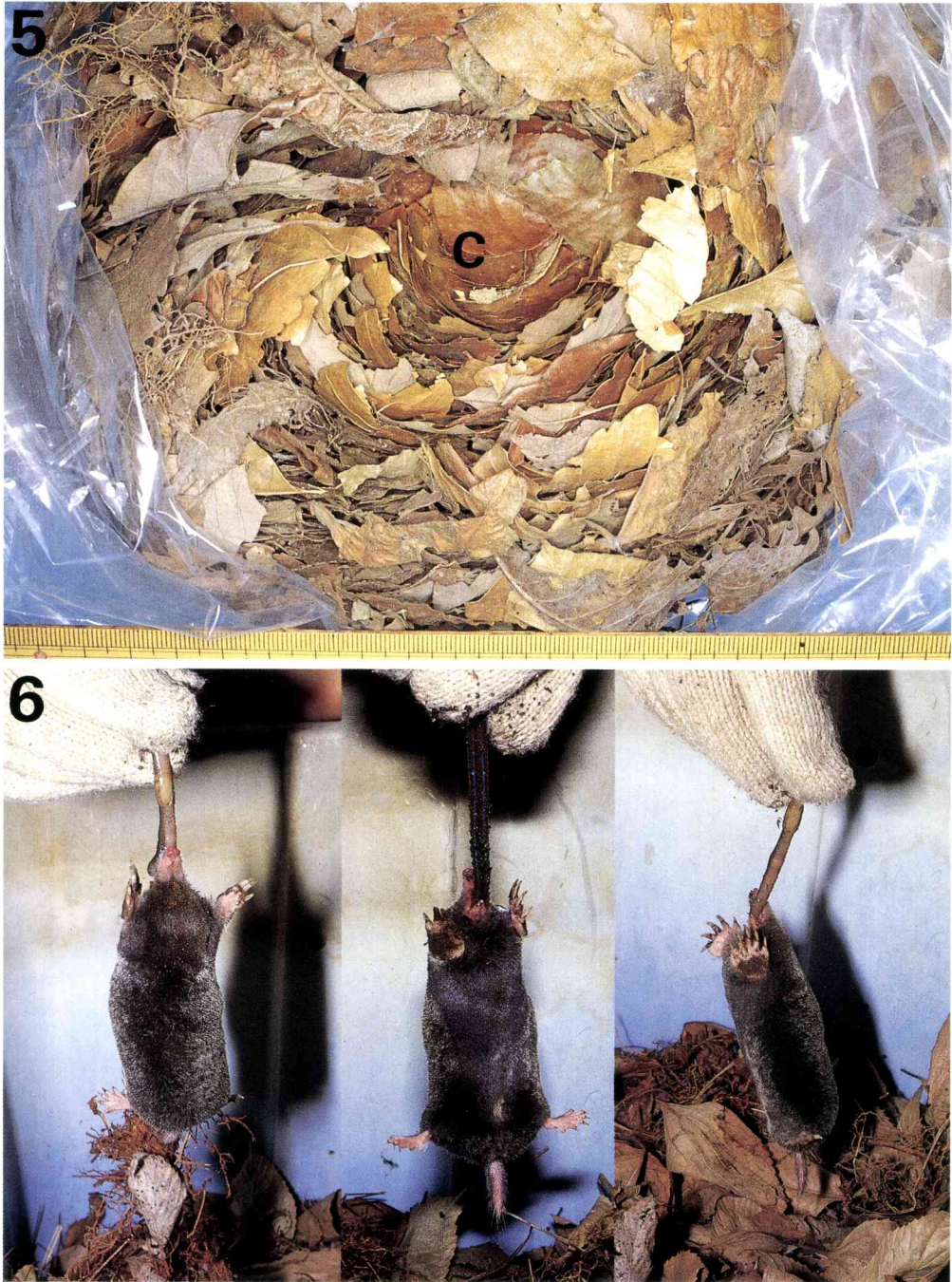


Fig. 5. Central portion of the nest of *Euroscaptor mizura* collected in the first excavation at this spot on 26 May 1983. C: Nest cavity (viewed from above after the nest ceiling was removed). Scales in mm.

