Roosting habits and habitats of the Indian Flying Fox *Pteropus medius* Temminck, 1825 in the northern districts of Tamil Nadu, India

**M. Pandian** 1 & **S. Suresh** 2

1 No. F1901, Taisha, Natesan Nagar West, Virugambakkam, Chennai, Tamil Nadu 600092, India.
2 Department of Statistics, University of Madras, Chepauk, Chennai, Tamil Nadu 600005, India.

**Abstract:** This paper pertains to the study on roosting habits and habitats of the Indian Flying Fox *Pteropus medius* Temminck, 1825 in 12 villages of four northern districts—Vellore, Krishnagiri, Tiruvannamalai, and Viluppuram—of Tamil Nadu. Studies targeted roosting tree species, population status, diurnal-roosting behaviour, interactions with other animals, and probable threats to the species. A total of 22,365 individuals of the species were observed in 72 roosting colonies in 72 trees belonging to nine families, 11 genera, and 13 species. The tree species that harbored the greatest population of *P. medius* (12,465) were those of *Tamarindus indica* L. (Fabaceae) (n=39), followed by *Ficus religiosa* L. (Moraceae) (n=3,960), *Madhuca latifolia* J.F. Macbr. (Sapotaceae) (n=2,760), and *Ficus benghalensis* L. (Moraceae) (n=1,620). One-Way ANOVA revealed that a significant relationship exists between colony size and tree diameter at breast height (dbh), and their canopy size (p <0.05). However, no significant difference occurred between the colony size and tree height. The time taken for emergence of individuals of the colony from the canopy for foraging varied between 20 and 40 min after 1750 h in the evening. The species mostly roosted on trees proximal to human settlements, electrical power lines, and water bodies. Individuals of *P. medius* used various tree species in different areas in different geographical regions and did not maintain any consistency in roosting tree species selection. A majority of individuals (88.7 %; n=887) were found roosting using both legs and a minority of *P. medius* (11.3 %; n=113) were clinging to tree branches using one. Individuals of *P. medius* flew to nearby water bodies to quench thirst and cool their bodies. Mating was observed during day roost in 146 pairs including male-female fellatio in seven pairs. Smoke from shrines in sacred groves, pruning of branches for various cultural reasons, populations of House Crow *Corvus splendens* (Viellot, 1817) (Corvidae), Black-winged Kite *Elanus caeruleus* (Desfontaines, 1789) and Black Kite *Milvus migrans* (Boddart, 1783) (both Accipitridae) were key disturbances to roosting populations of *P. medius*.

**Keywords:** Diurnal behaviours fellatio, mating, *Pteropus giganteus*, roosting trees, threats.

---

**Editor:** C. Srinivasulu, Osmania University, Hyderabad, India.  
**Date of publication:** 26 October 2021 (online & print)


**Copyright:** © Pandian & Suresh 2021. Creative Commons Attribution 4.0 International License. JoTT allows unrestricted use, reproduction, and distribution of this article in any medium by providing adequate credit to the author(s) and the source of publication.

**Funding:** None.

**Competing interests:** The authors declare no competing interests.

**Author details:**  
1 M. Pandian has completed MSc, PhD, in Botany and BLIS from University of Madras and Bachelor of Education (BEd) from Annamalai University, Chidambaram and now serves in Tamil Nadu Police Department. His area of interest is ecology and nesting biology of birds and has published a few papers on house sparrows, weaver birds, munias and ring-necked parakeets. S. Suresh has completed MSc, and PhD, in Manonmaniam Sundaranar University, Tirunelveli and a recipient of INSPIRE Fellow under Department of Science and Technology. He has published few articles in the field of time series analysis and data mining in reputed journals. He is a life member of statistics forums IISA and ISPS. He has rich knowledge in R programming languages.

**Author contributions:** MP has conceptualized, designed the research, performed survey, wrote paper, reviewed and edited the paper for final approval. SS has analysed the data and gave interpretations.

**Acknowledgements:** We thank D. Balaji (Villupuram district), Minnal A. Giridharan, Chitteri S. Prabakaran, Teacher (Ranipet district) and Minnal T. Selvapandian (Mumbai) for assisting in the survey by data collection, data analysis and taking photographs/ videography of bats in the field.
INTRODUCTION

The order Chiroptera consists of over 1,400 species of bats worldwide, of which 148 species occur in southern Asia (Simmons & Cirranello 2020; Srinivasulu et al. 2021a). Pteropodidae, the Old-World fruit-eating bats, are well adapted to live in the tropics, particularly in India, Bangladesh, Bhutan, Nepal, China, the Maldives, Myanmar, Pakistan, and Sri Lanka (Helgen et al. 2009; Jnawali et al. 2011). India harbors 12 species of fruit bats and among them three occur commonly; they include *Pteropus medius*, *P. leschenaultii*, and *Cynopterus sphinx* (Srinivasulu et al. 2021b). The Indian Flying Fox *Pteropus medius* Temminck, 1825 (earlier treated as *P. giganteus*) is one of the largest bats and is widely distributed in southern and south eastern Asia (Marimuthu 1996). This species is a gregarious, colonial mammal that roosts in large trees that possibly protect them from strong winds and offer an easy updraft access for flight. The number of individuals of *P. medius* per colony was found to be varied. Between 260 and 1,550 individuals were recorded during different months (January–October) in a single colony in the Kathmandu valley, Nepal (Manandhar et al. 2018), whereas a colony of 2,844 individuals was recorded in the Lower Dir district, Pakistan (Khan et al. 2021). A total of 11,000 individuals were counted on 182 trees in Jambughoda Wildlife Sanctuary, Gujarat (Vyas & Upadhyay 2014). An average of 43 to 6,141 individuals was counted in the colonies on 19 tree species in Odisha (Rao & Poyyamoli 2017). In Tamil Nadu, over 600 individuals in Nallur near Chennai (Smith 1998), 16,000 individuals in Srivaikundam (Sudhakaran et al. 2010), and 431 individuals in Pudukottai district were enumerated. They usually prefer to roost on tall trees in urban areas of Lahore, Pakistan (Gulraiz 2014). In Tamil Nadu, they preferred *Terminalia arjuna* trees in Srivaikundam (Sudhakaran et al. 2010) whereas *Vachellia leucophloea* (= *Acacia leucophloea*) and *Pongamia pinnata* in Pudukottai district (Tangavelou et al. 2013).

