Diversity and Conservation of Chiropteran Fauna

3

Vadamalai Elangovan, Virendra Mathur, Mukesh Kumar, and Yuvana Satya Priya

Abstract

Bats are the second largest order of mammals, accounting for about 1240 species. Bats utilize almost all the niches and make up a quarter of all known mammals on earth. India is known for its rich biodiversity and its natural history abound, but the bats of India are hardly ever mentioned, and very little is known about them. In India, about 119 species of bats incorporated in nine families, namely, Pteropodidae, Emballonuridae, Megadermatidae, Rhinolophidae, Hipposideridae, Vespertilionidae, Miniopteridae, Rhinopomatidae, and Molossidae. The present study was conducted at different districts of Uttar Pradesh. The present study was aimed to assess the diversity and conservation status of chiropteran fauna in Uttar Pradesh. Visual observations were conducted in old abandoned building, caves, crevices, historical monuments, and forest areas to assess the distribution of bats. A total of 15 species of bats were identified from the study area. Out of which, 3 species belong to suborder Megachiroptera, namely, *Rousettus leschenaulti*, *Cynopterus sphinx*, and *Pteropus giganteus*, and the remaining 12 species belong to the suborder Microchiroptera, namely, *Rhinopoma microphyllum*, *R. hardwickii*, *Hipposideros fulvus*, *H. lankadiva*, *Megaderma lyra*, *Pipistrellus coromandra*, *P. dormeri*, *P. tenuis*, *P. ceylonicus*, *Scotophilus heathii*, *S. kuhlii*, and *Taphozous nudiventris.* The colonies of *P. giganteus* were observed on tall trees such as *Mangifera indica*, *Ficus religiosa*, *F. glomerata*, *F. benghalensis*, *Eucalyptus* sp., *Azadirachta indica*, *Dalbergia sissoo*, *Madhuca indica*, and *Bambusa spinosa*. The

V. Elangovan (✉) · V. Mathur · M. Kumar
Department of Applied Animal Sciences, School for Biosciences and Biotechnology, Babasaheb Bhimrao Ambedkar Central University, Lucknow, Uttar Pradesh, India
e-mail: elango70@yahoo.com

Y. S. Priya
Residential Coaching Academy, Babasaheb Bhimrao Ambedkar Central University, Lucknow, Uttar Pradesh, India

C. Sivaperuman, K. Venkataraman (eds.), *Indian Hotspots*,
https://doi.org/10.1007/978-981-10-6605-4_3

medium-sized fruit bat *R. leschenaulti* occupied the abandoned buildings or old monuments such as Chunar Fort at Mirzapur and Bari Mosque at Jaunpur. The short-nosed fruit bat, *C. sphinx*, preferably occupied tree canopy, palm fronts, tree holes, and flower cluster; however, few colonies of *C. sphinx* were observed at abandoned buildings or monuments. The colonies of microchiropteran bats were observed at tree cleft, abandoned buildings, caves, and crevices throughout the study area. The results of field survey showed that *H. lankadiva* and *P. ceylonicus* were not earlier reported in Uttar Pradesh. The IUCN red list of threatened species 2011 categorized all 15 species of bats as least concern (LC version – 3.1). Scientific research coupled with education and awareness is a key to success for any conservation program. During field surveys, a number of discussions were held with students, teachers, forest officials, and public to increase the level of understanding on conservation of bats. The current study reveals the highest distribution of bats in eastern Uttar Pradesh due to the presence of a large number of old monuments, palaces, caves, deep well, and forests which harbor bats. These permanent structures give stable roosting sites to the bats. In general, there was no major threat to the bats in the study area, except sporadic observations at times. Another support is that a maximum of bat colonies are located in old monuments which are governed by the Archaeological Survey of India, while few more colonies are located in caves. Thus, the state Uttar Pradesh provides a range of suitable habitats for the distribution of both frugivorous and insectivorous bats.

Keywords
Chiroptera · Conservation · Distribution · Taxonomy

3.1 Introduction

Bats are the second largest order of mammals and second most species-rich order of mammals in the world, only surpassed by the rodents. In several localities, bat species can represent more than 50% of the local mammalian diversity (Wilson 1983), and this number is likely to increase as more bat surveys are being conducted in many parts of the world. The general pattern of worldwide bat distributions based on latitudinal gradients is similar to that of other mammals (Pagel et al. 1991), with bat communities with the highest diversity concentrated in the tropical regions (Findley 1976; Patterson et al. 2003). Bats constitute most diverse groups of mammals in the tropical regions, with only the rodents approaching them in number (Handley 1966; Nowak 1994; Emmons 1997). Bats are ecologically important fauna of our environment because many of the plant species depend upon bats for their pollination and seed dispersal.

The order Chiroptera is divided into two major suborders, Megachiroptera and Microchiroptera. In the Indian subcontinent, about 119 species of bats are incorporated into nine families, namely, Pteropodidae, Rhinopomatidae, Emballonuridae, Megadermatidae, Rhinolophidae, Hipposideridae, Molossidae, Vespertilionidae, and Miniopteridae (Bates and Harrisson 1997). The suborder Megachiroptera consists only one family Pteropodidae which restrict to the Old World tropics of Africa and Asia. The family Pteropodidae is one of the important pollinators and seed dispersers for a number of ecologically and economically important plants (Marshal 1985; Cox et al. 1991; Rainey et al. 1995). They are the only pollinator able to carry large-seeded fruits. Thus, they play a key role in structuring the forest community (Rainey et al. 1995), but the Indian legislation and policies have given poor recognition, and fruit bats are kept under Schedule V (along with vermin) of the Indian Wildlife Protection Act 1972. India being a tropical country has a rich diversity of chiropteran fauna. The microchiropteran or microbats are important for the agroecosystem as they consume nocturnal insect pest relatively in large volume up to 100% of their body weight (Davison and Zubaid 1992; Eckrich and Neuweuilar 1988). They play a major role in the regulation of insect population the landscape. Among the world's mammals, bats make up 25% of the total number. Bats are considered as the important regulator of the complex ecological processes through interaction such as seed dispersal, pollination, and insect regulation (Findley and Black 1983; Fleming 1986; Findley 1993). This study was aimed to investigate the status, distribution, and conservation of chiropteran fauna in eastern Uttar Pradesh.

3.1.1 Study Area

The state Uttar Pradesh has a geographical area of 29.44 million hectares which is about 9% of the land area of the country. Uttar Pradesh covers a large part of highly fertile and densely populated Upper Gangetic Plain. It lies between lat. 23° 52′ and 31° 28′ N and long. 77° 5′ and 84° 38′ E. The state Uttar Pradesh is known for its variety of natural resources like reserve forests, national parks, sanctuaries, etc. The recorded forest area of the state is about 5.17 million hectares which constitutes 17.55% of its geographical area. By legal status, reserve forest constitutes 70.51%, protected forest 2.90%, and unblessed forest 26.59%. The state has quite a good number of palaces, ancient temples, and historical monuments. Historical monuments and temples tend to be ideal roost sites for bats. Roosts are vital for bat survival and provide site for mating, rearing of young, consumption of prey, protection from predators and shelter from adverse weather conditions. This study was conducted at different districts of Uttar Pradesh (Fig. 3.1).

