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Redescription of the Malaysian Mole as to be a True Species, *Euroscaptor malayana* (Insectivora, Talpidae)

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Abstract. The Malaysian mole is far isolated population of genus *Euroscaptor*, described in 1940. Since the original description, the Malaysian mole has been placed as subspecies of Himalayan or Thailand species or synonym of the other species, and it has never been treated as a independent species. Recent results of the morphological, karyological and molecular phylogenetic researches assigned that the Malaysian mole is clearly distinct from other species of *Euroscaptor*. In this study, detail morphological characters of the Malaysian mole are redescribed. With the discussion of the history of the tea plantation of the mole's habitats in Peninsular Malaysia, the Malaysian mole is considered as a native species with distinct characters from other species of genus *Euroscaptor*.
Key words : *Euroscaptor malayana*, morphology, description, distinct species.

Introduction

The Malaysian mole was first discovered from Cameron Highlands in Peninsular Malaysia. Chasen (1940) described a new subspecies of Kloss's mole, *Talpa klossi malayana*, in his checklist of Malaysian mammals, "A handlist of Malaysian mammals". The type specimen of the Malaysian mole is deposited in the Natural History Museum, (BM 47.1418), sent from Chasen to London. Later collecting data were quite restricted. In the Natural History Museum, another specimen (BM62.712) collected by the Earl of Cranbrook is deposited. In the Raffles Museum, National University of Singapore, it possessed three additional specimens of skins, skulls and/or whole body in the liquid (ZRC.4.2082, ZRC.4.8101, ZRC.4.8102).

Recently, authors conducted a field research in the Cameron Highlands, and collected several specimens of moles (Kawada *et al*., 2003). They were identified as Chasen's Malaysian mole. Karyological and molecular phylogenetic data were published elsewhere (Shinohara *et al*., 2004; Kawada *et al*., 2005). From the results of these studies, it is repeatedly documented that the Malaysian mole is distinct from the other species studied belonging to genus *Euroscaptor*. In this study, morphological distinction of the Malaysian mole is redescribed as a true species, because the distinction of the color difference of pelage was only mentioned in the original description (Chasen, 1940; see also Cranbrook, 1962).

Taxonomy

***Euroscaptor malayana* (Chasen, 1940)**

Common name: Malaysian mole

Taxonomic transition.

1940 *Talpa klossi malayana*: Chasen, Bull. Raffles Mus. 15: 13.
1948 *Talpa micrura klossi*: Schwarz, Proc. Zool. Soc. Lond. 118: 46 (incomplete document).
1951 *Talpa micrura leucura*: Ellerman & Morrison-Scot, Checklist of Palaearctic and Indian Mammals: 40.
1962 *Talpa micrura malayana*: Cranbrook, J. Bombay Nat. Hist. Soc. 59: 945.
1966 *Talpa micrura malayana* (but also *T. malayana*): Cranbrook, J. Zool. Lond. 149: 65 (but see 66).
1977 *Talpar micrura*: Lekagul & McNeely, Mammals of Thailand: 20
1978 *Talpa micrura*: Medway, The Wild Mammals of Malaya and Singapore: 2.
1988 *Talpa micrura*: Lekagul & McNeely, Mammals of Thailand 2nd ed.: 20
1988 *Euroscaptor klossi malayana*: Yoshiyuki, Bull. Nat. Sci. Mus. Tokyo, Ser. A. 14: 215.
1992 *Talpa micrura*: Corbet & Hill, The Mammals of the Indomalayan Region.: 26.
1993 *Euroscaptor klossi*: Hutterer, Mammal Species of the World 2nd ed.: 125.
2003 *Euroscaptor micrura*: Kawada *et al.*, Mammal Study 28: 74.
2004 *Euroscaptor micrura*: Shinohara *et al.*, Mammal Study 29: 185.
2005 *Euroscaptor micrura*: Hutterer, Mammal Species of the World 3rd ed.: 305.
2005 *Euroscaptor micrura malayana*: Kawada *et al.*, Mammal Study 30, 109.

