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Cover: *Pipistrellus tenuis* recorded during the small mammalian fauna study, Manipur, India. © Uttam Saikia.

INTRODUCTION

Small mammals are a group of mammals with 'small' body size and comprise about 90 percent of the living global mammal species (Lidicker 2011). Although there is no accepted definition of the term 'small mammal', it generally denotes the relatively smaller sized mammalian species comprising the orders Chiroptera, Rodentia, Eulipotyphla, Scandentia, and smaller members of the order Carnivora. For example, the mean body mass of all rodents, shrews and tree shrews are less than 1,000 g (<https://small-mammals.org>) while over 70 percent of the extant bat species weigh less than 30 g (Giannini et al. 2012). Commensurate with their overwhelming dominance, numerical preponderance, and cosmopolitan distribution, small mammals exert very significant influence on ecology and human economy in the form of sustaining a prey base for higher carnivores, seed dispersal, pollination services, seed predation, and energy & nutrient cycling. For example, more than 500 species of tropical plants are pollinated by nectar and pollen eating bats (Fleming et al. 2009). Similarly, rodents are found to provide important intermediate ecosystem services, but also disservices in agricultural landscapes (Tschumi et al. 2018).

However, small mammals as a group are lesser studied compared to their more charismatic larger cousins. This is also reflected from the fact that lesser numbers of studies pertaining to small mammalian fauna were published in leading global conservation journals especially from the Oriental region (Amori & Gippoliti 2000). Their diminutive appearance, often nocturnal and cryptic nature does not attract much attention of zoologists. This is especially true in the context of northeastern India where the vital diversity and distribution information for this group is scant at best. Except for the order Chiroptera which has been relatively well documented in Meghalaya state (Saikia et al. 2018, 2021), information is largely inadequate for all other northeastern states. Predictably, Manipur is one such state where there is no recent information on the diversity and abundance of small mammalian fauna. The latest documentation on the mammalian fauna of Manipur enlists at least 42 species belonging to the small mammalian orders, e.g., Rodentia, Eulipotyphla, and Chiroptera (Mandal et al. 2005). However, a majority of these species records were based on past reports and no recent field surveys have been conducted. Such information gap has also significant conservation implication as it critically undermines our efforts in biodiversity conservation. In this backdrop, the present

work was undertaken to generate fresh data on the selected groups of small mammalian fauna of the state.

Review of literature

Most of the publications pertaining to the small mammalian fauna of Manipur state are old and new studies on this group in the state is far and few. One of the most important faunal works on this group from Manipur belongs to Roonwal (1950) who reported all the murid rodent species known from Manipur at that time. Some of the other notable works on this group includes Mandal et al. (1993, 1994). In their compilation on the mammalian fauna of the state, Mandal et al. (2005) mentioned at least 42 species under the three small mammalian orders albeit mostly based on secondary information. Singh et al. (2011) provided some morphometric data and distribution records of *Berylmys manipulus*, *Bandicota bengalensis gracilis*, and *Rattus rattus* in the state. In recent times, two species of rats *Rattus norvegicus* and *R. tanezumi* were added to the rodent fauna of the state (Chingangbam et al. 2014). As part of the present study, several new records of bats from Manipur were reported (Saikia et al. 2019); however the record of *Kerivoula picta* therein was later found to be a misidentified specimen of *Myotis formosus*. Therefore, this species should be deleted from the faunal list of Manipur. Barring these aforementioned scattered literature, no recent studies exist on the diversity and status of small mammalian fauna of Manipur.

MATERIALS AND METHODS

Study area

The state of Manipur spreads between 23.83° to 25.68° N and 92.96° to 94.78° E covering an area of 22,327 km². The state is bordered by Nagaland to the north, Mizoram to the south, Assam to the west, and shares international border with Myanmar to the east. Geographically, the state has been divided into a hill range running north-south abridging the Patkai and Lushai Hill range and central Imphal valley covering about 1,500 km². The valley also holds Loktak Lake, the largest freshwater lake in northeastern India. Major rivers like Barak, Imphal, Thoubal flows from north to south. As per the State Forest Report (2017), the state has a forest cover of over 77 percent. The state has two national parks and seven wildlife sanctuaries. Climate of the state is largely influenced by the topography of the region. The eastern lowlands along the Indo-Burma border and the western Assam Manipur border lowlands

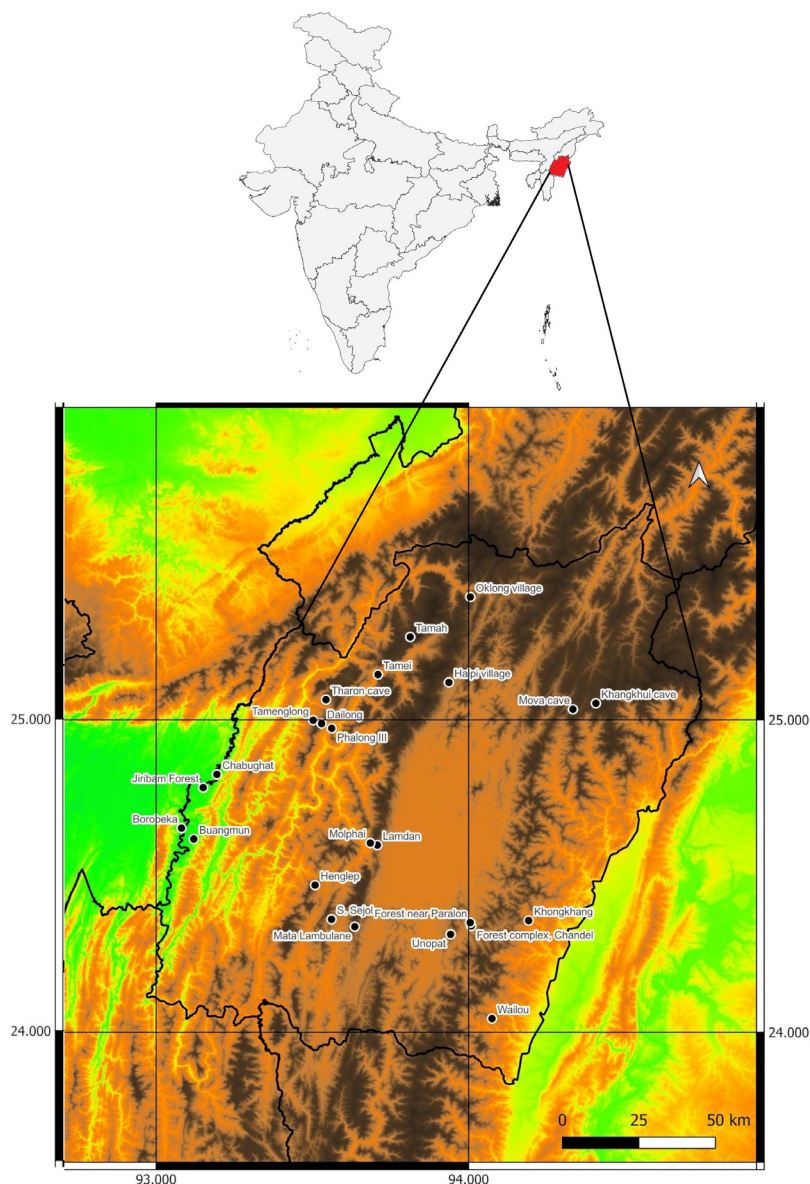


Image 1. Map of Manipur showing the survey localities (black dots).

fall between elevations 30–100 m and thus reigned by a tropical climate. The Manipur Valley at a height of 780–800 m has sub-tropical climate while the higher reaches of the mountains surrounding the valley have a temperate climate. Rainfall in this region is caused by the south westerly monsoon picking up moisture from the Bay of Bengal and heading towards the eastern Himalaya ranges (MASTEC 2022).