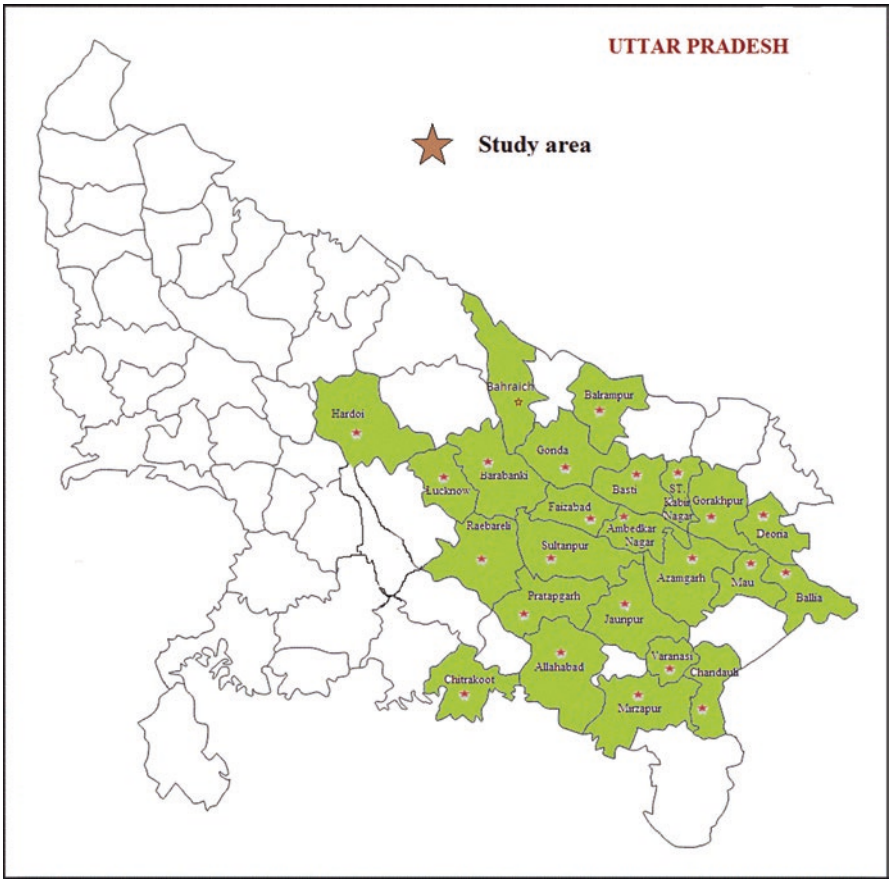

Fig. 3.1 The map of Uttar Pradesh and the study area is colored

3.2 Methods

Field surveys were carried out at different districts of eastern Uttar Pradesh through visual observations and mist netting/hoop netting. The study was conducted at Barabanki old temple, Banki village, Budhain Purva, Basauri, and Ram Sanehi Ghat in Barabanki district (26° 56′ N, 81°. 13′ E); Jais, Rani Harbans Ganj, Gangaganj, Harchandpur, and Balban Singh ka Purva in Raebareli district (26°.14′ N, 81°.16′ E); Diyara Fort (King Rudra Pratap Shahi), Kadipur, and Amethi Fort (King Ranvir Singh) in Sultanpur district (26°.16′ N, 81°.16′ E); Bara Imambara, Mohanlalganj, Sisandy house, Residency, Roomi Gate, and Telibagh in Lucknow district (26°.55′ N, 80°.59′ E); Makbara (Bahu Begum Shahiba), Begamganj, Gulab Bari, Rushi Temple, and Roosi temple in Faizabad (26°.47′ N, 81°.12′ E); Jaunpur Fort, Bari Masjid, and Atala Masjid in Jaunpur (25°. 46′ N, 82°. 44′ E); Allipur, Rafi Ahmad Intermediate College, Raja Rookmangal Singh Inter College, Kashipur,

Masit, and Kaimau in Hardoi (27°.23′ N, 80°.10′ N); Kunda, Pratapgarh, and railway station in Pratapgarh (25°.34′ N, 81°.59′ E); Sangam Fort, Jhushi Fort, and Khushroo Bagh in Allahabad (25°.28′ N, 81°.54′ E); hilly areas, Ram Ghat temple, Ashok Darwaja, and Hanuman Dhara Caves in Chitrakoot (25°.28′ N, 81°.54′ E); Mirzapur Fort, Chunar Fort, Durgaji Cave temple Chunar, Vindhyachal, hill areas, and Kali Khoh Temple in Mirzapur (25°.10′ N, 82°.37′ E); and Ramnagar Fort, Sarnath, Chaukhandi stoop, Paal kothi near Ganga River, Dr. Sampurnanand Sanskrit University, Queen Mary Inter College, and Banaras Hindu University campus in Varanasi (25°.20′ N, 83°.00 E).

The periodical visits were made through roost search and visual observations at roost sites twice in a month. Bats roosts were located based on the information given by local residents. Field surveys were conducted at historical monuments, tunnels, caves, crevices, old temples/buildings, wildlife sanctuaries, and forest areas. Bats were captured using nylon mist nets (9.0 m length, 2.0 m width, and 38.0 mm mesh size – Avinet, Dryden, USA). Mist nets were erected at 1800 h and closed at 0500 h. Individuals were kept inside the bat cage until morphological measurements were taken, and thereafter they were released at the site of capture. The morphological measurements such as forearm length, head and body length, and tail length were measured using digital venire calipers (Mitutoyo, Japan), and body mass was measured to the nearest 0.5 g using 50.0 g, 100 g, and 200 g spring balances. In addition, morphological measurements such as wingspan (cm); length of metacarpals 2nd, 3rd, 4th, and 5th (mm); length of tibia (mm); length of toe (mm); length of thumb (mm); and length of lower and upper jaw (mm) were recorded. Data were collected on distribution and diversity of bats in the study area. Population counts were made through photography with the help of digital camera (Kodak C 173). Dead bats were collected from the roosting sites, and bones were preserved for osteological studies.

3.3 Results

A total of 15 species of bats belong to six families observed in the study area. The distribution pattern of bats in the study area is given in Table 3.1.

3.3.1 Pteropodidae

The pteropodid bats can be easily identified by their simple external ear without tragus, and the edge of the pinna forms an unbroken ring around the ear canal. No nose leaf is present. The eyes are large with well-developed vision in all megachiropterans. The second finger has three bony phalanges, the last of which is very small or rudimentary and usually bears a small claw. The tail is usually either very short or absent. The shoulder joint is simple. The head looks like fox- or doglike appearance; hence, the common name “flying fox” is due to their fox-like faces. The canines are prominent, and the molar teeth are highly modified for fruit eating.

Table 3.1 Distribution of bats in Uttar Pradesh

Family	Species	Lucknow	Hardoi	Barabanki	Raebareli	Sultanpur	Faizabad	Ambedkar Nagar	Ballia	Mau	Mirzapur	Gorakhpur	Gonda	Allahabad	Pratapgarh	Varanasi	Jaunpur	Chandauli	Bahraich	Basti	Balrampur	S. Kabir Nagar	Deoria	Azamgarh	Chitrakoot
Pteropodidae	*R. leschenaulti*	+	+	+	–	–		+	+	+	+	–	+	–	+	+	+	–	–	–	–	–	–	–	+
	C. sphinx	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	P. giganteus	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+
Rhinopomatidae	*R. microphyllum*	–	–	–	–	–	–	–	–	–	+	–	–	–	–	+	–	+	–	–	–	–	–	–	+
	R. hardwickii	+	–	–	–	–	–	–	–	–	–	–	–	+	–	+	+	–	–	–	–	–	–	–	+
Hipposideridae	*H. lankadiva*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+	+
	H. fulvus	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	+
Megadermatidae	*M. lyra*	+	+	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	+	–	–	–
Vespertilionidae	*P. coromandra*	+	+	+	+	+	+	+	+	+	+	–	–	–	–	+	–	+	–	+	–	–	–	–	–
	P. dormeri	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	P. tenues	+	+	+	+	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–	–
	S. heathii	+	+	–	–	–	–	–	–	–	–	–	–	–	–	+	–	–	–	–	–	–	–	–	–
	S. kuhlii	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	P. ceylonicus	–	–	–	+	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Emballonuridae	*T. nudiventris*	–	–	–	–	–	–	–	–	–	+	–	–	–	–	+	–	–	–	–	–	–	–	–	–

+ = Present; – = Absent

These bats lack acoustic orientation except rousette bats (*Rousettus*), generally roost in trees, colonial, and often show cryptic markings or bright fur colors or patterns. The Indian pteropodids are predominantly frugivorous. Flying foxes gather in large numbers to roost, and in the evening, they start emerging from roost one by one at initial period and then large numbers. The distribution of pteropodid bats in the study area is shown in Table 3.1.

3.3.2 Fulvous Fruit Bat *Rousettus leschenaulti* (Desmarest, 1820)

It is a very common species and generally known as Indian fulvous fruit bat, *Rousettus leschenaulti*. It has a widespread distribution in the study area. This bat is intermediate in size between short-nosed fruit bat, *Cynopterus sphinx*, and Indian flying foxes, *Pteropus giganteus*, with an average forearm length of 80.6 mm (75–86 mm), and the hind feet and thumb are shorter. The muzzle is short and slender, and its body color on dorsal surface dark brown and ventral surface light brown. The pelage is soft fine and silky (Fig. 3.2). A small group of four individuals were observed in a building roost at Barabanki. A colony consists 10,000–10,500 individuals of *R. leschenaulti* observed in a dome of Bari Masjid (Mosque) located at Jaunpur, Uttar Pradesh. The mosque was constructed by the late Firuz Shah Tughlak during the thirteenth century. According to the local residents, the colony occupies the mosque for the last 20 years. Another colony of *R. leschenaulti* consists of 800–900 individuals observed in the tunnel of a deep well at Chunar Fort located 35 km east of Mirzapur.

A total of seven individuals (four males and three females) caught from different locations, namely, Banki, Jais in Raebareli, Bari Masjid in Jaunpur, and Gopal Khera in Lucknow to study the morphological measurements and the morphological measurements, are given in Table 3.2. There was no major threat to this species in the study area. However, little disturbance was observed due to human interference to the roost sites, since the roost sites are located in national monuments which

Fig. 3.2 Indian fulvous fruit bat *Rousettus leschenaulti* with a pup

Table 3.2 Morphological measurements of *Rousettus leschenaulti*

	Male ($n = 4$)		Female ($n = 3$)	
Morphological parameters	Mean	SD	Mean	SD
Body wt (g)	94.3	9.1	88.4	30.4
FAL (mm)	54.0	19.1	62.2	23.2
Head length	37.5	1.5	35.4	12.9
HB length (mm)	115.1	2.9	103.4	37.7
Ear length	27.2	6.1	21.7	7.5
Thumb length(mm)	34.4	10.7	30.2	9.2
Tibia length (mm)	22.9	7.0	29.3	12.9
Toe length (mm)	18.0	3.5	16.6	5.2
Tail length (mm)	16.7	0.6	14.6	5.3
WSP length (cm)	51.4	0.6	51.7	0.9
MET II (mm)	32.3	1.8	30.8	11.1
MET III (mm)	52.9	2.3	37.9	17.0
MET IV (mm)	49.7	7.6	46.8	15.3
MET V (mm)	29.1	10.2	37.9	17.0
Lower jaw length (mm)	21.5	1.9	19.6	6.7
Upper jaw length (mm)	20.4	0.8	17.4	6.3

are being visited by tourists. In addition, the roost sites are disturbed by the developmental activities of monuments. The IUCN red list of threatened species 2011 categorized *R. leschenaulti* as least concern, i.e., LC version – 3.1 (Table 3.17).

