Contents

Study of the Indian Flying Fox (Pteropus giganteus) Colonies of Jambughoda Wildlife Sanctuary, Gujarat, India: Record of largest roosting congregation at Targol, Raju Vyas and Kartik Upadhyay, Pp. 2-8

Records of roosting sites of Indian Flying Fox Pteropus giganteus (Brunnich, 1782) from Madhya Pradesh, India, S.S. Talmale, Pp. 9-11

Interaction of Indian Flying Foxes Pteropus giganteus (Brunnich, 1782) with the plant species in the Lower Brahmaputra Valley of Assam, Azad Ali, Pp. 12-14


Successful One year completion of Small Mammals Hiking Programme in Kathmandu, Nepal, Sabina Koirala, P. 19

Unexpected death of Indian Flying Foxes Pteropus giganteus in Jahangirnagar University campus, Savar, Bangladesh, Tahsinur Rahman Shihan, P. 20

Record of Endemic Malabar Spiny Tree mouse, Platacanthomys lasiurus Blyth 1859 from Nilgiri Biosphere Reserve, Kerala, Divin Murukesh and Anoop Das, P. 21

The Record of Elegant Water Shrew Nectogale elegans from Gaurishankar Conservation area, Nepal, Sagar Dahal, Kaustuv Raj Neupane and Giovanni Amori, Pp. 22-23

Small mammal awareness programme for local communities in Tamil Nadu - a report, Brawin Kumar, Pp. 24-28


Training Workshop on Building National Capacity in Research and Monitoring of Small Mammals, Nepal - Report by SMCRF, Pp. 36-39

Insect Pest Management by Horseshoe Bats of Kalakad Mundanthurai Tiger Reserve, Tamil Nadu, Selva Ponmalar, S. and Juliet Vanitharani, Pp. 40-47

Insect Pest Management by Horseshoe Bats of KMTR, Tamil Nadu, Pp. 40-47

Chiroptera Research Techniques and Conservation in Bangladesh, Pp. 29-35

Successful One year completion of Small Mammals Hiking Programme in Kathmandu, Nepal, P. 19
Study of the Indian Flying Fox (Pteropus giganteus) Colonies of Jambughoda Wildlife Sanctuary, Gujarat, India: Record of largest roosting congregation at Targol
Raju Vyas¹ and Kartik Upadhyay²

Abstract: Four colonies of Indian Flying Fox (Pteropus giganteus) was observed at Talawadi village, Jaban village and Jambughoda town, in Jambughoda Wildlife Sanctuary, Gujarat. These colonies were characterized by a large aggregation of adult bats ranging between a few hundreds to few thousands. The most remarkable colony was noted at Targol, where ~11,000 bats of mixed age groups (young ones, juveniles and adults) roosting on various ten species of 182 large tall trees. It is now considered as one of the largest ever recorded roosting colonies of Pteropus giganteus in Gujarat State and may be in India as well.

Key Words: Indian flying fox Pteropus giganteus, roost, colony, Jambughoda Wildlife Sanctuary.

Introduction: The order Chiroptera is the second largest order of Class: Mammalia, that comprises about over 1117 species of bats in which the suborder Megachiroptera contains one family (Pteropodidae) that includes 186 species of mainly frugivorous bats (Simmons 2005). India has 13 species of fruit bats (Bates and Harrison 1997, Srinivasulu et al. 2010) but only three are common and found throughout the country, they include Indian flying fox (Pteropus giganteus), Fulvous fruit bat (Rousettus leschenaultii) and Short-nosed fruit bat (Cynoiperus sphinx). The remaining species are rare and have restricted distribution. The Indian flying fox Pteropus giganteus is the largest bat in the group and widely distributed in the tropical region of South Central Asia from Pakistan to China and up to far south, the Maldives Islands (Nowak, 1999).

This species is a social and polygynandrous (promiscuous), living in large aggregations as colonies. Their diurnal roosts are found in various types of large and tall trees, including Ficus bengalensis, F. religiosa, Tamarindus indica, Mangifera indica, Dalbergia sissoo and Eucalyptus sp (Vendan, 2003). The colony size can vary from several hundred to thousand individuals but the largest congregations of this species have been so far recorded at Peradeniya Botanical Gardens near Kandy, Sri Lanka in September 2002 by Krystufek (2009). This is one of the most persecuted fruit bats in South Asia due to which this species is listed

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The Indian Flying Fox is very popular and even considered sacred in many parts of India (Marimuthu, 1988). The colony size of Indian Flying Fox varies depending on availability of food (Parry-Jones & Augee 1991; Eby 1996; Williams et al. 2006) and during mating season (Nelson 1965; Parry-Jones & Augee 2001; Holmes 2002).

**Study Area:** This bat colony is located on the west-south fringe of Jambughoda Wildlife Sanctuary and situated near Targol village (22°20'22.98"N; 73°39'14.38"E) at edge of the Targol Dam, Vadodara District. The colony is spread encompassing over one sq km area where various species of large to medium sized trees, along with few human residences (staff quarters of forest and irrigation department) and a small Eco-tourism complex.

The Jambughoda Wildlife Sanctuary lies between 22°20’-20°33’ N and 73°35’-73°45’ E in the Panchmahals and Vadodara districts of Gujarat State. It covers an area of 130.38 km² of forest within an altitudinal range from 230 to 354 m above sea level. The forest can be classified tropical dry deciduous type (Champion and Seth 1968). The flora and fauna of the sanctuary is moderately rich and diversified with a total of 17 mammalian species inhabitants (Pandya and Oza, 1998; Devkar et al., 2013).

**Methodology:** The bat census method was partially adapted here as mentioned by Krystufek (2009). Each tree was plotted onto a site map following a 20 x 20 meter grid with counted bats on each tree mentioned along. Our aim was to record all the trees that hosted roosting and other activities of the species. The number of bats was counted visually on each tree with the help of binoculars (8 x 40). When the direct counting was impossible especially in few large trees with dense canopies found along with large congregations of animals, or a part of the group was hidden in the canopy or tree remaining invisible from all sides (particularly along the water seepage areas of the dam), the numbers were estimated approximately.

### Table 1: List of Indian Flying Fox colonies in and around the Jambughoda Wildlife Sanctuary, Gujarat, India

<table>
<thead>
<tr>
<th>No</th>
<th>Location of Colony</th>
<th>Geo-coordination</th>
<th>No of Bats Roosted at site</th>
<th>Tree Species (No. of Tree)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Near Railway Station Shivrajpur Town</td>
<td>22°25'29.58&quot;N 73°36'19.07&quot;E</td>
<td>no bats</td>
<td>-</td>
<td>Earlier in 2000, there were bats roosting on eight large Eucalyptus Trees</td>
</tr>
<tr>
<td>2</td>
<td>Talawadi village</td>
<td>22°27'25.51&quot;N 73°36'44.61&quot;E</td>
<td>220</td>
<td>Madhuca indica (3)</td>
<td>seasonal dispersal of bats were observed</td>
</tr>
<tr>
<td>3</td>
<td>Panchayat Office Compound, Jambughoda Town</td>
<td>22°22'12.28&quot;N 73°43'47.23&quot;E</td>
<td>135</td>
<td>Ficus benghalensis (1)</td>
<td>seasonal dispersal of bats were observed</td>
</tr>
<tr>
<td>4</td>
<td>Jaban Village</td>
<td>22°24'11.50&quot;N 73°39'4.46&quot;E</td>
<td>285</td>
<td>Ficus religiosa (1) Ficus benghalensis (1) Palm sp. (2)</td>
<td>seasonal dispersal of bats were observed</td>
</tr>
<tr>
<td>5</td>
<td>Targol Dam</td>
<td>22°20'22.98&quot;N; 73°39'14.38&quot;E</td>
<td>9233</td>
<td>10 species (Table 2)</td>
<td>Largest roosting colony</td>
</tr>
</tbody>
</table>

Image 2: Spatial distribution congregation and roosting of Indian flying foxes (*Pteropus giganteus*) in Targol (Jambughoda Wildlife Sanctuary) site within 20 x 20 m squares. Bat numbers are grouped according to four classes.
We spent a total of eight days to study Indian Flying Fox colonies in and around the Sanctuary (four days in last week of March, two days in April and two days in the end of May 2012) to estimate the size of colony, threats and other relevant information of the species. The count of Targol site was undertaken in three different days (7th & 14th April and 31 May 2013) from morning.

**Observation and Results:** On 29th March 2013, we visited the Jambughoda Wildlife Sanctuary where numerous roosts of various species of bats (including Mega and Microchiroptera) were found in different locations. We were able to study four different colonies of Indian Flying Fox in and around the Sanctuary (Image 1 & 2). All these colonies comprise varying numbers of bats ranging from few hundreds to few thousands of individuals (Table 1). During the visit we found out most remarkable high numbers of Indian Flying Fox roosts at Targol Water Reserve on the border area of the Sanctuary. There were about 10,000 bats roosting in huge aggregations.

We again revisited the colony on 7th, 14th of April and in 31st of May 2013 to study and assess a correct estimation of Indian Flying Fox along with other relevant information about the species. We counted a total of 9233 adult bats (excluding the young suckling baby bats, which remain attached to their mothers) on 182 trees at Targol Dam site bat colony, as a result of a two day count during noon and evening, excluding the young suckling baby bats, which remain attached on mothers. The details of observations of bat colonies on each tree are provided in Table 2. Highest congregation of bats was observed on Mango trees (*M. indica*: n=3; Average=211.6 animals) and the least numbers were noticed on Peepal trees (*Ficus religiosa*: n=2; Average=20 animals). The least numbers of tree species used by bats for roosting were Kalam (*Haldinia cordifolia*) and Ambli (*Tamarindus indica*), respectively. Contrastingly, they used Peltrophorum trees in maximum for roosting.

The large concentrations of Indian Flying Fox roosting for breeding and nursing are usually interesting for other predators. But unfortunately, we did not come across any predators during our visits, except few indirect evidences of snakes as trails, or feline foot prints observed on the ground. During each visit we hardly found two to three dead young ones of Indian Flying Fox on the ground (Image 3). There may be a possibility of more young ones, which were consumed by nocturnal predators.

<table>
<thead>
<tr>
<th>No</th>
<th>Name of the trees</th>
<th>No. of Tree</th>
<th>Total No. of bats (Range in paranthesis)</th>
<th>Mean no. of bats</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Peltrophorum (<em>Peltrophorum ferrugineum</em>)</td>
<td>117</td>
<td>5839 (10-124)</td>
<td>49.9</td>
</tr>
<tr>
<td>2</td>
<td>Saru (<em>Casuarina equisetifolia</em>)</td>
<td>28</td>
<td>1232 (23-90)</td>
<td>44</td>
</tr>
<tr>
<td>3</td>
<td>Jambu (<em>Syzygium heymeanum</em>)</td>
<td>15</td>
<td>712 (30-80)</td>
<td>47.5</td>
</tr>
<tr>
<td>4</td>
<td>Nilgiri (<em>Eucalyptus sp.</em>)</td>
<td>10</td>
<td>300 (30-50)</td>
<td>30</td>
</tr>
<tr>
<td>5</td>
<td>Ambo (<em>Mangifera indica</em>)</td>
<td>3</td>
<td>635 (175-260)</td>
<td>211.7</td>
</tr>
<tr>
<td>6</td>
<td>Savan (<em>Gmelina arborea</em>)</td>
<td>3</td>
<td>115 (35-40)</td>
<td>38.3</td>
</tr>
<tr>
<td>7</td>
<td>Vad (<em>Ficus benghalensis</em>)</td>
<td>2</td>
<td>230 (105-125)</td>
<td>115</td>
</tr>
<tr>
<td>8</td>
<td>Piplo (<em>Ficus religiosa</em>)</td>
<td>2</td>
<td>40 (40-50)</td>
<td>20</td>
</tr>
<tr>
<td>9</td>
<td>Ambli (<em>Tamarindus indica</em>)</td>
<td>1</td>
<td>50 (50)</td>
<td>50</td>
</tr>
<tr>
<td>10</td>
<td>Kalam (<em>Haldinia cordifolia</em>)</td>
<td>1</td>
<td>30 (30)</td>
<td>30</td>
</tr>
<tr>
<td>Total</td>
<td>182</td>
<td>9183 (10-260)</td>
<td>50.46</td>
<td></td>
</tr>
</tbody>
</table>

**Table 2: List of tree species and numbers of bats roosting on each tree, average number of bats at Targol, Jambughoda Wildlife Sanctuary, Gujarat, India.**

![Image 3: A dead young Indian Flying Fox (*Pteropus giganteus*) found in the debris at the colony at Targol](image-url)
scavengers as no traces were found during daylight. We also noticed 100-150 (approx) adult Indian Flying Fox continuously flying from the colony and hovering over the surface of Targol water reservoir for drinking water. Once we observed that this situation attracts few adult Muggers (*Crocodylus palustris*) about 2-2.5 meters long. These crocodiles made numerous attempts to capture flying Indian Flying Foxes but in vain. The muggers may be opportunistic predators. During our visit and our observation periods, may be muggers were not successful but presumably they hold fair chances of prey, when bats fly and come closely over the surface of water.
The local people and residents around the colony seem not very pleased by the presence of bats in vicinity. The entire area remains noisy, by the screaming and squabbling of bats, continuously smelling foul due to droppings of bats. And roofs and walls of houses are stained due to the coloured dropping of bats. It was also observed that some of the trees and tree’s branches were cut down, lying over forest staff quarters. Also fire and smoke were set up regularly under the roosting trees to disturb the bats above to avoid particular trees or branches from inhabiting them.

