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A New Species of *Rhinolophus* (Chiroptera: Rhinolophidae) from China

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A new species of the genus *Rhinolophus* is described from Yunnan Province, southwestern China. The new taxon belongs to the *Rhinolophus* "*philippinensis*-group" and is distinguished by differences in the nose-leaf structures, craniodental characteristics, and bacular features.

Key words: China, Chiroptera, new species, *Rhinolophus*, taxonomy

INTRODUCTION

To date, a total of eighty-four species of *Rhinolophus* classified into fifteen groups are known from across the Old World (Ingle and Heaney, 1992; Csorba et al., 2003; Simmons, 2005; Yoshiyuki and Lim, 2005; Francis, 2008; Soisook et al., 2008; Sun et al., 2008; Wu et al., 2008; Wu et al., 2009; Zhou et al., 2009). Csorba et al. (2003) included six taxa in the "*philippinensis*-group": *R. macrotis* Blyth, 1844; *R. marshalli* Thonglongya, 1973; *R. montanus* Goodwin, 1979; *R. paradoxolophus* (Bourret, 1951); *R. philippinensis* Waterhouse, 1843; and *R. rex* Allen, 1923. Simmons (2005) regarded *R. macrotis siamensis* Gyldenstolpe, 1917 as a distinct species (*R. siamensis*). Wu et al. (2008) described a new species from China, *R. huananus*, belonging to the "*philippinensis*-group", and Sun et al. (2008) showed that the *R. macrotis* species complex consists of two distinct species, provisionally named "*R. macrotis* [large form]" and "*R. macrotis* [small form]". Therefore, the "*philippinensis*-group" currently comprises nine taxa (*Rhinolophus huananus*; *R. macrotis* [large form]; *R.* cf. *macrotis* [small form]; *R. marshalli*; *R. montanus*; *R. paradoxolophus*; *R. philippinensis*; *R. rex*; and *R. siamensis*).

Between 2006 and 2009, a series of intensive bat surveys were carried out in Vietnam and China, with particular emphasis on rhinolophoid bats. Among a large number of specimens belonging to the "*philippinensis*-group" obtained from the surveys was an adult male from China that was clearly distinct. Investigation of morphological, dental, and bacular features indicated that the specimen differs from all known taxa of *Rhinolophus*, and represents a new and as yet undescribed species.

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MATERIALS AND METHODS

External, cranial, dental, and bacular measurements were taken using a digital caliper to the nearest 0.1 mm from the holotype of the new species, and from specimens of closely related taxa (Supplemental material online), comprising *Rhinolophus rex*, *R. paradoxolophus*, *R. marshalli*, *R.* cf. *macrotis* [small form], and *R. macrotis* [large form]. The following external, craniodental, and bacular measurements were taken for each specimen examined:

FA, forearm length—from the extremity of the elbow to the extremity of the carpus with the wings folded; EH, ear height—length of ear conch; TIB, tibia length—from the knee joint to the ankle; HF, hind-foot length—from the extremity of the heel behind the os calcis to the extremity of the longest digit, excluding the hairs or claws; T, tail length—from the anal opening to the tip of the tail; 3rdF, total length of the third digit; 4thF, total length of the fourth digit; 5thF, total length of the fifth digit; SL, skull total length—from occiput to the most anterior part of the canine; CCL, condylocanine length—from the exoccipital condyle to the most anterior part of the canine; IOW, interorbital width—the least width of the interorbital constriction; ZW, zygomatic width—the greatest width of the skull across the zygomatic arches; MW, mastoid width—the greatest distance across the mastoid region; C1–C1, upper canine width—greatest width, taken across the outer borders of upper canines; M3–M3, upper molar width—greatest width, taken across the outer crowns of the last upper molars; C–M3, maxillary tooth row length—from the front of upper canine to the back of the crown of the third molar; ML, mandible length—from the anterior rim of the alveolus of the first lower incisor to the most posterior part of the condyle; c–m3, mandibular tooth row length—from the front of the lower canine to the back of the crown of the third lower molar; TBL, total bacular length—the greatest length of the bone from the tip to the base; GWB, greatest width at the base of the baculum; GWM, greatest width at the mid-point of the shaft of the baculum; GWT, greatest width at the bacular tip. The external, cranial, and dental measurements are illustrated in Bates and Harrison (1997) and Csorba et al. (2003). Sex and age were assessed following Brunet-Rossinni and Wilkinson (2009).

Table 1. External measurements (in mm) of the species belonging to the *philippinensis*-group; mean ± SD, minimum–maximum, sample size in parentheses where different from n. Abbreviations are defined in the "Material and Methods".