Holotype. Registration code of the Natural History Museum (London) BM47.1418 including stuffed skin and skull. Old male dated at 29, Aug., 1937 in Kuala Terla Tea Estate, Cameron Highlands, Pahang, Peninsular Malaysia, collected by Mr. Ben Ensoll (Dyak collector in the original description) according to Cranbrook and Medway (1962).

Cranbrook and Medway (1962) interviewed with the type collector and noted that moles were collected in the forest when new plantation was constructed. Among several moles killed by operation, only two were prepared as museum skin. Possibly another specimen (ZRC.4.2082) aforementioned was also collected by Mr. Ensoll. This specimen accompanies a label noted as 'Paratype', but not mentioned in the original description.

Referred specimens. Sixteen specimens (3 females, 10 males and 3 unknown sex) deposited in the following museums (Table 1): the Natural History Museum (London) collection, holotype and BM 62.712 (skull with part of the postcranial skeleton); Raffles Museum (Singapore) collection, ZRC.4.2082 (skin), ZRC.4.8101 (fluid whole body), ZRC.4.8102 (fluid part of body); National Museum of Nature and Science (Tokyo) collection, NSMT-M34738–34744 (skins, skulls and fluid bodies), NSMT-M34745 (fluid whole body); Wildlife Department of Malaysia collection, SIK556 and 558 (skins and skulls, fluid bodies in NSMT) and a specimen without number (fluid whole body).

Diagnosis. Endemic mole of Peninsular Malaysia with small body size. External morphology characterized by exclusively short tail and black pelage. Skull small with large trapezoid upper molars in the dorsal view. Pelvis thick and secondary sacral fusion incompletely developing.

External morphology. Body small, middle of the size between other *Euroscaptor* and *Parascaptor*, ranged 133–140 mm (M = 137 mm) by the examination of 10 specimens collected in BOH Tea Estate by Kawada *et al.* (2003). Pelage dark iron-gray and darker than Himalayan *E. micrura* and Thai *E. klossi*, rather similar to European *Talpa*. Tail club-shaped with long hair in the tip and quite short (5.0–8.5 mm, N = 10), unidentified under the fur. Tail ratio 3–7% (N = 10), close to *E. micrura* and *E. parvidens*. Snout almost triangular shape in the dorsal view with nostrils open mesio-laterally on the muzzle (Fig. 1). Upper part of nasal pad protruded forward. Penis thick, short and with many spines, representative of the Asian mole type.

The photograph of living *E. malayana* was shown in Kawada *et al.* (2003).

Skull (Fig. 2: a–g). General skull shape similar to that of *E. klossi*, but shorter and broader rostrum. Braincase rounded. Zygomatic arch starts from cheek bone and in the point of one tenth it curves to inner side, then parallely runs along the frontals toward backward until temporal bone. The shape of palate strongly constricted on the position between upper third and fourth

Table 1. Summary of the specimens of *Euroscaptor malayana* examined in this study.