During the study, we observed seasonal dispersal of bats from Talawadi, Jambughoda and Jaban to nearby new sites. In early April, we observed the bats of Talawadi were roosting on two large trees of Sirus (Albizia lebbeck: Image 4) but in the end of May, all the bats migrated from the trees and began roosting the nearby three large trees of Madhuca or ‘Mahudo’ (Madhuca indica: Image 5). Same was noticed at Jambughoda and Jaban, where all the bats abandoned Asopalav (Polyalthia longifolia), Sirus (Albizia lebbeck), Peltophorum (Peltophorum ferrugineum) at Jambughoda, and Kadam (Haldina cordifolia) and Savan (Gmelina arborea) at Jaban, migrated to the canopies of Banyan (Ficus benghalensis) at Jambughoda and Peepal (Ficus religiosa), Banyan (Ficus benghalensis) and Tad (Borassus flabellifer) at Jaban. These migrations and choice of denser tree canopies could be possibly done, to avoid direct sun light and to survive against harsh heat of summer. But the same phenomenon was not observed at Targol site, except the minor change in Indian Flying Fox density in roosting, especially on the roosting trees situated on the outer periphery.

Image 7: Indian Flying Fox (Pteropus giganteus) roosting on Saru (Casuarina equisetifolia) at Targol, Jambughoda Wildlife Sanctuary, Gujarat

Image 8: An adult female of Indian Flying Fox (Pteropus giganteus) carrying a 5-6 weeks old baby.
Discussion: The fruit bats from genus *Pteropus* are popularly known as flying fox that have been studied in much detail (Rainey and Pierson, 1992). Some *Pteropus* colonies contain up to a few hundred thousand bats and may have increased to millions of individuals (Nowak, 1999). The larger *Pteropus vampyrus* colonies revealed by Corbet and Hills (1992) had totals of 100,000 individuals in year 1920 from Philippines along with its conspecific *P. giganteus*. Recently this population has declined to 500-1000 (Mickelburgh et al., 1992). The current largest aggregation of *P. vampyrus* consists of more than 15,000 individuals in Borneo and 9,000-21,000 on the island of Palau Rambut (Kunz and Jones, 2000).

Over 6000 individuals of Indian Flying Fox colony was reported in Nallur near Chennai, Tamil Nadu (Smith, 1998). Khan (1985) claims the largest colony of IFF in Bangladesh with 2500 individual bats. Blincow (2000) reported huge figures of about 50,000 bats in Bundala, Sri Lanka. The largest colony mentioned in year 2006, had over 5000 Indian Flying Foxes roosting on three *Ficus* trees at Limkheda, Dahod District, Gujarat State (Singh, 2013).

The present large congregation built up of Indian Flying Fox (Image 6 & 7) at the Targol Dam site might be the result of rising favorable conditions at the site along with the other possibility of a nearer bat colony disturbed and hence migrated to the present site. It is very difficult to end up in concrete assumption without any authentic past data about other Indian Flying Fox roosting colonies from the entire area.

We made some inquiries with few locals and forest officials about the origin and any other sites of Indian Flying Fox colony, perception of the locals towards the roosting of bats and its impacts. As per the opinion of local villagers and nearer residents, especially forest staff and irrigation department—“this colony is one of the oldest colonies in the area but we have observed higher numbers of bats in the colony this year only”.

Pandya and Oza (1998) listed five sites of roosting colony (Shivrajpur, Jambughoda, Jabban, Targol and Pipla) during the study of biodiversity of the Sanctuary, whereas Padate (2006) listed only three roosting colonies (Shivrajpur, Jambughoda and Targol). The reason for not listing other two roosting sites by Padate (2006) might be due to the roosting colonies at Jabban and Pipla were disturbed/destroyed or shifted elsewhere. At present, we were able to search four roosting colonies namely, Talawadi, Jambughoda, Jabban and Targol, and were unable to find other two roosting colonies at Shivrajpur and Pipla. These roosting colonies were not sighted during the present survey due to the disturbances or bats might have shifted elsewhere.

The Targol site earlier was the forest nursery; therefore most of trees grown here are spaced closely and were dense. The dense tree canopies prevent the light from penetrating downwards and thus create an ideal dark situation for the roosting of Indian Flying Fox along with water seepage from adjoining water body. The multiple factors, including undisturbed protected forest pockets, moist dark low light areas with impenetrable canopies of tall trees, along with adjoining agricultural and fruit orchards added to the best environmental circumstances for luring high numbers of Indian Flying Fox to roost and breed.

As per a rough count, we also noted that every fifth or sixth bat carried a single young baby (Image 8) and in rare cases two young ones, estimating counts to over 1500-1800 babies. Therefore arriving to a final conclusion, the result includes adult bats along with young ones to an estimate of about 11,000 bats roosting in the colony. Such numbers have apparently never been reported for Indian Flying Fox congregations. It is so far one of the largest roosting colonies of IFF in the entire region and may be one of the largest recorded roosting sites of Indian Flying Fox in Gujarat State.

Acknowledgement
We are very thankful to Pritesh Patel and Reshma Solanki for great help and accompanying in field work. Special thanks to Dy. Conservator of Forest, Jambughoda Wildlife Sanctuary, Vadodara and Mr. Parmar, Forester of Targol, JWS, without whose permission this study and work in the sanctuary area would not have been possible.

References


Records of roosting sites of Indian Flying Fox (*Pteropus giganteus* (Brunnich, 1782)) from Madhya Pradesh, India

S.S. Talmale*

*Pteropus giganteus* (Brunnich), commonly known as Indian Flying fox are colonial in habit and roost on large trees, and are found throughout the Indian subcontinent. The colony size is reported to be between hundreds to several thousand individuals and also varies seasonally (Bates and Harrison, 1997). As per IUCN Red List (Version 2014.1) this species is categorized as Least Concern (Molur *et al.*, 2008) and listed as vermin under Schedule V of the Indian Wildlife (Protection) Act, 1972 (amended upto 2006). This species is also listed on Appendix II of CITES (valid from 12 June 2013).

While conducting surveys to study the small mammals of Madhya Pradesh, the districts of Anuppur, Betul, Burhanpur, Chhindwara, Dindori, Khandwa, Hoshangabad, Shahdol, Shivpuri, Singhorí Wildlife Sanctuary (Raisen Dist.), Veerangana Durgavati Wildlife Sanctuary (Damoh Dist.), Nauradehi Wildlife Sanctuary (Sagar, Damoh and Narsinghpur Dists.) were surveyed from November 2010 to January 2014. A total of 27 roosting sites of Indian Flying fox, *Pteropus giganteus* (Brunnich) were recorded from 9 districts of Madhya Pradesh (Table 1, Image 1). Most of the locations are in villages or towns and some are in the agricultural fields near villages. There are possibilities of small sized roosting sites (10 to 50 individuals) which might act as temporary roosting site for small scale local migrations. All the roosting sites recorded here were visited only once during the survey except the roost recorded at Bhagdei village in Singhorí Wildlife Sanctuary, Raisen district. This location was visited on 10.12.2010 and 22.02.2012. At the first instance the population size was about 30 individuals and at a later date the population was recorded to be more than 50 individuals. Therefore it is confirmed that the roost is permanent and some individuals may migrate seasonally to nearby localities. One or two individuals electrocuted by high tension live electric wire in the rural as well as in the urban areas were also recorded (Table 2, Image 2).

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Table 1: Detail account on the roosting sites of *Pteropus giganteus* (Brunnich) observed in Madhya Pradesh, India

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Name of locality</th>
<th>Date of observation</th>
<th>Name of Tree on roost observed</th>
<th>Approximate roost size</th>
<th>Latitude, Longitude &amp; Altitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Murgi Chowk, Sadar Bazar, Betul, Betul District</td>
<td>07.10.2012</td>
<td>Eucalyptus sp. (on five trees)</td>
<td>1000+</td>
<td>N 21°54.554’ E 077°54.327’ 2274 ft.</td>
</tr>
<tr>
<td>3</td>
<td>Kesala on Betul-Hoshangabad Road (NH-69), Betul District</td>
<td>07.10.2012</td>
<td>Albizia procera</td>
<td>1000+</td>
<td>N 22°28.551’ E 077°50.358’ 1544 ft.</td>
</tr>
<tr>
<td>4</td>
<td>Dolariya, Hoshangabad District</td>
<td>08.10.2012</td>
<td>Mangifera indica</td>
<td>10</td>
<td>N 22°35.434’ E 077°38.036’ 1005 ft.</td>
</tr>
<tr>
<td>5</td>
<td>Khamaria (Gotecaon-Jabalpur road), Narsinghpur District</td>
<td>12.10.2012</td>
<td>Terminalia sp.</td>
<td>200+</td>
<td>N 23°05.582’ E 079°32.888’ 1226 ft.</td>
</tr>
<tr>
<td>7</td>
<td>Lapta village, Anuppur-Vyankatnagar road, Anuppur District</td>
<td>16.02.2013</td>
<td>Eucalyptus sp. (Three trees)</td>
<td>300+</td>
<td>N 22°58.907’ E 081°53.091’ 1826 ft.</td>
</tr>
<tr>
<td>8</td>
<td>Dhangawa (Poorvi), Anuppur District</td>
<td>16.02.2013</td>
<td>Mangifera indica</td>
<td>500+</td>
<td>N 23°05.571’ E 081°54.283’ 2649 ft.</td>
</tr>
<tr>
<td>10</td>
<td>Pushpragargh (Rajendragram) on Amarkantak road, Anuppur District</td>
<td>19.02.2013</td>
<td>Eucalyptus sp. (3-4 trees)</td>
<td>100</td>
<td>N 22°56.049’ E 081°36.514’ 2742 ft.</td>
</tr>
<tr>
<td>11</td>
<td>Lilatola, on Rajendragram-Dindori Road, Anuppur District</td>
<td>21.02.2013</td>
<td>Peepal, Ficus religiosa</td>
<td>100</td>
<td>N 22°55.571’ E 081°54.283’ 2649 ft.</td>
</tr>
<tr>
<td>12</td>
<td>Kachhirmal village, Shahapura-Umaria road, Dindori District</td>
<td>15.02.2013</td>
<td>Peepal, Ficus religiosa</td>
<td>300+</td>
<td>N 23°19.443’ E 080°40.585’ 2087 ft.</td>
</tr>
<tr>
<td>13</td>
<td>16 kms. from Shahapura near Gram Pindarai on Shahapura- Mandla road, Dindori District</td>
<td>22.02.2013</td>
<td>Peepal, Ficus religiosa</td>
<td>200</td>
<td>N 23°03.929’ E 080°40.951’ 2021 ft.</td>
</tr>
<tr>
<td>14</td>
<td>Dungaria (Amera) on Shahapura-Dindori road (SH22), Dindori District</td>
<td>22.02.2013</td>
<td>Peepal, Ficus religiosa</td>
<td>50</td>
<td>N 23°05.112’ E 080°49.804’ 2246 ft.</td>
</tr>
<tr>
<td>15</td>
<td>Amarpur, Dindori District</td>
<td>23.02.2013</td>
<td>Eucalyptus sp. (2 trees)</td>
<td>500+</td>
<td>N 22°47.281’ E 080°57.645’ 2325 ft.</td>
</tr>
<tr>
<td>16</td>
<td>Chhanta, Dindori District</td>
<td>23.02.2013</td>
<td>Peepal, Ficus religiosa</td>
<td>100</td>
<td>N 22°51.208’ E 081°05.926’ 2431 ft.</td>
</tr>
<tr>
<td>18</td>
<td>Bondar, two kms. from Sunpuri on Bajag Road, Dindori District</td>
<td>25.02.2013</td>
<td>Peepal, Ficus religiosa</td>
<td>150+</td>
<td>N 22°49.289’ E 081°15.484’ 2521 ft.</td>
</tr>
<tr>
<td>19</td>
<td>Kosamdh on Sunpuri- Bajag road, Dindori District</td>
<td>25.02.2013</td>
<td>Peepal, Ficus religiosa</td>
<td>500+</td>
<td>N 22°47.057’ E 081°17.300’ 2526 ft.</td>
</tr>
<tr>
<td>20</td>
<td>Bajag, Dindori District</td>
<td>25.02.2013</td>
<td>Eucalyptus sp. (on 5 trees)</td>
<td>500+</td>
<td>N 22°40.417’ E 081°20.984’ 2590 ft.</td>
</tr>
<tr>
<td>21</td>
<td>Lalpur on Bajag-Gadasarai Road, Dindori District</td>
<td>25.02.2013</td>
<td>Peepal, Ficus religiosa</td>
<td>50+</td>
<td>N 22°46.617’ E 081°20.106’ 2507 ft.</td>
</tr>
</tbody>
</table>
In addition to the roosting sites reported (Table 1), there were earlier reports of this species from Madhya Pradesh (Bates and Harrison, 1997) namely from the districts of Morar, Bhind, Sabalgarh, Sheopore, Guna, Chachora, Agar Malwa, Agar, Gwalior, Mukhi, Supkhar, Balaghat, Sohagpur, Narsingarh, Ouda, Sonawanee, Jabalpur and Sehore shows that the population of *Pteropus giganteus* is widespread throughout the state.

