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Research Article

Distribution and roost preferences of Indian flying fox (*Pteropus medius*) in District Kasur, Punjab, Pakistan

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Abstract

The present study provides valuable insights into the distribution and roost tree characteristics of the Indian flying fox (*Pteropus medius*) in the Kasur district of Punjab, Pakistan. Field surveys were conducted monthly across six identified roosting sites, each exhibiting distinct environmental features. A total of 9730 individuals were observed throughout the year, with all roosting sites used year-round except Arain Modal Farm, where bats roosted from September to April. Seasonal migrations were noted, with *Pteropus medius* moving to the Changa Manga forest during the mating season and dispersing to other sites in winter due to unfavorable weather conditions. The study identified 103 roost trees belonging to 11 species, with Eucalyptus (n = 33) and Ficus (n = 29) being the most frequently used. Roost tree characteristics, including tree height and canopy cover, were positively correlated with bat abundance, indicating a preference for larger trees that provide better protection and space for large colonies. Additionally, habitat preferences were assessed by examining the correlation between bat colony size and various non-roost tree-dependent factors. A significant positive correlation was found between the colony size and the distance to the nearest water body ($r = 0.973$, $p = 0.001$), suggesting that bats prefer to roost near water bodies. In contrast, the distances to human settlements, roads, railway tracks, and fruit orchards showed insignificant correlations with colony size. These findings underscore the importance of preserving large trees and roosting habitats for conserving *Pteropus medius* in the region.

Keywords: forest management, colony size, *Pteropus medius*, roost tree, roost selection

Introduction

Bats form more than 20% of all mammalian species, which are present in all continents except the Arctic, Antarctica, and a few oceanic islands (Gunnell *et al.*, 2017). Order Chiroptera is the second largest class of Mammalia, mostly insectivores and frugivores (Li *et al.*, 2018). These mammals help pollinate and disperse seeds and play an important role in controlling pests. More than 1455 species of bats are present worldwide (Simmons and Cirranello, 2022). Order Chiroptera is represented by 23 genera from Pakistan, including Megabats. Megabats, also called fruit bats, belong to the genera *Acerodon* and *Pteropus* of the family Pteropodidae (Tsang, 2020). Members of the Pteropodidae family are found across a broad geographical range, demonstrating significant adaptability to various environmental conditions. The *Pteropus medius* is commonly reported from Pakistan, India, Bangladesh, Nepal, Sri Lanka, China, Maldives, and Myanmar (Elangovan *et al.*, 2018). *Pteropus medius* is distributed in Pakistan in Lahore, Islamabad, Karachi, Sialkot, Jacobabad, Shahpur, and Renala Khurd. Later, it was reported in Pakistan's northwestern regions (Mahmood-ul-Hassan & Salim, 2011). Roosting sites provide specific habitats for population viability, offspring development, social interaction, and reproduction. The selection of roosting trees is vital for *Pteropus medius* as they spend most of their life span roosts (Kerth *et al.*, 2003). *Pteropus medius* is a social animal with large colonies ranging from a few hundred to thousands of individuals. Mostly, they prefer roost in various habitats, including rural areas, urban areas, close agricultural fields, water bodies, and highways (Tsang, 2020; Kumar & Elangovan, 2019). *Pteropus medius* prefers dense canopies of large, stable, tall trees, which may protect them from predators and harsh weather (Kingston *et al.*, 2023). These roosts are mostly near water bodies such as ponds, lakes, canals, or rivers to meet their hydration needs and the growth of trees. *Pteropus medius* uses their roosts for grooming, vocalization, and spatial organization (Myint, 2023). These animals exhibit high roost fidelity as they return to the same roost yearly. *Pteropus medius* primarily feeds on fruits, including mangoes, guavas, and figs, making them important pollinators. Urban areas can provide many food and roosting opportunities and often form large city colonies. However, living close to humans resulted in conflicts imposing careful management and conservation strategies for these environment-friendly creatures (Heldbjerg *et al.*, 2023).