Generally, bat roosting sites are found adjacent to water bodies (Fenton & Barclay 1980; Kunz 1982; Thomas 1988). The colonies of *P. medius* mostly preferred to choose trees for roosting near human settlements in India and Nepal (Bates & Harrison 1997; Katuwal et al. 2019). They exhibit various diurnal behaviour during day roost and belly-soaking behaviour is very common among this species during summer in Purulia district of West Bengal probably to regulate body temperatures (Dey et al. 2015). This species utilizes rain water droplets to quench its thirst by licking rain droplets from its patagium (Baskaran et al. 2016). The majority of individuals cling to the branches using either both legs or with single leg (Rao & Poyyamozhi 2017). Mating in the day roost and fellatio behaviour in heterosexual pairs was common among bats (Wilkinson 1986; Kerth et al. 2003; Tan et al. 2009), and so in *P. medius* individuals (Maruthupandian & Marimuthu 2013). The emergence time of *P. medius* individuals from the roosting trees varied: early emergence occurred during winter (1720–1837 h) and delayed emergence during summer (1838–1946 h) in Mohanlal Ganj, Uttar Pradesh (Ramkumar et al. 2019).

Populations of flying foxes are declining worldwide (Mildenstein et al. 2005; Stier & Mildenstein 2005) due to growing human population, destruction of habitats by felling of trees (Chakravarthy & Yeshwanth 2008), hunting by humans (Marimuthu 1996), shortage of their food resources, and urbanization (Fujita & Tuttle 1991; Mickleburgh et al. 2002). Deforestation, electrocution, expansion of highways, construction of buildings, and hunting reduces populations of *P. medius* (Molur et al. 2008; Ali 2010). A variety of birds of prey and various reptiles including snakes and lizards prey upon bats (Pierson & Rainey 1992). Ethnic communities usually hunt the Indian Flying Fox for meat as they believe it to have medicinal value (Acharya 2008; Thapa 2008). Various conservation attempts have been made for tree roosting *P. medius* (Katuwal et al. 2019). The IUCN Red List of Threatened Species categorises conservation status of this species as ‘Least Concern’ (Tsang 2020). No detailed studies were carried out on the habits and habitats of *P. medius* in the northern parts of Tamil Nadu. Hence to fill up this gap the present study was carried out.

This study, focussing on how habitat disturbances will affect the populations of *P. medius*, will contribute to future studies on the role of habitat disturbances on species in southern India. In this study, we aimed to document the diurnal roosting behaviour of *P. medius* with special reference to trees utilized in northern Tamil Nadu. The following objectives were targeted: (1) to assess the population status of *P. medius* and roosting tree species in the study area; (2) to understand the relationship between the roosting sites of *P. medius* and distances from human settlements, electric power lines, water bodies, and mobile-phone towers; (3) to document diurnal behaviours including mating and pre-emergence patterns; (4) to know interaction with other animals; and (5) to access the probable threats to their populations.
MATERIALS AND METHODS

STUDY AREA
The study was carried out in 12 villages (listed in the legend of Figure 1) located in Krishnagiri, Vellore, Tiruvannamalai, and Viluppuram districts of northern Tamil Nadu (c. 17,000 km², c. 80,40,000 human population). Agriculture is the principal occupation of the residents. The maximum and minimum annual temperatures in these districts are 36 °C and 20 °C, respectively. The average annual rainfall is 1,060 mm (www.tn.gov.in).

METHODS
We selected 72 active roosting colonies of *P. medius* distributed on 72 trees belonging to 13 species in 12 villages where *P. medius* populations were known to be locally present through nomadic gypsies. The number of *P. medius* observed on each tree was considered a single roost/colony. The roosting colonies and trees were surveyed between 0600 and 1900 h from June 2020 to January 2021.

Questionnaire study: Eighty respondents, all above 60 years old, residing adjacent to the roosting sites were interviewed as they have information from the past, in
the selected 12 villages using a questionnaire survey form (in the Tamil language). The questionnaire form included questions on time periods of existence of the local P. medius colonies, population trends, details on roosting trees and tree selection, persecution and hunting of the flying fox, and perception of the local community about the animal as a nuisance, and the probable threats to the populations of local P. medius colonies.

Population count: A population count of the selected P. medius colonies was carried out visually and by using a pair of Super Zenith field binoculars (Model No. 20 x 50 Field 3°, Jack Berg, El Paso, Texas, USA) following Barlow’s (1999) direct roost-count method. The count was conducted fortnightly during June–July 2020 and the numbers were arithmetically averaged.

Behavioural study: Some behaviours of the species in the colonies such as grooming, mating, and interactions with other animals were also observed. Anthropogenic impacts such as smoke from cooking, hunting, and pruning of trees chosen for roosting were observed and the level of impact was categorized. The height was measured using Silva Clinometer (Gulraiz 2014), dbh (diameter at breast height), canopy width and distance between roosting trees were measured using 100 m measuring tape. The nearest human settlements, power lines, water bodies, and mobile-phone towers were measured using a 100 m measuring tape. The canopy width was obtained by cross method (Blozan 2006) by measuring the edge of the canopy shadow on the ground. The pre-emergence and emergence activities were observed between 1700 and 1900 h for 20 days in January 2021. Locations of the colonies and mobile-phone towers were determined using a standard GPS (Garmin Etrex 20x, 2017, Garmin Corporation, Taiwan). Photographs and videography were made using a digital camera (Nikon Coolpix P1000 Super-telephoto, Nikon).

