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# Diversity and Distribution of Chiroptera Species in Munnar and the Adjacent Enchanting Landscape of the Southern Western Ghats, Kerala, India

**Tijo K. Joy [a*] and L. Jeyapraba [a]**

*[a] Zoology Department and Research Centre, Sarah Tucker College (Autonomous), Affiliated to Manonmaniam Sundaranar University, Tirunelveli-7, India.*

***Authors' contributions***

*This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.*

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## ABSTRACT

Preserving suitable habitats and addressing potential threats is essential for the long-term survival of bat populations in this ecologically important region. We investigated the bat species diversity and species composition by using mist net and acoustic survey in the Munnar landscape of the Western Ghats region, Kerala, India. A total of 33 bat species from two suborders were identified. Microchiroptera was the dominant suborder, comprising 81.8% of the bat species, while Megachiroptera represented 18.2%. Notably, Salim Ali's fruit bat (*Latidens salimalii*), an endemic and endangered species, was documented during the survey. The study also identified other near-threatened species, data deficient and vulnerable species. The findings underscore the ecological significance of the Munnar landscape for bat conservation and provide valuable baseline data for future research and conservation initiatives.

**Corresponding author: Email: tijokjoyz@gmail.com;*

*Keywords: Munnar landscape; microchiroptera; megachiroptera; Salim Ali's fruit bat; conservation.*

## 1. INTRODUCTION

Species diversity is natural wealth of our nation. Chiropterans commonly known as bats are the only true flying mammals, These remarkable mammals possess advanced echolocation abilities and the unique ability to fly with their wings. Bats are represented all over the world except Antartica, Arctic Tundra and few remote Oceanic Islands [1]. Comprising altogether 1456 species globally, [2]. and they constitute about a quarter of the entire mammal species.

In India, bats represent the most diverse mammalian order with 127 species and 94 subspecies under 41 genera belonging to 9 families [3], followed by rodents with 102 species [4]. The extensive work conducted by Bates & Harrison [5] is considered to be the basic reference for bat research in India. They compiled all the previous work and presented complete taxonomic descriptions along with the distribution of 109 bat species in India. But the number of species is increasing with new finding of new species and range extensions. *Myotis frater* [6], *Phoniscus jagorii* [7] and *Eudiscopus denticulus* [8] were very recently documented from India, representing bat richness in India is mysterious and more research work on bat surveys can increase the species richness in this region.

The Western Ghats, renowned as a biodiversity hotspot, plays a critical role in influencing environmental threats through its diverse animal and plant species. However, the diversity of bat species in the Southern Western Ghats remains relatively understudied, with some species lacking significant research attention. However, landscape-based data alone are insufficient for comprehensively analyzing the diversity and distribution of bat species in the study location. Historical research in Kerala, for instance, has documented the dominant distribution of bat species in Silent Valley, providing valuable insights into the presence of various bat species [9]. Remarkably, rare and indigenous bat species such as *Latiden salimalii* and *Phoniscus jagorii* (Peters' Trumpet-eared Bat) have also been discovered in the study area [10,11] with a total of 42 bat species documented in Kerala [11]. Studies on bats are focused mainly on taxonomic identifications and species check list in various localities in the Western Ghats, but little research has been done to describe the patterns and processes involved in the distribution of bat species in this region. The present study focuses on the diversity and distribution and diversity of bat species within the Munnar landscape of Southern Western Ghats, Kerala, India.

## 2. MATERIALS AND METHODS

### 2.1 Survey

Field study was carried out from 2016 to 2019 in the study area. Multiple procedures and steps were employed in the bat survey to gather data on bat species and their characteristics. These included questioning, visual assessment, acoustic monitoring, trapping, and checking for bat activity in various structures such as old buildings, temples, and water wells.

### 2.2 Questioning

Local individuals, including witnesses, guards, forest service members and tribal members were questioned about the presence of bats or bat guano inside structures.

The list of the main questions are as follows

1. Have you personally observed bats or bat guano inside structures in this area?
2. Can you describe the characteristics or features of the bats or guano you have seen?
3. Where have you most commonly encountered bats or bat guano in this region?
4. Are there any specific structures or locations where bats tend to roost or leave guano?
5. Have you noticed any changes in the presence or behaviour of bats in recent years?
6. Do you have any photographs or evidence of bats or bat guano inside structures?
7. Are there any local beliefs or traditions associated with bats in this area?
8. Have there been any incidents or issues related to bats that you are aware of?
9. Do you know of any specific bat species that are commonly found in this region?
10. Are there any precautions or actions taken to manage or mitigate potential issues related to bats?

## 2.3 Visual Evaluation

Buildings were searched for signs of bat activity, such as urinary markings around entry and exit points, piles of guano, or other indications of roosting.

