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THE NAKED BULLDOG BAT, *CHEIROMELES TORQUATUS* IN SINGAPORE— PAST AND PRESENT RECORDS, WITH HIGHLIGHTS ON ITS UNIQUE MORPHOLOGY (MICROCHIROPTERA: MOLOSSIDAE)

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INTRODUCTION

The naked bulldog bat, *Cheiromeles torquatus* Horsfield, 1824, belongs to the insectivorous bat family, Molossidae, commonly referred to as the free-tailed bats (Francis, 2008; Freeman, 1981; Kingston et al., 2006). One of the most recognizable traits of molossid bats is their long tail, which extends well beyond the interfemoral membrane, hence the common name for the family. Other vernacular names applied to the naked bulldog bat include: the greater naked bat (Kingston et al., 2006; Simmons, 2005), the giant naked bat (Heller, 1995), the hairless bat (Anonymous, 1924; Harrison, 1956, 1964, 1974; Lekagul & McNeely, 1988; Tweedie, 1978), 'kelasar besar'—Malay (Harrison, 1964), 'kelawar batin'—Malay (Kingston et al., 2006), 'batin kelasar'—Malay (Tweedie, 1978; Khan, 1992). Currently, there are two species recognized in the genus *Cheiromeles* Horsfield; namely the type species itself, *Cheiromeles torquatus* (type locality: Penang, Malaysia) and *Cheiromeles parvidens* Miller & Hollister, 1921 (type locality: Sulawesi, Indonesia) (Nowak, 1991; Simmons, 2005). Confined to Southeast Asia, the naked bulldog bat has a typical Sundaic distribution, having been recorded from Peninsular Thailand and Malaysia, Sumatra, Java, Borneo, Palawan, and adjacent islands (Francis, 2008; Lekagul & McNeely, 1988).

Fig. 1. The naked bulldog bat, *Cheiromeles torquatus* Male no. 1 (head-body: 138.0 mm, tail: 62.5 mm, weight: 155 g) perched on a tree, shortly after being released on 26 Mar.2009 (ca. 2035 hours) near the summit of Bukit Timah at the Bukit Timah Nature Reserve. Note its quadrupedal posture.

The original description of the genus and species (Horsfield, 1824) was executed with almost surgical precision by Thomas Horsfield (1773–1859), a physician and naturalist, who was also the curator of the East India Company Museum at Leadenhall Street, London. His detailed written account of this unique bat was also accompanied by immaculate lithographs (engraved by W. Taylor) of various perspectives of the bat, including the skull and teeth. Its affinities with other closely related bat species were also considered and discussed at length. Horsfield's intended etymology for the generic name, *Cheiromeles*, is derived from the word *cheir* (Greek for hand), referring to the bat's unusual hindfoot, which resembles a hand, with an opposable 'thumb'. The assigned specific name, *torquatus* is derived from the word *torques* (Latin for collar), in reference to the ruff of long, fine hairs at its neck region. In addition to Horsfield's first description of the species, another excellent example of extensive illustrations of this bat may be found in Temminck's monograph on mammals (Temminck, 1835–1841: Pls. LXVI, LXVII, referred to as "*Pédimane caudataire*"). Coenraad Jacob Temminck (1778–1858) was a Dutch zoologist, and the Director of the National Museum of Natural History, Leiden from 1820–1858.

This article attempts to trace the historical and current records of naked bulldog bat in Singapore, highlighting a recent encounter with four individuals at the Bukit Timah Nature Reserve, plus providing an overview of the unique morphological characters, their functional implications and insights into other intriguing biological aspects of this bat species.

PAST AND PRESENT RECORDS

One of the earliest published records of the naked bulldog bat in Singapore was by Dobson (1878), who was also probably the first to note the sexually dimorphic characters of the secretory glands concealed beneath the gular sac at the neck. This early Singapore record was subsequently cited by Flower (1900), who also published an anecdotal remark by H. N. Ridley that 'this is not a rare species' in Singapore. Echoing the comments of Ridley was a brief report published in The Singapore Naturalist, which stated that this species 'is common at certain times in Singapore' (Anonymous, 1924). This same report briefly mentioned a collection of the naked bulldog bat from Singapore by G. H. Sworder in early Oct.1922. Upon investigation of the existing specimens of the naked bulldog bat deposited at the Zoological Reference Collection (ZRC) of the Raffles Museum of Biodiversity Research (RMBR), National University of Singapore, we discovered a series of seven bats (ZRC.4.7624–7630, one male, six females) collected from Kranji, Singapore on 3 Oct.1922 by various people, including "GHS"—G. H. Sworder himself! These specimens most certainly agree with the brief note as reported (Anonymous, 1924).

In a subsequent article by Chasen (1925), it was also noted that "the naked bat is not uncommon at certain seasons of the year in Singapore". Harrison (1974) stated that this species "is recorded from Singapore", possibly based on past documentation, rather than from a personal account. An article in the local newspaper, The Straits Times (19 Jan.1979) reported on a number of naked bulldog bats captured from "a derelict house near Braddell Road" (Anonymous, 1979). In 1995, a small flock of five naked bulldog bats was sighted flying over Chestnut Track forest (Teo & Rajathurai, 1997). In the early 2000s, Subaraj Rajathurai sighted and counted approximately 100 such bats flying over the Seletar Reservoir forest one evening. In 2005, Subaraj Rajathurai and TML encountered a small flock in flight at dusk at the Rifle Range Road forest and also from the top of Jelutong Tower (MacRitchie Reservoir forest).

