

**SUPPLEMENTARY MATERIAL****Annotated checklist, distribution and regional status of the bats (Mammalia: Chiroptera) of Kerala, South India**

Sreehari Raman, Akhil Padmarajan, Muhammed A. Faizal, Akhil A. Da<sup>3</sup>, Pooja Ushakumari, Sweta Singh, Alice C. Hughes

**Supplementary material 1: Key to the bat families and bat species seen in Kerala**

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|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| 1A | Large eyes; simple ear without tragus and anti-tragus; simple nose without any complex structure; second digit with claws (except <i>E. spelaea</i> ); tail is either very short or absent                             | <b>Family Pteropodidae</b>     |
| 1B | Eyes medium to small; ear pinna with distinctive tragus and/or antitragus; second digit without claws; tail and tail membrane are present (except one family-Megadermatidae)                                           | Go to 2                        |
| 2A | Muzzle with nose-leaf like structure                                                                                                                                                                                   | 3                              |
| 2B | Simple muzzle without any complex nose-leaf like structure                                                                                                                                                             | 4                              |
| 3A | Large oval-shaped ears; prominent and erected nose-leaf; bifid tragus; eyes medium to small; tail absent; emits short multi-harmonic frequency-modulated (FM) echolocation calls                                       | <b>Family Megadermatidae</b>   |
| 3B | Anterior nose-leaf horseshoe shaped; tragus absent; antitragus present; tail present and enclosed completely within the tail membrane                                                                                  | 5                              |
| 4A | Tail emerging on the upper surface from the mid-point of the tail membrane; well-developed and club-shaped tragus; wings are long and narrow; emits shallow frequency long multi-harmonic calls                        | <b>Family Emballonuridae</b>   |
| 4B | Stout tail emerging out of the outer edge of the tail membrane; wrinkled upper lip; small fleshy ears and sometimes joined across forehead; well-developed antitragus; emits shallow long duration FM calls            | <b>Family Molossidae</b>       |
| 4C | Characteristic very long and slender tail, with the longest part projecting free from the membrane; thickened narial pad present on the end of the muzzle; emits short duration multi-harmonic CF or slightly FM calls | <b>Family Rhinopomatidae</b>   |
| 4D | Well-developed tail membrane and the tail is completely enclosed within membrane or the last one or two vertebrae are projecting out from the membrane; tragus present                                                 | 6                              |
| 5A | Presence of sella between the nostrils; lancet pointed and raising to near or above the forehead; emits constant frequency (CF) calls with an FM component at the end                                                  | <b>Family Rhinolophidae</b>    |
| 5B | Noseleaf without sella or lancet; supplementary leaflets may or may not be present; notch-like antitragus; emits CF calls with an initial and terminal FM component                                                    | <b>Family Hipposideridae</b>   |
| 6A | Second phalanx of third finger much longer than first, the lengthened distal part folds upon the wing at rest; emits pure broadband FM calls                                                                           | <b>Family Miniopteridae</b>    |
| 6B | Second phalanx of third finger is almost same or slightly longer than the first; emits broad band FM calls                                                                                                             | <b>Family Vespertilionidae</b> |

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**Key to the bat family Pteropodidae (6 species)**


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|-----|------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|
| 1a. | Very large size, FA 145–183mm                                                                                                                  | <i>Pteropus medius</i>                       |
| 1b. | Medium size; FA < 90mm                                                                                                                         | 2                                            |
| 2a. | Short and board muzzle (Fig. 10A)                                                                                                              | 3                                            |
| 2b. | Slender and long muzzle (Fig. 10B)                                                                                                             | 4                                            |
| 3a. | Tail absent, one pair of upper and lower incisors, FA 66–70.55mm                                                                               | <i>Latidens salimalii</i>                    |
| 3b. | Short tail present, ears with white border, FA 64–79.0mm                                                                                       | <i>Cynopterus sphinx</i>                     |
| 3c. | Short tail present, ears with pale border or absent, FA 57.3–63.3mm                                                                            | <i>Cynopterus brachyotis<br/>ceylonensis</i> |
| 4a. | Second digit without claw, kidney shaped glands on either side of the genital organ, FA 66–78mm                                                | <i>Eonycteris spelaea</i>                    |
| 4b. | Second digit with claw, FA 75.0–90.0mm; emits echolocation calls using tongue clicks having a frequency of maximum energy (FmaxE) of 23.29kHz. | <i>Rousettus leschenaultii</i>               |

