

A Recent Assessment of Cave-dependent Bat Species, including the World's Smallest Mammal in Limestone Karst Areas of Mon and Kayin States

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Abstract

A series of cave-dwelling bat surveys was undertaken in limestone karst habitats from Mon and Kayin States in February–April, 2018. Bats were surveyed by using a combination of methods, including direct observation, photographic, and also trapping, where applicable, using mist net and harp trap. A total of 16 caves were surveyed. 14 species of bats belonging to 9 genera in 8 families were recorded. Information on caves, bat species, and conservation status are digitised as baseline data for future monitoring.

Key words: biodiversity, cave-dwelling bats, conservation, limestone karst.

Introduction

In SE Asia, bat represents 30% of mammal species which were described in this region (Kingston, 2008 & Furey *et al.*, 2010). A total of 100 bat species were recently reported in Myanmar. Bates *et al.*, 2001 mentioned that the limestone karst in southern Myanmar showed a well-defined biodiversity region, and many limestone caves including the caves in southern Myanmar have been disturbed by human activities, e.g. guano collections, extractions of cave swiftlet nest, hunting as well as insensitive tourisms. Since their roosting sites were disturbed by humans and mining activities in limestone caves in Myanmar, some species (eg. *Craseonycteris thonglongyai*) are listed as nearly threatened according to IUCN Red List.

Bats play a crucial role in biodiversity and a good indicator of ecosystem health (Hughes *et al.*, 2010). A member of both local and foreign researchers had ventured into the numerous studies on bats in different regions of the country especially in the central and far northern parts, and the number of species still increasing with the new species (i.e. Soisook *et al.*, 2017) and new records (Sai Sein Lin Oo *et al.*, 2017). Many unknown species might be discovered in different areas of Myanmar. However, their ecology and conservation are still poorly known, and a substantial proportion of species in cave habits could not be detected easily. This turns out that many species of cave-dwelling bats are very inadequately well-known, and it is important to monitor the population of bat communities in the limestone karst areas.

Therefore, this survey aimed to investigate and to organize all known bat species in limestone karst areas of Mon and Kayin States to provide baseline information to represent future biodiversity conservation of Myanmar.

Materials and Methods

Bat surveys were carried out in limestone cave areas of Mon and Kayin States from February to April, 2018. Species were provisionally identified following Francis (2008), Francis (2019) and Monadjem (2019). Current bat populations were determined by non-invasive methods (observation and photographic) and non-lethal collecting (mist nest and harp traps).

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Localities

Mon State – The surveys were focused on Kyeikmayaw Township and around Mawlamyine city. It is a coastal region between the Gulf of Mottama and the mountains in the east. The region is fairly mountainous and Mawlamyine is the only sizeable plain and occupies a tropical monsoon climate.

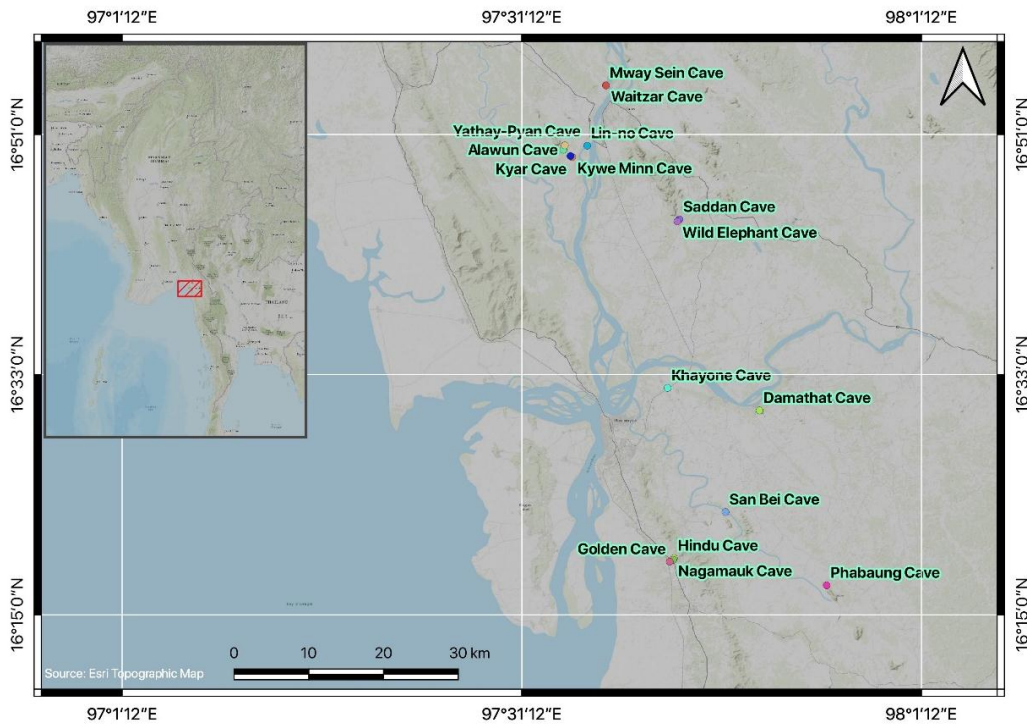


Fig. 1 Map showing cave sites visited during the survey.