On the 25 Mar.2009, a staff member of the telecommunications facility at the Bukit Timah Hill station informed us of the recent residence by a small number of bats within their building compounds. They had only arrived about a week earlier, and their defecation was unwelcome. The following day (26 Mar.2009, afternoon), the bats (two males, two females) were duly captured from their roost and presented to us for identification and translocation. Basic measurements were taken for all bats, after which one specimen (male) was retained as a voucher specimen, while the other three were promptly released at the summit of the Bukit Timah Nature Reserve on the same night (Figs. 1–4). The measurements are presented in Table 1. The male voucher specimen was catalogued as ZRC.4.8188, and carefully examined and photographed in greater detail to better understand its morphological characters (Figs. 5–10).

Table 1. Measurements of the four naked bulldog bat, *Cheiromeles torquatus*, individuals from the Bukit Timah Nature Reserve, examined on the 26 Mar.2009. Male no. 2 was retained as a voucher specimen (ZRC.4.8188, Fig. 5).

Sex/Bat no.	Head-body (mm)	Tail (mm)	Fore-arm (mm)	Tibia (mm)	Ear (mm)	Weight (g)
Male no. 1	138.0	62.5	81.1	33.0	19.5	155
Male no. 2	139.5	70.5	78.6	34.6	18.2	175
Female no. 1	126.8	53.7	80.8	35.0	20.0	161
Female no. 2	129.5	62.1	80.0	35.9	18.9	136

Fig. 2. Female no. 1 (head-body: 126.8 mm, tail: 53.7 mm, weight: 161 g) resting on a tree after release on 26 Mar.2009 (ca. 2045 hours). Note posterior orientation of first finger/thumb (arrowed), its distal claw being employed to help it climb upwards and backwards.

Fig. 3. Close-up of left axillary teat (arrowed) of Female no. 1, otherwise concealed within the subaxillary pouch.

While releasing the three bats on large, tall trees near the Bukit Timah summit, we were able to observe their quick reversing skills, as they easily clambered backwards and upwards with the aid of their powerful hindlimbs and claws on their enlarged first fingers. Their long thumbs were highly flexible and able to rotate towards the posterior so as to provide optimum grip onto the bark. The bats were able to manoeuvre themselves comfortably and effortlessly on all four limbs along the tree (upwards and sideways), clearly demonstrating what might be regarded as quadrupedal locomotion. While crawling about, the bats would consistently keep their bellies off the bark, preventing possible abrasion to their venters/wings. Prior to the release of Female no. 1 (Fig. 2), the wings were carefully removed from its subaxillary pouch to appreciate its full extent, and also to examine and photograph the axillary teat (Fig. 3), that was hidden inside the pouch.

When Female no. 2 was released (Fig. 4), it climbed to a height of ca. 3 m from the ground, where it paused momentarily and was observed to unfold its wings voluntarily, then retrieve it into the lateral pouches again. It was most likely attempting to stretch its muscles/tendons in preparation for perceived flight. Shortly after, it climbed for 0.5 m higher, then suddenly released itself, plunging straight down for at least 2 m, before abruptly flinging out both wings and flying straight down along the forest slope.

Fig. 4. Female no. 2 (head-body: 129.5 mm, tail: 62.1 mm, weight: 136 g) reversing up on a tree on 26 Mar.2009 (ca. 2100 hours), upon release at the Bukit Timah Nature Reserve. Note its unsheathed, protruding tail, one of the characteristics of the free-tailed bats (family Molossidae). After attaining a height of more than three metres from the ground, this female released its grip and demonstrated a vertical descent of about two metres, before expanding its wings to fly off into the forest.

MORPHOLOGY

The male naked bulldog bat specimen (ZRC.4.8188, Fig. 5) presented us with a rare opportunity to carefully document its multitude of characters that depart from the 'typical' microchiroptera, or insectivorous bats. This particular individual had a fresh weight of 175 g (Table 1), and this species has been known to attain an upper limit of 200 g (Kingston et al., 2006). By virtue of its sheer bulk, naked bulldog bat is regarded as the heaviest microchiropteran in the world (Francis, 2008). As a comparative illustration, this male naked bulldog bat is more than 40 times the weight of an adult male *Kerivoula hardwickii* (e.g., ZRC.4.8173 at 4.2 g, Leong & Lim, 2009) from Singapore!

Apart from its above-average size, its other claim to fame is its widespread reputation of "nudity" (e.g., Freeman, 1999). Such a concept must have originated by none other than Thomas Horsfield himself, who, in his original species description, remarked that 'the back is nearly naked'. He also added that "the shortness of the fur, affording an appearance of nakedness to the general surface, is characteristic of *Cheiromeles*" (Horsfield, 1824). Hence, the common names of naked bulldog bat and hairless bat.

However, such names may be potentially misleading, as the bat is actually covered with sparsely distributed, short, fine hairs on its entire body, which is not readily observable at a distance. A study on wind resistance in 27 species of bats found that for species with relatively high aspect ratio and wing loading, such as naked bulldog bat, the drastic reduction in fur resulted in significant aerodynamic benefits (Hassanloo et al., 1995). The 'bulldog' component of the vernacular name may have been conceived to reflect its: (a) loose, thick skin, and/or (b) large, powerful canine teeth.

