

**NEW RECORDS AND CONSERVATION STATUS OF BATS
(MAMMALIA: CHIROPTERA) IN LANG SON UNESCO GLOBAL GEOPARK,
NORTHEASTERN VIETNAM**

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Abstract. Lang Son UNESCO Global Geopark contains extensive karst landscapes, large cave systems, and diverse vegetation types that provide highly suitable habitats for bat species. This study updated the bat species composition of the geopark through nine field surveys conducted between February 2022 and July 2025 and through a review of relevant literature. A total of 26 species belonging to 14 genera and 7 families were recorded during the surveys, including five species first recorded for the geopark. When combined with previous records, the bat fauna of the geopark currently comprises at least 41 species representing 20 genera and 8 families. Of these, 12 species are listed in the 2024 Red Data Book of Vietnam, and six species are classified as Near Threatened, Vulnerable, or Endangered in the IUCN Red List of Threatened Species, indicating national and global conservation importance. In addition, the taxonomic status of nine species is updated in accordance with recent systematic revisions. These results provide a robust baseline for future research, long-term monitoring, and conservation planning, particularly for species of high conservation priority.

Keywords: bat, biodiversity, conservation, monitoring, taxonomy.

1. Introduction

Lang Son UNESCO Global Geopark, located in northeastern Vietnam, encompasses a complex and diverse range of natural ecosystems, including extensive limestone karst formations and cave systems that provide highly suitable habitats for bat species [1], [2]. Despite this ecological potential, the bat fauna of the geopark has received relatively little

attention from researchers and conservation authorities. Previous records were derived from only a limited number of publications, most of which focused on Huu Lien Nature Reserve and a few nearby localities [3]-[9]. Notably, the taxonomic status of several species reported in earlier studies has changed following recent systematic revisions [10]-[12], while large areas of the geopark remain unsurveyed.

In addition, bat habitats in Lang Son Geopark are also under increasing pressure from land-use change and the rapid expansion of wind energy development. Given the high conservation value of bats and the growing threats to their habitats, an updated assessment of species composition is urgently needed. The present study, therefore, combined field surveys with a critical review of published records to (i) update the bat species inventory of Lang Son UNESCO Global Geopark, (ii) incorporate recent taxonomic changes into the regional checklist, and (iii) evaluate the conservation status of all bat species currently known from the geopark.

2. Content

2.1. Materials and methods

Field surveys were conducted between February 2023 and July 2025 across five former districts of Lang Son province: Bac Son, Cao Loc, Huu Lung, Van Lang, and Van Quan. These study sites represent the important habitat types within the Lang Son UNESCO Global Geopark and adjacent areas that are suitable for supporting diverse bat species. Survey methods followed the protocols described by Vu [12]-[14] and Pham and Vu [15]. Bats were captured using three mist nets (6 - 9 m in height and 9 - 12 m in length, mesh size of 16 × 16 mm) and two four-bank harp traps as described by Francis (1989) [16]. Nets and traps were placed at cave entrances and beneath the canopy of plantations and natural vegetation. To maximize capture success, two mist nets were positioned adjacent to harp traps every night, while the remaining net was placed at a separate site. Captured bats were removed carefully from nets and traps. Their reproductive status and age were assessed according to the criteria of Racey (2009) [17] and Brunet-Rossini and Wilkinson (2009) [18]. All handling procedures were implemented following the guidelines of the American Society of Mammalogists [19]. All captured bats were adults and reproductively inactive at the time of sampling. They were identified based on morphological descriptions in the relevant references [4]. Representative individuals of each species were photographed after identification, and all captured bats were released at their capture sites immediately after the necessary observations and documentation had been completed.

2.2. Results and discussion

2.2.1. Bat species recorded during field surveys

A total of 286 bat individuals representing 26 species, 14 genera, and 7 families were captured during the field surveys (Figures 1-5; Table 1). All captured individuals were adults, and none exhibited visible signs of reproductive activity at the time of capture. Among the recorded species, five species: *Hipposideros khaokhouayensis*, *Taphozous theobaldi*, *Hypsugo pulveratus*, *Pipistrellus abramus*, and *Myotis hasseltii* are first

recorded for Lang Son Geopark (Table 1). The external morphology of the captured individuals corresponded closely to published diagnostic descriptions, allowing reliable identification in the field. In addition to the captured material, large cave-roosting colonies of *Taphozous melanopogon*, *T. theobaldi*, and *Mops plicatus*, each comprising hundreds to thousands of individuals, were observed during the surveys. Furthermore, 20 echolocating bat species belonging to four families (Hipposideridae, Miniopteridae, Rhinolophidae, and Vespertilionidae) were detected using an echolocation recording system, but their roosting sites were not found across the surveyed therefore, colony sizes for these acoustically detected taxa could not be estimated. Detailed analyses of echolocation calls and associated behavioral patterns will be presented in a separate, acoustics-focused study and are therefore not included here.