Fig. 6. *Euroscaptor mizura* captured in this study. The mole is being fed an earthworm. From left, dorsal view, ventral view, and lateral view. Photographs taken on 21 Oct. 1987.

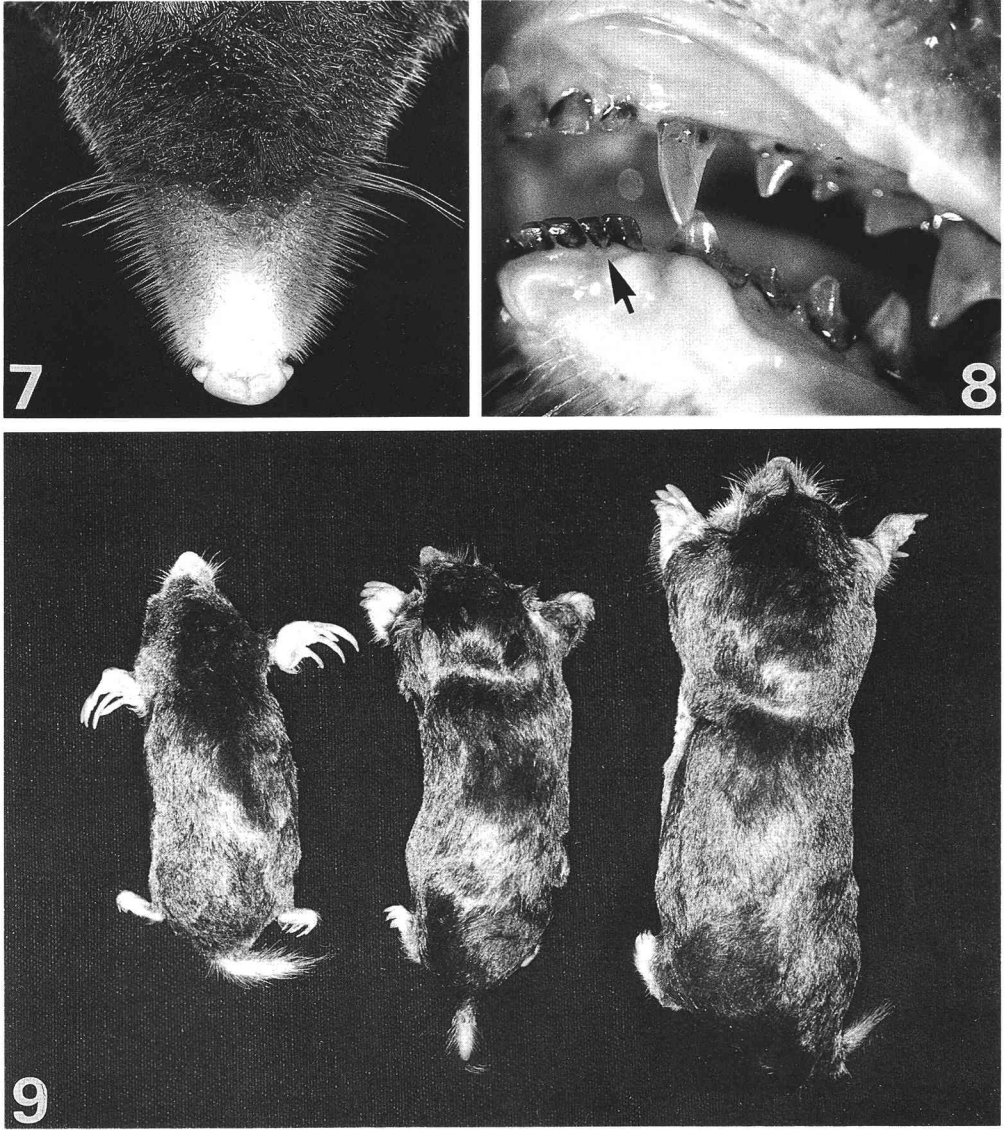


Fig. 7. Dorsal view of the muzzle of the *Euroscaptor mizura* specimen. Note that the naked portion is triangular. $\times 3.1$.