**Acknowledgements**
The author is grateful to Dr. K. Venkatraman, Director, Zoological Survey of India, Kolkata and Dr. S. Sambath, Scientist-C & Officer-in-Charge, ZSI, CZRC, Jabalpur for the facilities and encouragement.

Thanks are due to the Principal Chief Conservator of Forests, Bhopal for permission to conduct survey of the areas and provide facilities and accommodation during the survey. He is also thankful to Shri. M. E. Limje, photographer and Shri. Ramdayal Patel, Collection Tender who assisted during the field work.

**References**


Downloaded on 18 June 2014

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Name of locality</th>
<th>Date of observation</th>
<th>Name of Tree on roost observed</th>
<th>Approximate roost size</th>
<th>Latitude, Longitude &amp; Altitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>Khirala village (Kabraasthan), Khandwa District</td>
<td>17.10.2013</td>
<td>Banyan, <em>Ficus benghalensis</em></td>
<td>250+</td>
<td>N 21°28.288'E 076°17.382' 2092 ft.</td>
</tr>
<tr>
<td>27</td>
<td>Bhagaura vill. on Shivpuri-Jhansi Road, Shivpuri District</td>
<td>08.01.2014</td>
<td>Banyan, <em>Ficus benghalensis</em></td>
<td>200+</td>
<td>N 25°25.133'E 077°45.644' 1305 ft.</td>
</tr>
</tbody>
</table>

**Table 2: Details of dead specimens of *Pteropus giganteus* (Brunnich) electrocuted by high tension live electric wire recorded in Madhya Pradesh, India**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Name of locality</th>
<th>Date of observation</th>
<th>No. of individuals</th>
<th>Latitude, Longitude &amp; Altitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Chikhalmu village near Junnardev, Chhindwara District</td>
<td>03.10.2012</td>
<td>One</td>
<td>N 22°11.546'E 078°35.298' 2534 ft.</td>
</tr>
<tr>
<td>2</td>
<td>Damua, Chhindwara District</td>
<td>03.10.2012</td>
<td>One</td>
<td>N 22°11.380'E 078°27.578' 2570 ft.</td>
</tr>
<tr>
<td>3</td>
<td>Sohagpur, Hoshangabad District</td>
<td>12.10.2012</td>
<td>One</td>
<td>N 22°42.010'E 078°12.128' 1069 ft.</td>
</tr>
<tr>
<td>4</td>
<td>Jawar village, Khandwa District</td>
<td>18.10.2013</td>
<td>Two</td>
<td>N 21°55.747'E 076°26.582' 1038 ft.</td>
</tr>
</tbody>
</table>
Interaction of Indian Flying Foxes *Pteropus giganteus* (Brunnich, 1782) with the plant species in the Lower Brahmaputra Valley of Assam

Azad Ali

**Abstract**

The present study was aimed to identify the various roosting trees and food plant species used by the Indian flying foxes *P. giganteus* in Assam. The study was mainly carried out in the lower reach of the Brahmaputra Valley of Assam particularly in the Dhubri district (25°-27° North latitude and 89°-91° East latitude), the westernmost part of Assam. A total of 30 different roosting tree species and 51 different types of food plants were found associated with the Indian flying foxes (*P. giganteus*) in the Lower Brahmaputra Valley (LBV) of Assam.

**Introduction**

The role of megachiropterans or Old World fruit bats is well recognized in the regeneration of the forest as these bats are well known for seed dispersal and pollination. In India, three fruit bat species are very common and among these, Indian flying fox (*Pteropus giganteus* Brunnich, 1782) is ubiquitous. Sinha (1999) has described few lines on biology and feeding habit of *P. giganteus* in his records of the Zoological Survey of India. Indian flying fox (*Pteropus giganteus*) is the largest fruit bat species of Assam of the Order-Chiroptera, Suborder-Megachiroptera and Family-Pteropodidae. It is an exclusively plant dependent bat species (Ali, 2012). Marshall, 1985 also quoted that fruit bats feed almost exclusively on plants, taking floral resources (largely nectar and pollen but also petals and bracts), and fruits and often seeds and leaves. In the present study, all total 30 different roosting tree species have been identified. Most of the roosting trees were of East Himalayan moist mixed deciduous and Assam Valley semi-evergreen forest types. However evergreen trees were also used for roosting purposes in the study areas (Ali, 2013). For food, *P. giganteus* individuals of Assam have shown their interest in 51 plant species of 35 genera and 24 families.

<p>| Table 1: Roosting tree species of <em>Pteropus giganteus</em> from Lower Brahmaputra Valley of Assam |</p>
<table>
<thead>
<tr>
<th><strong>Family</strong></th>
<th><strong>Common names</strong></th>
<th><strong>Scientific names</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Fabaceae</td>
<td>Krishnasura jatio</td>
<td><em>Peltophorum pterocarpum</em></td>
</tr>
<tr>
<td></td>
<td>Sissoo</td>
<td><em>Dalbergia sissoo</em></td>
</tr>
<tr>
<td></td>
<td>Krishnasura</td>
<td><em>Delonix regia</em></td>
</tr>
<tr>
<td></td>
<td>Teteli</td>
<td><em>Tamarindus indica</em></td>
</tr>
<tr>
<td></td>
<td>Radhasura</td>
<td><em>Caesalpinia pulcherrima</em></td>
</tr>
<tr>
<td></td>
<td>Siris /Rain tree</td>
<td><em>Albizia saman</em></td>
</tr>
<tr>
<td>Arecaeeae</td>
<td>Tamul/Betel nut</td>
<td><em>Areca catechu</em></td>
</tr>
<tr>
<td></td>
<td>Fish tail palm</td>
<td><em>Caryota urens</em></td>
</tr>
<tr>
<td>Myrtaceae</td>
<td>Eucalyptus</td>
<td><em>Eucalyptus globulus</em></td>
</tr>
<tr>
<td></td>
<td>Jamu</td>
<td><em>Syzygium cumini</em></td>
</tr>
<tr>
<td></td>
<td>Madhurium</td>
<td><em>Psidium guajava</em></td>
</tr>
<tr>
<td>Malvaceae</td>
<td>Simalu</td>
<td><em>Bombax ceiba</em></td>
</tr>
<tr>
<td>Anacardiaceae</td>
<td>Aam/Mango</td>
<td><em>Mangifera indica</em></td>
</tr>
<tr>
<td>Poaceae</td>
<td>Bah/bamboo</td>
<td><em>Bambusa</em> sp.</td>
</tr>
<tr>
<td>Melliaceae</td>
<td>Neem</td>
<td><em>Azadirachta indica</em></td>
</tr>
<tr>
<td>Moraceae</td>
<td>Ahot</td>
<td><em>Ficus religiosa</em></td>
</tr>
<tr>
<td></td>
<td>Bot</td>
<td><em>Ficus benghalensis</em></td>
</tr>
<tr>
<td></td>
<td>Jagya Dimaru</td>
<td><em>Ficus racemosa</em></td>
</tr>
<tr>
<td></td>
<td>Kothal/Jackfruit</td>
<td><em>Artocarpus heterophyllus</em></td>
</tr>
<tr>
<td>Rubiaceae</td>
<td>Kadam</td>
<td><em>Neolamarckia cadamba</em></td>
</tr>
<tr>
<td>Apocynaceae</td>
<td>Sotiona</td>
<td><em>Alstonia scholaris</em></td>
</tr>
<tr>
<td>Annonaceae</td>
<td>Debadaru</td>
<td><em>Polyalthia longifolia</em></td>
</tr>
<tr>
<td></td>
<td>Mewa/Ateshfol</td>
<td><em>Annona squamosa</em></td>
</tr>
<tr>
<td>Combretaceae</td>
<td>Arjun</td>
<td><em>Terminalia arjuna</em></td>
</tr>
<tr>
<td>Dipterocarpaceae</td>
<td>Sal</td>
<td><em>Shorea robusta</em></td>
</tr>
<tr>
<td>Euphorbiaceae</td>
<td>Velkor</td>
<td><em>Trewia nudiflora</em></td>
</tr>
<tr>
<td>Rutaceae</td>
<td>Bel</td>
<td><em>Aegle marmelos</em></td>
</tr>
<tr>
<td>Lamiaceae</td>
<td>Segun/Teak</td>
<td><em>Tectona grandis</em></td>
</tr>
<tr>
<td></td>
<td>Gamari</td>
<td><em>Gmelina arborea</em></td>
</tr>
<tr>
<td>Phyllanthaceae</td>
<td>Amlakhu</td>
<td><em>Phyllanthus emblica</em></td>
</tr>
</tbody>
</table>

---

**I/C:** Bat Research and Conservation Division (BRCD), Coordinator, Biodiversity and Ecological Research Centre (BERC); Assistant Professor and Head, Department of Zoology, B. N. College, Dhubri, Assam.
Table 2: List of Food Plants and food items of *Pteropus giganteus* found in the Lower Brahmaputra Valley of Assam.

<table>
<thead>
<tr>
<th>Family</th>
<th>Common names (Assamese)</th>
<th>Scientific names</th>
<th>Parts consumed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arecaceae</td>
<td>Tamul</td>
<td>Areca catechu</td>
<td>Blossom &amp; Flower</td>
</tr>
<tr>
<td></td>
<td>Naricol</td>
<td>Cocos nucifera</td>
<td>Flower</td>
</tr>
<tr>
<td></td>
<td>Khejur</td>
<td>Phoenix dactylifera</td>
<td>Flower and fruit</td>
</tr>
<tr>
<td>Musaceae</td>
<td>Athiya kol/Vimkol</td>
<td>Musa balbisiana</td>
<td>Flower nectar &amp; fruit</td>
</tr>
<tr>
<td></td>
<td>Kashkol</td>
<td>Musa paradisiaca</td>
<td>Flower nectar</td>
</tr>
<tr>
<td></td>
<td>Monohor kol</td>
<td>Musa sapientum</td>
<td>Flower nectar &amp; fruit</td>
</tr>
<tr>
<td></td>
<td>Chenichampa kol</td>
<td>Musa champa</td>
<td>Flower nectar &amp; fruit</td>
</tr>
<tr>
<td></td>
<td>Malbhog kol</td>
<td>Musa velutina</td>
<td>Flower nectar &amp; fruit</td>
</tr>
<tr>
<td></td>
<td>Jahaji col</td>
<td>Musa acuminata</td>
<td>Flower nectar &amp; fruit</td>
</tr>
<tr>
<td>Moraceae</td>
<td>Bot</td>
<td>Ficus Benghalensis</td>
<td>Ripe figs</td>
</tr>
<tr>
<td></td>
<td>Kathalpatiabor</td>
<td>Ficus curtipes</td>
<td>Ripe figs</td>
</tr>
<tr>
<td></td>
<td>Silubor</td>
<td>Ficus retusa</td>
<td>Ripe figs</td>
</tr>
<tr>
<td></td>
<td>Ahot</td>
<td>Ficus religiosa</td>
<td>Ripe figs</td>
</tr>
<tr>
<td></td>
<td>Khokshadimarlu</td>
<td>Ficus hispida</td>
<td>Ripe figs</td>
</tr>
<tr>
<td></td>
<td>Ahotjatiya</td>
<td>Ficus infectoria</td>
<td>Ripe figs</td>
</tr>
<tr>
<td></td>
<td>Athabor</td>
<td>Ficus elastica</td>
<td>Ripe figs</td>
</tr>
<tr>
<td></td>
<td>Kathal</td>
<td>Artocarpus heterophyllus</td>
<td>Ripe fruit</td>
</tr>
<tr>
<td></td>
<td>Jagya Dimaru</td>
<td>Ficus racemosa</td>
<td>Ripe figs</td>
</tr>
<tr>
<td>Annonaceae</td>
<td>Atlas/Mewa</td>
<td>Anona reticulata</td>
<td>Ripe fruit</td>
</tr>
<tr>
<td></td>
<td>Debadaru</td>
<td>Polyalthiya longifolia</td>
<td>Ripe fruit</td>
</tr>
<tr>
<td>Anacardiaceae</td>
<td>Amara</td>
<td>Spondias pinnata</td>
<td>Ripe fruit</td>
</tr>
<tr>
<td></td>
<td>Mango/Aam</td>
<td>Mangifera indica</td>
<td>Blossom and fruit</td>
</tr>
<tr>
<td>Myrtaceae</td>
<td>Modhurium/Guava</td>
<td>Psidium guajava</td>
<td>Blossom &amp; Ripe fruit</td>
</tr>
<tr>
<td></td>
<td>Borjamu</td>
<td>Syzygium cumini</td>
<td>Flower &amp; Ripe fruit</td>
</tr>
<tr>
<td></td>
<td>Khudjamu</td>
<td>Calyptranthes cuspidata</td>
<td>Flower &amp; Ripe fruit</td>
</tr>
<tr>
<td></td>
<td>Eucalyptus</td>
<td>Eucalyptus sp.</td>
<td>Ripe fruit</td>
</tr>
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<td>Meliaceae</td>
<td>Mohaneem</td>
<td>Azadirachta indica</td>
<td>Ripe fruit</td>
</tr>
<tr>
<td></td>
<td>Ghoraneem</td>
<td>Melia azedarach</td>
<td>Ripe fruit</td>
</tr>
<tr>
<td>Rhamnaceae</td>
<td>Bogori</td>
<td>Ziziphus jujuba</td>
<td>Blossom &amp; Ripe fruit</td>
</tr>
<tr>
<td></td>
<td>Bilati bogori</td>
<td>Ziziphus vulgaris</td>
<td>Blossom &amp; Ripe fruit</td>
</tr>
<tr>
<td>Sapindaceae</td>
<td>Lechu</td>
<td>Litchi chinensis</td>
<td>Ripe fruit</td>
</tr>
<tr>
<td>Malvaceae</td>
<td>Simalu</td>
<td>Bombax ceiba</td>
<td>Flower</td>
</tr>
<tr>
<td>Caricaceae</td>
<td>Omita</td>
<td>Carica papaya</td>
<td>Flower &amp; fruit</td>
</tr>
<tr>
<td>Dilleniaceae</td>
<td>Outenga</td>
<td>Dillenia indica</td>
<td>Flower</td>
</tr>
<tr>
<td>Elaeocarpaceae</td>
<td>Rudrakhyta</td>
<td>Elaeocarpus sphaericus</td>
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<td>Elaeocarpus floribundus</td>
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<td>Oxalidaceae</td>
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<td>Averrhoa carambola</td>
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<tr>
<td>Combretaceae</td>
<td>Silika</td>
<td>Terminalia chebula</td>
<td>Ripe fruit</td>
</tr>
<tr>
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<td>Letuku</td>
<td>Baccaurea ramiflora</td>
<td>Ripe fruit</td>
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<td>Salicaceae</td>
<td>Poniyal</td>
<td>Flacourtia jangomas</td>
<td>Flower</td>
</tr>
<tr>
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<td>Grevillea robusta</td>
<td>Flower</td>
</tr>
<tr>
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<td>Modar</td>
<td>Erythrina variegata</td>
<td>Flower</td>
</tr>
<tr>
<td></td>
<td>Siris/Rain tree</td>
<td>Albizia saman</td>
<td>Flower and leaves</td>
</tr>
<tr>
<td></td>
<td>Teteli</td>
<td>Tamarindus indica</td>
<td>Leaves and fruit</td>
</tr>
<tr>
<td>Sapotaceae</td>
<td>Chapota</td>
<td>Manilkara zapota</td>
<td>Ripe fruit</td>
</tr>
<tr>
<td></td>
<td>Bokul</td>
<td>Mimusops elengi</td>
<td>Ripe fruit</td>
</tr>
<tr>
<td>Rosaceae</td>
<td>Plum</td>
<td>Prunus armeniaca</td>
<td>Ripe fruit</td>
</tr>
<tr>
<td>Rubiaceae</td>
<td>Kadam</td>
<td>Neolamarckia cadamba</td>
<td>Ripe fruit</td>
</tr>
<tr>
<td>Cucurbitaceae</td>
<td>Vatkakrel</td>
<td>Mimordica sp.</td>
<td>Ripe fruit</td>
</tr>
<tr>
<td></td>
<td>Kuavaturi</td>
<td>Citrullus colocynthis</td>
<td>Ripe fruit</td>
</tr>
</tbody>
</table>
Materials and Methods
The studies on the roosting trees and feeding trees were carried out independently at the roosting sites and foraging areas. For identification and naming of plants species botanical guide book (Borah, 2003) was used. In a few cases, helps of local experts were also taken. Food plants were marked in the foraging areas with the help of naked eyes through direct spot observation method during foraging hours. An indirect method of food plant identification was also used where partially consumed food plant were collected from the floor of traditional roosting trees as fruit bats sometime returned with food items to their traditional roosts to consume the food stuff at night.