(1) Kayone Cave, Kyeikmayaw, Mon State (16°32'00"N, 97°42'89"E) Fig. 1 – It is located within Kayone Hill, which lies approximately 10 km far from Mawlamyine. In most of the surrounding areas, rice paddies and vegetation can be found. There are numerous Buddha images are sited inside the cave. The interior takes the form of a long passage with some side chambers. *Taphozous melanopogon* were observed in the anterior chamber and in the inner chamber. *Hipposideros armiger* were observed roosting together in a relatively small top chamber of the ceiling. *Aselliscus* was observed to roost in the crevices of a column. None of the mining operations were found.

(2) Damathat Cave, Kyeikmayaw, Mon State (16°30'18.7"N, 97°49'2.9"E) Fig. 1 – This cave is situated about 150 metres above the surrounding plain. *Chaerephon plicatus*, are situated in a dark funnel-like subsidiary cave, located to the left of the main chamber. Bats are still an important source of guano at Damathat and, accordingly, the colony of *Chaerephon plicatus* receives the protection of the management committee. There are no mining and other threads.

(3) San Bei Cave, Kyeikmayaw, Mon State (16°22.418'N, 97°46.297'E) Fig. 1 - It lies 5 km. east of Kyeikmaraw on the west bank of the Attaran River. Two main colonies of bats were found inside the cave, one of *E. spelaea* and one of *Hipposideros armiger*. More than 500 individuals of *E. spelaea* were found near the entrance and the most interior chamber. This species is known as a cave-dwelling, colonial species and is usually found roosting in very large colonies. There is no evidence of mining and other threads such as human disturbance and hunting.

(4) Phabaung Cave, Kyeikmayaw, Mon State (16°17'12.5"N, 97°54'5.4"E) Fig. 1 - This is a vast cave in a limestone outcrop. There is a large shrine at the principal entrance and many people visit the cave to meditate. A larger colony of *C. thonglongyai* inhabits the inner chambers with *E. spelaea*, *H. armiger*, *A. stoliczkanus* and *M. lyra*. in Phabaung cave which is in the vicinity of monasteries and the bats are afforded protection by the resident monks. None of thread observed although the cave is very close to a cement factory. There is a high diversity of bats in Phabaung cave and it would benefit from conservation intervention.

(5) Hindu Cave, Mawlamyine, Mon State (16°19'14.6"N, 97°42'37.5"E) Fig. 1 - Hindu Cave is located in a small outcrop opposite the hill housing Nagamauk Cave. It is a small, deep, tunnel-like cave. A single bat, *Rhinolophus malayanus*, was found roosting alone in the middle of inner chamber. There is no mining thread, but the cave appears to be used by locals.

(6) Nagamauk Cave, Mawlamyine, Mon State (16°19'071"N, 97°4, 2'340"E) Fig. 1 – The cave system is located opposite side of the Hindu Hill. *Rhinolophus coelophyllus* was observed near the entrance. This entrance leads directly to the main colonies of bats in the cave, where *Craseonycteris thonglongyai*, *Aselliscus stoliczkanus*, *Hipposideros pomona*, *Hipposideros larvatus* and *Rhinolophus malayanus* share the chamber. The entire hill and all the caves in the vicinity including Nagamauk Cave are protected unofficially by the monks and the local villagers. There is currently no limestone mining in this area.

(7) Golden Cave, Mawlamyine, Mon State (16°18'58.8"N, 97°42'18.5"E) Fig. 1 - It is located on the opposite side (S.W.) of the same hill as Nagamauk Cave. The entrance is about 100 m. above ground level. Large Buddha statues are present inside the cave, which comprises a semi-circular chamber. A few *Rhinolophus* spp. was observed. There is no evidence of any threads in this site.

Hpa-An, Kayin State – situated on the eastern bank of Thanlwin river, and about 10 to 15 km from the town of Hpa-An. The area is a widespread fertile alluvial flood plain with numerous karst mountain, which contains large and religiously significant limestone caves. The surrounding land is given over in the most part to rice cultivation and vegetations. Bats were collected at the following sites.

(1) Waitzar cave (16°54'40.6"N, 97°37'31.0"E) Fig. 1 – It is situated in the Pha-Bhu hill that lies on the west bank of Thanlwin River. The cave is located in the waitzar monastery compound and about 5 km north-east of Myine-Ka-Lay cement factory. The cave was accessed through the monastery and a Buddhist shrine occupies the entrance of the cave, which is reached via the stone steps. It is very small and short cave, and there is only a small blind chamber on the right inner side of a shrine. Only a few individuals of *Megaderma spama* species were found on the wall and ceiling of the small chamber. The mining activities were observed 3 km far from this area, and no other threads were found.

(2) Lin-no Cave (16°50'916"N, 97°36'676"E) Fig. 1 – This cave is located on the west bank of the Thanlwin River at the northern extremity of Pha-kat village, 6 km. south-west of Hpa-an. The cave houses four species roosting closely together. Guano from the cave is harvested under a contract, which is given to the highest purchaser annually. Since the cave is restricted to access by the villagers to maintain a large and healthy bat population, the bats are disturbed only minimally. No thread was observed although mining operations were being undertaken previously.

