

## **First records of *Kerivoula kachinensis* (Chiroptera: Vespertilionidae) from Cambodia, Lao PDR and Thailand**

PIPAT SOISOOK<sup>1</sup>, SARA BUMRUNGSRI<sup>1</sup>, ARIYA DEJTARADOL<sup>1</sup>, CHARLES M. FRANCIS<sup>2</sup>,  
GABOR CSORBA<sup>3</sup>, ANTONIO GUILLÉN-SERVENT<sup>4</sup>, and PAUL J. J. BATES<sup>5, 6</sup>

<sup>1</sup>Department of Biology, Faculty of Science, Prince of Songkla University, Hat Yai, Songkhla, Thailand 90112

<sup>2</sup>National Wildlife Research Centre, Canadian Wildlife Service, Environment Canada, Ottawa, Ontario K1A 0H3, Canada

<sup>3</sup>Department of Zoology, Hungarian Natural History Museum, H-1083 Budapest, Ludovika tér 2., Hungary

<sup>4</sup>Instituto de Ecología, A.C., Km 2.5 Carretera Antigua a Coatepec #351, Congregación El Haya, Xalapa 91070, Veracruz, México

<sup>5</sup>Harrison Institute, Centre for Systematics and Biodiversity Research, Bowerwood House, St. Botolph's Road, Sevenoaks, Kent, TN13 3AQ, United Kingdom

<sup>6</sup>Corresponding author: E:mail: harrisoninstitute@btopenworld.com

*Kerivoula kachinensis* is reported for the first time from Cambodia, Lao PDR and Thailand. In April, 2005 and January, 2006, three individuals were collected in deciduous dipterocarp forest, near bamboo, in the Seima Biodiversity Conservation Area, Mondul Kiri Province, Cambodia. In September, 2007, two individuals were collected in lower montane forest, which included some mixed deciduous forest, bamboo groves and banana trees, in the hills of Phu Suan Sai National Park, Loei Province, and a single individual was collected in mixed deciduous forest, near bamboo, in the Nam Nao National Park, Petchabun Province, Thailand. In 1996–1998, seven specimens were collected from five localities in north, central and southern Lao PDR; most were associated with evergreen forest at altitudes between 150–800 m a.s.l. The species appears to be relatively widespread in continental Southeast Asia. Locally common, it is probably not currently at risk.

**Key words:** *Kerivoula kachinensis*, Vespertilionidae, Thailand, Lao PDR, Cambodia, distribution, first record

### **INTRODUCTION**

To date, 119 bat species, including 57 Vespertilionidae, are recorded from Thailand (Bumrungsri *et al.*, 2006). Six of these belong to the genus *Kerivoula*, including one, *K. pellucida*, which was first collected from the country as recently as May, 2003 (Bumrungsri *et al.*, 2006). In Cambodia, 50 species are known, including 20 Vespertilionidae of which three are *Kerivoula* (*K. papillosa*, *K. cf. hardwickii*

and *Kerivoula* sp. nov. — Matveev, 2005; Bates *et al.*, 2007). In Lao PDR, at least 90 species have been recorded (Francis *et al.*, 1999), including at least four species of *Kerivoula*.

*Kerivoula kachinensis* was described from northern Myanmar (Bates *et al.*, 2004). Subsequently, it was recorded from north and central Vietnam (Thong *et al.*, 2006). Its recent discovery in eastern Cambodia, several localities in Lao PDR, and northern Thailand represents a considerable

range extension. These new data suggest that it is a widespread, if currently little known species in the forests of continental Southeast Asia.

## MATERIALS AND METHODS

### Field Survey Sites

In Cambodia, Seima Biodiversity Conservation Area is situated in southern Mondul Kiri Province [centered on (= c.o.) 12°30'N, 107°15'E]. Extending for 3,034 km<sup>2</sup>, it comprises grasslands, secondary deciduous dipterocarp forest mixed with bamboo and some evergreen hill forest. Annual precipitation averages between 1700 and 1800 mm, with a wet season from May to October and a dry season from November to late April (SCW, 2006).