Fig. 8. Front-lateral view of the toothrows of the *Euroscaptor mizura* specimen, showing the presence of the third lower incisors (arrow). $\times 13$.

Fig. 9. Specimens of the three talpine species collected in Kami-tani, Ashiu. From left, *Euroscaptor mizura* reported in this paper, *Mogera wogura* collected on 5 Nov. 1987 (Point 2 in Fig. 2, body weight 44 g), and *Mogera kobeae* collected on 4 Dec. 1984 (Point 8 in Fig. 2, body weight 93 g). $\times 0.63$.

burrow of *M. wogura* was found connected with that of *M. kobeae* (Kobayashi, unpublished).

Discussion

This is the first report of the mushroom-mole nest association in *H. radicosum* and *E. mizura*, of the nest of *E. mizura*, and of the capture of a mole at the nesting site with the aid of indication by the fungus. The utilization of the fungal fruit body as a marker seems to be almost the only way to locate a mole's nest in Japan, unless radioisotope tagging and tracing techniques or radio tracking techniques are used. For, Japanese moles do not make "fortresses" as European moles (*Talpa europaea* L.) do, which contain nests. As was mentioned previously, we have obtained three more examples of *E. mizura* nest in Ashiu by the present method.

The nests of *E. mizura* resemble, in structure and material, those of *M. wogura* and *M. kobeae* described by Sagara (1978, 1980). The burrows observed around the nest ($37 - 40 \times 26 - 35$ mm diam) are larger than the ordinary ones of *E. mizura* ($29 - 35 \times 25 - 32$ mm diam) and are approximately as large as those of *M. wogura* ($37 - 46 \times 30 - 38$ mm diam). Burrows around the nest may have been more frequently used than those away from the nest, or conceivably they may have been previously used by *M. wogura*.

E. mizura has never been recorded from Ashiu, but the present results indicate that this species actually occurs in this region. Fujiwara (1955) reported *E. mizura* from Hiwa-cho, Hiroshima Prefecture, in western Honshu. His specimen was first regarded as a representative of an extremely isolated and relict population (Yukawa, 1977), since Hiwa-cho was far from the other known localities of the species, all scattered in the central and the northern parts of Honshu (Imaizumi, 1960, 1970). However, recent surveys revealed the occurrence of *E. mizura* in several localities in Kinki District, an intermediate region between western and central Honshu (Fig. 1). The present finding expands the range of *E. mizura* in Kinki District, and suggests its further westward distributions, presumably continuing to the population in Hiwa-cho.

The syntopic or contiguous occurrences of talpine species in Ashiu may be unusual, as it has been argued that the distributions or habitats of the Japanese talpine moles are sharply segregated from each other (Imaizumi and Imaizumi, 1970; Abe, 1974, 1985). However, there are several observations that may imply syntopic or contiguous occurrences of different mole species, as follows. The *E. mizura* specimen from Hiwa-cho was reported to have been collected at the place where *M. kobeae* had been obtained previously (Fujiwara, 1955). Imaizumi (1960, 1964, 1966) stated that *M. kobeae* and *M. wogura* co-exist in Hiwa-cho, Hiroshima Prefecture, and in Subashiri, Shizuoka Prefecture. He (1970) also wrote that *E. mizura* and *M. wogura* inhabit the same region and that the former often uses the latter's burrows. Yukawa (1977) observed that the place where *M. kobeae* had lived was invaded by *M. wogura*

after removal of the former by trapping. Abe (1967) wrote, "*M. kobeae* and *M. wogura* co-exist in part on the range between Ueda, Shiojiri City and Nakanohashi, Tatsuno Town, Nagano Pref., and at Nezame, Agematsu Town, Nagano Pref.", though he further wrote, "the ranges of colonies are usually segregated, even where they overlap, and no intermediate has been found". The terms 'co-existence', 'contiguous occurrences' and 'segregated distribution' may have been differently used by different authors. Thus, it seems that discussions based on practical field observations are required.

