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Frequent occurrence of partial albinism in lesser Japanese moles (*Mogera imaizumii*) on Kinkazan Island, Miyagi Prefecture, northeastern Japan

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Abstract. Forty lesser Japanese moles (*Mogera imaizumii*) were trapped on Kinkazan Island, which is a small island (959 ha) located 1 km off Honshu in northern Japan. Of these, 36 moles (90%) showed some degree of partial albinism of the fur, ranging from only small tufts of cream-colored hairs on their basal forefoot to multiple large interconnected patches spread around the whole body. Most tufts, spots and patches were cream-colored, but some tufts and spots on the lower abdomen were light brown. This coloration is attributable to staining by a secretion from skin glands that are distributed ventrally, with a higher density in the lower abdomen. The high frequency of partial albinism may be attributable to a lack of predators in this insular ecosystem or to low genetic diversity in the population, although it is difficult to know which of these two is more important.

Key words: insular isolation, lesser Japanese mole, *Mogera imaizumii*, partial albinism, Talpidae.

Partial or complete albinism in talpids has been reported for Japanese species (greater Japanese shrew mole *Urotrichus talpoides*: Miyao et al. 1981; Moribe et al. 2010; lesser Japanese mole *Mogera imaizumii*: Fujiwara 1960a, 1961; Imaizumi and Yoshiyuki 1960; Yamazaki and Obara 2001; larger Japanese mole *M. wogura*: Fujiwara 1960b; Yokohata 1997; Kawada and Himeda 2003), European species (Wilson 1860; Godfrey and Crowcroft 1960; Skoczeń 1961), and North American species (Bachman 1839; Jackson 1915; Svihla 1939, 1941; Cockrum and Meinkoth 1942; Klein 1944; Carraway and Verts 1991; Kamm et al. 2008). These studies have reported various patterns of albinism, from small white spots on the fur to complete albinism of the whole body (albino). Among the studies on Japanese species, only Imaizumi and Yoshiyuki (1960) reported the precise frequency of albinism. Among 384 greater Japanese shrew moles captured from 33 prefectures in Japan, one (0.26%) and five (1.3%) individuals showed white spots on their body and tail, respectively. Among

lesser and larger Japanese moles, 19 of 165 (average, 11.5%; range, 0.0–22.2% in seven regions) and one of 53 (1.9%; 0–2.5% in two regions) individuals, respectively, showed partial albinism. The frequency of albinism in the latter two species was higher than that in the greater Japanese shrew moles and probably higher than in many other non-subterranean mammals (e.g., Stoddart 1969). This can be attributed to their subterranean habit with fewer predators (Imaizumi and Yoshiyuki 1960; Yokohata 1998; Kawada and Himeda 2003).

None of these studies report on completely isolated populations, such as those on small islands, although such populations may provide valuable information on genetic and ecological aspects that can help to understand albinism in moles. In this study, we captured 40 lesser Japanese moles on Kinkazan Island, which is a small island in northern Japan, and found exceptionally numerous cases of partial albinism.

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Materials and methods

Lesser Japanese moles were captured from Kinkazan Island (latitude 32°1'N, longitude 130°10'E), Miyagi Prefecture, Japan, in November 2004; March and November 2005; and March, June and October 2006. This small island (959 ha) is located 1 km off Oshika Peninsula, northeastern Japan, which faces the Pacific Ocean. The island has been regarded as a sacred place, and its plants and animals have been protected for more than 100 years, with the exception of a short period after the Second World War (Takatsuki et al. 1991, 1994; Takatsuki and Ito 2009). The higher areas are covered by *Fagus crenata* forests, and the lower areas by *Abies firma*–*Carpinus tschonoskii* forests. Wildfires have created small clearings that are dominated by *Miscanthus sinensis* and *Zoysia japonica* communities (Yoshii and Yoshioka 1949). The *M. sinensis* community began to be replaced by *Z. japonica* under heavy sika deer grazing pressure, and the *Z. japonica* community continues to grow (Takatsuki 1999; Takatsuki and Ito 2009). A detailed description of the habitat is provided by Yoshii and Yoshioka (1949) and Takatsuki and Ito (2009). Duffus-type lethal metal traps (Gorman and Stone 1990; Yokohata 1998) and Nishi-type lethal cylinder traps

(Abe 1992; Yokohata 1998) were used in the grassland (*Z. japonica* community) and forest (mainly deciduous forest) areas on this island.

