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# A review of *Rhinolophus* (Chiroptera: Rhinolophidae) from Myanmar, including three species new to the country

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*Rhinolophus stheno*, *R. acuminatus* and *R. macrotis* are recorded from Myanmar for the first time based on authenticated voucher material. New data from recent surveys (2000–2003) are included for *R. affinis*, *R. malayanus*, *R. lepidus*, *R. marshalli*, *R. pusillus*, *R. pearsoni*, and *R. thomasi*. Additional records of *R. rouxi* and *R. sinicus* are listed on the basis of museum specimens. The status of *R. subbadius*, *R. yunanensis*, *R. luctus*, *R. trifoliatus*, *R. coelophyllus*, and *R. shameli* are reviewed. This brings the total number of *Rhinolophus* species known from Myanmar to eighteen and the number of all bat species to ninety-four. The possible reasons for the rich diversity of Rhinolophids are discussed.

*Key words*: *Rhinolophus*, Myanmar, Burma, systematics, distribution, ecology

## INTRODUCTION

In November, 1999, a series of field surveys focused on bat research was initiated in Myanmar by the Zoology Department of the University of Yangon (Rangoon) and the Harrison Institute. Initial results, which included the addition of five species and one family of bats new to the country's fauna, were published in two papers (Bates *et al*., 2000, 2001). In March 2002, following the award of a UK government sponsored Darwin Initiative grant, the programme was expanded.

To date, there have been nine field surveys involving Harrison Institute and Myanmar staff and students and many additional smaller field studies conducted by individuals from the University of Yangon. Forty-five bat species, including ten species of *Rhinolophus*, have been collected from twelve of the fourteen states and divisions of Myanmar, the only exceptions being Magway Division and Kayah State. Since 2002, many of the surveys have taken place in the extensive limestone karst areas of eastern and south-eastern Myanmar in Mon, Kayin and Shan States.

The ten *Rhinolophus* species include five that are first records for Myanmar. Two were included in the first two publications of the research programme: *R. malayanus* in Bates *et al*. (2000) and *R. marshalli* in Bates *et al*. (2001). *Rhinolophus stheno* and *R. acuminatus* are included in this current paper along with *R. macrotis*. This latter record is the first authentically documented for this taxon, although it has been included

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by some previous authors in the checklist of bats for Myanmar but without supporting data (Corbet and Hill, 1992; Bates *et al*., 2000). This increases the number of rhinolophids known from Myanmar to eighteen and the number of all bat species to ninety-four.

In addition, the status of all other *Rhinolophus* species currently included on Myanmar's faunal list (sensu Bates *et al*., 2000 and 2001) are reviewed. This review includes data, which were not used or incorrectly interpreted in four of the most recent relevant publications (Corbet and Hill, 1992; Bates and Harrison, 1997; Bates *et al*., 2000; Csorba *et al*., 2003). Where available, ecological data are included for the 18 species. A character matrix to help with the identification of all *Rhinolophus* species, currently recognised from the country is also provided (Table 1). Taxonomic groupings follow those of Csorba *et al*. (2003).

## Material and Methods

### *Study Areas*

Between November 1999 and August 2003, surveys were conducted in the following areas of Myanmar:

*Mon and Kayin States*: surveys took place in November, 1999, March and November, 2001, October to December, 2002. They were concentrated in areas which are accessible from the cities of Hpa-an (= Pa-an) and Mawlamyine (= Moulmein), either by road or by boat up the Thanlwin (= Salween) and Ataran Rivers. The region is characterised by steeply scarped limestone hills, that punctuate the flood plain which lies between the Dawna Range and Gulf of Mottoma (= Martaban). These isolated hills are relicts of a once great sheet of limestone, dating from the Upper Carboniferous and Permian period. The surfaces show solution hollows and swallow holes and large caves are common (Bender, 1983). The climate is tropical monsoon with a mean annual rainfall in excess of 4000 mm. The heavy rains fall between June and August, becoming lighter as October approaches. Mean monthly temperature varies little through the year, with a range of 24–27ºC. The vegetation of the study area originally comprised two overlapping vegetation types, coastal rain forest and moist deciduous forest (Wikramanayake *et al*., 2002). However, during the last one hundred and fifty years, much of this has been cleared and the land drained for agriculture. However, significant areas of forest do remain on the limestone outcrops, such as in the Zwe-ga-bin range, about 7 km south of Hpa-an. *Rhinolophus* species collected include *R. macrotis*, *R. malayanus*, *R. marshalli* and *R. stheno*.

*Mandalay Division*: short surveys took place in November 1999, March 2002 and March 2003. Mandalay Division is situated in the central Dry Zone of Myanmar. The area is characterised by a series of undulating hills, each with an elevation of 1000 m or less; the lowlands of the Ayeyarwady (= Irrawaddy) River Basin and the steep scarp slopes of the western margin of the Shan Plateau. The soils are predominantly fluvial sands with sandstone, limestone and marble outcrops (Bender, 1983). The vegetation was originally *acacia* and dry deciduous forest but most of this has been cleared for agriculture. Annual precipitation varies within the Division but averages about 1000 mm, most falling during the summer monsoon. Mean monthly temperatures exceed 30ºC between March and May (Wikramanayake *et al*., 2002). *Rhinolophus* species collected include *R. lepidus*.

*Rakhine and Chin States*: southern coastal Rakhine was surveyed in November, 2000; northern Rakhine and Chin States were briefly studied in March, 2003. The area was originally covered with lowland evergreen forest on the narrow coastal plain, with more extensive montane evergreen forest on the Rakhine Yoma and Chin hills. Today, much of this forest has been cleared for agriculture on the coastal strip, particularly rice production, whilst shifting cultivation in the hills has led to extensive areas of creeping bamboo (MacKinnon, 1997). The climate is tropical monsoon with an annual rainfall of between 4400 and 5200 mm. *Rhinolophus* species collected include: *R. lepidus*.

*Shan State*: surveys took place in March, 2002, March, 2003 and August, 2003. The plateau has an average elevation of 950 m. It has a few rugged mountains but the highest is only 2700 m. On the western edge of the plateau, there is a massive and clearly defined fault line marking the boundary between the ancient plateau and the much more recent geology of central Myanmar. There are many cave systems in the limestone outcrops of western Shan (Bender, 1983). The vegetation, which once included extensive dry deciduous forests, has been badly degraded. Rainfall is in the region of 1500 mm per annum (Hla Tun Aung, 2003). Temperatures are relatively cool owing to the altitude of the plateau.

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TABLE 1. Character matrix for the identification of 18 species of *Rhinolophus* currently recorded from Myanmar. All measurements including forearm length (FA), skull length (SL) and upper toothrow length ($C–M^3$) in mm. Sella type illustrated in Fig. 1

| No. | Species | Sella type | *n* | FA | SL | $C–M^3$ | Comments |
|---|---|---|---|---|---|---|---|
| | *megaphyllus*-group | | | | | | *lancet triangular, lateral margins more or less straight* |
| 1 | *R. malayanus* | A | 6♂♂/6♀♀ | 39.3–43.8 | 17.2–18.8 | 6.7–7.3 | short tibia (16.7–18.2) and 2nd phalanx of 3rd digit (16.7–18.8) |
| 2 | *R. stheno* | A | 1♂/1♀ | 43.7, 45.1 | 18.1, 18.6 | 7.0 | long tibia (20.7–21.3) and 2nd phalanx of 3rd digit (21.9–22.2) |
| 3 | *R. affinis* | A | 4♂♂/2♀♀ | 49.7–54.5 | 21.4–23.1 | 8.5–9.2 | long tibia (24.4–25.9) and 2nd phalanx of 3rd digit (26.6–28.3) |
| | *pusillus*-group | | | | | | *connecting process pointed* |
| 4 | *R. subbadius* | B | 5♂♂/2♀♀ | 33.4–35.9 | 14.2–14.5 | 5.1–5.5 | very narrow palate; $M^3–M^3$: 4.4–4.9; $C^1–C^1$: 2.7–3.2 |
| 5 | *R. pusillus* | B | 1♂/2♀♀ | 35.5–38.5 | 15.2–15.6 | 5.6–5.8 | narrow palate; $M^3–M^3$: 5.6–5.7; $C^1–C^1$: 3.7–3.9 |
| 6 | *R. lepidus* | B | 11♂♂/5♀♀ | 37.0–41.8 | 16.5–18.7 | 6.5–7.2 | medium palate; $M^3–M^3$: 6.3–7.0; $C^1–C^1$: 4.3–4.8 |
| 7 | *R. acuminatus* | B | 1♂/3♀♀ | 45.6–48.7 | 20.4–22.2 | 7.9–8.9 | broad palate; $M^3–M^3$: 8.1–8.5; $C^1–C^1$: 5.7–6.4 |
| | *pearsoni*-group | | | | | | *connecting process forming a continuous arch* |
| 8 | *R. pearsoni* | C | 2♂♂/1♀ | 49.8–53.8 | 21.9–23.3 | 8.8–9.4 | size smaller |
| 9 | *R. yunanensis* | C | 2♂♂/2♀♀ | 54.2–57.4 | 24.8–25.7 | 9.5–10.6 | size larger |
| | *philippinensis*-group | | | | | | *superior connecting process not forming a continuous arch* |
| 10 | *R. marshalli* | Di | 2♂♂ | 41.5–45.8 | 17.4–18.9 | 5.9–6.6 | large ears (26.0–27.2); broad sella; short, broad lancet |
| 11 | *R. macrotis* | Dii | 1♂/1♀♀ | 42.4, 43.2 | 17.5, 17.6 | 6.2, 6.3 | ears medium (20.2–20.4); long sella; medium-short, rounded lancet |
| | *rouxi*-group | | | | | | *lancet narrowed at centre, its lateral margins concave* |
| 12 | *R. thomasi* | E | 1♂/4♀♀ | 44.4–45.7 | 17.8–18.2 | 6.8–7.1 | smaller skull and teeth; tibia (18); 2nd phalanx of 3rd digit (20.2) |
| 13 | *R. sinicus* | E | 1♂ | 48.4 | 20.7 | 8.1 | medium skull and teeth; tibia (18.3); 2nd phalanx of 3rd digit (24.1) |
| 14 | *R. rouxi* | E | 1♂ | 48.1 | 21.8 | 8.8 | larger skull and teeth, tibia (21.1); 2nd phalanx of 3rd digit (21.6) |
| | *trifoliatus*-group | | | | | | *sella with basal lappets* |
| 16 | *R. trifoliatus* | F | 2?/1♀ | 50.8–53.3 | 21.8–24.7[i] | 8.5 | buffy brown woolly fur; smaller ears |
| 15 | *R. luctus* | F | 1♂/4♀♀ | 67.2–71.0 | 29.9–32.5 | 11.5–13.0 | black woolly fur; huge ears |
| | *euryotis*-group | | | | | | *lancet with vertical fissure enclosing rear of connecting process* |
| 17 | *R. coelophyllus* | G | ? | 40–46[i] | 18.5–18.8[ii] | 7.2–7.4[ii] | narrower horseshoe, rostral width < 5.5 |
| 18 | *R. shameli* | G | ? | 42–47[i] | 19.8 | 7.5–7.7 | broad horseshoe, rostral width > 5.5 |

[i] — measurements from Csorba (2003)
[ii] — specimens from Thailand

*Rhinolophus* species collected include *R. affinis*, *R. macrotis*, *R. malayanus*, *R. marshalli*, *R. pearsonii*, *R. pusillus*, *R. stheno* and *R. thomasi*.

In addition, a series of smaller field studies were conducted by University staff in various areas of Myanmar. Those in south-eastern Bago Division, near the mouth of the Sittang River and in Tanintharyi Division, in Myeik led to the collection of *Rhinolophus acuminatus*.