Species	n	Sex	External measurements								Bacular measurements			
			FA	EH	TIB	HF	T	3rdF	4thF	5thF	TBL	GWB	GWM	GWT
Rhinolophus schnitzleri sp. nov.	Holotype	♂	57.7	30.1	24.4	10.0	26.9	86.5	70.1	76.5	4.5 (1)	1.3 (1)	0.5 (1)	0.4 (1)
R. rex	8	♀♀	56.5 ± 1.8	31.4 ± 2.9	22.9 ± 1.0	9.7 ± 0.8	25.8 ± 2.2	–	–	–	–	–	–	–
			54.9–60.3	26.6–36.0	20.8–23.9 (7)	8.9–11.0	22.4–28.8	83.9, 85.8 (2)	69.1, 73.6 (2)	70.5, 73.7 (2)	–	–	–	–
	8	♂♂	56.5 ± 1.1	32.0 ± 1.2	24.1 ± 1.1	10.1 ± 1.0	26.4 ± 2.9	8.3 ± 1.7	68.8 ± 1.3	71.3 ± 1.5	3.1, 3.3 (2)	0.5, 0.6 (2)	0.2, 0.2 (2)	0.2, 0.2 (2)
			54.8–57.8	29.9–33.2	21.5–25.6 (7)	8.5–11.4	23.3–32.8	81.2–85.2 (4)	68.0–70.8 (4)	70.4–73.5 (4)	–	–	–	–
R. paradoxolophus	7	♀♀	54.4 ± 2.6	30.6 ± 1.4	21.9 ± 0.6	9.6 ± 0.2	26.8 ± 1.5	78.0 ± 1.5	62.4 ± 2.7	64.8 ± 2.2	–	–	–	–
			50.2–57.6	28.3–32.5	21.1–22.5 (4)	9.4–10.0 (4)	25.2–28.4 (4)	76.1–79.7 (4)	59.5–64.8 (4)	61.6–66.6	–	–	–	–
	7	♂♂	51.4 ± 2.1	29.4 ± 1.5	21.6 ± 0.9	8.6 ± 0.9	25.8 ± 2.0	77.1 ± 2.2	61.9 ± 2.2	64.0 ± 1.3	4.2 (1)	1.2 (1)	0.3 (1)	0.3 (1)
			48.0–54.1	27.7–32.0	20.4–22.8	7.4–9.5	23.4–28.4	74.0–80.2	58.8–65.2	62.5–66.5	–	–	–	–
R. marshalli	9	♀♀	46.3 ± 1.1	24.6 ± 1.0	19.3 ± 0.7	7.7 ± 0.4	–	–	–	–	–	–	–	–
			45.0–48.3	23.3–26.1	17.8–20.5	7.3–8.5	25.0, 26.8 (2)	65.2, 66.7 (2)	53.7, 55.9 (2)	55.7, 59.5 (2)	–	–	–	–
	9	♂♂	45.4 ± 1.4	25.2 ± 1.4	18.8 ± 0.7	7.5 ± 0.8	23.8 ± 1.8	66.4 ± 1.8	54.1 ± 1.8	56.3 ± 2.6	4.0 (1)	1.1 (1)	0.2 (1)	0.2 (1)
			43.1–48.3	23.1–27.4	17.7–20.1 (8)	6.4–8.2 (8)	22.0–26.1 (5)	64.5–69.2 (5)	51.2–56.0 (5)	52.2–58.5 (5)	–	–	–	–
R. macrotis [large form]	7	♀♀	45.6 ± 0.9	24.8 ± 0.8	19.1 ± 0.5	8.9 ± 0.3	23.3 ± 2.5	66.3 ± 1.3	54.5 ± 0.8	56.9 ± 0.8	–	–	–	–
			44.6–46.8	23.2–25.5	18.4–19.8	8.6–9.4	20.0–28.4	64.5–68.2	52.9–55.3	55.7–57.9	–	–	–	–
	6	♂♂	44.0 ± 0.6	24.1 ± 1.6	19.1 ± 0.3	8.7 ± 0.1	21.7 ± 1.5	64.5 ± 1.4	53.1 ± 1.0	55.4 ± 1.0	3.5 (1)	0.9 (1)	0.2 (1)	0.3 (1)
			43.5–45.2	21.2–25.6	18.8–19.6	8.5–8.8	19.0–23.4	63.0–66.6	51.9–54.6	54.4–56.8	–	–	–	–
R. cf. *macrotis* [small form]	9	♀♀	40.0 ± 1.2	20.7 ± 1.4	16.7 ± 0.5	7.1 ± 0.5	21.4 ± 2.4	59.3 ± 2.2	49.3 ± 1.4	51.5 ± 1.8	–	–	–	–
			38.8–42.3	19.2–23.0	15.7–17.2 (6)	6.3–7.8 (6)	17.0–24.0 (6)	56.2–62.9 (6)	47.8–51.5 (6)	49.8–54.8 (6)	–	–	–	–
	5	♂♂	38.9 ± 1.5	20.9 ± 1.9	–	–	–	–	–	–	2.1 (1)	0.6 (1)	0.1 (1)	0.1 (1)
			37.4–41.1	19.0–24.0	16.6, 17.4 (2)	6.8, 7.8 (2)	20.4, 22.0 (2)	58.9, 60.0 (2)	48.0, 50.0 (2)	51.3, 52.7 (2)	–	–	–	–

SYSTEMATIC DESCRIPTION

Rhinolophus schnitzleri sp. nov.

Holotype

Adult male, in alcohol, skull and baculum removed, Guang Zhou University GZHU 08144. Collected by Wu Yi and Yu Wen-hua on 31 July 2008.

Type locality

Xiao-dong Cave, Gengjiaying Commune, Yi-liang County, Kunming City, Yunnan province, China, 25°02′N, 103°14′E, 1550 meters above sea level (m a.s.l.).

Etymology

Rhinolophus schnitzleri is named after Professor Hans-Ulrich Schnitzler of the University of Tübingen, Germany, in recognition of his outstanding contributions to the study of horseshoe bats. The proposed English name is "Schnitzler's horseshoe bat".

Fig. 1. Ear and nose-leaves of *Rhinolophus schnitzleri* (holotype) from Xiao-dong Cave, Gengjiaying Commune, Yunnan Province, China.