Code	Sex	Date	Locality	Collector	Measurements							
					Weight	Total	Tail	F.Foot	H.Foot	Testis	Tail ratio	GLS
BM47.1418	♂	29, Aug, 1937	Kuala Terla Tea Estate, Cameron Highlands	Ben Ensoll	—	130.0	6.0	19.0×15.0	14.0	—	4.84%	31.13
BM62.712	♀	7, Mar, 1962	Cameron Highlands	The Earl of Cranbrook	—	—	—	—	—	—	—	31.25
ZRC4.2082	♀	21, Aug, 1937	Cameron Highlands (Kuala Terla Tea Estate?)	Ben Ensoll (?)	—	137.0	7.0	18.5×15.0	14.5	—	5.38%	—
ZRC4.8101	?	11, May, 1939	Tanah Rata, Cameron Highlands	—	—	102.5	3.4	—	13.5	—	3.43%	—
ZRC4.8102	?	25, Jun, 2000	Brinchang tea plantation, Cameron Highlands	Adrian H. B. Loo	—	—	4.4	—	15.8	—	—	—
no number	?	—	Cameron Highlands	—	—	—	—	—	—	—	—	—
SIK0556	♂	13, Jan, 2002	BOH Tea Estate, Cameron Highlands	Shin-ichiro Kawada	71.50	139.5	5.5	16.0×17.0	15.0	11.85×7.70	4.10%	32.47
SIK0558	♂	13, Jan, 2002	BOH Tea Estate, Cameron Highlands	Akio Shinohara	50.00	137.5	8.5	16.0×16.5	15.5	4.25×2.00	6.59%	30.94
NSMT-M34738	♂	11, Jan, 2002	BOH Tea Estate, Cameron Highlands	Shin-ichiro Kawada	58.50	133.5	5.0	15.5×17.0	15.5	11.00×6.85	3.89%	30.54
NSMT-M34739	♂	11, Jan, 2002	BOH Tea Estate, Cameron Highlands	Shin-ichiro Kawada	57.00	135.0	5.0	15.5×15.5	16.0	11.00×6.65	3.85%	31.10
NSMT-M34740	♂	12, Jan, 2002	BOH Tea Estate, Cameron Highlands	Shin-ichiro Kawada	53.00	137.5	6.0	16.0×16.5	16.0	10.95×6.35	4.56%	30.90
NSMT-M34741	♀	12, Jan, 2002	BOH Tea Estate, Cameron Highlands	Shin-ichiro Kawada	43.60	135.5	5.5	15.0×15.5	14.5	—	4.23%	—
NSMT-M34742	♂	12, Jan, 2002	BOH Tea Estate, Cameron Highlands	Shin-ichiro Kawada	62.50	139.0	4.5	16.5×16.5	16.5	10.95×6.35	3.35%	31.84
NSMT-M34743	♂	13, Jan, 2002	BOH Tea Estate, Cameron Highlands	Shin-ichiro Kawada	57.50	137.0	5.5	16.0×16.5	15.0	11.05×7.00	4.18%	31.07
NSMT-M34744	♂	13, Jan, 2002	BOH Tea Estate, Cameron Highlands	Akio Shinohara	64.00	137.0	6.0	16.0×17.0	16.0	12.20×7.00	4.58%	32.00
NSMT-M34745	♂	14, Jan, 2002	BOH Tea Estate, Cameron Highlands	Akio Shinohara	56.00	137.0	5.5	15.5×16.0	15.0	10.80×6.75	4.18%	—