All moles captured on this island were stuffed and their fur inspected macroscopically. We classified aberrantly colored areas on the mole's fur into four patterns: (1) "tuft": a few or more cream-colored or light brown hairs aggregated in small area(s) with a maximum width of <3 mm; (2) "spot": spherical or distorted area(s) with cream-colored or light brown hairs with a maximum width of ≥3 mm and length of <10 mm; (3) "line": elongated cream-colored or light brown zone(s) with a minimum width of <5 mm and a length of ≥10 mm; and (4) "patch": large white, cream-colored, or light brown area(s) of varying shape with a minimum width of ≥5 mm. Stuffed specimens of 216 lesser Japanese moles and 55 larger Japanese moles from nine regions (more than 10 moles per one region), deposited in the National Science Museum, Tokyo, were also inspected for comparison with the specimens from Kinkazan Island.

Results

Nine males and seven females were captured from the grassland; nine males and 15 females from the forest. Of

Table 1. Cases of partial albinism of various parts of the fur of lesser Japanese moles (*Mogera imaizumii*) captured on Kinkazan Island, Miyagi Prefecture, Japan, from 2004 to 2006 (T: tuft; S: spot; L: line; P: patch)

Number of animals	Portions affected by partial albinism					
	Basal forefoot	Throat	Chest	Lower abdomen	Upper abdomen	Back-flank
4	–	–	–	–	–	–
10	T	–	–	–	–	–
2	S	–	–	–	–	–
4	T	S	–	–	–	–
2	T	L	–	–	–	–
1	T	–	–	T	–	–
2	T	–	–	S	–	–
3	T	–	–	P	–	–
1	P*	–	P*	–	–	–
1	T	P*	P*	–	–	–
1	P	–	P	P	–	–
1	–	T	S	S	–	–
1	S	–	S	S	–	–
1	T	P*	P*	T	–	–
1	T	T	S	T	–	–
1	S	T	S	T	–	–
1	T	T	P	T	–	–
1	T + P*	T	T + P*	T	–	–
1	P*	P*	P*	P	S	–
1	P*	P*	P*	P + L	P*	P*

* connected to neighboring patch(es).



Fig. 1. Ventral view of the frontal part of a lesser Japanese mole (*Mogera imaizumii*), captured from Kinkazan Island, Miyagi Prefecture, Japan (No. 2005M-52), with a small tuft of cream-colored hairs on its basal forefeet (open triangle) and a cream-colored line on its throat.



Fig. 2. Ventral view of a lesser Japanese mole (*Mogera imaizumii*), captured from Kinkazan Island, Miyagi Prefecture, Japan (2006M-86), with cream-colored spots on its right basal forefoot (closed triangle) and chest, and light brown (arrowhead) and cream-colored (open triangles) spots on its lower abdomen.



Fig. 3. Ventral view of a lesser Japanese mole (*Mogera imaizumii*), captured from Kinkazan Island, Miyagi Prefecture, Japan (No. 2006M-21), with cream-colored tufts on its right basal forefoot, throat, and chest; a cream-colored patch on its basal left forefoot and chest; and a light brown tuft (arrowhead) on its lower abdomen.