Field sampling

Two surveys were conducted covering nine districts in the state between 30 September 2019–18 October 2019 and 11 October 2021–26 October 2021. Due to the Covid-19 pandemic induced situation, the scheduled survey in 2020 could not be undertaken. Twenty-four

localities representing a mix of dry deciduous forest, semi-evergreen forests, subtropical pine forest, caves and caverns and around human habitations were surveyed (Image 1,2; Table 1). For collecting bat samples, mist nets and a two bank harp trap was utilized whereas for rodents and shrews, several foldable Sherman traps were used. Opportunistic collections were also made inside a few of the prominent caves and from human dwellings using a collapsible butterfly net. Besides, as part of a faunal survey programme, the junior author also visited Zeilad Wildlife Sanctuary in Tamenglong district in October 2018 and collected a few bat specimens.

A total of 62 specimens of the target animal groups were collected during the aforementioned surveys. Additionally, 12 specimens of small mammals collected

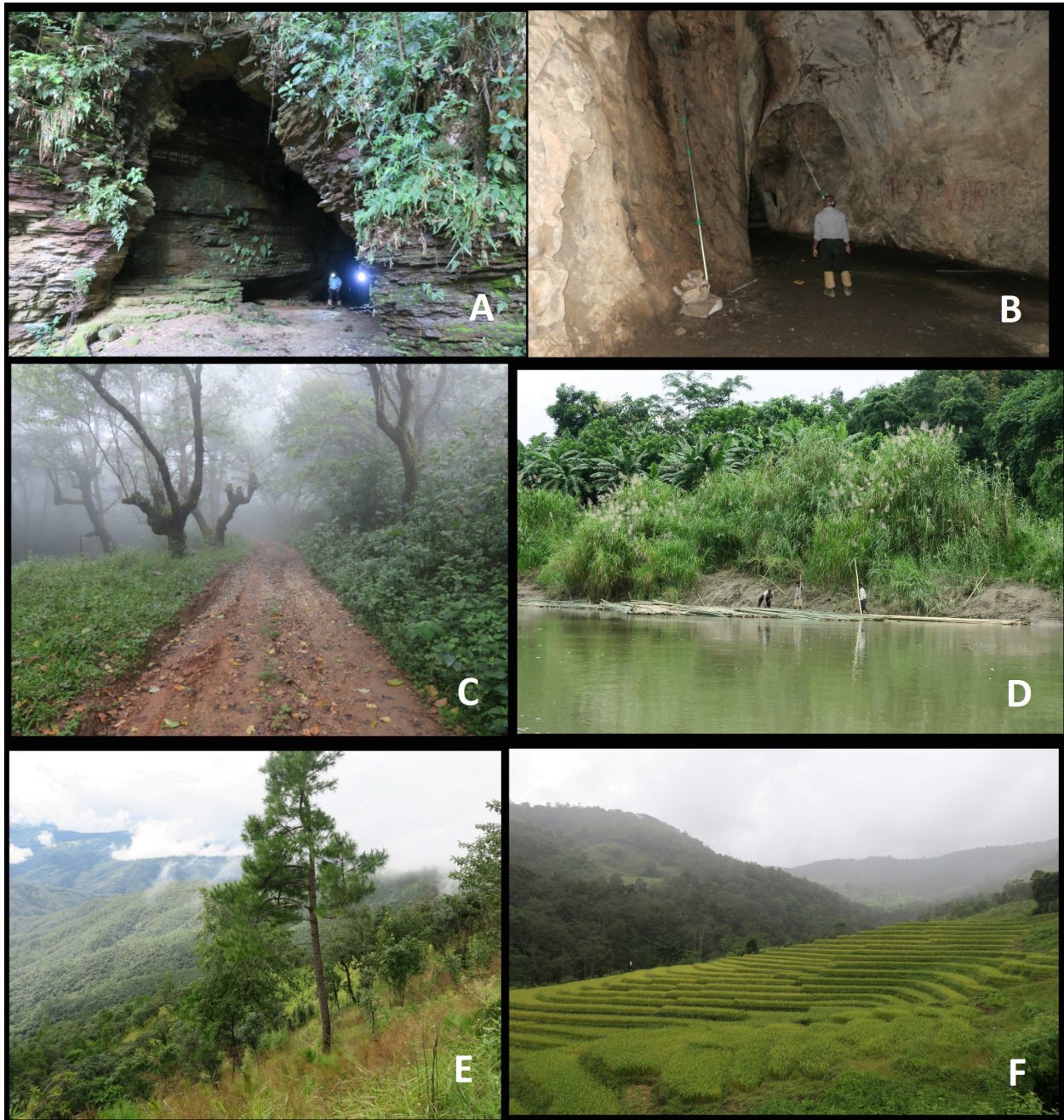


Image 2. Survey localities covering various habitat types. A—Tharon Cave | B—Khangkhui Cave | C—Mixed coniferous forest at Lamdan | D—Riparian habitat at Babughat | E—Coniferous forest at Wailou | F—Semi-evergreen forest and Rice paddy at Tamah. © Uttam Saikia.

in recent times and deposited in the collections of NERC, Shillong are also included in this study. Besides, data on two specimens of rodents from Manipur identified by the first author and now deposited in the Department of Zoology, Manipur University have also been incorporated. Photographic evidence of eight species of small mammals (dead specimens or field photograph) obtained during the aforementioned surveys were also included in the study. Bat species were

identified following Bates & Harrison (1997), Srinivasulu et al. (2010) except mentioned otherwise. Rodent specimens and photographs were identified following descriptions and measurements in Agrawal (2000) and Menon (2014) while the sole insectivore species was identified following Corbet & Hill (1992). The acronyms for chiropteran measurements are: Ear length (E); Tragus length (TR); Hindfoot length, including claw (HF c.u.); Forearm length (FA); Tibia length (TB); Greatest length

Table 1. List of surveyed localities in Manipur and their habitat characteristics.

	Survey locality	Habitat type
1	Borobekra, Jiribam District, (24.65333 N, 93.08108 E, 40 m)	Tropical semi-evergreen forest on the bank of river Jiri.
2	Sabughat Jiribam District, (24.82526 N, 93.1942 E, 36 m)	Tropical semi-evergreen forest on the bank of river Jiri
3	Forest adjacent to DFO Office, Jiribam District, (24.78305 N, 93.150466 E, 45m)	Deciduous forest dominated by Teak plantations.
4	Buangmun, Pherzawl District, (27.61851 N, 93.12028 E, 33 m)	Human habitation surrounded by bamboo and semi-evergreen forest.
5	Tamenglong, Tamenglong District (24.9985N, 93.50246E, 1,278 m)	Human habitation
6	Tharon cave, Tamenglong District (25.06445 N, 93.54346 E, 1,190 m)	Large limestone cave with multiple passageways.
7	Dialong village, Tamenglong District (24.98781 N, 93.52946 E, 1,350 m);	Lamtui Kai Cave along roadside with a small watercourse inside.
8	Phalong III, Tamenglong District (24.97249 N, 93.56166 E, 1,090 m)	Human habitation dominated by bamboo forest and Jhum fields.
9	Tamei, Tamenglong District (25.14472 N, 93.70972 E, 1,100 m)	Rocky riverbank inside semi-evergreen forest.
10	Tamah, Tamenglong District (25.26499 N, 93.81305 E, 1,100 m)	Human habitation
11	Oklong village, Senapati District (25.39295 N; 94.00534 E, 1,100 m)	Human habitation
12	Haipi village, Kangpokpi district (24.96888 N, 93.49946 E, 1,150 m)	Human habitation
13	Khangkhui cave, Ukhrul District (25.05281 N, 94.40716 E, 1,690 m)	Limestone cave
14	Mova cave, Ukhrul District (25.03375 N, 94.33363 E, 1,307 m)	Limestone cave along river Lungshang.
15	Forest Complex, Chandel, Chandel District (24.34027 N, 94.00833 E, 900 m)	A forest patch dominated by <i>Pinus kesiya</i> .
16	Forest near Paralon, Chandel District (24.35111 N, 94.00500 E, 920 m)	Moist deciduous forest patch with some Pine and bamboo associations.
17	Unopat, Chandel District (24.31361 N, 93.94222 E, 1,078 m)	<i>Pinus kesiya</i> dominated forest.
18	Wailou village, Chandel District (24.04388 N, 94.07472 E, 650 m)	Deep sinkhole situated amidst semi-evergreen forest.
19	Henglep, Churachandpur District (24.47111 N, 93.50861 E, 1,200 m)	Small cave along roadside surrounded by semi-evergreen forest.
20	Lamdan, Churachandpur District (24.59916 N, 93.70777 E, 1,260 m)	Mixed Oak and conifers forest
21	Mata Lambulan, Churachandpur District (24.33805 N, 93.63555 E, 1,200 m)	Jhum field
22	Molphai, Churachandpur District (24.60583 N, 93.68527 E, 990 m)	Semi-evergreen forest
23	S. Sejol, Churachandpur District (24.36166 N, 93.56111 E, 1,080 m).	Semi-evergreen forest
24	Khongkgang, Tengnoupal District (24.35750 N, 94.19194 E, 560 m)	Semi-evergreen forest