In Thailand, Phu Suan Sai National Park (Na Haeo) is situated in central Loei Province (c.o. 17°31'N, 101°30'E). With an area of 117.16 km<sup>2</sup>, it is mainly mountainous with a highest peak of 1408 m a.s.l. The vegetation comprises five forest types: lower montane, moist evergreen, dry evergreen, mixed deciduous and some dry dipterocarp (National Park, Wildlife and Plant Conservation Department, 2006b). The climate is tropical monsoon, with an annual precipitation of about 1200 mm. Most of the rains occur from May to October. The dry season lasts for six months. Mean monthly temperatures range from 20–24°C in the cool-dry season (November–January) to 25–29°C in the hot-dry season (February–April) (WorldClimate, 2005). Nam Nao National Park is situated in the Petchabun Range, in eastern Petchabun Province and northern Chaiyaphum Province (c.o. 16°44'N, 101°34'E). The national park covers a total area of 966 km<sup>2</sup> and comprises deciduous dipterocarp, mixed deciduous, dry evergreen, and pine forests and grassland. Annual temperature averages 22.7°C and annual precipitation is between 1300 and 1500 mm (National Park Research Division, 2004). The rainy season is between July and October. The coldest month is November, when temperatures may fall to 0°C (National Park, Wildlife and Plant Conservation Department, 2006a).

In Lao PDR, Nam Ha National Biodiversity Conservation Area (NBCA) is situated in Louang Namtha Province (survey locality 20°49'N, 101°28'E). It has a variety of habitats including evergreen and semi-evergreen lowland and hill forest with various degrees of disturbance, as well as some dry dipterocarp forest. Nam Et NBCA is situated in Houaphan Province (survey locality 20°27'N, 103°23'E).

TABLE 1. External, cranial and dental measurements (in mm) of specimens of *K. kachinensis* from Cambodia, Lao PDR and Thailand, including the length of head and body (HB); tail (TAIL); foot (HF); tibia (TIBIA); forearm (FA) and ear (EAR), greatest length of skull (GTL); condylo-basal length (CBL); zygomatic breadth (ZB); greatest breadth of the braincase (GBB); braincase height (BH); postorbital constriction (PC); upper toothrow length (C–M<sub>1</sub>); mandible length (MDL); relative height of braincase (BH/GBB × 100). Body mass (MASS) is given in grams. The mean, SD, minimum and maximum are provided. Sample sizes differing from those reported under *n* are in brackets

<i>n</i>	sex	HB	TAIL	HF	TIBIA	FA	EAR	MASS
7	♂ ♂	49.7, 2.3	54.9, 2.3	9.1, 0.2	22.6, 0.6	41.5, 1.2	13.0, 1.5	7.7, 1.2
		48.2–53.6 [5]	52.3–57.5 [5]	9.0–9.4 [5]	21.7–23.4 [5]	40.4–43.2	11.9–15.5 [5]	6.5–9.5
6	♀ ♀	51.3, 3.6	58.3, 2.5	9.1, 0.4	23.1	41.7, 1.0	14.9, 1.1	8.6, 0.6
		47.9–53.0 [3]	55.8–61.0 [5]	8.6–9.4 [4]	[1]	40.1–42.6	13.2–16.0 [5]	7.8–9.1 [4]

Habitats include moist evergreen forest, disturbed areas with larger rivers and small streams. Both Nam Ha and Nam Et have been heavily affected by slash and burn agriculture. Phou Khao Khouay NBCA in Vientiane Province includes a mixture of logged semi-deciduous forest and evergreen riverine forest (survey locality around 18°26'N, 102°57'E). Lak Sao in Khammouane Province is a town in central Lao PDR, with extensive patches of secondary forest as well as hills with limestone karst nearby (survey locality 18°12'N, 104°58'E). The Bolaven Plateau in Champasak Province is an elevated area (about 800 m a.s.l.) with extensive, partially logged evergreen hill forest (survey locality 15°03'N, 106°34'E).

### Specimen and Measurements

All external, cranial and dental measurements were taken using digital calipers. Skulls were extracted and prepared from wet specimens preserved in 70% alcohol (Lao specimens were originally fixed in 6% buffered formaline). The Thai material resides in the collections of the Prince of Songkla University (PSU), Hat Yai, Thailand and the Cambodian material in the Hungarian Natural History Museum (HNHM), Budapest. The Lao material has been deposited in the Royal Ontario Museum (ROM) in Canada or the Estación Biológica de Doñana (EBD) in Seville, Spain.