## *Specimens and Measurements*

The *Rhinolophus* were collected in Japanese mist nets, hand nets and harp traps. A small number of voucher specimens were taken for identification purposes. They were sacrificed, weighed, measured and preserved in 70% alcohol. Subsequently their skulls were extracted, prepared and measured. The specimens are housed in the zoological collections of the University of Yangon and the Harrison Institute. Field numbers are listed in the text.

The following external, cranial and dental measurements were taken using digital calipers. 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: foot length, from the extremity of the heel behind the os calcis to the extremity of the longest digit, not including the hair or 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; 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: length of the first phalanx of the third digit; 3D2P: length of the second phalanx of the third digit; 3D2P/3D1P: length of the second phalanx of the third digit divided by the length of the first phalanx; E: ear length, from the lower border of the external auditory meatus to the tip of the pinna; GTL: greatest length of skull, the greatest antero-posterior length of the skull, taken from the most projecting point at each extremity; SL: skull length, from the alveolus of the anterior canine to the most projecting posterior point of the skull; CCL: condylo-canine length, from an exoccipital condyle to the alveolus of the anterior canine; ZB: zygomatic breadth, the greatest width of the skull across the zygomatic arches; BB: breadth of braincase, greatest width of the braincase at the posterior roots of the zygomatic arches; PC: post orbital constriction; C–$M^3$: maxillary toothrow length, from the alveolus of the upper canine to the back of the crown of the third upper molar; $M^3$–$M^3$: palatal width, taken across the outer borders of the third upper molar, taken at the widest part; C–$M_3$: mandibular toothrow length, from the alveolus of the lower canine to the back of the crown of the third lower molar; $C^1$–$C^1$: greatest anterior palatal width measured across the outer borders of the canines, taken at the widest part; MDL: mandible length, from the most posterior part of the condyle to the most anterior part of the mandible. These measurements are illustrated in Figs. i–v in Bates and Harrison (1997). Body mass (MASS) was taken using a 60 g pesola scale.

Measurements included in Tables, 1, 2 and 3 are primarily based on specimens in the Harrison Institute, the University of Yangon and the Natural History Museum, London. The following abbreviations are used when referring to the collections of other museums: BMNH, The Natural History Museum, London; FMNH, Field Museum of Natural History, Chicago; LACM, Los Angeles County Museum; and USNM, Smithsonian National Museum of Natural History, New York.

## Systematic Review of Species

### *Megaphyllus*-group

Diagnosis: the superior connecting process of sella low and rounded (Fig. 1A); lancet triangular with the lateral margins more or less straight.

#### *Rhinolophus malayanus* Bonhote, 1903
North Malayan horseshoe bat

*Rhinolophus malayanus* Bonhote, 1903: 15; Biserat, Jalor, southern Thailand.

*New material from Myanmar*

Shan State: Pauk Inlay Cave, 17.3.2003, 2 ♀♀ (MN8, MN12); Montawa Cave, 21.3.2003, 1 ♀ (SH3); Hta Ein Cave, 18.8.2003, ?sex (IL1); Mandalay Division: Sanite Cave No 2, 18.3.2003, 1 ♀ (MN14); Kayin State: Bayint Nyi Cave, 9.11.2002, 1 ♀ (H16) and 21.11.2002, 1 ♂ (H24); Yathay Pyan Cave, 26.11.2001, 1 ♂ (Sc1); Mon State: Nagamauk Cave, 13.11.2002, 1 ♀ (H18); Saddan-Sin Cave, 16.3.2001, 1 ♂ (K43), 2.12.2001, 1 ♀ (Sc14) and 30.10.2002, 1 ♂ (H1). Collected by Si Si Hla Bu, P. J. J. Bates, I. Mackie, Khin Mie Mie, Win Maung, Khin Maung Swe, Aye

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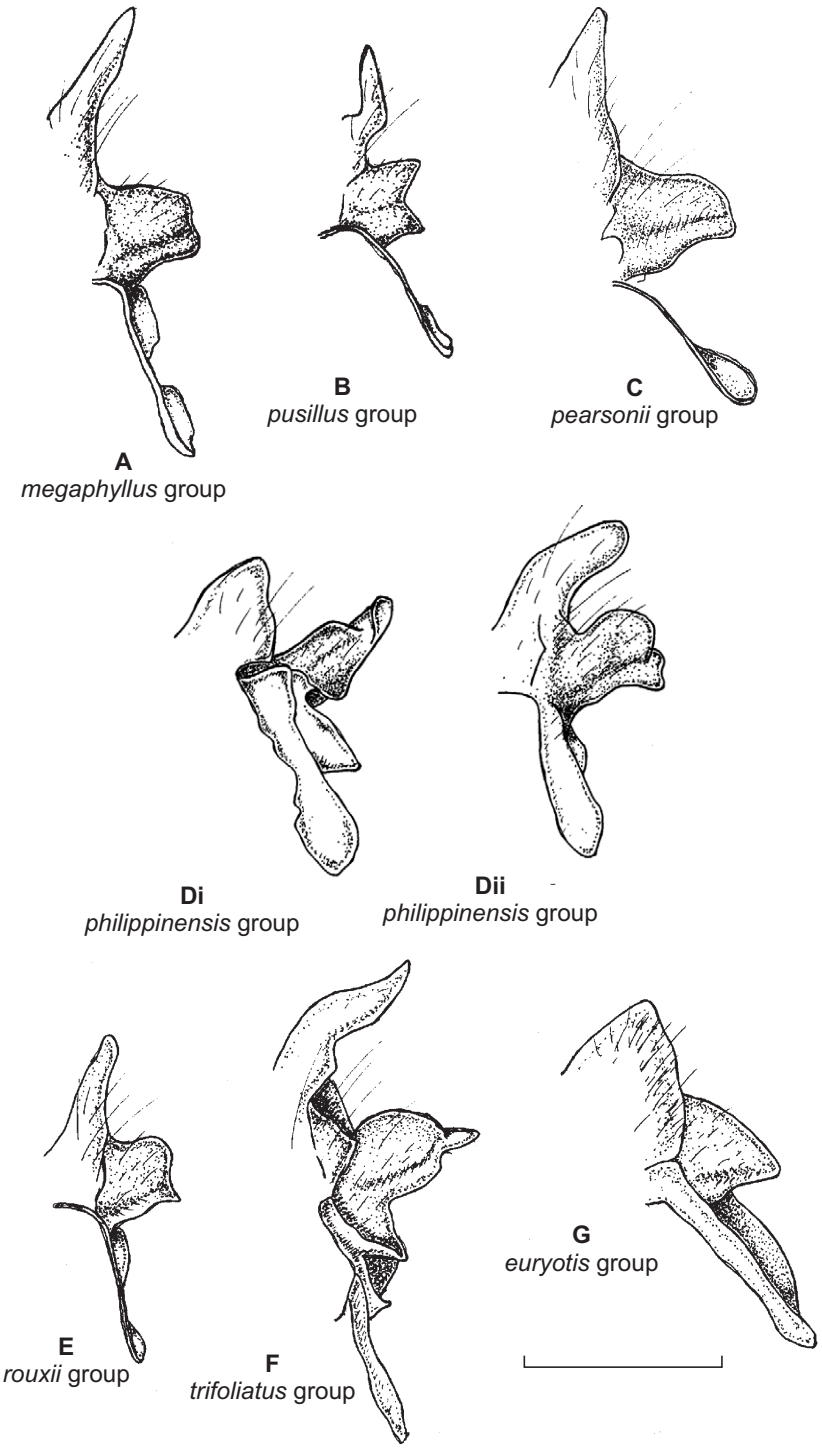



FIG. 1. Lateral views of the sella and superior connecting process of eight species of *Rhinolophus* belonging to the seven groups of the genus (sensu Csorba *et al*., 2003) present in Myanmar. The species illustrated are: A: *R. malayanus*; B: *R. pusillus*; C: *R. pearsoni*; Di: *R. marshalli*; Dii: *R. macrotis*; E: *R. thomasi*; F: *R. beddomei* (from Sri Lanka, comparable to *R. luctus*); G: *R. shameli*. Scale = 5 mm

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TABLE 2. External measurements (in mm) and body mass (in g) of 18 species of *Rhinolophus* recorded from Myanmar; mean, SD and minimum–maximum. Used abbreviations: HB: head and body length; TAIL: tail length; HF: foot; TIBIA: tibia length; FA: forearm length; 5MET, 4MET and 3MET: fifth, fourth, third metacarpal; 3D1P: first phalanx of third digit; 3D2P: second phalanx of third digit; 3D2P/3D1P: length of the second phalanx of the third digit divided by the length of the first; E: ear length. Sample sizes for males and females differing from those reported under *n* are given in parentheses after the measurement