Diagnosis

With a forearm length of 57.7 mm, this is a large species of *Rhinolophus* (Table 1). The horseshoe is almost circular in shape and very broad. The anterior median emargination is very deep, with two typical parallel sides (Fig. 1). The sella is large and very long, with a broadly blunt tip; its lateral sides are nearly parallel, slightly expanded upwards (Fig. 2A). The internarial region is well developed with lateral margins passing below the sella base. The lancet is exceptionally short

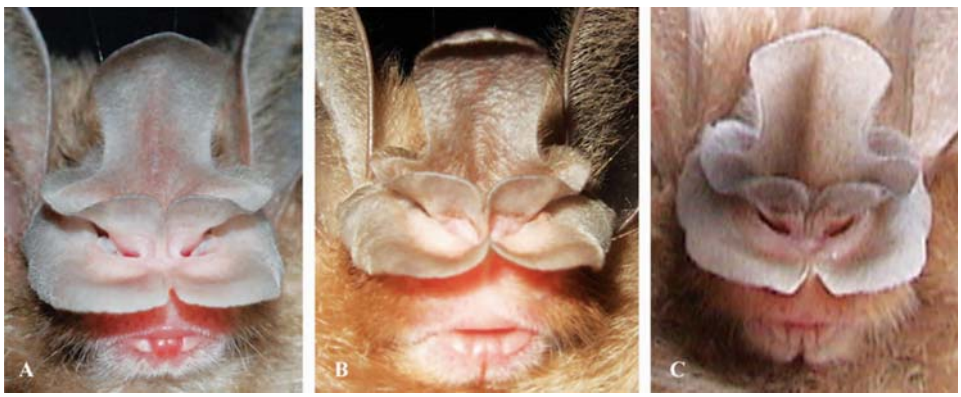

Fig. 2. Frontal view of nose-leaf structures. **(A)** *Rhinolophus schnitzleri* [holotype], **(B)** *R. paradoxolophus* [IEBR-T.120408.1], **(C)** *R. rex* [IEBR-T.061109.1]. Not to scale.

with a broadly rounded tip. The first upper premolar (P2) is separated from the canine (C1) and the second (P4) by equal spaces; its crown is almost elliptical in shape (Fig. 3A). The baculum is very large with a swollen and robust shaft; its tip is expanded, forming an oval "plate-like" structure with a medial depression. The basal part of the baculum is swollen and is without a vertical groove. The greatest length and width of the baculum are 4.5 mm and 1.3 mm, respectively (Fig. 4A; Table 1).

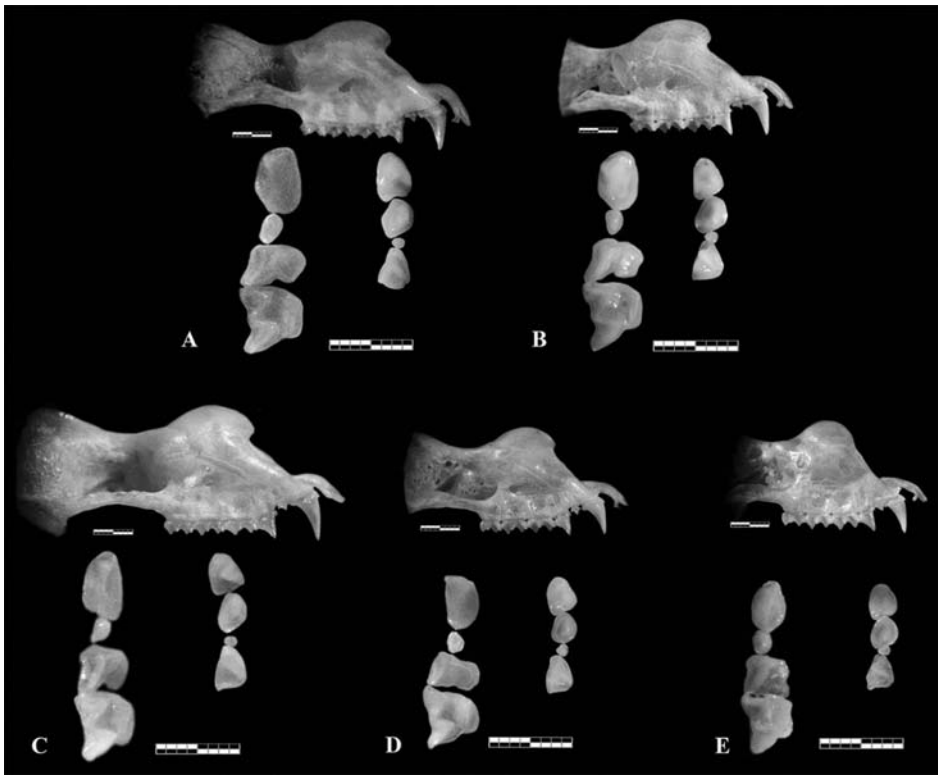

Fig. 3. Lateral view of the rostral part of the skull, and occlusal view of the left upper (bottom-left) and right lower (bottom-right) anterior dentitions. **(A)** *Rhinolophus schnitzleri* [holotype], **(B)** *R. paradoxolophus* [IEBR-T.120408.1], **(C)** *R. rex* [IEBR-T.061109.1], **(D)** *R. marshalli* [IEBR-T.090108.2], and **(E)** *R. macrotis* [large form; IEBR-T.290708.5]. Scale = 2 mm.