Results and Discussion
As mentioned above, a total of 30 different roosting tree species of 19 families along with 51 different species of food plants species under 25 families were found associated with the P. giganteus in the Lower Brahmaputra Valley (LBV) of Assam. Roosting trees are listed in the Table-1 and the food plants are shown in the Table-2 with their various parts consumed by the Indian Flying Foxes.

From the current study, it has been clearly came out that Indian Flying Fox (Pteropus giganteus) is an exclusively plant dependent bat species and emerged as an example of excellent Plant-Animal relationship. Plant species (Table-2) must have evolutionary relationships with the P. giganteus for pollination cum seed dispersal purposes. Through their pollination and seed dispersal activities, they are definitely helping us in reforestation thereby balancing our degraded forest cover. Fujita and Tuttle (1991) also explained that due to the multifaceted ecological and economic roles of pteropodid bats, especially in reforestation, their conservation and management must be considered an essential element of sustainable development planning for tropical forests.

Acknowledgements
Author wants to offer his heartiest thanks to Prof. T.C. Deka, Dr. R. Deka, Emani, Protiva, all the forest officials & police personnel of Guwahati and Dhubri, D.F.O. Campus and D.C. Campus respectively and all the members of “Biodiversity and Ecological Research Centre (BERC)”, “Bat Research and Conservation Division (BRCD)” and “Bat Assessment Troop (BAT)” for their kind support and help during survey periods.

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Ali, A. (2013). Indian Flying Fox of Assam. Scholars’ Press, Germany. 136pp


Population and Conservation status of the Indian Flying Fox roost in Itiadoh dam, Maharashtra
S.V. Bhandarkar¹  and G.T. Paliwal²

Abstract
Only few ecological studies on Indian flying fox Pteropus giganteus (Brunnich, 1782) (Chiroptera: Pteropodidae) were carried out in India. According to IUCN Red List, this species is Least Concern. There is no baseline data available for this species from eastern vidarba region of Maharashtra. In the present investigation authors reports population trend, monitoring and conservation status of roost of this species in Itiadoh Dam situated at Gondia district of eastern Vidarbha, Maharashtra. The observation disclosed that the population trend is gradually increasing and found no special threat to this site and it is naturally conserved.

Introduction
Bats are the second most specious group of mammals, after rodents. Approximately 1117 species of living bats make up around 20% of all known living mammal species. In some tropical areas, there are more species of bats than of all other kinds of mammals combined (Hill and Smith, 1984; Nowak, 1991; Vaughan et al., 2000). India has more than 11% of the world’s bats including 13 fruit bats and 101 insectivorous bats (Wilson and Reeder, 2005).


Due to poor knowledge about their status in Maharashtra particularly in eastern Vidarbha, we collected population data and their roosting sites from eastern Vidarbha region. Few ecological studies of fruit bats have been carried out in the Indian subcontinent, but are now more crucial with the accelerating rate of habitat destruction (Wilson & Engbring, 1992). Although the IUCN Red List has classified Indian fruit bat as Least Concern, the number of individuals are decreasing consistently (Venkatesan, 2007), primarily due to habitat loss and hunting. Accordingly, some populations are becoming locally Threatened (IUCN, 2012). Moreover, knowledge about their

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²Dept. of Zoology, S.S. Jaiswal College, Arjuni/Mor. Dist. Gondia, MS
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distribution, nesting and roosting habits is rudimentary (Pierson & Rainey, 1992). Hence, recognizing roost sites and protecting such areas are important for the conservation of P. giganteus populations. The present investigation was carried out from last five years and observations on the roost of P. giganteus at Itiadoh dam was carried out. Fluctuations in numbers of roosting animals at the sites were recorded.

**Material and Method:**

**Study Site**
The present observation was carried out near the Itiadoh Dam reservoir. Itiadoh Dam is constructed on Gadhavi River near Gothangaon village. This water body is a popular picnic spot. This is one of the biggest lakes in Bhandara-Gondia district. The observed bat roost is at 20°47'56.80" N, 80°09'56.18 E in the dense vegetation surrounded to stagnant water body of old stream of Gadhavi River.

**Methodology**
To study the population size of the Indian flying foxes in Itiadoh dam roosting site, bats were regularly counted from May 2010 until April 2014. The population was counted prior to evening flight. Direct roost count method was followed to estimate the population size of the colony (Barlow, 1999). In monsoon season the direct counting was difficult because of dense vegetation and also because of marginal area of the site was full of stagnant old river water. Therefore it was easy to count all the bats prior to evening flight. Most of the observations were done with the naked eyes. At times binoculars were used to spot out the bats.

**Result and Discussion:** In the present observation the bats were entangled to the branches of Terminalia arjuna. In the study area bats were found to be roosted in seven trees. The dense vegetation was a challenge to estimate the population size. But due to their day sound at roosts helped to orient them.

The observation and monitoring was started from the May 2010 to April, 2014. The population of the Itiadoh Dam roosting site was ca. 410 in the month of May, 2010. In 2011 and 2012, population of

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Month</th>
<th>Year</th>
<th>Population size</th>
<th>Status</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>April</td>
<td>2010</td>
<td>410</td>
<td>Decreased</td>
</tr>
<tr>
<td>2</td>
<td>April</td>
<td>2011</td>
<td>516</td>
<td>Increasing</td>
</tr>
<tr>
<td>3</td>
<td>April</td>
<td>2012</td>
<td>556</td>
<td>Increasing</td>
</tr>
<tr>
<td>4</td>
<td>April</td>
<td>2013</td>
<td>645</td>
<td>Increasing</td>
</tr>
<tr>
<td>5</td>
<td>April/May</td>
<td>2014</td>
<td>692</td>
<td>Increased</td>
</tr>
</tbody>
</table>

Satellite view of roosting site (S1)

Observing IFF roost by authors with volunteers
the site showed some increase and recorded as 516 and 556 respectively. In the 2013 it further increased and showed 645. In the recent population count carried out in the month of April 2014 numbers has been found to be 692. The trend of population size of the roost showed an increasing trend during the study period (Table.1). The colony preferred to roost on *Terminalia arjuna*. The study area also had *Ficus benghalensis*, *Ficus religiosa*, *Mangifera indica*, *Ficus racemosa*, *Albizia lebbeck*, etc in the vicinity. In the cold season they preferred *Albizia* tree.

This species is categorized as Least Concern under the Red List of threatened species of IUCN but its population is declining alarmingly due to habitat degradation (IUCN, 2011). Some local threats of this species observed are cutting down of roosting trees for road expansion or other purposes.

The Itiadho dam remains boon for the roosting organism in the summer season. It is observed that, in dusk the flock migrate towards the Itiadho open water for drink, they touch the water surface while flight and return to their roost. But they forage out towards west and northern region as they always found. It is noteworthy that the population trend is showing an increasing trend in the study area compared to other sites in Bhandara district (Bhandarkar and Paliwal, 2013b). The site is far away from the human habitation but some time they was disturbance from the tourists. The ban on activities by tourists will help to manage this population and conserve them. Awareness on conservation of bats is needed for the current generation (Mahanto *et al*., 2012).

According to some anecdotal information as well as Mr. Narayanapatil Dongarwar, Hon. Wildlife Warden stated that the population of this bat was more than thousand in this site about five to six year ago. But the acute mass death was observed due to extreme heat wave in the year 2009 that resulted in sudden decline in the population. In the May 11, 2009 many Indian flying foxes found dead in some sites of eastern Vidarbha due to extreme heat wave (Bhandarkar and Paliwal, 2013a).

Ecologically fruit bats are highly important species as they are one of the best pollinators and seed dispersers in tropical forests throughout the world (Marshall, 1983). This helps in maintaining forest diversity as well as forest regeneration (Cox *et al*., 1992).

Despite the importance of this fruit bat species, virtually no baseline population data or status monitoring exists for any of the flying foxes along with the *Pteropus giganteus*. Database information came out from study can be useful for policy makers for planning, better conservation-management programmes. At the same future researcher will get the chance to compare these set of data with their studies (Ali, 2010).
Acknowledgments
I would like to offer my thanks to volunteers of SENSE and Aranyayatri Wildlife Foundation. Authors are thankful to Mr. Bhimsenpatil Dongarwar for their valuable support during study period.

References


Successful One year completion of Small Mammals Hiking Programme in Kathmandu, Nepal
Sabina Koirala

Small Mammals Conservation and Research Foundation (SMCRF) has been conducting “Small mammals Hiking” since June 15, 2013 in Kathmandu valley regularly on every second Saturday of each month. The main aim of this hiking programme is to motivate students of natural science (zoology, environment science, botany, forestry etc.) of different universities to take up research and promote conservation of small mammals as well as to make local people and other nature lovers aware of small mammals along with larger mammals of their areas.

The visited area will be monitored for long time period and we hope that collected data helps for the habitat modeling of small mammals in future. This is our first effort to organize such a program in Nepal. Most of our hiking is being lead by Hem Bahadur Katiwal and Dipendra Adhikari, SMCRF.

During hiking, we follow roads and trails slowly and visually and encounter mammals and signs like burrow, fecal matter and footprints. During hiking, small mammals like martens, squirrels, civets, bats, different species of rodents and burrows of pangolin have been recorded. White-bellied Squirrel, Orange-bellied Himalayan Squirrel, Barking Deer and Rhesus Macaque are frequently seen mammals during our hiking.

Participants not only enjoy only mammalian fauna, but also birds, butterflies and simply nature watching.