| Species | *n* | HB | TAIL | HF | TIBIA | FA | 5MET |
|---|---|---|---|---|---|---|---|
| | | | *megaphyllus* group | | | | |
| *R. malayanus* | 6♂♂ | 44.3, 3.9 | 22.9, 2.2 | 7.4, 0.6 | 17.6, 0.4 | 41.3, 1.1 | 31.5, 0.7 |
| | | 37.4–49.3 | 19.7–24.4 | 6.4–8.0 | 16.9–18.2 | 40.1–43.3 | 30.3–32.6 |
| | 6♀♀ | 44.7, 4.1 | 22.1, 1.4 | 7.9, 1.0 | 17.1, 0.6 | 41.4, 1.6 | 31.4, 1.5 |
| | | 38.3–49.3 | 20.1–23.9 | 7.2–9.6 | 16.1–17.8 | 39.3–43.8 | 29.5–33.6 |
| *R. stheno* | 1♂ | 40.8 | 19.7 | 8.5 | 21.3 | 43.7 | 33.3 |
| | 1♀ | 43.1 | 17.4 | 8.0 | 20.7 | 45.1 | 33.8 |
| *R. affinis* | 4♂♂ | 55.3, 4.5 | 33.1, 5.1 | 11.1, 0.8 | 25.2, 0.9 | 51.9, 2.5 | 42.0, 1.6 |
| | | 52.2–62.0 | 28.0–40.2 | 10.0–12.0 | 24.4–26.0 | 49.7–54.5 | 40.3–44.1 |
| | 2♀♀[i] | 53.7 (1) | 29.1 (1) | 10.2 (1) | 25.1 (1) | 53.2 (1) | 41.2 (1) |
| | | | *pusillus* group | | | | |
| *R. subbadius* | 5♂♂ | 36.5, 0.6 | 18.3, 1.3 | 7.1, 0.5 | 14.4, 0.5 | 33.9, 0.3 | 26.1, 0.2 |
| | | 36–37 (4) | 16.0–19.0 | 6.6–8.0 (4) | 13.9–15.0 | 33.4–34.2 | 25.9–26.3 |
| | 2♀♀ | 35, 37 | 17.0, 17.0 | 7.0, 7.0 | 14.5, 14.9 | 34.2, 35.9 | 25.3, 26.8 |
| *R. pusillus* | 1♂ | 34.0 | 17.0 | 7.5 | 14.9 | 35.5 | 27.7 |
| | 2♀♀ | 37.0, 37.9 | 17.1, 18.0 | 6.2, 7.2 | 15.6, 16.1 | 38.5, 39.2 | 29.9, 30.0 |
| *R. lepidus* | 11♂♂ | 47.9, 4.0 | 22.0, 3.4 | 9.7, 0.5 | 17.2, 0.9 | 40.2, 1.3 | 32.7, 1.6 |
| | | 40.0–52.0 (10) | 16.2–27.0 (10) | 8.8–10.1 (10) | 15.4–18.5 | 37.5–41.8 | 29.9–34.6 |
| | 5♀♀ | 49.5, 3.2 | 24.0, 3.0 | 9.6, 0.4 | 16.3, 0.5 | 39.2, 1.3 | 32.0, 0.2 |
| | | 43.8–52.0 | 22.5–29.4 | 9.2–10.0 | 15.8–16.7 | 37.0–40.5 | 31.1–32.4 |
| *R. acuminatus* | 1♂ | 50.0 | 26.0 | 10.1 | 22.3 | 48.1 | 39.9 |
| | 3♀♀ | 50.3, 2.1 | 25.0, 1.7 | 9.8, 0.5 | 21.5, 0.7 | 47.1, 1.6 | 37.7, 1.1 |
| | | 48–52 | 23–26 | 9.3–10.3 | 20.8–22.2 | 45.6–48.7 | 36.9–39.0 |
| | | | *pearsoni* group | | | | |
| *R. pearsoni* | 2♂♂ | 49.3, 53.6 | 22.7, 24.5 | 9.7, 10.2 | 25.5, 26.6 | 52.9, 53.8 | 41.5, 41.6 |
| | 1♀ | 53.4 | 22.4 | 11.2 | 26.2 | 49.8 | 39.0 |
| *R. yunanensis* | 2♂♂ | 60.5, 62.0 | 21.5, 24.5 | 12.5, 13.0 | 27.3, 28.2 | 54.2, 55.8 | 43.3, 44.4 |
| | 2♀♀ | 64, 66 | 23, 26 | 14 (1) | 27.6, 30.0 | 56.2, 57.4 | 43.9, 44.3 |
| | | | *philippinensis* group | | | | |
| *R. marshalli* | 2♂♂ | 36.5, 44.8 | 20.0, 22.9 | 7.2, 7.3 | 17.4, 19.2 | 41.5, 45.8 | 31.8, 36.1 |
| *R. macrotis* | 1♂ | 39.0 | 18.7 | 6.7 | 17.1 | 42.4 | 31.4 |
| | 1♀ | 46.2 | 19.3 | 8.2 | 17.7 | 43.2 | 32.6 |
| | | | *rouxi* group | | | | |
| *R. thomasi* | 1♂[i] | * | 19.0 | 8.8 | 18.0 | 45.7 | 32.7 |
| | 4♀♀[i] | 47.8 | 19.0 | 7.9, 0.7 | 17.6, 0.4 | 45.0, 0.5 | 33.4, 1.2 |
| | | 46.4, 49.2 (2) | 19.0 (3) | 7.1–8.8 | 17.2–18.0 | 44.4–45.7 | 32.2–35.0 |
| *R. sinicus* | 1♂ | 55.0 | 29.0 | 10.0 | 18.3 | 48.4 | 38.8 |
| *R. rouxi* | 1♂ | 62.0 | 23.0 | 11.0 | 21.1 | 48.1 | 38.1 |
| | | | *trifoliatus* group | | | | |
| *R. trifoliatus* | 2? | * | * | * | 23.5, 25.0 | 50.8 (1) | 42.5 (1) |
| | 1♀ | 65.0 | 35.0 | 13.0 | 26.4 | 53.3 | 42.9 |
| *R. luctus* | 1♂ | 95.0 | 59.0 | 18.0 | 39.7 | 71.0 | 59.8 |
| | 3♀♀ | 80–99 | 46–50 | 17–18 | 37.0–38.4 | 67.2–71.0 | 56.3–59.7 |
| | | | *euryotis* group | | | | |
| *R. coelophyllus* | ?[ii] | * | * | * | * | 40.0–46.0 | * |
| *R. shameli* | ?[ii] | * | * | * | * | 42.0–46.5 | * |

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TABLE 2. Extended

| Species | 4MET | 3MET | 3D1P | 3D2P | 3D2P/3D1P | E | MASS |
|---|---|---|---|---|---|---|---|
| | | | *megaphyllus* group | | | | |
| *R. malayanus* | 32.2, 0.9 | 31.7, 1.0 | 12.4, 0.2 | 17.8, 0.9 | 1.44, 0.1 | 16.9, 1.4 | 6.8, 0.8 |
| | 30.6–33.0 | 30.4–33.2 | 12.2–12.7 | 16.7–18.8 | 1.37–1.53 | 15.0–18.6 | 6.0–8.0 |
| | 31.6, 1.3 | 31.3, 1.2 | 11.6, 0.6 | 17.3, 0.6 | 1.5, 0.1 | 15.7, 0.9 | 6.3, 0.6 |
| | 30.6–34.2 | 30.0–33.0 | 10.7–12.3 | 16.1–17.9 | 1.44–1.67 | 14.1–16.4 | 5.3–7.1 |
| *R. stheno* | 33.3 | 32.2 | 11.6 | 22.2 | 1.91 | 14.3 | 6.5 |
| | 33.0 | 30.9 | 13.2 | 21.9 | 1.66 | 16.0 | 6.0 |
| *R. affinis* | 40.7, 1.6 | 39.4, 2.0 | 15.8, 0.5 | 27.9, 0.9 | 1.76, 0.0 | 20.5, 5.0 | 14.0, 1.3 |
| | 39.1–42.6 | 37.9–42.1 | 15.1–16.2 | 26.6–28.7 | 1.74–1.80 | 16.2–27.0 | 12.6–15.2 |
| | 39.4 (1) | 37.9 (1) | 15.9 (1) | 22.8 (1) | 1.43 (1) | 16.1 (1) | 12,2 |
| | | | *pusillus* group | | | | |
| *R. subbadius* | 26.4, 0.2 | 25.3, 0.5 | 9.6, 0.6 | 12.7, 1.0 | 1.3, 0.0 | 16.0, 1.2 | * |
| | 26.2–26.7 | 25.0–26.1 | 9.0–10.2 (3) | 11.8–13.7 (3) | 1.29–1.34 (3) | 14.1–17.0 | * |
| | 25.2, 26.5 | 24.3, 25.7 | 9.2, 10.6 | 12.0, 13.2 | 1.13, 1.43 | 17, 18 | * |
| *R. pusillus* | 28.2 | 26.9 | 10.0 | 15.3 | 1.52 | 13.7 | 3.7 |
| | 29.1, 31.1 | 29.0, 29.6 | 10.3, 11.5 | 15.0, 16.2 | 1.40, 1.46 | 12.8, 13.8 | 4.2, 4.8 |
| *R. lepidus* | 32.8, 1.3 | 31.7, 1.3 | 12.2, 0.6 | 18.8, 0.8 | 1.53, 0.1 | 17.2, 1.2 | 7.5, 1.3 |
| | 30.8–34.6 | 29.7–33.1 | 11.3–13.0 (7) | 17.8–19.9 (7) | 1.44–1.64 (7) | 14.7–18.5 (10) | 6.0–8.8 (4) |
| | 32.0, 0.9 | 30.8, 0.7 | 11.7, 0.3 | 18.7, 1.0 | 1.60, 0.1 | 17.6, 1.0 | 6.2 |
| | 30.8–33.3 | 30.4–31.8 (4) | 11.4–12.0 (4) | 17.3–19.7 (4) | 1.45–1.69 | 15.8–18.0 | 6.2 (1) |
| *R. acuminatus* | 39.4 | 37.5 | 15.5 | 22.9 | 1.48 | 20.0 | * |
| | 37.6, 0.5 | 34.9, 0.5 | 15.2, 0.4 | 21.6, 1.2 | 1.42, 0.0 | 19.8, 1.5 | * |
| | 36.9–38.1 | 34.4–35.3 | 14.9–15.6 | 20.7–23.0 | 1.39–1.47 | 18.1–21.0 | * |
| | | | *pearsoni* group | | | | |
| *R. pearsoni* | 40.0, 40.8 | 36.4, 36.6 | 18,0 | 24.7, 25.7 | 1.37, 1.43 | 20.7, 21.2 | 8.8, 12.2 |
| | 36.8 | 34.4 | 16.6 | 25.6 | 1.54 | 21.4 | 10.8 |
| *R. yunanensis* | 41.1, 42.1 | 37.2, 38.6 | 19.5, 20.4 | 27.8, 28.8 | 1.41, 1.43 | 21.4 (1) | * |
| | 41.6, 42.5 | 38.4, 38.8 | 19.2, 20.1 | 26.3, 27.0 | 1.34, 1.37 | 26, 27 | * |
| | | | *philippinensis* group | | | | |
| *R. marshalli* | 31.9, 36.7 | 29.9, 35.1 | 12.1, 14.1 | 17.6, 19.8 | 1.41, 1.45 | 26.0, 27.2 | 6.2, 6.8 |
| *R. macrotis* | 32.2 | 30.6 | 13.0 | 19.1 | 1.47 | 20.2 | 4.3 |
| | 32.5 | 31.6 | 12.5 | 18.1 | 1.45 | 20.4 | 6,8 |
| | | | *rouxi* group | | | | |
| *R. thomasi* | 31.9 | 31.0 | 13.1 | 20.2 | 1.54 | * | * |
| | 32.1. 0.8 | 31.1. 0.8 | 13.4. 0.4 | 21.0. 1.0 | 1.57. 0.0 | 13.1. 0.2 | 6.3 |
| | 31.3–33.2 | 30.4–32.2 | 13.0–13.8 | 20.2–22.0 | 1.54–1.61 | 12.9–13.2 | 6.3, 6.3 (2) |
| *R. sinicus* | 37.6 | 36.7 | 15.1 | 24.1 | 1.59 | 21.0 | * |
| *R. rouxi* | 38.7 | 36.9 | 14.8 | 21.6 | 1.46 | 20.0 | * |
| | | | *trifoliatus* group | | | | |
| *R. trifoliatus* | 38.1, 41.2 | 33.5, 35.5 | 20, 20 | 27.5, 28.9 | 1.38, 1.45 | * | * |
| | 41.2 | 35.4 | 19.3 | 30.5 | 1.58 | * | * |
| *R. luctus* | 56.9 | 47.7 | 26.1 | 40.1 | 1.54 | 38.0 | * |
| | 56.2–58.3 | 48.6–50.1 | 26.7–29.3 | 34.2–40.1 | 1.17–1.45 | 38–42 | * |
| | | | *euryotis* group | | | | |
| *R. coelophyllus* | * | * | * | * | * | * | * |
| *R. shameli* | * | * | * | * | * | * | * |

[i] — partly based on Andersen (1905)
[ii] — based on Csorba *et al*. (2003)

Aye Khaing, Naing Naing Aung, Nu Nu Aye, Nyo Nyo, Yin Yin Toke, Khin Thein Soe, Aye Aye Myint and Khine Shwe War Win.

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*Previous record from Myanmar*

Mon State: Nagamauk Cave (Bates *et al*., 2000).

*Diagnosis*

A medium-small sized horseshoe bat (Table 1; full measurements in Tables 2 and 3). The tibiae are short. In the wing, the second phalanx of the third digit is short, usually less than 1.5 times the length of the first phalanx. In the skull, the anterior median compartments of the rostrum are well inflated and extend down the sides of the rostrum. The posterior compartments are moderately inflated and in consequence, there is a straight profile or only a slight concavity between the anterior and posterior parts (Bates *et al*., 2000). The post orbital constriction is not markedly narrow.

*Taxonomic notes*

Bates *et al*. (2000) noted that their specimen from Mon State was relatively large compared to *R. malayanus* collected elsewhere in its range. The seven additional specimens from Mon and Kayin States listed above support this view, with all but two exceeding the maximum range of skull length (SL) included in Csorba *et al*. (2003). In other measurements, such as lengths of the toothrows and zygomatic breadth this difference is less apparent. However, of those collected in March, 2003 from Shan State, one male specimen (MN8) from Pauk Inlay Cave is large and one (MN12) is smaller, approximately equal to the measurements listed in Csorba *et al*. (2003). That from Montawa Cave (SH3) is also smaller. Currently, no subspecies of *R. malayanus* have been described. Specimens from south-eastern Myanmar may possibly be referable to a new, as yet undescribed subspecies, but the variation in size of specimens in Shan State suggests that further study is needed before firm conclusions can be drawn. For the present, all specimens are therefore referred to the nominate race.