The evolutionary and competitive relationships among the three talpine species in Ashiu would be another problem to be discussed. It has been presumed that the Japanese Archipelago, when connected with the Asiatic Continent, was invaded in turn, by *E. mizura*, *M. wogura* and *M. kobeae* from the Continent (Imaizumi, 1964; Abe, 1967; Tsuchiya, 1988). It has further been suggested that these three species form a hierarchy in which *E. mizura* is the least competitive and *M. kobeae* is the most competitive species, and that the less competitive species have been displaced by the more competitive in the sequence, remaining as relicts in the montane regions especially in western Japan (Imaizumi, 1964; Abe, 1967). Abe (1974, 1985) showed that the distributions of the Japanese talpine species are changing, *M. wogura* being driven northwards by *M. kobeae*. If these theories and conclusions apply to the Ashiu region, the populations of *E. mizura* and *M. wogura* in Kami-tani may be relict ones on the verge of disappearance by invasion of *M. kobeae*.

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References

- Abe, H. 1967. Classification and biology of Japanese Insectivora (Mammalia). I. Studies on variation and classification. *J. Fac. Agr., Hokkaido Univ., Sapporo*, 55: 191-265, 2 pls.
- Abe, H. 1974. Change of the boundary-line of two moles' distributions in a period of 14 years (in Japanese, English summary). *J. mamm. Soc. Japan* 6: 13-23.
- Abe, H. 1985. Changing mole distributions in Japan. *Contemporary Mammalogy in China and Japan* (ed. T. Kawamichi), pp. 108-112. Mammalogical Society of Japan.
- Fujiwara, M. 1955. *Euroscaptor mizura* has been collected (in Japanese). *Hiba-kagaku* no. 35: 14.
- Imaizumi, Y. 1960. *Coloured Illustrations of the Mammals of Japan* (in Japanese). Hoikusha, Osaka. 196 p., 68 pls.

- Imaizumi, Y. 1964. My own view on the evolution of moles (in Japanese). *Iden* 18 (1): 64-68.
- Imaizumi, Y. 1966. *Principles and Methods for Zoological Classification* (in Japanese). Dai-ichi Hoki Publishing Co., Tokyo. 362 p.
- Imaizumi, Y. 1970. *The Handbook of Japanese Land Mammals*, Vol. I (in Japanese, English summary). Shin-shicho-sha Co., Tokyo. 350 p.
- Imaizumi, Y. & Imaizumi, T. 1970. Interspecific relationship in two mole species in the plains of Niigata, Honshu (in Japanese, English summary). *J. mamm. Soc. Japan* 5: 15-18.
- Kimura, M. & Hirose, S. 1982. Animals (Mammals) (in Japanese). In: *Inuyama-shi-shi Shiryo-hen = Shizen*, pp. 235-268. Inuyama City, Aichi Prefecture. Cited in: Teranishi, T. & Ohtake, M., 1985, Measurements of a *Euroscaptor mizura* specimen obtained in Aichi Prefecture (in Japanese), *Manmo-Su* no. 42: 3.
- Kobayashi, S. & Ueda, Y. 1986. New record of the Japanese mountain mole (*Euroscaptor mizura* (Günther, 1880)) from Kyoto Prefecture, Kinki District, Japan (in Japanese, English summary). *Nanki-seibutsu* 28 (1): 46-48.
- Sagara, N. 1978. The occurrence of fungi in association with wood mouse nests. *Trans. mycol. Soc. Japan* 19: 201-214.
- Sagara, N. 1980. Not mouse but mole. *Trans. mycol. Soc. Japan* 21: 519.
- Sagara, N., Honda, S., Kuroyanagi, E. & Takayama, S. 1981. The occurrence of *Hebeloma spoliatum* and *Hebeloma radicosum* on the dung-deposited burrows of *Urotrichus talpoides* (shrew mole). *Trans. mycol. Soc. Japan* 22: 441-455.
- Shimizu, Z. 1984. Distributions of small mammals in the mountain areas of Kii Peninsula (in Japanese). *Mie Dobutsu-gakkai Kaiho* no. 7: 16-23.
- Shimizu, Z. 1985. A record of *Euroscaptor mizura* trapped on Mt. Oike in Suzuka Mountain Range (in Japanese). *Mie Dobutsu-gakkai Kaiho* no. 8: 29-31.
- Shimizu, Z. 1988. Finding a dead *Euroscaptor mizura* (in Japanese). *Mie Dobutsu-gakkai Kaiho* nos 10 & 11: 64-66.
- Taruno, H. 1978. *Euroscaptor mizura* is also distributed in Kinki District (in Japanese). *Nature Study* 24 (12): 7-8.
- Teranishi, T. & Shimizu, M. 1985. A specimen of *Euroscaptor mizura* obtained in Suzuka Mountain Range, Shiga Prefecture (in Japanese). *Manmo-Su* no. 43: 1-2.
- Tsuchiya, K. 1988. Classification of Japanese Talpidae by karyotype (in Japanese). *Honyurui Kagaku* 28 (1): 49-61.
- Yukawa, M. 1977. Mammals of Hiwa-cho, Hiroshima Prefecture (in Japanese). In: *Hiwa no Shizen* (ed. Hiwa-cho Natural History Museum), pp. 157-180. Hiwa-cho, Hiroshima Prefecture.