The longest strands of readily perceivable hair on this bat may be found surrounding a distinct fold of skin at the base of its neck. This skin fold may be referred to as the gular sac (Dobson, 1878) or gular pouch (Kingston et al., 2006). Dobson's detailed examination of the underlying glands revealed structural differences between those of males and females. In the males, there are two separate, circular glands, whereas in females, there is a single, large 'orifice' (Dobson, 1878: Pl. XXI—Figs. 1, 1a).

These glands are only visible if the skin of its chest is gently pulled downwards to expose the gular sac (Fig. 6). This neck fold appears to be the principle source of viscous, oily secretions that radiate from the gular sac and may possibly be applied onto its wings and other parts of its body, perhaps by means of its hindfeet. Hence, it may be analogous to the preen gland in birds, from which they obtain essential oils for the maintenance of their feathers. But in the case of this bat, the oil may be applied to ensure optimum condition of their leathery skin and/or wing membranes.

Apart from the relative viscosity of the gular secretion, there is an undeniable, pungent odour that accompanies this bodily oil. Various authors have described the scent as "an unpleasant secretion" (Anonymous, 1924); "smelling offensively" (Harrison, 1956), "reminiscent of cedar wood" (Harrison, 1964), "cedar-wood oil" (Harrison, 1974), or "rather like burnt leather" (Hose, 1929). In the personal opinion of the first author, its repulsive stench is comparable to stale socks drenched in engine oil. While handling the bats with bare hands, the oily exudate was inevitably smeared onto the fingers of the first author, and the smell lingered for days, despite numerous washings. The oil has a particular tenacity for remaining on the finger nails, in particular.

While examining the male naked bulldog bat specimen (ZRC.4.8188), it was also noted that the thoracic cavity occupied a significantly large proportion of the entire torso (Fig. 5). The base of its sternum, clearly demarcated by the xiphisternum (Fig. 5: X) were readily observable, providing indications as to the extent of its lung size/inflation. An earlier morphometric study on the design of bat lungs (five species examined, including naked bulldog bat) measured the lung volume of a 173 g naked bulldog bat to be 10 cm^3 (Maina & King, 1984). For a flying mammal, bat lungs have attained an extreme level of morphological, as well as physiological superiority to cope with the immense oxygen demand when in flight.

For a microchiropteran, naked bulldog bat appears to have unusually stocky hindlimbs, as opposed to the relatively slender forms of other insectivorous bats. However, after considering its body weight and having witnessed its agility in reverse-climbing up a tree, one has a better appreciation of the necessity for such exaggerated hindlimb musculature. In fact, these posterior appendages and their associated muscles and tendons were the focus of an early anatomical study of naked bulldog bat (Allen, 1886).

In the eyes of Thomas Horsfield, the hindfoot "constitutes the chief distinguishing character of our animal". He described it as having "a distinct thumb" that is 'a complete antagonist to the fingers, enables the animal to take hold of objects, and thus constitutes a perfect hand' (Horsfield, 1824). Dobson (1878) reinforced this notion by adding that this first toe "is separated from the others like a thumb, and is probably opposable to them" (Fig. 5: T1). Indeed, this first toe does stick out like a sore thumb (pun intended) in more ways than one. The "claw" at its apex is better regarded as a "nail" instead, the term being used by Horsfield (1824), who described it as being "long, broad, perfectly even before, somewhat concave behind, and slightly rounded exteriorly at the extremity" (Fig. 7).

