



A new species of *Crocidura* (Soricomorpha: Soricidae) from southern Vietnam and north-eastern Cambodia

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Abstract

Knowledge of the Soricidae occurring in Vietnam has recently expanded with the discovery of several species previously unknown to science. Here we describe a new species of white-toothed shrew belonging to the genus *Crocidura* from lowland areas in southern Vietnam and from a river valley in north-eastern Cambodia. This small to medium sized species is diagnosed on the basis of external features, cranial proportions and morphology of the last upper and lower molars. Comparisons are made with other species of *Crocidura* known to occur in Vietnam and the biogeography of the regions where the new species has been found, is briefly discussed.

Key words: white-toothed shrew, Vietnam, Cambodia

Introduction

Knowledge of the soricid fauna of South-East Asia and particularly that of Vietnam is still poorly understood, while that of Cambodia is virtually unknown (Jenkins, 1982; Heaney & Timm, 1983; Jenkins & Smith, 1995; Motokawa *et al.*, 2005; Jenkins *et al.*, 2009). In 1983, Heaney & Timm recorded only three species of *Crocidura* for Vietnam, namely *C. attenuata* Milne Edwards, 1872, *C. fuliginosa* (Blyth, 1855) and *C. indochinensis* Robinson and Kloss, 1922. Recent small mammal surveys in Vietnam have resulted in the discovery of new distributional records of shrews, *C. wuchihensis* Shaw, Wang, Lu and Chang, 1966 (Lunde *et al.*, 2003) and *Blarinella griselda* Thomas, 1912 (Abramov *et al.*, 2007), and the description of several additional new species, including *Chodsigoa caovansunga* Lunde, Musser and Son, 2003, *Crocidura kegoensis* Lunde, Musser and Ziegler, 2004, *C. sokolovi* and *C. zaitsevi* Jenkins *et al.*, 2007, and *C. phuquocensis* Abramov *et al.*, 2008. Eight species of *Crocidura* are currently recorded from Vietnam (Abramov *et al.*, 2008; Can *et al.*, 2008). A further species of *Crocidura*, described herein, was found during the biodiversity surveys conducted by the Joint Vietnam – Russian Tropical Research and Technological Centre in southern Vietnam in 2007.

Information on the mammalian fauna of Cambodia is sparse and mainly confined to surveys of large mammals and Chiroptera (Desai & Vuthy, 1996; Timmins & Soriyun, 1998; Daltry & Momberg, 2000). Knowledge of the small mammals of the country is very limited. In 2006 Conservation International carried out a survey of the small mammals of the Virachey National Park in northeastern Cambodia and several specimens of *Crocidura* were found that closely matched the undescribed species from Vietnam. The description of this species is presented below.

Materials and methods

Conservation International carried out surveys in Virachey National Park in June 2006. Virachey National Park massif, located in the far northeast corner of Cambodia and bordering both Vietnam and Lao People's Democratic Republic (PDR), contains a range of mountains that reach over 1400 m altitude to the East and over 1500 m towards the Lao PDR border. The survey site encompassed a wide range of altitudes, from approximately 150 m above sea level (a.s.l.) to over 1000 m elevation, including lowland rivers, hill streams, lowland evergreen forest and montane forest. The site where shrews were collected was a steep river valley in hill evergreen forest, which characterizes the majority of Virachey National Park. Aluminium box traps measuring 9cm x 10cm x 32cm were employed to capture small mammals. The traps were baited with a mix of dried fish, dried beef, shrimp and peanut butter, and set in areas which showed signs of small mammal activity (for example hollows under trees, in rocky areas, near a hole). The traps were set in the afternoon and checked in the morning. Pitfall traps with straight-line drift fences were used to capture rare, cryptic, low-density ground-dwelling and fossorial species. A drift fence and pitfall trap array was positioned in mid-elevation forest along a hill stream for three days (two nights) and consisted of a 50 m long drift fence with pitfall traps positioned at both ends of each drift fence and at 10 m intervals. All shrews were caught in pitfall traps, in areas of 480 m a.s.l.

The Joint Russian – Vietnam Tropical Research and Technological Centre conducted biodiversity surveys in various biotopes in Yok Don National Park, Dak Lak Province and Binh Chau – Phuoc Buu Nature Reserve, Ba Ria – Vung Tau Province, southern Vietnam, from 1 to 30 June 2007. Shrews were captured using pitfall traps consisting of plastic buckets 40 cm deep and 30 cm in diameter, buried flush with the ground surface. The pitfall traps were checked every day.