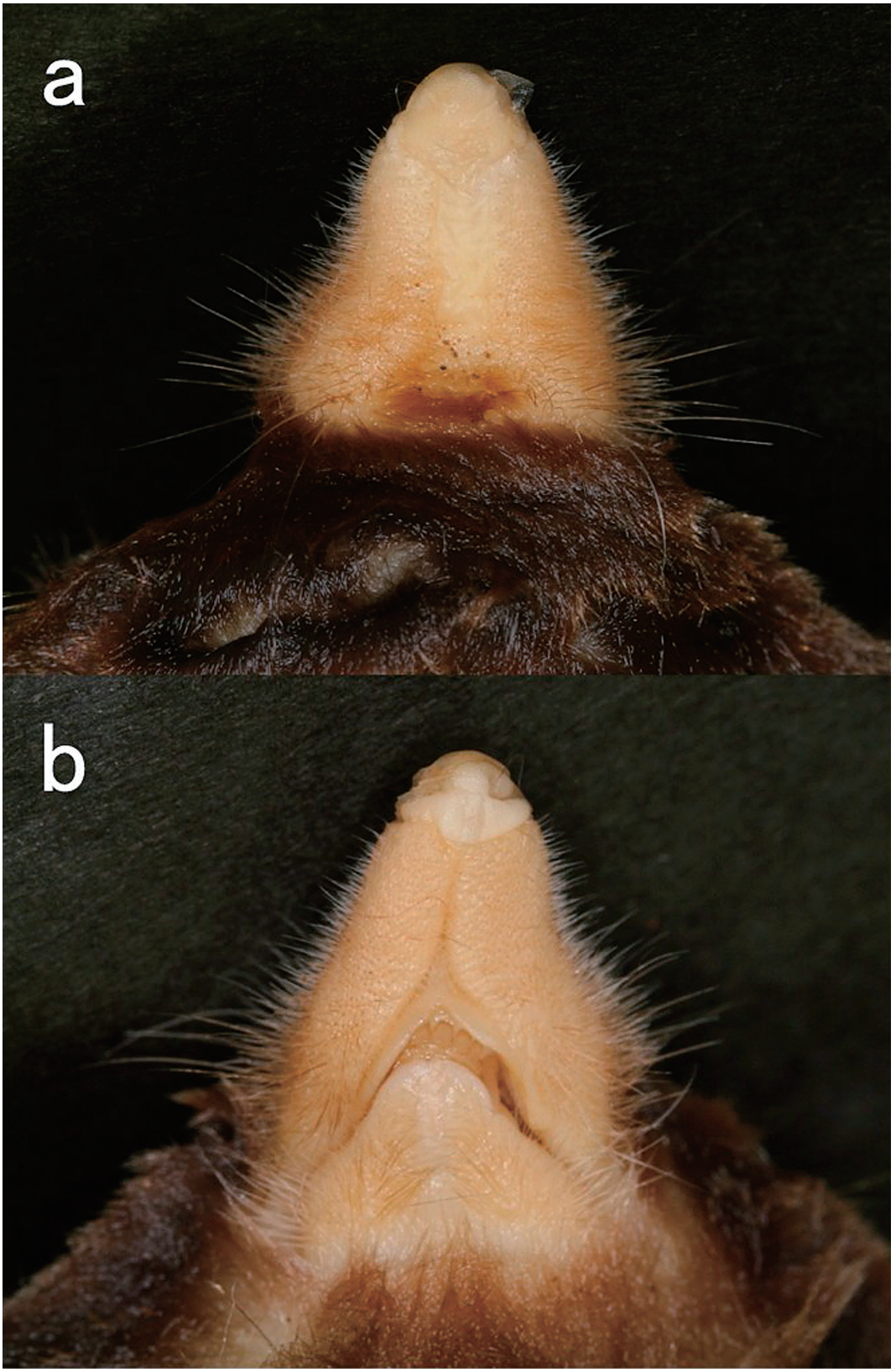

Fig. 1. Dorsal (a) and ventral (b) views of the snout of *Euroscaptor malayana* (NSMT-M34745).