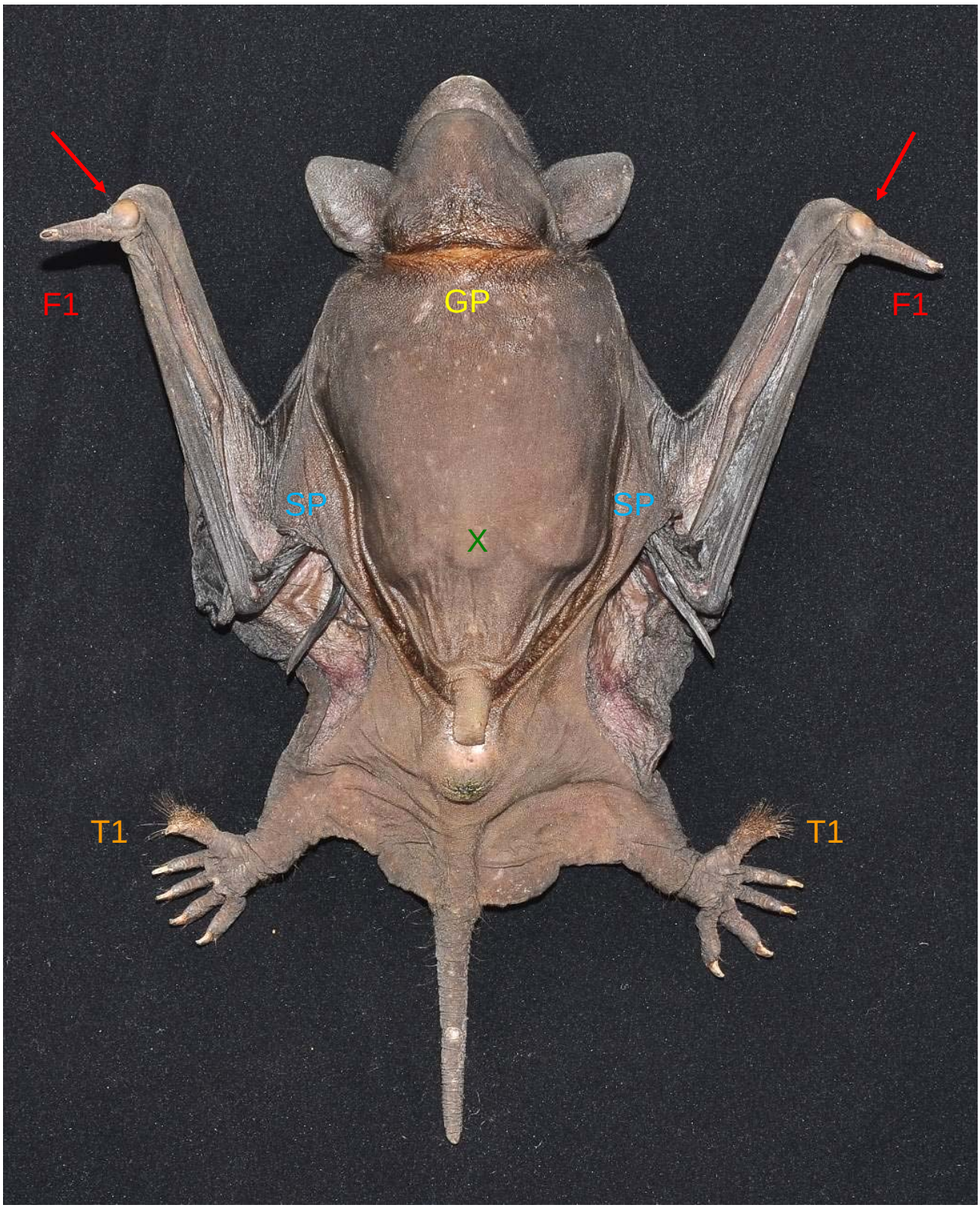

Fig. 5. Ventral view of Male no. 2 (ZRC.4.8188, head-body: 139.5 mm, tail: 70.5 mm, weight: 175 g). At the base of its first finger (F1) is a well-developed, circular cushion pad of callus tissue (arrowed). At its neck, a prominent gular pouch (GP) exudes copious amounts of an oily, pungent secretion. This pouch is surrounded with long, fine hairs (see Fig. 6). When not in use, the distal phalanges of its wings are systematically folded and neatly tucked into subaxillary pouches (SP) on both sides. The position of its xiphisternum/xiphoid process (X) demarcates the extent to which its thoracic chamber/lungs are developed. Its first toe (T1), or hallux, bears a dense aggregation of stiff hairs (see Fig. 7).

Another fascinating feature of the first toe is a dense profusion of stiff, bristly hairs on the outer face (Fig. 7). The individual bristles are of progressively increasing lengths from proximal to distal, with the majority being curved at their tips. Most of these hooked ends exhibit a spoon-like expansion, all uniformly oriented in the same direction. It is also interesting to note that the overall, combined apices of these bristles constitute a single, flat plane. While these toe

bristles were also described and discussed by Horsfield, he remained uncertain as to the actual applications of such peculiar structures. One of the most logical functions of such a brush-like device would be for grooming purposes (Kingston et al., 2006).

From the ventral perspective of this bat, there is a disc-shaped patch of callus growth at the base of the first finger in naked bulldog bat (Fig. 5: arrowed red). This patch presumably functions as a cushioning "paw" at the wrist when the bat is moving about over solid substrate on all fours. When the entire wing is folded out, the relative lengths of the individual fingers and their respective phalanges may be observed (Fig. 8). As pointed out by Horsfield (1824), only one phalanx is observed in the index/second finger, four phalanges in the middle/third finger, three phalanges in the fourth and fifth fingers. Horsfield also remarked that the 'phalanges of the third and fourth fingers are remarkably long and delicate'.

When at rest, the distal extremities of its wings are folded and tucked into a pair of subaxillary pouches on both flanks (Fig. 5: SP, Fig. 9). These unique pouches certainly offer a degree of protection for the fragile wing tips, especially when the bat is navigating over bark or rock by quadrupedal means. This, and other morphological specialisations of naked bulldog bat certainly indicate well evolved adaptations for effective locomotion in predominantly arboreal (large trees) or terrestrial (caves) roosting sites (Schutt & Simmons, 2001). The out-stretched wings of naked bulldog bat also have the reputation of being particularly elongated (Horsfield, 1824; Kingston et al., 2006). Our recent specimen (ZRC.4.8188) had a wingspan of 63.5 cm (Fig. 10).

While reviewing the specimens of naked bulldog bat in the chiropteran collection at the ZRC, we had the opportunity to examine the prepared skulls of two bats collected from Kranji, Singapore on 3 Oct.1922. The first was from an adult male (ZRC.4.7624, field no. 141, skull length: 37.3 mm, width: 24.8 mm, height: 26.7 mm, Figs. 11–14). The second was from a female (ZRC.4.7625, field no. 142, skull length: 32.3 mm, width: 23.0 mm, height: 22.8 mm).

Apart from early, detailed illustrations of the cranium and jaw of this species (Horsfield, 1824; Temminck, 1835–1841), more recent pictorial records have also been featured (e.g., Heaney et al., 1998; Leekagul & McNeely, 1988). The dental formula for this bat species is as follows; I: 2/2, C: 1–1/1–1, PM: 1–1/2–2, M: 3–3/3–3 (I: incisor, C: canine, PM: premolar, M: molar). Dobson (1878) was probably the earliest to systematically define its dental formula, which was also subsequently highlighted by Leekagul & McNeely (1988).

