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SHORT COMMUNICATION

A FIRST RECORD OF THREE HITHERTO UNREPORTED SPECIES OF BATS FROM KERALA, INDIA WITH A NOTE ON *MYOTIS PEYTONI* (MAMMALIA: CHIROPTERA: VESPERTILIONIDAE)

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A first record of three hitherto unreported species of bats from Kerala, India with a note on *Myotis peytoni* (Mammalia: Chiroptera: Vespertilionidae)

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Abstract: We provide specimen-based evidence and echolocation calls of an additional three species of bats in Kerala, India. A brief note on the taxonomy and nomenclature of Peyton's Whiskered Myotis, and an updated checklist of bats of Kerala is also included.

Keywords: Checklist, *Hipposideros galeritus*, *Miniopterus fuliginosus*, new records, *Rhinopoma hardwickii*.

Bats provide valuable ecosystem services, yet are threatened by habitat loss, roost destruction and superstitious beliefs leading to persecution and population reductions (Kunz et al. 2011). Inventories of bat species are important for understanding species diversity, ecological niches, and threats before effective conservation of bats and their habitats can be implemented. The bat fauna of Kerala is represented by 29 species (Nameer 2015). A recent survey conducted by us in parts of Kerala found the presence of three hitherto unreported species of bats. We additionally add a new distribution record of a *Myotis* species with a note on its updated nomenclature.

Study area and Methods

Bat surveys spanning 19 days between 12–31 October 2016 were conducted in 13 localities in four districts of Kerala. The details of the localities from where the new records are reported are as follows:

Kozhikode District: Surveys were conducted between 15–19 October 2016 in Tusharagiri, Janakikadu, and parts of Chempanodu, and Veliangad forest blocks. The topography of the area is dominated by steep hills covered with vegetation with elevations ranging from

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40–1,506 m interspersed with fast flowing streams. The vegetation is of west-coast tropical evergreen, west-coast semi-evergreen, southern moist mixed deciduous, southern hilltop evergreen forests, grasslands, and marshy grasslands. We observed six species of bats roosting in tree hollows, crevices in the walls of houses, and caves, in southern hilltop evergreen forests, moist mixed deciduous forests, and banana plantations in this district.

Palghat District: Surveys were conducted on 21 and 22 October 2016, in and around Sairandhri (11.087N & 76.454E) in Silent Valley National Park, which has an undulating terrain with steep ridges and high hills. The elevation ranges between 900–2,383 m. The vegetation of the national park is classified under four types namely west-coast tropical evergreen forest, southern subtropical broad-leaved hill forest, southern montane wet temperate forest and grasslands. Bats were observed flying about in the canopy of the forest. The Akathethara (10.814N & 76.644E) forest block in Walayar range was surveyed on 24 October 2016. The terrain is undulating with gentle hills covered with grass and shrubs. Here two species of bats were observed roosting in deep crevices within a shallow cave among large boulders.

Bats were caught using mist nets and hoop nets, photographed, measured and released at the site of capture. One male and one female individual of each bat species were retained as vouchers, euthanized humanely by exposure to a cotton ball dipped in ether, preserved in absolute ethanol and deposited in the collection of the Natural History Museum of Osmania University, Hyderabad. Wing biopsies were taken from the specimens for molecular analysis. External and craniodental measurements were taken using a digital vernier caliper to the nearest 0.01mm. External measurements (in mm) included: FA - forearm length, E - ear length, Tl - tail length, Tib - tibia length, Hf - hindfoot length, 3mt - third metacarpal, 4mt - fourth metacarpal, 5mt - fifth metacarpal, 1ph3mt - first phalanx of third metacarpal, 2ph3mt - second phalanx of third metacarpal, 1ph4mt - first phalanx of fourth metacarpal, and 2ph4mt - second phalanx of fourth metacarpal. Craniodental measurements (in mm) included: GTL - greatest length of the skull, CBL - condylobasal length, CCL - condylocanine length, CM^3 - maxillary toothrow, C^1-C^1 - anterior palatal width, M^3-M^3 - posterior palatal width, ZB - zygomatic breadth, BB - braincase breadth, CM_3 - mandibular toothrow, and M - mandible length. Bats were identified following Bates & Harrison (1997) and Srinivasulu et al. (2010).