In this one year, we have successfully completed 11 hiking events in eight different places like Bajrabarahi Forest, Suryabinayak Community Forest, parts of Nagrjun-Shivapuri National Park, Machhegaun Community Forest, Chobar-Bagmati Corridor etc. where more than one hundred nature lovers and students have participated.

Hiking programme of SMCRF is of special interest for university students of natural science related to wildlife specially students of zoology, forestry and environmental science.

On behalf of whole SMCRF family, I would like to thank all the participants for their participation in the hiking and also anticipate their help for coming days for the conservation of least studied mammalian fauna, the Small Mammals of Nepal.

Fresh burrow of pangolin seen during the hiking

Hikers during Eighth “Small Mammals Hiking” in Nagarjun forest of Shivapuri Nagarjun National Park - White-bellied Squirrel seen during the Hike

Fresh burrow of pangolin seen during the hiking

On behalf of whole SMCRF family, I would like to thank all the participants for their participation in the hiking and also anticipate their help for coming days for the conservation of least studied mammalian fauna, the Small Mammals of Nepal.

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Unexpected death of Indian Flying Foxes *Pteropus giganteus* in Jahangirnagar University campus, Savar, Bangladesh

Tahsinur Rahman Shihan*†

Jahangirnagar University campus has an area of 700 acres which harbour a variety of plants and wildlife. This campus is situated 30 km away from Dhaka city. Important bat species recorded from the campus are the Greater Short-nosed Fruit Bat (*Cynopterus sphinx*), Indian Flying Fox (*Pteropus giganteus*), Indian Pipistrelle (*Pipistrellus coromandra*), Asiatic Greater Yellow House Bat (*Scotophilus heathii*) and Asiatic Lesser Yellow House Bat (*Scotophilus kuhlii*) (Akter et al., 2013).

It is very unexpected that every year a number of fruit bats die due to electrocution. Mainly Indian Flying Foxes die due to their large size when they try to cross the unfolding high voltage electric supplier wires. An opportunistic survey done between 10 February 2014 to 03 May 2014 showed that during the study period a total of 14 dead flying foxes were recorded in eight different locations within the campus.

In the campus two types of electric supplier wires are used; one is 4 mm in diameter and another is 8 mm in diameter. Most of the cases the Flying foxes were found dead in the 4 mm wire. The six parallel wires each are 12 inches far from another settled 25 feet higher from the ground.

Replacement of the old unfolding 4mm electric wires by folding 8mm wire may reduce the fatality.

Reference

Akter, S., F. Rahman and M.A. Aziz (2013). Investigating the least known small mammals of Jahangirnagar University campus, Bangladesh. Small Mammal Mail – Annual Newsletter of CCINSA & RISCINSA 3 Volume 5, Number 1, June 2013.

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The distribution of Malabar Spiny Tree Mouse, *Platacanthomys lasiurus* is restricted to the southern part of Western Ghats of India and classified as Vulnerable as per the IUCN Red List (Molur and Nameer 2008). The type locality *P. lasiurus* is Bonacord, Thiruvananthapuram (Blanford, 1888). The species have been reported Bonacord area, Peppara Wildlife Sanctuary - Trivandrum District, Kerala, Upper Bhavani hills of the Nilgiris, Kariyanshola of Indira Gandhi Wildlife Sanctuary, Kalakkad Mundanthurai Tiger Reserve - Tamil Nadu and Shimoga in Karnataka (reviewed in Jayson and Jayahari 2009). A detailed study of this endemic mammal has been done by (Jayson 1996, Jayson and Jayahari 2009) and brought out the status and distribution of *P. lasiurus* in Kerala.

The present note is to report the occurrence of the *P. lasiurus* from Nilgiri Biosphere Reserve, Nadukani, Vazhikkadavu Range, Kerala confirmed with a specimen by road kill (11°26’13.25, 76°2’42.81). The specimen (Figure 1) was collected on 19.11.2009 as a part of study to evaluate road kills, conducted in 11 km road cruising through evergreen forests through State Highway 213, (Calicut-Nadukani-Gudalur Road) connecting Kerala & Tamil Nadu states. The area comprises of evergreen forest of Western Ghats. The present note confirms the indirect evidence reported by Jayson and Jayahari (2009). The habitat associations were also same as reported by Mudappa et al. (2009) with lianas and adjacent to rivulets as described by Jayson and Jayahari (2009).

Highways cause the fragmentation of the habitat which demonstrates the need for wildlife crossings over or underneath paths. This observation also substantiates the scarce information on fauna of this region and warrants further actions to prevent the road kills particularly at the Ghats roads in Western Ghats, which can influence conservation priorities. It is envisaged that to create awareness towards the drivers, and the need for constructing wildlife crossings, which could play a crucial role in protecting the fauna.

**References**


**Fig 1. Road kill of Platacanthomys lasiurus**
The Record of Elegant Water Shrew *Nectogale elegans* from Gaurishankar Conservation area, Nepal
Sagar Dahal¹-², Kaustuv Raj Neupane¹-² and Giovanni Amori³

Abstract

*Nectogale elegans*, the elegant water shrew also known as webbed foot water shrew was trapped at the waters of Tamakoshi in Dolakha. Snaring loops was set for fishing where this species was trapped which gives the account for its ecological characteristics. A dead specimen of *Nectogale elegans* was found on 1 November 2010 at Lamabagar, Dolakha in the fast flowing river of Tamakoshi. Lamabagar is at the height of 1945m. It was trapped in the snaring loops kept for fishing in the night.

Introduction

*Nectogale elegans* is a monotypic species found in the Oriental region of the world (Tate 1947). The Elegant Water Shrew is also found in the Himalayas and southeast Tibet, hence one of its other names, the Tibetan Water Shrew. (Corbet & Hill 1980). The elegant water shrew is distributed in China, India, Myanmar and Nepal (IUCN Red List). It is a terrestrial mammal inhabits in temperate forest, wetlands, permanent river streams, creeks fast flowing cold water rivers. Leaf litter acts as the niche and habitat distribution ranges from 900 to 2270m (Molur et al. 2005). This feeds on aquatic insects and small fish (Jnawali et al. 2011). A specimen of *Nectogale elegans* was trapped before by Karan Bahadur Shah (personal communication) and Mukesh Kumar Chalise (personal communication). It has been recorded in Sagarmatha National Park, Makalu-Barun National Park, Annapurna Conservation Area and Rara National Park (Suwal et al. 1995). A possible occurrence of this species was mentioned in Gaurishankar Conservation Area (Basnet G. et al. 2009) which is now confirmed. The global status of this species is Least Concern, whereas in Nepal its status is Data Deficient (Jnawali et al 2011). The South Asian status of this species is Near Threatened (Molur et al. 2005). CAMP report has estimated the decline in the qualitative and quantitative of habitat status by >10% in this 10 years due to human induced habitat alteration (Molur et al. 2005).

Recorded Area

Gaurishankar Conservation Area is located between 85° 46.8’ to 86° 34.8’ E and 27° 34.2’ to 28° 10’ N. It is situated between Langtang National Park and Sagarmatha National Park. Physiographic zones ranges from mid hills to high mountains. The altitudinal range varies from 968m. to 7,181m. The total area is 2,179 sq. km. which includes 6 v.d.c.s in Sindupalchowk district, 14 v.d.c.s in Dolakha district, and 2 v.d.c.s in Ramechaap. The major

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land cover types includes forest 34.98%, barren land 34.78%, bushes 9.5%, arable land 8.76% and grassland 8.6%. Water bodies in the form of rivers, streams and lakes also form significant habitats for many aquatic and semi aquatic fauna of the area. The main river systems are Tamakoshi, Bhotekoshi, Sunkoshi, Khimti khola, Likhu khola and several of their tributaries. Tso Rolpa, Dudh Pokhari, Panch Pokhari and Kal Pokhari in Dolakha district, Bhairab Kunda of Sindhupalchowk district, and Baula Pokhari of Ramechhap district are some of the significant lentic water bodies of the area.

Biological diversity
There are 16 forest types including subtropical to alpine. Five hundred and sixty five species of flora is recorded from the GCA, with 34 species of mammals, 9 species of amphibians, 22 species of reptiles which includes Jerdon’s pit viper, 16 species of fishes and 236 species of birds representing 36 bird families. Eight species are protected by the National Park Wildlife Conservation Act 2009 which includes 2 bird species, 19 species are listed in CITES appendices, 9 species are listed in IUCN Red List, 21 species are listed in National Red Data Book (Basnet G. et. al.).

Vegetation
Out of total 35 forest types as indentified by Stainton (1972), the region has sixteen forest types. The main forest types found in the region are Chirpine forest, Schima castanopsis forest, Alnus forest, Pinus patula forest, Pinus wallichiana forest, Rhododendron forest, Quercus lanata forest, lower temperate oak forest (Quercus semicarpifolia forest), Lower temperate mixed broad leaved forest, Abies forest, Upper temperate mixed forest (birch Rhododendron forest), Temperate mountain oak forest, East Himalayan oak forest, Juniperous Forest, Shrubland (Rhododendron anthopogon bushes), and moist alpine scrubs. (Basnet et. al.)

Result
A dead specimen of Necogale elegans was found on 1 November 2010 at GPS location of N 27° 54.209" E 86° 12.237" Lamabagar, Dolakha in the fast flowing river of Tamakoshi. Lamabagar is at the height of 1945m. It was trapped in the snaring loops kept for fishing in the night.

Morphometric measurement of the species are:
Head & body: 12.1 cm
Tail: 10.2cm
Head: 1.8cm
Hindlimb: 2.3cm
Forelimb: 1.2cm
Femur: 1.7cm
Whisker: many
Mouth: On ventral side
Skin colour: dorsal side: Greyish black
Ventral side: grey ash colored
Sex: Female

Hindlimbs were larger than forelimbs and web like structure was well developed for swimming (Fig. 1). The tail was hairy with fin like structure (Fig. 3). The main food of the species is small fish, planktons found in the water.

References
Small mammal awareness programme for local communities in Tamil Nadu - a report
Brawin Kumar*

In South Asia 17.3% of Rodentia are threatened with the risk of extinction as per IUCN Red List (www.iucnredlist.org). Rodents play a major role in the food chain (Sahoo and Bhattacharjee, 2012) and seed dispersal across vast distances is one of their major roles in the ecosystems (Janson et al., 2012). The importance of conserving rodents is not an easy concept to promote in developing countries (Alpin et al., 2003). Of the total mammal species in India, 64.77% are small mammals, many of them are less studied and under no protection (Kumar, 2014). There seem to be many on-going threats to the various small mammals in India, but the major threat may be the use of these animals by tribal and non-tribal communities as traditional medicine (Solavan et al., 2004; Padmanabhan and Sujana, 2008; Mahawar and Jaroli, 2008; Kumar and Iyer 2013). Based on a basic literature survey it can be said that mammals such as Indian Flying Fox, Indian Hare, hedgehogs, pangolins, five-striped palm squirrels and flying squirrels are being used. There is a need to fill the gap in conservation awareness of small mammals and to have a dialogue with the tribal communities, as they are the primary stakeholders.

To address this gap in small mammal conservation, various field-based small mammal outreach programmes were conducted in Tamil Nadu, between November 2013 - May 2014. The goal of this programme is to create awareness for youth belonging to tribal communities about the various amazing small mammal species in India, particularly in Western Ghats and Eastern Ghats; work towards an attitude change in the communities and ensure sustainable utilization of resources. Also, this initiative is a small contribution to the Convention on Biological Diversity AICHI Target 1: By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use them sustainably.

The first phase of the programme has been initiated by imparting information about the small mammal populations, their distribution, ecological significance and threats to the target audiences. The second phase will include developing small mammal conservation clubs at school level and build capacity of the youth. The final phase of the programme will be to identify

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site champions to conserve small mammals.

The first phase has already been kick-started with 12 programmes across seven districts of Tamil Nadu. Relevant methods such as classroom as well as outdoor activities using various field-based active learning tools were used during these programmes.

**Community level small mammal awareness programme**

1. **ACT India Foundation - Kodaikanal**

A half-day session about bats and hedgehogs was conducted in ACT India Foundation in Pannaikadu, Kodaikanal on 17th November 2013. Totally, 35 Paliyar tribal kids participated in this awareness programme. General information about bats, their types, and common bats in their region, bat behaviour and threats were explained using Zoo Outreach bat education packets. A group activity of ‘bat echolocation’ was conducted with children to learn about communication of bats. Bat posters were used to explain about the distribution, amazing facts and differences between the megachiropteran and microchiropteran bats. A colouring activity was conducted with the kids and various threats to flying bats were explained. A pledge was taken by the children to protect the bats in their region. Photos of all three hedgehogs were showed and details were provided for the Madras Hedgehog (*Paraechinus nudiventris*). The students were not aware of the hedgehogs and many of them thought it to be a porcupine. Students asked questions about the various small mammals like squirrels and shrews. The kids shared information about the use of small mammals in traditional medicine.

