Diversity, Roost Selection and Ecological Importance of the Bats of Uttar Pradesh

Vadamalai Elangovan and **Mukesh Kumar**
Department of Applied Animal Sciences,
Babasaheb Bhimrao Ambedkar University, Lucnow, Uttar Pradesh.
*Email: **elango70@yahoo.com**

Introduction

Bats are the second largest group of mammals. At present there are about 1,232 species of bats distributed throughout the world (Schipper *et al.*, 2008; Simmons, 2010; Kunz *et al.*, 2011). The Indian subcontinents are relatively rich in bat fauna comprising about 119 species of bats incorporated in 8 families namely Emballonuridae, Megadermatidae, Rhinolophidae, Hipposideridae, Vespertilionidae, Miniopteridae, Rhinopomatidae and Mollosidae (Bates and Harrison, 1997). Bats act as primary, secondary and tertiary consumers in the ecosystem. Insectivorous species, largely feed on airborne insects and other arthropods, suppress both naturally occurring and anthropogenically generated insect populations and contribute to the maintenance of ecosystem stability. As the primary consumer of night-flying insects, they are vital for the control of many agricultural and forest pest species and insects that transmit specific pathogens to humans and other mammals (Kunz *et al.*, 2011).

The fruit bats benefit us pollination and seed dispersal and play crucial role in the maintenance of forest ecosystems worldwide (Wiles and Fujita 1992). They help to maintain the diversity of forests by dispersing seeds across different ecosystems and often introducing novel plant species into previously disturbed landscapes (Whittaker *et al.*, 1992; Kelm *et al.*, 2008). Similarly, nectarivorous bats that visit flowers provide valued ecosystem services by pollinating plants, dispersing pollen, and thus, helping to maintain genetic diversity of flowering plants. Medellin and Gaona (1999) showed that bats disperse more seeds than birds in deforested areas.

Bats spend over half of their lives in their roost environments. The condition and events of roosts play a prominent role to their ecology. Roost characteristics play an important role to the success of a species. It provides suitable environment for mating, hibernation, rearing their young, protection from adverse weather and predators (Kunz, 1982). The micro-chiropteran bats prefer dark sites for roosting especially in caves, rock crevices, tree cavities and man-made structures. Caves that offer a wide thermal range combined with structural and elevational complexity provide the greatest diversity of roosting sites (Tuttle and Stevenson, 1978). Artificial structures also are used by bats, including a wide range of buildings such as houses and historical monuments, temples, mosque etc. Within such sites they use crevices in walls, attic spaces, chimneys, or under tiles or other roofing materials. Some bats use only one type of roost, for example caves, while others may vary the roost type seasonally. The present paper deals about diversity, roost selection and ecological importance of the bats of Uttar Pradesh. The diversity of bats was assessed through periodical field visits at different districts of Uttar Pradesh. The roosting ecology of bats was carried out through visual observations and video recording at roost sites.

Study Area

The state has quite a good number of palaces, ancient temples, historical monuments and natural forests. The study was conducted at 45 districts of Uttar Pradesh between 2011 and 2014. Bats were captured by standard mist netting methods using 3 meter nylon mist nets (AVINET, USA) / Hoop net (Self designed) at different locations of Uttar Pradesh for species recognition.