(3) Mway Sein Cave (16°54'40.3"N, 97°37'31.2"E) Fig. 1 – It is another cave on the same hill south of Waitzar cave. The cave is located approximately 60 m depth below the ground plain. The forepart of the cave is wide with a high ceiling, and dried guano were observed on the floor. There is a small chamber on the right side of the cave which connects with a very narrow

passage via by the stone steps. Approximately 50 individuals of *Craseonycteris thonglongyai* were found in the crevices along this small passage and about 10 individuals were flying inside the cave. The plum trees were mostly found in the vicinity of the cave. No other threads were found.

(4) Yathay-Pyan Cave (16°50'109"N, 97°34'258"E) Fig. 1 - Yathay-Pyan Cave is located 2.5 km. north of Kawgun Cave and occupies part of a similar, steeply-scarped limestone hill. The hill is 385 m. above the surrounding plain at its highest point. The entrance to the cave, which is accessible via a flight of concrete steps, houses a Buddhist shrine. The cave comprises three principal chambers. *Taphozous melanopogon* and *Rhinolophus malayanus* are present in the cave's anterior chamber. A further colony of *T. melanopogon* and *Miniopterus magnater* were observed.

(5) Alawun cave (16°49'51.4" N, 97°34'19.4" E) Fig. 1 – It is located in a very large and steep limestone outcrop 2 km south-east of Yathay-Pyan cave. Access to the hill is through Alawun lake about 1 km. by boating from the Alawun village, and the foot of the hill is flooded almost the entire year. The colonies of *Taphozous melanopogon* were found in the second chamber, and approximately more than 50 individuals of *Craseonycteris thonglongyai* were observed in the very small chamber that lies 3 m. above on the right side of this second chamber. The rice cultivations, banana plantation, and vegetation have been found in the vicinity of the hill. Mining and any other threads were not found.

(6) Kyar cave (16°49'22.7"N, 97°34'51.4"E) Fig. 1 - The cave is located approximately 2 km. north of Kywe-Minn cave. It is a kind of a natural underground tunnel of the limestone, and it is a hidden cave that lies underneath the water level during the raining season. A few numbers of *Megaderma spama* were found on the ceiling of the forepart of the cave which tapers backward and forms a tunnel-like extending. A few individuals of unidentified *Rhinolophus* species were flying near the ceiling. It seems that this cave could provide as a temporary shelter for bats during summer period. There are no mining and other threads.

(7) Kywe Minn Cave (16°49'18.0"N, 97°34'59.2"E) Fig. 1 - It is located about 200 m. to the left of Kawgun Cave where is a site of tourist attraction and no bat species were observed. The small entrance features a Buddhist shrine, which is protected by a monk. The cave is about 100 m. deep with two main chambers. A large colony of *Hipposideros larvatus* were observed. Approximately 100 or more *Craseonycteris thonglongyai* were also seen scattered irregularly on the walls and occupying crevices. There is no evidence of mining and other threads.

(8) Saddan Cave (16°44'38"N, 97°43'02"E) Fig. 1 – The cave houses an important Buddhist temple within the vast main chamber. Many visitors come to worship at the site and to explore the cave, for which purpose defined routes illuminated by candle-light have been created. Underground streams and pools of water are to be found at the deeper levels within the cave's complicated structure. The cave has two major entrances, approximately 700 m. apart. *Aselliscus stoliczkanus*, *Hipposideros armiger*, *Hipposideros lylei* and *Taphozous melanopogon* were recorded. The large population of *Eonycteris spelaea* were found near the entrance that is also an exit to approach a stream. There is persistent human movement within the cave, which may disturb the bats but which may not necessarily pose a direct threat. Local people stated that bats have been hunted in the cave in the past. There is no evidence of mining thread.

(9) Wild Elephant Cave (16°44'29"N, 97°42'53"E) Fig. 1 - This cave is in the same hill as Saddan Cave. The entrance is opposite the second entrance of Saddan Cave, from which it is approximately 200 m. distant. The two are separated by a swamp. The cave is about 10 m. in width, 5-10 m. in height, and about 100 m. deep. There is a Buddhist shrine at the entrance.

Taphozous melanopogon and *Aselliscus stoliczkanus* were observed. Mining and other threads were not observed.

Specimens and Measurements

A total of 14 species of bats, belonging to 9 genera of 8 families, were recorded during the recent survey in Mon and Kayin States. The external characters of individuals were measured following Bates and Harrison (1997). The specimens were measured by using a dial caliper (to the nearest 0.1 mm) for external characters. Body mass (MASS) were measured using Pesola scale to the nearest 1.0 g.

The measurements and their definitions are as follows.

MASS: weight of the samples; HB: head and body length - from the tip of the snout to the base of the tail, dorsally; FA: forearm length - from the extremity of the elbow to the extremity of the carpus with the wings folded; E: ear length - from the lower border of the external auditory meatus to the tip of the pinna; T: tail length - from the tip of the tail to its base adjacent to the anus; HF: high foot length - from the extremity of the heel behind the os calcis to the extremity of the longest digit, not including the hairs or claws; TIB: length of tibia - from the knee joint to the ankle.

Results

Table 1 External measurements (mm) and conservation status of the 14 known species of bat recorded including forearm (FA), body mass (MASS, in g), head-body length (HB), tibia length (TIB), hind foot length (HF), tail length (T) and ear length (E). Conservation status: LR: lc, Low Risk: Least Concern; LR: nt, Low Risk: Near Threatened, following IUCN (2020).

