

A new species of *Kerivoula* (Chiroptera: Vespertilionidae) from Myanmar (Burma)

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A new species of *Kerivoula* is described. Currently, it is known only from Namdee Forest in southern Kachin State, Myanmar. Externally, superficially similar to *Kerivoula papillosa* and with a dentition comparable to that of *Kerivoula lenis*, it is distinguished by its flattened skull. It was collected in evergreen forest in an area that also includes some mixed deciduous forest, shifting cultivation, and bamboo groves.

Key words: *Kerivoula* sp. nov., Kachin State, Myanmar (Burma)

INTRODUCTION

In November 1999, the Harrison Institute and the University of Yangon conducted the first international field survey for bats in Myanmar for fifty-five years. Four years later, following the award of a Darwin Initiative grant, an international bat workshop in the University of Yangon, numerous additional field surveys and 10 international expeditions to 12 of the 14 states and divisions of Myanmar, the programme of bat studies continues to develop. Results have been, and are being, published in a series of scientific papers and reports (Bates *et al.*, 2000, 2001, 2004; Pearch *et al.*, 2003).

In March 2003, a second team of UK scientists joined forces with students and staff of the University of Mandalay to conduct additional researches (M. J. Struebig,

pers. comm.). This team, with its experience of working in forest habitats elsewhere in South-east Asia, had a particular interest in the forest bats of northern Myanmar. Results of their preliminary studies in southern Kachin showed a particularly rich bat fauna, with fourteen species collected from two survey sites. At least one of these represents a previously unknown species of *Kerivoula*, which is here described and compared to other taxa within the subfamily Kerivoulinae, Asiatic representatives of which were recently reviewed by Vanitharani *et al.* (2003).

MATERIALS AND METHODS

Field Survey

Namdee Forest was one of twenty-five localities in Kachin and Shan States and Mandalay and Sagaing

Divisions in Upper Myanmar which were surveyed in March–April, 2003 by a team from the University of Mandalay and the UK (M. J. Struebig, pers. comm.).

Measurements

All external measurements were taken using digital calipers. Cranial and dental measurements of the holotype were taken using calipers and a graticule in a Leica MZ8 stereo microscope. The definitions of the measurements are as follows: FA*: forearm length, from the extremity of the elbow to the extremity of the carpus with the wings folded; TAIL*: tail length, from the tip of the tail to its base adjacent to the anus; TIBIA*: length of tibia, from the knee joint to the ankle; 5Met*, 4Met, 3Met: length of the metacarpal of the fifth, fourth, and third digits respectively, taken from the extremity of the carpus to the distal extremity of each metacarpal; 3d1p*, 3d2p*: length of the first and second phalanges of the third digit respectively; 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*: condylo-basal 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–M³*: maxillary toothrow length, from the most anterior part of the upper canine to the back of the crown of the third upper molar; M²–M^{2ext}: external palatal width, taken across the outer borders of the second upper molar at the widest part; M²–M^{2int}: internal palatal width, taken across the inner borders of the second upper molar at the narrowest part; BOW: basioccipital width, taken at narrowest point between the cochleae; C–M₃*: mandibular toothrow length, from the most anterior part of the lower canine to the back of the crown of the third lower molar; C¹–C^{1int}*: anterior palatal width measured across the inner borders of the canines, taken at the narrowest part; MDL*: mandible length, from the most posterior part of the condyle to the most anterior part of the crowns of the first lower incisors; MDLH: posterior mandibular height, taken from the apex of the concavity adjacent to the angular process on the inferior border of the ramus to the tip of the coronoid process. Measurements marked with a star

(*) are illustrated in Figs. i–v in Bates and Harrison (1997). Body mass (MASS) was taken using a 60 g Pesola scale.

SYSTEMATIC DESCRIPTION

Kerivoula kachinensis sp. nov.

Holotype

HZM.1.35288 (Field No. MA.030411.3), adult ♀, body in alcohol, skull extracted, collected by M. J. Struebig, Sai Sein Lin Oo, Sein Sein Win, Moe Moe Aung, and Aye Aye Nwe on 11 April, 2003.

Type locality

Namdee Forest, Bhamo Township, Kachin State, Myanmar, 24°34.203'N, 97°07.501'E.

Diagnosis

This is a large *Kerivoula*, with a forearm length of 41.3 mm and a condylo-canine length of 15.5 mm. The skull is characterised by its distinctly flattened braincase (Fig. 1). At its widest part, the braincase measures 8.2 mm (= 7.8 mm at the posterior roots of the zygomatic arches); its greatest height is 5.2 mm.