*Ecological notes*

The recent specimens from Myanmar were all collected from caves in limestone outcrops in Mon, Kayin and Shan States. Cave size varied considerably. Some such as Saddan-Sin Cave and Yathay-Pyan Cave are large, with a number of chambers, complex roofs, more than one exit and a maximum roof height of between 28 and 30 m. Others such as Bayint Nyi, Nagamauk Cave and Pauk Inlay Cave are much smaller. Bayint Nyi is essentially a long tunnel-like structure with a maximum height of 3 to 4 m and a width of 5 to 8 m, opening out to 16 m in places. Nagamauk is also a short tunnel like structure, some 4 m in height leading to a small chamber. Pauk Inlay Cave comprises a series of thin fissure-like tunnels leading to a series of small chambers. Colony size within the roosts is not known yet. To date, 15 other bat species are known from the six caves from which *R. malayanus* have been collected. These include *Rousettus leschenaulti*, *Cynopterus sphinx*, *Eonycteris spelaea*, *Craseonycteris thonglongyai*, *Taphozous melanopogon*, *Megaderma spasma*, *Rhinolophus marshalli*, *R. stheno*, *Hipposideros armiger*, *H. larvatus*, *Aselliscus stoliczkanus*, *Myotis chinensis*, *Pipistrellus paterculus*, *Miniopterus magnater*, and *M. pusillus*

### *Rhinolophus stheno* Andersen, 1905
Lesser brown horseshoe bat

*Rhinolophus stheno* Andersen, 1905: 91; Selangor, Malaya.

*Rhinolophus stheno microglobosus* Csorba and Jenkins, 1998: 208; Na Hang Nature Reserve, Tuyen Quang Province, Vietnam.

*New material from Myanmar*

Mandalay Division: Sanite Cave No2, 18.3.2003, 1 ♀ (MN14); Mon State: Indian Single Rock Temple Cave, 17.11.2002, 1 ♂

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(H21). These are the first records from Myanmar. Collected by I. Mackie, Khin Mie Mie, Aye Aye Khaing, Naing Naing Aung, Nu Nu Aye, Nyo Nyo, Yin Yin Toke, Khin Thein Soe, Si Si Hla Bu, P. J. J. Bates, Khin Maung Swe, and Khine Shwe War Win.

*Diagnosis*

A medium-sized horseshoe bat (Table 1; full measurements in Tables 2 and 3). The tibiae are relatively long. In the wing, the first phalanx of the third digit is short but the second phalanx is long. In the skull, the anterior median compartments of the rostrum are well inflated and extend down the sides of the rostrum. The posterior compartments are little inflated and in consequence, there is a distinct 'step' in the profile between the anterior and posterior parts (Bates *et al*., 2000). The post orbital constriction is very narrow.

*Taxonomic notes*

According to McFarlane and Blood (1986), there are no reliable external characters that can be used to distinguish between *R. stheno* and *R. malayanus*. Robinson (1995) generally supported this view but suggested like Lekagul and McNeely (1988) that *R. malayanus* had a wider noseleaf, although Csorba *et al*. (2003) found little difference in noseleaf breadth when examining large series of both species. However, Csorba noted that the median septum of the lancet was very broad in *R. stheno*. Hendrichsen *et al*. (2001) recorded significant differences in tibia length (contrary to Robinson, 1995) between specimens of *R. stheno* and *R. malayanus* from Vietnam: 20.7–22.6 mm ($n = 2$) in *R. stheno* and 16.0–16.6 mm ($n = 2$) in *R. malayanus*. Despite the small sample sizes, the same differences are also observed in the specimens from Myanmar: 20.7–21.3 mm ($n = 2$) and 16.1–18.2 mm ($n = 12$), respectively. Hendrichsen *et al*. (2001) also noted that the second phalanx of the third digit is long in *R. stheno* but absolutely and relatively shorter in *R. malayanus*. In Vietnam, the ratio of the second phalanx to the first phalanx of the third digit in *R. stheno* is 1: 1.63–1.82 ($n = 2$) and in *R. malayanus* is 1: 1.40–1.43 ($n = 2$). In Myanmar, it is 1: 1.66–1.91 ($n = 2$) and 1: 1.37–1.67 ($n = 12$), respectively. These findings support Lekagul and McNeely (1988) who noted that in *R. stheno* "the second phalanx of the third finger is over 1.5 times the length of the first phalanx, relatively much longer than in *malayanus*." Specimens from Myanmar and Vietnam do not support the contention of Lekagul and McNeely (1988) that the two species can be distinguished by the the length of the tail, although in Myanmar the tail is usually shorter in *R. stheno*. In the skull, the difference in rostral morphology between *R. stheno* and *R. malayanus* is discussed and illustrated in Bates *et al*. (2000). Csorba *et al*. (2003) note the narrow post orbital constriction of *R. stheno* in comparison to *R. malayanus*. This character is also present in the specimens from Myanmar.

On the basis of size and development of the rostral inflations, the specimens from Sanite Cave No 2 and Indian Single Rock Cave, Myanmar are referable to *R. stheno microglobosus* Csorba and Jenkins, 1998, which is currently known from Thailand and Vietnam.

*Ecological notes*

Two individuals were collected in a mist net set at the entrance to Indian Single Rock Cave. One, a male, was kept as a voucher specimen. The other, a non-pregnant female, was released. The cave, one of three in the vicinity, is situated in an isolated outcrop of limestone. The natural vegetation in the surrounding area has been cleared and has been replaced with paddy fields and there are some small trees and bushes. The

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TABLE 3. Cranial and dental measurements (in mm) of 18 species of *Rhinolophus* recorded from Myanmar; mean, SD and minimum–maximum. Used abbreviations: GTL: greatest length of skull; SL: skull length; CCL: condylo-canine length; ZB: zygomatic breadth; BB: breadth of braincase; PC: post orbital construction; C–$M^3$: maxillary toothrow length; $M^3$–$M^3$ palatal breadth; C–$M_3$: mandibular toothrow length; $C^1$–$C^1$: anterior palatal width; MDL: mandible length. Sample sizes for males and females differing from those reported under *n* are given in parentheses after the measurement

| Species | *n* | GTL | SL | CCL | ZB | BB |
|---|---|---|---|---|---|---|
| | | | *megaphyllus* group | | | |
| *R. malayanus* | 6♂♂ | 19.1, 0.4 | 18.3, 0.3 | 16.1, 0.3 | 8.9, 0.2 | 7.8, 0.2 |
| | | 18.3–19.4 | 17.9–18.8 | 15.6–16.3 (5) | 8.6–9.2 (5) | 7.7–8.2 |
| | 6♀♀ | 18.7, 0.6 | 17.8, 0.5 | 15.6, 0.4 | 8.6, 0.2 | 7.6, 0.3 |
| | | 18.1–19.5 (5) | 17.2–18.5 (5) | 15.2–16.2 (5) | 8.7–8.9 (5) | 7.1–8.0 |
| *R. stheno* | 1♂ | 19.2 | 18.6 | 16.3 | 9.2 | 8.1 |
| | 1♀ | 19.2 | 18.1 | 15.8 | 8.5 | 7.9 |
| *R. affinis* | 6♂♂ | 23.8, 0.5 | 22.6, 0.5 | 19.9, 0.3 | 11.3, 0.3 | 9.5, 0.3 |
| | | 23.1–24.3 | 22.1–23.1 | 19.5–20.3 | 10.7–11.6 | 9.0–9.8 |
| | 2♀♀ | 22.2, 23.4 | 21.4, 22.3 | 19.0, 19.6 | 10.5, 10.9 | 8.9, 9.6 |
| | | | *pusillus* group | | | |
| *R. subbadius* | 5♂♂ | 14.8, 0.4 | 14.5 (1) | 12.7 (1) | * | 6.4 (1) |
| | | 14.5–15.2 (3) | 14.5 (1) | 12.7 (1) | * | 6.2–6.5 (2) |
| | 2♀♀ | 14.6 (1) | 14.2 (1) | * | * | 5.7 (1) |
| *R. pusillus* | 1♂ | 16.2 | 15.6 | 13.6 | 7.6 | 6.7 |
| | 2♀♀ | 16.0, 16.1 | 15.2, 15.5 | 13.3, 13.7 | 7.4, 7.5 | 6.8, 6.9 |
| *R. lepidus* | 11♂♂ | 18.9, 0.5 | 18.0, 0.4 | 15.9, 0.4 | 9.0, 0.2 | 7.7, 0.2 |
| | | 17.8–19.5 (10) | 17.2–18.7 | 15.2–16.7 | 8.7–9.3 (10) | 7.4–8.1 |
| | 7♀♀ | 17.5, 0.1 | 17.2, 0.4 | 15.2, 0.3 | 8.6, 0.3 | 7.3, 0.4 |
| | | 17.4–17.7 (3) | 16.5–17.5 (5) | 14.8–15.7 (5) | 8.2–8.8 (5) | 6.9–8.0 (6) |
| *R. acuminatus* | 1♂ | 22.9 | 22.2 | 19.9 | 11.7 | 9.5 |
| | 3♀♀ | 21.1, 0.3 | 20.4, 0.1 | 18.1, 0.2 | 10.9, 0.4 | 9.0, 0.3 |
| | | 20.8–21.4 | 20.4–20.5 | 18.0–18.3 | 10.5–11.2 | 8.7–9.3 |
| | | | *pearsoni* group | | | |
| *R. pearsoni* | 2♂♂ | 23.2, 24.4 | 22.6, 23.3 | 20.0, 20.7 | 11.1, 11.6 | 9.8, 10.3 |
| | 1♀ | 22.4 | 21.9 | 19.5 | 11.3 | 9.4 |
| *R. yunanensis* | 2♂♂ | * | 25.7 (1) | 22.9 (1) | 13.1 (1) | 9.9 (1) |
| | 2♀♀ | 26.1 (1) | 24.8, 25.0 | 22.3, 22.7 | 12.2, 12.4 | 9.7, 9.8 |
| | | | *philippinensis* group | | | |
| *R. marshalli* | 1♂ | 18.7 | 17.4 | 15.2 | 8.2 | 7.9 |
| *R. macrotis* | 1♂ | 18.5 | 17.5 | 15.5 | 7.8 | 7.9 |
| | 1♀ | 17.7 | 17.6 | 15.3 | 8.0 | 7.8 |
| | | | *rouxi* group | | | |
| *R. thomasi* | 1♂ | 18.5 | 18.2 | 16.1 | 9.4 | 7.9 |
| | 4♀♀ | 18.7, 0.5 | 18.0, 0.2 | 15.8, 0.2 | 9.6, 0.3 | 8.1, 0.1 |
| | | 18.3–19.2 (3) | 17.8–18.2 | 15.7–16.0 | 9.4–9.9 (3) | 8.1–8.2 (3) |
| *R. sinicus* | 1♂ | 21.9 | 20.7 | 18.2 | 10.4 | 8.9 |
| *R. rouxi* | 1♂ | 22.9 | 21.8 | 19.2 | 11.5 | 9.1 |
| | | | *trifoliatus* group | | | |
| *R. trifoliatus* | 2? | * | * | * | 11.5 (1) | 9.5 (1) |
| | 1♀ | * | * | * | * | * |
| *R. luctus* | 1♂ | * | 32.0 | 28.5 | 15.5 | 12.3 |
| | 4♀♀ | 31.7 (1) | 29.9–32.5 | 26.6–27.7 (3) | 14.4–16.5 (3) | 11.5–12.5 (3) |
| | | | *euryotis* group | | | |
| *R. coelophyllus* | 1♂ | 19.3 | 18.5 | * | 9.4 | 8.3 |
| *R. shameli* | 2? | 20.8 (1) | 19.8 (1) | 17.5 (1) | 9.5 (1) | 8.6 (1) |