Table 1. Bat species and numbers of individuals captured during field surveys

Scientific name	English Name	Number of individuals
Pteropodidae	Old World fruit bats	
<i>Cynopterus sphinx</i>	Greater Short-nosed Fruit Bat	6
<i>Eonycteris spelaea</i>	Dawn Bat	3
<i>Rousettus leschenaulti</i>	Leschenault's Rousette	9
Rhinolophidae	Horseshoe bats	
<i>Rhinolophus affinis</i>	Intermediate Horseshoe Bat	20
<i>Rhinolophus siamensis</i>	Thai Horseshoe Bat	15
<i>Rhinolophus marshalli</i>	Marshall's Horseshoe Bat	12
<i>Rhinolophus pearsonii</i>	Pearson's Horseshoe Bat	8
<i>Rhinolophus pusillus</i>	Least Horseshoe Bat	22
<i>Rhinolophus rex</i>	King Horseshoe Bat	3
Hipposideridae	Leaf-nosed bats	
<i>Aselliscus stoliczkanus</i>	Stoliczka's Asian Trident Bat	5
<i>Hipposideros armiger</i>	Great Himalayan Leaf-nosed Bat	2
<i>Hipposideros khaokhouayensis</i> *	Phou Khao Khouay leaf-nosed Bat	3
<i>Hipposideros gentilis</i>	Andersen's leaf-nosed Bat	8
<i>Hipposideros poutensis</i>	Allen's Leaf-nosed Bat	16
Emballonuridae	Sac-winged bats	
<i>Taphozous melanopogon</i>	Black-bearded Tomb Bat	26
<i>Taphozous theobaldi</i> *	Theobold's Bat	68
Molossidae	Free-tailed bats	
<i>Mops plicatus</i>	Wrinkle-lipped Free-tailed Bat	36
Vespertilionidae	Evening bats	
<i>Hypsugo pulveratus</i> *	Chinese Pipistrelle	2
<i>Ia io</i>	Great Evening Bat	3

<i>Pipistrellus abramus</i> *	Japanese Pipistrelle	2
<i>Myotis alticraniatus</i>	Indochinese Whiskered Myotis	2
<i>Myotis chinensis</i>	Large Myotis	2
<i>Myotis hasseltii</i> *	Lesser Large-footed Myotis	3
<i>Myotis pilosus</i>	Rickett's Big-footed Myotis	6
<i>Murina cyclotis</i>	Round-eared Tube-nosed Bat	1
Miniopteridae	Long-winged bats	
<i>Miniopterus fuliginosus</i>	Asian Long-fingered Bat	3

Note: * = first recorded species for Lang Son Geopark



Figure 1. Bat species of Pteropodidae: A = *C. sphinx*, B = *E. spelaea*, C = *R. leschenaultii*