Description

This is a large *Kerivoula* (see Table 1), with a forearm length of 41.3 mm taken from the wet specimen (42.4 mm taken in the field). The muzzle, including the lips, is hairy with only the nostrils naked; they are slightly protuberant and face outwards and slightly downwards. The ears are essentially naked and large; the anterior border of each is convex; the tip is rounded off and there is a distinct concavity just below the tip on the posterior border. The tragus is tall (9.5 mm) and narrow: the anterior margin is virtually straight until near the tip, where it is very slightly convex; the posterior margin is concave and has a small basal lobe

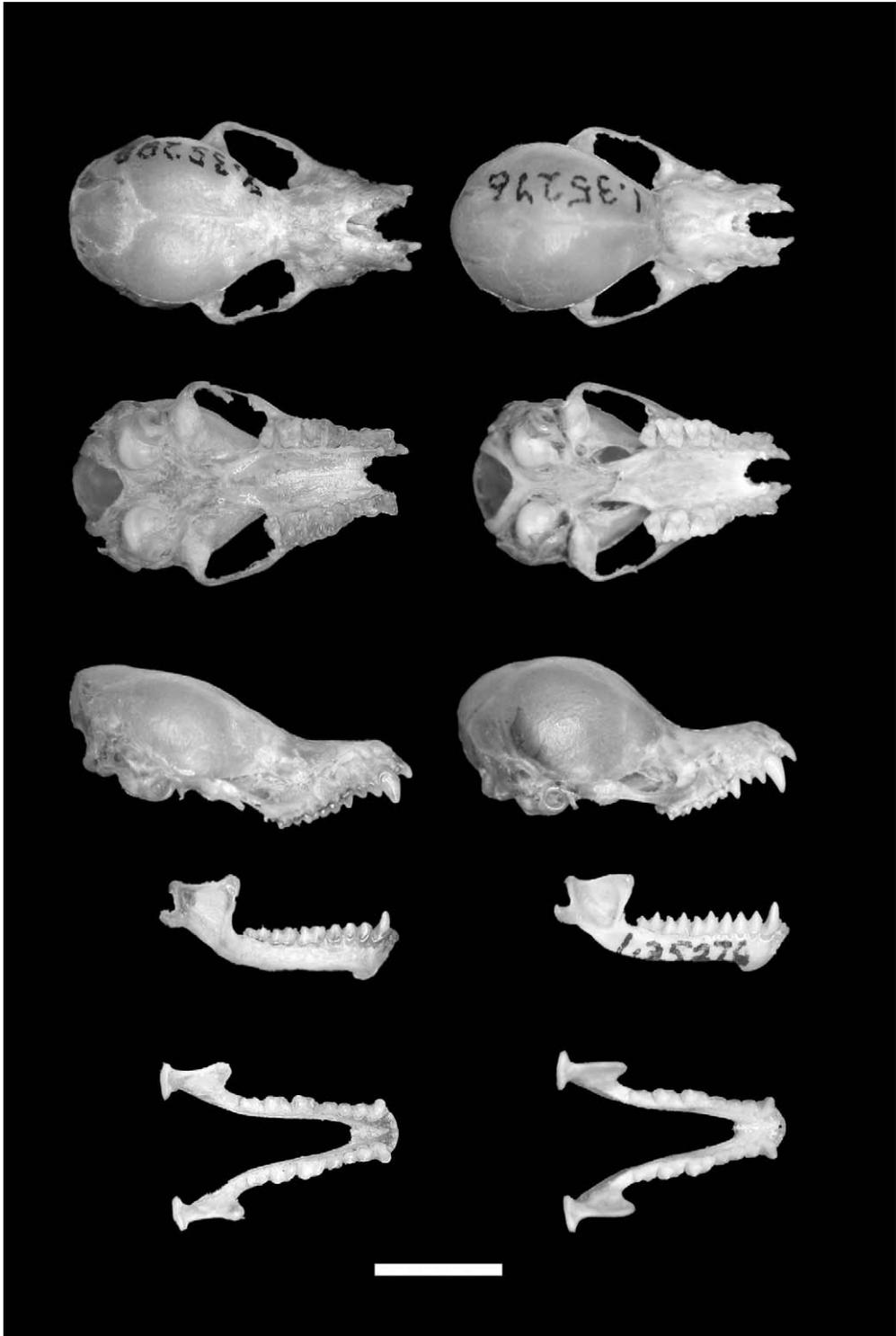


FIG. 1. Dorsal, ventral and lateral views of the cranium, and lateral and dorsal views of the mandible of (left) *Kerivoula kachinensis*, H.Z.M.1.35288, Kachin, Myanmar and (right) *K. lenis*, H.Z.M.1.35276, Tamil Nadu, India. Scale = 5 mm