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**Key to the bat family Emballonuridae (3 species)**


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| 1a. | Wings attached to ankle, naked chin                                                                                                            | 2                              |
| 1b. | Wings attached to tibiae, hairy chin, males have a black beard, prominent radio-metacarpal pouch; FA 60–68mm; FmaxE 29.71kHz.                  | <i>Taphozous melanopogon</i>   |
| 2a. | Gular sac present, radio-metacarpal pouch inconspicuous or absent; pelage is black with irregular white patches; FA 63–68.2mm; FmaxE 32.03kHz. | <i>Saccolaimus saccolaimus</i> |
| 2b. | Prominent radio-metacarpal pouch, gular sac present only in males; FA 55.6–62.0mm; FmaxE 30.83kHz.                                             | <i>Taphozous longimanus</i>    |

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**Key to the bat family Megadermatidae (2 species)**


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|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| 1a. | Short (~6.5mm) and convex sided noseleaf with longitudinal ridge and a distinctly heart-shaped base; inner margins of the ears fused at about 15% or less of its height; FA: 54.0–62.0mm; FmaxE 60.37kHz. | <i>Megaderma spasma</i> |
| 1b. | Tall (~10mm) and straight sided noseleaf with longitudinal ridge and a simple rounded horizontal base; inner margins of the ears fused at about 30% of its height; FA: 56.0–71.5mm; FmaxE 45.8kHz.        | <i>Lyroderma lyra</i>   |

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**Key to the bat family Molossidae (3 species)**


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| 1a. | Ears joint across forehead; FA 43.1–50.2mm; FmaxE 23.65kHz.                               | <i>Mops plicatus</i>       |
| 1b. | Ears separated                                                                            | 2                          |
| 2a. | Relatively large molossid; three pairs of lower incisors; FA 58.4–63.9mm; FmaxE 12.47kHz. | <i>Tadarida teniotis</i>   |
| 2b. | Small molossid; usually two pairs of lower incisors; FA 46–52.3mm; FmaxE 19.44kHz.        | <i>Tadarida aegyptiaca</i> |

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**Key to the bat family Rhinopomatidae (1 species)**


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| 1. | Tail length > FA length; ears are joined across the forehead; simple ears with a well-developed tragus; FA 52.9–64.0; FmaxE 32.48kHz. | <i>Rhinopoma hardwickii</i> |
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**Key to the bat family Rhinolophidae (5 species)**

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| 1a. | Sella type 1 (Fig. 10C)                                                                      | 2                             |
| 1b. | Sella type 2 (Fig. 10D)                                                                      | 3                             |
| 1c. | Sella type 3 (Fig. 10E); woolly textured body hairs                                          | 4                             |
| 2a. | Bluntly pointed lancet (Fig. 10F); FA 37–43.26mm; FmaxE 100.02kHz.                           | <i>Rhinolophus lepidus</i>    |
| 2b. | Broadly pointed lancet (Fig. 10G); FA 34.9–37.8mm                                            | <i>Rhinolophus pusillus</i>   |
| 3a. | Comparatively smaller; FA 46.7–50.71mm; FmaxE 81.46kHz.                                      | <i>Rhinolophus rouxii</i>     |
| 3b. | Comparatively bigger; FA 50.1–52.29mm; FmaxE 93.38kHz.                                       | <i>Rhinolophus indorouxii</i> |
| 4.  | Parallel sided lancet and becomes narrower at its proximal end; FA 55–64.3mm; FmaxE 43.2kHz. | <i>Rhinolophus beddomei</i>   |

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**Key to the bat family Hipposideridae (6 species)**