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TABLE 3. Extended

| Species | PC | C–$M^3$ | $M^3$–$M^3$ | C–$M_3$ | $C^1$–$C^1$ | MDL |
|---|---|---|---|---|---|---|
| | | | *megaphyllus* group | | | |
| *R. malayanus* | 2.5, 0.1 | 7.2, 0.1 | 6.4, 0.2 | 7.5, 0.1 | 4.6, 0.1 | 12.4, 0.4 |
| | 2.4–2.7 | 7.1–7.3 | 6.1–6.6 | 7.4–7.6 | 4.5–4.6 | 11.9–12.8 (5) |
| | 2.5, 0.1 | 7.0, 0.2 | 6.4, 0.2 | 7.2, 0.2 | 4.3, 0.1 | 12.1, 0.3 |
| | 2.4–2.6 | 6.7–7.2 | 6.2–6.5 | 6.9–7.4 | 4.3–4.4 (2) | 11.9–12.6 |
| *R. stheno* | 1.5 | 7.0 | 7.0 | 7.6 | 4.8 | 12.4 |
| | 1.8 | 7.0 | 6.4 | 7.5 | 4.6 | 11.9 |
| *R. affinis* | 2.2, 0.2 | 8.9, 0.2 | 8.4, 0.2 | 9.4, 0.2 | 6.1, 0.2 | 15.8, 0.4 |
| | 2.1–2.5 | 8.8–9.2 | 8.2–8.5 | 9.2–9.6 | 5.9–6.4 | 15.2–16.2 |
| | 1.8, 2.0 | 8.5, 9.0 | 8.2, 8.3 (3) | 8.9, 9.7 | 5.9, 6.3 | 15.0, 15.8 |
| | | | *pusillus* group | | | |
| *R. subbadius* | 2.2 (1) | 5.2, 0.1 | 4.3, 0.2 | 5.8, 0.2 | * | 9.4, 0.2 |
| | 2.2 (1) | 5.1–5.4 | 4.2–4.4 (4) | 5.6–6.1 | * | 9.3–9.7 |
| | * | 5.4, 5.5 | 4.5, 4.6 | 5.2, 5.6 | * | 9.2, 9.5 |
| *R. pusillus* | 2.0 | 5.8 | 5.7 | 6.3 | 3.9 | 10.1 |
| | 2.0, 2.2 | 5.5, 5.6 | 5.6 | 5.9, 6.2 | 3.7, 3.8 | 9.8, 10.2 |
| *R. lepidus* | 2.4, 0.2 | 6.9, 0.1 | 6.6, 0.2 | 7.5, 0.2 | 4.6, 0.2 | 12.4, 0.4 |
| | 2.2–2.6 | 6.8–7.2 | 6.3–7.0 | 7.2–7.9 | 4.4–4.8 (5) | 11.7–13.0 |
| | 2.3, 0.1 | 6.6, 0.2 | 6.4, 0.2 | 7.1, 0.2 | 4.3, 0.0 | 11.8, 0.2 |
| | 2.2–2.4 (6) | 6.5–6.9 | 6.3–6.7 (6) | 6.8–7.5 | 4.3–4.4 (6) | 11.6–12.2 |
| *R. acuminatus* | 2.8 | 8.9 | 8.5 | 9.7 | 6.4 | 15.8 |
| | 2.6, 0.0 | 8.0, 0.1 | 8.2, 0.1 | 8.7, 0.2 | 5.7, 0.1 | 14.2, 0.2 |
| | 2.6–2.7 | 7.9–8.1 | 8.1–8.3 | 8.5–8.8 | 5.6–5.8 | 14.0–14.3 |
| | | | *pearsoni* group | | | |
| *R. pearsoni* | 2.1, 2.2 | 8.8, 9.4 | 8.2, 8.5 | 9.4, 10.2 | 5.8, 6.3 | 15.9, 16.6 |
| | 2.3 | 8.8 | 8.4 | 9.4 | 5.9 | 15.4 |
| *R. yunanensis* | 2.6 (1) | 10.5–10.5 | 9.6–9.7 | 11.2–11.5 | 6.4–6.8 | 18.2–18.3 |
| | 2.0, 2.3 | 9.5, 10.6 | 9.3, 9.6 | 10.8, 11.3 | 6.6, 6.7 | 17.7, 18.1 |
| | | | *philippinensis* group | | | |
| *R. marshalli* | 2.7 | 5.9 | 5.5 | 6.0 | 4.1 | 11.0 |
| *R. macrotis* | 2.3 | 6.2 | 5.7 | 7.0 | 3.9 | 11.3 |
| | 2.6 | 6.3 | 5.4 | 6.7 | 4.1 | 11.4 |
| | | | *rouxi* group | | | |
| *R. thomasi* | 2.5 | 6.9 | 6.9 | 7.7 | * | 12.4 |
| | 2.4, 0.0 | 6.9, 0.1 | 7.1, 0.1 | 7.6, 0.2 | 4.7, 0.3 | 12.4, 0.2 |
| | 2.4–2.5 (3) | 6.8–7.1 | 7.0–7.2 (3) | 7.5–7.8 (3) | 4.5–4.9 (3) | 12.2–12.6 (3) |
| *R. sinicus* | * | 8.1 | 8.1 | 8.7 | 4.8 | 14.1 |
| *R. rouxi* | 2.3 | 8.8 | 8.9 | 9.9 | 6.3 | 15.6 |
| | | | *trifoliatus* group | | | |
| *R. trifoliatus* | 2.1 (1) | 8.5, 8.5 | 8.0, 8.2 | 9.1, 9.5 | 5.5–5.9 | 15.5 (1) |
| | * | * | * | * | * | * |
| *R. luctus* | 3.1 | 11.9 | 10.6 | 13.0 | * | 22.8 |
| | 2.8–3.3 | 11.5–13.0 | 10.2–11.2 | 12.2–14.2 | 7.9–8.9 | 22.2–23.6 |
| | | | *euryotis* group | | | |
| *R. coelophyllus* | 2.6 | 7.4 | 6.7 | 7.6 | 4.7 | 12.2 |
| *R. shameli* | 2.0 (1) | 7.5–7.7 | 7.1–7.3 | 8.0 (1) | 5.0–5.1 | 13.0 (1) |

cave has a small entrance and a narrow tunnel, approximately 2.5 to 3 m wide and 0.7 to 1.3 m high leading to a Hindu temple in a small terminal chamber (5.8 m wide by 8.4 m high). The *R. stheno* were apparently roosting in an inaccessible side tunnel close to the cave entrance. Although the weather was overcast with heavy rain, many bats

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were seen flying at dusk in the general area. However, no other bat species were collected from this particular roost. At Sanite Cave No 2, *R. stheno* was collected along with *R. malayanus* and *A. stoliczkanus*. The cave has a small entrance which leads into a series of three small and one large chamber. It is situated in a limestone outcrop on the side of a valley, which has secondary forest cover of deciduous and evergreen trees. There is a large stream and a waterfall at the base of the valley and agricultural land in the near vicinity. Although exact colony sizes could not be determined, only one *R. stheno* was collected, whilst *R. malayanus* seemed to be much more abundant.

### *Rhinolophus affinis* Horsfield, 1823
### Intermediate horseshoe bat

*Rhinolophus affinis* Horsfield, 1823: pt 6; Java.
*R. a. himalayanus* Andersen, 1905: 103: Masuri, Kumaon, N-W India.
*R. a. macrurus* Andersen, 1905: 103: Taho, Karennee, S-E Burma.
*R. a. tener* Andersen, 1905: 103: Pegu, Burma.

*New material from Myanmar*

Shan State: Mant Hai Village, 23.3.2002, 2 ♂♂ (C5, C6); Taung Pauk Village, 25.3.2003, 1 ♂ (SH17) and 1 ♀ (SH18); Yan Twine Cave, 19.8.2003, 1 ♂ (IL6). Collected by P. J. J. Bates, Si Si Hla Bu, Khin Maung Swe, Soe Soe Aung, Aik Kyu, Khin Mie Mie, I. Mackie, Khine Shwe War Win, Aye Aye Khaing, Naing Naing Aung, Nu Nu Aye, Nyo Nyo, and Yin Yin Toke.

*Previous records from Myanmar*

Bago Division: Bago (= Pegu) (type locality of *tener*, Andersen, 1905); Kachin State: Myitkyina (USNM collection), Nam Tamai Valley (BMNH); Hai Bum (Carter, 1943); Sagaing Division: Hisweht (Wroughton, 1916*a*); Shan State: Taho (type locality of *macrurus*, Andersen, 1905); no exact locality: Dobson (1878), Sterndale (1884) and Blanford (1888–91).

*Diagnosis*

A medium-large sized horseshoe bat (Table 1; full measurements included in Tables 2 and 3). The tibiae are long. In the wing, the first phalanx of the third digit is relatively long and the second phalanx very long. There is one exception to this, a female specimen (SH18) from Taung Pauk Village, which despite being an adult with worn teeth, has short, poorly developed (possibly abnormal) second phalanges of the third digits on both wings. The skull is robust and the bony palate is short, about one quarter or less the length of the upper toothrow ($C–M^3$).

*Taxonomic notes*

Two races of *R. affinis* have been named from Myanmar. *Rhinolophus affinis tener* from Bago (= Pegu) was described by Andersen (1905) on the basis of its small size (forearm = 50 mm), small ears (length = 18.8 mm) and short tail (23 mm) but broad horseshoe (9.5 mm) and rather long tibiae (24 mm). The skull is short (total length = 21.9 mm), the nasal swellings (width across nasal swellings = 5.7 mm) and braincase narrow (9.0 mm) and the toothrows short (upper toothrow = 8.7 mm; lower toothrow = 9.2 mm). *R. affinis macrurus* Andersen, 1905 from Taho was considered to be of moderate size, based on three specimens (forearm = 51–53.8 mm), with ears larger (length = 20.0–20.7 mm), horseshoe broader (9.0–9.8 mm), tail longer (26–29.3 mm) and tibiae long (23.9–25.4 mm). Skull length (total length = 22.5–23.2 mm), braincase width (9.3–9.8 mm), toothrow lengths (upper toothrow = 8.8–9.2 mm; lower toothrow = 9.6–9.9 mm) and width of nasal swellings (5.8–6.2 mm) moderate. All measurements are after Andersen (1905). The four recent specimens from

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Shan State are most comparable in size to *R. a. macrurus*. However, they are also within the size range of *R. a. himalayanus* Andersen, 1905 and would appear to support further the view of Osgood (1932) that *macrurus* and *himalayanus* differ only in minor average differences and are therefore consubspecific. *R. a. himalayanus*, named from Mussoorie, northern India, is the prior name by line priority and therefore the two recent specimens are provisionally referred to this taxon. This view is contrary to Koopman (1994), who recognised both *macrurus* and *himalayanus* as valid subspecies. The status of *tener* remains unclear but must be considered only doubtfully distinct.

*Ecological notes*

In March, 2002, two specimens of *R. affinis* were collected in 30 foot mist nets set over a small stream in highly degraded woodland adjacent to the Muse-Nankham road on the south bank of the flood plain of the Lengchuan Jiang (River) on the Myanmar-China border. There were stands of bamboo along the stream and secondary forest on the steeper slopes of the hill range to the south, although this had been extensively cleared in places. To the north, within the flood plain, was open agricultural land, primarily rice paddy. Both bats were collected just after dusk and no other bats were seen. In March, 2003, two additional specimens were collected from Taung Pauk Village.