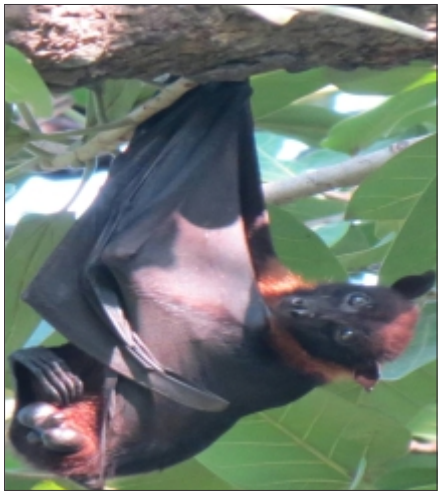

Plate 1 : Indian flying fox

Plate 2 : Fulvous fruit bat

Plate 3 : Short-nosed fruit bat

Plate 4 : Little Indian bat

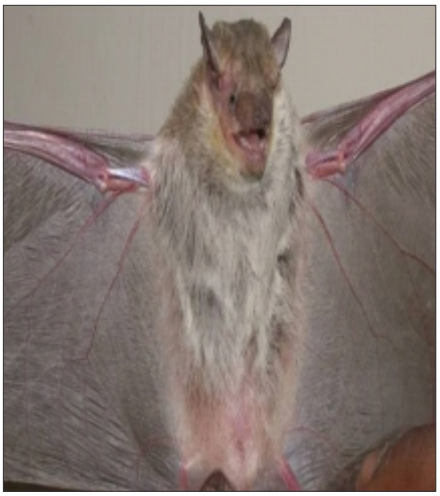

Plate 5 : Kelaart's Pipistrelle bat

Plate 6 : Asiatic lesser yellow house bat

Results and Discussion

In the present study **a total of 14 species of bats were recorded**. Out of which, three species belong to the family Pteropodidae, namely *Pteropus giganteus, Rousettus leschenaulti* and *Cynopterus sphinx* and remaining 11 species belong to five insectivorous families such as Vespertilionidae, Hipposideridae, Emballonuridae, Megadermatidae and Rhinopomatidae, namely *Pipistrellus coromandra, P. ceylonicus, Scotophilus kuhlii, S. heathii, Hipposideros lankadiva, H. fulvus, Taphozous nudiventris, T. melanopogon, Megaderma lyra, Rhinopoma microphyllum* and *R. hardwickii*.

1. The Indian flying fox, *Pteropus giganteus* (Brunnich 1782)

Pteropus giganteus is a largest fruit bat and largest flying mammal in India (Plate 1). The average forearm length was 150.66 ± 3.08 mm. As a social species, *P. giganteus* lives in large diurnal roost which comprises several hundreds of individuals usually located in well exposed larger trees such as *Azadirachta indica* (Neem), *Bambusa balcooa* (Bamboo), *Dalbergia sissoo* (Shisham), *Eucolyptus tereticornis* (Eucalyptus), *Ficus bengalensis* (Baniyan), *F. glomerata* (Cluster fig.), *F. racemosa* (Gular), *F. religiosa* (Peepal), *Holoptelea integrifolia* (Chilbil), *Limonia acidissima* (Kaitha),