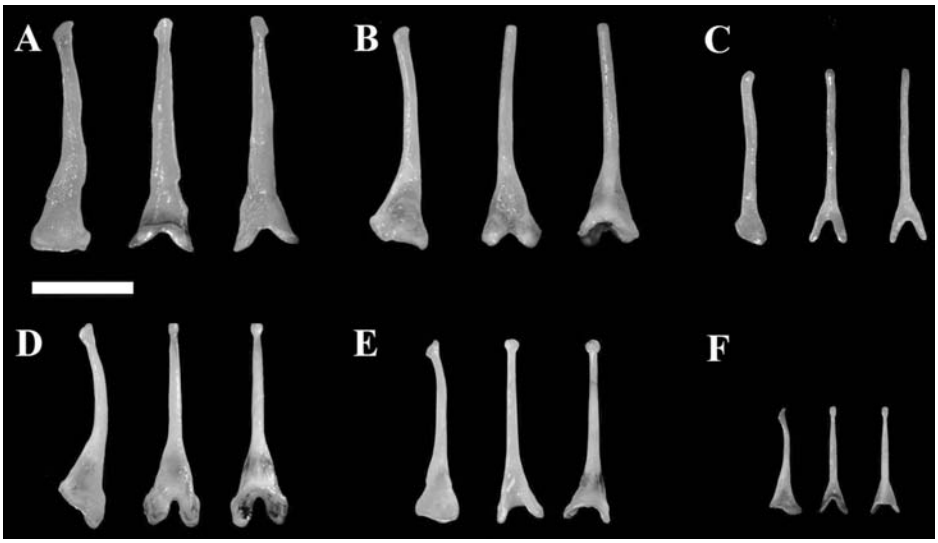

Fig. 4. Lateral (left), ventral (central), and dorsal (right) views of the bacula of six *Rhinolophus* taxa: **(A)** *Rhinolophus schnitzleri* [holotype], **(B)** *R. paradoxolophus* [IEBR-T.120408.1], **(C)** *R. rex* [IEBR-T.061109.1], **(D)** *R. macrotis* [large form; IEBR-T.290708.5], **(E)** *R. marshalli* [IEBR-T.090108.2], **(F)** *R.* cf. *macrotis* [small form; IEBR-T.290708.3]. Scale = 2 mm.

Description

External characteristics. The ear is very large with a length of 30.1 mm, and has a broadly rounded tip. The antitragus is well developed, over one-third the pinna height. The horseshoe is a uniform light grey. It is unusually broad, almost circular in shape, posteriorly contiguous with the anterior face of the lancet, and greatly exceeding the breadth of the muzzle. There is a deep median emargination with two parallel sides (Figs. 1, 2A). There is no supplementary leaflet. The internarial region is greatly developed forming a wide, cup-like structure with a deep anterior median notch. It completely covers the nostrils, expands for about two-thirds the horseshoe width, posteriorly passes the sella base, and connects to the base of the connecting process. The sella is large and long with a broadly blunt tip. It has a longitudinal median depression extending towards the tip, deepest at its base. The two lateral sides of the sella are slightly expanded upwards. The connecting process is low and convex; it slopes from the base of the lancet to the sella, which it joins at about two-thirds of the sella length. The lancet is short, swollen medially, and has a rounded tip with slightly convex lateral margins. There are three shallow and narrow grooves on the chin.

Generally, the pelage is light brown and chestnut on the ventral and dorsal regions, respectively. Each individual hair is long, approximately 13.5 mm and 8.6 mm on the middorsal and the mid-ventral surfaces, respectively. The tail length is 26.9 mm. The interfemoral and wing membranes are a uniform brown color. The plagiopatagium is without hairs, and inserted into the ankle. The extreme tip of its tail

Table 2. Cranial and dental measurements (in mm) of the species belonging to the *philippinensis*-group; mean ± SD, minimum–maximum, sample size in parentheses where different from n. Abbreviations are defined in "Materials and Methods".

Species	n	Sex	Cranial and dental measurements									
			SL	CCL	IOW	ZW	MW	C1–C1	M3–M3	C–M3	ML	c–m3
Rhinolophus schnitzleri sp.nov.	Holotype	♂	21.8	19.7	2.7	9.7	10.9	4.9	6.6	7.9	14.5	8.8
R. rex	8	♀♀	22.1 ± 0.4	19.5 ± 0.2	2.9 ± 0.1	9.6 ± 0.2	10.5 ± 0.2	4.5 ± 0.1	6.5 ± 0.2	7.8 ± 0.1	14.0 ± 0.3	7.8 ± 0.2
			21.6–22.7	19.1–19.7	2.9–3.0	9.2–10.0	10.3–10.8	4.3–4.7	6.1–6.7	7.6–8.0	13.6–14.3	7.6–8.1
	5	♂♂	21.9 ± 0.4	19.5 ± 0.4	2.9 ± 0.1	9.7 ± 0.3	10.6 ± 0.1	4.6 ± 0.2	6.5 ± 0.2	7.7 ± 0.2	14.0 ± 0.5	7.9 ± 0.2
			21.3–22.3	18.8–19.8	2.7–3.0	9.3–9.9	10.4–10.7	4.3–4.9	6.2–6.8	7.5–8.0	13.3–14.4	7.6–8.0
R. paradoxolophus	5	♂♂	20.2 ± 0.3	18.1 ± 0.4	2.8 ± 0.1	9.1 ± 0.3	10.3 ± 0.1	4.3 ± 0.1	6.3 ± 0.2	7.2 ± 0.2	13.0 ± 0.3	8.1 ± 0.3
			19.7–20.4	17.4–18.5	2.7–2.9	8.8–9.4	10.2–10.4	4.2–4.4	6.1–6.5	6.9–7.5	12.5–13.4	7.6–8.4
R. marshalli	2	♂♂	18.0, 18.7	16.1, 16.5	2.3, 2.5	8.3, 8.3	9.2, 9.4	3.8, 3.8	5.6, 5.8	6.4, 6.5	11.2, 11.9	6.8, 7.4
R. macrotis [large form]	1	♀	17.9	16	2.5	8.2	8.9	3.8	5.9	6.5	11.5	6.7
	2	♂♂	18.0, 18.2	16.3, 16.6	2.5, 2.7	8.2, 8.2	8.9, 9.0	3.8, 4.0	5.9, 5.9	6.5, 6.7	11.6, 11.8	7.1, 7.3
R. cf. *macrotis* [small form]	2	♀♀	15.8, 17.1	14.1, 15.3	2.2, 2.4	7.3, 7.6	7.7, 7.9	3.7, 3.8	5.1, 5.3	5.6, 6.0	10.3, 10.8	6.4, 6.5
	2	♂♂	16.5, 17.6	14.8, 15.7	2.3, 2.6	7.5, 7.9	8.1, 8.3	3.7, 3.9	5.2, 5.5	5.9, 6.4	10.5, 11.3	6.5, 6.5