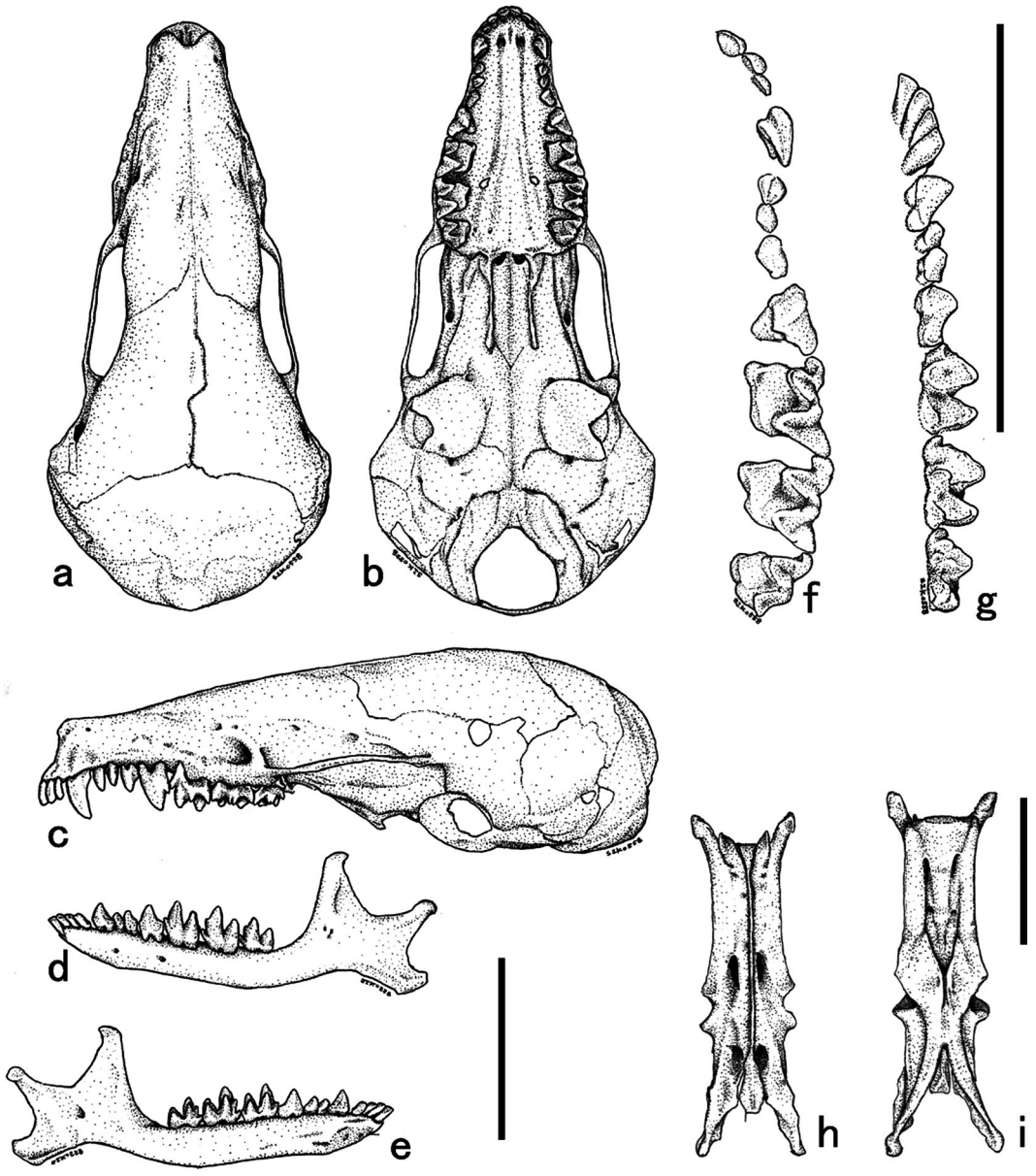

Fig. 2. Cranium, mandible and pelvis of *Euroscaptor malayana*. Scale bars indicate 10 mm. a, the dorsal view of cranium. b, ventral view. c, left side. d, outer side of left mandible. e, inner side. f, occlusal view of left upper tooth row. g, occlusal view of right lower tooth row. h, dorsal view of pelvis. i, ventral view.

premolars. Postorbital bridge slender than these of *E. micrura* and *E. klossi* (Fig. 3), and its connection to the proximal zygomatic arch above the mesostyle of upper second molar. Auditory bulla rather flat and fore edge rounded. Aperture of bulla wide in relative of other species of *Euroscaptor*.

Mandible usual shape of talpid mole. The coronoid process high and slender as in *E. micrura* and *E. klossi*, but its summit skewed to backward. The length of lower tooth row reaches 58–60% of the mandible length. The lamina between the condylar process and angular process less developed, resulting mandibular notch constricts

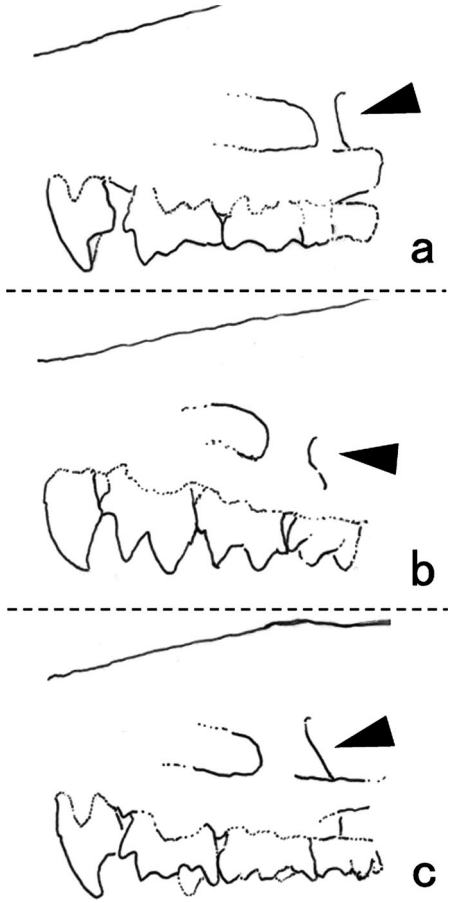

Fig. 3. Comparison of postorbital bridges (arrowheads) among three species of *Euroscaptor*. a, *E. malayana*. b, *E. klossi*. c, *E. micrura*.