RESULTS

Tree species selection for roosting

A total of 22,365 individuals of P. medius were counted from 72 colonies (Table 1). The roosting sites occurred in and around 11 human settlements, 11 sites in farmlands, and five sites near shrines within sacred groves. Out of the 12 colonies, the maximum individuals that is 32.64 % (n= 7,298) occurred in Ongapadi (Vellore district) and the least 1.77 % (n= 398) in Junjupalli (Krishnagiri district). Among four districts, the highest population of P. medius (n= 9,268; 41.45 %) occurred at Vellore district on 10 trees, followed by 23.68 % (n= 5,298) on 47 trees in Tiruvannamalai district, and 20.91 % (n= 4,678) on seven trees in Krishnagiri district. The least populations of 13.95 % (n= 3,121) were counted on eight trees in Viluppuram district. On an average, 310 individuals of P. medius /tree existed in the study area. (Table 1, Image 1).

Altogether, 13 species belonging to 11 genera and nine families of 72 trees were roosted upon by P. medius. Bambusa arundinacea (L.) Voss (Poaceae), a large, arborescent herb, was one among the 13 species. A total of 12,465 individuals (55.73 %) of P. medius lived on 49 trees of the family Fabaceae. Most of the colonies (53.9 % of their total population, n= 12,055) were on Tamarindus indica L. (n= 39) and a minimum population (0.12%, n= 28) on a single Lannea coromandelica (Houtt.) Merr. (Table 2). The tree species used for roosting, such as Delonix regia (Boj.ex Hook.) Raf, Azadirachta indica A. Juss., Ceiba speciosa (A.St.Hil.) Ravenna, Lannea coromandelica (Houtt.) Merr., Madhuca longifolia J.F.Macbr., Syzygium cumini (L.) Skeels., and Terminalia arjuna L. were represented only by either one or two trees which were excluded from the analysis. Statistical testing (ANOVA) revealed a significant relationship between the means of P. medius individuals and the tree species chosen by P. medius for roosting (F<sub>5,68</sub>= 5.35, p <0.05).

One-way ANOVA shows the relationship between the height, dbh, and canopy size of the roosting trees. However, no significant relationship occurred between the average number of P. medius and heights of the trees (F<sub>5,69</sub>= 1.42, p >0.05). Nevertheless, there was a significant difference between the average number of P. medius and the dbh of trees used by P. medius for roosting (F<sub>2,69</sub>= 8.25, p <0.05). In addition, significant differences occurred between the number of P. medius and the canopy size of roosting trees (F<sub>2,69</sub>= 10.34, p <0.05).
Roosting habits and habitats of Indian Flying Fox in northern districts of Tamil Nadu

Pandian & Suresh


Apparent preference of trees close to human settlements

Sixty per cent of the trees used for roosting (n = 43) and 80 % individuals of total population of *P. medius* (n= 17,880) occurred within 100 m radius from human settlements. No roosting trees were located between 100 and 250 m. Only 40 % trees used for roosting (n= 29) and 20 % individuals (n= 4,485) of *P. medius* were found beyond 250 m (Figure 2).

Forty-three per cent of trees used for roosting (n= 31) and 64.75 % of *P. medius* (n= 14,482) occurred within a 25-m radius from electric power lines. A maximum of 84.72 % of trees used for roosting and 92.1 % *P. medius* (n= 20,600) occurred within a 100-m radius from power lines. Only 15.28 % of trees used for roosting (n= 61) and 7.9 % of *P. medius* (n= 1,765) occurred beyond 100 m. No mortality of *P. medius* due to electrocution was noticed during the study period (Figure 3).

Ninety-six per cent of trees used for roosting (n= 69) and 80.86 % of *P. medius* individuals (n= 18,085) occurred within a 1,000-m radius from water bodies such as lakes, ponds, rivers, and canals (Figure 4). Thirty-two per-cent of trees used for roosting (n= 23) and 50.4 % *P. medius* individuals (n= 11,272) occurred within a 500-m radius from mobile-phone towers and 62.5 % trees (n= 45) and 28.62 % *P. medius* (n= 6,403) were observed within a 501‒2000 m radius from mobile-phone towers. The remaining 5.55 % trees (n= 4) and 20.97 % *P. medius* (n= 4,690) occurred beyond 2001 m from mobile-phone towers (Figure 5).

Perception of local people

Of the 80 local respondents interviewed, 87 % residents (n= 66) were concerned over the declining populations of *P. medius* and the numbers of trees

---

Table 1. District-wise details of villages, GPS co-ordinates, number of roosting trees and total number of *Pteropus medius* counted in the study area.

<table>
<thead>
<tr>
<th>District</th>
<th>Name of the village</th>
<th>GPS</th>
<th>Total no. of trees have roosting colony</th>
<th>Total no. of <em>P. medius</em> counted on these trees</th>
<th>Percentage (%) of <em>P. medius</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Vellore</td>
<td>Gudiyatham</td>
<td>12.938438°N, 78.861062°E</td>
<td>4</td>
<td>1970</td>
<td>8.8</td>
</tr>
<tr>
<td>Krishnagiri</td>
<td>Ongapadi</td>
<td>12.822734°N, 78.946628°E</td>
<td>6</td>
<td>7298</td>
<td>32.63</td>
</tr>
<tr>
<td>Tiruvannamalai</td>
<td>Junjuvali</td>
<td>12.564656°N, 78.164119°E</td>
<td>4</td>
<td>398</td>
<td>1.64</td>
</tr>
<tr>
<td></td>
<td>Chenur</td>
<td>12.360311°N, 78.583989°E</td>
<td>3</td>
<td>4280</td>
<td>19.13</td>
</tr>
<tr>
<td></td>
<td>Rayandapuram</td>
<td>12.092188°N, 78.928710°E</td>
<td>13</td>
<td>2723</td>
<td>12.17</td>
</tr>
<tr>
<td></td>
<td>Kesavapuram</td>
<td>12.655683°N, 79.126282°E</td>
<td>18</td>
<td>1417</td>
<td>6.33</td>
</tr>
<tr>
<td></td>
<td>Vandavasi</td>
<td>12.510984°N, 79.597503°E</td>
<td>10</td>
<td>700</td>
<td>3.12</td>
</tr>
<tr>
<td></td>
<td>Marudhadu</td>
<td>12.490742°N, 79.653357°E</td>
<td>6</td>
<td>458</td>
<td>2.94</td>
</tr>
<tr>
<td>Vilupuram</td>
<td>Kashuperumpakkam</td>
<td>12.067317°N, 79.829502°E</td>
<td>1</td>
<td>780</td>
<td>3.48</td>
</tr>
<tr>
<td></td>
<td>Anumandhai</td>
<td>12.131806°N, 79.911418°E</td>
<td>4</td>
<td>1251</td>
<td>5.59</td>
</tr>
<tr>
<td></td>
<td>Maruvur</td>
<td>12.164664°N, 79.515650°E</td>
<td>1</td>
<td>410</td>
<td>1.83</td>
</tr>
<tr>
<td></td>
<td>Padhiri</td>
<td>12.314802°N, 79.755639°E</td>
<td>2</td>
<td>680</td>
<td>3.04</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>4</td>
<td>12</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 2. Details on the diversity of roosting trees and total *Pteropus medius* counted in the study area.