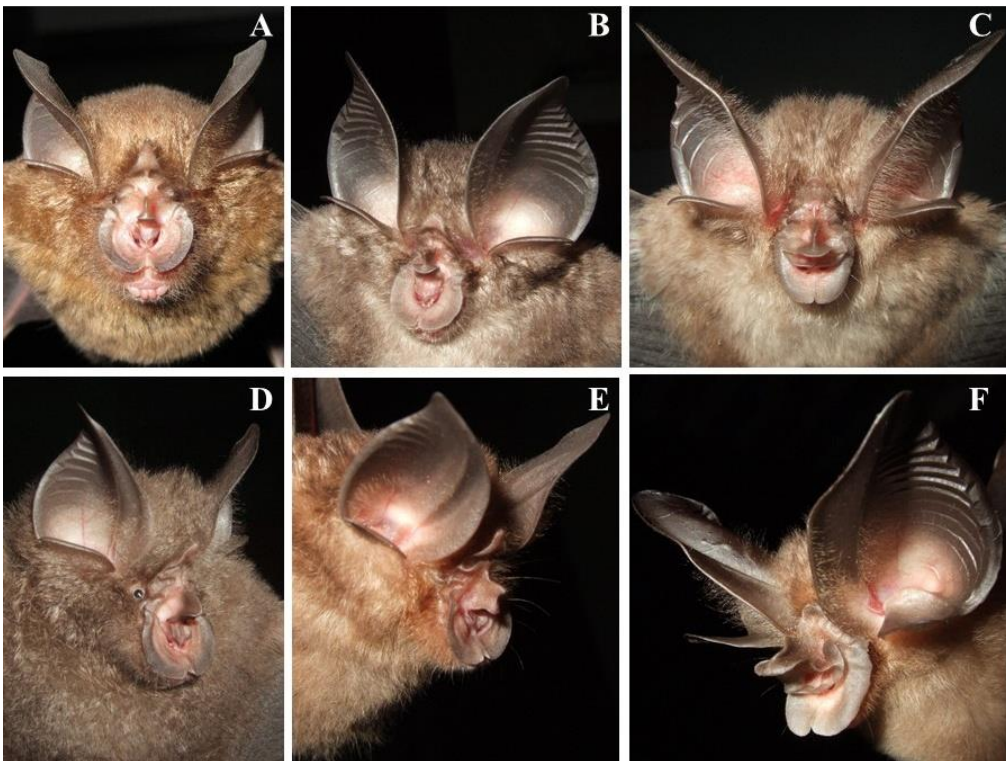


Figure 2. Bat species of Rhinolophidae: A = *R. affinis*, B = *R. siamensis*, C = *R. marhsalli*, D = *R. pearsonii*, E = *R. pusillus*, F = *R. rex*

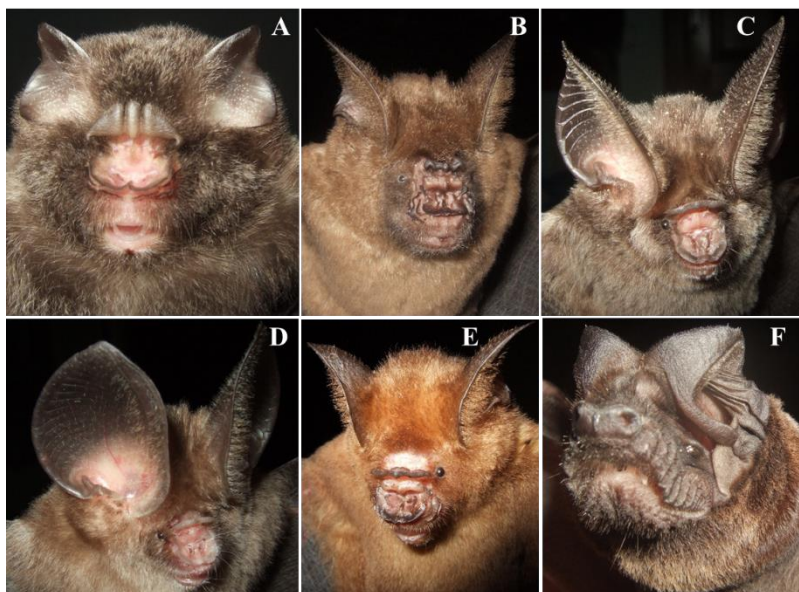


Figure 3. Bat species of Hipposideridae and Molossidae: A = *A. stoliczkanus*, B = *H. armiger*, C = *H. khaokhouayensis*, D = *H. gentilis*, E = *H. poutensis*, F = *M. plicatus*



Figure 4. Bat species of Vespertilionidae and Miniopteridae: A = *H. pulveratus*, B = *I. io*, C = *P. abramus*, D = *M. alticraniatus*, E = *M. chinensis*, F = *M. hasseltii*, F = *M. pilosus*, H = *M. cyclotis*, I = *M. fuliginosus*



Figure 5. Bat species of Emballonuridae: A = *T. melanopogon*, B = *T. theobaldii*