slightly protrudes the interfemoral membrane. All digits are remarkably long and gracile. The fourth and fifth metacarpals are equal in length being slightly longer than the third. The first and second phalanges of the fourth digit are almost equal in length; this is also the case with the fifth digit.

Craniodental characteristics. With a total length of 21.8 mm, the skull is large in size (Table 2). The zygomata are thin; zygomatic breadth (9.7 mm) is considerably narrower than the mastoid width (10.9 mm). The anterior median swellings are well developed and prominent with slightly convex borders in dorsal view; they protrude forwards beyond the rostral wall (Figs. 3A, 5). The lateral swellings are narrow, elongated, and less prominent. The posterior median swellings are less developed. The sagittal crest is very low, especially in the interorbital region; it is tallest over the posterior part of the braincase. The supraorbital ridges are well-defined, and the rostral depression is noticeably deep. Both frontal and parietal are slightly inflated, the former is more visible. The tympanic bulla is strongly prominent and well developed, occupying around one and half of the respective cochlea (Fig. 5). The distance between the cochleae is noticeably narrow. The palate is very long, about 68% of upper maxillary tooth row length; it is emarginated anteriorly to a point corresponding to the mid-point of the second premolar (P4), and posteriorly to a point corresponding to about the posterior border of the third molar (M3).

The upper incisor (I2) is clearly bifid, the outer cusp considerably exceeds the inner one. The canine (C1) is robust, and has a concave inner side with two sharp antero-inner and posterior edges. It has a faint vertical groove on its postero-lateral surface and well defined vertical grooves on its inner surface. The first premolar (P2) is situated in the toothrow, separated from the canine (C1) and the second (P4) by narrow spaces of equal length; the shape of the crown is almost elliptical (Fig. 3A). The second premolar (P4) is well developed; its anterior cusp is about 50% of the canine (C1) height (Figs. 3A, 5). The first (M1) and second (M2) molars are equal in size; the W-shape cusp patterns on their surface are well developed. The third molar (M3) is small, its size approximately two thirds that of the first (M1) or second (M2) molar.

Each half mandible has a gracile condyle and a thin coronoid process. The coronoid process is lower than the canine (c1). The angular process is weak (Fig. 5). The lower incisors are trifid. The second incisor (i2) is situated just behind the first (i1), and is in contact with the canine (c1). The canine (c1) is tall and has a faint vertical groove on its antero-inner and posterior surfaces, respectively. The first premolar (p2) is much shorter than the third (p4), but the crown area of these two teeth is equal. There is a faint vertical groove on the antero-inner and posterior surfaces of the third premolar (p4). The second premolar (p3) is minute, fully situated in the tooth row, separated from the first (p2) by a narrow space and just in contact with the third (p4). The first molar (m1) slightly exceeds the third premolar (p4) in

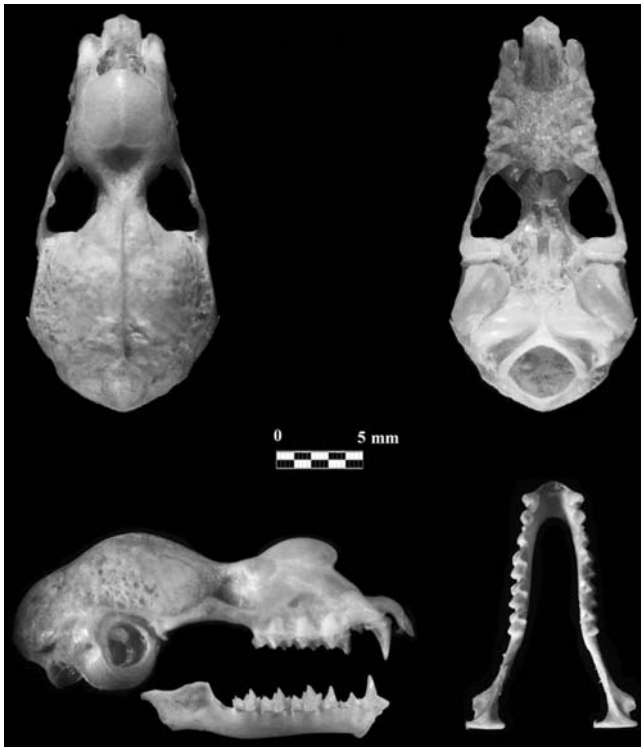

Fig. 5. Dorsal, ventral, and lateral (from top-left clockwise) views of the skull and mandible of *Rhinolophus schnitzleri* (holotype). Scale = 5 mm.

both crown area and height (Fig. 5). The first (m1) and second (m2) molars are almost equal in crown area; the third (m3) is considerably smaller; its crown area is approximately 80% of that of the first (m1) (Fig. 5).

Bacular morphology. The baculum is large, exceeding in size of those of the other taxa in the '*philippinensis*-group' (Fig. 4; Table 1). There is a deep hollow in the base with slightly expanded margins. The proximal margin of the base is almost horizontal in lateral view. The dorsal and ventral emarginations on the corresponding proximal margins are rather wide and equal in depth. The dorsal knob is indistinct. The entire baculum is very large, cylindrically swollen, without a vertical groove at the base, and tapers uniformly to the tip. The shaft slightly bends dorsally. The tip is unusually expanded, forming an oval "plate-like" structure with a median depression that slopes backwards.