The following measurements were taken (Table 1): HB — head and body length, from the tip of the snout to the base of the tail, dorsally; TAIL — tail length, from the tip of the tail to its base adjacent to the anus; HF — from the extremity of the heel behind the os calcis to the extremity of the longest digit, not counting the claws; TIBIA — length of tibia, from the knee joint to the ankle; FA — forearm length, from the extremity of the elbow to the extremity of the carpus with the wings folded; EAR — ear length, from the lower border of the external auditory meatus to the tip of the pinna; GTL — greatest length of skull, taken from the tip of the incisors to the lambda; CBL — condylobasal length, from an exoccipital condyle to the anterior alveolus of an incisor; CCL — condylo-canine length, from an exoccipital condyle to the anterior alveolus of a canine; ZB — zygomatic breadth, the greatest width of the skull across the zygomatic arches; BB — breadth of braincase, taken at the posterior roots of the zygomatic arches; GBB — greatest width of the braincase; BH — braincase height, taken from the basisphenoid to the highest part of the skull; PC — post orbital constriction; C-M<sup>3</sup> — maxillary toothrow length, from the most anterior part of the upper canine to the back of the crown of the third upper molar; M<sup>2</sup>-M<sup>2ext</sup> — external

TABLE 1. Extended

<i>n</i>	sex	GTL	CBL	CCL	ZB	BB	GBB	BH	PC	C-M <sup>3</sup>	M <sup>2</sup> -M <sup>2ext</sup>	C-M <sub>3</sub>	MDL	BH/GBB × 100
5	♂	17.7, 0.6	16.1, 0.4	15.5, 0.6	10.4, 0.5	7.7, 0.4	8.1, 0.3	5.5, 0.3	3.4, 0.3	6.8, 0.4	6.4, 0.3	7.2, 0.4	12.6, 0.4	67.8, 2.7
		17.0–18.3	15.5–16.5 [4]	14.8–16.1 [4]	9.6–11.0	7.1–8.1	7.6–8.4	5.2–5.9	2.9–3.7	6.2–7.2	5.9–6.6	6.5–7.6	12.0–13.0	65.0–71.5
2	♀	17.3, 18.4	16.0, 16.6	15.5, 16.1	10.7, 11.0	8.1, 8.2	8.4, 8.4	5.6, 5.9	3.6, 3.7	6.7, 7.2	6.5, 6.5	7.3, 7.6	12.9, 13.0	66.1, 69.6

palatal width, taken across the outer borders of the second upper molar at the widest part; C-M<sub>3</sub> — mandibular toothrow length, from the most anterior part of the lower canine to the back of the crown of the third lower molar; MDL — mandible length, from the most posterior part of a condyle to the most anterior part of a crown of a first lower incisor. Body mass (MASS) was recorded to the nearest 0.1 g or 0.5 g using a 50 g or 100 g Pesola scale. The definitions of the measurements are according to Bates and Harrison (1997) and Bates *et al.* (2004).

Echolocation calls of the three Thai specimens were recorded with a Pettersson D 240× ultrasound detector (in 10× time-expansion mode) connected to a digital iRiver iHP-120 Multi-Codec Jukebox. Calls were recorded from free flying bats in a room (3 × 4 × 3 m). Calls were analysed using Bat Sound Pro sound analysis software (Pettersson Electronik AB, Uppsala, Sweden) on a laptop computer. The most energy frequency (peak frequency) and call duration were examined. At least ten calls from each individual were analysed.

#### SYSTEMATIC REVIEW OF SPECIES

*Kerivoula kachinensis* Bates *et al.*, 2004  
Kachin woolly bat

*Kerivoula kachinensis* Bates *et al.*, 2004: 220; Namdee Forest, Bhamo Township, Kachin State, Myanmar, 24°34'N, 97°08'E.

#### New Material

Cambodia: ♀ HNHM 2005.82.3, Seima Biodiversity Conservation Area, Mondul Kiri Province, approx. 12°16'N, 107°04'E, April, 2005; ♂ HNHM 2006.34.50/51, Seima Biodiversity Conservation Area, Mondul Kiri Province, 12°16'N, 107°04'E, 360 m a.s.l., 29 January, 2006.

Thailand: ♂ PSU-M07.242/243, Phu Suan Sai National Park, Loei Province, 17°30'N, 100°57'E, 1300 m a.s.l., 11 September, 2007; ♂ PSU-M07.244, Nam Nao National Park, Petchabun Province, 16°45'N, 101°34'E, 958 m a.s.l., 14 September, 2007.