## 2.4 Acoustic Monitoring

Mist net surveys are typically conducted at dusk and dawn when bats are actively foraging. They are usually done in the evening before complete darkness. On the other hand, bat detector surveys can be conducted throughout the night, as they rely on recording bat echolocation calls. The detectors can be left running continuously to capture bat activity. Bat detectors are devices used to monitor and record the ultrasonic calls of bats. They are designed to convert the high-frequency echolocation calls of bats into audible sounds that can be detected and analyzed. Two commonly used bat detectors are the Wildlife Acoustic EM3 and the Echo Meter Touch 2 PRO.

## 2.5 Wildlife Acoustic EM3

The EM3 is equipped with advanced features that enable it to record ultrasonic bat calls and store them as digital files for further analysis.Operating in a frequency range of 15-150 kHz, the EM3 covers the majority of bat echolocation frequencies, allowing for comprehensive monitoring of bat species.

## 2.6 Echo Meter Touch 2 PRO

The Echo Meter Touch 2 PRO is a portable and user-friendly bat detector that combines a hardware module with a smartphone app. With a frequency range of 10-200 kHz, the Echo Meter Touch 2 PRO covers a wide range of bat echolocation frequencies, allowing for the detection and study of diverse bat species. The smartphone app enhances data management and sharing capabilities, making it a popular choice among researchers and wildlife enthusiasts for bat research and conservation efforts.

## 2.7 Bat-Capturing Techniques

The capture methods used in this study included mist netting and hand nets. Mist nets, measuring 12m and 6m with a mesh size of 36mm, were strategically placed along bat flight routes near the water sources at both ground and canopy levels during dusk. Additionally, bats were captured using hoop nets at diverse roosting locations, including caves, rock crevices, temples, stone water wells, abandoned buildings, and fissures during day time. To maintain capture rates, the mist nets were relocated to different sites every two or three nights. Captured bats were temporarily held in separate canvas bags and then identified based on physical characteristics such as sex, forearm and wing measurements, weight, following the methodology described by Bates and Harrison [5] and echolocation call library [6,12,13]. However, there are other important traits that can assist in species identification, including plumage, facial features, ear shape and size, tail length, specific markings or color patterns, and the shape and size of various body parts.

## 2.8 Species Diversity Index and Site Wise Index

Each site was visited for three times in one year. A total of 10 sites were selected at different elevations. The species diversity index is a measure used to assess the diversity or richness of species within a given area or sample.

The formula for calculating the Shannon-Wiener Index is: $H' = \Sigma (pi * \ln (pi))$

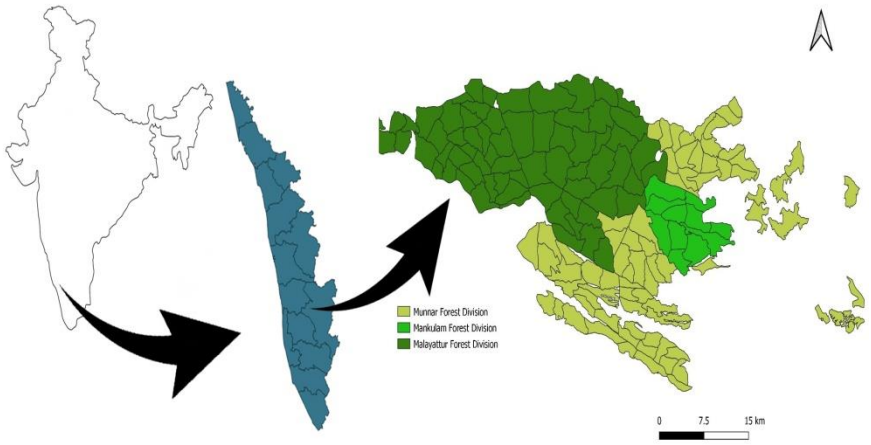
$\Sigma$ = Sum, $n$ - individuals of a given type/species, $N$ - Total number of individuals in a community, pi - proportion of individuals of i-th species in a whole community, ln= Natural log

## 2.9 Species-Wise IUCN Conservation Status

The IUCN (International Union for Conservation of Nature) Red List is a comprehensive assessment of the conservation status of species worldwide.

## 2.10 The Study Area

The High Range Mountain Landscape of Munnar, is ecologically significant and diverse. It comprises three Forest Divisions: Malayattoor,




**Map 1. Study area**

Munnar, and Mankulam, located in Idukki and Ernakulam districts. Situated on the western slopes of Anamudi and the Edamalayar Valley, the region exhibits tropical evergreen, semi-evergreen, and moist deciduous forest types, along with grassland and montane shola ecosystems.