DISCUSSION

Comparison with other species

Of the other nine taxa of the "*philippinensis*-group", *R. schnitzleri* differs distinctly from seven (*Rhinolophus huananus*; *R. macrotis* [large form]; *R.* cf. *macrotis* [small form]; *R. marshalli*; *R. montanus*; *R. philippinensis*; and *R. siamensis*) in the structure of the nose-leaf. The lateral margins of the internarial regions of these seven taxa are integral to their sella margins (Andersen, 1905; Tate, 1943; Hill, 1972; Hill and Total, 1990; Corbet and Hill, 1992; Csorba and Bates, 1995; Borissenko and Kruskop, 2003; Csorba et al., 2003; Wu et al., 2008). Only *R. paradoxolophus* and *R. rex* have nose-leaf structures similar to that of *R. schnitzleri*. The lateral margins of the internarial regions of these three taxa are well expanded, passing below the base of the sella (Figs. 1, 2). Zhang et al. (2009) considered *R. paradoxolophus* and *R. rex* conspecific due to similarities in morphology and echolocation calls. However, results from intensive echolocation recordings of *R. paradoxolophus* from Vietnam (Thong et al., unpublished data) and Lao PDR (Eger and Fenton, 2003; Francis, 2008) suggest that *R. rex* may be a distinct taxon. Since the taxonomy of *R. paradoxolophus* and *R. rex* remains uncertain, they are here treated as two distinct taxa in comparisons with *R. schnitzleri*.

Comparison of *R. schnitzleri* and *R. paradoxolophus*

External characteristics. The shape and size of the anterior nose leaf (horseshoe) discriminate between these two taxa. The horseshoe of *R. schnitzleri* is considerably larger than that of *R. paradoxolophus*. Furthermore, the horseshoe of *R. schnitzleri* is almost circular, whereas in *R. paradoxolophus* the sides are essentially convergent anteriorly. The anterior median emargination of the horseshoe of *R. schnitzleri* is very deep and narrow with two essentially parallel sides, whilst *R. paradoxolophus* has a well-defined notch (Fig. 2A, B). The sella of *R. schnitzleri* is considerably narrower and longer than that of *R. paradoxolophus*. Particularly, the sella tip of *R. schnitzleri* is broadly blunt while that of *R. paradoxolophus* is typically rounded and markedly curved forwards (Fig. 2A, B). TIB and the length of the third, fourth, and fifth digits of the wing of *R. schnizleri* are noticeably longer than the respective ones of *R. paradoxolophus* (Table 1).

Craniodental characteristics. The skull of *R. schnitzleri* is generally larger than that of *R. paradoxolophus*. The skull total length (SL), condylocanine (CCL), mastoid width (MW), upper canine width (C1–C1), mandible length (ML), and mandibular tooth row length (c–m3) of *R. schnitzleri* are slightly or distantly larger than those measurements of *R. paradoxolophus* (Table 2). The anterior portions of the median nasal swellings of *R. schnitzleri* are less bulbous than those of *R. paradoxolophus* in lateral view (Fig. 3A, B). The canine (C1) and the first premolar (P2) of *R. schnitzleri* are larger than those of *R. paradoxolophus*. The first premolar (P2) of *R. schnitzleri* is separated from the canine (C1) and the second (P4) by two spaces of equal length; whereas the first premolar (P2) of *R. paradoxolophus* is nearly or actually in contact with the canine (C1), and only separated from the second (P4) by a clear interspace (Fig. 3A, B). Although this character exhibits some variability amongst the individuals, in all examined skulls of *R. paradoxolophus*, the space between P2 and C1 is noticeably narrower than that between P2 and P4. The crown area of the first premolar (P2) of *R. schnitzleri* is large and elliptical, while that of *R. paradoxolophus* is small and almost circular. The outer cusp of the second premolar (P4) of *R. schnitzleri* is low and blunt, whilst that of *R. paradoxolophus* is high and pointed. The first lower premolar (p2) of *R. schnitzleri* is also separated from the canine (c1) and the second (p3) by two equal spaces, that of *R. paradoxolophus* is closely attached to both canine (c1) and the second premolar (p3) (Fig. 3). The second premolar (p3) of *R. schnitzleri* is small whilst that of *R. paradoxolophus* is relatively large.

Bacular morphology. The baculum of *R. schnitzleri* differs distinctly from that of *R. paradoxolophus* in both shape and size (Fig. 4A, B; Table 1). The baculum of *R. schnitzleri* is typically very large, generally cylindrical, with an indistinct dorsal knob, while that of *R. paradoxolophus* is visibly gracile with a well-defined dorsal knob. In lateral view, the proximally protruding portion of the lateral margin of *R. schnitzleri* is almost undeveloped, but that of *R. paradoxolophus* is very developed. The ventral and dorsal emarginations of the corresponding proximal margins of *R. schnitzleri* are equal in depth and width, whereas those of *R. paradoxolophus* are clearly different in both depth and width (Fig. 4A, B). The basal cone of *R. schnitzleri* has no depression, but that of *R. paradoxolophus* has a well-defined longitudinal median depression on its ventral surface. The tip of *R. schnitzleri* is distinctly expanded, forming an oval "plate-like" structure with a median depression, while that of *R. paradoxolophus* is narrowly rounded without knob. All examined bacula of ten adult males of *R. paradoxolophus* from different localities within Vietnam clearly exhibited the typical features of the species as described above (Thong et al., unpublished data).