Five specimens resulting from the 2007 Vietnamese survey were compared with material in the collections of the Zoological Institute, Russian Academy of Sciences, Saint-Petersburg, Russia (ZIN) and the Zoological Museum of the Moscow State University, Moscow, Russia (ZMMU). The shrews were sent for further comparative study to the Natural History Museum, London (BM(NH)), where they were compared with material in the reference collection and with shrews from Cambodia recently sent in for identification by Conservation International. Additional comparisons were also made with material in the collections of the American Museum of Natural History, New York, USA (AMNH) and the Museum für Tierkunde, Dresden (MTD). The new taxon was compared with Vietnamese material of the following species of *Crocidura*: *C. attenuata* (25 specimens plus 3 specimens from Cambodia), *C. fuliginosa* (24), *C. indochinensis* (9), *C. kegoensis* (1), *C. phuquocensis* (5), *C. sokolovi* (3), *C. wuchihensis* (16), *C. zaitsevi* (12).

Measurements in millimetres were taken with digital callipers. Cranial and dental nomenclature follows that of Meester (1963), Mills (1966), Swindler (1976), Butler & Greenwood (1979) and Dannelid (1998). Abbreviations for the dental nomenclature are given in the text, with premaxillary and maxillary teeth denoted by uppercase and mandibular teeth by lowercase letters, thus incisor (I/i), unicuspid (Un), premolar (P/p), molar (M/m).

Results

Crocidura phanluongi sp. nov.

Holotype. ZIN 97092, collector's number 24, male, body in ethanol, skull extracted, collected 26 June 2007 by A.V. Abramov.

Type Locality. Northern portion of Yok Don National Park, Dak Lak Province, Vietnam, 12° 58' N, 107° 49' E, altitude 250 m a.s.l.

Paratypes. ZIN 97090, collector's number 15, female, collected 23 June 2007; ZIN 97091, collector's number 23, female, collected 26 June 2007; ZIN 97093, collector's number 30, female, collected 28 June 2007; all bodies in ethanol, skulls extracted, collected by A.V. Abramov from the same locality as the holotype.

Referred material. ZIN 97089, collector's number 3, male, collected 10 June 2007 by A. V. Abramov from Binh Chau – Phuoc Buu Nature Reserve, Ba Ria – Vung Tau Province, Vietnam, 10° 32' N, 107° 29' E, altitude 50 m a.s.l.; ZMMU S-162801, male and ZMMU S-162802, female, both collected September 1994 by N. V. Belyaeva and M. V. Kalyakin from Ma Da Forest, Dong Nai Province, Vietnam, 11° 18' 50" N, 107° 04' 18" E, altitude 50 m a.s.l.; all bodies in alcohol, skulls extracted.

BM(NH) 2008.718, collector's number CCP-AO 0077, female; BM(NH) 2008.719, collector's number CCP-AO 0078, female; BM(NH) 2008.720, collector's number CCP-AO 0079, male; BM(NH) 2008.721, collector's number CCP-AO 0080, sex unknown; BM(NH) 2008.722, collector's number CCP-AO 0082, female; BM(NH) 2008.723, collector's number CCP-AO 0083, sex unknown; all collected 22 – 23 June 2006 by Annette Olsson from Virachey National Park, North East Cambodia 14° 18' 49" N 107° 22' 5" E, altitude 480 m a.s.l.; all bodies in alcohol, skulls extracted. See Figure 1 for a map of collection localities.