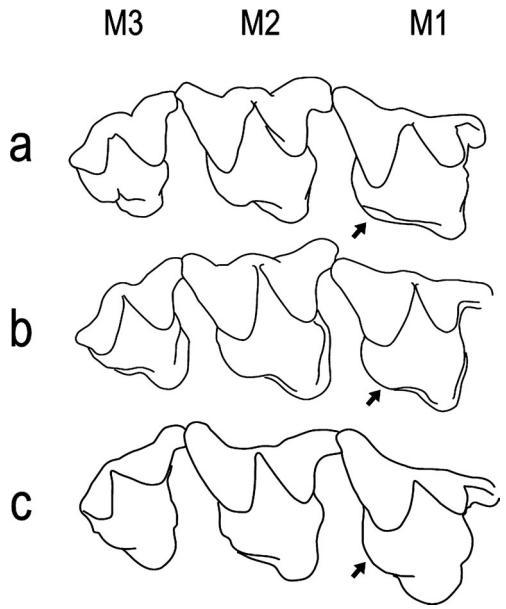

Fig. 4. Comparison of upper molars (M^1–M^3) among three species of *Euroscaptor*. a, *E. malayana*. b, *E. klossi*. c, *E. micrura*. Arrows indicate metaconule of upper first molars.

well. The position of mental foramen positioned under the boundary of lower first and second premolars, but one or two additional opening occasionally localized under lower fourth premolar and first molar.

Dental formula same as *Talpa* and *Euroscaptor* type, I3/3, C1/1, P4/4, M3/3＝44, but one case (NSMT-M34742) lower second premolar symmetrically missing. Upper incisor row protruded fore and arranged V-shape. The first incisor clearly larger than the others and especially toward to fore direction. Upper premolars small unicuspids and crowdedly arranged. First and third are same height but third one is mesio-distally elongated. Second one is lower than first and third, and lanceolated sharp shape. Fourth one is twice higher than first and third, with well-developed protocone and distal styler cusp. Relative size of upper molars to the greatest length of skull is largest in genus *Euroscaptor*. The first to third upper molars have metaconules lingually well-developed and the position of protocone is displaced to mesial direction, resulting to make the shape of teeth as a broad trapezoid. The development of mesostyle well and three styler cusps fall into the outline of palate. Metastyle does not protrude outside, dissimilar to that of *E. micrura* (Fig. 4). The outline between these metaconules and protocone weakly constricted. In third upper molar, the robe including metacone well developed in the same degree of paracone.

Lower incisors and canine small and arranged sector-shape. Lower canine thin chisel-shaped tooth with minute subcusp in the distal edge. The first premolar large and highest canine-like tooth with long mesio-distal diameter but distal subcusp not well developed. Second and third lower

premolars almost same in height, and fourth one enough higher than fore teeth. Lower molar has well developed talonids. In each lower molar, protoconid is much higher than hypoconid.

Postcranial skeleton. Vertebral formula is C7, T13, L5, S5, Cd4+, thus original type of Talpid mole (Yoshiyuki, 1986).

Pelvis (Figs. 2: h, i, 5) characterized by the only one pair of sciatic foramina, so-called *Talpa* type, although weak connection present between fifth sacrum and illium in the process of development. In this aspect, second sciatic foramina are incomplete and this can be situated as the transitional form of *Talpa* and *Mogera* types (Stroganov, 1948; Grulich, 1982). Width of pelvis very thick, especially in the position of least breadth of ilium. Right and left ischia very short, and distal ends not strongly curved outside.

On the context of shoulder girdle, Cranbrook (1966) reported with the comparison with European *Talpa* and Asian *Parascaptor* in detail. *Euroscaptor malayana* has a clavicle with a foramen pierces for the course of a vein. This character is similar in other *Euroscaptor* species.