Lao PDR: ♀ ROM 106458, Lak Sao, Khammouane Province 18°12'N, 104°58'E, 16 April, 1996; ♀ ROM 110603, Bolaven Plateau, Champasak Province, 15°03'N, 106°34'E, 800 m a.s.l., 25 May, 1997; ♂ EBD 25122, Phou Khao Khouay NBCA, Vientiane Province 18°26'N, 102°57'E, 4 June, 1997; ♀ ROM 118063, Phou Khao Khouay NBCA, Vientiane Province, 18°23'N, 103°04'E, 4 February, 1998; ♂ EBD 25747, Nam Et NBCA, Houaphan



FIG. 1. *Kerivoula kachinensis*, ♂, Phu Suan Si National Park, Thailand

Province, 20°27'N, 103°23'E, 22 March, 1998; ♀ ROM 118279, Nam Et NBCA, Houaphan Province, 20°21'N, 103°22'E, 26 March, 1998; ♀ not catalogued, field number AGS980420-18; near Nam Ha NBCA, Louang Nam Tha Province, 20°49'N, 101°28'E, 20 April, 1998.

#### Description and Taxonomic Notes

This is a large sized *Kerivoula* with a forearm length of 40.1–43.2 mm for Cambodian, Thai and Lao material (Table 1) and 41.3 mm and 40.4–43.4 mm for Myanmar and Vietnamese material (Bates *et al.*, 2004; Thong *et al.*, 2006). The dorsal and ventral pelage has dark grey roots, the mid-parts are grey-brown and the tips whitish brown. The ventral surface is slightly paler than dorsal surface. The muzzle and lips are covered with hairs except for the nostrils, which are naked (Fig. 1). The wings are attached to the base of the toes. The tail is long (52.3–61.0 mm). The external and cranial morphology of the recent specimens is essentially similar to that described in Bates *et al.* (2004). In the skull, the most distinctive character is the flattened braincase. Its height relative to its width ( $BH/GBB \times 100$ ) is 65.0–71.5% in the Cambodian, Thai and Lao material (Table 1), which compares favourably to the 62.9–69.6% in the four Vietnamese specimens (Thong *et al.*, 2006) and 64.0% in the holotype (Bates *et al.*, 2004). In *K. lenis* and *K. papillosa*, the respective figures are 82.4–89.3% ( $n = 4$ ) and 80.6–91.6% ( $n = 22$ ) (Bates *et al.*, 2004).

DNA barcodes (sequences of the cytochrome *c* oxidase subunit I mitochondrial gene, COI) were obtained for six of the specimens from Lao PDR, and included as *K. kachinensis* in Fig. 3 of Francis *et al.* (2007). The sequences indicated all six were very similar to each other, but differed in their average sequences by more than 12% from any other species of *Kerivoula*

examined, confirming the distinctiveness of this species. This gene provides no evidence that they are closely related to the similar sized *K. papillosa*, but the