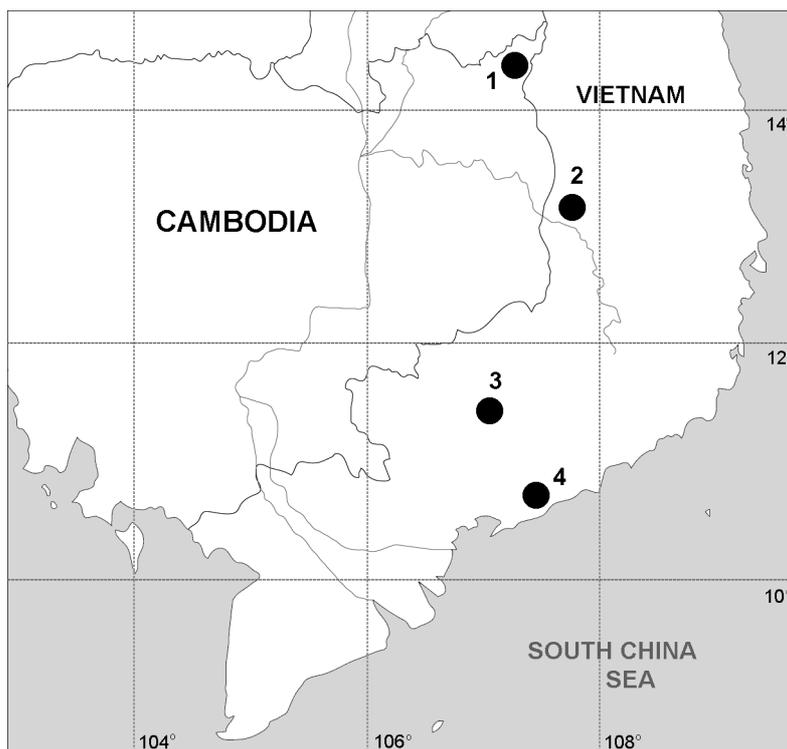


FIGURE 1. Map of collection localities of *Crocidura phanluongi*. Cambodia: 1. Virachey National Park. Vietnam: 2. Yok Don National Park; 3. Ma Da Forest; 4. Binh Chau – Phuoc Buu Nature Reserve.

Etymology. The new species is named in honour of the late Dr. Phan Luong (1948 – 2008). From 1990 he directed the ecological researches of the Joint Vietnam - Russian Tropical Research and Technological Centre, Hanoi. During the last 20 years, he organised many Vietnamese - Russian biodiversity surveys, including his last fieldwork in Yok Don and Binh Chau – Phuoc Buu National Parks in 2007.

Diagnosis. A small to medium sized shrew distinguished from similar sized species recorded from Vietnam and Cambodia by the following combination of characters: skull with a narrow interorbital region relative to maxillary and braincase breadth, upper third molar slender, and lower third molar with a simple talonid, reduced to a hypoconid.

Description. A small to medium sized shrew (see Table 1), with a moderately long tail, 61 – 83% of head and body length. Dorsal pelage dark grey, grading into the slightly paler ventral pelage (see Fig. 2). The tail is similarly coloured to the body, slightly paler below, with bristle hairs present on the proximal two thirds to three quarters of its length. The dorsal surfaces of the fore and hind feet are markedly paler than the body.

Skull (see Fig. 3) with a slender rostrum and zygomatic region but a broad maxillary region; interorbital region narrow, braincase moderately narrow and short with prominent angled superior articular facets and well developed lambdoid crests.

TABLE 1. Comparison of external and cranial measurements of *Crocidura phanluongi* and *C. indochinensis*. Measurements in millimetres are presented as the mean and standard deviation, range and number of specimens in parentheses.

Character	<i>C. phanluongi</i>	<i>C. indochinensis</i>
Head and body length	59.6 ± 4.33 54 – 66 (13)	64.3 ± 2.92 59 – 68 (9)
Tail length	44.4 ± 2.32 40 – 48 (13)	55.0 ± 2.96 50 – 58 (9)
Hindfoot length	11.7 ± 0.69 10 – 12 (13)	12.2 ± 0.43 12 – 13 (9)
Condylbasal length	17.4 ± 0.47 16.8 – 18.1 (12)	17.5 ± 0.33 16.9 – 17.8 (9)
Upper toothrow length	7.7 ± 0.3 7.3 – 8.2 (13)	7.7 ± 0.24 7.3 – 8.0 (9)
Maxillary breadth at M2	5.3 ± 0.19 5.1 – 5.8 (13)	5.2 ± 0.07 5.1 – 5.3 (9)
Least interorbital breadth	3.6 ± 0.16 3.4 – 3.9 (13)	4.0 ± 0.09 3.9 – 4.2 (9)
Braincase breadth	7.9 ± 0.24 7.5 – 8.2 (12)	8.2 ± 0.15 7.9 – 8.4 (9)
Braincase height	4.4 ± 0.19 4.1 – 4.7 (12)	4.4 ± 0.11 4.2 – 4.5 (9)
Braincase length	7.0 ± 0.27 6.6 – 7.4 (12)	7.3 ± 0.14 7.2 – 7.5 (9)
Ratio of tail length to head and body length	0.75 ± 0.06 0.61 – 0.83 (13)	0.86 ± 0.04 0.81 – 0.92 (9)
Ratio of tail length to condyloincisive length	2.47 ± 0.13 2.25 – 2.74 (13)	3.04 ± 0.13 2.85 – 3.19 (9)
Ratio of interorbital breadth to maxillary breadth at M2	0.68 ± 0.02 0.65 – 0.71 (13)	0.77 ± 0.02 0.75 – 0.79 (9)
Ratio of interorbital breadth to braincase breadth	0.45 ± 0.01 0.43 – 0.48 (12)	0.49 ± 0.01 0.47 – 0.5 (9)