Variation. *Euroscaptor malayana* is only known from Cameron Highlands, so geographic variation is unknown. Females are rather smaller than males. One specimen (ZRC4.2082) has white spot in the chest part of skin. Another specimen (NSMT-M34742) shows dental reduction of lower second premolar in each jaw. As shown in the other Talpidae, the molars of *E. malayana* show the conspicuous tooth wearing, which make us estimate their age (Abe, 1967). Based on this criterion, young animal shows the rounded shape of the skull. This variation is remarkable in the brain case, i.e. relative height of the brain case is decreasing with the age, giving flat appearance of old skulls. Zygomatic arch is curved toward to inner side in juvenile and changes strait and parallel in young to old.

Distribution and ecology. All the specimens of the Malaysian mole were collected in Kuala Terla Tea Estate, BOH Tea Estate and some surrounding gardens. The altitude of known habitats is ranged 1300 to 1600 m above sea level. It is notable that mole's run was found in Talikom Station on Brinchang Peak about 2000 m a.s.l. according to Cranbrook and Medway (1962). There were no recent report of collecting the mole from mountain forest of Cameron Highlands, but possible range also covers in these forest areas, as mentioned by Medway (1978). Further field survey in Peninsular Malaysia will possibly enlarge the distribution area of the Malaysian mole.

Cranbrook (1966) noted about the behavior of this mole that they do not construct the mole hills, as seen in the European and Japanese mole species (Gorman & Stone, 1990). Cranbrook and Medway (1962) reported that the lactating female was collected in March. According to Kawada *et al.* (2003), most males had reproductively enough size of testes in January. Thus reproductive season of *E. malayana* is likely to fall in the period between January and March. Food items include earthworms, arthropods and small reptile (blind snake). As noted in the other mole species, they eat most of subterranean animals that they can find.

One Malaysian mole (ZRC4.8102) deposited in Raffles Museum of Biodiversity Research, Singapore was recorded from a stomach of the road killed snake, *Elaphe purphyracea* (Leong *et al.,* 2001). In the case of other species of moles, owls and raptors usually use this animal for their preys.

Discussion

All the known specimens of *Euroscaptor malayana* were collected from Cameron Highlands, Pahang, Peninsular Malaysia. In the other montane areas of Peninsular Malaysia, there are no records so far. This fact may make us to suspect if the mole from Peninsular Malaysia was artificially introduced with the plantation of tea or other plants.

The history of Cameron Highlands started in 1885. British government surveyor, William Cameron first found this highland plateau. In this

time, he did not certificate the exact location, but it was rediscovered by British military's mapping expedition of Malaya after that. In 1925, Sir George Maxwell visited here and decided to construct a hill station that would be later used in 1931. In 1927, George Archibald Russell planed to make tea estate in Cameron Highlands. He deforested the primary forest vastly under suggestions of A. B. Milne, a tea planter in Ceylon. It is said that the tea was transported from Darjiling, northern India, and many local workers also migrated to Cameron Highlands (Eliot & Bickersteth, 2002).

As mentioned above, the first record of the mole from Malaysia was in 1937 from a forest area during tea plantation development and this mole was described in 1940 by Chasen. If the Malaysian mole was introduced from any other place with tea, it is difficult to explain that its morphological distinction had accumulated within ten years, i.e. at most ten generations, after tea transportation. In Darjiling where the tea in Cameron Highlands originated, the short-tailed mole, *E. micrura*, is distributed. This mole is rather large sized species in genus *Euroscaptor* (greatest length of skull 33 to 35 mm) and the range of the skull size does not overlap with the Malaysian mole. Kawada *et al.* (2003) denoted that the Malaysian mole was classified as a subspecies of *E. micrura* based on the similar characters of its short tail and relative upper molar length, although examined characters and specimens were limited. In the present description of the Malaysian mole, the shape of upper molars (Fig. 4) and pelvis (Fig. 5) are conspicuously different from those of *E. micrura*. Therefore, we conclude that the Malaysian mole is morphologically considered as a distinct species, *E. malayana*, native to Peninsular Malaysia.