<table>
<thead>
<tr>
<th>Type of roosting trees</th>
<th>Family</th>
<th>Total no. of trees have <em>P. medius</em> roosting</th>
<th>Total no. of <em>P. medius</em> individuals counted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albizia lebbeck (L.) Benth.</td>
<td>Fabaceae</td>
<td>5</td>
<td>219</td>
</tr>
<tr>
<td>Dellonix regia (Boj. ex Hook.) Raf.</td>
<td>Fabaceae</td>
<td>1</td>
<td>120</td>
</tr>
<tr>
<td>Pongamia pinnata (L.) Panigrahi</td>
<td>Fabaceae</td>
<td>4</td>
<td>71</td>
</tr>
<tr>
<td>Tomorindus indicus L.</td>
<td>Fabaceae</td>
<td>39</td>
<td>12055</td>
</tr>
<tr>
<td>Azadirachta indica A.Juss.</td>
<td>Meliaceae</td>
<td>1</td>
<td>46</td>
</tr>
<tr>
<td>Bambusa arundinacea (L.) Voss</td>
<td>Poaceae</td>
<td>7</td>
<td>468</td>
</tr>
<tr>
<td>Ceiba speciosa (A.St.Hil.) Ravenna</td>
<td>Malvaceae</td>
<td>2</td>
<td>175</td>
</tr>
<tr>
<td>Ficus benghalensis L.</td>
<td>Moraceae</td>
<td>4</td>
<td>1620</td>
</tr>
<tr>
<td>Ficus religiosa L.</td>
<td>Moraceae</td>
<td>3</td>
<td>3960</td>
</tr>
<tr>
<td>Lannea coromandelica (Houtt.) Merr.</td>
<td>Anacardiaceae</td>
<td>1</td>
<td>28</td>
</tr>
<tr>
<td>Madhuca longifolia J.J.F.Macbr.</td>
<td>Sapotaceae</td>
<td>1</td>
<td>2760</td>
</tr>
<tr>
<td>Syzygium cumini (L.) Skeels.</td>
<td>Myrtaceae</td>
<td>2</td>
<td>56</td>
</tr>
<tr>
<td>Terminalia arjuna (Roxb.) Wight &amp; Arn.</td>
<td>Combretaceae</td>
<td>2</td>
<td>787</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>9</td>
<td>22365</td>
</tr>
</tbody>
</table>

---

J TT
Roosting habits and habitats of Indian Flying Fox in northern districts of Tamil Nadu

Pandian & Suresh

Image 1. Roosting habitats of Pteropus medius: a & b—Roosting habitats in sacred groves | c & d—Roosting in Tamarindus indica tree | e—Male in Ficus benghalensis tree | f—Female in Ficus benghalensis tree | g—Power cables passing adjacent to roosting tree Tamarindus indica | h—Roosting Bambusa arundinacea bush near water body. © M. Pandian
used for roosting. That the residents of these villages consider roosting populations of flying foxes important in their culture and life is notable. For example, if they considered it a bad omen, they would have either cut those trees that accommodate roosting populations of *P. medius* or chased the roosting colonies away from the trees. However, in Junjupalli village, we observed that soon after a marriage ceremony, the married couple worshipped the tree (*Ficus benghalesis*) supporting a roosting population of *P. medius*. Residents from the villages reported that the numbers of *P. medius* had reduced, compared to six decades ago. Thirty-five residents (44%) indicated either occasional or clandestine hunting of *P. medius* for folk-medicinal reasons. Seventy-four residents (92%) considered the presence of a roosting colony as a sign of prosperity to their village. Sixty residents (75%) indicated that cracker bursting was always done only after sunset when *P. medius* population was away from the trees for foraging. To protect roosting colonies of *P. medius* residents of Ongapadi village avoided bursting crackers during festive times. Seventy-four residents (92%) considered *P. medius* populations within the village were never a nuisance; despite the fact that these animals desecrate houses, walls, and other common public areas under the roosting trees, and the foul odour emanating from the droppings. Sacredness and an environmental value addition because of culture, offer ‘protection’ to populations of *P. medius* contributing to their conservation.

**Behaviour of *P. medius***

During the north-east monsoon rains (October—November 2020), individuals of *P. medius* were observed clinging to tree branches with their heads and ventral parts of their body wrapped with their membranous wings. Immediately after the rain, they flap their wings speedily and move from one branch to another. After the rain, they groom, scratch, and lick water droplets from their body (Image 2).

During hot summer days (June—July), individuals of *P. medius* moved from the top of the canopy downwards, i.e., midparts of the tree and roosted on large tree trunks, probably to avoid direct exposure to sunlight. In June—July 2020 in Marudhadu village, five incidents of *P. medius* individuals flying to a nearby lake and soaking the ventral part of their body were observed.