Echolocation calls of the bats were recorded using Pettersson D500X (Pettersson Electronik AB) - a full spectrum bat detector with a sampling frequency of 500kHz. Recordings of echolocation calls were made from hand-held individuals in the case of bats using constant frequency (CF) calls and hand-released free flying for the bats using frequency-modulated (FM) and frequency-modulated /quasi constant frequency (FM/QCF) calls. The recorded calls were analyzed using BatSound Pro v4.0 (Pettersson Elektronik AB). Two call parameters, namely—frequency of maximum energy (FMAXE in kHz) and duration (d in ms) were measured for the CF calls, while for the FM and FM/QCF calls, four parameters, namely— frequency of maximum energy (FMAXE in kHz), duration (d in ms), start frequency (Fs in kHz) and end frequency (Fe in kHz) were measured. Only the calls with good signal to noise ratio were used for the analysis.

Results

Until 2000, the bat diversity of Kerala was represented by 24 species (Madhavan 2000). A recent checklist reports 29 species of bats from Kerala (Nameer 2015), however the publication does not mention the record of *Hipposideros pomona* from Kerala (Bates & Harrison 1997; Madhavan 2000). The present study adds three more bat species, namely—*Hipposideros galeritus*, *Miniopterus fuliginosus* and *Rhinopoma hardwickii* increasing the total to 33 species (Table 1). During the present survey, we captured individuals of Peyton's whiskered Myotis from a new locality in Kerala. Owing to recent taxonomic changes we discuss this taxon in the present communication.

Rhinopoma hardwickii Gray, 1831 Lesser Mouse-tailed Bat (Image 1)

This species was found roosting in a shallow cave among large boulders at Akathethara section of Walayar range in Palghat District. It is a widespread species and has been reported from Andhra Pradesh, Bihar, Delhi, Gujarat, Karnataka, Madhya Pradesh, Odisha, Rajasthan, Tamil Nadu, Telangana, Uttar Pradesh, West Bengal (Bates & Harrison 1997; authors' personal observations). Four individuals were captured using hoop nets of which one specimen (NHM.OU.CHI.61.2016) was retained as a voucher (Table 2). We observed many individuals of this species in the gaps among the boulders. This is the first record of this species from Kerala.

Echolocation calls: *R. hardwickii* use FM/QCF calls and the echolocation calls were recorded from a hand-released free-flying bat. The echolocation call was

Table 1. Updated checklist of bats of Kerala, India.