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| 1a. | Supplementary leaflets are absent                                                                                                                                 | 2                             |
| 1c. | Two pairs of supplementary leaflets; FA 43.3–51.3mm; FmaxE 113.43kHz.                                                                                             | <i>Hipposideros galeritus</i> |
| 1d. | Three pairs of supplementary leaflets; FA 45.6–54mm; FmaxE 125.46kHz.                                                                                             | <i>Hipposideros speoris</i>   |
| 1e. | Four pairs of supplementary leaflets; FA 75–99mm; FmaxE 78.33kHz.                                                                                                 | <i>Hipposideros lankadiva</i> |
| 2a. | Triangle shaped internarial septum with blunt tip (Fig. 10H); FA 34.9–38mm; FmaxE 164.97kHz.                                                                      | <i>Hipposideros ater</i>      |
| 2b. | Tower shaped internarial septum (Fig. 10I); FA 38.4–44mm; FmaxE 153.53kHz.                                                                                        | <i>Hipposideros fulvus</i>    |
| 2c. | Broad internarial septum with parallel sides, becomes wider as it is nearing the proximal end and broadly rounded tip (Fig. 10J); FA 38.4–45.1mm; FmaxE 124.4kHz. | <i>Hipposideros pomona</i>    |

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**Key to the bat family Miniopteridae (2 species)**

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| 1a. | Hairs on the interfemoral membrane close to the body; FA 44.7–48.35mm; FmaxE 52.61kHz.                    | <i>Miniopterus fuliginosus</i> |
| 1b. | Hairs on the interfemoral membrane extend further away from body parts; FA 35.56–42.05mm; FmaxE 65.99kHz. | <i>Miniopterus pusillus</i>    |

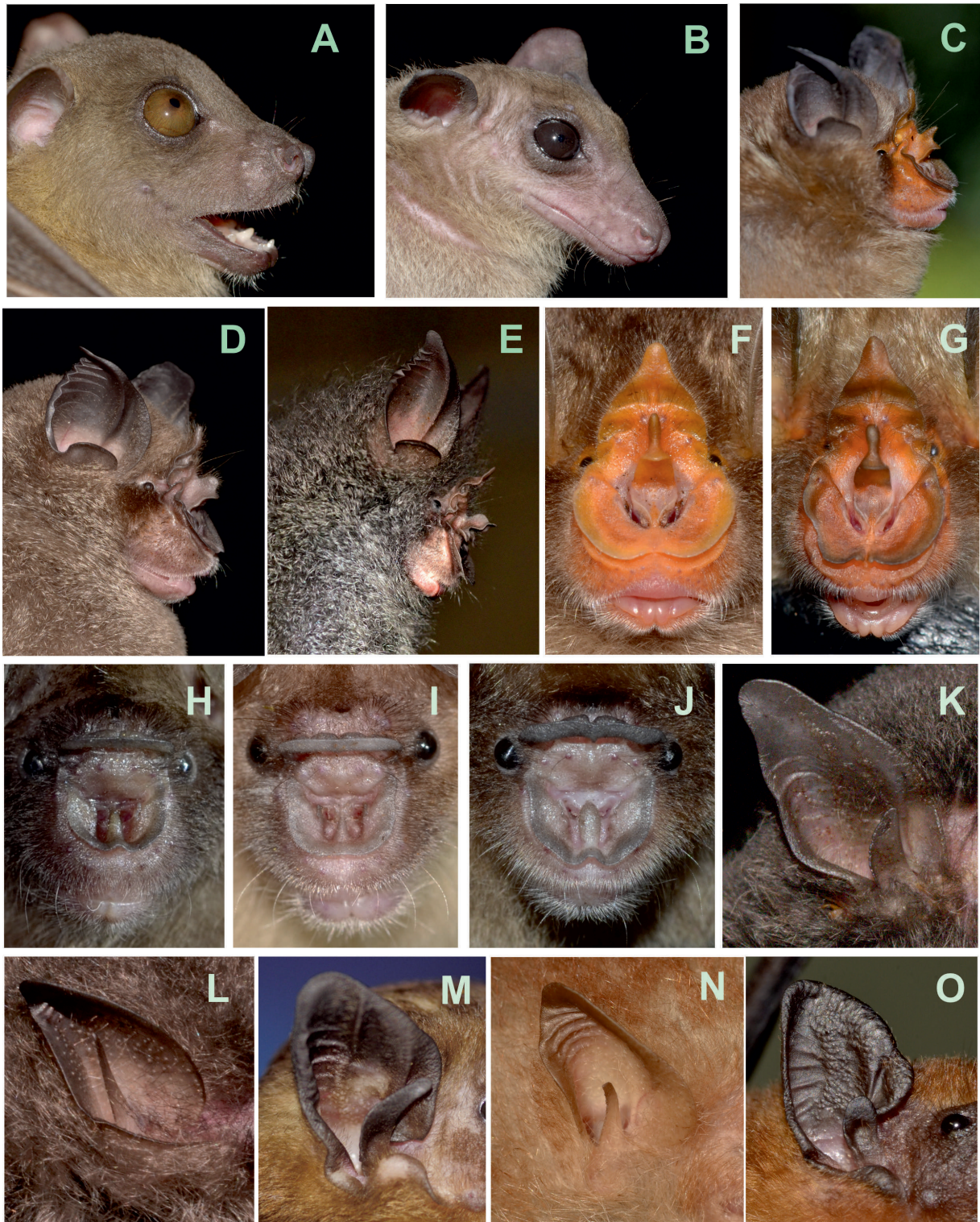
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**Key to the bat family Vespertilionidae (17 species)**