FIGURE 2. Photograph of adult female *Crocidura phanluongi* (ZIN 97090).

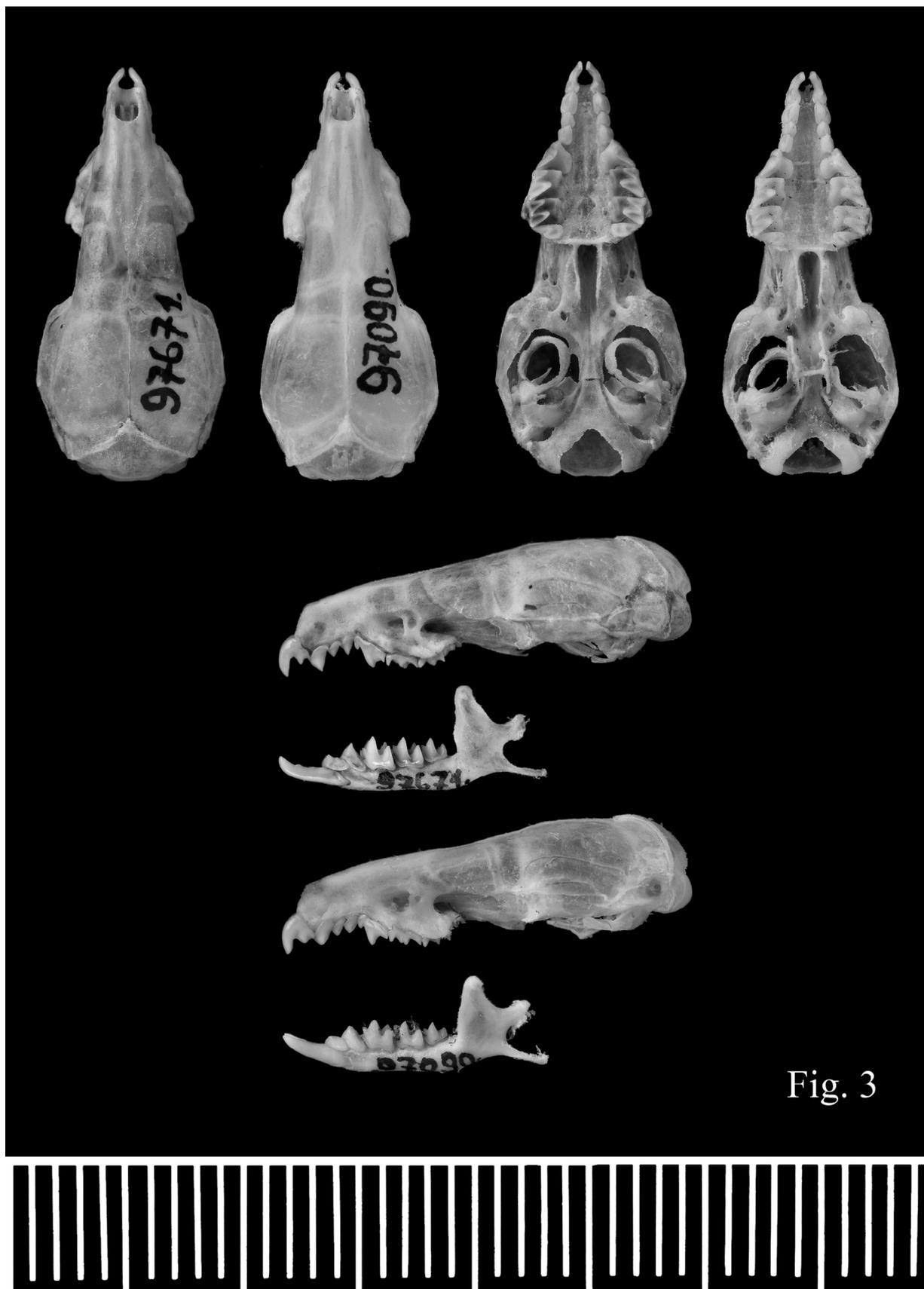


Fig. 3

FIGURE 3. Comparison of crania of *Crocidura phanluongi* (ZIN 97090) and *Crocidura indochinensis* (ZIN 97671). Top row: dorsal and ventral views of the skulls of *Crocidura indochinensis* (left) and *Crocidura phanluongi* (right). Second row: left lateral view of skull and mandible of *Crocidura indochinensis*. Bottom row: left lateral view of skull and mandible of *Crocidura phanluongi*.