## 3. RESULTS

### 3.1 Distribution of Bat Species

#### 3.1.1 Bat survey

A total of 33 bat species, representing 16 different genera belongs to two suborders were recorded in the study area. Table 1 shows the comprehensive information about the bat species documented during the study, including their order, family, common name, scientific name, and IUCN (International Union for Conservation of Nature) status. Among the identified 33 bat species, Microchiroptera was the most prevalent, comprising 81.8% and Megachiroptera accounted for the remaining 18.2% (Fig. 1). Mixed woodland and riparian forest habitats provide suitable conditions for foraging, roosting, and other ecological requirements of the 33 bat species.

#### 3.1.2 Status of identified bat species in each Family

Fig. 2 provides information about the status of bat families found in the High Range Mountains of the Munnar Landscape.

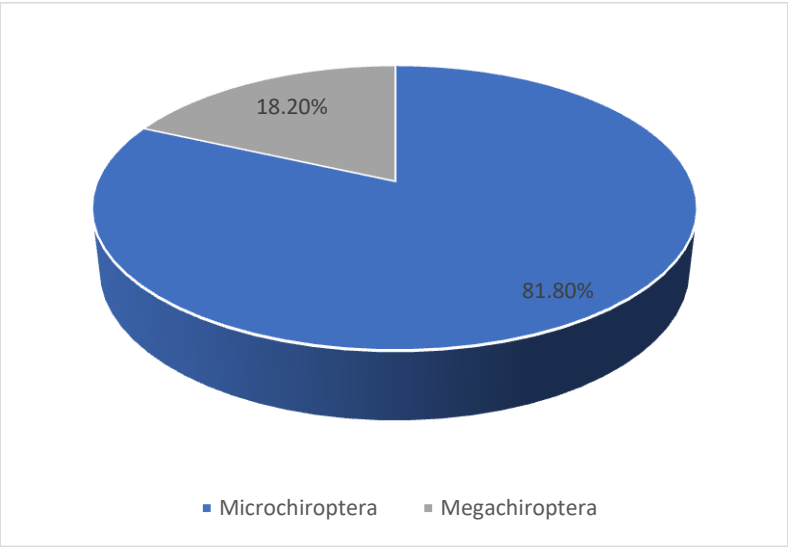



**Fig. 1. Distribution of microchiropteran and megachiropteran bat species**

**Table 1. List of Identified bat species with IUCN Status in the study area**

| Sl. No | Order Chiroptera | Common Name | Scientific Name | IUCN Status |
|---|---|---|---|---|
| 1 | **Suborder:** | Fulvous Fruit Bat | *Rousettus leschenaulti* | LC |
| 2 | **Megachiroptera** | Indian Flying Fox | *Pteropus giganteus* | LC |
| 3 | Family: Pteropodidae | Greater Short-nosed Fruit Bat | *Cynopterus sphinx* | LC |
| 4 | | Lesser Short-nosed Fruit Bat | *Cynopterus brachyotis* | LC |
| 5 | | Salim Ali's fruit bat | *Latidens salimalii* | EN |
| 6 | | Lesser Dawn Bat | *Eonycteris spelaea* | LC |
| 7 | **Sub-Order Microchiroptera** Family: Rhinopomatidae | Lesser Mouse-tailed Bat | *Rhinopoma hardwickii* | LC |
| 8 | Family Rhinolophidae | Least Horseshoe Bat | *Rhinolophus pusillus* | LC |
| 9 | | Rufous Horseshoe Bat | *Rhinolophus rouxii* | NT |
| 10 | | Rufous Horseshoe Bat | *Rhinolophus indo rouxii* | DD |
| 11 | | Blyth's Horseshoe Bat | *Rhinolophus lepidus* | LC |
| 12 | | Lesser Woolly Horseshoe Bat | *Rhinolophus beddomei* | NT |
| 13 | Family Megadermatidae | Greater False Vampire | *Megaderma lyra* | LC |
| 14 | | Lesser False Vampire | *Megaderma spasma* | LC |
| 15 | Family:Emballonuridae | Long-winged Tomb Bat | *Taphozous longimanus* | LC |
| 16 | | Black-bearded Tomb Bat | *Taphozous melanopogon* | LC |
| 17 | Family Hipposideridae | Schneider's Roundleaf Bat | *Hipposideros speoris* | LC |
| 18 | | Fulvus Roundleaf Bat | *Hipposideros fulvus* | LC |
| 19 | | Cantor's Roundleaf Bat | *Hipposideros galeritus* | NT |
| 20 | | Dusky Roundleaf Bat | *Hipposideros ater* | LC |
| 21 | | Andersen's Round leaf Bat | *Hipposideros pomona* | LC |
| 22 | Family: Molossidae | Egyptian Free-tailed Bat | *Tadarida aegyptiaca* | LC |
| 23 | Family: Vespertilionidae | Lesser Asiatic Yellow House Bat | *Scotophilus kuhlii* | LC |
| 24 | | Greater Asiatic Yellow House Bat | *Scotophilus heathii* | LC |
| 25 | | Indian Pipistrelle | *Pipistrellus coromandra* | LC |
| 26 | | Least Pipistrelle | *Pipistrellus tenuis* | LC |
| 27 | | Kelaart's Pipistrelle | *Pipistrellus ceylonicus* | LC |
| 28 | | Dormer's Pipistrelle | *Scotozous dormeri* | LC |
| 29 | | Burmese Whiskered Bat | *Myotis montivagus* | VU |
| 30 | | Horsfield's Myotis | *Myotis horsfieldii* | LC |
| 31 | | Peyton's Whiskered Myotis | *Myotis peytoni* | DD |
| 32 | | Painted Bat | *Kerivoula picta* | LC |
| 33 | Family: Miniopteridae | Small bent-winged bat | *Miniopterus pusillus* | VU |