Order Chiroptera Blumenbach, 1779		
Family Pteropodidae Gray, 1821		
1.	*Cynopterus sphinx* (Vahl, 1797)	Greater Short-nosed Fruit Bat
2.	*Cynopterus brachyotis* (Müller, 1838)	Lesser Short-nosed Fruit Bat
3.	*Eonycteris spelaea* (Dobson, 1871)	Lesser Dawn Bat
4.	*Pteropus giganteus* (Brunnich, 1782)	Indian Flying Fox
5.	*Rousettus leschenaultii* (Desmarest, 1820)	Fulvous Fruit Bat
Family Rhinolophidae Bell, 1836		
6.	*Rhinolophus pusillus* Temminck, 1834	Least Horseshoe Bat
7.	*Rhinolophus rouxii* Temminck, 1835	Rufous Horseshoe Bat
8.	*Rhinolophus lepidus* Blyth, 1844	Blyth's Horseshoe Bat
9.	*Rhinolophus beddomei* Andersen, 1905	Lesser Woolly Horseshoe Bat
Family Hipposideridae Lydekker, 1891		
10.	*Hipposideros speoris* (Scheneider, 1800)	Schneider's Roundleaf Bat
11.	*Hipposideros fulvus* Gray, 1838	Fulvus Roundleaf Bat
12.	*Hipposideros galeritus* Cantor, 1846*	Cantor's Roundleaf Bat
13.	*Hipposideros ater* Templeton, 1848	Dusky Roundleaf Bat
14.	*Hipposideros pomona* Andersen, 1918	Andersen's Roundleaf Bat
Family Megadermatidae H. Allen, 1864		
15.	*Megaderma spasma* (Linnaeus, 1758)	Lesser False Vampire
16.	*Megaderma lyra* E. Geoffroy, 1810	Greater False Vampire
Family Rhinopomatidae Bonaparte, 1838		
17.	*Rhinopoma hardwickii* Gray, 1831*	Lesser Mouse-tailed Bat
Family Emballonuridae Gervais, 1855		
18.	*Saccolaimus saccolaimus* (Temminck, 1838)	Pouch-bearing Tomb Bat
19.	*Taphozous longimanus* Hardwicke, 1825	Long-winged Tomb Bat
20.	*Taphozous melanopogon* Temminck, 1841	Black-bearded Tomb Bat
Family Molossidae Gill, 1872		
21.	*Tadarida aegyptiaca* (E.Geoffroy, 1818)	Egyptian Free-tailed Bat
Family Vespertilionidae Gray, 1821		
22.	*Scotophilus kuhlii* (Leach, 1821)	Lesser Asiatic Yellow House Bat
23.	*Scotophilus heathii* (Horsfield, 1831)	Greater Asiatic Yellow House Bat
24.	*Pipistrellus tenuis* (Temminck, 1840)	Least Pipistrelle
25.	*Pipistrellus ceylonicus* (Kelaart, 1852)	Kelaart's Pipistrelle
26.	*Scotozous dormeri* (Dobson, 1875)	Dormer's Pipistrelle
27.	*Falsistrellus affinis* (Dobson, 1871)	Chocolate Pipistrelle
28.	*Tylonycteris pachypus* (Temminck, 1840)	Lesser Bamboo Bat
29.	*Myotis horsfieldii* (Temminck, 1840)	Horsfield's Myotis
30.	*Myotis peytoni* Wroughton et Ryley, 1913	Peyton's Whiskered Myotis
31.	*Harpiocephalus harpia* (Temminck, 1840)	Hairy-Winged Bat
32.	*Kerivoula picta* (Pallas, 1767)	Painted Bat
Family Miniopteridae Miller, 1907		
33.	*Miniopterus fuliginosus* (Hodgson, 1835)*	Eastern Bent-wing Bat

* Species are new records for Kerala

Image 1. *Rhinopoma hardwickii* (NHM.OU.CHI.61.2016) from Akatethara, Walayar Range, Palghat District, Kerala, India

typical for a rhinopomatid consisting of a multiharmonic FM component (Fig. 1). The call (n = 1; 12 passes) had a mean FMAXE of 32.48±0.75 kHz (31.3–33.6 kHz), a mean Fs of 37.05/ ± 0.46 kHz (35.8–38 kHz), a mean Fe of 26.66±0.94 kHz (25.6–29 kHz), and a mean duration of 2.21±0.44 ms (1.6–3.1 ms).

Hipposideros galeritus Cantor, 1846 Cantor's Round-leaf Bat (Image 2)

This species was found roosting in a multi-chambered hilltop cave near Veliangad (11.779N & 75.765E) in Kozhikode District. Three individuals were captured using hoop nets, and one male and one female (NHM.OU.CHI.54.2016; NHM.OU.CHI.55.2016) were retained as vouchers, while the third individual was released. Only the main chamber of the cave was accessible while the other chambers were inaccessible. However, we observed many individuals of this species flying in