The first upper incisor (I1) is moderately slender and the posterior cusp is broad, approximately one third the height of the first unicuspid (Un1). The second unicuspid (Un2) is only slightly smaller than the third (Un3) and subequal in height. The parastyle of the upper premolar (P4) is small, approximately half the height as Un3; the lingual border of the tooth is nearly parallel to the medial axis of the skull, with the hypocone only slightly more lingually positioned than the protocone; the posterolingual border of the tooth is shallowly concave. The talon of the third upper molar (M3) is narrow. Lower incisor with two denticulations evident in unworn dentition. A trace of a posterolingual cuspid is present on the lower premolar (p4). The talonid of the third lower molar (m3) is simple (see Fig. 4) and reduced to a hypoconid, lacking other elements, although it may show a wear facet.

Variation. In specimens from Virachey National Park, Cambodia the dorsal pelage is grey brown, the ventral pelage contrasting silvery grey, with the light coloured venter grading into the dorsal colour on the flanks, or showing moderately sharp demarkation in some specimens. Fore and hind feet markedly paler in coloration than the body; limbs light buffy grey, digits cream. Tail grey above, lighter below, bicolored at least proximally in all specimens and for the greater part of the length in others. Bristle hairs present on the proximal two thirds of the length, with silver hairs at the tip.

The specimen from Binh Chau – Phuoc Buu has a slightly shorter tail (61% of head and body length) than specimens from other localities (68 – 83%). Specimens from Yok Don and Binh Chau – Phuoc Buu average smaller in condylobasal and upper toothrow length than those from Ma Da and Virachey, and specimens from Yok Don have narrower braincases than specimens from other localities (see Table 2).

TABLE 2. Variation in *Crocidura phanluongi*. Measurements in millimetres are presented as the mean and standard deviation, range and number of specimens in parentheses.

Character	Yok Don	Binh Chau	Ma Da	Virachey
Condylobasal length	17.0 ± 0.24 16.8 – 17.3 (4)	17.2	18.1	17.6 ± 0.36 17.1 – 18.1 (6)
Upper tooth row length	7.5 ± 0.16 7.3 – 7.6 (4)	7.3	7.8, 8.1	7.9 ± 0.23 7.6 – 8.2 (6)
Braincase breadth	7.7 ± 0.15 7.5 – 7.9 (4)	8.2	8.2	8.0 ± 0.12 7.9 – 8.2 (6)

Comparisons. The tabular key (Table 3) shows that the new species is considerably smaller than most species of *Crocidura* recorded from Vietnam, namely *C. fuliginosa*, *C. attenuata* and *C. sokolovi*, and smaller than *C. phuquocensis*. It is larger than *C. wuchihensis*, *C. kegoensis* and *C. zaitsevi*.

It is comparable in size to *C. indochinensis* but differs in a number of features. Externally the two species are distinguished by the tail length, which is longer relative to head and body length and to condyloincisive length in *C. indochinensis* than in *C. phanluongi* (see Table 1). The cranium of *C. phanluongi* has a narrower interorbital region relative to maxillary breadth and to braincase breadth than that of *C. indochinensis* (see Fig.3 and Table 1). The talon of M3 is slender relative to the size of M2 in *C. phanluongi* in comparison to that of *C. indochinensis* in which the talon is relatively larger. In contrast to the simple talonid of m3 in *C. phanluongi*, that of *C. indochinensis* is complex, with all elements, hypoconid, entoconid, entoconid ridge and talonid basin present (see Fig. 4).