TABLE 1. Comparative measurements (in mm) and body mass (in grams) of *K. kachinensis*, *K. lenis* and *K. papillosa* (male and female specimens combined). Sample size (*n*), mean \pm standard deviation (SD), and range are shown

Character	<i>K. kachinensis</i>			<i>K. lenis</i>			<i>K. papillosa</i>		
	<i>n</i>	value	range	<i>n</i>	$\bar{x} \pm SD$	range	<i>n</i>	$\bar{x} \pm SD$	range
Forearm length (FA)	1	41.3		5	39.4 \pm 1.5	37.2–41.0	18	42.6 \pm 2.3	39.4–48.9
Tail length (TAIL)	1	54.0		1	48.0	–	4	52.3 \pm 3.1	48.0–55.0
Tibia length (TIBIA)	1	21.8		3	19.7 \pm 1.4	18.2–20.7	15	21.5 \pm 1.4	18.6–23.8
Ear length (EAR)	1	13.5		1	13.8	–	3	13.0 \pm 1.0	12.0–14.0
Body mass (MASS)	1	7.0		–	–	–	2	8.6	7.0–10.1
Greatest length of skull (GTL)	1	17.1		4	16.8 \pm 0.3	16.4–17.1	22	18.0 \pm 0.4	17.5–19.0
Condyllo-basal length (CBL)	1	16.1		3	15.4 \pm 0.2	15.2–15.5	21	16.7 \pm 0.4	15.8–17.6
Condyllo-canine length (CCL)	1	15.5		4	14.8 \pm 0.3	14.5–15.1	21	16.2 \pm 0.4	15.4–17.1
Zygomatic breadth (ZB)	1	10.2		4	10.2 \pm 0.5	9.6–10.6	18	11.3 \pm 0.4	10.7–11.9
Breadth of braincase (BB)	1	7.8		4	7.4 \pm 0.3	7.1–7.7	22	8.0 \pm 0.2	7.7–8.4
Greatest breadth of braincase (GBB)	1	8.2		4	7.9 \pm 0.2	7.7–8.2	22	8.4 \pm 0.2	8.0–8.9
Braincase height (BH)	1	5.2		4	6.8 \pm 0.2	6.7–7.0	23	7.3 \pm 0.3	6.8–7.8
Relative height of braincase (BHI/GBB \times 100%)	1	64.0		4	86.3 \pm 3.2	82.4–89.3	22	86.4 \pm 3.3	80.6–91.6
Postorbital constriction (PC)	1	3.5		4	3.4 \pm 0.2	3.1–3.6	25	3.6 \pm 0.2	3.2–3.9
Upper toothrow length (C–M ³)	1	6.8		5	6.7 \pm 0.1	6.6–6.8	25	7.4 \pm 0.2	7.1–7.8
Palatal width (M ² –M ^{2ext})	1	6.4		5	6.3 \pm 0.2	6.0–6.6	25	6.8 \pm 0.1	6.7–7.1
Lower toothrow length (C–M ₃)	1	7.1		5	7.3 \pm 0.2	7.2–7.6	25	8.0 \pm 0.2	7.6–8.6
Mandible length (MDL)	1	12.7		4	12.1 \pm 0.3	11.8–12.4	25	13.1 \pm 0.5	11.8–14.0

(projection) at the widest part, above and below which are shallow concavities. The pelage is long and dense. Pelage colour is difficult to determine in the wet specimen but dorsally it appears to have grey-brown hair tips with darker grey bases. The wing and tail membranes are a uniform dark grey-brown. Although, there is a scattering of hairs on the posterior margin of the inter-femoral membrane, there is no definite fringe. In the wings, the fifth metacarpal (5Met = 42.0 mm) is shorter than the fourth (44.5 mm) and third (45.3 mm) but still exceeds the forearm in length. The second phalanx of the third digit (3d2p = 23.5 mm) slightly exceeds the first (22.4 mm) in length. An enlarged fleshy callosity, oval in shape, which measures 2.1 mm in width \times 3.5 mm in length, is present on the ball of the first digit (thumb) of each wing; it is centrally smooth and marginally rugose. The wings are attached to the outer base of the first phalanx of the outer toes. The soles of the feet are not enlarged and are typical of the genus.