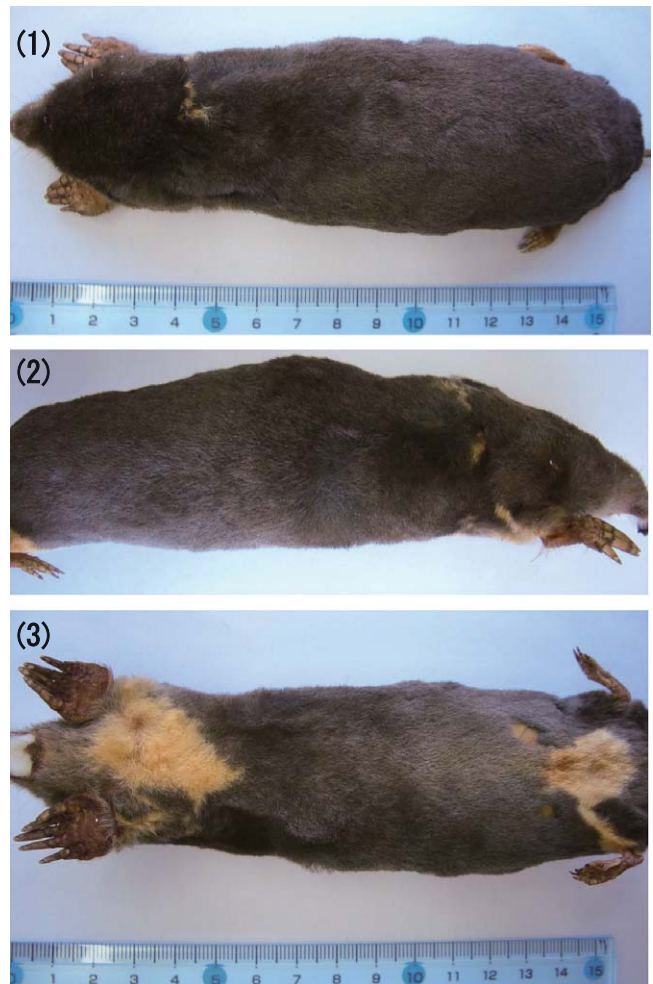


Fig. 4. A lesser Japanese mole (*Mogera imaizumii*), captured from Kinkazan Island, Miyagi Prefecture, Japan (No. 2006M-88), with cream-colored tufts on its right basal forefoot, right shoulder, and the dorsal surface of the neck portion; a large cream-colored patch on its basal left forefoot and chest; and a cream-colored and light brown patch on its lower abdomen, connected to a cream-colored line on its right basal rear foot. (1) Dorsal view, (2) lateral view (right side), and (3) ventral view.

these 40 individuals, 36 moles (90%) showed some degree of partial albinism of the fur over various portions of their body. Partial albinism ranged from only small tufts of cream-colored hairs on the basal forefoot to extreme partial albinism in the form of large, interconnected, cream-colored, and/or light brown patches on multiple sites over the whole body (Table 1). Five representative moles are shown in Figs. 1–5. Most of these tufts, spots, lines, and patches were cream-colored, but some tufts and spots on the lower abdomen were light brown. The latter were limited to the front part of the lower abdomen, with those on the posterior part being cream-colored (Fig. 2). One individual (2006M-88)

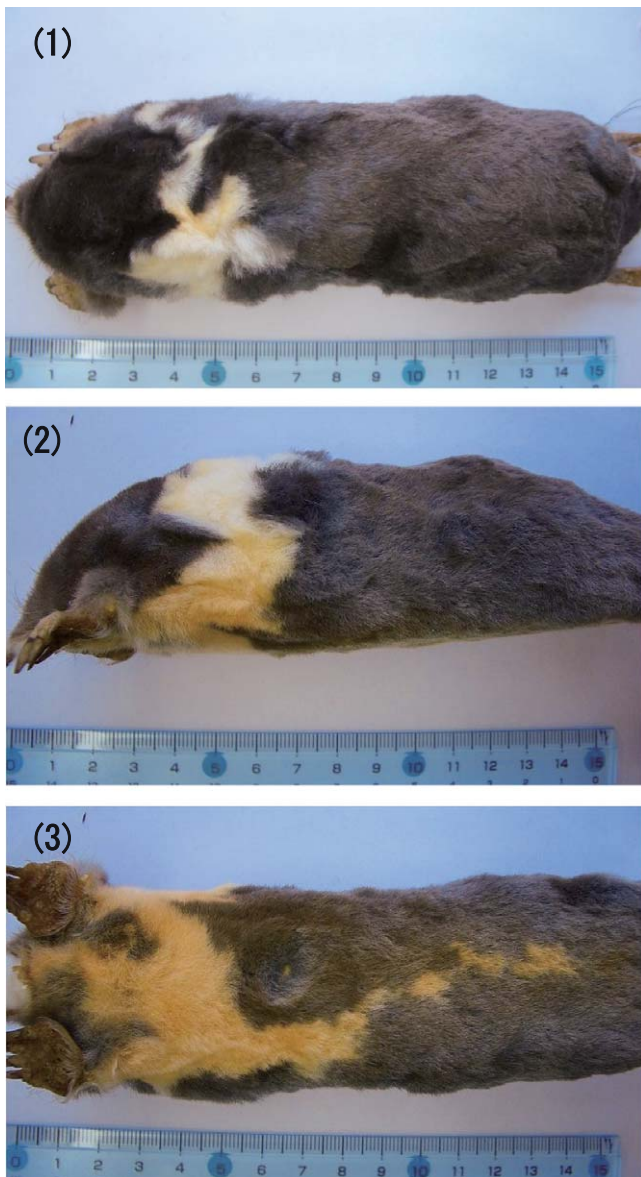


Fig. 5. A lesser Japanese mole (*Mogera imaizumii*), captured from Kinkazan Island, Miyagi Prefecture, Japan (2006M-63), with a complicated patchwork of interconnected white and cream-colored patches and lines on its throat, chest, shoulders, two basal forefeet, and the dorsal surface of the neck portion and upper abdomen; and three light brown spots positioned front to rear on its lower abdomen. (1) Dorsal view, (2) lateral view (left side), and (3) ventral view.