## *Pusillus*-group

Diagnosis: the superior connecting process of sella triangular in profile (Fig. 1B).

### *Rhinolophus subbadius* Blyth, 1844
Little Nepalese horseshoe bat

*Rhinolophus blythi* Blyth, 1844: 486; Nepal.

*New material from Myanmar*

There is no new material from Myanmar.

*Previous record from Myanmar*

Kachin State: Nam Tamai Valley (Hill, 1962).

*Diagnosis*

The smallest horseshoe bat in the *pusillus* group (Table 1; full measurements in Tables 2 and 3). The skull is smaller than that of *R. pusillus* and the palate is narrower.

*Ecological notes*

No new data.

### *Rhinolophus pusillus* Temminck, 1834
Least horseshoe bat

*Rhinolophus pusillus* Temminck, 1834: 29; Java.

*R. blythi* Andersen, 1918: 376; Almora, Kumaon, India, 5500 ft.

*R. blythi szechuanus* Andersen, 1918: 376; Chunking, Sichuan, China.

*New material from Myanmar*

Shan State: Nant Khun Village, 23.3.2002, 1 ♂ (C4); Tone Khan Village, 23.3.2002, 1 ♀ (C3); Taung Pauk Village, 25.3.2003, 1 ♀ (SH15). Collected by Si Si Hla Bu, P. J. J. Bates, I. Mackie, Khin Mie Mie, Khin Maung Swe, Khine Shwe War Win, Aye Aye Khaing, Naing Naing Aung, Nu Nu Aye, Nyo Nyo, Yin Yin Toke and Soe Soe Aung.

*Previous records from Myanmar*

Bago Division*:* Bago (= Pegu) (= *R. minor* in Dobson, 1876); Kachin State: Hai Bum (Carter, 1943); Myitkyina (LACM); Sagaing Division: Sagaing (= Tsagain/ Isagine, but no exact locality) (= *R. minor* in Dobson, 1876); Alaungdaw Kathapa (P. J. J. Bates, pers. comm.); no exact locality: (= *R. minor* in Dobson, 1876; Anderson, 1881; Sterndale, 1884, and Blanford, 1888–91).

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*Diagnosis*

This is a small horseshoe bat within the *pusillus* group. It is intermediate in size between the larger *R. lepidus* and the smaller *R. subbadius* (Table 1; full measurements in Tables 2 and 3). Some large specimens tentatively referred to *R. pusillus* are virtually impossible to distinguish from small specimens referred to *R. lepidus* (Csorba *et al*., 2003). The skull is small with a narrow palate.

*Taxonomic notes*

In the past, specimens from Myanmar have been referred to *R. p. szechuanus* Andersen, 1918, which was described on account of its paler colour (Koopman, 1994). However, Sinha (1973) found little difference between *szechuanus* and the northern Indian race *blythi* Andersen, 1918. Since, *blythi* is the prior name by line priority, all specimens from Myanmar are here referred to *R. p. blythi*.

*Ecological notes*

A single female specimen was collected from a small limestone cave near the village of Tone Khan. The cave, which was in a small clump of trees and bamboo was 15 m in length with a maximum height of 3 m and a maximum width of 2 m. About six *R. pusillus* were present. The second specimen, a male *R. pusillus*, was collected from a man-made tunnel in a sandstone cliff in a small but well vegetated gorge near the village of Nant Khun. The tunnel extended about 25 m into the rock face. It was about one metre high by one metre wide. A third specimen from Shan State was collected at Taung Pauk Village. In Alaungdaw Kathapa, a single individual was netted on 25 January, 1999 whilst flying at dusk around the Forestry Department buildings within the National Park. It was photographed and released.

## *Rhinolophus lepidus* Blyth, 1844
### Blyth's horseshoe bat

*Rhinolophus lepidus* Blyth, 1844: 486; Calcutta, India.

*Rhinolophus feae* Andersen, 1907: 474; Biapo, Karin Hills (Karenni Hills = Kayah Hills), SE Burma.

*Rhinolophus shortridgei* Andersen, 1918: 376; Bagan, Irrawaddy River, Burma.

*New material from Myanmar*

Rakhine State: Bar Min Gu, 13.3.2003, ♂ (MV8); Shit Taung Temple, 13.3.2003, ♂ (MV9). Bago Division: Pyay, 25.11.2000, 2 ♂♂ (Z90, Z91). Collected by Si Si Hla Bu, Malcolm Pearch, Khin Maung Swe, Ohn Mar Ohn, Yin Yin Win, Nilar Lwin and Soe Soe Aung.

*Previous records from Myanmar*

Kachin State: Nam Tamai Valley (BMNH); Kayah State: Biapo (type locality of *feae*); Mandalay Division: Kanbalu (USNM); Mandalay (FMNH); Bagan (= Pagan) (type locality of *shortridgei*); Nyaung Oo (Bates *et al*., 2000); Rakhine State: Mayan Haung (Pearch *et al*., In press); Sagaing Division: Kindat (Wroughton, 1916*a*).

*Diagnosis*

A medium-small horseshoe bat of the *pusillus* group (Table 1; full measurements in Tables 2 and 3). The skull is larger than that of *R. pusillus* and the palate is broader.

*Taxonomic notes*

A detailed discussion of the systematics of *lepidus*, *feae* and *shortridgei* is included in Pearch *et al*. (In press). They noted that although specimens of *feae* and *shortridgei* average larger than *R. l. lepidus* from India, there are no diagnostic morphological characters to distinguish them. They therefore concluded that contrary to Csorba *et al*. (2003) *shortridgei* is conspecific with *lepidus* and that *feae* and *shortridgei* are consubspecific, since there is an overlap in

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size between these two taxa. Since *feae* is a prior name to *shortridgei*, all specimens from Myanmar are referable to *R. lepidus feae*.

*Ecological notes*

In Pyay, two adult male specimens were collected by local people from the 'gardens of the city'. Pyay is located on the Ayeyarwady at the head of the extensive delta region and at the southernmost extent of the central dry zone. The roost site was not seen. In March, 2003 a small colony of *R. lepidus* was located in a narrow brick alcove, some 3 m in length, in the Shit Taung Temple in Mrauk-U.

*Rhinolophus acuminatus* Peters, 1871
Acuminate horseshoe bat

*Rhinolophus acuminatus* Peters, 1871: 308; Gadok, Java.

*New material from Myanmar*

Bago Division: Nyaungkharshay Village, November, 2002, 1 ♂ (B-154) and 3 ♀♀ (B-143, B-144, B-149); Daik Oo, 6.3.2003 (Yangon Univ collection). These are the first records from Myanmar. Collected by Mar Mar Thi and Thida Oo. Tanintharyi Division: Myeik, 5.8.2003, 1 ♂ (TN1) and 1 ♀ (TN2). Collected by Si Si Hla Bu, Khin Mie Mie and Pyone Aye.

*Diagnosis*

The largest horseshoe bat in Asia within the *pusillus*-group (Table 1; full measurements included in Tables 2 and 3). Pelage colour varies considerably between individuals with grey and a brown/orange-brown morphotypes. The lancet is short with concave margins and a clearly defined tip. The tibiae are relatively short. In the wing, the second phalanx of the third digit is not greatly lengthened, usually less than 1.5 times the length of the first phalanx. The skull is short and broad. The anterior median compartments of the rostrum are inflated but do not extend down the sides of the rostrum. The posterior compartments are little inflated.

*Taxonomic notes*

The recent discovery of *R. acuminatus* in Myanmar is a significant range extension for the species. Those from Bago Division represent the most northern and western locality of the taxon. The subspecific variation in *R. acuminatus* has not been studied in detail (Sanborn, 1952). Provisionally, specimens from Myanmar like those from Thailand are referred to the nominate race. Initial studies in Myanmar suggest that males usually exceed females in size. Of the eight males collected, five were the grey morphotype and three the brown to orange-brown morphotype. Of the fourteen females, none was grey, all being brown to orange-brown in colour. Chasen (1940) also observed considerable variation in size in *R. acuminatus* in Sumatra (forearm 47–52 mm) but did not ascribe this to sexual differences but suggested that there might be more than one taxon present.

*Ecological notes*

A diurnal roost of about one hundred *R. acuminatus* was located in a cellar beneath a monastery in Nyaungkharshay village, which is on the eastern margin of Waw Township. The cellar was about 13 m by 30 m with a height of one metre. The surrounding area, which lies to the west but within the flood plain of the Sittang River, is primarily agricultural, with rice paddy, and there are many fruit trees. Raw grass locally known as kaings and reeds grow in the low-lying parts. No other bat species were collected from the roost. A second roost in Bago Division was found in the roof of a prison in Daik Oo. In Tanintharyi Division, a colony was found in the basement of a town house in Zay Tan Ward, Talinesu in Myeik city.

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*Pearsoni*-group

Diagnosis: the superior connecting process of sella forms a continuous arch (Fig. 1C); lower lip with one mental groove.

*Rhinolophus pearsoni* Horsfield, 1851
Pearson's horseshoe bat

*Rhinolophus pearsoni* Horsfield, 1851: 33; Darjeeling, West Bengal, N-E India.

*New material from Myanmar*

Shan State: Naga Cave, 22.3.2003, 2 ♂♂ (SH6, SH8) and 16.8.2003, ?sex (TA4); Mon State: Hnidon Hill Cave, 3.11.2002, 1 ♂ (H6). Collected by Si Si Hla Bu, I. Mackie, Khin Mie Mie, P. J. J. Bates, Khin Maung Swe, Aye Aye Khaing, Naing Naing Aung, Nu Nu Aye, Nyo Nyo, Yin Yin Toke, Khin Thein Soe and Khine Shwe War Win.

*Previous records from Myanmar*

Kachin State: Tasu Bum (Carter, 1943); Shan State: Taho (Andersen, 1907).

*Diagnosis*

A medium-large species of the *pearsoni* group (Table 1; full measurements included in Tables 2 and 3). Size smaller than the morphologically similar *R. yunanensis*.

*Taxonomic notes*

All specimens from Myanmar are referred to *R. p. pearsoni*.

*Ecological notes*

An adult male specimen was collected in a 6-m mistnet set at the entrance to Hnidon Hill Cave, which is situated some 5 km east of Kyaikmaraw and the Ataran River. No other individuals were seen of this species. The cave is in a large limestone outcrop, which is surrounded by agricultural land, with relatively little forest cover. The cave is a complex of chambers and tunnels, which extend some 300 m in to the outcrop. Other bat species recorded from the cave include *E. spelaea*, *Megaderma lyra*, *H. armiger*, *H. lylei*, *A. stoliczkanus*, and *Myotis chinensis*. A further two specimens were collected at Naga Cave in Taunggyi District. The cave has a large, long chamber and associated tunnels that extend several hundred metres in to the limestone outcrop. The surrounding vegetation is moderately sparse, with some trees and shrubs present.

*Rhinolophus yunanensis* Dobson, 1872
Dobson's horseshoe bat

*Rhinolophus yunanensis* Dobson, 1872: 336; Hotha, Yunnan, China.

*New material from Myanmar*

No new material from Myanmar.

*Previous records from Myanmar*

Kachin State: Nam Tamai Valley, Kajihtu and Mahtum (Hill, 1986).

*Diagnosis*

A medium-large species (Table 1; full measurements included in Tables 2 and 3). Size larger than the morphologically similar *R. pearsoni*.

*Taxonomic notes*

All specimens from Myanmar are referred to *R. y. yunanensis*.

*Ecological notes*

No new data.

*Philippinensis*-group

Diagnosis: the superior connecting process of the sella not forming a continuous arch (Fig. Di and Dii); lower lip with three mental grooves.