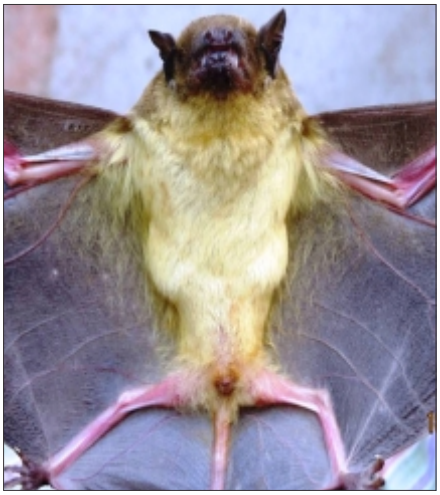

Plate 7 : Asiatic greater yellow house bat

Plate 8 : Fulvous leaf-nosed bat

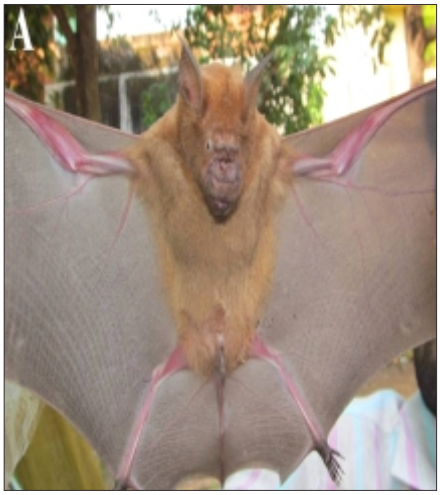

Plate 9 : Kelaart's leaf-nosed bat

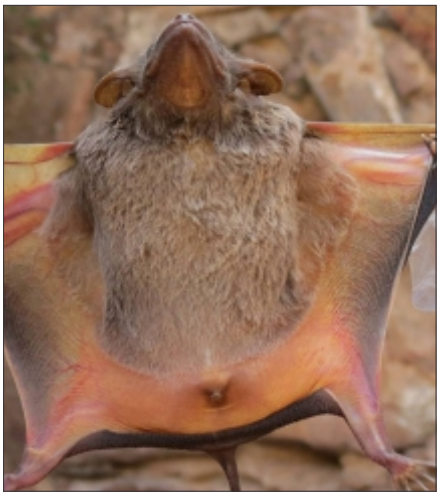

Plate 10 : Nacked-rumped tomb bat

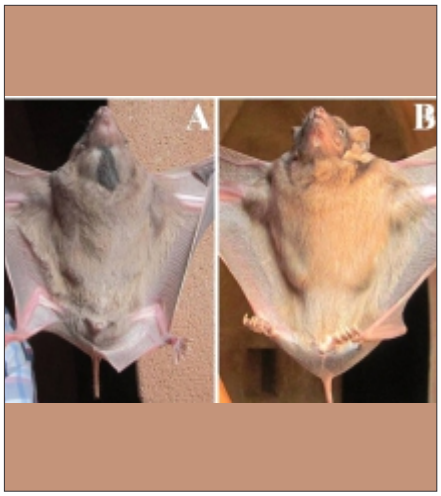

Plate 11 : Black-bearded tomb bat, (A) Male, (B) Female

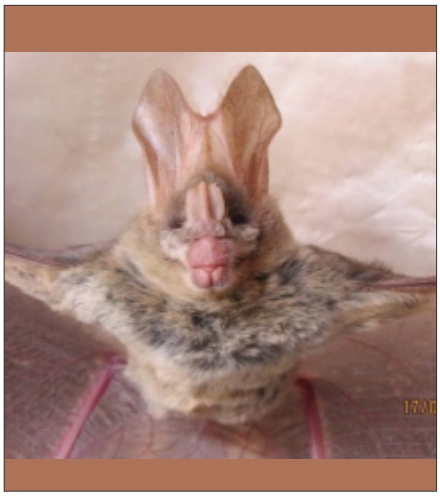

Plate 12: Greater False Vampire bat

Madhuca indica (Mahua), *Mangifera indica* (Mango), *Syzyium cumini* (Jamun), *Tamarindus indica* (Tamarind) and *Vachellia nilotica* (Babool). *Pteropus giganteus* leaves the roost site about sunset and returns to its day roost at dawn. It commonly roosts with its head downward and wrapped wings around its body but during warm hours of the day individuals often cool themselves by fanning their wings. *Pteropus giganteus* roosts in trees and is usually associated with forest fragments or linear patches of vegetation alongside water and nearby human habitation.

2. The Fulvous fruit bat, *Rousettus leschenaulti* (Desmarest 1820)

The fulvous fruit bat, *Rousettus leschenaulti* is a medium-sized bat (Plate 2) with forearm length of male 78.90 ± 3.13 mm and female 79.08 ± 1.24 mm, widely distributed in India. It lives in caves or man-made structures (*i.e.* historical monuments, abandoned houses or water tunnels) etc. It is a colonial species which lives together in large population containing hundreds or even thousands of individuals at the same roosting sites. A total of nine colonies of *R. leschenaulti* consist about 5400 individuals were observed in the study area. All nine colonies were located in the historical