Species	Conservation status	n	FA	HB	E	T	HF	TIB	MASS
Pteropodidae									
<i>Eonycteris spelaea</i>	LR:lc	2 ♂♂	67.1-69.5	79.5-116.0	16.517.9	17.2-18.9	17.2-18.0	30.2-33.5	54.5-59.7
Rhinolophidae									
<i>Rhinolophus coelophyllus</i>	LR:lc	2 ♂♂ 2 ♀♀	42.2-43.8	47.0-48.9	16.2-18.2	16.0-22.5	7.4-8.2	20.0-21.1	7.2-8.0
<i>Rhinolophus malayanus</i>	LR:lc	2 ♂♂ 2 ♀♀	38.9- 41.2	44.0 -44.2	17.9 -18.1	22.4 - 22.8	7.0-7.2	16.5-16.8	5.0-6.4
Hipposideridae									
<i>Aselliscus stoliczkanus</i>	LR:lc	2 ♂♂ 1 ♀	39.9-41.2	42.0-42.4	11.0 - 11.9	35.0 - 35.4	6.0-7.0	19.0-19.8	4.3-4.8
<i>Hipposideros armiger</i>	LR:lc	2 ♂♂	89.8, 89.2	90.0, 89.4	27.5, 27.2	55.4, 55.0	15.4, 15.2	37.0	45.7, 45.5
<i>Hipposideros cf. larvatus</i>	LR:lc	3 ♂♂♂ 3 ♀♀♀	59.3-63.4	59.1-67.1	17.2-19.6	27.1-19.6	8.6-11.3	21.2-24.2	14.0-16.0
<i>Hipposideros lylei</i>	LR:lc	1 ♂ 2 ♀♀	74.4-75.2	85.1-86.4	28.2-28.6	51.1-52.6	16.6-17.3	32.2-32.7	38.5-41.0
<i>Hipposideros pomona</i>	LR:lc	1 ♂ 2 ♀♀	38.4-42.1	42.9-48.5	19.5-20.1	28.5-29.1	5.6-6.9	18.2-19.8	4.9-6.5
Megadermatidae									
<i>Megaderma lyra</i>	LR:lc	1 ♂	67.9	95.0	34.2	-	22.1	-	49.2
<i>Megaderma spasma</i>	LR:lc	1 ♀	60.2	68.0	37.2	-	16.1	34.0	20.2
Craseonycteridae									

<i>Craseonycteris thonglongyai</i>	LR:nt	2 ♂♂ 1 ♀	24.0-24.6	34.1-34.7	10.9-11.1	4.0-4.3	12.1-12.5	2.0-2.1	
				Emballonuridae					
<i>Taphozous melanopogon</i>	LR:lc	1 ♀	66.5	69.5	19.5	22.5	12.1	18.2	25
				Molossidae					
<i>Chaerephon plicatus</i>	LR:lc	1 ♂	44.2	67	18.1	37.9	10.0	16.1	23
				Miniopteridae					
<i>Miniopterus magnater</i>	LR:lc	2 ♂♂ 1 ♀	49.5-49.8	56.0-57.1	11.1-11.9	46.5-46.9	-	9.6-9.8	14.0-14.2