*Rhinolophus marshalli* Thonglongya, 1973
Marshall's horseshoe bat

*Rhinolophus marshalli* Thonglongya, 1973: 590; foothills of Khao Soi Dao Thai, Amphoe Pong Nam Ron, Chantaburi, Thailand.

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*New material from Myanmar*

Shan State: Naga Cave, 16.8.2003, 1 ♂, (TA3). Collected by Khin Mie Mie, I. Mackie, Aye Aye Khaing, Naing Naing Aung, Nu Nu Aye, Nyo Nyo, and Yin Yin Toke.

*Previous record from Myanmar*

Mon State: Saddan-Sin Cave (Bates *et al*., 2001).

*Diagnosis*

A medium-small sized species of the *philippinensis* group (Table 1; full measurements in Tables 2 and 3). It has enormous ears and a very broad horseshoe, which covers most of the upper lip. The lancet is low and with a rounded tip. Unlike *R. macrotis*, the internarial region forms a wing-like structure which joins up with the base of the broad sella.

*Taxonomic notes*

Bates *et al*. (2001) noted that the first specimen from Myanmar was small with forearm and skull lengths less than the minimum ranges included in Corbet and Hill (1992) and Csorba *et al*. (2003). Therefore, the second specimen of *R. marshalli* is of particular interest since its cranial measurements exceed those listed in Csorba *et al*. (2003). However, its morphology seems closely comparable to that of the smaller specimen and therefore both individuals are currently included in *R. marshalli*. A molecular study might reveal the presence of a yet undescribed sibling species.

*Ecological notes*

A single individual was collected from Naga Cave, which comprises a large, long chamber and tunnels which extend deep into a limestone outcrop. The roost was shared with *R. pearsoni*, *R. macrotis*, *R. thomasi*, *A. stoliczkanus* and *Myotis* sp. The previous specimen, from Mon State, was caught in a mist net set at the entrance to the large cave complex of Saddan-Sin (Bates *et al*., 2001).

*Rhinolophus macrotis* Blyth, 1844
Big-eared horseshoe bat
*Rhinolophus macrotis* Blyth, 1844: 485; Nepal.

*New material from Myanmar*

Shan State: Naga Cave, 22.3.2003, 2 ♂♂ (SH9, SH14) and 16.8.2003, 1 ♀ (TA1); Shwe Oo Min Cave, 24.8.2003, 1 ♂, (KL1). Collected by Khin Mie Mie, I. Mackie, Khine Shwe War Win, Aye Aye Khaing, Naing Naing Aung, Nu Nu Aye, Nyo Nyo, and Yin Yin Toke.

This is the first authenticated record from Myanmar, although *R. macrotis* was included erroneously in the checklist of Myanmar bats in Bates *et al*. (2000) on the basis of the distribution data given in Map 44 in Corbet and Hill (1992). However, there appears to be no specimens or literature records to support this earlier distribution map and it has not been included for Myanmar in Csorba *et al*. (2003).

*Diagnosis*

A medium-small sized species of the *philippinensis* group (see Tables 1, 2 and 3). The ears are large with a broad sella. The lancet is relatively short and with a characteristically rounded apex. There are well developed nasal swellings on the rostrum of the skull and the zygomata are narrow.

*Taxonomic notes*

Recent specimens from Myanmar are referred to the nominate race *R. m. macrotis*.

*Ecological notes*

Three specimens were collected from Naga Cave in March and August, 2003. As noted above for *R. pearsoni*, this cave comprises a large, long chamber and tunnels

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which extend deep into a limestone outcrop. In addition, to *R. pearsoni*, *R. macrotis* shared the roost with a number of other bat species including *R. thomasi*, *A. stoliczkanus* and *Myotis* sp. A further specimen was collected in Shwe Oo Min Cave, also in Shan State.

*Rouxi*-group

Diagnosis: the superior connecting process of sella low and rounded (Fig. 1E); lancet abruptly narrowed in the mid part, with its lateral margins concave or strongly concave.

*Rhinolophus thomasi* Andersen, 1905
Thomas's horseshoe bat

Rhinolophus thomasi Andersen, 1905: 100; Karin Hills, SE Myanmar.

*New material from Myanmar*

Shan State: Naga Cave, 22.3.2003, 2 ♂♂ (SH7, SH12); Myin-Ma-Hti Cave, 26.3.2003, 1 ♀ (SH19). Collected by Khin Mie Mie, I. Mackie, Khine Shwe War Win, Aye Aye Khine, Naing Naing Aung, Nu Nu Aye, Nyo Nyo and Yin Yin Toke.

*Previous record from Myanmar*

Shan State: Taho Hills (Andersen, 1905).

*Diagnosis*

A medium sized species of the *rouxi* group (Table 1; full measurements included in Tables 2 and 3). It is smaller than *R. sinicus* and with a very short lancet. In the skull, the canines are reduced in comparison to *R. sinicus.*

*Taxonomic notes*

Specimens from Myanmar are referred to *R. t. thomasi*, which was originally described from Shan State (Andersen, 1905).

*Ecological notes*

A single specimen was collected from Naga Cave near Taunggyi , which as noted above for *R. pearsoni*, comprises a large, long chamber and tunnels which extend deep into a limestone outcrop. A further two specimens were collected from Myin-Ma-Hti Cave in Kalaw Township. This cave is complex with two entrances and a long tunnel, which extends for some 250 m in to the limestone outcrop and has a series of side chambers.

*Rhinolophus sinicus* Andersen, 1905
Chinese horseshoe bat

Rhinolophus rouxi sinicus Andersen, 1905: 98; Chinteh, Anhui, China.

*New material and previous records from Myanmar*

There is one previous record based on a specimen collected in 1939 from Vijawlaw in Kachin State (Anthony, 1941). It was referred to *R. rouxi sinicus*, which following Thomas (2000) is now considered to be a distinct species. However, Anthony (1941), noted that the specimen is "badly mutilated, and the skull has been removed for study. The head skin is so torn that it is difficult to discern the facial characters, but they seem to agree with those ascribed to *sinicus*." Clearly, some doubt remained about this record. However, an additional specimen (BM.50.410) from Nam Tamai Valley, Kachin State has been located in the Natural History Museum, London. It was originally included in the collection as *R. affinis himalayanus* but a recent re-examination shows that this is incorrect. Its cranial measurements are significantly smaller than those of *R. affinis* and compare most favourably to those listed for *R. sinicus* in Thomas (2000).

*Diagnosis*

A medium sized species of the *rouxi* group (Table 1; full measurements in Tables

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2 and 3). The second phalanx of the third digit is relatively long. In the skull, the bony palate is short about one quarter the length of the upper toothrow (C–$M^3$).

*Taxonomic notes*

Specimens from Myanmar are referred to *R. s. sinicus*.

*Ecological notes*

A specimen was caught by local people in a bamboo clump in dense jungle in the Nam Tamai Valley (data from the specimen label of BM.50.410).

*Rhinolophus rouxi* Temminck, 1835
Rufous horseshoe bat

*Rhinolophus rouxi* Temminck, 1835: 30; Pondicherry and Calcutta, India.

*New material and previous records from Myanmar*

There is one previous record from Myanmar, a single specimen in the Zoological Survey of India, Calcutta (No: 12726) collected in January, 1927 from Toungoo in Bago Division (Lal, 1981). An additional specimen (BM.27.11.18.4) collected on 2 April, 1927 also from Toungoo is in the collection of the Natural History Museum, London (Thomas, 2000).

*Diagnosis*

A medium-large species of the *rouxi* group (Table 1; full measurements in Tables 2 and 3). In comparison to *R. affinis*, the second phalanx of the third digit is relatively short. In the skull, the bony palate is about one third the length of the upper toothrow (C–$M^3$). In *R. affinis*, it is about one quarter.

*Taxonomic notes*

Specimens from Myanmar are referred to *R. r. rouxi*.

*Ecological notes*

A single specimen was found in April, 1927 in a crevice in a wall in Toungoo, which has an altitude of 30 m (data from the label of specimen BM.27.11.18.4).

*Trifoliatus*-group

Diagnosis: The superior connecting process is broadly rounded off and very reduced (Fig. 1F); the sella of the horseshoe has clearly defined basal lappets.

*Rhinolophus trifoliatus* Temminck, 1834
Trefoil horseshoe bat

*Rhinolophus trifoliatus* Temminck, 1834: 24; Bantam, W. Java.

*Rhinolophus edax* Andersen, 1918: 378: Singapore.

*New material and previous records from Myanmar*

No new material from Myanmar. Previous records include Tanintharyi Division: Bankachon (Wroughton, 1915) and Myeik (= Mergui) (BMNH).

*Diagnosis*

A medium large species of horseshoe bat of the *trifoliatus* group (see Tables 1, 2 and 3). The pelage is pale buffy brown to buffy grey. The sella is narrow (ca. 1.4 mm at the apex).

*Taxonomic notes*

Specimens from Myanmar are referred to *R. t. edax*.

*Ecological notes*

No new data.

*Rhinolophus luctus* Temminck, 1834
Woolly horseshoe bat

*Rhinolophus luctus* Temminck, 1834: 23; Tapos, Java.

*Rhinolophus perniger* Hodgson, 1843: 414; Nepal.

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*New material and previous records from Myanmar*

No new material from Myanmar. Previous records include Shan State: Gokteik Gorge (= *R. perniger* in Ryley, 1914). Tanintharyi Division: Bankachon (Wroughton, 1915); Chin State: Chin Hills (= *R. perniger* in Wroughton, 1916*b*); Kachin State: Kindat, Nam Tamai Valley, Taron Valley (BMNH); no exact locality: Blanford (1888–91).

*Diagnosis*

The largest species of horseshoe bat (Table 1; full measurements included in Tables 2 and 3). The pelage is black and woolly. The sella is broad (approx. 4.3 mm).

*Taxonomic notes*

Specimens from Myanmar are referred to *R. l. perniger*.

*Ecological notes*

No new data.

*Euryotis*-group

Diagnosis: the connecting process of the sella forms a continuos arch (Fig. 1G) and in the two local species the lancet is thickened and folded to form a vertical fissure enclosing the rear of the connecting process; three mental grooves on the lower lip.

*Rhinolophus coelophyllus* Peters, 1867
Croslet horseshoe bat

*Rhinolophus coelophyllus* Peters, 1867: 426; Salween River, Burma.

*New material and previous records from Myanmar*

No new material. Previous records in Myanmar: Mon State: east of Mawlamyine (= Moulmein) on the Thanlwin River (= Salween River). A subsequent record from Sagaing (= Tsagain/Isagine) in central/northern Myanmar based on a specimen (BM.76.5.26.2) was originally assigned to this species by Dobson (1876), Blanford, (1888–91) and others, but according to Hill and Thonglongya (1972) is actually referable to a sibling species *R. shameli* Tate, 1943.

*Diagnosis*

A medium sized species of the *euryotis* group (Table 1; full measurements included in Tables 2 and 3). The horseshoe is narrower than that of *R. shameli*. The width across the anterior lateral swellings of the rostrum is also narrower, less than 5.5 mm.

*Taxonomic notes*

Specimens from Myanmar are referred to *R. c. coelophyllus*.

*Ecological notes*

No new data.

*Rhinolophus shameli* Tate, 1943
Shamel's horseshoe bat

*Rhinolophus shameli* Tate, 1943: 3; Koh Chang Island, Thailand.

*New material and previous records from Myanmar*

No new material. Previous records from Myanmar include Sagaing Division (= Tsagain/Isagine, no exact locality). One of these specimens (BM.76.5.26.2) was originally referred to *R. coelophyllus* (for details, see *R. coelophyllus*). The second (BM.9.1.4.14), also in the Natural History Museum, London is included in Hill and Thonglongya (1972).