Fig. 6. Close-up of contents of gular pouch in the male individual (ZRC.4.8188), with skin on chest pulled back to reveal the pair of secretory glands beneath. Note long, fine strands of hair along the margin of the shallow pouch.

Fig. 7. Close-up of right hindfoot of a male individual (ZRC.4.8188), illustrating the unique assemblage of stiff bristles on the outer face of its first toe. The lengths of these bristles increase progressively from proximal to distal. Most of the bristles are back-curved and spatulate at their apices.

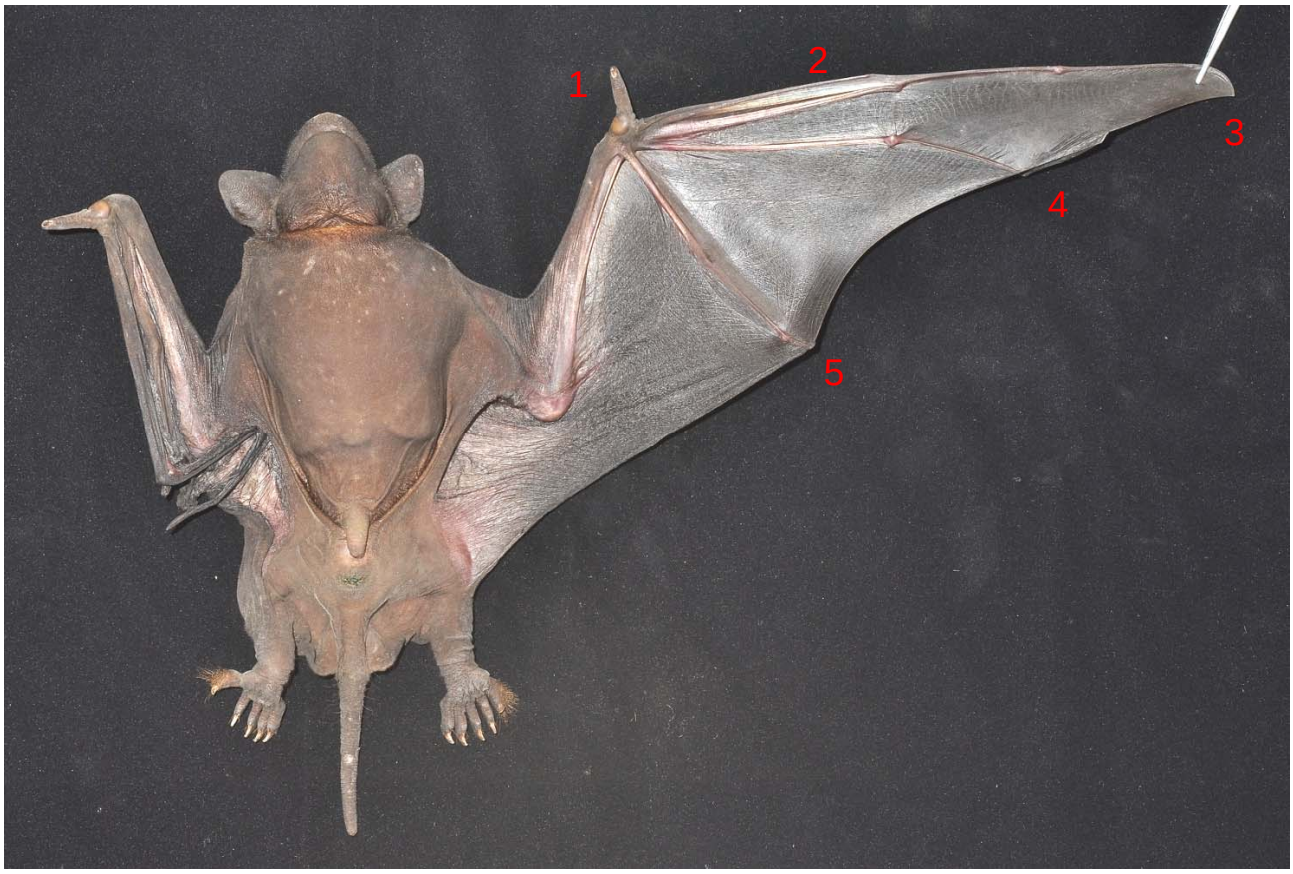

Fig. 8. Left wing of a male individual (ZRC.4.8188) removed from its subaxillary pouch, to illustrate the relative shapes, lengths and position of its five fingers (1–5), with their respective phalanges.

Fig. 9. Ventro-lateral view of left subaxillary pouch of the male individual (ZRC.4.8188) when wing was stretched out.

Fig. 10. The male individual (ZRC.4.8188) had a wingspan of 63.5 cm.

At first glance of the skull and jaw, its canine teeth are most striking, owing to their size and bulk (Figs. 11, 12). In the upper canine, a deep, longitudinal furrow is noticeable on its anterior face (Fig. 12), which renders an angular cross-section to this tooth (Freeman, 1992). The shape and size of the upper incisors are also remarkable. They are significantly larger than the lower incisors and have sharp apices that converge towards the median (Figs. 12, 13).