3.3.3 Short-Nosed Fruit Bat *Cynopterus sphinx* (Vahl, 1797)

The short-nosed fruit, *Cynopterus sphinx*, is commonly distributed throughout the study area. It can be easily identified by its dog-shaped head, divergent nostril, large prominent eyes, and short ears with white margin as unique morphological characters. The muzzle is short, broad, and covered with the hairs as far as nostril which project well forward. In males, the chin, anterior part of shoulder, sides of the chest, belly, and thighs are characteristically orange tinted.

In females, the color is usually towny brown; the rump is gray brown with paler gray belly. The forehead and the neck are darker and rich russet brown; posteriorly the back is gray brown (Fig. 3.3). A colony consists 250–300 individuals of *C. sphinx* observed in 12 harems at different locations in the study area. In addition, a huge colony of *C. sphinx* consists 55–60 individuals observed in the dome of Khushroo Bagh (a historical monument) located in Allahabad. According to local residents, bats are living in the monuments for the last 12 years. A total of 12 individuals (6 males and 6 females) were captured using mist nets, and they were released after taking the morphological measurement (Table 3.3).

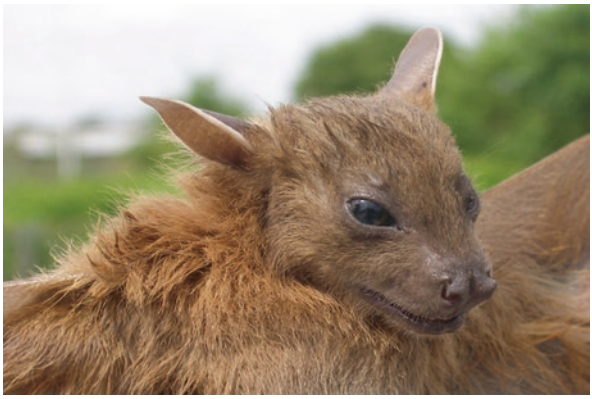

Fig. 3.3 Short-nosed fruit bat *Cynopterus sphinx* (male)

Table 3.3 Morphological measurements of *Cynopterus sphinx*

	Male ($n = 6$)		Female ($n = 6$)	
Morphological parameters	Mean	SD	Mean	SD
Body wt (g)	51.1	6.1	59.1	3.1
FAL (mm)	71.3	1.9	72.4	1.6
Head length	41.1	1.1	41.9	0.9
HB length (mm)	106.5	5.5	108.7	2.3
Ear length	21.1	1.7	20.7	1.3
Thumb length (mm)	18.1	0.8	17.5	0.7
Tibia length (mm)	31.0	1.2	31.2	0.9
Toe length (mm)	8.3	0.6	8.0	0.3
Tail length (mm)	12.1	0.4	12.1	0.8
WSP length (cm)	43.5	0.7	43.5	0.6
MET II (mm)	42.6	1.0	43.2	0.5
MET III (mm)	46.0	1.0	45.8	1.1
MET IV (mm)	45.1	0.8	45.1	0.5
MET V (mm)	46.6	0.6	45.9	0.3
Lower jaw length (mm)	11.3	0.6	11.7	0.9
Upper jaw length (mm)	13.0	0.5	12.8	0.7

There was no major threat observed to this species in the study area. However, in some parts of the study area, it was observed that people are hunting them with a myth that the flesh of *C. sphinx* has some medicinal values. Though the fruit bats are playing a key role in pollination and seed dispersal, the farmers of guava and mango orchards at Malihabad consider them as pest as the bats are damaging their crops and reducing the yield. The IUCN red list of threatened species 2011 categorized this species as least concern (LC version – 3.1).

Table 3.4 Morphological measurements of *Pteropus giganteus*

Morphological parameters	Male	Male
Body weight (g)	600.0	400.0
Head and body length (mm)	220	155.0
Tail length (mm)	0	0
Toe (mm)	22.9	15.2
Length of tibia (mm)	74.7	63.3
Forearm length (mm)	155.1	137.5
Ear length (mm)	36.2	26.3
Ear width (mm)	18.7	14.1
Wing span (cm)	104.0	93.0
Length of thumb (mm)	43.8	33.9
2 MT (mm)	79.1	71.8
3 MT (mm)	108.2	93.1
4 MT (mm)	103.9	90.6
5 MT (mm)	114.1	96.5

Fig. 3.4 Indian flying fox *Pteropus giganteus* with a pup

3.3.4 Indian Flying Fox *Pteropus giganteus* (Brunnich, 1782)

Indian flying fox, *Pteropus giganteus*, has widespread distribution in eastern Uttar Pradesh. A total of about 15,906 individuals were observed from 35 colonies of *P. giganteus* roosting in different locations of the study area. The colonies of *P. giganteus* were observed in at Mohanlalganj, Hullaskhera, Masit, Nakarsen, and Hardoi. It is the largest fruit bat in India with the forearm length of 152–183 mm. The morphological measurements of two bats which died due to electrical shock were collected and given in Table 3.4.

Pteropus giganteus has long snout, well-developed nostril, and long pointed black ears. The pelage is chestnut brown on the crown of the head and relatively darker around the eyes (Fig. 3.4). There was no major threat observed to *P. giganteus* in the study area. In some part of study area, this species found locally threatened by cutting down of roost trees because of road expansion or other domestic

purposes. The species is rarely hunted by people for bush meat. The IUCN red list of threatened species 2011 categorized this species as least concern (LC version – 3.1).

3.3.5 Rhinopomatidae

The family Rhinopomatidae is traditionally considered to be one of the most ancient chiropteran clades. It is a small family of insect-eating bats of primitive structure found in the arid and semiarid region. The tail is very long and slender with the longest part projecting free from the membrane. The family Rhinopomatidae consists of three known species, namely, *Rhinopoma hardwickii*, *R. microphyllum*, and *R. muscatellum*. Two species of rhinopomatid bats, namely, *R. microphyllum* and *R. hardwickii*, were observed at specific locations in the study area.

3.3.6 Greater Mouse-Tailed Bat *Rhinopoma microphyllum* (Brunnich, 1782)

The greater mouse-tailed bat, *Rhinopoma microphyllum*, is widespread and relatively common species. *Rhinopoma microphyllum* roosts in historical monuments in the study area. The distribution of greater mouse-tailed bat was very limited in eastern Uttar Pradesh and observed only three colonies in the study area. It is the largest of three species of *Rhinopoma* in the Indian subcontinent with the forearm length 68.54–74.6 mm with short tail. The face, ears, and connecting membrane on the forehead are found naked. The ears are well developed with bluntly sickle-shaped tragus. The pelage is short and fine, and its body color is gray brown on the dorsal surface and paler in ventral side (Fig. 3.5). A colony of greater mouse-tailed bat consists 11,000–11,500 individuals observed in Chunar Fort located 30 km away from east of Mirzapur. The second colony of *R. microphyllum* was observed in an old monument, namely, Pal Kashi Naresh Fort located at Varanasi. The colony consists of 2500–3000 individuals of *R. microphyllum*.

In addition, a colony consists 1800–2000 individuals of *R. microphyllum* observed in a cave located at Chitrakoot. According to the local residents, *R. microphyllum* lives in the cave for the last 25 years. Human disturbance was observed at roost sites during the study period; however, hunting was not observed. The IUCN red list of threatened species 2011 categorized this species as least concern (LC version – 3.1). A total of seven adults (three males and four females) were captured using mist nets, morphological measurements were taken, and the bats were released at the site of capture. A list of morphological measurements is given in Table 3.5.