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| 1a. | Tragus: slender, short, bluntly pointed more or less straight (Fig. 10K)                            | 2                         |
| 1b. | Tragus: long and narrow; funnel shaped ears (Fig. 10L)                                              | 3                         |
| 1c. | Tragus: elongated crescent shaped tragus (Fig. 10M)                                                 | 4                         |
| 1d. | Tragus: large triangle shape, slightly convex anteriorly and concave on posterior border (Fig. 10N) | 5                         |
| 1e. | Tragus: short, crescent shape and forward facing (Fig. 10O)                                         | 6                         |
| 2a. | Wings attached to the outer metatarsal of each foot; FA 36.5–41.5mm; FmaxE 53.8kHz.                 | <i>Myotis horsfieldii</i> |
| 2b. | Wings attached to the base of the outer phalanx of each foot; FA 42.07–46.8mm; FmaxE 48.99kHz.      | <i>Myotis peytoni</i>     |

- 3a. Wing membranes parti-coloured orange and black, interfemoral membrane orange to scarlet and hairy above; FA 31.5–37.9mm; FmaxE 115.81kHz. ***Kerivoula picta***
- 3b. Grey-brown to brown coloured woolly fur; FA 30–33.38mm; FmaxE 132.24kHz. ***Kerivoula hardwickii***
- 3c. Four banded body hairs ending with golden tips, tragus white; FA 35.3–38.2mm; FmaxE 113.79kHz. ***Phoniscus jagorii***
- 4a. Comparatively larger; ventral pelage with distinctly yellow tinge; FA 55.4–65.8mm; FmaxE 41.20kHz. ***Scotophilus heathii***
- 4b. Comparatively smaller, ventral pelage buffy brown; FA 44–56.4mm; FmaxE 49.03kHz. ***Scotophilus kuhlii***
- 5a. Forward facing broad ears with 5–6 furrows and joined at the base over forehead; FA 38.7–42.1mm; FmaxE 29.23kHz. ***Barbastella darjelingensis***
- 5b. Nostrils prominent and tubular, extensive hairs on tail membrane and base of wings, FA 44.1–50.1mm; FmaxE 88.17kHz. ***Harpiocephalus harpia***
- 5c. Tubular nostril, smaller size, FA <40mm; FmaxE 110.48kHz. ***Murina sp.***
- 6a. Distinct yellowish-brown fur and ears, FA 50–60.4mm; FmaxE 28.32kHz. ***Hesperoptenus tickelli***
- 6b. Soles of the feet and thumb have circular fleshy pads; head noticeably flattened, FA 26.1–29mm; FmaxE 72.84kHz. ***Tylonycteris pachypus***
- 6c. Very small, interfemoral membrane haired near the body both above and below; FA 25.5–34.3mm; FmaxE 57.97kHz. ***Pipistrellus coromandra***
- 6d. Very small, interfemoral membrane not haired, FA 25–30.5mm; FmaxE 37.8kHz. ***Pipistrellus tenuis***
- 6f. Medium size, interfemoral membrane sparsely haired above and below, FA 33–42mm; FmaxE 41.65kHz. ***Pipistrellus ceylonicus***
- 6g. Medium size, interfemoral membrane not haired, broad rounded ears, FA 38.4–41.4mm; FmaxE 77.9kHz. ***Hypsugo affinis***
- 6h. First upper incisor without secondary cusp but possess a distinct posterior cingular cusp. Second upper incisor is absent or minute when present, FA 32.7–37mm ***Scotozous dormeri***