*Note: Endangered (EN) : Very high risk of extinction in the wild.*
*Vulnerable (VU) : High risk of extinction in the wild.*
*Near Threatened (NT) : Close to qualifying for a threatened category.*
*Least Concern (LC) : Lowest risk category, indicating a widespread and abundant species.*
*Data Deficient (DD) : Insufficient data to assess the species conservation status.*

## 3.2 Bat Acoustic for Bat Species Identification (Call Library)

The bat call library in the study area includes a diverse range of species with varying frequency ranges. 23 species of Bat call library in the study area is given in Table 2.

## 3.3 Species Diversity

### 3.3.1 Diversity in Food preference of bat species in munnar landscape

Fig. 3 presents the findings regarding the relationship between bat species' food

preferences and their roosting behaviour in the study area. The values obtained for 6 species of frugivorous, 2 species of both carnivorous and insectivorous, and 27 species of insectivorous bats are 27%, 14%, and 59%, respectively. These values represent the proportion of bats within each food preference category that exhibit a preference for specific roosting sites.

#### 3.3.2 Species-wise IUCN conservation status 2022

Fig. 4 shows the findings regarding the conservation status of bat species in the study area based on assessments conducted by the IUCN Red List 2022.

### 3.4 Diversity of Bat Species

#### 3.4.1 Site wise diversity

A total of 10 sites were sampled for three times in a year. Altogether, 851 individuals of 33 species were recorded and identified to species level, based on their external morphology. Total number of individuals of each species recorded in each site and Site wise diversity are shown in Table 3 and Figs. 5 & 6. More number of bats (122) was recorded in site 4 and 7. High diversity value (3.27) was recorded in Site 1 followed by Site 2 (2.88). High value of diversity (3. 27) occur in Site 1.

#### 3.4.2 Species wise diversity

Table 4 shows the species diversity index and population densities of different bat species. Species diversity indices indicates the species richness and evenness. Among all, more number of *Pteropus giganteus* was observed, followed by *Rhinolophus lepidus* and *Rhinolophus rouxii. Latidens salimalii* was recorded in less number. *Pteropus giganteus* bat species shows high diversity value (3.32) and *Latidens salimalii* shows low diversity value (0.89).