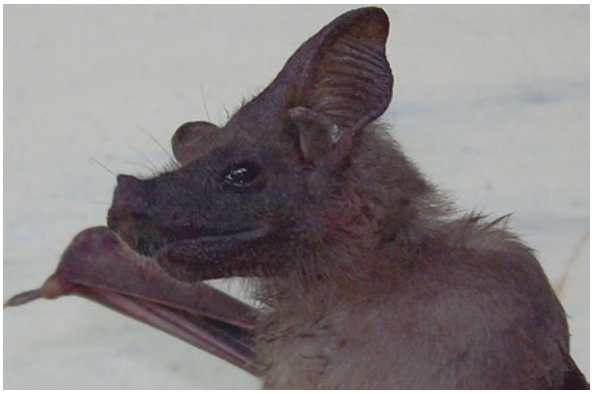

Fig. 3.5 Greater mouse-tailed bat, *Rhinopoma microphyllum*

Table 3.5 Morphological measurements of *Rhinopoma microphyllum*

	Male (n = 3)		Female (n = 4)	
Morphological parameters	Mean	SD	Mean	SD
Body wt (g)	22.8	0.8	22.1	1.9
FAL (mm)	67.0	2.9	67.7	1.5
Head length	26.6	0.5	26.3	0.7
HB length (mm)	77.0	3.0	77.1	0.6
Ear length	18.5	0.8	19.6	0.5
Thumb length (mm)	14.6	0.5	15.2	0.3
Tibia length (mm)	28.7	0.4	29.4	0.5
Toe length (mm)	13.1	0.3	14.4	0.6
Tail length (mm)	54.7	2.3	57.5	0.5
WSP length (cm)	36.6	0.3	36.0	0.8
MET II (mm)	50.9	0.9	52.2	0.6
MET III (mm)	51.7	0.5	53.3	0.4
MET IV (mm)	42.8	0.7	43.5	0.4
MET V (mm)	46.9	0.2	47.3	0.3
Lower jaw length (mm)	11.1	0.2	12.0	0.6
Upper jaw length (mm)	18.0	0.2	18.6	0.3

3.3.7 Lesser Mouse-Tailed Bat *Rhinopoma hardwickii* (Gray, 1831)

The lesser mouse-tailed bat, *Rhinopoma hardwickii*, has a wide distribution in Uttar Pradesh. It is a small bat with slender long free tail. The face is glandular, and the ears are connected across the forehead. The eyes and tragus are well developed. The muzzle bears small trigonal nose leaf terminally (Fig. 3.6). The roosts of *R. hardwickii* were observed in caves and roofs of deserted buildings. The colony size varies from 250 to 1000. The distribution of *R. hardwickii* was observed in the cave (Jhushi Fort, Ulta Kila), historical monument (Khushroo Bagh), and Atala Mosque, Jaunpur.

Fig. 3.6 Lesser mouse-tailed bat *Rhinopoma hardwickii*

Table 3.6 Morphological measurements of *Rhinopoma hardwickii*

	Male (n = 3)		Female (n = 3)	
Morphological parameters	Mean	SD	Mean	SD
Body wt (g)	20.0	1.1	21.3	0.5
FAL (mm)	62.3	0.6	62.7	0.8
Head length	23.8	0.2	24.1	0.2
HB length (mm)	71.6	0.3	72.3	0.6
Ear length	17.8	0.2	17.9	0.1
Thumb length (mm)	13.7	0.2	14.0	0.2
Tibia length (mm)	31.3	0.6	31.8	0.4
Toe length (mm)	13.8	0.2	13.6	0.2
Tail length (mm)	87.1	0.8	87.0	0.3
WSP length (cm)	34.4	0.1	34.9	0.1
MET II (mm)	46.5	0.4	46.5	0.3
MET III (mm)	46.7	0.3	46.6	0.3
MET IV (mm)	39.4	0.6	39.7	0.1
MET V (mm)	45.4	0.3	45.7	0.3
Lower jaw length (mm)	6.9	0.1	6.8	0.2
Upper jaw length (mm)	6.8	0.2	7.4	0.3

The IUCN red list of threatened species 2011 categorized this species as least concern (LC version – 3.1). A total of six adults (three males and three females) were captured using mist nets, morphological measurements were taken, and the bats were released at the site of capture. The morphological details are given in Table 3.6.

3.3.8 Hipposideridae

In general, most hipposiderids have brown or reddish-brown shade, but fur color varies intraspecifically. Like their close relatives, the rhinolophids, members of

Hipposideridae, possess an ornate nose leaf and broad mobile ears. The nose leaf is basically a horseshoe shape. Behind the anterior leaf, there is an intermediate swollen area which sometimes has a small central projection. The intermediate leaf forms a base for a thinner, more elaborate, and erect posterior element. This posterior leaf is not pointed, as in rhinolophids, but usually rounded or flat across the top. In addition, the face of the posterior leaf may have several thin-walled compartments. The complexity of the nose leaf may be further enhanced by secondary foliations of skin from under the edges of the horseshoe. Hipposiderids fly 1–2 m above the ground, frequently avoid bushes and use their short broad wings for slow and maneuverable flight. Hipposiderids hang free by their toes and usually roosts in cave ceiling. The family has found scanty distribution in the study area.

3.3.9 Indian Leaf-Nosed Bat *Hipposideros lankadiva* (Kelaart, 1850)

It is commonly known as the Kelaart's leaf-nosed bat. This large *Hipposideros* has an average forearm length of 83.5 mm (75.0–99.0 mm). Its nose leaf usually has four supplementary leaflets bordering the horseshoe. The intermediate leaf is expanded, its central part is inflated and swollen, and its upper surface is evenly concave. The posterior leaf is broad, and the pelage color ranges from pale cream to brown (Fig. 3.7).

A colony of *H. lankadiva* consists 1000–1100 individuals observed in a cave at Chitrakoot. No major threat was observed to this species during study period. However, *H. lankadiva* faces disturbance at times due to pilgrims who are visiting this religious place. Morphological measurements were taken from six adult bats (three males and three females), and the details are given in Table 3.7.

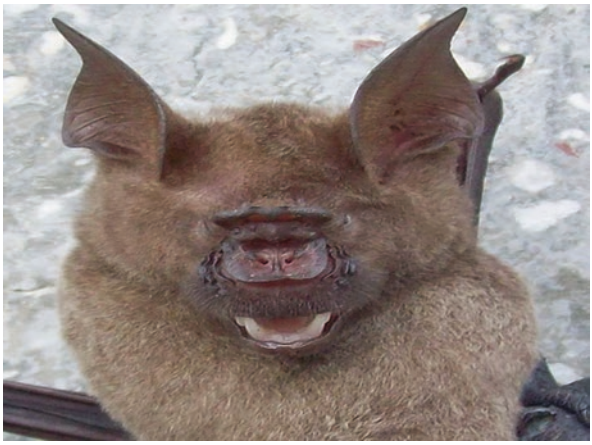

Fig. 3.7 Indian leaf-nosed bat *Hipposideros lankadiva* (male)

Table 3.7 Morphological measurements of *Hipposideros lankadiva*

	Male (n = 3)		Female (n = 3)	
Morphological parameters	Mean	SD	Mean	SD
Body wt (g)	42.0	1.0	41.7	2.1
FAL (mm)	84.3	0.4	84.9	1.0
Head length	33.0	0.2	32.5	0.4
HB length (mm)	91.4	0.7	92.3	0.6
Ear length	22.6	0.4	22.6	0.4
Thumb length (mm)	13.3	0.2	13.6	0.3
Tibia length (mm)	33.5	0.3	34.0	0.1
Toe length (mm)	12.5	0.2	12.5	0.1
Tail length (mm)	42.9	0.6	44.3	0.7
WSP length (cm)	49.6	0.4	49.5	0.5
MET II (mm)	62.7	0.3	62.7	0.3
MET III (mm)	62.4	0.2	62.6	0.3
MET IV (mm)	59.3	0.3	59.4	0.2
MET V (mm)	56.4	0.1	56.8	0.3
Lower jaw length (mm)	13.6	0.3	13.7	0.3
Upper jaw length (mm)	12.7	0.2	12.6	0.3

Fig. 3.8 Fulvus leaf-nosed bat *Hipposideros fulvus* (female)

3.3.10 Fulvus Leaf-Nosed Bat *Hipposideros fulvus* (Gray, 1838)

This is a small-sized leaf-nosed bat and commonly known as fulvous leaf-nosed bat with characteristically very large ear, and the tips are broadly rounded off. The feet are small, and the length of the nose leaf is about 5.0 mm. The pelage is pale gray (Fig. 3.8).

Table 3.8 Morphological measurements of *Hipposideros fulvus*

	Male (n = 3)		Female (n = 3)	
Morphological parameters	Mean	SD	Mean	SD
Body wt (g)	11.5	0.5	12.6	0.4
FAL (mm)	40.8	0.5	41.3	0.5
Head length	20.6	0.4	20.5	0.5
HB length (mm)	48.6	0.5	49.1	0.2
Ear length	20.0	0.4	21.0	0.6
Thumb length (mm)	11.0	0.2	10.5	0.7
Tibia length (mm)	18.0	0.3	18.0	0.5
Toe length (mm)	7.5	0.3	8.0	0.2
Tail length (mm)	27.0	0.3	28.0	0.6
WSP length (cm)	25.8	0.4	25.9	0.9
MET II (mm)	33.8	0.5	34.2	0.3
MET III (mm)	23.7	0.2	24.9	0.7
MET IV (mm)	31.4	0.5	31.7	0.5
MET V (mm)	30.6	0.2	31.3	0.4
Lower jaw length (mm)	8.7	0.4	8.8	0.1
Upper jaw length (mm)	10.0	0.2	9.9	0.7

It has limited distribution in the eastern Uttar Pradesh. A colony of *H. fulvus* consists 300–350 individuals observed in an abandoned palace (King Rudra Pratap Shahi Diyara) at Sultanpur. The distribution of *H. fulvus* was also observed in Gupt Godavari cave at Chitrakoot. No major threat was observed to *H. fulvus* in the study area. However, *H. fulvus* faces roost site destruction due to developmental activities in the monument and Gupt Godavari religious site. Morphological measurements of six adults (three males and three females) were taken and presented in Table 3.8.

3.3.11 Megadermatidae

The family Megadermatidae comprises four genera and five species; however, only one species *Megaderma lyra* was observed in the study area. Externally the members of the family can be recognized by the very large ears which are joined at their bases across the head and have very large and bifurcate tragus. The tail is very short or absent, and a large well-developed nose leaf is present. This species may roost singly or in small groups.