This recognition is supported by the recent genetic surveys. Shinohara *et al.* (2004) examined the molecular phylogenetic relationships among Asian mole species. In their results, the Malaysian mole is far apart from the Japanese *Mogera* group and the Japanese mountain mole, *E. mizura*. In the results of the additional data including *E. klossi* from northern Thailand, the rate of their nucleotide change of mitochondrial cytochrome *b* is 9.2% between the two species calculated by the Kimura-2-parameter model (Kimura, 1980; Shinohara, unpublished data). This substitution rate is relative to Japanese two species of mole, *M. wogura* and *M. imaizumii* (Tsuchiya *et al.*, 2000).

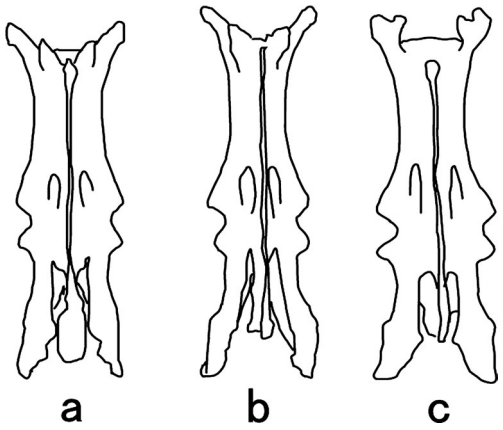

Fig. 5. Comparison of pelvis among three species of *Euroscaptor*. a, *E. malayana*. b, *E. klossi*. c, *E. micrura*.

On the other hand, Kawada *et al.* (2005) examined differentially stained karyotype of the Malaysian mole. Chromosome number of *E. malayana* is 2n=36 and autosomal fundamental number is NFa=52. This chromosomal data was different from Kloss's mole, *E. klossi*, by the change of one whole arm reciprocal translocation followed by a pericentric inversion (Kawada *et al.*, 2006). It is generally considered that chromosomal differences by the reciprocal translocation and pericentric inversion can be affect to the postmating isolation mechanisms, thus estimated that the reproductive isolation was accomplished between the Malaysian and Kloss's moles.

Based on the skull dimensions, *E. malayana* is most closely related with Thai *E. klossi*. *Euroscaptor klossi* is distributed in the eastern to northern Thailand where possible southern limit is Tak Province. The area missing the Talpidae stretchs more than 1000 km between Thailand and Peninsular Malaysia. Therefore, *E. malayana*

is an isolated southernmost species of genus *Euroscaptor*. On the biogeographic contexts, it is well known that some mammal species of Peninsular Malaysia are diversified from the Thai population by Kra Isthmus (Fooden & Albrecht, 1993; Hayashida *et al.* 2007). As the moles are one of temperate animals, most of the lowland area in this region is not good habitat for them because of scarcity of litter deposits and poor soil development. Therefore, the distribution of the Malaysian mole tends to be patchy only in the high altitude place (Kawada, 2005). The climate of Cameron Highlands at present is moderate and humid (air temperature 13–23°C, relative humidity 73–98%) throughout the year, similar to some temperate regions. It is likely that such climate is suitable for the Malaysian mole to maintain the population in the area since its ancestor's immigration from Indochina. In the recent progression of global warming, this species can be one of the most concerned species on the context of natural resources conservation.

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独立種としてのマレーシアモグラ *Euroscaptor malayana* の再記載

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半島マレーシア産のモグラは *Euroscaptor* 属の遠隔地個体群として1940年に記載された．原記載以来，本地域個体群はヒマラヤやタイ国に生息する種の亜種とされるのが一般的で，独立種としての扱いはなされていない．近年発表された形態，核型，分子系統の成果は，半島マレーシア産のモグラが明らかに *Euroscaptor* 属の他種とは異なることを示唆している．本研究では，半島マレーシア産のモグラに関する詳細な形態的記載を行った．半島マレーシアにおいてモグラの主な生息地とされる茶畑の由来に関しても考察を加え，本地域個体群が *Euroscaptor* 属の他種とは明確に異なる形態的特徴を持つ，固有種として位置づけられることを示した．