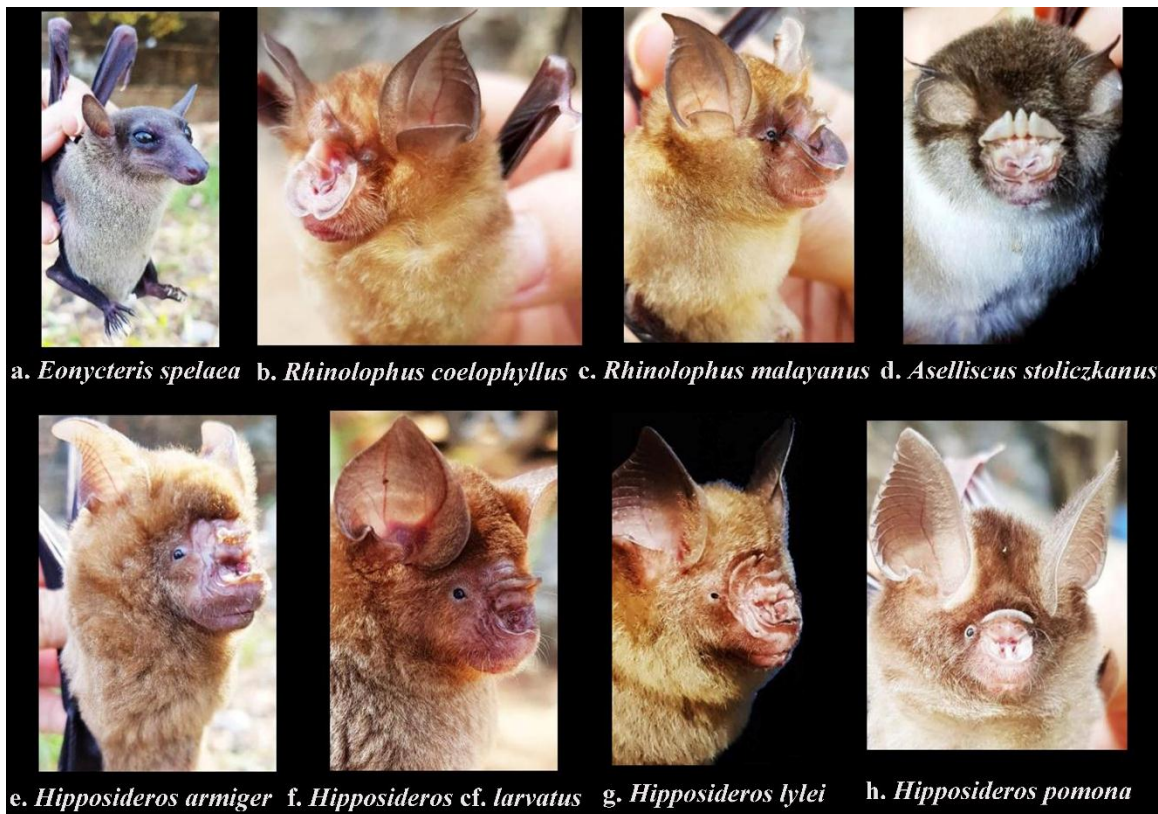


Plate 1 Bat species recorded during the survey.

Eonycteris spelaea (Dobson, 1871) Plate 1(a)

Cave Nectar bat

Recent Records

HPA-AN: Lin-no Cave; Saddan Cave. MAWLAMYINE: San Bei Cave; Phabaung Cave; Saddan-Sin Cave.

Descriptive notes

FA 67.1-69.5 mm; HB 79.5-116.0 mm; E 16.5-17.9 mm; T 17.2-18.9 mm; HF 17.2-18.0 mm; TIB 30.2-33.5 mm; MASS 54.5-59.7 g. The color of upperparts is grey-brown and slightly paler in the underparts. It is similar but smaller than *Rousettus* spp., and easily identified by the lack of claws in the second digit.

Ecological notes and Conservation status

A significant colony was observed in Sadden Cave together with *Taphozous melanopogon*, *Aselliscus stoliczkanus*, *Hipposideros armiger*, *H. larvatus*, *H. lylei*, and *H. cineraceus*. together with *Craseonycteris thonglongyai*, *Aselliscus stoliczkanus*, *Hipposideros armiger*, and *H. larvatus* in Phabaung Cave. It is classified as least concern on The IUCN Red List. (ver. 3.1, 2008).

Rhinolophus coelophyllus Peters, 1867. Plate 1(b)

Croslet Horseshoe bat.

Recent Records

MAWLAMYINE: Nagamauk Cave.

Descriptive notes

FA 42.2-43.8 mm; HB 47.0-48.9 mm; E 16.2-18.2 mm; T 16.0-22.5 mm; HF 7.4-8.2 mm; TIB 20.0-21.1 mm; MASS 7.2-8.0 g. The noseleaf is broad with rudimentary secondary noseleaf underneath. The upper parts are brown and paler and more greyish below.

Ecological notes and Conservation status

Rhinolophus coelophyllus was recorded in Nagamauk Cave near Mawlamyine in Mon State together with *Craseonycteris thonglongyai*, *Rhinolophus malayanus*, *Aselliscus stoliczkanus*, *Hipposideros armiger*, *H. larvatus*, *H. pomona*, and *Miniopterus magnater*. No major threats to the species have been identified. It is classified as least concern on The IUCN Red List. (ver. 3.1, 2008).

Rhinolophus malayanus Bonhote, 1903. Plate 1(c)

Malayan Horseshoe bat.

Recent Records

HPA-AN: Yathay-Pyan Cave. MAWLAMYINE: Golden Cave, Hindu Cave, Nagamauk Cave.

Descriptive notes

FA 38.9 - 41.2 mm, HB 44.0 - 44.2 mm, E 17.9 - 18.1 mm, T 22.4 - 22.8 mm, HF 7.0 - 7.2 mm, TIB 16.5 - 16.8 mm, MASS 5.0 - 6.4 g. Sella is relatively broad and lancet is tall and triangular. The upperparts usually brown and the belly is whitish in contrast to the color of the upperparts.

Ecological notes and Conservation status

A single specimen was found in Yathay-Pyan Cave alongside *Taphozous melanopogon* and *Miniopterus magnater*. In Nagamauk Cave, some *R. malayanus* were noted to roost in the company of *Craseonycteris thonglongyai*, *Rhinolophus coelophyllus*, *Aselliscus stoliczkanus*, *Hipposideros armiger*, *H. larvatus*, *H. pomona*, and *Miniopterus magnater*. There are no major threats to the species, which occurs in a number of protected areas. It is classified as least concern on The IUCN Red List. (ver. 3.1, 2008).

Aselliscus stoliczkanus (Dobson, 1871). Plate 1(d)

Common Trident Bat

Stoliczka's Trident Bat

Recent Records

HPA-AN: Yathay-Pyan Cave; Saddan Cave. MAWLAMYINE: Kayone Cave; Phabaung Cave.

Descriptive notes

FA 39.9–41.2 mm; HB 42.0–42.4 mm; E 11.0–11.9 mm; T 35.0–35.4 mm; HF 6.0–7.0 mm; TIB 19.0–19.8 mm; MASS 4.3–4.8 g. Small roundleaf bat and has a tridentate noseleaf margin in posterior leaf. The dorsal pelage is dark brown with whitish in ventral parts.