**Mating**

One-hundred-and-forty-six incidents of mating were observed in the studied villages between 0700 h and 1645 h during October—December 2020. A maximum of 26 pairs engaged in courtship and copulation was observed in Kesavapuram village, and two mating pairs in Anumandhai village. Before copulation, seven incidents of males licking the genitalia of the females
were observed, which occurred for 2—4.5 min. After copulation, both pairs moved away from each other and female–male fellatio stopped. Two instances of males licking their own penises before copulation were observed in Padhiri village (Table 3; Image 3).

**Emergence from trees**

A total of 20 pre-emergence and emergence activities were observed for 20 days continuously from 1700 to 1900 h in Kazhuperumbakkam and Maruvur (Viluppuram district). Frequent and irregular migrations of individuals from one branch to another either in the same tree or between different trees occurred between 1710 and 1750 h. From a minimum of one to a maximum of 11 were found flying, encircling the canopy for a few minutes and returning to the tree used for roosting.
Image 3. Roosting habits of *Pteropus medius*: a & b—*Pteropus medius* individuals migrate to tree trunk to avoid exposure to direct sunlight | c—Individual with punctured patagium | d—Female-male fellatio | e—Copulation | f—Desecration of residence due to excreta of roosting individuals | g & h—Pruned roosting trees. © M. Pandian
Wing flapping and grooming activities were high and almost all individuals of *P. medius* concurrently made vocal communications, resulting in a loud, collective noise around the roost. The emergence of the first batch of individuals (10–50) from the colony occurred between 1750 and 1810 h. The emergence time of the last batch of the colony was between 1820 and 1840 h. The time taken for emergence of individuals (80–100) of the colony from the canopy varied between 20 and 40 min.

**Interactions with other animals**

Twelve incidents of *Macaca radiata* (E. Geoffroy, 1812) (Cercopithecidae) living on *T. indica* trees in Gudiyatham and Rayandapuram were observed. When a troop of *M. radiata* climbed over *T. indica* trees to feed on flowers and raw fruits, *P. medius* individuals from the nearby branches flew away from these trees to nearby trees. In one instance, one *M. radiata* was found slapping a roosting *P. medius* when the latter hindered it while plucking fruits of *T. indica*. *Corvus splendens* frequently visited the trees used by *P. medius* for roosting, disturbing them. When the *P. medius* started to fly, *C. splendens* selectively chased the juveniles of *P. medius* away. A total of 36 incidents of *C. splendens* chasing *P. medius* individuals from roosting colonies were observed. But no incidents of *C. splendens* predating on the juveniles of *P. medius* were found during the study (Fig 10).

**Threats**

Smoke disturbance to roosting colonies of *P. medius* was common around shrines located within sacred groves. Local residents cook porridge on firewood stoves to offer to deities in the sacred groves in Marudhadu, Kazhuperumpakkam, Padhiri, Maruvur, and Chenur during July–August and January–February. The emerging smoke disturbed *P. medius* individuals, driving them away from the trees to migrate to other trees (e.g., *T. indica* and *F. religiosa*) situated outside the villages for roosting.

Trees chosen for roosting by *P. medius* adjacent to residential areas and farm lands are frequently pruned because the village administrators see them as obstructions to electric power lines and villagers who see
them preventing sunlight to crop plants. One P. medius individual was noticed with a damage on its patagium. Although the exact cause for the damage was unknown. One Black-winged Kite Elanus caeruleus (Desfontaines, 1789) was seen hovering and roosting on power lines in the vicinity of trees used by P. medius for day roost at Maruvur village, although no incident of attack by E. caeruleus on P. medius was observed. Villagers remarked that Black Kites, Black-winged Kites, and House Crows occasionally predate on the juveniles of P. medius.

**DISCUSSION**

**Tree species selection for roosting**

The Indian Flying Fox has been known to use nine tree species in villages in Delhi (Mishra 2010) and 18 tree species in Uttar Pradesh (Kumar et al. 2017). In the present study conducted in Vellore, Krishnagiri, Tiruvannamalai, and Viluppuram districts. In Pudukkottai district, central Tamil Nadu, P. pinnata and V. leucophloeus, especially in the sacred groves, were the trees used maximally for roosting (Tangavelou et al. 2013). In the present study, P. pinnata was the tree that housed maximum roosting populations of P. medius (n= 71). Different species of Eucalyptus (Myrtaceae) were the most used trees for roosting in Kathmandu (Nepal) (Manandhar et al. 2018). But in the present study area no Eucalyptus tree species was used by P. medius for roosting, although various species of Eucalyptus occur abundantly in the studied districts. The reason may be due to the felling of Eucalyptus trees periodically by the social forestry department because these trees were not allowed grow for long periods and hence, P. medius might have avoided selecting this tree species. These findings indicate that P. medius use various tree species in different geographical regions and do not maintain any consistency in tree selection for roosting.

No positive relationship occurred between the numbers of P. medius and heights of the trees used for roosting (F_{2,69} = 1.42, p >0.05). Significant relationship existed between the dbh and canopy size of trees selected for roosting and the number of P. medius individuals in urban and semi-urban areas in Uttar Pradesh (Kumar & Elangovan 2019). In the present study, a significant, positive relationship occurred between the means of P. medius individuals and numbers of A. lebbeck, P. pinnata, T. indica, B. arundinacea, F. benghalensis, and F. religiosa chosen by P. medius for roosting (F_{5,66} = 5.35, p <0.05). There was a significant difference between the average number of P. medius and the dbh (F_{2,69} = 8.25, p <0.05) and the canopy size of trees used by P. medius for roosting (F_{2,69} = 10.34, p <0.05). It indicates that individuals of P. medius preferred trees with larger dbh and larger canopy size for roosting in the study area.