Addresses of the Authors:

(Mr) Naohiko Sagara, D. Agr. 相良直彦

Biological Laboratory, Yoshida College, Kyoto University 京都大学教養部生物学教室
Yoshida, Sakyo-ku, Kyoto 606, JAPAN 京都市左京区吉田二本松町 (〒606)

(Mr) Shuji Kobayashi 小林秀司

Department of Systematics and Phylogeny, Primate Research Institute, Kyoto University
京都大学霊長類研究所系統研究部門
Kanrin, Inuyama, Aichi 484, JAPAN 愛知県犬山市官林 (〒484)

(Mr) Hidetoshi Ota 太田英利

Department of Zoology, Faculty of Science, Kyoto University 京都大学理学部動物学教室
Kitashirakawa, Sakyo-ku, Kyoto 606, JAPAN 京都市左京区北白川追分町
(Present Address) Department of Biology, University of the Ryukyus
(現住所) 琉球大学理学部生物学科
Nishihara-cho, Okinawa 903-01, JAPAN 沖縄県中頭郡西原町字千原 1 (〒903-01)

(Mr) Toyoaki Itsubo 井坪豊明

Department of Forestry, Faculty of Agriculture, Kyoto Prefectural University
京都府立大学農学部林学科
1 Nakaragi-cho, Shimogamo, Sakyo-ku, Kyoto 606, JAPAN 京都市左京区下鴨半木町 1
(Present Address) Kyoto Prefectural Torio High School (現住所) 京都府立東稜高等学校

Ura-machi, Shin-machi, Daigo, Fushimi-ku, Kyoto 601-13, JAPAN. 京都市伏見区醍醐新町裏町
(〒601-13)

(Mr) Hiroaki Okabe, D. Agr. 岡部宏秋

Kyoto University Forest, Faculty of Agriculture, Kyoto University

京都大学農学部附属演習林

Kitashirakawa, Sakyo-ku, Kyoto 606, JAPAN 京都市左京区北白川追分町

(Present Address) Soil Microbiology Laboratory, Forest Biology Division, Forestry and Forest
Products Research Institute

(現住所) 農林水産省森林総合研究所森林生物部土壤微生物研究室

1 Matsunosato, Kukizaki-cho, Inashiki-gun, Ibaraki 305, JAPAN 茨城県稲敷郡茅崎町松の里 1
(〒305)