*Diagnosis*

A medium sized species of the *euryotis* group (Table 1; full measurements included in Tables 2 and 3). The horseshoe is broader than that of *R. coelophyllus*. The width across the anterior lateral swellings of the rostrum is also broader, exceeding 5.5 mm.

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TABLE 4. Check list of *Rhinolophus* species from nine countries in southern, South-East and central Asia, with a listing of their conservation status based on Hutson *et al*. (2002). Used abbreviations: CR: critically endangered; VU: vulnerable; LR; nt: lower risk: near threatened; LR: lc: lower risk: least concern; DD: data deficient

| Species | Conservation status | Pakistan | India | Myanmar | Thailand | Lao/ Cambodia | Vietnam | Malaysia | China |
|---|---|---|---|---|---|---|---|---|---|
| *R. acuminatus* | LR: lc | | | x | x | x | | x | |
| *R. affinis* | LR: lc | | x | x | x | x | x | x | x |
| *R. beddomei* | LR: nt | | x | | | | | | |
| *R. blasii* | LR: nt | x | | | | | | | |
| *R. borneenensis* | LR: lc | | | | | x | x | x | |
| *R. coelophyllus* | LR: lc | | | x | x | x | | x | |
| *R. cognatus* | VU | | x | | | | | | |
| *R. convexus* | CR | | | | | x | | x | |
| *R. ferrumequinum* | LR: nt | x | x | | | | | | x |
| *R. hipposideros* | VU | x | x | | | | | | |
| *R. lepidus* | LR: lc | x | x | x | x | | x | x | x |
| *R. luctus* | LR: lc | | x | x | x | x | x | x | x |
| *R. macrotis* | LR: lc | x | x | x | x | x | x | x | x |
| *R. malayanus* | LR: lc | | | x | x | x | x | | |
| *R. marshalli* | LR: nt | | | x | x | | x | x | |
| *R. megaphyllus* | LR: lc | | | | x | | | x | |
| *R. mitratus* | DD | | x | | | | | | |
| *R. osgoodi* | DD | | | | | | | | x |
| *R. paradoxolophus* | VU | | | | x | x | x | | |
| *R. pearsoni* | LR: lc | | x | x | x | x | x | | x |
| *R. pusillus* | LR: lc | | x | x | x | x | x | x | x |
| *R. rex* | VU | | | | | | | | x |
| *R. rouxi* | LR: lc | | x | x | | | | | |
| *R. sedulus* | LR: lc | | | | | | | x | |
| *R. shameli* | LR: nt | | | x | x | x | | | |
| *R. sinicus* | LR: lc | | x | x | | | x | | x |
| *R. stheno* | LR: lc | | | x | x | x | x | x | |
| *R. subbadius* | DD | | x | x | | | | | |
| *R. thomasi* | LR: nt | | | x | x | x | x | | |
| *R. trifoliatus* | LR: lc | | x | x | x | | | x | |
| *R. yunanensis* | LR: nt | | x | x | x | | | | x |
| Country totals | | 5 | 16 | 18 | 17 | 14 | 13 | 14 | 11 |

*Taxonomic notes*

Specimens from Myanmar are referred to *R. s. shameli*.

*Ecological notes*

No new data.

## DISCUSSION

The recent surveys of the Harrison Institute/Yangon University (1999–2003) have added five *Rhinolophus* species (*acuminatus*, *macrotis*, *malayanus*, *marshalli* and *stheno*) to the faunal checklist of Myanmar. The status of *R. sinicus* from northern Myanmar has been confirmed and a second specimen of *R. rouxi* from the country has been examined, supporting the view of Lal (1981). The three specimens of *R. thomasi* from Shan State are the first for nearly one hundred years and only the second record for the country. Two species

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(*R. coelophyllus* and *R. trifoliatus*) are still only known from one specimen each.

With 18 species of *Rhinolophus*, some 25% of those currently recognised (Csorba *et al*., 2003), Myanmar has the most diverse Rhinolophid fauna recorded for any country in southern or South-east Asia (Table 4). In part, this is a consequence of the rich variety of habitats and climatic zones available in Myanmar. For as MacKinnon (1997) writes, the "country shows an ecological spectrum of almost unique variety, ranging from tropical rain forests and coral reefs in the south to temperate forests of conifers, oaks and rhododendrons in the far north…". In part, it is a reflection of its geographical position. Myanmar is a meeting point of South-East Asian and southern Asian *Rhinolophus* taxa. For nine of the eighteen species, Myanmar is either the most western extent of the distribution or the most eastern. Thus seven species (*acuminatus*, *coelophyllus*, *malayanus*, *marshalli*, *shameli stheno* and *thomasi*) occur in southern and eastern Myanmar (or in the case of *shameli* central Myanmar) but not to the north or west. Whilst for two species (*subbadius* and *rouxi*), northern and central Myanmar respectively represent the most eastern extent of the species range. Of the remaining nine species, all have broad geographical distributions extending from the Indian subcontinent to southern China and/or South-East Asia.

This distribution pattern reinforces the ideas of Guillén Servent *et al*. (2003) who suggest that in the past there were two major clades of Asian rhinolophids. According to these authors, their divergence followed vicariance between the Indian and Malaysian faunas when both were restricted to southern pockets on the two mega-peninsulas during one or several cooling episodes around 12 mya in the middle Miocene. This divergence was reinforced by the continued uplift of the Himalayas and Tibetan Plateau. Guillén Servent *et al*. (2003) also suggest that subsequently the southern Indian clade progressively expanded to the southern slopes of the Himalayas and then east and south into Indochina and Malaysia. This expansion was most closely associated with montane forms such as *R. rouxi*, *R. thomasi*, *R. pearsoni* and *R. affinis*. Following this expansion, speciation took place in central Indochina, today reflected in the presence of *R. stheno*, *R. shameli* and *R. coelophyllus*.

The Malaysian clade, which was isolated in southern Malaysia during the middle Miocene, includes three species (*R. acuminatus*, *R. malayanus* and *R. chaseni*) currently distributed in Indochina, Malaysia and Indonesia. Two of these (*R. acuminatus* and *R. malayanus*) have recently been collected in Myanmar. Meanwhile, all the small-bodied species within the classical *R. pusillus* group appear to have speciated in Indochina. The presence of *R. lepidus* in India and *R. subbadius* and *R. macrotis* in the southern Himalayas probably resulted from a westward expansion of these species. Although, further work, particularly looking at the molecular aspects, are needed to help clarify the details of the Guillén Servent *et al*.'s (2003) hypothesis, the recent results from Myanmar certainly seem to support the general outline of their ideas.

The results of the recent survey also suggest that the westward expansion of some Rhinolophid taxa may still be taking place. For, it is noteworthy that species such as *R. malayanus*, that are common today in eastern Myanmar (as well as less common taxa such as *R. marshalli*, *R. macrotis*, *R. acuminatus* and *R. stheno*) were not collected by earlier field workers such as the Italian naturalist Signor Leonardo Fea or during the extensive surveys of the Bombay Natural History Society (see Bates *et al*., 2000 for details). Many of the past

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naturalists worked in the same geographical areas as the present studies and did collect other 'rare' and interesting Rhinolophid taxa such *R. shameli*, *R. thomasi*, *R. affinis* and *R. ceolophyllus*. Currently, it is not possible to know whether this difference in species collected reflects a change in distribution of at least some of the *Rhinolophus* or simply a change in collecting techniques, particularly with the use of mist nets and harp traps.

From a conservation viewpoint, the recent surveys have added one globally near threatened species (*R. marshalli*) to the Myanmar fauna, increasing the number of near threatened *Rhinolophus* to four (*marshalli*, *yunansensis*, *thomasi* and *shameli*) (Table 4). In addition, there is one species (*subbadius*) that is Data Deficient. The remaining species are considered of least concern from an international perspective.

## Gazetteer

Alaungdaw Kathapa, Sagaing Division, 22º30'N, 94º20'E;
Bagan, Mandalay Division, 21º07'N, 94º53'E;
Bago, Bago Division, 17º18'N, 96º31'E;
Bankachon, Tanintharyi Division, appr 10º12'N, 98º37'E;
Bar Min Gu, Rakhine State, 20º37'N, 93º11'E;
Bayint Nyi Cave, Kayin State, 16º58'N, 97º30'E;
Biapo, Kayin State, not located;
Chin Hills, Chin State, imprecise locality;
Daik Oo, Bago Division, 17º46'N, 96º40'E;
Gokteik Gorge, Shan State, 22º21'N, 96º50'E;
Hai Bum, Kachin State, appr. 26º02'N, 95º52'E;
Hisweht, Sagaing Division, appr. 23º42'N, 94º29'E;
Hnidon Hill Cave, Mon State, 16º22'N, 97º46'E;
Hpa-an, Kayin State, 16º51'N, 97º37'E;
Hta Ein Gu, Shan State, 20º40'N, 96º58'E;
Indian Single Rock Temple Cave, Mon State, 16º19'N, 97º43'E;
Kajihtu, Kachin State 26º18'N, 97º50'E;
Kalaw, Shan State, 20º37'N, 96º35'E;
Kanbalu, Mandalay Division, 23º10'N, 95º31'E;
Kindat, Sagaing Division, 23º42'N, 94º29'E;
Mahtum, Kachin State, 26º06'N, 97º58'E;
Mandalay, Mandalay Division, 21º57'N, 96º04'E;
Mant Hai Village, Mon State 23º55'N, 97º50'E;
Mawlamyine, Mon State, 16º30'N, 97º39'E;
Mayan Haung, Rakhine State, 17º35'N, 94º40'E;
Montawa Cave, Shan State, 21º59'N, 96º10'E;
Muse, Shan State, 24º00'N, 97º54'E;
Myeik, Tanintharyi Division, 12º26'N, 98º34'E;
Myin-Ma-Hti Cave, Shan State, 20º34'N, 96º36'E;
Myitkyina, Kachin State, 25º24'N, 97º25'E;
Naga Cave, Shan State, 20º45'N, 97º01'E;
Nagamauk Cave, Mon State, 16º19'N, 97º42'E;
Nankham, Shan State, 23º49'N, 97º43'E;
Nam Tamai Valley, Kachin State, 27º42,N, 97º54'E;
Nant Khun Village, Shan State, 23º60'N, 97º58'E;
Nyaungkharshay Village, Bago Division, 17º27'N, 96º50'E;
Nyaung Oo, Mandalay Division, 21º12'N, 94º55'E
Pauk Inlay Cave, Shan State, 22º28'N, 96º60'E;
Pyay, Bago Division, 18º50'N, 95º14'E;
Saddan-Sin Cave, Mon State, 16º44'N, 97º43'E;
Sagaing, Sagaing Division, 21º55'N, 95º56'E;
Sanite Cave No2, Mandalay Division, 22º06'N, 96º37'E;
Shit Taung Temple, Rakhine State, 20º36'N, 93º12'E;
Shwe Oo Min Cave, Kalaw, Shan State, 20º36'N, 93º12'E;
Taho, Shan State, not located;
Taron Valley, Kachin State, 27º38'N, 98º12'E;
Tasu Bum, Kachin State, appr. 26º01'N, 96º12'E;
Taunggyi, Shan State, 20º49'N, 97º01'E;
Taung Pauk Village, Shan State 20º21'N, 96º53'E;
Tone Khan Village, Shan State, 23º60'N, 97º58'E;
Toungoo, Bago Division, 18º57'N, 96º26'E;
Vijawlaw, Kachin State, appr 26º10'N, 98º37'E;
Yan Twine Cave, Naungshwe Township, Shan State, 20º42'N, 96º58'E;
Yathay Pyan Cave, Kayin State, 16º50'N, 97º34'E.

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