3.3.12 Indian False Vampire Bat *Megaderma lyra* (Geoffroy, 1810)

Megaderma lyra is commonly known as Indian greater false vampire bat. It has an average forearm length of 66.5 mm (56–71.5 mm). The head is characterized by its large oval ears which have fringe of white hairs on their inner margins. The ears are joined medially between one third and half of their length. Each ear has bifid tragus, the posterior process of which is taller. The face of *M. lyra* is hairy on the forehead

Fig. 3.9 Indian false vampire bat *Megaderma lyra* (male)

Table 3.9 Morphological measurements of *Megaderma lyra*

	Male (n = 3)		Female (n = 3)	
Morphological parameters	Mean	SD	Mean	SD
Body wt (g)	21.3	1.2	22.7	1.5
FAL (mm)	65.5	0.6	67.2	0.8
Head length	29.5	0.5	29.6	0.3
HB length (mm)	88.9	0.3	89.8	0.1
Ear length	40.4	0.6	40.5	0.5
Thumb length (mm)	15.8	0.4	16.2	0.3
Tibia length (mm)	38.0	0.2	38.0	0.2
Toe length (mm)	17.8	0.4	18.0	0.3
Tail length (mm)	0.0	0.0	0.0	0.0
WSP length (cm)	43.62	0.21	43.22	0.6
MET II (mm)	60.9	0.8	61.3	0.6
MET III (mm)	52.7	0.4	52.7	0.4
MET IV (mm)	56.9	0.2	57.0	0.2
MET V (mm)	55.5	0.5	55.6	0.5
Lower jaw length (mm)	15.0	0.1	15.6	0.2
Upper jaw length (mm)	14.9	0.3	14.5	0.4

and upper cheeks and naked at the snout. The nose leaf is erect, straight, and about 9 mm in height, and it has a longitudinal ridge and a simple rounded horizontal base. The pelage is fine soft and moderately long. The color of the body is grayish brown dorsally and paler at ventral side. The membrane of the ear is grayish black and semitranslucent, and the wings are broad (Fig. 3.9).

A colony of *M. lyra* consists about 550 individuals observed roosting beneath the staircase of a building (Rafi Ahmad Inter College) at Hardoi. No major threat was observed to this species in the study area. However, the bats used to get little disturbance due to human interference to the roost sites. A total of six adult bats (three males and three females) were captured; morphological measurements were taken and presented in Table 3.9.

3.3.13 Vespertilionidae

Vespertilionidae is the largest family of Indian bats and one of the most widely dispersed group of mammals in the world. As might be expected, this large and adaptable group of bats displays a correspondingly diverse range of morphological variation. A number of features distinguish the group as a whole from other bats. This group lacks nose leafs and has simple, unmodified lips and nostrils; they are commonly called the "plain-faced" bats. The tragus is usually well developed, and the tail is not free from the uropatagium. The facial region may have a variety of swollen glands and related structures. The eyes are usually small and the ears of vespertilionids are generally separate, small, and simple in structure. The tragus is usually a simple tongue-shaped structure. Occasionally, the lower margin of the ear is attached on the side of the head just behind the corner of the mouth. Most vespertilionids are brown, gray, or blackish brown in color. Belly fur is generally lighter than back fur. Internally, vespertilionids are distinguished by the highly developed double articulation between the scapula and humerus, the very rudimentary ulna, the essentially unmodified shoulder girdle and pelvis, and the conspicuous anterior emargination of their bony palate. There is a general trend throughout the family whereby the jaws are shortened to increase the effectiveness of the chewing muscles. The ulna is usually fused with the radius at its head, and the shaft is reduced to a fine ossified fibrous strand. The third finger bears three phalanges, of which the distal one is cartilaginous throughout except at the extreme base where a distinct joint is formed with the middle phalanx.

3.3.14 Little Indian Bat *Pipistrellus coromandra* (Gray, 1838)

The little Indian bat, *Pipistrellus coromandra*, is average larger, but there are significant overlaps in all external measurement. Pelage color is generally uniform brown on the dorsal surface ranging from dark chestnut to dark clove brown. The ventral surface is conspicuously pale brown. The ears and its membrane are mid to dark brown and essentially naked although there are some hairs on the interfemoral membrane adjacent to the body and tail above and below (Fig. 3.10).

Pipistrellus coromandra colonies were observed in crevices of Rushi temple, Ayodhya, in tree cavities at Hardoi Railway Station, and in wall crevices at Allipur; Telibagh; Banki (Barabanki); Jais, Raebareli; and B.B. Ambedkar University hostel building, Lucknow. No major threat was observed to this species and its habitat. Morphological measurements were collected from 12 adult bats (6 males and 6 females), and the details are given in Table 3.10.

3.3.15 Dormer's Bat *Pipistrellus dormeri* (Dobson, 1875)

It is commonly known as Dormer's bat. It is a medium-sized *Pipistrellus*, with an average forearm length of 34–30 mm. The tail is considerably shorter than the head

Fig. 3.10 Little Indian bat *Pipistrellus coromandra*

Table 3.10 Morphological measurements of *Pipistrellus coromandra*

	Male ($n = 6$)		Female ($n = 6$)	
Morphological parameters	Mean	SD	Mean	SD
Body wt (g)	10.2	0.7	10.8	0.7
FAL (mm)	28.0	0.3	28.2	0.6
Head length	14.0	0.3	14.1	0.6
HB length (mm)	42.8	1.0	44.5	0.5
Ear length	8.8	0.2	9.3	0.4
Thumb length (mm)	6.3	0.3	7.1	0.4
Tibia length (mm)	10.9	0.4	11.1	0.5
Toe length (mm)	5.6	0.1	5.8	0.6
Tail length (mm)	28.0	0.6	29.2	0.9
WSP length (cm)	21.0	0.6	21.1	0.5
MET II (mm)	26.5	0.4	27.4	0.4
MET III (mm)	27.5	0.3	27.9	0.2
MET IV (mm)	26.7	0.3	26.4	0.2
MET V (mm)	25.7	0.2	25.5	0.3
Lower jaw length (mm)	4.8	0.3	4.6	0.2
Upper jaw length (mm)	5.7	0.2	6.3	0.4

and body. The pelage on the dorsal surface is grayish brown with some of the tip almost silver in color, while the roots are dark brown/black; overall there is a slight glossy sheen. The ventral surface is contrastingly paler, with all hair tips white or pale white, and the roots are very dark. The ears, naked areas of the face, and the membrane are brown. In some specimen, the veins in the interfemoral membrane are conspicuously marked in white (Fig. 3.11).

It has a limited distribution in the study area and found a single colony of *P. dormeri* was observed in the crevice of Makbara of Bahu Begum Shahiba, Faizabad. Overall there was no major threat observed to *P. dormeri* in the study area. Morphological measurements of six bats (three males and three females) were taken, and details are presented in Table 3.11.

Fig. 3.11 Dormer's bat *Pipistrellus dormer*

Table 3.11 Morphological measurements of *Pipistrellus dormeri*

	Male (n = 3)		Female (n = 3)	
Morphological parameters	Mean	SD	Mean	SD
Body wt (g)	11.0	1.0	10.3	1.5
FAL (mm)	33.0	3.5	36.1	0.2
Head length	17.3	2.2	18.6	0.2
HB length (mm)	35.1	23.5	49.1	0.7
Ear length	9.8	0.3	12.0	0.6
Thumb length (mm)	6.8	0.5	7.1	0.3
Tibia length (mm)	12.7	0.9	13.8	0.2
Toe length (mm)	6.1	0.2	6.1	0.4
Tail length (mm)	30.1	0.8	31.3	0.6
WSP length (cm)	22.2	0.7	23.3	0.6
MET II (mm)	30.6	3.5	32.3	0.5
MET III (mm)	31.8	3.2	34.3	0.4
MET IV (mm)	30.9	3.4	33.1	0.1
MET V (mm)	29.6	3.3	32.0	0.6
Lower jaw length (mm)	6.7	1.9	7.9	0.4
Upper jaw length (mm)	8.1	1.3	8.8	0.15

3.3.16 Indian Pygmy Bat *Pipistrellus tenuis* (Temminek, 1840)

It is a small *Pipistrellus* and commonly known as Indian pygmy bat. The dorsal pelage is uniform, brown varying in tone from mid brown to deep brown, the ventral surface is paler, and hair tips are buffy brown. The ear membrane is dark and essentially naked (Fig. 3.12). Colonies of *P. tenuis* were observed roosting in wall crevices of old buildings at Telibagh, Lucknow. No major threat was observed to this species in the study area. Morphological measurements were collected from six bats (three males and three females), and details are given in Table 3.12.