showed a light brown part in its cream-colored patch (Fig. 4-(3)). Only one individual, with the largest and most complicated patch, showed a white part in its dorsal portion (Fig. 5 (1), (2)). We found no case of a complete albino, “piebold” (Bachman 1839; mentioned in Carraway and Verts (1991)), or pied variation (Imaizumi and Yoshiyuki 1960).

Among the specimens deposited in the National Science Museum, Tokyo, we identified 0–13 moles

($\leq 37.1\%$) with some degree of partial albinism in eight regions (Table 2). The frequency of partial albinism among the lesser Japanese moles of Kinkazan Island was much higher than that in other regions.

Discussion

In this study, most specimens showing partial albinism had cream-colored or light brown hairs, and only one individual had white hairs dorsally. The light brown hairs were limited to the front and central areas of the lower abdomen. Imaizumi and Yoshiyuki (1960) attributed the cream-colored and light brown hairs to staining by a secretion from skin glands that are distributed ventrally, with a higher density in the lower abdomen. They stated that moles with such colors represent cases of albinism, similar to albino individuals of other animals showing white hairs, and our observations are identical to their findings and interpretations. Kamm et al. (2008) discussed identically on the pelage spotting and staining in Eastern moles (*Scalopus aquaticus*).

It is noteworthy that complete albinism, i.e., albinism of the whole body, was not observed in the moles of Kinkazan Island, despite the overall high frequency of partial albinism. Complete albinism is attributed to a lack of melanin pigments in hairs because of various mutations, such as in genes encoding tyrosinase (King et al. 1995). The present finding seems novel and interesting because most previous reports on albinism in Japanese moles have documented complete albinism (Fujiwara 1960a, b, 1961; Imaizumi and Yoshiyuki 1960; Yokohata 1997; Yamazaki and Obara 2001; Kawada and Himeda 2003). This observation suggests that partial albinism is caused by a different mechanism than complete albinism, at least in the lesser Japanese moles.

Stoddart (1969) found higher frequency of occurrence of the partial albinism in the head fur of water vole of the genus *Arvicola* in British Islands (7.2–95.5%, totally 44.8%) than in Eurasia Continent (0.0–44.0%, totally 2.7%), and pointed out the importance of environmentally induced population characteristics. In Kinkazan Island, there are no terrestrial predators of moles, except for a few feral cats (*Felis catus*) (Morita and Suda 2009). The high frequency of partial albinism may, at least partly, be attributable to a lack of predators in this insular ecosystem. On the other hand, low genetic diversity in the present mole population, probably because of a bottle-neck effect and/or genetic drift on Kinkazan

Table 2. Partial albinism observed in lesser Japanese moles (*Mogera imaizumii*) and larger Japanese moles (*M. wogura*), captured in various regions in Japan

Species	Prefectures	Regions	Number of moles examined	Number of moles with partial albinism (%)
<i>M. imaizumii</i>	Miyagi	Kinkazan Island*	40	36 (90.0)
		Momoo	35	13 (37.1)
	Saitama	Chichibu	22	7 (31.8)
		Tokyo	Meguro	35
	Niigata	Fuchu	69	13 (18.8)
		Nagaoka	19	3 (15.8)
	Nagano	Kita-Azumi	14	2 (14.3)
		Higashi-Chikuma	11	1 (9.1)
	Hiroshima	Hiwa	11	0 (0.0)
<i>M. wogura</i>	Hiroshima	Hiwa	55	5 (9.1)

* This study

Island, which is small and isolated, could be another important contributing factor. It is difficult to establish whether ecological or genetic factors are more important (Yokohata 1998). Unfortunately, there is no information on the molecular population genetics of the moles on Kinkazan Island; therefore, more studies on this aspect are needed.

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