2.2.2. Current bat species composition in Lang Son Geopark

To date, a total of 41 bat species representing 20 genera and 8 families have been recorded from Lang Son Geopark (Table 2). Among this species composition, the taxonomic status of 10 species (*Rhinolophus siamensis*, *R. microglobosus*, *R. rex*, *R. thomasi*, *Hipposideros gentilis*, *H. poutensis*, *H. swinhoii*, *Lyroderma sinense*, *Myotis alticraniatus*, and *M. pilosus*), which were previously listed in existing literature, has been revised in accordance with recent systematic studies (Table 2). Most species reported by Hendrichsen et al. [4] originated from a single locality, Huu Lien Nature Reserve. By contrast, Dang et al. [3], [6] and several later checklist-type publications mainly summarized the national mammal fauna and relied heavily on previously published records rather than on original material from the geopark itself. The present study, therefore, provides the first consolidated and taxonomically updated account of the bat fauna of Lang Son Geopark.

In addition, the taxonomic status of two nationally and globally threatened species, *Hipposideros lylei* and *H. swinhoii*, in Lang Son Geopark requires an extensive study for confirmation in the coming time due to their close morphological similarity. Hendrichsen et al. (2001) [4] considered the record of *H. swinhoii* (= *H. pratti*) from the geopark to be questionable or unconfirmed. To date, there remains insufficient evidence to confirm the occurrence of *H. swinhoii* in Lang Son Geopark, and further integrated morphological and molecular analyses are needed to resolve this issue.

Table 2. Current bat species composition of Lang Son Geopark, with notes on taxonomic changes where applicable

Species composition	Data sources	
	Present study	Major references
Pteropodidae		
<i>Cynopterus brachyotis</i>		g
<i>Cynopterus horsfieldii</i>		e
<i>Cynopterus sphinx</i>	x	b, c, d, f
<i>Eonycteris spelaea</i>	x	g
<i>Rousettus leschenaulti</i>	x	c, d, e, f, g

Species composition	Data sources	
<i>Scientific name</i>	<i>Present study</i>	<i>Major references</i>
Rhinolophidae		
<i>Rhinolophus affinis</i>	x	a, b, c, d
<i>Rhinolophus siamensis</i>	x	c (=R. macrotis), d (=R. macrotis)
<i>Rhinolophus marshalli</i>	x	b, c, d
<i>Rhinolophus microglobosus</i>		c (=R. stheno microglobosus)
<i>Rhinolophus pearsonii</i>	x	b, c, d
<i>Rhinolophus pusillus</i>	x	c
<i>Rhinolophus rex</i>	x	c (=R. paradoxolophus), d (= R. paradoxolophus)
<i>Rhinolophus sinicus</i>		d
<i>Rhinolophus thomasi</i>		c (=R. rouxi)
Hipposideridae		
<i>Aselliscus stoliczkanus</i>	x	a, b, c, d
<i>Coelops frithii</i>		c, d
<i>Hipposideros armiger</i>	x	b, c, d
<i>Hipposideros khaokhouayensis</i>	x	
<i>Hipposideros lylei</i>		c
<i>Hipposideros gentilis</i>	x	b (=H. pomona), c (= H. pomona), d (=H. pomona), f (=H. pomona)
<i>Hipposideros poutensis</i>	x	b (=H. larvatus), c (=H. larvatus)
<i>Hipposideros swinhoii</i>		b (=H. pratti), c (=H. pratti), d (=H. pratti)
Megadermatidae		
<i>Lyroderma sinense</i>		b (= Megaderma lyra), c (= M. lyra), d (= M. lyra)
Emballonuridae		
<i>Taphozous melanopogon</i>	x	e, f
<i>Taphozous theobaldi</i>	x	
Molossidae		
<i>Mops plicatus</i>	x	f
Vespertilionidae		
<i>Hypsugo pulveratus</i>	x	

Species composition	Data sources	
	Present study	Major references
<i>Ia io</i>	x	c, d
<i>Pipistrellus abramus</i>	x	
<i>Pipistrellus paterculus</i>		c, d
<i>Scotomanes ornatus</i>		c, d
<i>Scotophilus kuhlii</i>		c
<i>Myotis alticraniatus</i>	x	a (=M. siligorensis), b (=M. siligorensis), c (=M. siligorensis)
<i>Myotis chinensis</i>	x	b, c, e, f
<i>Myotis hasseltii</i>	x	
<i>Myotis pilosus</i>	x	b, c (=M. ricketti), d (=R. ricketti)
<i>Harpiocephalus harpia</i>		b, c, d
<i>Murina cyclotis</i>	x	c, d
<i>Kerivoula hardwickii</i>		c, d
Miniopteridae		
<i>Miniopterus fuliginosus</i>	x	c, d
<i>Miniopterus magnater</i>		b

Notes: a = Dang et al. (1994) [3], b = Hendrichsen et al. (2001) [4], c = Dang et al. (2008) [6], d = Kruskop (2013) [10], e = Vu (2014) [7], f = Nguyen & Cao (2021) [8], g = Lopatin (2024) [9].