Ecological notes and Conservation status

In Nagamauk Cave, the species was found with *Craseonycteris thonglongyai*, *Rhinolophus malayanus*, *R. coelophyllus*, *Hipposideros armiger*, *H. larvatus*, *H. pomona*, and *Miniopterus magnater*. *A. stoliczkanus* were present at Phabaung Cave, which they shared with *Hipposideros armiger* and *H. larvatus*, *Craseonycteris thonglongyai*, *Taphozous melanopogon*, and a colony of *Eonycteris spelaea*. The species occurs in primary forest, agricultural land and degraded areas. It is classified as least concern on The IUCN Red List. (ver. 3.1, 2019).

Hipposideros armiger (Hodgson, 1835). Plate 1(e)

Great Leaf-nosed bat.

Recent Records

HPA-AN: Saddan Cave; MAWLAMYINE: San Bei Cave, Kayone Cave, Nagamauk Cave, Phabaung Cave.

Descriptive notes

FA 89.8 and 89.2 mm; HB 90.0 and 89.4 mm; E 27.5 and 27.2 mm; T 55.4 and 55.0 mm; HF 15.4 and 15.2 mm; TIB 37.0 mm; MASS 45.7 and 45.5 g, respectively. This large *Hipposideros* species has four lateral leaflets, and the outer ones distinctly smaller than the other three. The dorsal pelage is soft and long. Fur generally dark-brown.

Ecological notes and Conservation status

H. armiger was recorded with *H. lylei* and some *E. spelaea* in San Bei Cave and with *Aselliscus stoliczkanus*, *H. larvatus*, *H. lylei*, and a colony of *Taphozous melanopogon* in Kayone Cave. In Nagamauk Cave, *H. armiger* was noted to roost in the company of *Craseonycteris thonglongyai*, *Rhinolophus coelophyllus* and *Aselliscus stoliczkanus*, *Hipposideros cineraceus*. The species is associated with caves but forages over a wide area. It occurs in protected areas throughout its range and no targeted conservation measures are in place. It is classified as least concern on The IUCN Red List. (ver. 3.1, 2008).

Hipposideros cf. larvatus (Horsfield, 1823). Plate 1(f)

Intermediate Leaf-nosed bat.

Recent Records

HPA-AN: Kywe Minn Cave, Saddan Cave; MAWLAMYINE: Kayone Cave, Nagamauk Cave, Phabaung Cave.

Descriptive notes

FA 59.3–63.4 mm, HB 59.1–67.1 mm, E 17.2–19.6 mm, T 27.1–19.6 mm, HF 8.6–11.3 mm, TIB 21.2–24.2 mm, MASS 14.0–16.0 g. This species complex is believed to comprise several

species. The noseleaf has three lateral leaflets. It is generally dark grey-brown to reddish-brown with paler underparts.

Ecological notes and Conservation status

A significant colony of *H. larvatus* was recorded from Kywent Min Cave together with approximately *H. pomona* and *Craseonycteris thonglongyai*. This is a widespread throughout much of its range. It is a common species in limestone habits, and population appears to be typically stable. Local movements of this species have been found in several places in Myanmar. No major threats to the species have been identified. It is classified as least concern on The IUCN Red List. (ver. 3.1, 2008).

Hipposideros lylei Thomas, 1913. Plate 1(g)

Shield-faced Leaf-nosed bat.

Recent Records

HPA-AN: Saddan Cave. MAWLAMYINE: San Bei Cave, Kayone Cave.

Descriptive notes

FA 74.4-75.2 mm, HB 85.1-86.4 mm, E 28.2-28.6 mm, T 51.1-52.6 mm, HF 16.6-17.3 mm, TIB 32.2-32.7 mm, MASS 38.5-41.0 g. It has conspicuous enlarged fleshy lobes behind posterior noseleaf and two lateral leaflets. Noseleaf is very large in males but smaller in females. Ears large and triangular. The upperparts greyish-brown and underparts paler.

Ecological notes and Conservation status

At Saddan Cave near Hpa-An, *H. lylei* was recorded with *Taphozous melanopogon*, *Aselliscus stoliczkanus*, *Hipposideros armiger*, *H. larvatus*, and a significant colony of *Eonycteris spelaea*. This bat is usually found sharing caves and mixing in the large colonies with other *Hipposideros*. The current population rate is decreasing. It is classified as least concern on The IUCN Red List. (ver. 3.1, 2019).

Hipposideros pomona K. Andersen, 1918. Plate 1(h)

Pomona Leaf-nosed bat.

Recent Records

HPA-AN: Kywe Min Cave, MAWLAMYINE: Nagamauk Cave

Descriptive notes

FA 38.4–42.1 mm, HB 42.9-48.5 mm, E 19.5-20.1 mm, T 28.5-29.1 mm, HF 5.6-6.9 mm, TIB 18.2-19.8, MASS 4.9–6.5 g. Noseleaf small and rounded with no lateral supplementary leaflet. Ears very large and rounded. The dorsal pelage is dark-brown with significantly pale base, and slightly paler in the ventral.