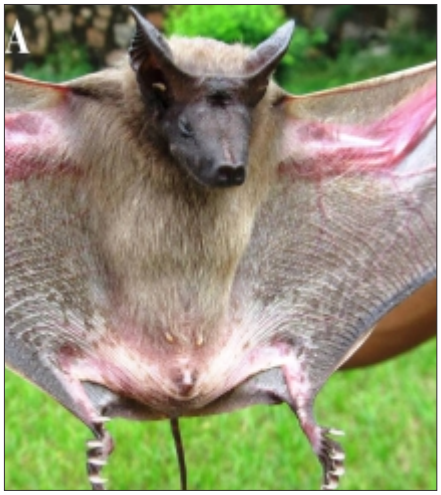

Plate 13 : Greater Mouse tailed bat

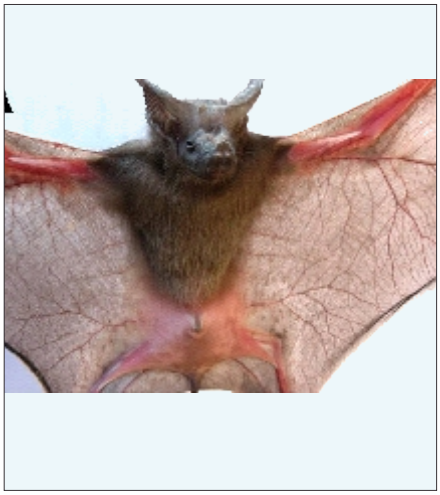

Plate 14 : Lesser Mouse-tailed bat

monuments which had less human interference. The population size of colonies ranged from 54 - 2000.

3. The Short-nosed fruit bat, *Cynopterus sphinx* (Vahl 1797)

he short-nosed fruit bat, Cynopterus sphinx is relatively a small fruit bat with an average forearm length of male 72.12 ± 3.46 mm and female 74.44 ± 0.88 mm with short tail. It has large eyes, short muzzle and easily distinguished from other bat species by the pale borders around the ears and wings (Plate 3). It is the only species that constructs its own roosts by its tent-making behavior. It is reported to roost on several tree species by modifying different parts of the plants, such as aerial roost, tree branches, fruit clusters and fronds. A total of 17 colonies were observed in the study area. Out of the total colonies observed, 12 colonies were observed in plant as tree roost and 5 colonies were observed as building roost. The tree roosts were identified in *F. bengalensis, F. religiosa, B. flabellifer* and *P. longifolia*. The roosts were located nearby plantation, water body, road side, residential area and city area.

4. The little Indian bat, *Pipistrellus coromandra* (Gray 1838)

Pipistrellus coromandra is a small bat with an average forearm length of 28.98 ± 3.67 mm. The wings were relatively narrow, legs were short with small feet and the tragus was almost half of the height of ears. The dorsal surface was uniform brown, ranging from chestnut to dark clove brown. The ears and wing membranes were dark brown and necked (Plate 4). The membranes of the wings and tail were thin. The emergence of *P. coromandra* was observed around sunset. The flight was rather slow, fluttering and erratic. There were eight colonies of *P. coromandra* observed in the study area. All those colonies were observed in old and abandoned buildings and in historical monuments.

5. The Kelaart's *Pipistrelle bat*, *Pipistrellus ceylonicus* (Kelaart 1852)

Pipistrellus ceylonicus was relatively larger than *P. coromandra* with an average forearm length of 39.32 ± 0.82 mm. The dorsal pelage was variable in colour ranging from grey-brown to chestnut. The ventral surface of the species had dark hair bases and pale grey tips (Plate 5). The average body weight of the male species was 5.66 ± 0.29 g with a wing span of about 275.66 ± 11.02 mm. It is an uncommon species in the study area. It was observed as small group consists of 4 - 5 individuals in crevices of abandoned houses and historical monuments. The roosting behaviour of *P. ceylonicus* was similar to *P. coromandra*.