**Apparent preference of trees close to human dwellings**

In the Indian subcontinent, populations of P. medius mostly preferred to choose trees for roosting near human settlements (Bates & Harrison 1997). In lower Nepal, most of the colonies of P. medius were recorded close to human settlements and in farmlands (Katuwal et al. 2019). This species roosts on trees that occur close to human settlements in Tirunelveli district, viz., sacred...
Roosting habits and habitats of Indian Flying Fox in northern districts of Tamil Nadu

Pandian & Suresh

Behavioral observations

In New South Wales, Australia, flying foxes were observed to visit nearby water bodies in peak summers to soak their fur and wings to cool their bodies (Welbergen et al. 2008). Belly-soaking behaviour is very common among the Indian Flying Fox during summer in Purulia district of West Bengal (Dey et al. 2015). In the present study, the observations of partial dipping of its ventral body surfaces in water might have been to quench its thirst and to reduce its body temperatures during hot summer and hence it matches with the views of Dey et al. (2015) and Welbergen et al. (2008).

Populations of *P. medius* usually roost on trees for 12–14 h daily hanging from branches. A majority of individuals (88.7%) were found roosting using both legs and a minority of *P. medius* (11.3%) were clinging to tree branches using one. They probably relax their leg muscles by alternately using both or a single leg and it requires further studies. The majority of individuals clinging to the branches used both legs during day roost as stated by Rao & Poyyamozhi (2017).

After rainfall the individuals of *P. medius*, groom, scratch, and lick their body to remove the water droplets (Maruthapandian & Marimuthu 2013). This species utilizes rain water droplets to quench their thirst by licking rain droplets from the wing membrane (Baskaran et al. 2016). As stated by the above authors, in the present study also we observed similar behaviours of *P. medius* individuals scratching and licking its body and removing water droplets. The droppings of *P. medius* desecrate human residences, common usage areas, and cause foul odour, but the residents tolerate it and allow roosting colonies on trees in their villages.

The occurrence of mating in the day roost and fellatio behaviour in hetero-sexual pairs is common among *P. medius* individuals (Wilkinson 1986; Kerth et al. 2003; Maruthapandian & Marimuthu 2013; Tan et al. 2009). Similar behaviours while mating during day and female-male fellatio were observed in the current study as stated by the above authors.

Emergence from trees

The emergence time of *P. medius* individuals from the trees varied: early emergence occurred during winter (1720–1837 h) and delayed emergence during summer (1838–1946 h) in Mohanlal Ganj, Uttar Pradesh (Ramkumar et al. 2019). In the present study the emergence period during the winter season was between 1750–1840 h and it nearly corroborates with the observations of Ramkumar et al. (2019). The time taken for emergence of all the individuals of the colony was found to vary: 21 min to 39 min. The variations of emergence time during summer have not been studied.

Interactions with other animals

A variety of birds of prey, both Falconiformes and Strigiformes, various reptiles including snakes and lizards prey upon them (Pierson & Rainey 1992). Though monkeys and house crows caused disturbance to *P. medius* individuals, no incidents of predation was reported in the present study area. Villagers remarked that individuals of Black Kites and Black-winged Kites had frequented roosting colonies and predate of juveniles of *P. medius* and hence it corroborates with the findings of and Pierson & Rainey (1992). However, no predation by Black Kites, Black-winged Kites, and reptiles were noticed in the study sites.

Threats

This species roost on trees that occur close to human settlements, farmlands and sacred groves. Because of human habitation, electrical power lines usually occur close to those roosting trees. Ali (2010) reported small numbers of *P. medius* were found electrocuted and died in Dhubri district, Assam. The present survey revealed that no mortality of *P. medius* individuals was found in the surveyed four districts. Although 84.72% trees chosen for roosting and 92.1% *P. medius* individuals (n= 20,600) occurred within a 100-m radius from electrical power lines, no mortality due to electrocution was observed.

Hunting of bats for meat is still prevalent in some parts of Nepal (Katuwal et al. 2019). The meat of flying foxes (‘valguli mamsa’ in local language) is believed to be of some therapeutic value and its consumption is recommended locally. Meat of this species is consumed for treating rheumatism in India (Nowak 1999) and the people of Attapadi region (Kerala) believe that the meat of *P. medius* treats asthma and chest pain (Padmanaban & Sujana 2008). During the survey, 44% of residents (n= 35) indicated either occasional or clandestine hunting of *P. medius* for folk-medicinal reasons.

Electromagnetic radiations exert an abnormal behaviour and affect the foraging activities of bats in Aberdeen, Scotland. Their activity was more rigorous in
the control sites than the sites exposed to a high level (>2v/m) of electromagnetic radiation (Nicholls & Racey 2007). In Mumbai, the number of flying foxes was found to have decreased when mobile-phone towers occurred within 80 m from a roosting colony (Kumar 2010). In the present study the minimum distance between a tree used for roosting and a mobile-phone tower was 40 m at Ongapadi (Vellore district) and the maximum 6,000 m in Maruvur (Viluppuram district). The trees used for roosting and P. medius populations revealed that a large number of trees chosen for roosting (31.94 %; n= 23) and P. medius individuals (50.4 %; n= 11,272) occurred within 500 m radius from the mobile-phone towers. However, in the event of the existence of mobile-phone towers in almost all villages, the situation of a tree 40 m distance from the mobile-phone tower, the exact impact of the mobile-phone tower on the roosting colonies of P. medius needs further study.

CONCLUSION

The populations of P. medius used 13 tree species belonging to 11 genera and nine families for roosting at various habitats, such as human dwellings, farmlands, and water bodies. No positive relationship occurred between the numbers of P. medius and heights of the trees used for roosting. There was a significant difference between the average number of P. medius and the dbh and the canopy size of trees used by P. medius for roosting. The individuals of P. medius were found soaking themselves in water during summer probably to reduce body temperatures. While roosting, they mostly cling on to tree branches using both legs, rarely using one. Mating and fellatio behaviour in hetero-sexual pairs were observed during the day roost. The time taken for emergence of individuals of the colony from the canopy varied between 20 and 40 min. No mortality due to electrocution was observed. The impact of mobile-phone towers on roosting colony needs further study. The roosting populations were disturbed by individuals of Bonnet Macaque, House Crow, Black Kite, and Black-winged Kite. Anthropogenic impacts like hunting, pruning trees used for roosting and smokes emanated from sacred groves during festivals pose a threat to the populations of P. medius.