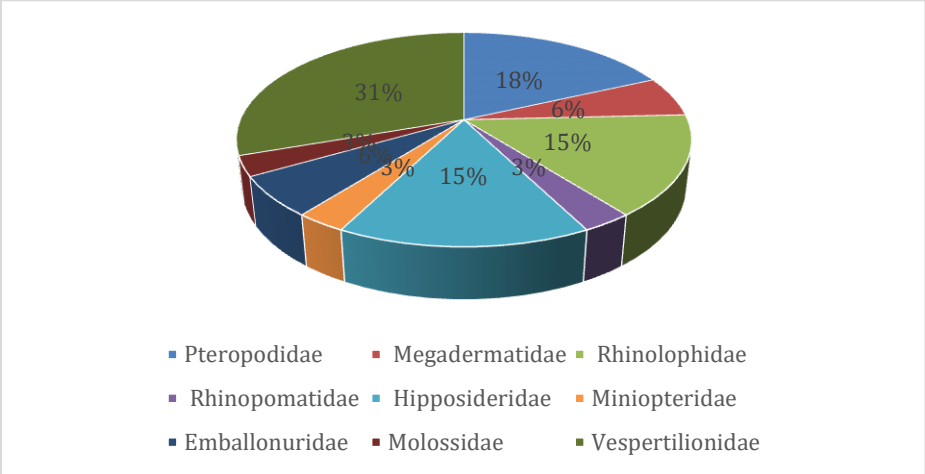



**Fig. 2. Status of identified bat families in the study area**

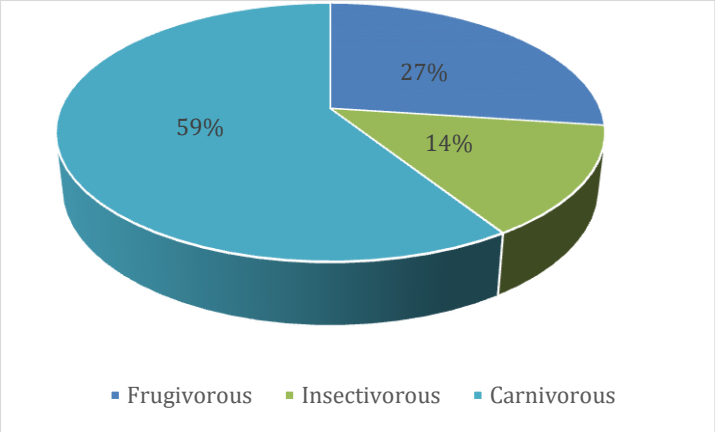



**Fig. 3. Diversity in Food preference of Bat species in the study area**

**Table 2. Bat call library in the study area**

| Sl. No | Scientific Name | Frequency Range (kHz) |
|---|---|---|
| 1 | *Rhinopoma hardwickii* | 15-90 |
| 2 | *Rhinolophus pusillus* | 102-111 |
| 3 | *Rhinolophus rouxii* | 80-90 |
| 4 | *Rhinolophus indorouxii* | 92-95 |
| 5 | *Rhinolophus lepidus* | 102-104 |
| 6 | *Rhinolophus beddomei* | 40-45 |
| 7 | *Megaderma lyra* | 15-70 |
| 8 | *Megaderma spasma* | 15-70 |
| 9 | *Taphozous longimanus* | 10.-14 |
| 10 | *Taphozous melanopogon* | 15-90 |
| 11 | *Hipposideros speoris* | 130-136 |
| 12 | *Hipposideros fulvus* | 155-160 |
| 13 | *Hipposideros galeritus* | 107-129 |
| 14 | *Hipposideros pomona* | 122-130 |
| 16 | *Tadarida aegyptiaca* | 18-23 |
| 17 | *Scotophilus kuhlii* | 64-75 |
| 18 | *Scotophilus heathii* | 33-59 |
| 19 | *Pipistrellus coromandra* | 115-127 |
| 20 | *Pipistrellus tenuis* | 47-70 |
| 21 | *Pipistrellus ceylonicus* | 34-40 |
| 22 | *Myotis horsfieldii* | 54-58 |
| 23 | *Miniopterus pusillus* | 62-65 |