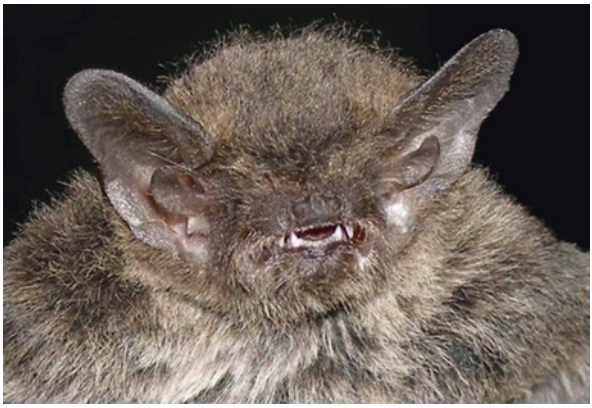

Fig. 3.12 Indian pygmy bat *Pipistrellus tenuis*

Table 3.12 Morphological measurement of *Pipistrellus tenuis*

	Male (n = 3)		Female (n = 3)	
Morphological parameters	Mean	SD	Mean	SD
Body wt (g)	11.0	1.0	11.0	2.0
FAL (mm)	31.2	4.0	28.7	0.8
Head length	13.9	4.2	13.0	0.2
HB length (mm)	41.0	7.6	38.1	0.9
Ear length	9.9	1.1	10.3	1.3
Thumb length (mm)	7.3	0.3	7.1	0.8
Tibia length (mm)	13.6	0.5	14.6	0.5
Toe length (mm)	6.5	0.4	6.1	0.3
Tail length (mm)	28.1	2.5	28.4	1.4
WSP length (cm)	22.8	1.3	20.0	0.6
MET II (mm)	26.2	5.4	24.0	0.3
MET III (mm)	28.4	4.8	26.4	1.7
MET IV (mm)	29.5	2.9	28.1	0.4
MET V (mm)	28.5	2.8	27.1	1.8
Lower jaw length (mm)	6.6	2.0	6.0	0.2
Upper jaw length (mm)	7.4	1.9	7.3	0.6

3.3.17 Kelaart's Pipistrelle *Pipistrellus ceylonicus* (Kelaart, 1852)

Kelaart pipistrelle is relatively large with an average forearm length of 33–60 mm. The ears, naked area of face, wings, and interfemoral membrane are uniform dark brown in color. There are some hairs found on the interfemoral membrane above and below, adjacent to the body tail and femora. The dorsal pelage is variable color ranging from grayish brown to chestnut, reddish, or golden brown. The ventral surface has dark hair bases and pale gray tips (Fig. 3.13).

Colonies of *P. ceylonicus* were observed in roof crevices of abandoned building at Kasharawan, Raebareli, and in wall crevices of abandoned building at Jais, Raebareli. There was no major threat observed to *P. ceylonicus*. Morphological measurements of six adult bats (three males and three females) were taken and presented in Table 3.13.

Fig. 3.13 Kelaart's pipistrelle *Pipistrellus ceylonicus*

Table 3.13 Morphological measurements of *Pipistrellus ceylonicus*

	Male (n = 3)		Female (n = 3)	
Morphological parameters	Mean	SD	Mean	SD
Body wt (g)	9.0	2.6	10.0	1.0
FAL (mm)	35.6	4.8	38.7	1.1
Head length	15.0	1.6	16.3	0.7
HB length (mm)	49.8	6.5	54.0	1.0
Ear length	12.6	0.7	10.7	0.7
Thumb length (mm)	5.6	1.3	5.2	0.6
Tibia length (mm)	13.8	0.7	13.6	0.8
Toe length (mm)	5.7	1.7	5.4	0.4
Tail length (mm)	31.5	1.5	34.9	0.4
WSP length (cm)	21.3	0.5	21.0	0.1
MET II (mm)	32.4	3.6	35.1	0.6
MET III (mm)	33.9	3.0	36.2	0.6
MET IV (mm)	34.5	3.5	36.1	0.8
MET V (mm)	33.5	3.1	35.2	0.6
Lower jaw length (mm)	5.2	0.4	5.7	0.3
Upper jaw length (mm)	6.0	0.7	6.6	0.4

3.3.18 Greater Asiatic Yellow House Bat *Scotophilus heathii* (Horsefield, 1831)

Asiatic greater yellow house bat is widely distributed in the study area. It is a robust insectivorous bat. The tail is long with only the terminal 2.0–3.0 mm projecting free from the interfemoral membrane. The muzzle is broad and blunt; it is swollen on the sides, dark in color, and naked. The nostrils are simple in form, round, and slightly outward facing. The ears are small in relation to the size of the head; they are naked and have a number of transverse ridge. The pelage is short and fine, it is longer on the nap of the neck and throat. The head and back have pale buffy brown hairs. The throat, chest, and belly are pale yellow buff. In some individuals, the back is chestnut brown with reddish or golden yellow belly. The interfemoral membrane and

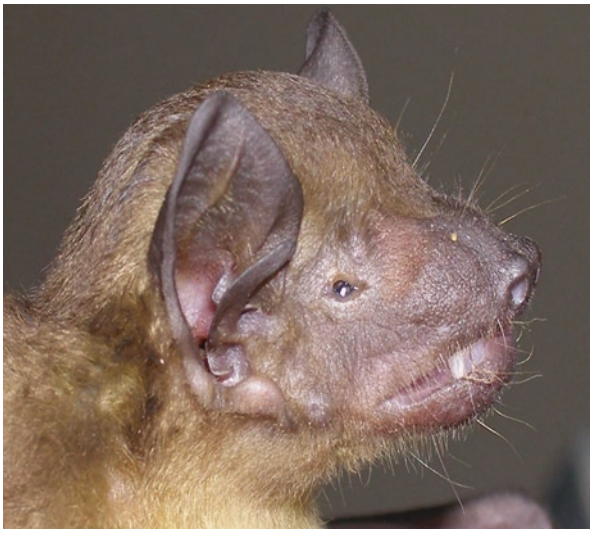

Fig. 3.14 Greater Asiatic house bat *Scotophilus heathii*

wings are uniformly dark brown and essentially naked except some hairs adjacent to the body and forearm on the ventral surface of each wing (Fig. 3.14).

Colonies of *S. heathii* were found roosting in tree holes, wall crevices, and door crevices at Hardoi, Allipur, Pratapgarh, Kunda, Raebareli, and Sisandy house in Lucknow. Destruction of roost site was observed during the study period. Morphological measurements of eight adult bats (four males and four females) were taken, and the details are given in Table 3.14.

3.3.19 Lesser Asiatic Yellow House Bat *Scotophilus kuhlii* (Leach, 1821)

The lesser yellow house bat is found in limited distribution in the study area. Dorsally, the pelage is soft and olive brown in color and ventrally creamish. The muzzle is broad and blunt. Ears are small compared to the head, and the tragus is about half the size of the ear and is crescent shaped. The tragus is separated from the pinna by a distinct notch. The pelage is chestnut brown but usually without the characteristic yellowish (Fig. 3.15).

Colonies of *S. kuhlii* were found roosting inside the tree hole of Banyan tree at Mamman purva and wall crevices at Hardoi. There was no major threat observed to this species in the study area. Morphological measurement of *S. kuhlii* taken from six individuals (three males and three females), and details are given in Table 3.15.

Table 3.14 Morphological measurement of *Scotophilus heathii*

	Male (n = 4)		Female (n = 4)	
Morphological parameters	Mean	SD	Mean	SD
Body wt (g)	31.3	2.2	31.5	1.3
FAL (mm)	60.1	3.1	58.4	1.3
Head length	20.2	0.9	19.3	1.2
HB length (mm)	87.4	6.0	90.1	1.8
Ear length	12.6	2.0	13.3	1.0
Thumb length (mm)	12.4	4.4	11.3	1.0
Tibia length (mm)	22.5	1.3	24.9	0.9
Toe length (mm)	8.9	1.4	10.6	0.9
Tail length (mm)	51.3	2.4	54.4	3.5
WSP length (cm)	42.5	0.9	41.0	0.4
MET II (mm)	55.8	1.3	55.6	0.6
MET III (mm)	56.4	2.0	58.4	0.4
MET IV (mm)	55.9	2.9	57.0	0.6
MET V (mm)	53.5	1.9	53.2	1.1
Lower jaw length (mm)	10.1	1.7	10.8	0.5
Upper jaw length (mm)	11.7	2.1	12.6	0.47

Fig. 3.15 Lesser Asiatic house bat *Scotophilus kuhlii*

3.3.20 Emballonuridae

The family Emballonuridae consists of small to reasonably large microchiropteran bats with a forearm ranging in length from 35 to 95 mm. It has scanty distribution in the study area.

Table 3.15 Morphological measurement of *Scotophilus kuhlii*

	Male (n = 3)		Female (n = 3)	
Morphological parameters	Mean	SD	Mean	SD
Body wt (g)	30.3	2.1	31.3	1.5
FAL (mm)	61.5	0.7	63.6	2.0
Head length	20.2	0.5	19.9	0.9
HB length (mm)	79.2	0.7	77.2	2.1
Ear length	8.5	0.5	8.6	1.1
Thumb length (mm)	20.3	0.6	20.5	0.5
Tibia length (mm)	21.5	0.3	21.5	0.5
Toe length (mm)	7.0	0.6	7.1	0.1
Tail length (mm)	49.0	0.3	49.1	0.3
WSP length (cm)	41.9	0.4	42.7	0.1
MET II (mm)	46.2	10.2	51.9	0.7
MET III (mm)	47.1	9.1	53.5	0.4
MET IV (mm)	46.7	9.5	52.7	0.3
MET V (mm)	45.5	8.3	49.9	0.3
Lower jaw length (mm)	6.9	1.4	6.9	0.4
Upper jaw length (mm)	7.9	1.3	8.7	0.37

3.3.21 Naked-Rumped Tomb Bat *Taphozous nudiventris* (Cretzschmar, 1830)

It is a medium-sized species of family Emballonuridae and commonly known as naked-rumped tomb bat or sheath-tailed bat. It has limited distribution in the study area. It is characterized by the naked rump which may contain copious fat reserve, especially in the post-monsoon season. The head is flattened in appearance while the jaw extremely powerful. The ears are long and rather narrow, semitranslucent, and widely separated from each other and the tip bluntly rounded off. The pelage is short, fine, and dense its body dark brown on the dorsal surface and paler brown in the ventral surface (Fig. 3.16).