6. The Asiatic lesser yellow house bat, *Scotophilus kuhlii* (Leach 1821)

The Asiatic lesser yellow house bat, *Scotophilus kuhlii* was widely distributed in the study area. The pelage colour of the dorsal region was soft and olive brown and ventrally creamish (Plate 6). The ears of the species are small compared to the head, the tragus was about half of the size of the ear and crescent shaped. The tragus was separated from the pinna by a distinct notch. The average forearm length of male individuals was 49.47 ±

1.55 mm, ear length 10.14 ± 0.76 mm and tail length was 43.55 ± 2.56 mm. It was distinguished certainly from *S. heathii* by its smaller size. It was frequently found in both the rural and urban areas in association with man. Individuals of *S. kuhlii* roost under roofs, crevices and holes in walls of huts and old buildings, caves, temples, palm fronds, hollows in palm trees and dried leaves on trees.

7. The Asiatic greater yellow house bat, *Scotophilus heathii* (Horsfield 1831)

The Asiatic greater yellow house bat, *Scotophilus heathii* was distributed throughout the study area. The dorsal region of the species was covered with fine pelage of pale buffy brown in colour and ventrally pale yellow buff (Plate 7). The feet were about half the length of the tibia. The muzzle is broad and blunt, swollen on the side of face, necked and dark in colour. The nostrils were simple in form, round and slightly outward facing. The ears were small in relation to the size of the head and have a number of transverse ridges. The tragus was half height of the pinna and crescent shaped. *Scotophilus heathii* was larger than the *S. kuhlii* with an average forearm length of 59.69 ± 5.06 mm and body weight about 37.20 ± 5.93 g.

Scotophilus heathii roosted in natural environment as well as rural and urban areas in association with human. In the natural environment they roost in dark caves, hollow tree trunks. In the vicinity of people they lived in crevices, cracks, holes in buildings, walls and on the building roofs. *Scotophilus heathii* roost in group and the group size varies depending on the roost environment.

8. The fulvous leaf-nosed bat, *Hipposideros fulvus* (Gray 1838)

Hipposideros fulvus was a medium-small species of family Hipposideridae with characteristically very large ears which broadly rounded off. The pelage colour of the species was pale grey (Plate 8). The average forearm length of the species was 39.39 ± 1.24 mm. The feet were small and the nose-leaf has a greatest width of 16.57 ± 1.41 mm. The ears of *H. fulvus* were very large and rounded, longer than the head. The upper third posterior margins are very slightly flattened. The narial margins of the anterior leaf were not expanded and the nostrils clearly visible. The flight was slow and fluttering. The roosting sites of the *Hipposideros fulvus* include old houses, dilapidated buildings, caves and tunnels. It has limited distribution in the study area.

9. The Kelaart's leaf-nosed bat, *Hipposideros lankadiva* (Kelaart 1850)

Hipposideros lankadiva was a larger species of family Hipposideridae. The pelage colour ranges from pale cream to fulvous brown (Plate 9). The nose-leaf usually has four supplementary leaflets. The intermediate leaf is expanded, its central part inflated and swollen. The posterior-leaf was high and broad. The upper border of the posterior nose-leaf was trilobate. There were three vertical ridges on the front face of the posterior-leaf; the lateral ones were quite as strong as median one. The ears of the species were large and acutely pointed, with their posterior margins slightly concave behind the tip. The average forearm length of male individuals was 85.20 ± 3.32 mm and the body weight was 59.00 ± 1.00 g. *Hipposideros lankadiva* had very limited distribution in the study area. It roost ranged from a variety of habitats which includes caves, dilapidated buildings, tunnels and temples.

10. The Nacked-rumped tomb bat, *Taphozous nudiventris* (Cretzschmar 1830-31)

Taphozous nudiventris was a medium-sized species with an average forearm length 74.08 ± 1.14 mm. It was characterised by naked rump which contain copious fat reserves. The pelage was short, fine and dense. It was dark brown on the dorsal surface and ventrally paler brown in colour. The tail of *T. nudiventris* emerges from the central part of the interfemoral membrane or slightly further back (Plate 10). The head was flattened in appearance whilst the jaws were extremely powerful. The ears of the species were long and rather narrow. The colours of ears were blackish brown and semi translucent. They were widely separated from each other and tips bluntly rounded off. The tragus was narrow above base. The wings of the species were long and narrow and

attached to the tibia. *Taphozous nudiventris* diurnal roost includes cave, temple, tombs, crevices and underground tunnels. This species had limited distribution in the study area.