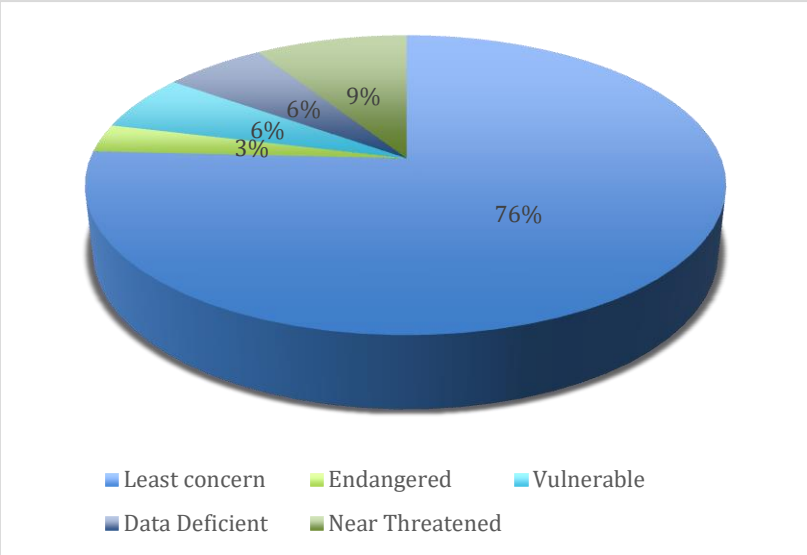



**Fig. 4. IUCN conservation status of available bat species in the study area**

**Table 3. Site wise distribution of bat species in the study area**

| S. No | Species | Site 1 | Site 2 | Site 3 | Site 4 | Site 5 | Site 6 | Site 7 | Site 8 | Site 9 | Site 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | *Rousettus leschenaulti* | 2 | 4 | 0 | 1 | 4 | 5 | 2 | 0 | 3 | 0 |
| 2 | *Pteropus giganteus* | 24 | 0 | 23 | 45 | 0 | 23 | 45 | 0 | 34 | 0 |
| 3 | *Cynopterus sphinx* | 5 | 5 | 0 | 5 | 0 | 2 | 4 | 5 | 0 | 2 |
| 4 | *Cynopterus brachyotis* | 2 | 2 | 0 | 4 | 4 | 5 | 3 | 2 | 4 | 5 |
| 5 | *Latidens salimalii* | 2 | 0 | 0 | 2 | 0 | 0 | 2 | 1 | 0 | 0 |
| 6 | *Eonycteris spelaea* | 2 | 3 | 0 | 1 | 3 | 4 | 0 | 2 | 1 | 3 |
| 7 | *Rhinopoma hardwickii* | 2 | 3 | 0 | 0 | 1 | 3 | 3 | 1 | 1 | 3 |
| 8 | *Taphozous longimanus* | 1 | 2 | 3 | 2 | 3 | 1 | 3 | 4 | 5 | 2 |
| 9 | *Taphozousmelanopogon* | 2 | 3 | 4 | 0 | 2 | 0 | 4 | 3 | 2 | 0 |
| 10 | *Megaderma lyra* | 3 | 4 | 5 | 2 | 0 | 1 | 2 | 3 | 0 | 0 |
| 11 | *Megadermaspasma* | 0 | 2 | 3 | 6 | 0 | 3 | 2 | 0 | 3 | 0 |
| 12 | *Rhinolophus pusillus* | 2 | 3 | 0 | 5 | 2 | 0 | 4 | 3 | 2 | 0 |
| 13 | *Rhinolophus rouxii* | 6 | 3 | 5 | 5 | 3 | 3 | 6 | 4 | 2 | 7 |
| 14 | *Rhinolophus indo rouxii* | 3 | 0 | 0 | 2 | 0 | 0 | 2 | 4 | 0 | 3 |
| 15 | *Rhinolophus Lepidus* | 4 | 4 | 7 | 6 | 2 | 2 | 6 | 5 | 4 | 4 |
| 16 | *Rhinolophus beddomei* | 2 | 0 | 0 | 0 | 0 | 3 | 2 | 4 | 0 | 2 |
| 17 | *Hipposiderosspeoris* | 6 | 3 | 0 | 4 | 3 | 0 | 3 | 4 | 0 | 3 |
| 18 | *Hipposideros fulvus* | 0 | 1 | 2 | 4 | 5 | 0 | 2 | 2 | 3 | 4 |
| 19 | *Hipposideros galeritus* | 1 | 2 | 3 | 2 | 0 | 1 | 3 | 4 | 0 | 2 |
| 20 | *Hipposidero sater* | 2 | 0 | 0 | 2 | 2 | 0 | 0 | 4 | 3 | 2 |
| 21 | *Hipposideros pomona* | 0 | 2 | 0 | 2 | 7 | 1 | 2 | 3 | 0 | 0 |
| 22 | *Tadarida aegyptiaca* | 0 | 2 | 3 | 0 | 0 | 3 | 2 | 0 | 3 | 0 |
| 23 | *Scotophilus kuhlii* | 0 | 3 | 0 | 0 | 2 | 0 | 4 | 0 | 2 | 0 |
| 24 | *Scotophilus heathii* | 0 | 3 | 0 | 0 | 3 | 3 | 0 | 1 | 2 | 0 |
| 25 | *Pipistrellus coromandra* | 3 | 4 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 3 |
| 26 | *Pipistrellus tenuis* | 4 | 0 | 0 | 6 | 2 | 2 | 0 | 5 | 4 | 4 |
| 27 | *Pipistrellus ceylonicus* | 2 | 4 | 0 | 0 | 0 | 3 | 2 | 4 | 0 | 2 |
| 28 | *Scotozous dormeri* | 6 | 3 | 0 | 4 | 3 | 0 | 3 | 4 | 0 | 3 |
| 29 | *Myotis montivagus* | 2 | 1 | 2 | 4 | 5 | 0 | 2 | 2 | 3 | 4 |
| 30 | *Myotis horsfieldii* | 2 | 4 | 0 | 0 | 0 | 3 | 2 | 4 | 0 | 2 |
| 31 | *Myotis peytoni* | 0 | 3 | 0 | 4 | 3 | 0 | 3 | 4 | 0 | 3 |
| 32 | *Kerivoula picta* | 2 | 1 | 2 | 0 | 5 | 0 | 2 | 2 | 3 | 4 |
| 33 | *Miniopteruspusillus* | 2 | 0 | 0 | 2 | 2 | 0 | 0 | 4 | 3 | 2 |
| | Total | 94 | 74 | 62 | 122 | 66 | 71 | 122 | 88 | 87 | 69 |
| | Site wise Diversity H' | 3.27 | 2.88 | 2.65 | 2.84 | 2.42 | 2.65 | 2.76 | 2.74 | 2.83 | 2..63 |