Distribution. The species seems to have a fairly widespread distribution, potentially ranging across three ecoregions as defined by Wickramanayake *et al.* (2002). Both Virachey National Park and Ma Da Forest, lie within the non-montane Ecoregion 59: Southeastern Indochina dry evergreen forests. Yok Don National Park is classified as Ecoregion 72: Central Indochina Dry Forests, whereas Binh Chau – Phuoc Buu Nature Reserve, described by Wickramanayake *et al.* (2002) as an area of low rolling hills containing a variety of dry forest communities, is in Ecoregion 58: Southern Vietnam Lowland Dry Forests.

The series of type specimens was collected from a variety of habitats in the northern portion of Yok Don National Park: disturbed dipterocarp forest; mixed evergreen forest near a small stream; in bamboo forest; and at the edge of mixed forest near the top of a small hill. The specimen from Binh Chau – Phuoc Buu Nature

Reserve was collected in a small area of wetland surrounding a narrow brook in a vast sandy area with *Melaleuca* forest. The Ma Da Forest where the two other Vietnamese specimens were collected, is a large dipterocarp forest. From these specimens it appears that the new species is widely distributed in lowland areas of southern Vietnam (see Fig. 1).

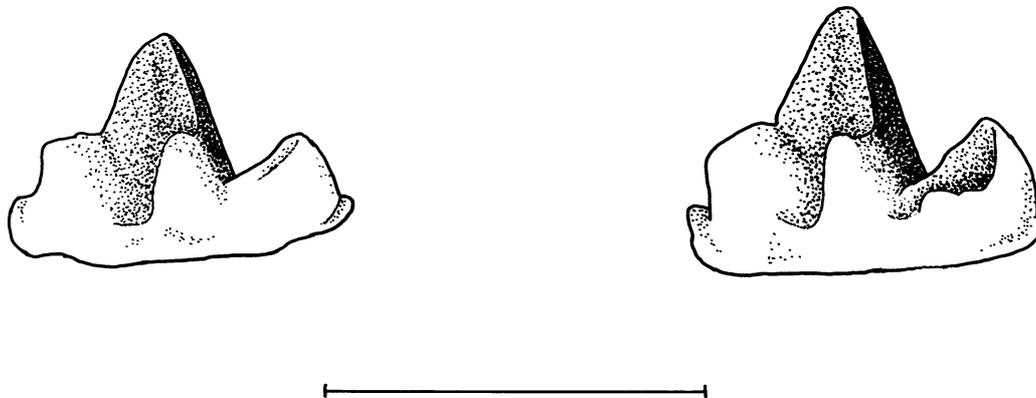


FIGURE 4. Lower right third molar of *Crocidura phanluongi* (BM(NH) 2008.722) on the left and *Crocidura indochinensis* (ZIN 97671) on the right. Scale 1 mm.

TABLE 3. Tabular key of morphological measurements (range in millimetres or percentage) to distinguish the species of *Crocidura* recorded from Vietnam, including the new species *C. phanluongi*.

	<i>Crocidura fuliginosa</i>	<i>Crocidura attenuata</i>	<i>Crocidura sokolovi</i>	<i>Crocidura indochinensis</i>	<i>Crocidura phanluongi</i>	<i>Crocidura wuchihensis</i>	<i>Crocidura phuquocensis</i>	<i>Crocidura zaitsevi</i>	<i>Crocidura kegoensis</i>
Character									
Head and body length	79–107	67–83	70–78	59–68	54–66	55–65	68–72	48–58	48
Tail length as % of head and body length	59–91	63–76	87–93	81–92	61–83	59–85	69–87	62–81	56
Tail pilosity as % of tail length	50–60	50	< 33	33	65–75	20	60	65	50
Condylar-basal length	21.3–23.4	18.8–21.2	18.8–20.4	16.9–17.8	16.8–18.1	15.0–16.4	17.6–18.2	14.2–15.3	14.9
Upper tooth row length	9.8–10.8	8.2–9.6	8.3–9.2	7.3–8.0	7.3–8.2	6.4–7.2	7.7–8.0	6.2–6.8	6.5
Ratio of interorbital breadth to maxillary breadth at M2	0.67–0.75	0.69–0.78	0.79–0.82	0.75–0.79	0.65–0.71	0.72–0.83	0.7–0.75	0.8–0.86	0.77

In contrast the specimens from Virachey National Park, Cambodia were collected in a steep valley, amongst many large rocks in the understory of evergreen hill forest, 15 metres from a river, at an higher altitude (480 m a.s.l.). The forest was very dense with a closed canopy. The end of June, when the shrews were collected, is the rainy season, with heavy rainfall expected every day, especially in mountain areas such as Virachey National Park.

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