**School level small mammal awareness programme**

1. **Small mammal awareness programmes**

A half day small mammal conservation awareness programme was conducted in Avvai Ashram, foothills of Kalakad Mundanthurai Tiger Reserve, Tirunelveli on 13th January 2014 for school students (14-18 age) and teachers. Attitude assessment, bat video session and group discussion were organized on bats and hedgehog. Photos of small mammal were shown to the participants and they responded enthusiastically by mentioning the local names. Bat facts and information on conservation of the flying fox was also provided. Data on giant squirrel species and their respective distribution ranges was shared with the youngsters. The students enjoyed using the Zoo Outreach bat education kit and learned about bat ecology, behaviour and protection with a lot of zest. The seriousness was broken by the audiovisual titled, “Meet the World’s Largest Flying Fox” which the participants enjoyed. The bat placard and
posters proved to be a very useful tool to teach the concepts in a short time. The youngsters made creative illustrations of bats and rats based on the posters and banners. All the drawings were put up for display and all of them got prizes. A final assessment to understand the recall value of the participants was conducted by asking five relevant questions relating to the content of the programme. Most of them were able to recall the information regarding flying fox and rodent distribution and numbers. The children assured that they would protect the bat roost in their campus and help them to survive.

2. Bat photo exhibition
A half-day bat photo exhibition was conducted for the students and staff of the Ayikudy Amar Seva Sangam, Tenkasi on 23rd February 2014. Dr. G.S. Vijaya Lakshmi (Department of Environmental Sciences, Sri Paramakalyani Centre for Environmental Studies, M.S. University) inaugurated the bat exhibition hall. The micro and megachiropteran bat photos were displayed. All the students from this school visited and learnt about various bats. Bats’ importance in relation to agriculture was explained and various posters were used. Bat facts were explained using bat puppet. The attractive Painted Bat (*Kerivoula picta*) intrigued the audience and many of them wanted to know more about this colourful member.

3. Bats and hedgehogs outreach programme
A half-day session on bats and hedgehogs was conducted on 21st March 2014 in Kasturiba middle school in Chennimalai in Erode District. The programme was conducted to commemorate the World Forest Day celebrations. Information and facts about the Indian Flying Fox and the Madras Hedgehog were provided to the children orally and an audiovisual on the giant flying foxes of Andaman Islands was played. Two posters referring to bats’ role in pollination and one on common bats around us were used to educate the students. Bat education packets were used to explain bat biology, behaviour, locomotion, types, differences between mega and microchiropteran bats and ecological significance. Totally 60 students participated in the session. The school students had been exposed to handling and sighting the prickly-pokey hedgehogs. To further enhance their knowledge on hedgehogs, a wide range of information such as types, ecological significance was shared with the students.

4. Small mammal conservation education programme
A half-day program on small mammal awareness was conducted on 30th April 2014 in a government school in Katteripatti in Kadayam, Tirunelveli District. Totally 29 school students participated. The program started with an attitude assessment activity in the school ground, followed by a group discussion on the various common small mammals around them. Common facts about the common Indian hare and Pangolin were explained. Puzzle game focussing on small mammals were played with the children. Photographs of bats were showed and bat facts, bat behavior, importance were explained using Zoo Outreach bat education packets. Bat posters were also displayed. Students took a pledge to protect the bats in their village and also the kids tied rakhi to each other. An final assessment was carried out with the question and answer session. The programme concluded with a video on the World’s Largest Flying Fox.

5. Berijam lake – Kodaikanal – bat session with school children
A one-hour outdoor session on bat was conducted on 18th May 2014 in Berijam Lake in Kodaikanal. A total of 60 school children from all over Tamil Nadu participated in this programme. An introduction about bats, their ecological importance and types were explained and the student’s role to protect the amazing creature was explained through games. These active learning tools proved to be very effective in getting the message across to these school children and this ensured their complete involvement in the programme.
Student took pledge to save the bats from threats. Onlookers were also engrossed in the programme and shared feedback after the programme.

**Village level bat education programme**

1. **Nanalkulam village – bat conservation outreach programme**

A one day bat conservation outreach programme was conducted in Nanalkulam village at foothills of Kalakad Mundanthurai Tiger Reserve (KMTR), Tirunelveli on 07th April 2014 in collaboration with Agastyamalai field-based community conservation centre of Ashoka Trust for Research on Ecology and Environment. Totally 13 young kids from Nanalkulam village participated in this bat programme. The programme started with a video introducing "extinction" with suitable examples. Attitude assessment was carried outside the community hall. Information on the common small mammals of KMTR was explained and the photos of common bats in this region were showcased. Zoo Outreach bat education materials such as posters and booklets were used to explain the bat facts, distribution, World’s largest and smallest bat, locomotion, ecological importance and temple bats and threats. A group discussion was also conducted with the participants; team leaders from each group came forward and discussed the bat facts that had been explained in the programme. A coloring activity was conducted focusing on bats with the children. All of them actively participated in this activity. The drawings provided for the coloring activity had information on pollination, insect eating bats, temple bats and their conservation significance. A small bat photo exhibition was set up inside the hall. This was the first programme on bats in that village with the youngsters. These kids are the bat protectors of this village. Pledge was taken by these kids to conserve the bat roosts in their village temple. In future, these kids will be involved in bat count and monthly monitoring bat roosts in this taluk as part of ATREE’s ongoing temple bat conservation project.

2. **Thenur village – bat awareness and education programme**

One-day bat awareness and education programme was conducted in Thenur village in Trichirapalli District, Tamil Nadu on 15th May 2014 in collaboration with Payir Trust. Youngsters from near by villages also participated. The programme was introduced using bat puzzles and the details about the common flying foxes were provided. Facts about Western Ghats and endemic bats were discussed. Importance of bats was explained and the role of bat guano in agriculture was also mentioned. This was followed by a session with the Zoo Outreach posters and booklets. The participants were divided into five groups and given ten minutes to discuss within themselves about bats. The team leader from each group came forward to present what they learnt about bats. A group bat colouring activity was conducted. A pledge was taken to save the bats from threats. Colourful bat photos were displayed inside the hall. All the youngsters were happy to understand more and interested to join in the bat monitoring walk conducted by Payir Trust in the near future.

**Outreach programme for College student**

**CSI Polytechnic college - small mammal awareness session**

A special programme for the World Forest Day was conducted in CSI Polytechnic college, Salem on 21st March 2014. This programme was organized by District Forest Office, Salem, Tamil Nadu. A talk about threatened small mammals was delivered. A total of 120 students from the college participated. An interactive session to convey information about the status, distribution and conservation importance of rats, shrews, tree mouse, hedgehogs and tree shrews was explained in the local language (Tamil) was conducted. The students participated with a lot of rigour.

**Programme for Organic farming community**

**Kaanagam – bats our friends**

A half-day programme on bat conservation was conducted in "Kaanagam group" in Kadavur, Karur District, Tamil Nadu on 25th May 2014. Totally 45 kids belonging to active organic farming families from all across Tamil Nadu participated. Programme started with a bat puzzle. Information on common bats, role of flying fox in agriculture, bat ecology, echolocation were explained. This was followed by a video about the world largest bat roosts. Also, the children learned the two major types of bats and their basic identification. Various active learning tools such as indoor and outdoor games, coloring and interactive discussions were used with these kids. The programme concluded with the students
taking a pledge to protect the bats. Six interested kids were identified who may be suitable volunteers for the citizen science project called pterocount bat-monitoring programme.

Radio Programmes
1. All India Radio (AIR)
The International Union for Conservation of Nature and Nature resources (IUCN), calls for conservation of all threatened flora and fauna and fungi. And to achieve this objective it is imperative to take the message of conservation to the common person. A radio programme on threatened rodents and insectivores was recorded on 09th February 2014 in All India Radio (AIR), Tirunelveli, Tamil Nadu to serve this purpose. Basic information and facts on rodents and insectivores, threats, their conservation significance and role of youth in conservation were discussed in the recording.

2. Key Stone Community Radio
A radio interview at Keystone Community Radio in Kotagiri about hedgehogs and bats was given on 9th March 2014. Facts and interesting information about bats, rats and hedgehogs were shared with local communities in the Nilgiris.

All these programmes have helped in laying the foundation to share information on small mammals and help communities change their attitude towards these gentle less-glamorous creatures. These programmes will be followed up to work on the second phase of the programme of setting up small mammal conservation clubs and youth forums for the tribal communities. Research is very important but taking the scientific information to the common man in a lucid language is imperative to ensure conservation implementation involving various stakeholders on ground.

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I thank Zoo Outreach Organization and Wildlife Information and Liaison Development for the bat education materials, posters and greeting cards. I wish to thank Ms. Sally Walker and Dr. Sanjay Molur for their constant encouragement and support. I thank Dr. B.A. Daniel and Mr. Marimuthu for their enormous comments and active support to conduct the program in various areas. I thank ACT India Foundation, Vanavil Tribal Foster House, Kodaikanal; Avvai Ashram, Sivasaliam; Amar Seva Sangam, Ayikudy; Sussee auto, Tirunelveli; Tamil Nadu Science Forum, Erode District; ATREE – Agasthiyamalai Field Based Community Conservation Center, Singampatti, Tirunelveli; Government middle school, Katteripatti, Kadayam; Arulagam, Coimbatore; Payir Nursery and Primary School, Thenur, Perambalur District; District Forest Office, Salem; Tamil Nadu Ariviyal Mandram; Kaanagam, Kadavur, Trichy; I would like to thank All India Radio (AIR), Tirunelveli and Key Stone Community Radio, Kotagiri, Tamil Nadu. Such conservation outreach programs would not be possible without the active participants who are the torchbearers and on ground stakeholders impacting conservation of small mammals!

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Chiroptera Research Techniques and Conservation in Bangladesh - Report
Nurul Islam

Group for Conservation & Research of Bats, One Health Young Voice Bangladesh (OHYVB)

On 23-25 January, 2014 Chittagong Veterinary and Animal Sciences University (CVASU) hosted the second workshop on bat research techniques and conservation in Bangladesh at the University itself initiated by the Group for Conservation & Research of Bats, One Health Young Voice Bangladesh (OHYVB) and CVASU, in collaboration with the Zoo Outreach Organization, Chiroptera Conservation & Information Network of South Asia (CCINSA) and the Conservation Breeding Specialist Group. Funding was generously provided by Bat Conservation International, Chester Zoo and the Food & Agricultural Organization (FAO) and CCINSA. Dr. Neil M. Furey from Fauna & Flora International (Cambodia) was key resource person for the workshop. A total of 25 participants and 5 volunteers with backgrounds in biological and environmental study were involved in the workshop.

Honorable Chief Guest Prof. Dr. A.S. Mahfuzul Bari delivers a most encouraging speech in the inaugural session of this unique and much wanted and needed workshop.

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Bats provide important ecological services worldwide and though they are among the most neglected mammals in Bangladesh, the country is home to at least 33 bat species. For instance, fruit bats play major roles in plant pollination, seed dispersal and forest regeneration, while insectivorous bats control harmful crop insects and serious disease vectors. Bats in Bangladesh made international news in 2001 when the first outbreak of Nipah virus occurred.

In other regions, bats are known to carry other zoonotic diseases such as Ebola, SARS, Hendra and MERS. Risks of bat-related disease outbreaks have increased due to habitat destruction and wildlife trade bringing bats into closer contact with human beings. To safeguard environmental and public health, increased research on bats is needed from ecological, conservation and medical standpoints.

To address this need, training of younger generations in multi-disciplinary approaches is required to stimulate greater interest and effort in bat research and conservation. A volunteer bat research group at Chittagong was created to this end and is dedicated to improving understanding and conservation of bats in Bangladesh.

As such, the purpose of the three-day workshop was to:

- Educate 25 science students on basic bat biology and their conservation importance
- Provide hands-on training in field research methods through field prakticals
- Review the status of bat research and identify key gaps and needs in Bangladesh
- Promote bat research and conservation in Bangladesh through future collaborations

Workshop Details

Opening Ceremony

The workshop was inaugurated on 22 January through a ceremony in CVASU by Prof. Dr. A.S. Mahfuzul Bari (CVASU Vice-Chancellor). Special guests attending the event included Prof. Dr. Md. K.I. Khan, Prof. Dr. A.K.M. Saifuddin, Prof. Dr. Md. A. Hoque, Prof. Dr. Md. A. Hossain, Prof. Dr. A.N.M. Rahman and Dr. B.C. Sutradhar, among others.

In addition to several speeches on the importance of bats, the new website for the Group for Conservation and Research of Bats, Bangladesh (www.gcrbbd.org) was launched.

It is hoped to develop the website over time so that it becomes a key resource for all bat researchers and enthusiasts in Bangladesh in future.

Workshop, Day 1

The first day of the workshop ran from 0900 to 1900 hrs and included class-room sessions and a field practical at the Bangladesh...
Agricultural Research Institute (BARI) in Chittagong. The morning session included a series of lectures and open discussions led by Dr. Furey and Md. Nurul Islam on basic taxonomy, natural history, reproduction, ecosystem services, conservation threats and the bat fauna of Bangladesh. The early afternoon session provided instruction on live trapping methods, bat handling, field safety, data collection & management, along-side gender, age and reproductive diagnoses.

Following the early afternoon session, the participants went to BARI to undertake the field practical. During the practical, Dr. Furey demonstrated methods of setting up and handling mist nets in the field. Two nets were erected by the participants in locations thought suitable for capturing bats, and as darkness fell, two ultrasound (bat) detectors were used to demonstrate acoustic sampling methods. Three fruit bats (Pteropodidae) were caught in the mist nets, two of which were Cynopterus sphinx, and one appearing to be Megaerops niphanae. If confirmed, it would constitute a new country record for Bangladesh. Bat handling generated great interest also attended by the CVASU vice-chancellor.