**Fig. 5. Total number of individuals in each site of the study area**

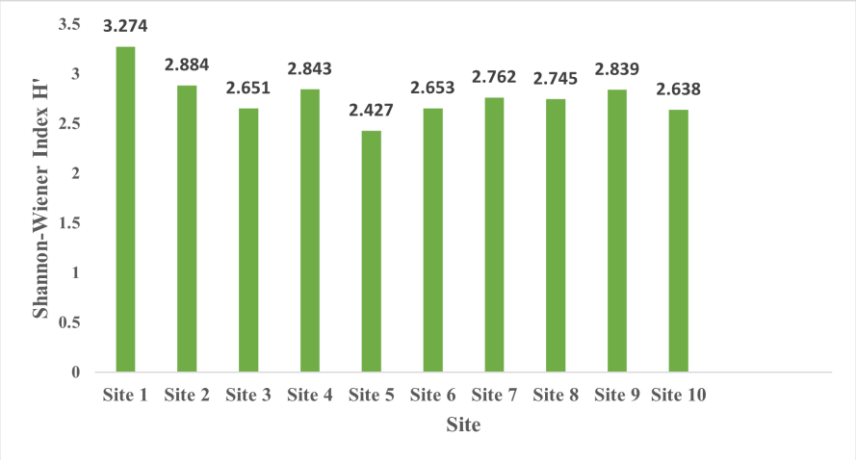



**Fig. 6. Site wise diversity of bats in the study area**

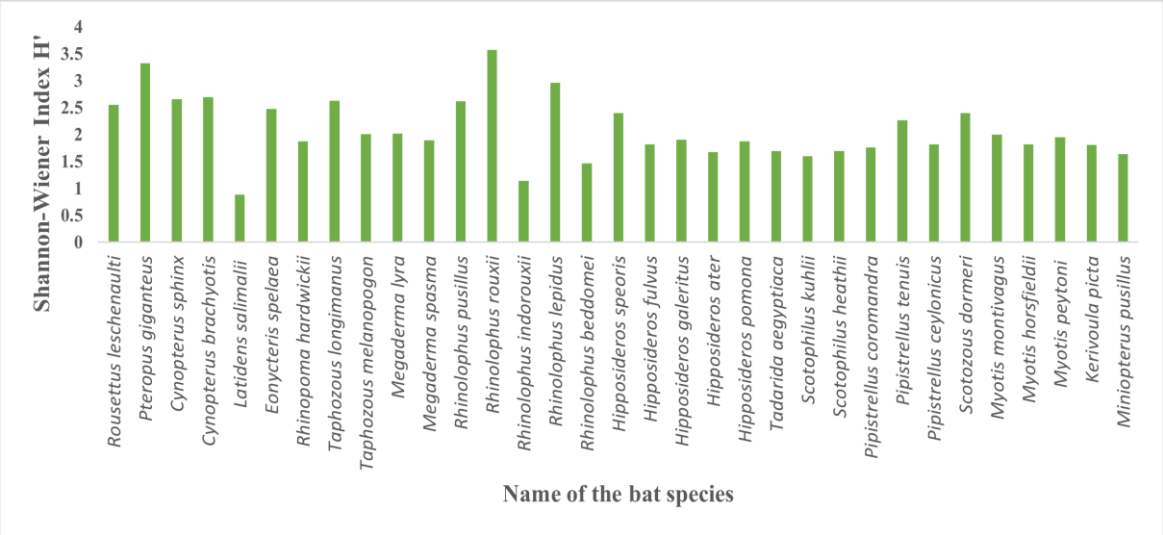



**Fig. 7. Bat species diversity in the study area**

*Latiden salimalii* *Rhinolophus rouxii* *Rhinolophus beddomei* *Hipposideros galeritus*