**Fig. 10** - Key identification characteristics of bat species showing A: short and board muzzle of *C. sphinx*; B: slender and long muzzle of *E. spelaea*; C: sella structure of *R. Lepidus*; D: sella of *R. indorouxii*; E: sella of *R. beddomei*; F: bluntly pointed lancet of *R. lepidus*; G: broadly pointed lancet of *R. pusillus*; H: internarial septum of *H. ater*; I: internarial septum of *H. fulvus*; J: internarial septum of *H. pomona*; K: ear and tragus of *M. peytoni*; L: tragus of *K. hardwickii*; M: tragus of *S. heathii*; N: tragus of *H. harpia* and O: tragus of *T. pachypus*. Images: Sreehari Raman

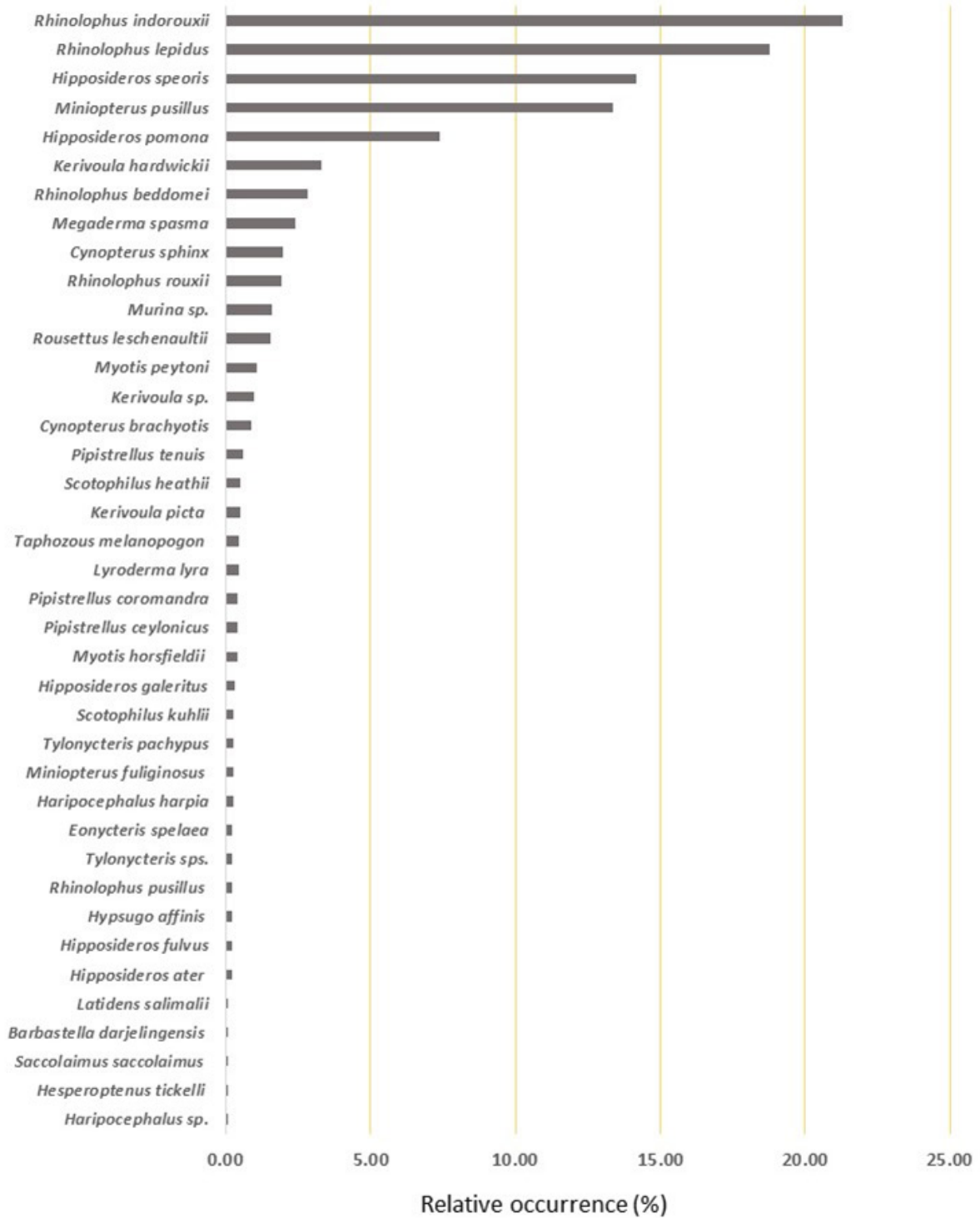


Fig. 2 - Relative occurrence of bat species in Kerala based on the sampling frequency.