of skull including incisors (GTLi); Condylacanine length (CCL); Maxillary tooththrow length (CM³); Width across third molars (M³M³); Zygomatic breadth (ZB); Postorbital constriction (POC); Breadth of braincase (BB); Length of mandible including incisors (MLi); Mandibular tooththrow length (CM₃); Coronoid height (COH).

RESULTS

Based on examination of voucher specimens, 28 species of small mammals mostly bats could be recorded from the study area. Besides, another 10 species of rodents and bats were also recorded based on other evidences, i.e., field sightings, photographs of hunted animals, and field and laboratory examination of carcass (Table 2).

Species account:

Order: Chiroptera

Family: Pteropodidae

1. *Cynopterus sphinx* (Vahl, 1797)

(Greater Short-nosed Fruit bat)

Material examined: 1 male, 1 female, 07.x.2018, Zeilad WLS, Tamenglong district; 1 male, 1 male, 02.x.2019, Jiribam, Jiribam district; 1 female, 1 female, 22.x.2021, Henglep, 1 female, (released) 15.x.2021, Lamdan, Churachandpur district; 1 female (released), Paralon, 20.x.2021, 1 female (released), 19.x.2021, Chandel Town (Chandel district)

Locality records: Churachandpur town (940 m), Henglep (1,200 m), Lamdan (1,260 m), Churachandpur district; Uchathal (175 m), Jiribam (30 m), Jiribam district; Zeilad WS (260 m), Tamenglong town (1,280 m), Tamenglong district; Paralon (920 m), Chandel Town (900 m), Chandel district (Sinha 1999; Mandal et al. 2005; present study).

Remarks: Apparently widespread and a very common

Table 2. List of species recorded during the present study (species with asterisk indicate new records for Manipur state).

	Species	No of examples	Registration Number(s)/ remarks
Chiroptera: Pteropodidae			
1	<i>Cynopterus sphinx</i> Vahl	6	V/M/ERS/500, 501, 584, 585, 667, 675
2	<i>Eonycteris spelaea</i> (Dobson)	1	V/M/ERS/674
3	<i>Pteropus medius</i> (Temminck)	-	Field photograph
4	<i>Rousettus leschenaulti</i> (Desmarest)	-	Field photograph
Chiroptera: Hipposideridae			
5	<i>Hipposideros armiger</i> Hodgson	10	V/M/ERS/589-595, 669-671
6	* <i>Hipposideros cineraceus</i> Blyth	1	V/M/ERS/672
7	* <i>Hipposideros gentilis</i> Andersen	1	V/M/ERS/677
8	<i>Hipposideros lankadiva</i> Kelaart	2	V/M/ERS/432, 666
Chiroptera: Rhinolophidae			
9	* <i>Rhinolophus affinis</i> Horsfield	1	V/M/ERS/610
10	* <i>Rhinolophus lepidus</i> Blyth	1	V/M/ERS/613
11	* <i>Rhinolophus perniger</i> Hodgson	1	V/M/ERS/581
12	* <i>Rhinolophus macrotis</i> Blyth	1	V/M/ERS/614
13	<i>Rhinolophus sinicus</i> Andersen	3	V/M/ERS/453, 588, 596
14	<i>Rhinolophus yunnanensis</i> Dobson	2	V/M/ERS/423, 587
Chiroptera: Megadermatidae			
15	* <i>Lyroderma lyra</i> E. Geoffroy	3	V/M/ERS/573, 574, 673
Chiroptera: Vespertilionidae			
16	* <i>Myotis annectans</i> (Dobson)	3	V/M/ERS/572, 582, 679
17	* <i>Myotis formosus</i> Hodgson	1	V/M/ERS/502
18	<i>Myotis muricola</i> (Gray)	3	V/M/ERS/450, 583, 616
19	<i>Pipistrellus coromandra</i> (Gray)	4	V/M/ERS/503-506
20	<i>Pipistrellus javanicus</i> (Gray)	4	V/M/ERS/611, 612, 668, 681
Chiroptera: Miniopteridae			
27	<i>Miniopterus magnater</i> Sanborn	4	V/M/ERS/431, 578-580
Rodentia: Sciuridae			
28	<i>Callosciurus erythraeus</i> (Pallas)	-	Photograph of dead specimen
29	<i>Tamias maclellandi</i> (Horsfield)	-	Field sightings
30	<i>Ratufa bicolor</i> (Sparrman)	-	Field sighting
Rodentia: Muridae			
31	<i>Berylmys mackenziei</i> (Thomas)	1	Unregistered specimen deposited in Manipur University
32	<i>Rattus nitidus</i> (Hodgson)	1	Unregistered specimen deposited in Manipur University
33	<i>Niviventer fulvescens</i> (Gray)		Crushed specimen examined in the field
34	<i>Rattus rattus tistae</i> Hinton	1	V/M/ERS/696
35	<i>Cannomys badius</i> (Hodgson)	-	Photograph of dead specimen
Rodentia: Hytridae			
36	<i>Hystrix brachyura</i> Linnaeus	-	Photograph of dead specimen
37	<i>Atherurus macrourus</i> Linnaeus	-	Photograph of dead specimen
Soricomorpha: Soricidae			
38	<i>Anourosorex squamipes</i> Milne Edwards	1	V/M/ERS/409

species throughout the state. It was mist netted both inside moist deciduous and mixed coniferous forest and also near human habitations. Most of the individuals caught during October 2021 were lactating.

2. *Eonycteris spelaea* (Dobson, 1871)

(Dawn Bat)

Material examined: 1 male, 18.x.2021, Forest Complex, Chandel, Chandel district

Locality records: Imphal (c.780 m), Imphal district; forest complex, Chandel (900 m), Chandel district (Sinha 1994; present study).

Remarks: Apparently uncommon in the state with

a single record obtained in the present study. The male individual was caught in a mist net among *Pinus kesiya* forest on the way back from a foraging trip around 1830 h (seeds still in the mouth). Mandal et al. (2005) could not obtain any specimen from the state.

3. *Pteropus medius* (Temminck, 1825)

(Indian Flying Fox)

Material examined: Nil, field photograph from near Bishnupur, Bishnupur district.