The skull has a condylo-canine length of 15.5 mm (Fig. 1). The narial pit of the rostrum is V-shaped and large. There is only the slightest indication of a rostral sulcus. The postorbital constriction is narrower than the posterior part of the rostrum. The braincase is broad and distinctly flattened. It is aligned at about 45 degrees to the basicranial axis. In the bony palate, the widest part is adjacent to the margin between M^1 and M^2 ($M^2 - M^{2int} = 3.2$ mm). It narrows towards the canines ($C^1 - C^{1int} = 2.3$ mm) but is not especially convergent. The basioccipital space is relatively broad (BOW = 1.7 mm) and the basioccipital pits are shallow. In the mandible, the coronoid process is well developed (MDLH = 3.9 mm), considerably exceeding the condyle in height.

In the upper dentition, the first incisor (I^2) is unicuspid and with a cingulum on its

internal posterior border. The second incisor (I^3) is compressed between I^2 and the canine (C^1) and is equal to I^2 in crown area; it is too worn to determine its cusp pattern. The canine (C^1), although worn, appears to have had a well defined cingulum on its internal border; the shaft is smooth on its outer side, without a deep longitudinal groove; its posterior part is without a conspicuous cutting edge. The three upper premolars are compressed in the toothrow (Fig. 2). The transverse diameters (width) of the first (P^2) and third (P^4) premolars exceed their respective longitudinal diameters (length); in the second (P^3) the length and width are about equal; P^3 is 90% of the crown area of P^2 , whilst P^4 is about 60% of the crown area of the first molar (M^1). The first (M^1) and second (M^2) molars have well developed para-, meso-, and metastyles. The third molar (M^3) has the

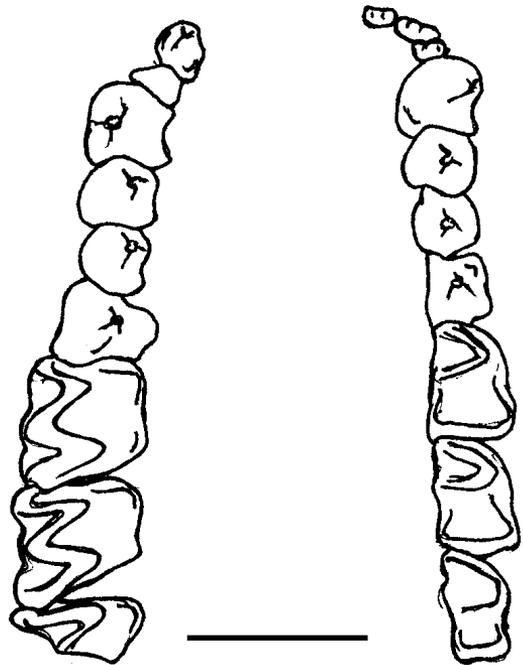


FIG. 2. Occlusal views of the right maxillary (left) and right mandibular (right) dentition of *K. kachinensis*, HZM.1.35288, Kachin, Myanmar. Scale = 2 mm

metastyle absent. In the lower dentition, the first and second incisors (I_1 , I_2) are tricuspid. The third incisor (I_3) is smaller, with a well defined central cusp; the presence of lateral cusps cannot be determined because the teeth are worn. The canine probably had a cingular cusp on its antero-internal border but again each tooth is worn. The premolars are compressed in the toothrow; the width of the first (P_2) exceeds its length; in the second (P_3) and third (P_4), the length slightly exceeds the width; the crown area of the second premolar (P_3) is about 90% that of P_2 . The crown area of the talonid of the first molar (M_1) exceeds very slightly that of the second (M_2). In the third molar (M_3), the talonid is reduced to about 70% that of the trigonid.

Etymology

Named from Kachin, the state in Myanmar where it was found and *ensis* (Latin for 'belonging to'). Its proposed English name is 'Kachin woolly bat'.

Comparative Material

Kerivoula lenis

India: Calcutta, West Bengal [22°35'N, 88°21'E], BM.79.11.21.126; Therkumalai, Tamil Nadu, [08°50'N, 77°21'E], HZM.1.35276; Malaysia: Pasoh Forest Reserve [approx. 02°58'N, 102°16'E], BM.84.2071/2075; Sepilok, (Sabah), BM.84.2071/2075.