**Table 1** - Location details of the 43 trapping stations included in the present study in Kerala. WLS: Wildlife Sanctuary, NP: National Park, TR: Tiger Reserve, RF: Reserved Forest, FD: Forest Division

#	Location	Latitude (N)	Longitude (E)	Habitat type	Alt (m)	Trapping effort	
						Harp trapping	Mist netting
1	Neyyar WLS	8.53722	77.25485	Evergreen	300	12	2
2	Neyyar WLS	8.598637	77.22492	Evergreen	497	12	1
3	Neyyar WLS	8.619768	77.21822	Evergreen	910	12	1
4	Periyar TR	9.43508	76.94604	Evergreen	124	12	2
5	Periyar TR	9.52846	77.11563	Evergreen	824	12	1
6	Periyar TR	9.436004	77.15986	Evergreen	1155	12	1
7	Nelliyampathy RF	10.52548	76.63366	Evergreen	248	12	2
8	Nelliyampathy RF	10.52899	76.69319	Evergreen	560	12	2
9	Nelliyampathy RF	10.52773	76.69319	Evergreen	1016	12	1
10	Wayanad South FD	11.50378	76.22541	Evergreen	201	12	1
11	Wayanad South FD	11.45723	76.19394	Evergreen	524	12	1
12	Wayanad South FD	11.48003	76.14985	Evergreen	1061	12	2
13	Kasargod FD	12.52909	75.26044	Evergreen	254	12	1
14	Kasargod FD	12.42682	75.32735	Evergreen	674	12	2
15	Kasargod FD	12.4145	75.36603	Evergreen	866	12	1
16	Neyyar WLS	8.544237	77.24234	Deciduous	209	12	1
17	Neyyar WLS	8.578024	77.23931	Deciduous	588	12	1
18	Neyyar WLS	8.5836	77.24578	Deciduous	862	12	1
19	Periyar TR	9.442451	76.94702	Deciduous	253	12	2
20	Periyar TR	9.441251	76.95979	Deciduous	506	12	1
21	Periyar TR	9.58498	77.18161	Deciduous	995	12	1
22	Peechi WLS	10.53075	76.37845	Deciduous	95	12	1
23	Peechi WLS	10.49563	76.40981	Deciduous	461	12	1
24	Nelliyampathy RF	10.50036	76.6763	Deciduous	940	12	1
25	Nilambur RF	11.42687	76.38291	Deciduous	224	12	2
26	Nilambur RF	11.42687	76.34808	Deciduous	529	12	1
27	Nilambur RF	11.5318	76.16305	Deciduous	887	12	1
28	Kasargod FD	12.5765	75.28457	Deciduous	141	12	1
29	Kasargod FD	12.46966	75.43179	Deciduous	538	12	1
30	Kasargod FD	12.42328	75.35726	Deciduous	809	12	1
31	Shendhuruni WLS	8.871058	77.11615	Evergreen	607	4	1
32	Shendhuruni WLS	8.896691	77.13133	Evergreen	194	4	1
33	Silent Valley NP	11.10826	76.51909	Evergreen	843	6	1
34	Silent Valley NP	11.09365	76.44589	Evergreen	995	6	1
35	Eravikulam NP	10.13411	77.04394	Evergreen	1567	2	1
36	Mathikettanshola NP	10.00487	77.13247	Evergreen	1003	2	1
37	Pampadumshola NP	10.14420	77.26837	Evergreen	2243	2	1
38	Anamudishola NP	10.19043	77.17835	Evergreen	2034	2	1
39	Chinnar WLS	10.33279	77.21911	Riverine	463	2	1
40	Dhoni, Palakkad FD	10.85952	76.62287	Deciduous	119	2	1
41	Walayar, Palakkad FD	10.85054	76.75150	Deciduous	420	2	1
42	Mankulam FD	10.11321	76.92739	Deciduous	679	2	1
43	Vazhachal FD	10.27775	76.85437	Deciduous	942	2	1