Locality records: Imphal Town (780 m), Imphal district (Mandal et al. 2005); near Bishnupur town (806 m), Bishnupur district (present study).

Remarks: Unlike in many other parts of the country, this large pteropodid appears to be uncommon in the state. Previous records indicate only one locality (Imphal city) from the state. We observed a colony of >150 individuals of this species roosting in three large *Eucalyptus camaldulensis* trees along NH 2 near Bishnupur town.

4. *Rousettus leschenaulti* (Desmarest, 1820)

(Fulvous Fruit Bat)

Material examined: Nil, field photograph from Zeilad WS, Tamenglong district

Locality records: No particular locality, Imphal district; Zeilad WS (260 m), Tamenglong district; 4–5 km from S. Sejol towards Henglep (1,160 m) (Mandal et al. 2005; present study)

Remarks: Based on the lighter colour coat of the photographic specimen (as against darker grey brown in *R. amplexicaudatus*), it was provisionally identified as belonging to fulvous fruit bat. A few carcasses apparently of this species were observed entangled in nylon nets between S. Sejol and Henglep which are being used by villagers to catch wild birds.

Family: Hipposideridae

5. *Hipposideros armiger* (Hodgson, 1835)

(Great Roundleaf Bat)

Material examined: female, 05.x.2019, Dialong cave, 3 male, 1 female, 08.x.2019, Cave near Tamei, 1 male, 04.x.2019, Tharon cave (Tamenglong district); 1 female, 13.x.2019, Khangkhui cave (Ukhrul district); 3 male, 14.x.2021, Cave at S. Sejol (Churchandpur district).

Locality records: Dialong cave (1350 m), Cave near Tamei (1300 m), Tharon cave (1190 m), Tamenglong district; Khangkhui cave (1750 m), Ukhrul district; Cave at S. Sejol (1080 m), Churchandpur district; Wailou 650 (m) (Mandal et al 2005, present study)

Remarks: A widespread species especially in the hilly areas. Mostly caught inside caves and also in rocky caverns. In a rock fissure along a hill near S. Sejol village, a small group of about 10–12 individuals was found roosting with smaller populations of *Lyroderma lyra*, *Hipposideros cineraceus* and *H. gentilis*. A photographic specimen was obtained from Wailou village in Chandel district. It was caught from a deep sinkhole inside a forest and the villagers informed that a large colony of this species roost there during the drier period.

6. *Hipposideros cineraceus* Blyth, 1853

(Ashy Roundleaf Bat)

Material examined: 1 male, 14.x.2021, Cave at S.

Sejol (Churchandpur district).

Locality records: Cave at S. Sejol (1080 m), Churchandpur district (present study)

Remarks: A small group of <10 were observed roosting inside a rock fissure and sharing roosting space with *H. armiger*, *H. gentilis* and *L. lyra*. This is the first record of this species from Manipur.

7. *Hipposideros gentilis* Andersen, 1918

(Andersen's Roundleaf Bat)

Material examined: 1 male, 14.x.2021, Cave at S. Sejol (Churchandpur district).

Locality records: Cave at S. Sejol (1080 m), Churchandpur district (present study). This is the first record of this species from Manipur.

8. *Hipposideros lankadiva* Kelaart, 1850

(Indian Roundleaf Bat)

Material examined: 1 female, 23.vi.2017, Dialong cave, Tamenglong district; male, 22.x.2021, Henglep, Churchandpur district

Locality records: Dialong cave (1350 m), Tamenglong district and Henglep (1200 m), Churchandpur district (present study)

Remarks: One specimen was collected from a shallow cave in near Dialong village which it shared with a few rhinolophids. In Henglep, several individuals were seen roosting in an underground tunnel amidst semi-evergreen forest.

Family: Rhinolophidae

9. *Rhinolophus affinis* Horsfield, 1823

(Intermediate Horseshoe Bat)

Material examined: 1 male, 05.x.2019, Dialong cave, Tamenglong district;

Locality records: Cave at Dialong (1350 m), Tamenglong district (present study).

Remarks: In a small cave along a hillside, a small colony of this species was observed with a few individuals of *R. macrotis*. This is the first record of this species from the state.

10. *Rhinolophus lepidus* Blyth, 1844

(Blyth's Horseshoe Bat)

Material examined: 1 male, 13.x.2019, Khangkhui cave, Ukhrul district

Locality records: Khangkhui cave (1690 m), Ukhrul district (present study)

Remarks: The specimen was identified based on bacular morphology following Csorba et al. (2003). The bacula is 2.9 mm length and 0.83 mm wide at the basal



Image 3. Bat species recorded during the present study (not to scale): A—*Cynopterus sphinx* | B—*Eonycteris spelaea* | C—*Pteropus medius* | D—*Rousettus leschenaulti* | E—*Hipposideros armiger* | F—*Hipposideros lankadiva* | G—*Hipposideros gentilis*. © Uttam Saikia.

cone. In side profile, it is almost straight with a dorsal bend near the basal cone and a ventral bend near the tip. The basal cone has a wide and deep indentation on the dorsal surface.

Khangkhui is a large cave system with multiple passageways. Three species of bats were located in this cave albeit in smaller numbers, *R. perniger*, *R. lepidus* and *H. lankadiva*. This cave is a popular tourist destination in Ukhrul district and according to some villagers, until recent times, the cave harbored a large population of bats which were exterminated by the local authorities to make the cave tourist 'friendly'! This is the first record of *R. lepidus* from the state.

11. *Rhinolophus cf macrotis* Blyth, 1844

(Blyth's Horseshoe Bat)

Material examined: 1 female, 05.x.2019, cave at Dialong, Tamenglong district

Locality records: Dialong (1350 m), Tamenglong district.

Remarks: The specimen was collected from inside a small cave along the hillside and was roosting singly. The female individual was not showing any apparent sign of breeding or lactation. This is the first record of this species from Manipur.

12. *Rhinolophus perniger* Hodgson, 1843

(Northern Woolly Horseshoe Bat)

Material examined: 1 male, 13.x.2019, Khangkhui cave, Ukhrul district

Locality records: Khangkhui cave (1690 m), Ukhrul district (present study)

Remarks: One individual was shot from an inner chamber of the cave by a villager. About 10 individuals of this species were observed in the cave. This is a new record for the state.

13. *Rhinolophus sinicus* Andersen, 1905

(Chinese Horseshoe Bat)

Material examined: 1 female, 07.vi.2017, Phalang I, Tamenglong district; 2 male, 04.x.2019, Tharon cave, Tamenglong district

Locality records: Phalang I (1012 m), Tamenglong district; Tharon cave (1190 m), Tamenglong district (Saikia et al. 2019; present study)

Remarks: A lactating female was collected by a villager from a small cave in Phalang I village in early June while two male individuals were collected from Tharon cave in October. This species was recently reported from the state (Saikia et al. 2019).

14. *Rhinolophus yunanensis* Dobson, 1827

(Dobson's Horseshoe Bat)

Material examined: 1 female, 07.vi.2017, 1 female, 05.x.2019, Lamtuai Kai, Dailong, Tamenglong district

Locality records: Lamtuai Kai, Dialong (1350 m), Tamenglong district (Saikia, et al. 2019; present study)

Remarks: Two female individuals were collected from two cave sites at Dailong during June and October respectively. In one cave site, it was sharing roosting space with a few *R. affinis* while in another cave, a single individual was roosting alone. These small caves were located on the hillside surrounded by semi evergreen forest. Because of its rich biodiversity and long tradition of conservation of forests, Dialong has been declared as Biodiversity Heritage Site in Manipur by the state government. This species was recently reported from the state (Saikia et al. 2019).