Kerivoula papillosa

Malaysia: Baturong, [05°01'N, 118°20'E], BM.84.2079; Bodi Tai (Sabah), BM.84.2064; Caves near Long Lama, Baram River [03°46'N, 114°28'E], BM.51.161; Ginting, Bidai [approx. 01°22'N, 110°08'E], BM.47.1438; Goman-tong [05°33'N, 118°06'E], BM.84.2066/67;

Madai [05°01'N, 118°20'E], BM.84.2068; Pahang, [03°51'N, 102°11'E], BM.60.1569, BM.67.1608; Rinangisan (Sabah), BM.84.2080; 'Sarawak', BM.93.4.1.30/31; Segarong [approx. 04°29'N, 118°36'E], BM.84.2098; Semangko Pass [approx. 03°36'N, 101°44'E], BM.16.4.20.6; Sepilok, (Sabah), BM.84.2070/2072/2073/2076/2077; Tamok [approx. 02°21'N, 103°18'E], BM.74.440; Ulu Gombok [03°20'N, 101°45'E], BM.60.723/724; Indonesia: River Ranu, C. Sulawesi [01°51'S, 121°30'E], BM.1982.147. Cambodia: no exact locality, BM.7.1.1.535–537.

DISCUSSION

Comparison with Other Taxa

With a forearm length of 41.3 mm, condylo-canine length of 15.5 mm and an upper toothrow length ($C-M^3$) of 6.8 mm, *K. kachinensis* is distinguished from all other Asiatic *Kerivoula* Gray, 1842 (sensu Corbet and Hill, 1992), except *K. papillosa* Temminck, 1840 and *K. lenis* Thomas, 1916, by its large size (Vanitharani *et al.*, 2003). *Kerivoula lenis* was recently removed from the synonymy of *K. papillosa* and is now treated as a separate species (Vanitharani *et al.*, 2003). The morphology of the upper incisors, canines and rostrum distinguish *K. kachinensis* from the three Asiatic species currently referred to *Phoniscus* Miller, 1905, a taxon which is included by some authors, such as Koopman (1993), as a subgenus of *Kerivoula*. Unlike *Phoniscus*, the second upper incisor (I^3) of *K. kachinensis* is not greatly reduced, it is about equal in crown area to the first (I^2); the upper canine (C^1) does not have a deep longitudinal groove on its outer side and is without a conspicuous posterior cutting edge and the postorbital region is constricted; in *Phoniscus*, it is nearly as wide as the posterior part of the rostrum.

To date, *K. kachinensis* is the only large *Kerivoula* that has a distinctly flattened skull. Braincase height is 64% of greatest braincase width (braincase height/greatest braincase width \times 100). In *K. lenis*, it ranges from 82–89% ($n = 4$) and in *K. papillosa* 81–92% ($n = 22$). Externally, its size (forearm, tail, tibia and ear length) is most similar to that of *K. papillosa*. The callosity on the first digit of each wing is a character shared with some individuals of *K. papillosa*, for example BM.74.440 from Tamok, Malaysia. It appears to have no taxonomic significance and may result from the repetitive rubbing of the skin as the bat crawls in and out of its roost. Braincase shape apart, the skull is most similar to *K. lenis*. The dentition and most particularly the size and shape of the upper and lower premolars are virtually identical to those of *K. lenis*.

Habitat

Currently, *K. kachinensis* is only recorded from a single locality, Namdee Hill, which is located near the settlement of Shet Shar on the eastern bank, north of the first defile, of the Ayeyarwady River. Evergreen forest covers the hill and the immediate area but changes to mixed deciduous forest further away from the river. At the time of the visit, approximately 2 ha of forest were being cleared for shifting cultivation at the edge of the river. There are a number of bamboo groves within the forest and two limestone caves near the top of the hill about 700 m from the forest edge. Local people reported that guano is infrequently collected from the caves, which are used for meditation 3–4 times per year by visiting monks. *Aselliscus stoliczkanus* and *Hipposideros larvatus* were caught in the main cavern of one of the caves and *Eonycteris spelaea* was

also observed. In the forest surrounding the caves, the following taxa in addition to *K. kachinensis* were collected in harp traps: *A. stoliczkanus*, *H. larvatus*, *H. pomona*, *Rhinolophus pearsoni*, *R. shameli*, *R. malayanus*, *R. pusillus*, *R. stheno*, *Rhinolophus* sp., *K. hardwickii*, *Kerivoula* sp., and *Murina tubinaris* (M. J. Struebig, pers. comm.).