Ecological notes and Conservation status

A colony of *H. pomona* were observed with *H. larvatus* and *Craseonycteris thonglongyai* in Kywe Minn Cave near Hpa-An. In Nagamauk Cave near Mawlamyine, the species was recorded together with *Craseonycteris thonglongyai*, *Rhinolophus coelophyllus*, *R. malayanus*, *Aselliscus stoliczkanus*, *Hipposideros armiger*, *H. cineraceus*, *H. larvatus*, and *Miniopterus magnater*. It roosts principally in caves, rock crevices and hollow trees. It is classified as least concern on The IUCN Red List. (ver. 3.1, 2019). However, the population status needs to be re-reviewed, and conservation measures may require for this species (Monadjem, A.,2019).



Plate 2 Bat species recorded during the survey.

Megaderma lyra E. Geoffroy, 1810. Plate 2(a)

Greater False Vampire bat.

Recent Records

MAWLAMYINE: Phabaung Cave; HPA-AN: Waitzar Cave.

Descriptive notes

FA 67.9 mm, HB 95.0 mm, E 34.2 mm, HF 22.1 mm, TIB 35.1 mm, MASS 49.2 g. The noseleaf is erect, parallel-sided flaps on sides and squared off at the top and has a longitudinal ridge and a rounded horizontal base. The pelage is soft, moderately long, greyish-brown in the dorsal and paler in the ventral.

Ecological notes and Conservation status

M. lyra is a common and widespread species throughout its range. It occurs in a variety of habitats including arid areas, warm and humid forests, and coastal regions. Colonies may number a few individuals or many hundreds of bats. No major threats to the species have been identified. It is classified as least concern on The IUCN Red List. (ver. 3.1, 2008).

Megaderma spasma (Linnaeus, 1758). Plate 2(b)

Lesser False Vampire bat.

Recent Records

MAWLAMYINE: Phabaung Cave. HPA-AN: Waitzar cave.

Descriptive notes

FA 60.2 mm, HB 68.0 mm, E 37.2 mm, HF 16.1 mm, TIB 34.0 mm, MASS 20.2 g. The noseleaf has long dorsal lobe, broad convex flaps on the sides with a heart-shaped base. The pelage is deep grey above and pale grey below.

Ecological notes and Conservation status

M. spasma was observed together with *R. malayanus*, *Aselliscus stoliczkanus* in Phabaung Cave. It is a common and widespread species throughout south and South-East Asia, where it is usually encountered in small colonies, often in caves. There are no major threats to the species although there may be local disturbance where caves are located in hills that are being mined for limestone. It is classified as least concern on The IUCN Red List. (ver. 3.1, 2019).

Craseonycteris thonglongyai Hill, 1974. Plate 2(c)

Kitti's Hog-nosed bat.

Bumblebee bat.

Recent Records

HPA-AN: Kywe Minn Cave, Mway Sein cave, Alawun cave. MAWLAMYINE: Nagamauk Cave, Phabaung Cave.

Descriptive notes

FA 24.0–24.6 mm, HB 34.1–34.7 mm, E 10.9–11.1 mm, HF 4.0–4.3 mm, TIB 12.1–12.5, MASS 2.0–2.1 g. This is very small sized bat without tail. The pelage color is light brown and grow pale from above to below. The eyes are tiny and the ears are large with a fully developed tragus. A large glandular swelling appears on the lower part of the throat. The genetic result showed that the two populations from Thailand and Myanmar are monophyletic (Ramos Pereira et al., 2006), however, a significant difference in echolocation calls (peak frequency) were found between the two populations (Ramos Pereira et al., 2006; Puechmaille et al., 2009).

Ecological notes and Conservation status

C. thonglongyai were recorded from Kywent Min Cave, Hpa-An and *Hipposideros larvatus* and *H. pomona* shared the roosting site. Near Mawlamyine, *C. thonglongyai* was recorded at Nagamauk Cave alongside *Rhinolophus coelophyllus*, *R. malayanus*, *Aselliscus stoliczkanus*, *Hipposideros armiger*, *H. larvatus*, *H. pomona*, and *Miniopterus magnater*. In Phabaung Cave, *C. thonglongyai*, was observed together with *Eonycteris spelaea*, *Aselliscus stoliczkanus*, *Hipposideros armiger*, and *H. larvatus*. *C. thonglongyai* has a very limited range with the total population being restricted in Myanmar and Thailand. *C. thonglongyai* roosts invariably in caves in limestone outcrops near rivers and it can survive in degraded areas. It is classified as near threatened on The IUCN Red List. (ver. 3.1, 2019).

Taphozous melanopogon Temminck, 1841. Plate 2(d)

Black-bearded Tomb bat.

Recent Records

HPA-AN: Alawun Cave, Lin-no Cave, Saddan Cave, Yathay-Pyan Cave. MAWLAMYINE: Kayone Cave, Phabaung Cave.

Descriptive notes

FA 66.5 mm, HB 69.5 mm, E 19.5mm, T 22.5 mm, HF 12.1 mm, TIB 18.2, MASS 25 g. Chin covered with hairs, most adult males have a black 'beard'. Tail slightly swollen at tip. Wing

membrane attaches to tibia. The pelage color is ranging from grey-brown to almost black on the back, and paler on the belly.

Ecological notes and Conservation status

T. melanopogon is a common and abundant species in Myanmar with a stable population. It occupies a variety of habitats and no major threats to the species have been identified. It is classified as least concern on The IUCN Red List. (ver. 3.1, 2019).