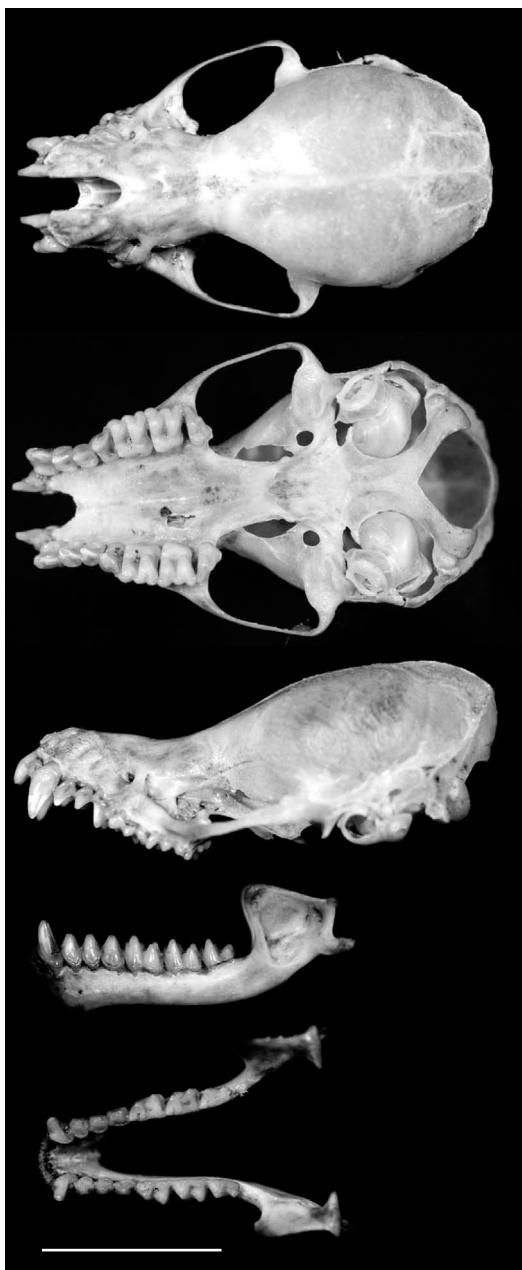


FIG. 2. Dorsal, ventral and lateral views of the cranium and dorsal and lateral views of the mandible of *K. kachinensis*, ♂, Phu Suan Sai National Park, Thailand. Scale = 5 mm

divergences among the lineages are so great that the relatively rapidly evolving COI gene does not provide sufficient resolution to determine phylogenetic branching orders in this genus.

### *Echolocation*

In Loei Province, Thailand, the echolocation calls of *K. kachinensis* are characterized by a broadband FM sweep with a peak frequency of 123.9 kHz (123.0–124.9). Calls are of low intensity and short duration (1.5–2.3 ms).

### *Breeding*

In Lao PDR, females captured on 16 April 1996 near Lak Sao, and 20 April 1998 in Nam Ha were pregnant, while an individual caught on 25 May 1997 on the Bolaven Plateau was lactating. Females captured on 4 February 1998 at Phou Khao Khouay and 26 March 1998 in Nam Et were not visibly in breeding condition, though an early pregnancy might not have been detected.

### *Ecological Notes and Conservation Status*

In the Seima Biodiversity Conservation Area, Cambodia, two specimens were collected in a harp trap that was set across a path in deciduous dipterocarp forest near bamboo. A small stream was present within 200 metres. No exact details are available for the third specimen, although it is known that it was collected in a similar manner from the same general vicinity.

In Phu Suan Sai National Park, Thailand, two individuals were captured in a harp trap, which was set across a small path (2.5 m wide) in the transition zone between lower montane forest and mixed deciduous forest. Bamboo groves and banana trees were also present in the area. The September night was foggy and wet, although the rain had stopped at the time of capture.

*Kerivoula hardwickii* was collected at the same site. In Nam Nao National Park, Thailand, a single specimen was captured in a harp trap which was set across a nature trail at the edge of mixed deciduous forest near bamboo, 100 m far from a highway.

In Lao PDR, all specimens were captured in 4-bank harp traps. The individual captured near Lak Sao was in disturbed semi-evergreen forest at the edge of a limestone escarpment. On the Bolaven Plateau, one was caught along a small logging track in relatively intact hill evergreen forest. In Phou Khao Khouay, one individual was collected along a small path next to the Nam Leuk River in partially disturbed evergreen forest, while the other was caught a few kilometres away, flying over a narrow logging road. In Nam Et, one of the specimens was caught over a small creek in moist evergreen forest near the Nam Chong River. The other was collected over a 6 m wide stream flanked by riparian forest in a limestone area with caves and escarpments. There was some hill forest on the slopes but in the flatter areas the land was used intensively for paddy fields and other crops. The forest was actively being felled and burned on the slopes. An additional 10 specimens of large *Kerivoula* were captured and released in the same general area. Although originally recorded as *K. papillosa*, that species has not been confirmed from Lao PDR, and it seems likely they were also *K. kachinensis*. In Nam Ha, the only specimen examined was caught over a small creek near the banks of the Nam Tha River, in an area surrounded by active slash and burn agriculture with crop fields and recently burned and young secondary forest. Again, 9 additional individuals of large *Kerivoula* were caught in Nam Ha, most or all of which probably represent this species.

The conservation status of *K. kachinensis* has not yet been officially assessed. However, these recent records, together

with the previous ones from Myanmar and Vietnam (Thong *et al.*, 2006), suggest that it is a widespread and possibly locally common species in continental Southeast Asia. Further, survey work in forest habitats using harp traps will probably provide many additional records.