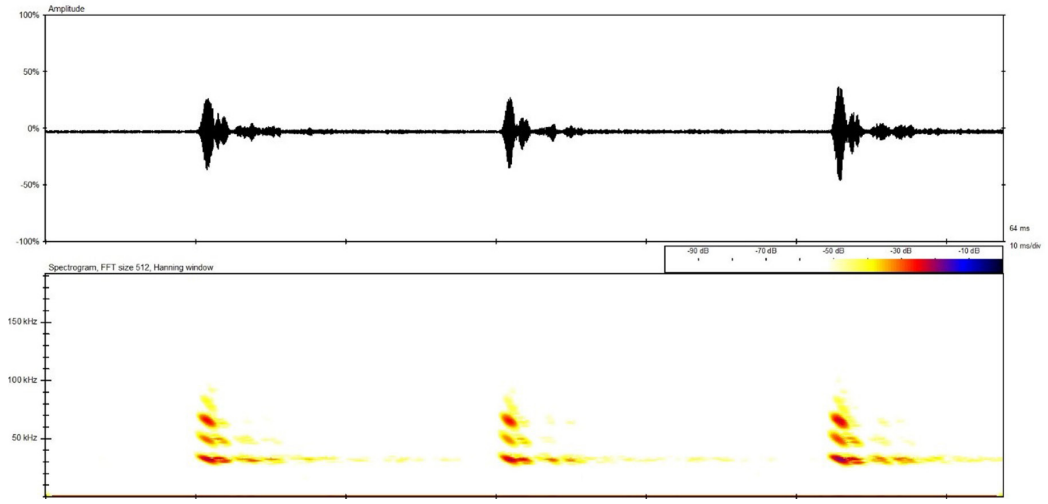

Figure 1. Spectrogram of echolocation call of *Rhinopoma hardwickii* from Kerala

Image 2. *Hipposideros galeritus* (NHM.OU.CHI.54.2016) from Kozhikode District, Kerala, India

and out of these chambers and also entering the main chamber through another opening on the other side of the cave. This species was identified based on the presence of two pairs of supplementary leaflets on either side of the noseleaf, and the external and craniodental measurements (Table 2). In India, *H. galeritus* has been recorded from Andhra Pradesh, Telangana, Odisha, Karnataka, Bihar, Madhya Pradesh, Maharashtra and Gujarat (Bates & Harrison 1997; Srinivasulu 2004, Debata et al. 2015, Srinivasulu et al. 2015). This is the first time this species has been reported from Kerala, and this record constitutes the southern-most distribution of this species in mainland India.

Echolocation call: *H. galeritus* emits CF calls, hence the echolocation calls of this species was recorded from

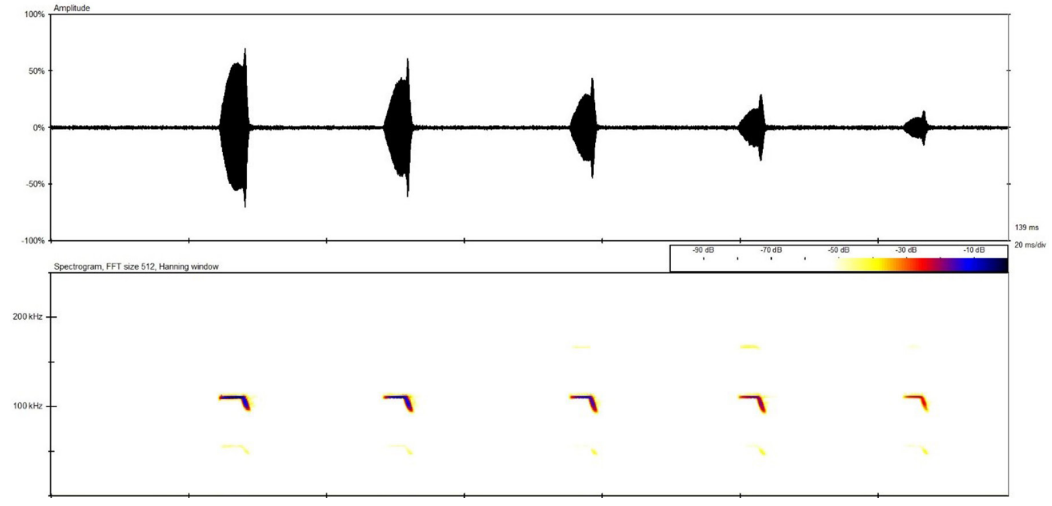

Figure 2. Spectrogram of echolocation call of *Hipposideros galeritus* from Kerala

a hand-held individual. The echolocation call is a typical hipposiderid call consisting of a short CF component followed by a downward FM sweep (Fig. 2). The call (n=1; 9 pulses) had a mean FMAXE of 113.54±0.43 kHz (112.2–114.1 kHz) and a mean duration of 6.65±0.65 ms (5.7–8.6 ms). The echolocation call of *H. galeritus* from Kerala matched with those from other parts of peninsular India (Srinivasulu et al. 2015).