2.2.3. Conservation status of bat species in Lang Son Geopark

Of the bat species identified within the Lang Son Geopark, twelve are listed in the 2024 Red Data Book of Vietnam [20], and six are classified as Near Threatened, Vulnerable, or Endangered in the IUCN Red List of Threatened Species [21], highlighting their national and global conservation significance, respectively (Table 3). Although *Hipposideros swinhoii* is included in the current species composition of the Geopark (Table 2), its presence within the geopark remains unconfirmed, as discussed in subsection 2.2.2. Therefore, *Hipposideros swinhoii* is not considered a species of conservation concern in the province pending confirmation of its presence through robust scientific data in future studies.

Lang Son province, including the Geopark, is among the regions in Vietnam currently targeted for intensive development of wind energy infrastructure, with at least 21 wind farm projects planned for the period 2025–2030 [22]. The conservation status of many bat species, particularly open-space foragers, is likely to be affected by wind farms unless effective mitigation strategies are implemented with a focus on protecting threatened populations. Previous studies on the impacts of wind energy development have indicated that many bat species, including species of global conservation concern, are vulnerable

to turbine-related mortality and habitat disturbance [23]. Therefore, comprehensive assessments of bat diversity and conservation status, together with evaluations of the potential impacts of wind farm development, are urgently needed to conserve nationally and globally threatened species in Lang Son Geopark and elsewhere in Vietnam. Data derived from such assessments will be essential for designing and implementing effective mitigation strategies to reduce the negative impacts of wind farms and other energy projects on bats and broader biodiversity in the future.

Table 3. Bat species of conservation concern in Lang Son Geopark

Species composition	Conservation status	
<i>Scientific name</i>	<i>VNRB2024</i>	<i>IUCN</i>
Pteropodidae		
<i>Cynopterus brachyotis</i>	VU	
<i>Rousettus leschenaulti</i>		NT
Rhinolophidae		
<i>Rhinolophus siamensis</i>	NT	
<i>Rhinolophus marshalli</i>	VU	
<i>Rhinolophus rex</i>	VU	EN
Hipposideridae		
<i>Coelops frithii</i>	VU	NT
<i>Hipposideros khaokhouayensis</i>	EN	VU
<i>Hipposideros lylei</i>	VU	
Molossidae		
<i>Mops plicatus</i>	EN	
Vespertilionidae		
<i>Ia io</i>	VU	NT
<i>Scotomanes ornatus</i>	EN	
<i>Myotis pilosus</i>	EN	VU
<i>Harpiocephalus harpia</i>	VU	

*Note: VNRB2024 = the 2024 Red Data Book of Vietnam [20],
IUCN = the current IUCN Red List of the Threatened Species [21],
VU = Vulnerable, NT = Near Threatened, EN = Endangered.*

3. Conclusions

This study provides the first comprehensive assessment of bat diversity in Lang Son Geopark and highlights the geopark as an important area for bat research and conservation in northeastern Vietnam. Based on field surveys and a literature review, at least 41 bat species belonging to 20 genera and 8 families - including five species first recorded for

the geopark, are known in Lang Son UNESCO Global Geopark. Of these, twelve species are listed in the 2024 Red Data Book of Vietnam, and six species are included in the IUCN Red List of Threatened Species, showing the high conservation value of the provincial bat fauna. However, these species face increasing threats from the development of wind energy infrastructure. Practical and scientific solutions are therefore clearly required to mitigate negative impacts, especially for species vulnerable to turbine-related mortality. These study results provide an essential baseline for future research, monitoring, and conservation actions in Lang Son Geopark and surrounding areas. Extensive field surveys for biodiversity assessments in the context of wind farm development are crucial for effective conservation of bat diversity in the geopark.

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