Chaerephon plicatus (Buchanan, 1800). Plate 2(e)

Asian Wrinkle-lipped bat.

Recent Records

HPA-AN: Lin-no Cave. MAWLAMYINE: Damathat Cave.

Descriptive notes

FA 44.2 mm, HB 67 mm, E 18.1 mm, T 37.9 mm, HF 10.0 mm, TIB 16.1 mm, MASS 23 g. Upper lip heavily wrinkled. The pelage short, soft and dense; dark brown in upperparts and paler underparts.

Ecological notes and Conservation status

Chaerophon plicatus was observed roosting closely *E. spelaea* and *T. melanopogon* in Lin-no Cave near Hpa-An in Kayin State. In Damathat Cave near Mawlamyine, a roost of just about 50,000 *C. plicatus* was recorded. This was the only species present in this cave. It is a very abundant species in Myanmar, and commonly forages near roost sites, where it has been recorded in forested areas and over paddy fields. It is classified as least concern on The IUCN Red List. (ver. 3.1, 2014).



Plate 3 Some cave sites visited during the survey

Miniopterus magnater Sanborn, 1931. Plate 2(f)

Large Bent-Winged Bat

Recent Records

HPA-AN: Yathay-Pyan Cave. MAWLAMYINE: Nagamauk Cave.

Descriptive notes

FA 49.5-49.8 mm, HB 56.0-57.1 mm, E 11.1-11.9 mm, T 46.5-46.9 mm, HF 9.6-9.8 mm, MASS 14.0-14.2 g. Ear is short and slightly rounded. The pelage is generally black or dark brown above and paler below.

Ecological notes and Conservation status

A colony of some *M. magnater* was identified in one of the inner chambers of Yathay-Pyan Cave near Hpa-An. Other species present within the cave were *Rhinolophus malayanus*, *Taphozous melanopogon*. In Nagamauk Cave near Mawlamyine, *M. magnater* was observed together with *Rhinolophus malayanus*, *Craseonycteris thonglongyai*, *Taphozous melanopogon*. There are no known major threats to the species. It is classified as least concern on The IUCN Red List. (ver. 3.1, 2019).

Discussion

In the recent survey, all of the recorded bats are classified by I.U.C.N. as Least Concern with the exceptions of *Craseonycteris thonglongyai* (Nearly threatened). Bates *et al.*, 2001 recorded *Craseonycteris thonglongyai* in Saddan-sin cave, Mon State. The extent survey was undertaken and recorded in another nine cave sites in Mon and Kayin States (Pereira *et al.*, 2006) and mentioned that there are no significant threats for this population. However, the pollution (i.e., dust, smoke) that was produced from the cement plants may affect in the foraging area of *C. thonglongyai* (Bates *et al.*, 2001), and needed to conserve the population of this species (Puechmaille *et al.*, 2009). *C. thonglongyai* were detected in 5 caves during this study and the mining process has been found about 3 km south west of the Alawun cave near Hpa-an. The foraging range of *C. thonglongyai* appears within 1 km from the roosting site (Hutson *et al.* 2001). However, their habitats would be more or less disturbed by fragmentation, consequently, it might be threatened the population of this nearly threatened species, and the population rate is still declining (IUCN, ver.2020-1). Therefore, a further survey and urgent conservation would be needed to protect them from the habitat destruction, harvesting and disturbance by local villagers.

Eonycteris spelaea species is also known as a crucial pollinator of many plant species although it often destroys crops with individuals being found trapped in mist nets around orchards. Francis, 2019 declared that the population of this species is declining due to disturbance of their cave roosts. During this study, the significant colonies of *E. spelaea* were recorded in Lin-no Cave, Saddan Cave, San Bei Cave and Phabaung Cave.

The major bat species occurring in caves with intensive guano harvesting is the Wrinkle-lipped bat, *Chaerephon plicatus*, which usually roosts in large colonies in Lin-no cave and Damathat Cave. It is a very important bio-controller of insect pests and the overharvesting of guano with no understanding of basic cave ecology may have a detrimental impact on cave ecosystems (Pearch and Soisook, 2015). Therefore, Lin-no cave and Damathat caves are the important sources of guano and, on account of its commercial importance and also considered as a supportable roosting site to maintain the bat colonies.

Of the recorded *Hipposideros* species during this survey, *H. cf. larvatus* is regarded as a diversified taxonomic group (Kruskop, 2015) and may comprise several distinct species (Francis, 2019). It is suggested that a thorough taxonomic study would be needed to elucidate the taxonomic problems of this complex.

Taphozous melanopogon is the most abundant species that were recorded in six cave sites during this survey. Moreover, two *Rhinolophus* and three *Hipposideros* species were recorded in Nagamauk cave during this study. Nonetheless, Pearch and Soisook, 2015 recorded

four *Rhinolophus* spp. and five *Hipposideros* spp. in Nagamauk cave and mentioned that it is an interesting site in terms of bat diversity, hence, additional survey would be required.

The recent survey afforded the baseline information into the current situation of bat diversity in limestone karsts area around Mon and Kayin States. However, further investigations of bat diversity in this area would be needed. In the conservation point of view, cave dwelling bats, including nearly threatened species in limestone caves were identified necessitating conservation outreach, community involvement and more detailed surveys are required to sustain biodiversity conservation of Myanmar.

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