***Miniopterus fuliginosus* Hodgson, 1835 Eastern Bent-wing Bat (Image 3)**

Bates & Harrison (1997) included the taxon *fuliginosus* as a subspecies of *Miniopterus schreibersii* (Kuhl 1819); however, based on morphological and molecular data, the taxon *fuliginosus* has been upgraded as a distinct species: *M. fuliginosus* (Tian et al. 2004). Four individuals were captured in two mist nets put up in different parts of Sairandhri in Silent Valley National Park of which two were retained as vouchers (NHM.OU.CHI.56.2016; NHM.OU.CHI.59.2016). The specimens were identified based on the highly developed second phalanx of the third metacarpal (Table 2). *Miniopterus fuliginosus* is distributed in Maharashtra, Tamil Nadu, Uttarakhand, West Bengal, Sikkim, Arunachal Pradesh and Meghalaya in India (Bates & Harrison 1997). This is the first time this species has been reported from Kerala.

Echolocation calls: This species uses FM calls. Echolocation calls of one hand-released free-flying individual was recorded. The echolocation call is a typical miniopterine call consisting of a broadband FM sweep, followed by a narrowband tail (Fig. 3). The call (n = 1; 9 pulses) had a mean FMAXE of 53.19±1.65 kHz (50.60–55.70 kHz), mean Fs of 97.61±10.35 kHz (70–108 kHz), a mean Fe of 45.80±2.13 kHz (42–54 kHz), and a mean duration of 4.08±1.03 ms (2.6–6.0 ms).

Image 3. *Miniopterus fuliginosus* (NHM.OU.CHI.56.2016) from Sairandhri, Silent Valley National Park, Kerala, India

***Myotis peytoni* Wroughton & Ryley, 1913 Peyton's Whiskered Myotis (Image 4)**

Until recently, this taxon was assigned to *Myotis montivagus* (Dobson, 1874) and listed as its subspecies (Bates & Harrison 1997). Multivariate statistical analysis of the morphometrics and dental characteristics of *M. montivagus* and *M. peytoni* distinguished between these taxa prompting assignment of the nomen *M. montivagus* to the Burmese and eastern populations and recognition of the Indian populations as *M. peytoni*