Comparison of *R. schnitzleri* and *R. rex*

External characteristics. The horseshoe of *R. schnitzleri* is considerably larger and more circular than that of *R. rex*. The anterior median emargination of the horseshoe of *R. schnitzleri* is very deep with two essentially parallel sides whilst that of *R. rex* is typically wide notched (Csorba et al., 2003; Figs. 1, 2A, C). The sella of *R. schnitzleri* is narrower and longer than that of *R. rex*. Generally, the sella of *R.*

schnitzleri has two slightly parallel margins, whereas that of *R. rex* is tongue-shaped, narrowest at the base and continuously expanded upwards (Allen, 1923; Thonglongya, 1973; Csorba et al., 2003; Figs. 1, 2). The nose-leaves of all *R. rex* examined for this study showed a similarity in shape and structure.

Craniodental characteristics. The median nasal swellings of *R. schnitzleri* are visibly prominent and more bulbous anteriorly, while those of *R. rex* are more bulbous posteriorly (Fig. 3A, C). The zygomatic arch of *R. schnitzleri* is expanded medially, whereas that of *R. rex* is almost slender. The crown area of the first upper premolar (P2) of *R. schnitzleri* is considerably larger than that of *R. rex*. The second upper premolar (P4) of *R. schnitzleri* is slightly smaller with a less developed outer cusp than that of *R. paradoxolophus*. The first premolar (P2) of *R. schnitzleri* is separated from both the canine (C1) and the second (P4) by two equal spaces; in *R. rex* it is in contact with the canine (C1) and only separated from the second (P4) by a space.

Bacular morphology. The baculum of *R. schnitzleri* also differs distinctly from that of *R. rex* in shape and size. The baculum of *R. schnitzleri* is distinctly larger than that of *R. rex* in all aspects and measurements (Fig. 4A, C; Table 1). In lateral view, the proximal margin of the base of *R. schnitzleri* is almost horizontal, but that of *R. rex* is visibly sloping ventrally. The dorsal knob and the proximally protruding portion of the lateral margin of *R. schnitzleri* are indistinct, while those of *R. rex* are well-defined. The tip of *R. schnitzleri* is typically expanded, whereas that of *R. rex* is narrowly rounded and slightly curved ventrally. All examined bacula of three adult males of *R. rex*, which were collected from far distant localities in China, exhibited a certain similarity in all features of the species. Additionally, all bacular features strongly support a distinction between *R. paradoxolophus* and *R. rex* at the species level.

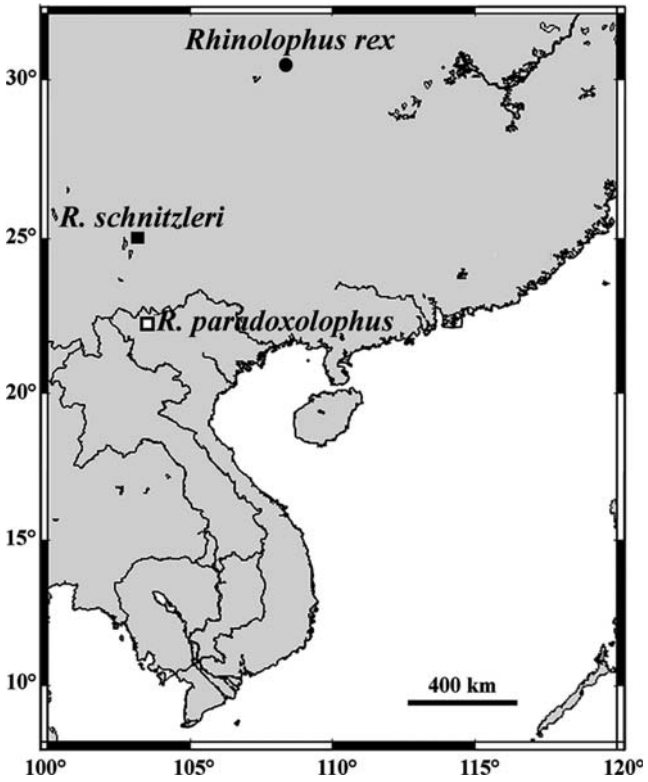

Fig. 6. Type localities of *R. schnitzleri* (closed square), *R. rex* (closed circle [Wanhsien, Szechwan Province: 30°42′N, 108°33′E, 440 m a.s.l.]), and *R. paradoxolophus* (open square). The map was created using Online Map Creation (see http://www.aquarius.ifmgeomar.de).

Distribution

To date, *Rhinolophus schnitzleri* is only known from the type locality (Fig. 6). Further studies are required to determine if it is more widely distributed in southwestern China or present in adjacent areas of Myanmar, Vietnam, or Lao PDR.

Habitat

Little is known of the habitat preferences or behaviour of *R. schnitzleri*. The holotype was captured from a cave surrounded by cultivated areas, within a distance of 200 meters to the closest village, and about 50 kilometers to Kunming City. Other bat species captured at the cave during the same night were *Rhinolophus macrotis* [large form], *R. marshalli*, *R. sinicus*, and an unidentified *Myotis* species.

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Supplemental Material

Comparative materials

The specimens examined are adults, (in CHINA) held in the College of Life Science, Guang Zhou University (GZHU), Institute of Zoology, Chinese Academy of Sciences, Beijing (BJZ), West China Normal University (WCNU), and (in VIETNAM) held in the collection of Vu Dinh Thong in the Institute of Ecology and Biological Resources (IEBR-T.).