In spite of rapid urbanization, industrialization, population increase, habitat destruction, hunting by villagers and decreasing areas of cultivation including orchards, considerable P. medius populations exist in the study area. A special management plan could be devised for the area, considering the anthropogenic and natural stresses to which the habitat is currently subjected. The present roosting sites should be declared as protected areas and further organisations (NGOs) have to play a major role in creating awareness among the general public to protect this species. This study clearly demonstrates the presence of 22,365 Indian Flying Fox individuals in their natural habitats and identifies current and emerging challenges in conservation of habitats of such key species in the natural ecosystems.

REFERENCES

Roosting habits and habitats of Indian Flying Fox in northern districts of Tamil Nadu

Pandian & Suresh

on 10 February 2021.


Birds

Dr. Hem Sagar Baral, Charles Sturt University, NSW Australia
Dr. Chris Bowden, Royal Society for the Protection of Birds, Sandy, UK
Dr. Priya Davinder, Pondicherry University, Kalapet, Puducherry, India
Dr. J.W. Dukworth, IUCN SSC, Bath, UK
Dr. Rajiv Jayapal, SACCIN, Coimbatore, Tamil Nadu, India
Dr. Raju S. Kalsi, M.L.N. College, Yamuna Nagar, Haryana, India
Dr. V. Santharam, Rishi Valley Education Centre, Chittoor Dt., Andhra Pradesh, India
Dr. S. Balachandran, Bombay Natural History Society, Mumbai, India
Mr. J. Praween, Bengaluru, India
Dr. C. Srinivasulu, Osmania University, Hyderabad, India
Dr. K.S. Gopi Sundar, International Crane Foundation, Baraboo, USA
Dr. Gombobataar N., Professor of Ornithology, Ulaanbaatar, Mongolia
Prof. Reuven Yosef, International Birding & Research Centre, Eilat, Israel
Taej Mundkur, Wetlands International, Wageningen, The Netherlands
Dr. Carol Inskipp, Bishop Auckland Co., Durham, UK
Dr. Tim Inskipp, Bishop Auckland Co., Durham, UK
Dr. V. Gokula, National College, Tiruchirappalli, Tamil Nadu, India
Dr. Arkady Leje, Russian Academy of Sciences, Vladivostok, Russia
Dr. Simon Dowell, Science Director, Chester Zoo, UK
Dr. Mário Gabriel Santiago dos Santos, Universidade de Trás-os-Montes e Alto Douro, Quinta de Prados, Vilas Real, Portugal
Dr. Grant Czonne, Smithsonian Institution, Royal, VA, USA
Dr. M. Zafar-ul-Islam, Prince Saud Al Faisal Wildlife Research Centre, Taif, Saudi Arabia

Mammals

Dr. Giovanni Amori, CNR - Institute of Ecosystem Studies, Rome, Italy
Dr. Anwaruddin Chowdhury, Guwahati, India
Dr. David Mallon, Zoological Society of London, UK
Dr. Shomita Mukherjee, SACCIN, Coimbatore, Tamil Nadu, India
Dr. Angie Appel, Wild Cat Network, Germany
Dr. P. G. Namas, The George Washington University, Washington, USA
Dr. John N. E. Veron, Coral Reef Research, Townsville, Australia
Dr. Daniel Whitmee, National Museums of Scotland, Rosenten, Germany.
Dr. Yu-Feng Hu, National Taiwan Normal University, Taipei City, Taiwan
Dr. Keith V. Wolffe, Antioch, California, USA
Dr. Siddharth Kulkarni, The Hormiga Lab, The George Washington University, Washington, D.C., USA
Dr. Tomas Ditrich, Faculty of Education, University of South Bohemia in Ceske Budejovice, Czech Republic
Dr. Mihaly Foldvari, Natural History Museum, University of Oslo, Norway
Dr. P.V. Uniyal, Wildlife Institute of India, Dehradun, Uttarakhand 248001, India
Dr. John T.D. Caleb, Zoological Survey of India, Kolkata, West Bengal, India
Dr. Priyadarshani Dharma Rajan, ATREE, Bengaluru, India
Dr. Phil Alderslade, CSIRO Marine And Atmospheric Research, Hobart, Australia
Dr. John E. Veron, Coral Reef Research, Townsville, Australia
Dr. Tim Inskipp, Bishop Auckland Co., Durham, UK
Dr. V. Gokula, National College, Tiruchirapalli, Tamil Nadu, India
Dr. Arkady Leje, Russian Academy of Sciences, Vladivostok, Russia
Dr. Karin Schwartz, George Mason University, Fairfax, Virginia.
Dr. Lala K. Singh, Bhutanewar, Orissa, India
Dr. Mewa Singh, Myore University, Myore, India
Dr. Paul Racey, University of Exeter, Devon, UK
Dr. Honnava N. Kumar, SACCIN, Anakatty P.O., Coimbatore, Tamil Nadu, India
Dr. Nishith Dhariaya, HNG University, Patan, Gujarat, India
Dr. Spartaco Gippoliti, Socio Onorario Societa Italiana per la Storia della Fauna "Giuseppe Altolbo"; Rome, Italy
Dr. Justus Joshua, Green Future Foundation, Tiruchirappalli, Tamil Nadu, India
Dr. H. Raghrum, The American College, Madurai, Tamil Nadu, India
Dr. Paul Bates, Harson Institute, Kent, UK
Dr. Jim Sanderson, Small Wild Cat Conservation Foundation, Horsham, UK
Dr. Dan Challenger, University of Kent, Canterbury, UK
Dr. David Mallon, Manchester Metropolitan University, Derbyshire, UK
Dr. Brian L. Cypher, California State University-Stanislaus, Bakersfield, CA
Dr. S.S. Talmale, Zoological Survey of India, Pune, Maharashtra, India
Dr. Karin Schwartz, George Mason University, Fairfax, Virginia.
Dr. Michael A. Kafley, Wildlife Sciences, Tarleton State University, Texas, USA