Colonies of *T. nudiventris* were observed in Chunar Fort at Mirzapur district and Kashi Naresh Pal kothi, Munshi Ghat, Varanasi. The roosting sites of *T. nudiventris* were ruined due to renovation of old buildings. The IUCN red list of threatened species 2011 categorized this species as least concern (LC version – 3.1). A total of six adult bats (three males and three females) were captured for morphometry. The morphological measurements are given in Table 3.16.

Fig. 3.16 Naked-rumped tomb bat *Taphozous nudiventris*

Table 3.16 Morphological measurements of *Taphozous nudiventris*

	Male (n = 3)		Female (n = 3)	
Morphological parameters	Mean	SD	Mean	SD
Body wt (g)	42.7	7.6	54.0	7.9
FAL (mm)	71.5	10.0	77.9	0.8
Head length	28.1	6.4	32.9	0.9
HB length (mm)	97.0	4.0	100.9	0.8
Ear length	21.4	6.4	24.7	0.6
Thumb length (mm)	14.1	2.8	16.2	0.6
Tibia length (mm)	29.8	4.3	32.2	0.5
Toe length (mm)	14.2	3.1	15.9	0.6
Tail length (mm)	40.4	14.6	32.7	1.0
WSP length (cm)	44.3	2.7	45.7	0.9
MET II (mm)	61.8	4.4	65.0	0.5
MET III (mm)	65.5	6.9	68.8	1.0
MET IV (mm)	53.2	4.2	52.0	1.0
MET V (mm)	51.2	3.1	50.4	0.4
Lower jaw length (mm)	13.6	1.7	14.2	0.4
Upper jaw length (mm)	16.7	3.5	18.6	0.47

Table 3.17 Present status of bats of eastern Uttar Pradesh

Name of the species	Earlier status/past records		Present distribution	Remarks
	Status/location	Reference/reported by		
R. leschenaulti	Tanakpur, Chunar, Dehradun, Pauri, Almora, Nainital, Pithoragarh, and Chamoli	Wroughton (1914) and Bhat (1974)	Lucknow, Barabanki, Jaunpur, and Mirzapur	IUCN red list 2011 categorized as least concern
C. sphinx	Luck now, Pilibhit, Varanasi, Mirzapur, Dehradun, Nainital, Almora, Pithoragarh Pauri, and Chamoli	Wroughton (1914), Bhat (1974), and Khajuria (1953)	Widely distributed in study area	IUCN red list 2011 categorized as least concern
P. giganteus	Lucknow, Pilibhit, Varanasi, Mirzapur, and Farrukhabad	Wroughton (1914), Sinha (1980), and Bhatnagar and Srivastava (1974)	Widely distributed in study area	IUCN red list 2011 categorized as least concern
R. microphyllum	Agara, Fatehpur Sikri	Brosset (1962) and Sinha, (1980)	Varanasi, Chunar, and Chitrakoot	IUCN red list 2011 categorized as least concern
R. hardwickii	Fatehpur Sikri, Pratapgarh, Allahabad, and Agra	Brosset (1962) and Khajuria (1953)	Allahabad and Jaunpur	IUCN red list 2011 categorized as least concern
H. fulvus	Varanasi	Khajuria (1980)	Sultanpur and Chitrakoot	IUCN red list 2011 categorized as least concern
H. lankadiva	No record	No record	Chitrakoot	IUCN red list 2011 categorized as least concern
M. lyra	Rani Bagh, Nisarga, Agara, Gazipur, and Lucknow	Wroughton (1914) and Sinha (1980)	Hardoi and Unnao	IUCN red list 2011 categorized as least concern
P. coromandra	Dhakhuri, Lawarkhet, Mirzapur, Ramnagar, and Pilibhit	Wroughton (1914)	Lucknow, Hardoi, Barabanki, Faizabad, and Raebareli	IUCN red list 2011 categorized as least concern
P. dormeri	Khamaria	No record	Faizabad	IUCN red list 2011 categorized as least concern
P. tenuis	Sitabani, Ramnagar, Delajerna, Pilibhit, Haldwani, Varanasi, and Kaladhungi	Wroughton (1914), Bhat (1974), and Pathak and Sharma (1969)	Lucknow and Hardoi	IUCN red list 2011 categorized as least concern
P. ceylonicus	No record	No record	Observed at Bachhrawan and Raebareli	IUCN red list 2011 categorized as least concern

(continued)

Table 3.17 (continued)

Name of the species	Earlier status/past records		Present distribution	Remarks
	Status/location	Reference/reported by		
S. heathii	Haldwani, Ramnagar, Allahabad, Meerut, Bareilly, Pilibhit, and Mirzapur	Bhat (1974), Bhatanagar and Srivastava (1974), and Gandhi (1986)	Pratapgarh, Kunda, Jaunpur, Ayodhya, Hardoi, and Raebareli	IUCN red list 2011 categorized as least concern
S. kuhlii	Pilibhit and Ramnagar	Wroughton (1914)	Hardoi	IUCN red list 2011 categorized as least concern
T. nudiventris	Chunar, Fatehpur Sikri, and Agra	Brosset (1962)	Varanasi and Mirzapur	IUCN red list 2011 categorized as least concern

3.4 Discussion

The results revealed the distribution of 15 species of bats out of 119 known species of bats of Indian subcontinent. The observed 15 species of bats were distributed at different locations of study sites, namely, Sultanpur, Lucknow, Varanasi, Mirzapur, Chitrakoot, Allahabad, Pratapgarh, Hardoi, Jaunpur, Faizabad, and Raebareli. Out of 15 species, 3 species belong to Megachiroptera, namely, *R. leschenaulti*, *C. sphinx*, and *P. giganteus.* Inconsistent with the wide distribution of *R. leschenaulti* in India, the study area also had a wide distribution with good population of *R. leschenaulti*. The *Rousettus leschenaulti* was observed in permanent building roost or tunnels at deep well in the study area. *Rousettus leschenaulti* was already reported in the districts of Chunar and Pithoragarh, Uttar Pradesh (Bhat 1974).

Further studies are needed to understand abundance, reproduction, and population ecology of this species. *Cynopterus sphinx* is a common species which distributed throughout India. The study area also provides suitable roosting habitats for a wide distribution of *C. sphinx* in Uttar Pradesh. The distribution of *C. sphinx* was already reported in the districts of Lucknow, Varanasi, and Pilibhit (Wroughton 1914; Khajuria 1953). The current study revealed the distribution of *C. sphinx* in all 23 districts of eastern Uttar Pradesh. The colonies of *C. sphinx* were observed roosting in buildings as well as tree roost in the study area, while a large number of studies report the usage of tree roosts. It reveals that the population of *C. sphinx* is more adaptable and stable than *R. leschenaulti*. Molur et al. (2002) reported that *C. sphinx* is considered to be more adaptable than *C. brachyotis*. Like most other fruit bats in India, *C. sphinx* is considered as vermin under Schedule V of the Indian Wildlife Protection Act 1972. Though the Indian flying fox, *Pteropus giganteus*, is widely distributed throughout India, the current study reveals the occurrence of very high population of *P. giganteus* in Uttar Pradesh. The distribution of *P. giganteus* was already reported in Pilibhit (Wroughton 1914), Lucknow and Varanasi (Sinha 1980), and Allahabad (Bhatnagar and Srivastava 1974).

Two species of the family Rhinopomatidae were observed in the study area. The distribution of *R. microphyllum* ranges from Mauritania, Senegal, Nigeria, and Cameroon to Egypt, Arabia, Iran, Afghanistan, Pakistan, India, and Sumatra (Schlilter and Qumsiyeh 1996). In India, *R. microphyllum* has a widespread distribution. The distribution of *R. hardwickii* ranges from Niger, Morocco, Mauritania, East Africa, Arabia, Iran, Afghanistan India, to Myanmar (Koopman 1993). The distribution of *R. hardwickii* was common in the study area. Hipposiderids are found throughout the tropical areas of the Old World from Africa, Madagascar through India to southeastern Asia, the Philippines, New Guinea, Australia, New Caledonia, and the New Hebrides (Vanuatu). *Hipposideros fulvus* is distributed from Afghanistan to India and Sri Lanka. The distribution of *H. fulvus* in Uttar Pradesh was reported at Varanasi (Khajuria 1980). The current study reveals the distribution of *H. fulvus* at more sites in Uttar Pradesh. The Indian false vampire bat, *M. lyra*, has a distribution range from Afghanistan to Southern China and South to Pakistan, Sri Lanka, Malaysia, and India (Bates and Harrison 1997). The distribution of *M. lyra* in Uttar Pradesh is reported at Rani Bagh (Wroughton 1914), Agra, Ghazipur, and Lucknow (Sinha 1980).