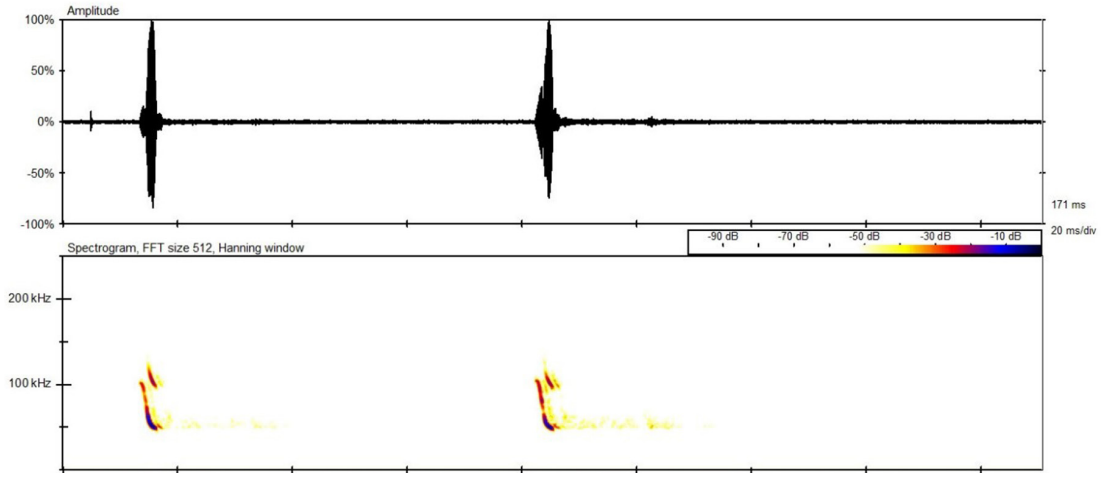

Figure 3. Spectrogram of echolocation call of *Miniopterus fuliginosus* from Kerala

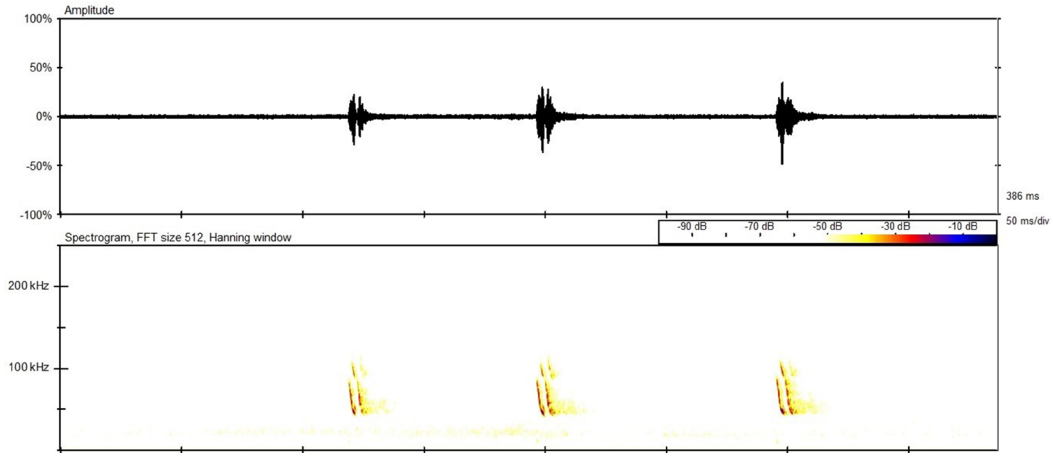

Figure 4. Spectrogram of echolocation call of *Myotis peytoni* from Kerala

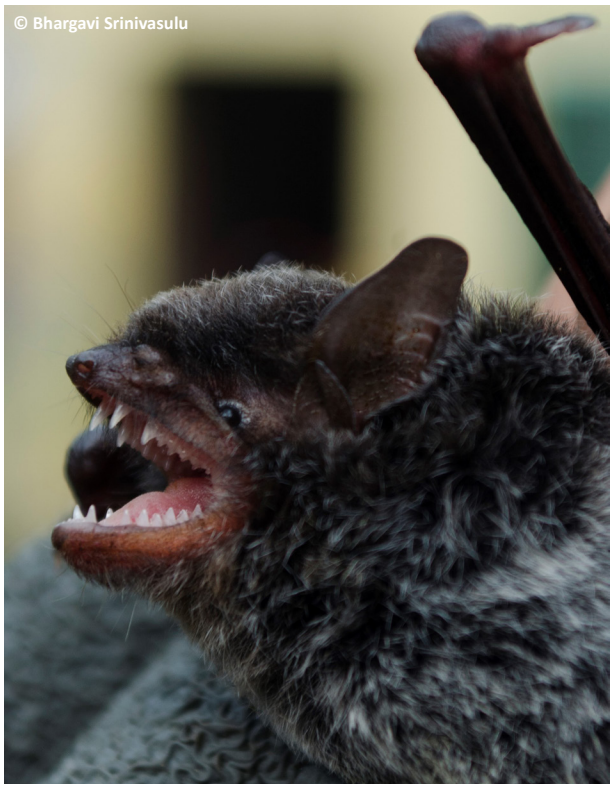

Image 4. *Myotis peytoni* (NHM.OU.CHI.57.2016) from Sairandhri, Silent Valley National Park, Kerala, India