**Plate 1. Endangered, near threatened species representative Bat species in the study area**

**Table 4. Species Diversity in the study area**

| Sl No | Species | No of Individuals | Shannon-Wiener index H' |
|---|---|---|---|
| 1 | *Rousettus leschenaulti* | 21 | 2.55 |
| 2 | *Pteropus giganteus* | 194 | 3.32 |
| 3 | *Cynopterus sphinx* | 28 | 2.66 |
| 4 | *Cynopterus brachyotis* | 27 | 2.70 |
| 5 | *Latidens salimalii* | 5 | 0.89 |
| 6 | *Eonycteris spelaea* | 19 | 2.4783 |
| 7 | *Rhinopoma hardwickii* | 16 | 1.8724 |
| 8 | *Taphozous longimanus* | 23 | 2.6312 |
| 9 | *Taphozous melanopogon* | 23 | 2.0129 |
| 11 | *Megaderma lyra* | 17 | 2.0168 |
| 12 | *Megaderma spasma* | 17 | 1.8964 |
| 13 | *Rhinolophus pusillus* | 17 | 2.6186 |
| 14 | *Rhinolophus rouxii* | 47 | 3.5773 |
| 15 | *Rhinolophus indorouxii* | 14 | 1.1439 |
| 16 | *Rhinolophus lepidus* | 48 | 2.959 |
| 17 | *Rhinolophus beddomei* | 13 | 1.47 |
| 18 | *Hipposideros speoris* | 26 | 2.4009 |
| 19 | *Hipposideros fulvus* | 23 | 1.8151 |
| 20 | *Hipposideros galeritus* | 20 | 1.9056 |
| 21 | *Hipposideros ater* | 17 | 1.673 |
| 22 | *Hipposideros pomona* | 17 | 1.8753 |
| 23 | *Tadarida aegyptiaca* | 13 | 1.6989 |
| 24 | *Scotophilus kuhlii* | 11 | 1.596 |
| 25 | *Scotophilus heathii* | 12 | 1.6989 |
| 26 | *Pipistrellus coromandra* | 16 | 1.7646 |
| 27 | *Pipistrellus tenuis* | 23 | 2.2679 |
| 28 | *Pipistrellus ceylonicus* | 17 | 1.8199 |
| 29 | *Scotozous dormeri* | 26 | 2.4009 |
| 30 | *Myotis montivagus* | 23 | 1.9991 |
| 31 | *Myotis horsfieldii* | 19 | 1.8199 |
| 32 | *Myotis peytoni* | 20 | 1.9558 |
| 33 | *Kerivoula picta* | 24 | 1.8104 |
| 10 | *Miniopterus pusillus* | 15 | 1.6356 |
| Total | | 851 | |

## 4. DISCUSSION

Bat species representation in the study area is the indication of chiropteran species richness in southern Western Ghats. The lengthy rainfall season and high humidity levels maintain floral community, faunal community are also responsible for the distribution of bat species [14]. Previous studies on distribution of amphibians, angiosperms, birds, butterflies and fishes have shown that southern Western Ghats is rich in species [15-17]. Food resources like Insects and Fruiting trees are abundant in the study area leads to rich diversity of bat species.

The study conducted in the Munnar landscape of the Western Ghats region revealed a total of 33 bat species belonging to two suborders. The predominant suborder was Microchiroptera, representing 81.8% of the bat species, while Megachiroptera accounted for the remaining 18.2% [18-20]. Salim Ali's fruit bat (*Latidens salimalii*), an endemic and endangered species, was documented, underscoring the importance of the Munnar landscape for conservation efforts [10,21]. A significant bat hotspot in India, the Western Ghats (WG) range of mountains in peninsular India is a habitat for 63 different species [12] and 33 species recorded in KMTR, Southern Western Ghats [14]. Reach a total of 42 documented bat species in Kerala [11], the understanding of the diversity and distribution of bat species in the Munnar landscape. Other

near-threatened species, such as *Rhinolophus rouxii, Rhinolophus beddomei,* and *Hipposideros galeritus*, were also identified, emphasizing the ecological significance of the region [18]. *Pteropus giganteus* was the most abundant species observed, followed by *Rhinolophus lepidus* and *Rhinolophus rouxii. Latidens salimalii* ), an endemic and endangered species was observed in lower numbers.

The IUCN [22] Red List assessments contribute to expanding our understanding of landscape-level biodiversity. The majority (75.75%) of bat species were classified as least concern. However, the endemic endangered species *Latiden salimalii* was identified as threatened due to its limited distribution and specific habitat requirements. Due to insufficient research and reporting, 6.06% of species were categorized as vulnerable, while 9.09% were close to being endangered.

Further research with larger sample sizes and extended survey periods would enhance our understanding of bat species diversity in the Munnar landscape. These findings contribute to the knowledge of bat diversity and conservation in the Western Ghats region, specifically highlighting the importance of the Munnar landscape for bat conservation. They provide valuable insights for future research and conservation initiatives aimed at protecting bat populations and their habitats in this ecologically significant area.

## 5. CONCLUSION

We highlight the presence of diverse bat species in the Munnar landscape of the Western Ghats region. The identification of 33 bat species belonging to two suborders, with Microchiroptera being the predominant group, indicates the richness of bat fauna in the area. The documentation of Salim Ali's fruit bat (*Latidens salimalii*), an endemic and endangered species, emphasizes the importance of the Munnar landscape for conservation efforts. The presence of other near-threatened species further underscores the ecological significance of the region. These findings provide valuable insights for future research and conservation initiatives aimed at protecting bat populations and their habitats in this ecologically significant landscape.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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