Family: Megadermatidae

15. *Lyroderma lyra* E. Geoffroy, 1810

(Greater False Vampire Bat)

Material examined: 1 female, 1 male, 02.x.2019, Buangmun, Pherzawl district;

Locality records: Buangmun (33 m), Pherzawl district and Jiribam (30 m), Jiribam district; Ningthoukong (800 m), Bishnupur district (present study).

Remarks: Apparently a common species especially in the valley area, no specimen or roosting colony could be located in the hilly region of the state. This species was invariably observed to roost in abandoned human dwellings and call signatures were obtained around human periphery as well. Our present report constitutes the first record of this species from Manipur.

Family: Vespertilionidae

16. *Myotis annectans* (Dobson, 1871)

(Hairy-Faced Bat)

Material examined: 1 female, 1 male, 02.x.2019, Buangmun, Pherzawl district;

Locality records: 1 female, 1 male, 15.x.2019, and 1 male, 23.x.2021 Lamdan (1272 m) Churchandpur district (present study).

Remarks: This species is little known bat from India and individuals were harp trapped on two occasions in mixed Oak-conifer forest at Lamdan. It is apparently a highland species since previous Indian records are around 1000 m or above. This is the first record of this species from Manipur.

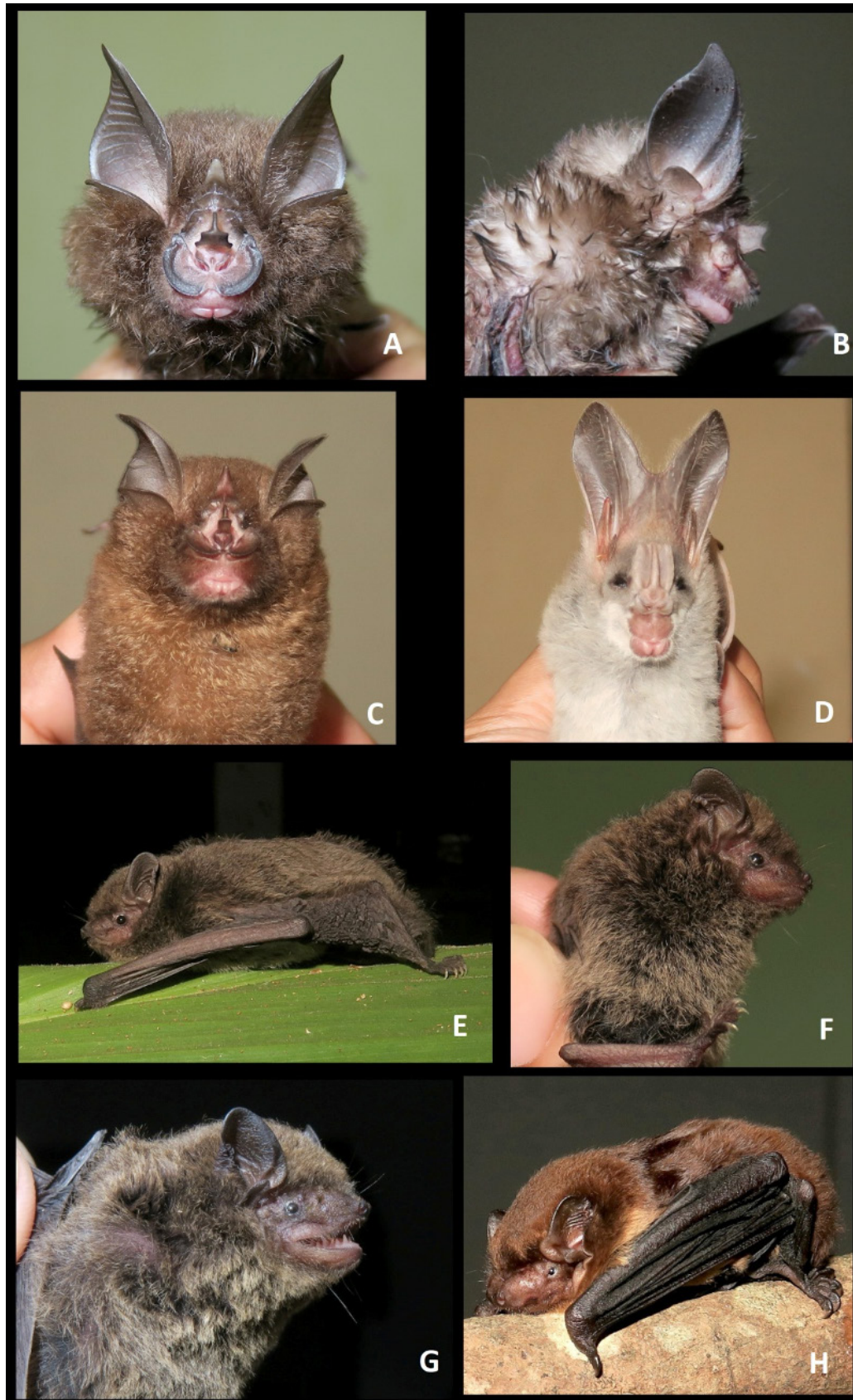


Image 4. A—*Rhinolophus perniger* | B—*Rhinolophus lepidus* | C—*Rhinolophus sinicus* | D—*Lyroderma lyra* | E—*Pipistrellus tenuis* | F—*Pipistrellus javanicus* | G—*Pipistrellus coromandra* | H—*Mirostrellus joffrei*. © Uttam Saikia.

17. *Myotis formosus* (Hodgson, 1835)

(Hodgson's bat)

Material examined: 1 female, 10.v.2018, Toubal, Bishnupur district**Locality records:** Only single record from Toubal (760 m), Bishnupur district (present study)**Remarks:** Based on a photograph, Saikia et al. 2019 erroneously reported this specimen as *Kerivoula picta*, however, re-examination of the specimen confirmed it to be *M. formosus* which is significantly larger than the former. The specimen was collected from a cow shed on the bank of Loktak lake and surrounded by farmlands on three sides. This record constitutes first mention of this species from Manipur.**18. *Myotis muricola* (Gray, 1846)**

(Nepalese whiskered bat)

Material examined: 1 female, 12.vi.2017, Phalang III, Tamenglong district; 2 female, 16.x.2019, MMTA campsite, Lamdan, Churchandpur district;**Locality records:** Phalang III (728 m), Tamenglong district; Lamdan (1272 m), Churchandpur district (Saikia et al. 2019; present study).**Remarks:** In Phalang III, one individual was taken down by villagers during early evening flight by beating with a flexible bamboo stick which is a common practice in the area. In Lamdan, two individuals were captured in harp trap amidst pine forest.**19. *Pipistrellus coromandra* (Gray, 1838)**

(Coromandal Pipistrelle)

Material examined: 1 male, 3 female, 04.x.2018, Ningthoukhong, Bishnupur district**Locality records:** Imphal district; Ningthoukhong (770 m), Bishnupur district (Mandal et al., 2005; Present study).**Remarks:** The specimens were primarily identified based on bacular morphology of the male individual. The bacula is about 4 mm long which is significantly longer than that of *P. tenuis* specimen examined (3.4 mm), has a slightly cylindrical shaft with a bifid tip and the basal portion has two deflected lobes. A primarily commensal species roosting in human periphery and also found in tree holes, under bark etc. The present specimens were collected from the attic of a house which according to the owners have been roosting for several years. Likely to be widely distributed in the state especially the valley area.**20. *Pipistrellus javanicus* (Gray, 1838)**

(Javan Pipistrelle)