***Rhinolophus rex* (Sixteen specimens)**

CHINA: GZHU0433 (male), GZHU0432 [IEBR-T.231107.2] (male), both in alcohol, skulls removed and bacula dissected, collected on 28 February 2004, Shui-lian Cave, Shi-men-tai Natural Reserve,Yingde City, Guangdong Province, 24°25′N, 113°18′E, 464 m a.s.l.; GZHU95003 (male), in alcohol, skull removed, baculum dissected, collected on 30 July 1995, Lu-you Cave, Wushan County, Chongqing City, 31°04′N, 109°53′E, 134 m a.s.l.; GZHU0480 (female), in alcohol, skull removed, collected on 16 January 2001, Shui-tou Village,Yun-ling Township, Yingde City, Guangdong Province, 24°24′N, 113°22′E, 149 m a.s.l.; GZHU2001055 (female), in alcohol, skull removed, collected on 14 January 2001, Qian-jin Village, Bo-luo Township, Yingde City, Guangdong Province, 24°29′N, 113°06′E, 510 m a.s.l.; GZHU01018 (female); GZHU01019 (male); GZHU01020 (male), all in alcohol, skulls removed, collected on 28 July 2001, Tian-shi-yan Cave, Lang-tian Township, Lechang County, Guangdong Province, 25°09′N, 113°28′E, 118 m a.s.l.; BJZ-176 (male), in alcohol, skull removed, collected on 14 December 1979, Qi-xing-yan Cave, Guilin City, Guangxi Province, 25°16′N, 110°19′E, 163 m a.s.l.; BJZ-184 (female), collected on 15 December 1979; BJZ-185 (female), collected on 16 December 1979, both in alcohol, skulls removed, Tai-ping-yan Cave, Guilin City, Guangxi Province, no co-ordinate; WCNU 95001 (male), in alcohol, skull removed, collected on 30 July 1995, Lu-you Cave, Wushan County, Chongqing City, 31°04′N, 109°53′E, 134 m a.s.l.; WCNU 80001, (female), in alcohol, skull removed, collected in 1980, Xinwen County, Sichuan Province, 28°11′N, 105°09′E, 684 m a.s.l.; WCNU 05018 (male); WCNU 05017 (female); WCNU 05019 (female), all in alcohol, skulls removed, collected in 2005, Sichuan Province, no co-ordinate.

***R. paradoxolophus* (Five specimens plus nine released individuals)**

VIETNAM: IEBR.T-231107.2 (male), in alcohol, skull removed, collected on 23 November 2007, Muong Do Commune, Phu Yen District, Son La Province, 21°12′N, 104°52′E, 780 m a.s.l.; IEBR-T.291107.1 (male), in alcohol, skull removed, collected on 29 November 2007, Choi Cave, Choi Village, Mai Hich Commune, Mai Chau District, Hoa Binh Province, no co-ordinate; IEBR-T.120408.1 (male), in alcohol, skull removed, collected on 12 April 2008, Nam Trang Large Cave, Nam Trang Area, Na Hang Nature Reserve, Na Hang District, Tuyen Quang Province, 22°20′N, 105°26′E, 370 m a.s.l.; IEBR-T.201004.22 (male), in alcohol, skull removed, collected on 20 October 2004, Phuong Hoang Cave, Than Sa - Phuong Hoang Tourism Area, Thai Nguyen Province, no co-ordinate; IEBR-T.050508.1 (male), in alcohol, skull removed, collected on 05 May 2008, Ta Phin Cave, Ta Phin Commune, Sa Pa District, Lao Cai province, 22°24′N; 103°50′E, 1329 m a.s.l. [type locality of the species].

***R. marshalli* (Four specimens plus fourteen released individuals)**

VIETNAM: IEBR-T.271107.1 (male), in alcohol, skull removed, collected on 27 November 2007, Binh Thuan Area, Phong Lai Commune, Thuan Chau District, Son La Province, no co-ordinate; IEBR-T.090108.2 (male), collected on 9 January 2008, skull removed; IEBR-T.070909.1 (female), collected on 7 September 2009; IEBR-T.090909.1 (male), collected on 9 September 2009, both in alcohol, skulls remained, Cat Ba National Park, Hai Phong City, 20°47′N, 106°59′E, 38 m a.s.l..

***R. macrotis* [large form] (Three specimens plus eleven released individuals)**

VIETNAM: IEBR-T.290708.5 (male); IEBR-T.290708.4 (female), both in alcohol, skulls removed, collected on 29 July 2008, Xuan Son National Park, Tan Son District, Phu Tho Provovince, 21°07′N, 104°57′E, 558 m a.s.l.; IEBR-T.B44 (male), in alcohol, skull removed, collected on 19 May 2003, Pu Luong Nature Reserve, Thanh Hoa Province, no co-ordinate.

***R.* cf. *macrotis* [small form] (Five specimens plus nine released individuals)**

VIETNAM: IEBR-T.210508.2 (female), in alcohol, skull remained, collected on 21 May 2008, Cai Keng Cave, Tam Dao National Park, Vinh Phuc Province, 21°28′N, 105°39′E, 1034 m a.s.l.; IEBR-T.290708.3 (male), in alcohol, skull removed, collected on 29 July 2008, Xuan Son National Park, Tan Son District, Phu Tho Provovince, 21°07′N, 104°57′E, 558 m a.s.l.; IEBR-T.090708.12 (female); IEBR-T.090708.13 (male), both in alcohol, skulls removed, collected on 9 July 2008, Chu Mom Ray National Park, Kon Tum Province, 14°25′N; 107°44′E, 656 m a.s.l.; IEBR-T.300808.4, (female), in alcohol, skull removed, collected on 30 August 2008, Ba Be National Park, Bac Kan Province, 22°23′N; 105°36′E, 278 m a.s.l..