Workshop, Day 2
The second day of the workshop ran from 0800 to 1830 hrs and similarly comprised classroom sessions and a field practical. Topics dealt with during the morning session included lectures on bat species identification, specimen collection and methods for determining species habitat preferences (via eco-morphology) and dietary composition. During the early afternoon session, instruction was given on population census and monitoring methods for flying foxes, as well as bat diseases in Bangladesh. Practical methods for preventing Nipah encephalitis were included in the latter.

Following the early afternoon session, the participants visited a permanent colony of Indian flying fox (Pteropus giganteus) in Chittagong city. The participants were divided into five equal-sized groups (5 members each), and using standardized survey protocols provided earlier on, were given the
task of undertaking: a) a colony description, b) a direct roost count, and, c) an evening dispersal count. A single flying fox was also briefly captured by the field assistants for a short handling demonstration and released unharmed afterwards.

**Workshop, Day 3**
The last day of the workshop ran from 0900 to 1800 hrs and proved especially busy with a recap session on the field practical of the previous day, a series of theoretical lectures, practical demonstrations, course evaluations and a closing session.

A presentation was provided by Dr. S.K. Shil on bat skeletal features and several lectures were given on bioacoustics including: functional basis and taxonomic patterns of bat echolocation, field equipment and recording methods, strengths and weaknesses of acoustic sampling, and finally echolocation call scaling, variation, measurement and description. Various models of bat detectors were also demonstrated.

Following course evaluations by participants, the closing session began at 1700 hrs. This was attended by Dr. M. Yamage (FAO representative), Prof. Dr. F. Ahsan from Chittagong University and Prof. Dr. P. K. Biswas, all of whom gave excellent talks which included a vote of thanks to the event organizers. Participant certificates were distributed by Dr. Furey during the session, as were two copies of “Ecological and Behavioral Methods for the Study of Bats” (given to the CVASU Central Library and Green Explore Society), after which a wrap-up presentation of the workshop was given.
Workshop Evaluation
Towards the end of day 3 of the workshop, a simple questionnaire was provided to the 25 participants to solicit their opinions and evaluation of the training program.

Asked whether they found the event useful, 55% said that they found the training “extremely useful”, 40.7% said they found it “really useful” and 3.7% said they found it “definitely useful”. None of the participants opted for the remaining two categories: “not useful” and “A little useful” (Figure 1). When asked if they thought they might like to work with bats in future, all said they would and indicated their areas of interest in descending order as: “Research” = 62.9%, “Conservation” = 18.5%, “Education” = 11.1% and “Other” (Disease studies) = 7.04% (Figure 2).

The following comments illustrate what participants liked most about the course:

“I liked the technical section of the course, especially the field research parts and where Dr. Furey described behavioral patterns of bats and field research techniques” (Animesh Ghose).

“It was really amazing experience to learn these relatively new concepts (for us) about bats. I especially liked the population monitoring and emergence counts of the fruit bats (Pteropus giganteus). I was also pleased with our exposure to real field conditions. We were really surprised to see the differences in emergence counts between the different groups” (Rahul Talukdar).

“I especially liked the echolocation and mist netting techniques in BARI. It was really surprising to hear bat calls through the detectors. I also enjoyed the sessions on live-trapping and species identification” (Fakrul Islam).
When asked for suggestions for future courses, responses were:

"Almost all of us had no or only very basic knowledge on bat research and techniques. The workshop was only for 3 days and had a packed schedule. Though the course content was much as an hour. It would be better to have breaks after 30 to 40 minutes to help participants keep their concentration. And it would also be great if future workshops were longer, at least 7 days" (Ferdous Alom).

"It was good to learn and get practical experience from the field trip each day, but we now need to use what we have learnt. Sophisticated equipment like bat detectors and even simple things like mist nets are not available in Bangladesh. We need to develop our resources so that we can apply our new knowledge. We can also pass it onto others that couldn’t participate in the workshop" (Rubyath Binth Hasan).

"The workshop venue was in a busy metropolitan area and I was really interested to learn about bat echolocation. But due to time constraints I didn’t have many opportunities to use the bat detectors. It would be great if field trips focusing on echolocation could be included after the training on call measurement. Also the software was not installed on participant laptops so we missed some exciting opportunities!” (Tawhid Hossain).

From the organizers point of view:

"It was a lot of work to manage all of the daily tasks associated with 25 participants. Some topics were not covered and some had to be dealt with rather quickly due to time constraints. It would be worth expanding this type of workshop to at least 10 days.” (Nurul Islam).

Recommendations

Capacity building for bat taxonomy
Knowledge of the Bangladeshi bat fauna remains in its infancy. The current checklist of species for the country is incomplete and due to training and resource limitations, the taxonomic capacity needed to identify bat species does not yet exist. As correct species identifications are fundamental to effective research & conservation efforts, we recommend:

Organization of a ten-day workshop to build taxonomic capacity in Bangladesh.
Development of a bat voucher specimen collection at Anatomy Museum of Chittagong Veterinary and Animal Sciences University to facilitate training and research.

Resources & Networking
GRCB aims to develop resources in Chittagong for bat enthusiasts throughout Bangladesh. Though these are still very limited, students and researchers can borrow materials free (only domestic shipping costs will apply) for the duration of their projects. GCRB should explore ways to develop its available resource in terms of equipment and literature. The GCRB website (www.gcrbbd.org) should be actively developed to stimulate and maintain interactions between all interested parties. All participants and bat enthusiasts should also be urged to become a member of CCINSA of the Zoo Outreach Organization.

Funding Opportunities
Securing funding is the major challenge to develop bat research and conservation initiatives in Bangladesh. Nonetheless, participants are recommended to do all they can to explore potential funding sources. The GCRB website should also maintain a database of potential donors interested in supporting research and conservation of bats.

Bats & Diseases
Nipah virus is an important and widespread issue in Bangladesh. All bat researchers are recommended to adopt Personal Protective Equipment (PPE) protocols (provided during the workshop) when undertaking field studies.

The report has been prepared by
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Evaluation results

Figure 1: Participant evaluation on the usefulness of the workshop

Figure 2: Participant responses on their future career interests relating to bats

Participants with the trainer and guest in a frame!
Training Workshop on Building National Capacity in Research and Monitoring of Small Mammals, Nepal
Report by SMCRF

Background
Small mammals are widely distributed in high density compared to large mammals but their ecological study is more difficult. Nepal has 200 years of history of scientific study of small mammals but in spite of that there is long intervals including several decades and almost all studies were limited temporally and spatially. Neither natives nor government ever took the study of small mammals seriously. 48.1% of small mammals of Nepal are under the category of Data Deficient, 8.9% are Endangered and 43% are Least Concern (Jnawali et al. 2011). Small mammals are often the indicators of healthy ecosystems, means of seed dispersals, pollination, prey base for variety of reptiles, raptors and small carnivores. Small mammals including small carnivores are one of the least known mammalian group of Nepal. There are few small mammals enthusiasts and even fewer experts in the country. This training with the help of experts covered introduction to small mammals, tools used in their study, their research design and data analysis methods. The experts maintained and trained with the highest ethical value of handling these tiny species in the field. Thus, this training was certainly a step towards capacity building in research and monitoring of small mammals. After the training, we expect the participants to be able to design research, undertake field survey using available advance technologies, data analysis and write scientific papers.

The proposed work on “Training Workshop on Building National Capacity in Research and Monitoring of Small Mammals” is a part of Hariyo Ban’s IR 1 Activity Reducing threat to the focal species.

Objectives
The main objective of the training was to capacitate field biologists on small mammal research and survey in the country.

Methodology
The training was based on lectures and field practicals from the experts. Training sessions also encouraged discussion on the lectures and field practicals. The training lasted for 7 nights and 8 days.

Small Mammals Conservation and Research Foundation, Balkhu, Kathmandu, Nepal. Email: sanjan@smcrf.org
Selection of the Participants
Twelve graduate level students from ecology, environment science, forestry, sociology and zoology were selected on the merit basis. Participants were interviewed by the selection committee before selecting them. Among twelve participants one each from chepang, rai, magar and gurung community, two participants from newar community and six participants from brahmin community.

Lectures and Practical
Different experts of small mammals were invited to present the lectures. They were also involved in the practical session for field techniques study of small mammals. Wildlife and ecological study is a multidimensional subject. To carry out a successful wildlife study one must have sound health, ability to work in a group, good interpersonal skill, ability to tackle the emergency situation, field techniques skill, knowledge of data analysis tool, ability to use GIS, photography skills, knowledge of scientific paper writing process. All these topics were covered in the training workshop through various experts.

Summary
A seven days Training Workshop on Building National Capacity in Research and Monitoring of Small Mammals was conducted at the premises of Biodiversity Conservation Center, National Trust for Nature Conservation, Sauraha, Chitwan. Small Mammals Conservation and Research Foundation organized this training with the support of WWF/Hariyo Ban Program with its partner organizations (USAID, WWF, CARE, FECOFUN and NTNC), Chester Zoo and Zoo Outreach Organization. Twelve participants were chosen for the training from different institutions viz. Central Department of Zoology, TU, Institute of Forestry, Hetauda and Pokhara, T.U., Kathmandu Forestry College, Kathmandu, Khwopa College, TU and Central Department of Botany, TU.

Training included the theoretical classes followed by practicals in the buffer zone of Chitwan National Park. Trainees were introduced with the general concept of small mammal’s species of Nepal which included bats, rodents, shrews, small cats, small carnivores, pangolins and red panda and their practical research techniques. Trainees were also made familiar with GIS technology, First aid methods during the field wildlife photography and data analysis using open software R.

The training practical included the bat survey using mist nets and bat detectors. Trainees were shown the methods to handle the bats in the field and take necessary morphometric measurement needed for the identification of bats. Tube traps were used to study the rodents and shrews. Traps kept in the

![Greater Asiatic Yellow Bat, Scotophilus heathii demonstrated to the participants (Photo ©SMCRF)](image)

![Demonstration of installing method of camera traps to the participants at the BCC, Sauraha (Photo ©SMCRF)](image)
evening were checked early in the next day morning. Captured rodents and shrews were handled in the field and morphometric measurements and weight were taken. No animals were harmed. They were identified and released at the trapping sites. Camera traps were used to record the nocturnal animals, like cats, civets etc. The traps were set in the evening and checked early in the morning just before the lecture class sessions.

Training workshop was followed by seven days bat survey of Deukhuri valley in Dang. The survey focused on diversity and distribution of bat species, their habitat mapping and impact of climate change on bat population. Nine species of bats namely *Hipposideros armiger*, *Rousettus leschenaultii*, *Megaderma lyra*, *Scotophilus heathii*, *Cynopterus sphinx*, *Pteropus giganteus*, *Pipistrellus* sp., *Rhinolophus* sp., *Nyctalus* sp. were recorded from different sites of Deukhuri valley of Dang district. More than 50% survey respondents stated the decreasing pattern of bat population in Dekhuri valley due to habitat loss, deforestation and hunting. In addition to that more than 50% of respondent felt the intensity of rainfall is increasing with hail stone and the earlier maturation of flowering plants.

**Outcome of the Training**

The training workshop enhanced the knowledge on handling and research of trainee on small mammals. The training developed the basic working knowledge on concept, size, distribution and weight of small mammals. Trainee gained basic working knowledge on taxonomy of small mammals, small mammals handling equipments, GIS, field research experience, research design concept, wildlife photography methods, data analysis techniques. The training also formed a platform to bring the experts of different wildlife field in one place and created an environment to disseminate the.
collective knowledge on research and conservation of small mammals to the trainees. University professor, medical practitioner, bureaucrats, wildlife managers, wildlife scientist, photo journalist, data analyst, GIS expert were the training faculty whereas the students of forestry, zoology, botany and environment science were the trainees which created a very academic environment for the success of the training.

**Course Evaluation**

Training evaluation test were conducted to know the success of the training. Trainees were asked to fill the pre and post assessment forms regarding the training workshop, different aspects of small mammals and the usefulness of the training to them. Feedback of trainees on the training quality, topics of the training and management were also collected.

**Reflection from the Participants**

Participants were highly motivated to work in the sector of small mammals of Nepal. The syllabus of the training was highly praised for its overall approach on the research of small mammals. However, participants wanted a bit more sessions on data analysis and GIS techniques for presentation of the research. Participants and trainers praised the overall management of the logistics and preparation of the training. Video sessions, precaution on biohazard sessions, wildlife crime sessions, were added on the proposed training syllabus.

Insect Pest Management by Horseshoe Bats of Kalakad Mundanthurai Tiger Reserve, Tamil Nadu
Selva Ponmalar, S. and Juliet Vanitharani

Abstract
Being the only flying mammal, bats are capable of sustained flight and are the most gregarious and successful group of beneficial animals to the ecosystem and have lured the attention of ethologists. Kalakad Mundanthurai Tiger Reserve (KMTR), which is the home for many endemic, rare and threatened species of plants and animals, is selected as the study area. Insect pests, being the most destructive agents affecting forest and shade trees are by far the most numerous animal lives inhabiting the forest. As the primary predators of nocturnal insects, the species of Rhinolophus genus help to control insect pest populations throughout its geographic range. The studies on faecal pellet analysis has proved their control over the lepidopteran, coleopteran, dipteran, hymenopteran, homopteran, orthopteran, hemipteran trichopteran and neuropteran group of insect pests that infects the forest trees of KMTR. The valuable pest controlling service provided by the study species needs special protection through conservation measures.