Distribution

Although it is only known to date from Namdee Hill, Bhamo Township (24°34'07"N, 97°07'11"E), future studies may show that it is much more widespread in the forests of Kachin and possibly elsewhere in South-east Asia.

Taxonomic and Behavioural Notes

With its flattened skull, *K. kachinensis* is clearly a specialised member of the genus *Kerivoula*. As such, future studies may suggest that it should be given sub-generic status, especially if other species exhibiting this character are subsequently found elsewhere in the Old World tropics.

Although the skull of *K. kachinensis* is not as flattened as that of *Tylonycteris pachypus*, *T. robustula* or *Eudiscopus denticulus*, it does suggest that like these other taxa, *K. kachinensis* roosts in constricted spaces. The larger size of *K. kachinensis* may prevent it roosting in the internodes of bamboo, the preferred roosting site of *Tylonycteris* (Bates and Harrison, 1997) and *E. denticulus* (Schliemann and Kock, 2000). However, it may roost under the bark of trees or perhaps in narrow crevices or tree cavities. The recent discovery of *K. kachinensis* raises interesting questions about the taxonomy, ecology, and behaviour of this little known and under-researched genus.

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LITERATURE CITED

- BATES, P. J. J., and D. L. HARRISON. 1997. The bats of the Indian Subcontinent. Harrison Zoological Museum Publications, Sevenoaks, 258 pp.
- BATES, P. J. J., TIN NWE, M. J. PEARCH, KHIN MAUNG SWE, SI SI HLA BU, and T. TUN. 2000. A review of bat research in Myanmar (Burma) and results of a recent survey. *Acta Chiropterologica*, 2: 53–82.
- BATES, P. J. J., TIN NWE, KHIN MAUNG SWE, and SI SI HLA BU. 2001. Further new records of bats from Myanmar (Burma), including *Craseonycteris thonglongyai* Hill, 1974 (Chiroptera: *Craseonycteris*). *Acta Chiropterologica*, 3: 33–41.
- BATES, P. J. J., MAR MAR THI, TIN NWE, SI SI HLA BU, KHIN MIE MIE, NYO NYO, AYE AYE KHAING, NU NU AYE, THIDA OO, and I. MACKIE. 2004. A review of *Rhinolophus* (Chiroptera: Rhinolophidae) from Myanmar, including three species new to the country. *Acta Chiropterologica*, 6: 23–48.
- CORBET, G. B., and J. E. HILL. 1992. The mammals of the Indomalayan region. Natural History Museum Publications. Oxford University Press, Oxford, 488 pp.
- GRAY, J. E. 1842. Description of some new genera and fifty unrecorded species of Mammalia. *Annals Magazine Natural History*, 10: 255–267.
- KOOPMAN, K. F. 1993. Order Chiroptera. Pp. 137–241, in *Mammal species of the World*, 2nd edition (D. E. WILSON and D. M. REEDER, eds). Smithsonian Institution Press, Washington, D.C., 1206 pp.
- MILLER, G. S. JR. 1905. A new genus of bats from Sumatra. *Proceedings of the Biological Society of Washington*, 18: 229–230.
- PEARCH, M. J., KHIN MIE MIE, P. J. J. BATES, TIN NWE, KHIN MAUNG SWE, and SI SI HLA BU. 2003. First record of bats (Chiroptera) from Rakhine State, Myanmar (Burma). *Natural History Bulletin of the Siam Society*, 51: 241–259.
- SCHLIEHMANN, H., and D. KOCK. 2000. Notes on the rare vespertilionid bat *Eudiscopus denticulus* (Osgood, 1932) (Chiroptera, Vespertilionidae). *Mitteilungen Hamburgischen Zoologischen Museum und Institut*, 97: 131–134.
- TEMMINCK, C. J. 1840. *Monographies de mammalogie, ou description de quelques genres de mammifères, dont les espèces sont observées dans les différents musées de l'Europe*. Tome 2. G. Dufour and E. D'Ocagne, Libraires, Paris, 392 pp.
- THOMAS, O. 1916. Two new Indian bats. *Journal Bombay Natural History Society*, 24: 415–417.
- VANITHARANI, J., A. RAJENDRAN, P. J. J. BATES, D. L. HARRISON, and M. J. PEARCH. 2003. A taxonomic reassessment of *Kerivoula lenis* Thomas, 1916 (Chiroptera: Vespertilionidae) including a first record from peninsular India. *Acta Chiropterologica*, 5: 49–60.

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