Other Disciplines

Dr. Aniruddha Belsare, Columbia MO 65203, USA (Veterinary)
Dr. Mandeep K. Gander, University of Pune, Pune, Maharashtra, India (Molecular)
Dr. Jack Tordoff, Critical Ecosystem Partnership Fund, Arlington, USA (Communities)
Dr. Ulfke Streicher, University of Oregon; Eugene, USA (Veterinary)
Dr. Hari Balasubramaniam, EcoAdvisors, Nova Scotia, Canada (Communities)
Dr. Rayanna Helem Santos Bezerra, Universidade Federal de Sergipe, Brazil (Sao Paulo, Brazil)
Dr. Brian L. Cypher, California State University-Stanislaus, Bakersfield, CA
Dr. M. Zafar-ul-Islam, Prince Saud Al Faisal Wildlife Research Centre, Taif, Saudi Arabia

Reviewers 2018–2020

Due to paucity of space, the list of reviewers for 2018-2020 is available online.

The opinions expressed by the authors do not reflect the views of the Journal of Threatened Taxa, Wildlife Information Liaison Development Society, Zoo Outreach Organization, or any of the authors, the publisher, the host, and the partners are not responsible for the accuracy of the political boundaries shown in the maps by the authors.

Print copies of the Journal are available at cost. Write to: The Managing Editor, JoTT, c/o Wildlife Information Liaison Development Society, No. 12, Thiruvannamalai Nagar, Saravanampatti - Kalapatti Road, Saravanampatti, Coimbatore, Tamil Nadu 641035, India

ravi@threatenedtaxa.org
Articles
Roosting habits and habitats of the Indian Flying Fox Pteropus medius Temminck, 1825 in the northern districts of Tamil Nadu, India
– M. Pandian & S. Suresh, Pp. 19675–19688

Diversity and distribution of avifauna at Warathenna-Hakkinda Environmental Protection Area in Kandy, Sri Lanka
– Dinelka Thilakarathne, Tihira Lakkanca, Gayan Hirimuthugoda, Chaminda Wijesundara & Shalika Kumburegama, Pp. 19689–19701

Grass species composition in tropical forest of southern India
– M. Ashokkumar, S. Swaminathan & R. Nagarajan, Pp. 19702–19713

Communications
Habitat use and conservation threats to Wild Water Buffalo Bubalus arnee (Mammalia: Artiodactyla: Bovidae) in Koshi Tappu Wildlife Reserve, Nepal
– Reeta Khulal, Bijaya Neupane, Bijaya Dhami, Siddhartha Regmi, Ganesh Prasad Tiwari & Manita Parajuli, Pp. 19734–19724

Get my head around owls: people perception and knowledge about owls of Andaman Islands
– Shammugavel Sureshmarimuthu, Santhanakrishnan Babu, Nagaraj Rajeshkumar & Honnavalli Nagaraj Kumara, Pp. 19725–19732

Abundance and diversity of threatened birds in Nangal Wetland, Punjab, India
– Rajwinder Kaur & Onkar Singh Braich, Pp. 19733–19742

Evaluation of fish diversity and abundance in the Kabul River with comparisons between reaches above and below Kabul City, Afghanistan
– Ugyen Kelzang, Ahmad Farid Habibi & Ryan J. Thoni, Pp. 19743–19752

New record of Myrmoracne melanocephala MacLeay, 1839 (Araneae: Salticidae) from Jharkhand, India and biogeographical implications of the co-occurrence of its ant model Tetraponerinae rufonigra Jerdon, 1851
– Rahul Kumar, Mirtunjay Sharma & Ajay Kumar Sharma, Pp. 19753–19761

Diversity of spiders (Arachnida: Araneae) and the impact of pruning in Indian sandalwood plantations from Karnataka, India
– S. Padma 1 & R. Sundararaj, Pp. 19762–19772

New records of cheilostome Bryozoa from the eastern coast of India encrusting on the exoskeleton of live horseshoe crabs of Indian Sundarbans
– Swati Das, Maria Susan Sanjay, Basudev Tripathy, C. Venkatraman & K.A. Subramanian, Pp. 19773–19780

On the pteridophytes of Bherjan-Borajan-Padumoni Wildlife Sanctuary, Assam, India
– Pranjal Borah & Jayanta Barukial, Pp. 19781–19790

Population status of Heritiera fomes (Buch.-Ham., a threatened species from closely related M. mukhlesuri

Notes
A recent sighting of the Stripe-backed Weasel Mustela striigordora (Mammalia: Carnivora: Mustelidae) in Hkakabo Razi Landscape, Myanmar

Are the uplifted reef beds in North Andaman letting nesting Olive Ridley Sea Turtle Lepidochelys olivacea stranded?
– Nehru Prabakaran, Anoop Raj Singh & Vedagiri Thirumurugan, Pp. 19860–19863

First record of the orb-weaving spider Araneus tubulobiminus Zhu & Zhang, 1993 (Araneae: Araneidae) from India

The genus Catapiestus Perty, 1831 (Coleoptera: Tenebrionidae: Cnoodalmonini) from Arunachal Pradesh with one new record to India
– V.D. Hegde & Sarita Yadav, Pp. 19867–19869

Rediscovey and extended distribution of Indigofera santapauji Sanjappa (Leguminosae: Papilionoideae) from the states of Maharashtra and Gujarat, India
– Kumar Vinod Chhotupuri Gosavi, Sanjay Gajanan Auti, Sharad Suresh Kambale & Munivenukatappa Sanjappa, Pp. 19870–19873

Additional distribution records of Ceropogia anjanaeras, an endemic and ‘Endangered’ lantern flower of the northern Western Ghats, India

Notes on the extended distribution of Impatiens malayalamayana, a recently described balsam in Western Ghats, India
– Anoop P. Balan & A.J. Robi, Pp. 19878–19883

Book Review
A look over on the scented tree of India (Santalum album)
– S. Suresh Ramanan & A. Arunachalam, Pp. 19884–19886

Publisher & Host
WILD Threatened Taxa

Creative Commons Attribution 4.0 International License