Key words: KMTR, pests, predators, Rhinolophus pest controller.

Introduction
Kalakad Mundanthurai Tiger Reserve (KMTR), which is situated in the south Western Ghats of Tamil Nadu, India, is one among the 35 world biodiversity hotspots which is bound by different types of forests in west, north and south and by villages in the east. This is the only area of Western Ghats which has longest raining period. Insect pests are the most destructive agents that affect forest and shade trees (Grindal and Brigham 1999, Douce et al. 2002). They affect tree roots, stems, leaves of healthy or weakened trees, hardwoods etc. Insectivorous bats play a significant role of pest management in all forested ecosystems (Barclay 1985, Freeman 1979, Fenton 2003). Flight has enabled them to exploit a variety of foraging niches inaccessible to other mammals. Undoubtedly, they are the most gregarious and successful group of beneficial animals to the ecosystem.
Among the insectivorous bats, the species of the *Rhinolophus* are rich in number, play a crucial role thereby keeping the insect population under control. They forage and feed insects throughout its geographic range. They roost in large numbers in caves, underground tunnels and abandoned old buildings. These insectivorous bats have many morphological adaptations that allow them to capture and handle prey in flight. Their dietary adaptations are commonly reflected in the skull (feeding apparatus) and wing (flight apparatus) morphology. Teeth and skull are the morphological indicators with food and the relationship in dietary diversity (Neuweiler 2001). To suit their diet preference they show considerable diversity in wing morphology (Fenton 1992) and flight style (Neuweiler 1984). The present study focuses on the impact of rhinolophids as pest controllers in the forests of KMTR.

**Materials and methods**
The field work was conducted between May 2011 and December 2013 in KMTR (8.6833° N; 77.3167° E; Elevation range 40 – 1800 m). Initially, the study sites were surveyed to collect baseline data on bat species and abundance. The distribution of the study species was confirmed by erecting mist nets, setting canopy nets, harp nets and using hand-held nets. Photographic record of the mist netted bats was done for closer look on morphological features. Roost searches were carried out in abandoned buildings, rock crevices, cracks, tunnels, caves etc. The bats from roosting sites were collected using hand-held nets and mist nets to confirm identification. Measurements were taken following Bates and Harrison (1997). The bats were then released back in the place where they were caught.

Dietary habitat analysis of studied rhinolophids was done by faecal pellet analysis. Fresh faecal pellets were collected from the day roost by spreading polythene sheets once in a fortnight. Twenty
pellets were randomly selected and their dried weight (0.15gm) was taken to 0.01 gm accuracy by using digital balance (OHAUS-USA). The pellets were soaked in 70 percent alcohol and teased apart individually using fine needle under microscope. Then they were mounted in DPX on glass slides. Each slide was systematically searched for identifiable insect parts under binocular microscope (Olympus CH2Oi. Japan). Identifications were made with the help of authenticated literatures (Borror 1992) available on Indian insects. Identifications were made up to the order level following Nair (1989) and Borror (1992). Common insects collected from the foraging area helped in easy comparison of prey selection of the bat and the major pest prevailing in the study area. The percentage frequency of insect orders consumed and percentage volume of preferred insect orders by these horseshoe bats were calculated for the entire study period by using the following formulae (Kunz 1988).

\[
\text{Percentage Volume} = \frac{\text{Sum of individual volumes}}{\text{Total volume of the sample}} \times 100
\]

\[
\text{Percentage frequency} = \frac{\text{Number of occurrence of categories}}{\text{Total occurrence of all categories}} \times 100
\]

**Statistical analysis**

A significance test was done to find the food selection and food consumption rate among the rhinolophids of KMTR. Differences in consumed prey categories were assessed using ANOVA. Analyses were performed in SPSS 13 software.

**Results**

The present project has documented the variation in dietary preference and food consumption as well as their
correlation to flight and feeding niches of Horseshoe bats (*Rhinolophus indorouxii*, *Rhinolophus pusillus*, *Rhinolophus lepidus* and *Rhinolophus beddomei*) of KMTR. Morphological measurements and body weights of the studies species are available in a different publication by Selva Ponmalar and Vanitharani (2014). Plate 1 shows the variation in the wing and skull structural morphology of bat species to suit their dietary and foraging preference. The body parts, wing fragments and scales belonging to nine orders of insects were found to predominate the bat droppings examined. The faecal pellet analysis of the study species showed their hierarchy in the diet selection and consumption of major insect orders preference throughout the year. In all the four study species, the major dietary composition belongs to the order Lepidoptera, Coleoptera, Diptera and Hymenoptera which are the major orders that comprise the major insect pests of the forest ecosystem. The percentage frequency of insect consumption and the identified parts from their dietary items are represented in plates 2 a,b,c and d.

**Discussion**

Bats (Chiroptera), are the major contributors to mammalian biodiversity, comprising about 20% of mammalian species globally (Simmons 2005). In tropical ecosystems the insect eating bats fulfill key ecosystem services as control agents of arthropod populations (Kalka et al. 2008, Williams-Guillén et al. 2008). The present study is focused on the pest
suppression impact of identified horseshoe bats (Rhinolophus indorouxi, Rhinolophus pusillus, Rhinolophus lepidus and Rhinolophus beddomei) of KMTR. These bats were captured from foraging areas, roosting caves and tunnels at Sengaltheri, Kodayar, Mundanthurai and Servalar hills.

Dietary selection and consumption

Food consumption was not alike in all the studied horseshoe bats. The orders Lepidoptera, Coleoptera, Diptera and Hymenoptera were consumed by all the four Rhinolophus species. Neuropterans were preferred only by R. beddomei, Orthopterans were selected by only R. indorouxi, Hemipterans by R. pusillus and R. lepidus. Homopterans by R. indorouxi and R. beddomei, trichopterans by R. lepidus. The dietary preference of the studied rhinolophids shows that they prey predominantly on lepidopterans (23%). Sharifi and Hemmati (2001, 2004) also reported that lepidopterans were the most consumed and preferred prey item of Rhinolophus species. The larvae of many lepidopteran species are considered as major pests. By preying a single lepidopteran the bat really protect the vegetation from 200 to 600 caterpillars a female lepidopteran can produce.

The ranking of insect order consumed by these bats are Coleoptera (22%), Diptera (19%), Hymenoptera (12%) and Hemiptera (8%). Many coleopteran
beetles are hardwood pests and they infest the trees which cannot be even saved with insecticide treatments. Thereby, to limit beetle population, the predation by bats on these insects in the forest ecosystem is very beneficial. In addition, the studied rhinolophids also consume insects belong to the order Trichoptera (5%), Homoptera (5%), Orthoptera (4%) and Neuroptera (2%). Incidentally these groups of insects are also the pests that attack forest trees. The dietary preference, thereby confirms the impact of horseshoe bats as pest controllers in the forest ecosystem.

**Correlates of Flight and Skull Morphology in Insect Pest Management**

A suite of morphological factors influences foraging behaviour in insectivorous bats, including body mass and the size and shape of the skull, jaws and wings. Large bats with large jaws are capable of eating a wider range of prey sizes than small bats, resulting in a broader feeding niche. Differences in skull and dental morphology that correlate with dietary hardness are found among insectivores (Freeman 1979, Dumont 1999). To consume large size prey, the *Rhinolophus beddomei* are adapted with broader palate. This structure presumably made them to prefer hard food item like beetles, moth, caddish fly etc. The other study species *R.indorouxii*, *R.pusillus* and *R.lepidus* seem to have narrow palate as they feed on butterflies, bugs, wasps and small moths, the soft prey items. This type of feeding behaviour correlated to the dental and skull structures were confirmed by the earlier studies (Philips 1980, Advani 1981, Whitaker et al. 1996, Bates and Harrison 1997).

The large difference in physical properties (size, hardness, toughness) of food item demands adaptations in cranial morphology and the performance of the feeding apparatus (Freeman 1979, 1988, 1995). The assessment of physical properties of food items thus offer tremendous insights into the range of variation in cranial and mandibular adaptations, to suit food utilization patterns among insectivores (Strait 1993). *R.beddomei* has higher coronoid process allowing for the attachment of well developed jaw muscle which is essentially robust to counter the reaction forces while biting hard prey like beetles. This type of feeding behaviour in *R.beddomei* was strongly confirmed by Phillips (1980). Bogdanowlez et al. (1999) said that the well developed coronoid process allows increased leverage and accommodated large jaw muscle. Increase in the size of temporal muscle can allow an animal to resist the increased stress of struggling, crush hard shelled items and facilitate more extensive use of canines (Maynard Smith and Savage 1959, Bates and Harrison 1997, Sinha and Advani 1976, Whitaker et al. 1999, Advani 1980, 1981, 1982, Philips 1980). But the other studied rhinolophids exhibit lesser coronoid process with thinner jaws. These characteristics assume that these rhinolophids prefer soft food items like butterflies, grasshoppers, etc. Findings of Brosset 1962, Phillips 1980 and Jones et al. 1994 also confirmed the rhinolophid feed analysis results. Next to feeding apparatus the flight mechanism in bats are associated with partitioning of food resources among bats (Norberg and Rayner 1987). Bats with different wing designs, varied flight style and performance show considerable diversity in diet preference (Neuweiler 1984 and Fenton 1992). Body mass, wingspan and wing area are the primary measures of wing design. From these parameters, wing loading and aspect ratio are derived, which describe the size and shape of the wings respectively (Norberg and Rayner 1987). Interaction between aspect ratio, wing loading and wing tip shape index affect flight (Norberg and Rayner 1987, Neuweiler 1989, Habersetzer and Storch 1989, Rayner et al. 1989, Fenton 1990). Maneuverability and agility are the two factors that are strongly influenced by flight adaptation. These two factors explain the ability of bats to change the flight direction without loss of speed and with small turning radius.

Among the studied bat species, the *R. beddomei* has higher wing loading, lesser maneuverability and forage in open uncluttered habitat. *R.indorouxii* has wing loading lesser than *R.beddomei* and they forage in less cluttered habitat whereas the other two study species *R. lepidus* and *R. pusillus* have very lesser wing loading, greater maneuverability and they

**Megaderma spasma colony - tree hole**
exploit cluttered vegetation. They fly among foliage canopy catching insects among branches. Although Rhinolophidae has short wing tips, slow flight and low manoeuvrability they can fly with same hovering often within clutter (Barrett-Hamilton 1910 and Wallin 1969). The low wing loading and the short, cambered wings permit highly manoeuvrable flight and the slow light turns, which are essential for insect hawking near vegetation. These bats can also glean on resting insects. The wing morphology thereby assists these bats to do various flight performances to catch the detected prey by echolocation. After prey capture, the dental morphology aids the bats to consume them.

Conclusion
The dietary analysis and the morphological correlations of the rhinolophids of KMTR confirmed their role as a great pest manager. Bats being the vital member in the ecosystem functioning, and their potentials as indicator species, stressed their importance for sustainable forest management and biodiversity conservation. The bat conservation will not only keep a check on insect pest population but also replenish the forest ecosystem. These reviewed facts confirmed the importance and need for monitoring bat populations. Without scientific information and thorough documentation of their ecological values, it is difficult to convince the government to protect them through legislation.

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References


**SMALL MAMMAL NETWORKS**

**Chiroptera Conservation and Information Network of South Asia (CCINSA)**

CCINSA is a network of South Asian Chiroptera specialists, educators and enthusiasts. The network aims to enhance communication, cooperation and collaboration among chiroptera specialists of this region and thereby create a chiroptera conservation “community” for better biodiversity conservation.

Chair: Sripathi Kandula  
Convenor and Administrator: Sally Walker  
Red List and Technical Advisor: Sanjay Molur

**Rat, Insectivore, and Scandentia Conservation & Information Network of South Asia (RISCINSA)**

RISCINSA network of South Asia was suggested by interested biodiversity conservation specialists and the purpose of this network, then is to link together rodent field researchers and their field knowledge throughout South Asia (Afghanistan, Bangladesh, Bhutan, India, Nepal, Maldives, Pakistan and Sri Lanka) so the pooling of information can lead to conservation action.

Scientific Chair: Sujit Chakraborty  
Convenor and Administrator: Sally Walker  
Red List and Technical Advisor: Sanjay Molur

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**Small Mammal Mail**

SMM is a web-based bi-annual Newsletter celebrating the most useful yet most neglected Mammals for both CCINSA & RISCINSA -- Chiroptera, Rodent, Insectivore, & Scandens Conservation and Information Networks of South Asia.

Editor: Sally Walker; Technical Advisors: Sanjay Molur, B.A. Daniel, R. Marimuthu; and Publication Assistants: Latha Ravikumar and Radhika Suresh.

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Note: ZOO’s PRINT Magazine, Journal of Threatened Taxa, Newsletters and a variety of reports can be found on our websites: www.zooreach.org and www.zoosprint.org.

**Small Mammal Mail, C/o Zoo Outreach Organization**

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