11. The Black-bearded tomb bat, *Taphozous melanopogon* (Temminck 1841)

The Black-bearded tomb bat, *Taphozous melanopogon* was a medium-sized bat with an average forearm length of 65.50 ± 0.54 mm. The pelage colour of individuals recorded in Jhansi and Latipur was grayish-brown and the belly was usually paler. The tail was thickened toward the tip and somewhat laterally compressed. Male had a patch of hairs at throat region (Plate 11 A & B). *Taphozous melanopogon* was highly gregarious species living in diurnal roosts which were usually in ruins, caves, fort and temples. It had a limited distribution in the study area.

12. The Greater false vampire bat, *Megaderma lyra* (Geoffroy 1810)

Megaderma lyra was a robust species with an average forearm length 67.48 ± 1.28 mm. The head was characterised by its large oval ears which have a fringe of white hairs on their inner margins. The pelage was fine, soft and moderately long. The snout was naked and flesh colored. The ventral surface was paler, the dorsal fur was mouse-grey and belly white (Plate 12). The ears were joined medially for between one third and half of their length. *Megaderma lyra* was widely distributed bat found in variety of habitats. It roosts in small or large colonies ranging from a few individuals to several hundred individuals in caves, old building, thatched huts, temples and forts.

13. The Greater Mouse-tailed bat, *Rhinopoma microphyllum* (Brunnich 1782)

Rhinopoma microphyllum was a largest species of family Rhinopomatidae with an average forearm length 65.60 ± 3.07 mm and tail length 62.61 ± 2.11 mm. The tail of the species was relatively shorter than *R. hardwickii* and does not usually exceed the length of the forearm. The face, ears and connecting membrane on the forehead were all without fur. They have well developed ears with a bluntly sickle-shaped tragus (Plate 13). The pelage was short and fine; the dorsal surface of the species was grey-brown and ventrally paler. The lowest part of the abdomen of *R. microphyllum* was hairless and looked like a fatty tissue during the winter season. It roosts in small caves, underground tunnels, old monuments and dilapidated buildings. In winter seasons they prefer their roost in dark crevices, at other times it may be seen in large numbers in swarms of ceiling and walls. It was very agile and can easily run across vertical walls. Colonies size varied from a few individuals to thousands.

14. The Lesser Mouse-tailed bat, *Rhinopoma hardwickii* (Gray 1831)

Rhinopoma hardwickii was a medium-sized mouse-tailed bat with an average forearm length of 59.38 ± 2.70 mm and tail 66.03 ± 5.01 mm. It was characterized by its exceptionally long tail which usually exceeds forearm length. The pelage was short and fine; it was grey-brown on dorsal and ventrally paler hairs (Plate 14). They had naked chin, the lower abdomen and posterior back were also naked. The ears were well developed with sickle-shaped tragus. *Rhinopoma hardwickii* was adapted to dry and semi-desert conditions. Its diurnal roosts include caves, old monuments, abandoned buildings and temples.

Conclusion

Among fruit bats, the Indian flying fox Pteropus giganteus, the fulvous fruit bat Rousettus leschenaulti and the short-nosed fruit bat *Cynopterus sphinx* are widely distributed in the study area. The roosts of these pteropodid bats usually found in larger trees (*P. giganteus*), buildings and caves (*R. leschenaulti*) and buildings, trees and foliages (*C. sphinx*) and feed on fruits, leaves nectar and pollen. The selected roost trees are long lasting and stable during unfavourable climatic conditions. The wide distribution and high colony size of *P. giganteus* show that the state Uttar Pradesh has suitable habitats for the survival of bats. Further, the location of majority of colonies nearby water bodies suggests that the bats select their day roost to avoid high temperature during day hours.