A total of 59 species belong to the family Vespertilionidae widely distributed throughout India. However, four species belong to the genus *Pipistrellus* observed in the study area during the current study. *Pipistrellus coromandra* was distributed from Afghanistan to Southern China, India, Sri Lanka, Nicobar Island, Thailand, and Vietnam. In India, the distribution of *P. coromandra* was reported in Pilibhit and Ramnagar.

Pipistrellus tenuis was distributed from Afghanistan, Pakistan, India, and Sri Lanka to Thailand and Vietnam. In India, the distribution of *P. tenuis* was reported from Varanasi (Pathak and Sharma 1969) to Ramnagar, Pilibhit, and Sitabani (Wroughton 1914). The current study reveals the additional roost sites of *P. tenuis* in the study area. *Pipistrellus ceylonicus* was distributed from Pakistan, India, Sri Lanka, Myanmar, China, Vietnam, to northern Borneo (Bates and Harrisson 1997). The distribution of *P. ceylonicus* was not observed in Uttar Pradesh; however, the current study revealed the distribution of *P. ceylonicus* at different sites of Uttar Pradesh. *Scotophilus heathii* was distributed from Afghanistan to Southern China, Sri Lanka, Vietnam, and India. In Uttar Pradesh, the distribution of *S. heathii* was reported in Ramnagar (Bhat 1974), Allahabad (Bhatnagar and Srivastava 1974), and Meerut (Gandhi 1986). The current study reveals the distribution of *S. heathii* at Hardoi, Allipur, Pratapgarh, Kunda, Bareilly, and Sisandy house in Lucknow. The distribution of *S. kuhlii* in India is reported in Andhra Pradesh, Bihar, Gujarat, Madhya Pradesh, Maharashtra, Meghalaya, Karnataka, Kerala, Orissa, Rajasthan, Tamil Nadu, Tripura, Uttar Pradesh, and West Bengal (Bates and Harrison 1997; Molur et al. 2002). *Scotophilus kuhlii* was reported in both rural and urban landscapes and known to roost in crevices and holes in walls of huts and old buildings, caves, old temples, palm fronds, hollows in palm trees, and dried leaves on trees (Wroughton 1915; Brosset 1962; Sinha 1986). The current study also reveals that *S. kuhlii* prefers to roost in tree holes and wall crevices. In addition to the above findings, *S. kuhlii* was observed at Mamman purva and Hardoi. The current study

revealed the distribution of *H. lankadiva* and *P. ceylonicus* in eastern Uttar Pradesh. Tree holes and wall crevices provide ideal roost site for *S. heathii* and *P. coromandra*.

The family Emballonuridae comprises 13 genera and about 50 species (Honacki et al. 1982). *Taphozous nudiventris* was distributed in a limited part of the study area. However, it has a widespread distribution in Africa ranging from Mauritania to Egypt in Asia (Brosset 1962). The current study reveals the highest distribution of bats in eastern Uttar Pradesh due to the presence of a large number of old monuments, palaces, caves, deep well, and forests which harbor bats. These permanent structures gave stable roosting conditions to the bats. In general, there was no major threat to the bats in the study area, except sporadic observations at times. Another support is that a maximum of bat colonies are located in old monuments which are governed by the Archaeological Survey of India, while few more colonies are located in caves. Thus, the state Uttar Pradesh provides a range of suitable habitats for the distribution of both frugivorous and insectivorous bats.

Acknowledgments The authors thank the Archaeological Survey of India for permitting us to conduct the field survey in old monuments of Uttar Pradesh. The State Forest Department is acknowledged for its permission to perform field survey in Uttar Pradesh. The financial assistance of Uttar Pradesh State Biodiversity Board, Uttar Pradesh, and the University Grants Commission, New Delhi, through research projects (No. 493/3-4-48/2013) and (No. 42-530/2013(SR)), respectively, to VE is acknowledged. VM acknowledge the university for financial support through UGC University fellowship. MK is a University Grants Commission-Rajeev Gandhi National fellowship holder.

References

Bates PJJ Harrison DL (1997) Bats of the Indian subcontinent. Harrison Zoological Museum Press, England, 258 p

Bhat HR (1974) Records and observations on bats of Himalayan region of Uttar Pradesh and West Bengal, India. J Bombay Nat Hist Soc 71(1):51–57

Bhatnagar VS, Srivastava MDL (1974) Somatic chromosomes of four common bats of Allahabad. Cytologia 39(2):327–334

Brosset A (1962) The bats of central and western India. Part I. J Bombay Nat Hist Soc 59:1–57

Cox PA, Elmqvistpierson TED, Rainey WE (1991) Flying foxes as strong interactors in South Pacific Island ecosystems: a conservation hypothesis. Conserv Biol 5:448–454

Davison GNH, Zubaid A (1992) Food habits of the lesser false vampire, *Megaderma spasma*, from Kuala Lumpur, Peninsular Malaysia fur sangetier kunde 57: 310–312

Eckrich M, Neuweiler G (1988) Food habits of the sympatric insectivorous bats *Rhinolophus rouxi* and *Hipposideros lankadiva* from Sri Lanka. J Zool (London) 215:729–737

Emmons LH (1997) Neotropical rain forest, 2nd edn. University press Chicago, Chicago

Findley JS (1976) The structure of bat communities. Am Nat 110:129–139

Findley JS (1993) Bats: a community perspective. Cambridge University Press, Cambridge

Findley JS, Black HL (1983) Morphological and dietary structuring of a Zambian insectivorous bat community. Ecology 64:625–630

Fleming TH (1986) Opportunism versus specialization: the evolution of feeding strategic in frugivorous bats. In: Estrada A, Fleming TH (eds) Frugivorous and seed dispersal. Junk, Dordrecht, pp 105–118

Gandhi S (1986) A new record of Plagiorchis vespertillionides from a bat in India. Res Bull Punjab Univ 37(1–2):147–148
Handley CO (1966) Checklist of the mammals of Panama. In: Wenzel RL, Tipton VJ (eds) Ectoparasite in Panama. Field Museum Natural History, Chicago, pp 753–795
Honacki JH, Kinman KE, Koeppl JW (eds) (1982) Mammal species of the world: a taxonomic and geographic reference. Allen Press and The Association of Systematics Collections, Lawrence, p 694
Khajuria H (1953) Taxonomic studies on some Indian Chiroptera. Rec Indian Mus 50:113–128
Khajuria H (1980) Taxonomical and ecological studies on bats of Jabalpur district Madhya Pradesh, India, part 2nd. Families Megadermatidae, Rhinolophidae Vespertilionidae. Miscellaneous publication occasional paper. Rec Zool Surv 19:1–69
Koopman KF (1993) Order Chiroptera. In: Wilson DE, Reeder DM (eds) Mammals species of the world: a taxonomic and geographic reference. Smithsonian Institution Press, Washington, DC, pp 137–241
Marshall AG (1985) Old World phytophagous bats (Megachiroptera) and their food plants: a survey. Zool J Linnean Soc 83:351–369
Molur S, Marimuthu G, Srinivasulu C, Mistry S, Hutson AM, PJJ B, Walker S, Padma KP, ARP B (2002) Status of south Asian Chiroptera: conservation assessment and management plan (C.A.M.P.) workshop report. Zoo Outreach Organization/CBSG-South Asia, Coimbatore
Nowak RM (1994) Walkers bats of the world, 5th edn. John Hopkins University Press, Baltimore, pp 1–187
Pagel MD, May RM, Collie AR (1991) Ecological aspects of the geographic distribution and diversity of mammalian species. Am Nat 137:791–815
Pathak S, Sharma T (1969) Chromosomes of five species of Indian species Vespertilionidae bats. Caryologia 22(1):35–46
Patterson BD, Willing MR, Stevens RD (2003) Trophic strategies, niche partitioning and patterns of ecological organization. In: Kunz TH, Fenton MB (eds) Bat ecology. The University of Chicago Press, Chicago, pp 536–579
Rainey WE, Pierson ED, Elmqvist T, Cox PA (1995) The role of Pteropodids in oceanic island ecosystems of the Pacific. In: Racey PA, Swift M (eds) Ecology, behaviour and evolution of bats. Symposium Zoological Society London. Oxford University Press, Oxford
Sinha YP (1980) The bats of Rajasthan: taxonomy and zoogeography. Rec Zool Surv India 76(1–4):7–63
Sinha YP (1986) The bats of Bihar: taxonomy and field ecology. Records Zool Surv India Misc Publ Occas Pap 77:1–60
Wilson DE (1983) Check list of mammals. In: Janzen DH (ed) Costa Rican natural history. University of Chicago Press, Chicago, pp 443–447
Wroughton RC (1914) Report no 15: Bombay natural history society's mammal survey of India, Kumaon. J Bombay Nat Hist Soc 22(4):282–301
Wroughton RC (1915) Report no 16: dry zone, Central Burma & Mount Popa. Bombay natural history society's mammal survey of India, Burma and Ceylon. J Bombay Nat Hist Soc 23:460–480