Material examined: 1 male, 1 female, 16.x.2019, 2 male, 23.x.2021, Lamdan, Churchandpur district**Locality records:** "Manipur" no exact locality; Lamdan (1270 m), Churchandpur district (Bates and Harrison, 1997; Present study).**Remarks:** The bacula of the male specimen is about 5.2 mm in length, has a bilobate base, the shaft is thin and the tip is sharply bifid. This matches the description of Myanmar's specimens in Bates et al (2005). The present specimens were harp trapped inside a mixed coniferous forest on two occasions and apparently common in the area. On one occasion, call signatures resembling this species were also recorded near Leimatak village (600 m) in Churchandpur district.**21. *Pipistrellus tenuis* (Temminck, 1840)**

(Indian Pygmy Pipistrelle)

Material examined: 2 male, 23.x.2021, Lamdan, Churchandpur district; 1 male, 20.x.2021, Paralon, Chandel District; 2 male, 6 female, 01.x.2019, Buangmun, Pherzawl district and 1 female, Tamenglong town, Tamenglong district.**Locality records:** Uchathal (175 m), Jiribam District; Imphal city (790 m), Imphal district; Buangmun (33 m), Pherzawl district; Lamdan (1270 m), Churchandpur District; Tamenglong town (1580 m), Tamenglong district and Paralon (920 m), Chandel district (Mandal et al., 2005 as *P. mimus*; present study)**Remarks:** The specimens were identified by a combination of skull and bacular morphology. Widely distributed in the state both in the hills and valleys. Specimens were caught in human periphery and also in relatively undisturbed forested areas.**22. *Murina huttonii* (Peters, 1872)**

(Huton's Tube-nosed Bat)

Material examined: 1 female, 23.x.2021, Lamdan, Churchandpur district**Locality records:** Lamdan (1270 m), Churchandpur District**Remarks:** A specimen was collected in harp trap in mixed Pine forest at the same spot where *M. muricola* and *M. annectans* were also trapped. This is first record of this bat from the state.**23. *Murina cyclotis* Dobson, 1872**

(Round-eared Tube-nosed Bat)

Material examined: 1 female, 1 male 20.x.2021, Forest at Paralon, Chandel district

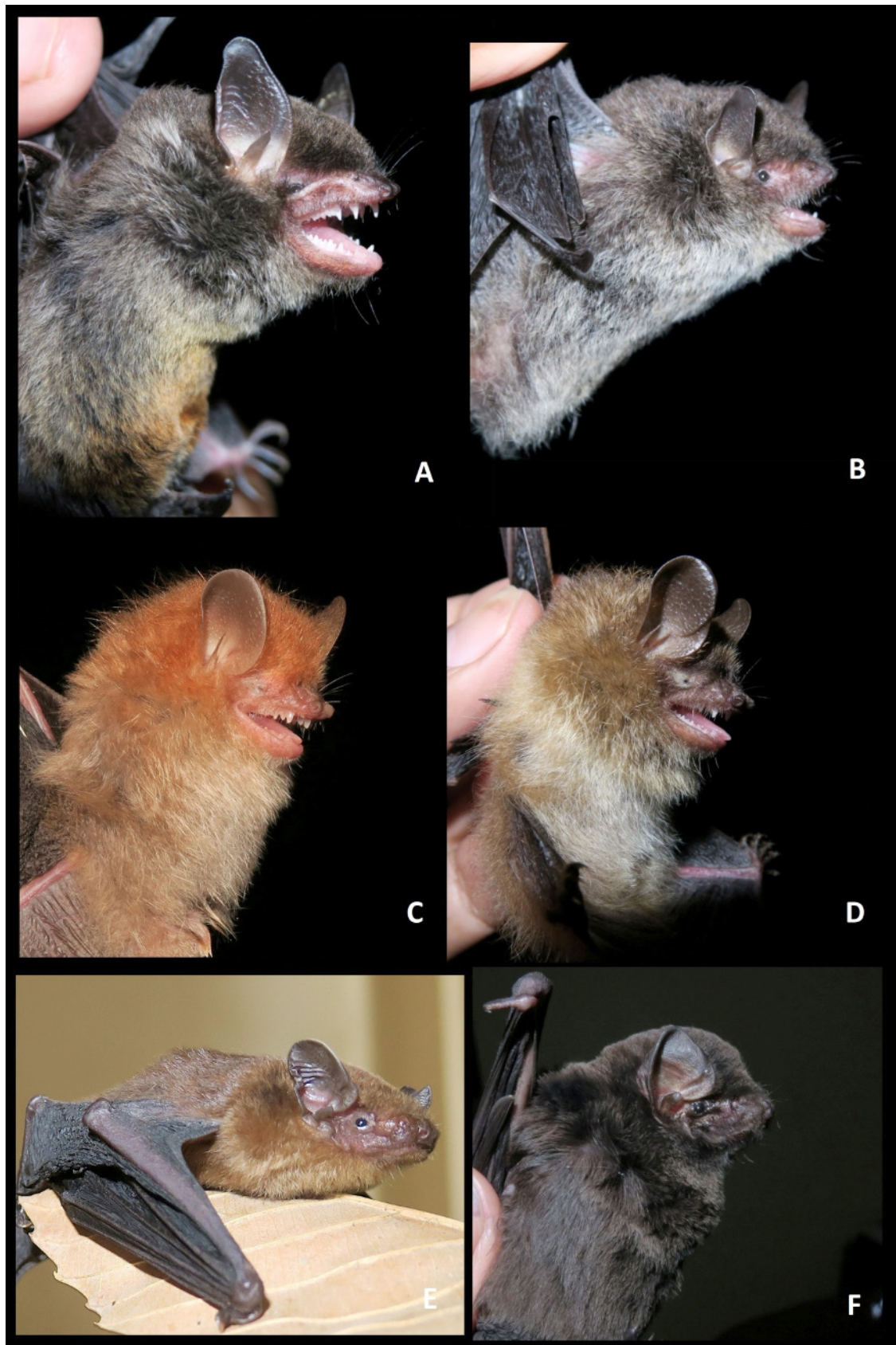


Image 5. A—*Myotis annectans* | B—*Myotis muricola* | C—*Murina cyclotis* | D—*Murina huttonii* | E—*Tylonycteris fulvida* | F—*Miniopterus magnater*. © Uttam Saikia

Locality records: Paralon (920 m), Chandel District

Remarks: Two specimens were mist netted across a newly constructed forest path in pine forest along with *P. tenuis*. The female was significantly bigger (FA=33.2 mm) than the male (FA=30.7 mm) (Appendix 1). First report of this species from the state.

24. *Mirostrellus joffrei* (Thomas, 1915)

(Joffrei's Pipistrelle)

Material examined: 1 male, 16.x.2021, Lamdan, Churchandpur district

Locality records: Lamdan (1260 m), Churchandpur District

Remarks: The specimen was caught in a mist net set across a forest path inside a semi-evergreen forest patch. An uncommon bat, this species was recently reported from Shillong in India (Saikia et al. 2017), but was also subsequently reported from Uttarakhand (Chakravarty et al. 2020). The external and craniodental character of this Manipur specimen conform well to the descriptions in Saikia et al. (2017). Like the specimen from Meghalaya, it was very docile and did not try to escape. The male individual caught in October did not show any sign of reproductive activity. This is an addition to the bat fauna of Manipur state.

25. *Scotophilus heathii* (Horsfield, 1831)

(Greater Yellow House Bat)

Material examined: 1 female, 10.x.2019, DC Office compound, Senapati, Senapati District; 2 male, 11.x.2019, Haipi village, Kongpokpi District.

Locality records: Jiribam (30m), Jiribam District; Senapati town (1100 m), Senapati district District; Haipi village (1150 m), Kongpokpi District (Mandal et al. 2005; present study).