Amongst all the species of insectivorous bats, *H. lankadiva, H. fulvus, T. nudiventris, T. melanopogon, M. lyra, R. microphyllum* and *R. hardwickii* were observed in a variety of man-made structure in proportionate number. The species was found to roost sites where fresh water in abundance. The diurnal roost of *P. coromandra, P. ceylonicus* include trees, the roof of building, crevices between logs, the ceiling and walls of houses, among the tiles of huts, old buildings. *Hipposideros fulvus* and *H. lankadiva* roosted in cellar of old houses. It favours cool damp places and relies on the proximity of water and shad. The roost of *T. nudiventris* includes crevices of roof, wall and sometime hanging with roof and ceiling of building.

The finding of the study on the roosting ecology of insectivorous species showed that *H. fulvus, H. lankadiva, T. nudiventris, T. melanopogon, M. lyra, R. microphyllum* and *R. hardwickii*, found almost exclusively roost in man-made structures. *Rhinopoma hardwickii* shared its roosts with *R. microphyllum, T. nudiventris, T. melanopogon* and *H. lankadiva*. The association of bats with man-made structure appears to vary geographically. During the study period monument and old buildings were renovated to promote tourism. Loss of their natural habitat by increased human population and human activities such as deforestation, use of pesticides, industrial activities, loss of buildings and their renovations are the major causes for decline of bat population. Historical monuments, forts and temple were found as important habitats for bats. Care should be taken to protect the natural roosting habitats. Human activities should be restricted at least in regions of remarkable bat population. Being a pioneering effort this study has brought issues of conservation and research to the forefront. Thus, it is critically important to preserve the existing roosting habitats of bats in Uttar Pradesh, because bats play vital role in balancing the ecosystem, seed dispersal, regeneration of forests.

Acknowledgements

We thank to the Archaeological Survey of India for permitting us to conduct field surveys at historical monuments of Uttar Pradesh. The financial assistance of Uttar Pradesh State Biodiversity Board, Uttar Pradesh and University Grants Commission, New Delhi through research projects is gratefully acknowledged.

References

BATES, P. J. J., AND D. L. HARRISON. 1997. Bats of the Indian Subcontinent. Harrison Zoological Museum Press, England.

KELM, D. H., K. R. WIESNER, AND O. VONHELVERSEN. 2008. Effects of artificial roosts for frugivorous bats on seed dispersal in a neotropical forest pasture mosaic. *Conservation Biology* 22:733-741.

KUNZ, T. H. 1982 Roosting ecology. Pp. 1-46 in Ecology of Bats (T.H. Kunz eds.). Plenum Publishing Corporation, New York.

KUNZ, T. H., B. T. ELIZABETH, B. DANA, T. LOBOVA, AND T. H. FLEMING. 2011. Ecosystem services provided by bats. *Annals of the New York Academy of Sciences* 1223:1-38.

MEDELLIN, R. A., AND O. GAONA. 1999. Seed dispersal by bats and birds in forest and disturbed habitats in Chiapas, Mexico. Biotropica 31(3):478-485.

SCHIPPER, J., J. S. CHANSON, F. CHIOZZA, ET AL. 2008. The status of the world's land and marine mammals: diversity, threat, and knowledge. Science 322:225-230.

SIMMONS, N. B. 2010. Personal Communication. American Museum of Natural History. New York.

TUTTLE, M. D., AND D. E. STEVENSON. 1978. Variation in the cave environment and its biological implications. Pp. 108-121 in National Cave Management Symposium Proceedings (R. Zuber, J. Chester, S. Gilbert, and D. Roberts eds.). Adobe Press, Albuquerque, N.M.

WHITTAKER, R. J., M. B. BUSH, T. PARTOMIHARDJO, ET AL. 1992. Ecological aspects of plant colonisation of the Krakatau Islands. *Geo Journal* 28:201-211.

WILES, G. L., AND M. S. FUJITA. 1992. Food plants and economic importance of flying foxes on Pacific Islands. Pp. 24-35 in Pacific Island flying foxes: Proceedings of an International Conservation Conference (D. E. Wilson and G. L. Graham eds.). USF&WS Biological Report. 90(23) Washington, D.C