#### ACKNOWLEDGEMENTS

In Cambodia, we are most grateful to Joe Walston and all at the Wildlife Conservation Society, who co-ordinated the study and to L. Duval and G. Ronkay, who assisted with the collection of specimens. The subsequent taxonomic work of GC was supported by the SYNTHESYS Integrated Infrastructure Initiative Grant. In Thailand, we are grateful to Tewarit Koyaphokaisawan, the Head of Phu Suan Sai National Park and Viroj Naknan, the head of Nam Nao National Park and their staff for granting us permission to conduct a field survey. In addition, we would like to thank Worapong Poonpipit and Thannongsak Jongsiri who assisted in the field work. In Lao PDR, surveys were carried out by CMF and AGS with financial and logistical support from the Wildlife Conservation Society in cooperation with the Center for Protected Areas and Watershed Management (CPAWM) of the Lao Department of Forestry. Assistance during field work was provided by Soulisak, Khoonmy, Chanhthavy Vongkhamheng, Fung Yun Lin, Fiona Francis and Carlos Ibáñez. The support of W. Robichaud, P. Davidson, J. Walston and R. J. Tizard greatly helped with logistics on various surveys. In the UK, we would like to thank David Harrison and Malcolm Pearch of the Harrison Institute for their help and advice, and the Darwin Initiative (DEFRA), UK for their financial support.

#### LITERATURE CITED

- BATES, P. J. J., and D. L. HARRISON. 1997. Bats of the Indian Subcontinent. Harrison Zoological Museum, Sevenoaks, 258 pp.
- BATES, P. J. J., M. J. STRUEBIG, S. J. ROSSITER, T. KINGSTON, SAI SEIN LIN OO, and KHIN MYA MYA. 2004. A new species of *Kerivoula* (Chiroptera: Vespertilionidae) from Myanmar (Burma). *Acta Chiropterologica*, 6: 219–226.
- BATES, P. J. J., M. J. STRUEBIG, B. D. HAYES, N. M. FUREY, KHIN MYA MYA, VU DINH THONG, PHAM DUC TIEN, NGUYEN TRUONG SON, D. L. HARRISON, C. M. FRANCIS, and G. CSORBA. 2007. A new species of *Kerivoula* (Chiroptera: Vespertilionidae) from Southeast Asia. *Acta Chiropterologica*, 9: 323–337.
- BUMRUNGSRI, S., D. L. HARRISON, C. SATASOOK, A. PRAJUKJITR, S. THONG-AREE, and P. J. J. BATES. 2006. A review of bat research in Thailand with eight new species records for the country. *Acta Chiropterologica*, 8: 325–359.
- FRANCIS, C. M., A. GUILLÉN, and M. F. ROBINSON. 1999. Order Chiroptera: Bats. Pp 225–235, in Wildlife in Lao PDR: 1999 Status report (W. J. DUCKWORTH, R. E. SALTER, and K. KHOUNBOLINE, comp.). IUCN/WCS/CPAWM, Vientiane, 275 pp.
- FRANCIS, C. M., T. KINGSTON, and A. ZUBAID. 2007. A new species of *Kerivoula* (Chiroptera: Vespertilionidae) from peninsular Malaysia. *Acta Chiropterologica*, 9: 1–12.
- MATVEEV, V. A. 2005. Checklist of Cambodian bats (Chiroptera), with new records and remarks on taxonomy. *Russian Journal of Theriology*, 4: 43–62.
- NATIONAL PARK RESEARCH DIVISION. 2004. Strategy plan for the management master plan of Nam Nao National Park. National Park, Wildlife and Plant Conservation Department, Bangkok, Thailand, 17 pp. [in Thai].
- NATIONAL PARK, WILDLIFE AND PLANT CONSERVATION DEPARTMENT. 2006a. Nam Nao National Park. <http://www.dnp.go.th/parkreserve/asp/style1/default.asp?npid=36&lg=2>.
- NATIONAL PARK, WILDLIFE AND PLANT CONSERVATION DEPARTMENT. 2006b. Phu Suan Sai National Park (Na Haeo). <http://www.dnp.go.th/parkreserve/asp/style1/default.asp?npid=23&lg=2>.
- SCW. 2006. Atlas of Cambodia: national poverty and environment maps. Save Cambodia's Wildlife, Phnom Penh, 139 pp.
- THONG, V. D., S. BUMRUNGSRI, D. L. HARRISON, M. J. PEARCH, K. M. HELGEN, and P. J. J. BATES. 2006. New records of Microchiroptera (Rhinolophidae and Kerivoulinae) from Vietnam and Thailand. *Acta Chiropterologica*, 8: 83–93.
- WORLDCLIMATE. 2005. Climate data for 17°N, 101°E. <http://www.worldclimate.com/cgi-bin/grid.pl?gr=N17E101>.

Received 21 May 2007, accepted 14 November 2007