Remarks: A huge colony of several hundred individuals was located on the ceiling of a school building at haipi Village, Kongpokpi district. According to the school authorities, this large bat colony was roosting there for many years and has become a nuisance but several efforts to chase them away proved futile. Such huge congregation of this species is of uncommon occurrence as according to Sinha (1986), colony size in India varies from one to about fifty individuals.

26. *Tylonycteris fulvida* (Blyth, 1859)

(Lesser Bamboo Bat)

Material examined: 1 female, 05.x.2019, 1 female, 12.vi.2017, Phalang III, Tamenglong District

Locality records: Phalang III (730 m), Tamenglong district (Blanford 1891; Saikia et al. 2019; present study).

Remarks: Specimens were caught by villagers from inside bamboo internodes. Bamboo bats are apparently very common in bamboo dominated areas in Tamenglong as several people reported finding them while cutting bamboos although species identity was not ascertained.

27. *Miniopterus magnater* Sanborn, 1931

(Western Bent-winged Bat)

Material examined: 1 female, 12.x.2017, Phalang III, Tamenglong District; 2 male, 1 female, 14.x.2019, Mova cave, Ukhrul district

Locality records: Phalang III (730 m), Tamenglong district and Mova cave (1280 m), Ukhrul District (Saikia et al. 2019; present study).

Remarks: After Ruedi et al. (2012) reported this species from Meghalaya, it was also reported from Manipur state (Saikia et al. 2019) and several other locations in Meghalaya by Saikia et al. (2020). A widespread species in the northeastern India and all earlier records of *M. fuliginosus* from this region are most likely referable to this species.

Order: Rodentia

Family: Sciuridae

28. *Callosciurus erythraeus* (Pallas, 1778)

(Pallas's Squirrel)

Material examined: Nil, Photograph of dead specimen and field sightings

Locality records: Luanglong Khullen (990 m), Phalang III (730 m), Tamenglong district Kanglatongbi (c. 1068 m), Imphal district; Buangmun (33 m), Pherzawl District; no exact locality, Senapati and Chandel Districts (Mandal et al. 2005; present study)

Remarks: Although we could record this species only on two occasions, from the previous records, it is apparently widely distributed both in the valleys and hilly region of the state

29. *Tamiops maclellandi* (Horsfield, 1840)

(Himalayan Striped Squirrel)

Material examined: Nil, field observations in Jiribam and Chandel districts.

Locality records: Uchathal (175 m), Jiribam District; Luanglong Khullen (990 m), Tamenglong district; Chandel town, Chandel District; no exact locality, Ukhrul District (Mandal et al. 2005; present study)

Remarks: A widely distributed and common species throughout the state.

30. *Ratufa bicolor* (Sparrman, 1778)

(Malayan Giant Squirrel)

Material examined: Nil, field sighting at Buangmun.**Locality records:** Nanglea Atrow (990 m) Tamenglong districts and Buangmun (33 m), Pherzawl District (Mandal et al. 2005; present study).**Remarks:** This species was briefly sighted once at Buangmun. According to locals, it is also distributed in forested areas of Chandel and Ukhrul districts but sightings are infrequent now days presumably because of hunting pressure.**Family: Muridae****31. *Berylmys mackenziei* (Thomas, 1916)**

(Kenneth's White-toothed Rat)

Material examined: 1 male, .vii.2017, Phalong, Tamenglong district.**Locality records:** No exact locality, Bishnupur District; Luanglong Khullen (990 m) and Phalong (1090 m), Tamenglong districts; Kharam Waiphei (Senapati District) (Agrawal, 2000; Mandal et al. 2005; Chingangbam et al., 2014; present study).**Remarks:** According to locals, this species is common in Tamenglong area especially in the crop fields. A few farmers at Mata Lambulan village in Churhandpur district also indicated the common presence of this large rat in their crop fields especially nearer to forests. People in the region hunt them for bush meat.**32. *Rattus nitidus* (Hodgson, 1845)**

(Himalayan Field Rat)

Material examined: 1 male, viii.2017, Phalong, Tamenglong district.**Locality records:** No exact locality, Imphal, Tamenglong and Senapati districts; Mao (1750 m), Senapati District; Phalong (1090 m), Tamenglong district (Agrawal, 2000; Chingangbam et al. 2014; present study).**Remarks:** A male individual caught from Phalong during August was examined. It had a dark brown dorsum and greyish venter with a unicoloured tail which was subequal to head and body length. The hind feet were whitish. It was in reproductive stage with enlarged testes.**33. *Rattus rattus tistae* Hinton, 1918**

(House Rat)

Material examined: 1 male, 23.x.2021, Lamdan, Churhandpur district.**Locality records:** Practically distributed throughout the state. The recorded localities include Chandel (900

m), Chandel district; Lamdan (1200 m), Churhandpur (915 m), Churhandpur district; Turibari (c. 1250 m), Kongpokpi district; Ukhrul (1800 m), Ukhrul district; Tamenglong (1280 m), Tamenglong district (Mandal et al. 2005; present study).

34. *Niviventer fulvescens* (Gray, 1847)

(Indomalayan Niviventer)

Material examined: Nil, Filed sightings**Locality records:** Nungba-Bishnupur Road (740 m), Noney district; Nungba-Tamenglong Road (1180 m), Tamenglong district.**Remarks:** Several crushed carcasses were seen along the Nungba-Bishnupur Road and also along Nungba-Tamenglong stretch during October, 2021 presumably killed by farmers in the crop field. They all had characteristic rufous brown fur along the midback and grey brown along the flanks. The venter was pure white and the tail was bicoloured (Fig 5C). Villagers in Churhandpur district informed that white bellied rats with rufous back are also common in the area and presumably belong to this species.**35. *Cannomys badius* (Hodgson, 1841)**

(Lesser Bamboo Rat)

Material examined: Nil, photograph of dead specimen (Image 5, A).**Locality records:** Luanglong Khullen (990 m) and Phalong (1090 m), Tamenglong district; Bishnupur (Mandal et al. 2005; present study).**Family: Hystricidae****36. *Hystrix brachyura* Linnaeus, 1758**

(Malayan Porcupine)

Material examined: Nil, photograph of dead specimen (Image 5B).**Locality records:** Phalong (1090 m), Tamenglong district; no exact locality, Senapati district and Imphal, Imphal district (Roonwal 1950; Agrawal 2000; present study)**Remarks:** A photograph of a killed animal from Phalong village in Tamenglong district was examined. Present status in the state is unclear as most of the earlier records are old.**37. *Atherurus macrourus* (Linnaeus, 1758)**

(Asiatic Bush-tailed Porcupine)

Material examined: Nil, photograph of dead specimen (Image 5D).**Locality records:** Phalong (1090 m), Tamenglong district (Mandal et al. 2005; present study).

Remarks: Along with *H. brachyura*, vigorously hunted by the locals as it is considered a delicacy. According to villagers in Phalong, it is much more uncommon than *H. brachyura* and one villager in Chandel reported it to be rare in the region.

Order: Eulipotyphla

Family: Soricidae

38. *Anourosorex squamipes* Milne Edwards, 1872

(Assam Mole Shrew)

Material examined: 1 male, 28.v.2015, Bhalok, Tamenglong district.

Locality records: Bhalok (580 m), Tamenglong district.

Remarks: One specimen was examined from Tamenglong area and according to the collector; it is not uncommon in the region especially in the Jhum fields and adjoining hilly tracts.