(see Görföl et al. 2013). Four mistnets were put up in different parts of Sairandhri in Silent Valley National Park. Three individuals were mistnetted of which, two were retained as vouchers (NHM.OU.CHI.57.2016; NHM.OU.CHI.58.2016). The specimens were identified based on forearm length, cranio-dental measurements, and dental characters (Table 1). *Myotis peytoni* is known from Karnataka, Kerala and Andhra Pradesh (Bates & Harrison 1997). This species was first reported from Anakkampoyil, Kozhikode District (Bates & Harrison 1997; Madhavan 2000), and our observation from Silent Valley National Park, Palghat District constitutes the second record of this species from Kerala.

Echolocation calls: This species uses FM calls. Echolocation calls of one hand-released free-flying individual was recorded. A typical myotine call consisting only of a broadband FM sweep (Fig. 4). The calls (n=1; 8 pulses) had a mean FMAXE of 48.56±0.68 kHz (47.7–49.6 kHz), a mean fs of 84.37±1.18 kHz (83–86 kHz), a mean ft of 40.62±1.18 kHz (39.0–42.0 kHz), and a mean duration of 3.58±0.26 ms (3.28–4.0 ms).

Conclusion

Confirmation of the presence of three hitherto unreported species of bats as a result of the present study reflects poor understanding of the geographic distribution (Wallacean shortfall) of bats in the Western Ghats. An earlier study reported the presence of Eastern barbastelle *Barbestella darjelingensis* from the Valparai plateau (Wordley et al. 2014), which was detected due to systematic netting and acoustic surveys. More systematic bat surveys aided by acoustic detection will enhance the knowledge of species richness and diversity in many parts of the Western Ghats.

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Table 2. External and cranio-dental measurements (in mm) of *Rhinopoma hardwickii, Hipposideros galeritus*, *Miniopterus fuliginosus* and *Myotis peytoni* from Kerala, India

Morphometrics	*R. hardwickii*	*H. galeritus*		*M. fuliginosus*		*M. peytoni*	
	NHM. OU.CHI.61.2016	NHM. OU.CHI.54.2016	NHM. OU.CHI.55.2016	NHM. OU.CHI.56.2016	NHM. OU.CHI.59.2016	NHM. OU.CHI.57.2016	NHM. OU.CHI.58.2016
External							
FA	56.75	45.99	46.61	47.53	47.51	44.05	44.07
HBL	66.47	48.55	48.64	55.23	50.06	51.05	50.41
E	16.51	11	11.67	10.51	11.95	16.22	15.39
Tl	66.54	29.82	31.31	48.98	48.83	38.44	40.81
Tib	28.29	18.26	19.37	21.1	19.1	18.2	17.42
Hf	10.96	5.88	5.08	8.16	9.38	9.33	8.16
3mt	41.24	34.5	35.58	45.27	44.42	40.61	43.12
4mt	35.03	34.71	37.63	42.95	41.97	40.13	41.76
5mt	39.62	29.54	32.88	38.96	37.83	38.34	39.85
1ph3mt	7.5	14.29	14.89	11.16	11.29	16.02	15.82
2ph3mt	14.69	19.51	21.18	37.41	34.94	21.26	21.31
1ph4mt	11.79	11.32	11.46	9.19	9.48	11.03	10.62
2ph4mt	8.34	8.97	10.08	19.38	16.72	9.76	10.34
Craniodental							
GTL	18.8	17.53	Unskulled	16.17	Unskulled	16.71	Unskulled
CBL	17.53	15.02		15.36		16.61	
CCL	16.77	14.96		14.43		15.24	
CM^3	6.3	5.71		6.18		6.66	
M^3-M^3	8.02	5.87		6.74		7.36	
C^1-C^1	4.2	3.23		4.77		4.52	
ZB	11.05	8.62		8.86		11.35	
BB	8.84	7.55		8.13		8.71	
CM_3	7.03	6.11		6.73		7.17	
M	12.31	10.36		11.39		12.44	

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