There is just one upper premolar and two on the lower, although the first lower premolar is much reduced (Fig. 13: PM1). As noted by Dobson (1878), the third/last upper molar is 'less than half the size of the second molar' (Fig. 13: upper M3). Its premolars and molars have distinctly raised cusps (Fig. 14), designed for crushing, slicing and grinding insect prey.

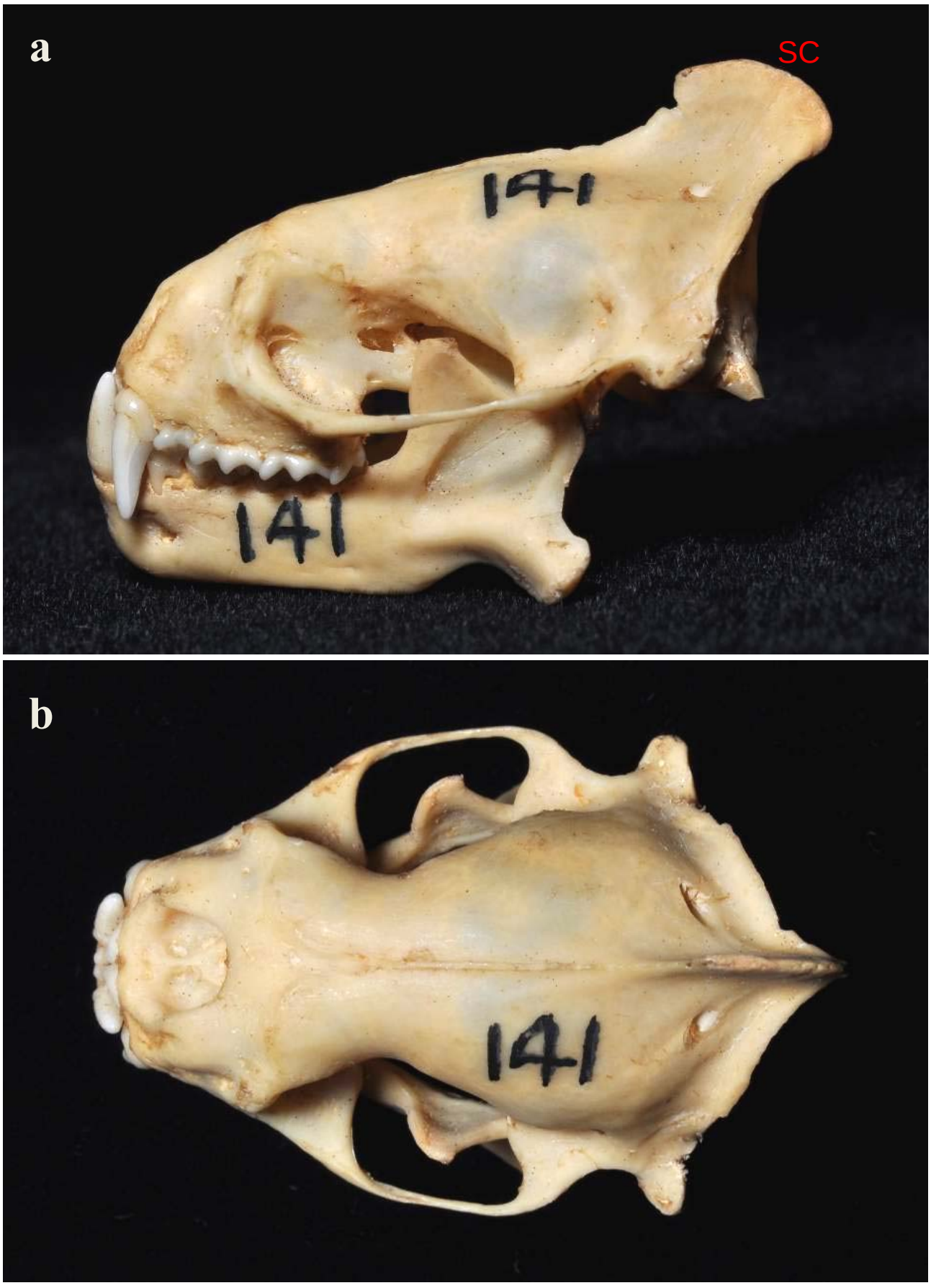

Fig. 11. Lateral (a) and dorsal (b) views of the entire skull of a male individual (ZRC.4.7624, field no. 141, skull length: 37.3 mm, width: 24.8 mm, height: 26.7 mm), prepared from a specimen collected at Kranji, Singapore on 3 Oct.1922. A total of seven bats (ZRC.4.7624–7630; one male, six females) were collected from this same locality/date. Note pronounced posterior sagittal crest (SC) and large canine teeth.

Fig. 12. Frontal view of a male (ZRC.4.7624) skull to appreciate the extent of sagittal crest (SC) and canine development. The upper canines possess a longitudinal furrow on its anterior surface. Note also the enlarged upper incisors, with converging extremities.

One of the most prominent features of its cranium is the pronounced development of its posterior sagittal crest (Figs. 11a, 12: SC), anatomically designed for the attachment of extensive jaw muscles (Freeman, 1981). Among the bats in the family Molossidae, *Cheiromeles* has the thickest jaws, widest face and a distinctly heightened posterior sagittal crest (Freeman, 1981). This combination of mandibular and cranial characters, plus fewer and larger teeth, provides supporting evidence for a natural diet that would regularly include hard-shelled insect prey, e.g. beetles (Coleoptera) (Freeman, 1979, 1984).