CONSERVATION ISSUES

Like elsewhere, most species of small mammals in Manipur are threatened primarily by human activity. This is more pronounced for bats and the larger rodents (murids and larger arboreal species). Globally, bats are under threat from severe human pressure like habitat destruction & degradation, overexploitation, persecution etc. and the situation is no different in India (Mistry 2003). Khangkhui cave in Ukhrul district is a well-known tourist destination in the state. We were told by the local guides that until 2016-17, the cave used to hold large roosting populations of Rhinolophid and Hipposiderid bats. But they were all killed and evicted out of the cave in recent times purportedly to make the cave "more tourist friendly". In some places, bats are also eaten for its supposed medicinal properties or as supplementary source of protein. In Wailou village in Chandel district, we were informed that people do occasionally hunt bats in a nearby cave although this practice is not widespread throughout the state. Another serious threat we noticed is death of bats as unintended victims of illegal bird trappings. This particular phenomenon was observed in Henglep and surrounding areas of Churhandpur district. Villagers set long nylon nets across flyways in hillside to catch birds. However, these nets also catch bats especially the larger ones which get entangled and die and people hardly bothers to remove them from the nets. We could observe large numbers of bat carcass especially *Cynopterus* and *Rousettus* at several locations along S. Sejol-Henglep Road which without doubt poses

a serious threat to the fruit bat populations in the area. Hunting of rodents especially squirrels, porcupines and larger rats is a fairly common practice in the hilly region of the state. In fact, we could obtain photographic evidence of several species of rodents including highly protected Asiatic Bush-tailed Porcupine and Himalayan Crestless Porcupine that were killed for consumption. Many communities in the rural areas consider hunting wild animals as a traditional way of life that has been continuing for generations and are not aware of the importance of protecting wildlife. Fortunately, certain level of awareness about wildlife conservation has been growing in some areas in recent times. Special mention worthy is Dailong village in Tamenglong district which has been at the forefront of community led conservation efforts. The forests in and around Dailong village has rich biodiversity and for generations, people have been protecting these forests as their heritage. It has been declared as a Biodiversity Heritage Site by the Manipur government. It is desirable that the same level of awareness and wisdom spread to fur flung areas where enforcement of wildlife laws is inherently difficult. This is indeed a huge challenge, but the onus primarily lies with the government who can rope in community leaders, youth organizations, and non-governmental organizations. This should be one of the priorities of the State Government and should take steps before it is too late to act.

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Image 6. Photographs of dead rodents obtained during the present surveys (not to scale). All animals were killed by villagers and could not be retrieved: A—*Cannomys badius* | B—*Hystrix brachyura* | C—*Niviventer fulvescens* | D—*Atherurus macrourus* | E—*Callosciurus erythraeus* | F—*Tamiops maclellandi*. © Gaikhuanlung Ngaomei and Uttam Saikia.

Appendix 1. Biometrics of some of the bat species from Manipur examined during the present study.

Species	HF	TB	FA	ER	TR	GTLI	CCL	ZW	BW	POC	CM ³	M ³ M ³	MLI	CM _j	COH	No. of exs.
<i>Eonycteris spelaea</i>	19.5	30.4	68.9	15.8	-	-	-	-	-	-	-	-	-	-	-	1
<i>Cynopterus sphinx</i>	13.5, 15.6	25.4, 25.6	68.1, 68.9	16.9, 18.1	-	-	-	-	-	-	-	-	-	-	-	1
<i>Lyroderna lyra</i>	18.2, 19.7	35.6	68.1, 68.7	31.7, 34.8	11.9, 13.7	-	-	-	-	-	-	-	-	-	-	2
<i>Hipposideros armiger</i>	15.2-16.9 (16.1)	39.4-41.4 (40.5)	87.9-90.2 (89.3)	27.0-29.3 (28.3)	-	-	-	-	-	-	-	-	-	-	-	4
<i>H. lankadiva</i>	16.7	37.5	89.2	27.4	-	31.13	27.4	16.91	11.21	4.60	12.21	12.20	-	13.58	-	1
<i>H. gentilis</i>	7.3	17.4	38.9	20.5	-	-	-	-	-	-	-	-	-	-	-	1
<i>Rhinolophus affinis</i>	12.3		51.50	20.8	-	-	-	-	-	-	-	-	-	-	-	1
<i>R. lepidus</i>	6.2	15.9	37.5	13.8	-	-	-	-	-	-	-	-	-	-	-	1
<i>R. macrotis</i>	7.83	18.5	41	19.9	-	-	-	-	-	-	-	-	-	-	-	1
<i>R. perniger</i>																1
<i>Rhinolophus sinicus</i>	9.6, 11.5	20.5	49.0, 53.2	15.2, 16.9	-	22.67	19.22	10.88	8.90, 9.09	2.65	7.65, 8.78	8.06, 8.21	14.28, 15.18	8.22, 9.09	2.97, 3.08	2
<i>R. yunnanensis</i>	14.4	25.5	54	22.0	-	26.60	22.83	12.86	10.14	3.20	10.38	9.37	18.20	11.32	-	1
<i>Mirotrellus joffrei</i>	9.0	15.65	38.5	10.3	4.3	14.90	14.12	10.82	7.73	4.58	5.08	7.43	10.77	5.68	4.00	1
<i>Myotis annectans</i>	11.4, 11.9	19.3, 19.9	43.0, 46.7	14.9, 16.5	6.3, 7.1	16.85	14.97	11.00	7.84	4.30	6.65	7.34	13.15	6.80	4.18	2
<i>M. formosus</i>	11.1	24	48.7	14	7.6	-	-	-	-	-	-	-	-	-	-	1
<i>M. muricola</i>	6.4-8.6 (7.4)	16.3-17.7 (17.0)	36.8-37.8 (37.4)	13.8, 12 (12.6)	4.3-6.4 (5.3)	14.07- 14.30 (14.20)	12.25- 12.73 (12.43)	8.75-9.10 (8.93)	6.37-6.51 (6.44)	3.29-3.53 (3.41)	4.92-5.27 (5.14)	5.72-5.82 (5.76)	10.32- 10.90 (10.66)	5.65-5.57 (5.6)	2.70-3.18 (2.99)	3
<i>Murina cyclotis</i>	6.9-7.0	17.3-17.7	30.7-33.2	11.9-12.1	5.4-6.4	17.17	14.75	9.87	7.48	4.36	5.58	5.68	11.50	5.76	4.90	2
<i>M. huttonii</i>	9.4	15.8	34.7	15.0	7.2	18.07	15.83	10.38	8.00	4.72	6.00	6.12	12.91	6.66	4.77	1
<i>Pipistrellus coromandra</i>	4.4-6(5.0)	11-12.2 (11.6)	27.5-29.6 (28.4)	6.0-9.1 (7.6)	3.3-3.7 (3.5)	-	-	-	-	-	-	-	-	-	-	4
<i>P. javanicus</i>	6.7, 7.5	14, 14.3	32.4, 32.1	9.4, 10.1	4.4, 4.7	12.69, 12.90	11.28, 11.59	7.92, 8.02	6.50, 6.52	3.30, 3.61	4.37, 4.40	5.35, 5.58	8.72, 9.13	4.73, 4.80	2.54	2
<i>P. tenuis</i>	5.0, 6.4	12.5, 12.8	28.0, 30.7	8.5, 8.9	3.4, 4	11.10	9.87	7.18	5.76	3.37	3.35	5.33	7.83	4.24	2.44	2
<i>Scotophilus heathii</i>	12.9, 13.7	25.0, 25.4	58.5, 59.1	15.3, 16.2	7.0, 7.6	-	-	-	-	-	-	-	-	-	-	2
<i>Tylonycteris fulvida</i>	5.0	9.7	24.3	8.5	3.5	11.7	10.32	8.43	6.57	2.78	3.75	5.34	8.14	4.20	2.26	1
<i>Miniopterus magnater</i>	10.5-11.2 (10.9)	20.2-21.9 (21.32)	50.1-51.3 (50.6)	9.0-11.0 (10.3)	3.9-4.3 (4.4)	17.02	16.05	9.85	8.58	4.28	6.87	7.50	13.14	7.23	-	4

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