ECHOLOCATION AND ECTOPARASITES

Other ecological and behavioural aspects of naked bulldog bat have also been studied. Successful efforts have been invested to qualify and quantify the variety of echolocation emissions broadcast by this bat species, with respective spectrograms published to illustrate the frequency modulation at various calling scenarios (Heller, 1995; Kingston et al., 2003). A variety of ectoparasites have been documented from naked bulldog bat, with a group of earwigs (Insecta: Dermaptera: Arixeniidae) being most unusual candidates. At least two species in the genus *Arixenia* and three species in the genus *Xeniaria* are known to be associated with naked bulldog bat (Kirk-Spriggs, 1989; Marshall, 1977).

More typically, mites (Arachnida: Acari) also reside on the skin of these bats, with five species documented thus far (Fain et al., 1984; Klompen, 1992). These include one species in the family Myobiidae: *Ewingana cheiromeles* Fain, 1972 and four in the family Sarcoptidae: *Notoedres alexfaini* Lavoipierre, 1968, *Notoedres cheiromeles* Fain, 1959, *Notoedres elongatus* Fain, 1963, *Notoedres rajamanickami* Lavoipierre, 1968. It may be noted that two of these parasitic mite species were named after the generic name of the bat host. More recently, a species of tick, *Ixodes kopsteini* Oudemans, 1926 (Acari: Ixodida: Ixodidae) has been reported from naked bulldog bat in Cambodia (Robbins et al., 2004).

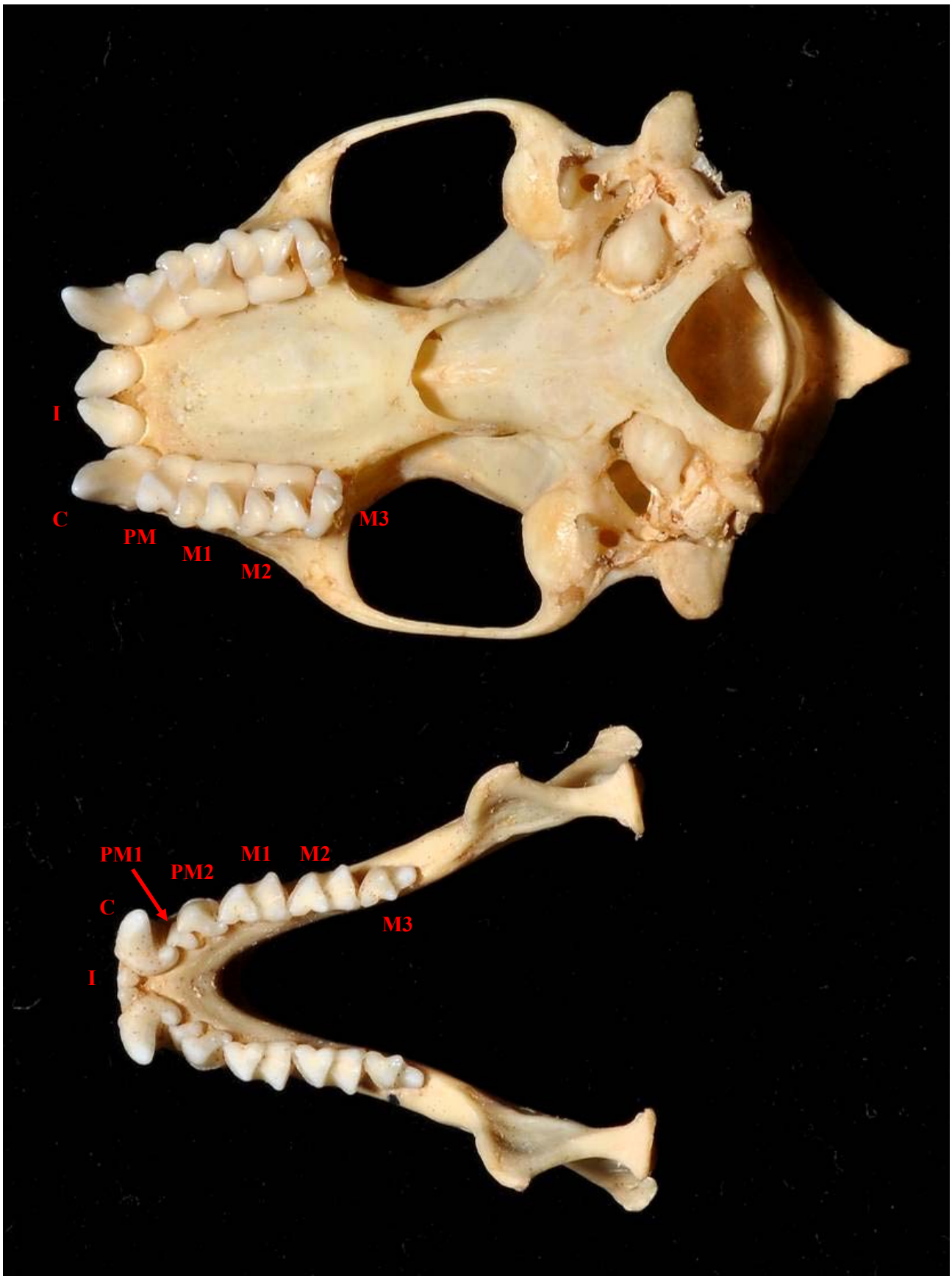

Fig. 13. Occlusal view of skull and mandible of a male individual (ZRC.4.7624) to appreciate its dentition. Its dental formula is I: 2/2, C: 1–1/1–1, PM: 1–1/2–2, M: 3–3/3–3 (I: incisor, C: canine, PM: premolar, M: molar). Note dilambdodont condition of the molars (M1, M2), with a W-shaped outer ridge.

Fig. 14. Lateral view of skull and mandible of a male individual (ZRC.4.7624). Note thick-set jaws and sharply raised cusps of the premolars and molars, adaptations for an insectivorous diet, which would include hard-shelled prey, such as beetles.

MISCONCEPTIONS AND CLARIFICATIONS

From our preview of the available literature on naked bulldog bat, it became apparent that a number of unsubstantiated deductions and suppositions have been spawned, either from observations of live bats in the wild, or from examination of preserved specimens in museums. At least two such 'hypotheses' have repeatedly surfaced and should warrant clarifications and discussion at this stage.

The first 'hypothesis' revolves around the 'mysterious' function of the subaxillary pouches. These cavernous skin folds had been purported to be "brood pouches" or "nursing pouches", in which the young bats were carried when in flight, either by the mother, or father (Dobson, 1878; Anonymous, 1924; Harrison, 1954, 1964). Confounding this idea was the proposition that twins are always born, as having just one baby would upset the balance (Harrison, 1974). Observations of a captive naked bulldog bat by Kitchener (1954b) in Peninsular Malaysia certainly helped to solve this mystery, as he witnessed how the elongated wings were unfolded and then folded back into the subaxillary pouches, thus "completely protecting the delicate tissues of the wing membrane".

In the same bat, Kitchener (1954b) had also witnessed its characteristic quadrupedal locomotion and reported that "it makes considerable use of its forearm and clawed thumb in moving about (on all fours as it were) and was very agile indeed". It was only many decades later that such a logical explanation was eventually supported with thorough morphological analyses (e.g., Schutt & Simmons, 2001).

Moreover, a better understanding of its life history has also helped to quell the myths of such pouches for ferrying the young and the suggested birth of twins. We now know that the females have one litter per year, with one young per birth, and the young are retained at the roost while the mother is on feeding flights (Leekagul & McNeely, 1988).

The other 'hypothesis' approximates towards a 'rumour' or 'legend', rather than an intellectual conjecture. This pertains to a rather amusing hearsay that these bats feed on rice grains among the rice fields and even store them in hollows of jungle trees, resulting in considerable crop damage (Anonymous, 1924; Harrison, 1964, 1974).

Once again, Kitchener (1954a) was able to provide the most sensible explanations for an apparently outrageous claim. He reasons that at the time when the padi is ripe and the water is drained, there may be a profusion of hatched insects hovering over the grain, which naturally become easy pickings for insectivorous bats, such as naked bulldog bat. The culprits for the 'stolen' grain are more likely to be rats or squirrels instead, who might hoard them at the base of hollow trees, in which naked bulldog bats are also known to roost. Hence, based on circumstantial evidence in such a scenario, fingers would have pointed to an otherwise 'innocent' colony of bats.

HUMAN PERCEPTIONS AND FUTURE RESEARCH

If beauty is in the eye of the beholder, then the naked bulldog bat certainly draws a broad spectrum of impressions from different individuals. Based on published comments, naked bulldog bat has been variously described as a "loathsome beast" (Anonymous, 1924), a "somewhat ugly animal" (Tweedie, 1978), even as a "Malay Hantu" (Malay *hantu*, ghost) by a local village boy (Kitchener, 1954a). As a result of Kitchener's (1954a, b) curiosity and conscious efforts to rear the bat in captivity (sustained on a diet of grasshoppers and moths for four weeks), he was able to observe many enlightening aspects of the bat's behaviour.

A few others also appreciated this bat as a "most remarkable species" (Dobson, 1878) and "one of the most interesting of the Cheiroptera" (Allen, 1886). From a gastronomic perspective, these bats have also been a source of food for certain natives, including the Dayaks of Borneo and the Jakun of Peninsular Malaysia (Harrison, 1954). However, we wish to share the opinion of Othman (1997), who believes that "many people would consider themselves lucky to have seen one".

Since its initial introduction to the scientific community as a novel genus and species in 1824, a wealth of information has been cumulatively harvested for naked bulldog bat from a diverse representation of scientists, each specialising in their specific fields. Collectively, their findings have helped us paint a relatively more holistic picture of the bat's biology. Nevertheless, our understanding of the naked bulldog bat remains incomplete, with a number of behavioural and ecological questions remaining to be addressed.

For Singapore, one of the initial tasks would be to locate or identify potential roost sites in our forest reserves and determine their population size and status. Such roosting habitats may occur in the form of sheltered rock crevices or large, hollow trees, both of which may be found in the hilly terrain at the Bukit Timah Nature Reserve. Thus far, local faunal surveys targeted at bats have resulted in the rediscovery of *Hipposideros bicolor* (Temminck, 1834) (family Hipposideridae), plus a new record of *Kerivoula hardwickii* (Horsfield, 1824) (family Vespertilionidae) (Leong & Lim, 2009). Other data on possible reproductive patterns and ectoparasite diversity/abundance are progressively being gathered. It is hoped that continued research efforts may successfully shed light on the biology of our nocturnal chiropteran residents.

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