Human-induced environmental pressures, such as extensive deforestation for urban development, food scarcity, road expansion, construction of buildings, habitat loss and fragmentation, public disturbances, and hunting are significant factors contributing to the decline in the population of *Pteropus medius* (Chakraborty & Chakraborty, 2021). Understanding the ecological needs and

roosting habits of *Pteropus medius* is vital for their conservation. To address this gap, the present study was planned to assess the habitat preferences and roost characteristics of *Pteropus medius* in District Kasur, Punjab, Pakistan.

Material and methods

Study area

The present one-year study was conducted in District Kasur, Punjab, Pakistan, from August 2022 to July 2023. District Kasur is located at 31° 7' 7.6548" N and 74° 27' 47.7792" E and 200 m above sea level, having a total area of 3995 km^2. The summer lasts from April until September, and temperatures fluctuate between 26.8 °C and 48.4 °C. The hot and dry months of the year are May and June, and the humid monsoon season begins after the summer's downpour, and annual precipitation is approximately 424 mm (Peel *et al.*, 2007; DDMP-Kasur, 2022). The winter season starts from November through March, with temperatures ranging from 4°C to 18 °C. Significant vegetation includes *Dalbergia sisso* (Sheesham), *Acacia nilotica* (Kikar), *Morus alba* (White mulberry), *Bombax ceiba* (Simbal), *Pongamia pinnata* (Sukhechain), *Azadirachta indica* (Neem), *Melia azedarach* (Bakiain), *Acacia nilotica* (Desi kikar), *Ficus benghalensis* (Bohr), *Ficus religiosa* (Peepal), *Morus nigrz* (Tutsiah), *Eucalyptus citriodora* (Safaida) and *Ziziphus mauritiana* (Bairi). Significant fruit orchards trees were *Psidium guajava* (Guava), *Mangifera indica* (Mango), *Syzygium cumini* (Jamun), *Ziziphus mauritiana* (Ber) and *Morus macroura* (Shahtot). The primary crops cultivated in the district include rice, cotton, sugarcane, wheat and various types of fodder. Human activity has greatly modified The district's flowery and is represented by Pakistan’s largest thick forest, Changa Manga. The district lies in a sub-tropical belt and has many nurseries for floriculture and horticulture (Ali *et al.*, 2017).

Sampling strategy and data collection

Investigative visits were conducted to find out the roosts of *Pteropus medius* in the study area. A total of six roosting sites were observed closely along with their GPS coordinates (Fig. 1). The assessment of roosting and non-roosting tree characteristics was done following Leverett and Bertolette (2015). Diameter at breast height (DBH) was determined at approximately chest height, roughly 4.5 feet above the tree's base, and was calculated by dividing the tree's circumference by 3.141. The canopy spread (average of the broadest length and the width of the tree crown at a 90-degree angle) was measured following the American Forests Champion Trees Measuring Guidelines handbook by Leverett and Bertolette (2014). Furthermore, unoccupied large and tall trees having a wide canopy (tree height > 11 m, dbh > 42 cm, and canopy spread > 13 m) positioned in the closer surrounding to roost trees were considered as non-roost trees. The roost-dependent

factors, including the distance of roosting sites from the nearest human settlement, nearest road, nearest water body, nearest fruit orchard, and nearest railway track, were measured using GIS-based distribution maps. GIS-based distribution maps of bats were constructed using ArcGIS 10.0 in GIS and Remote Sensing Lab, Department of Wildlife and Ecology, UVAS, Ravi Campus (ESRI, 1996). Environmental attributes such as temperature and humidity were measured by using a digital meter. Bats were counted in each roosting site through the direct roost count method (TH, K. 1996). A maximum level of caution was exercised while counting the bats at the roosting sites, and the surveys were conducted during the daytime when most of the bats were at rest.

Statistical analysis

Characteristics of roost trees (height, circumference, DBH) and abiotic factors such as temperature and humidity were considered independent factors. The Pearson correlation analysis was done to check the relationship between these factors on the abundance of bats and the effect of temperature and humidity on the roosting site (Devi & Kumar, 2024). Correspondingly, the influence of dependent factors such as distance of roosting sites from the nearest human settlement, nearest road, nearest water body, railway track and fruit orchard on colony size was examined using a multiple regression (Kumar and Elangovan, 2019).

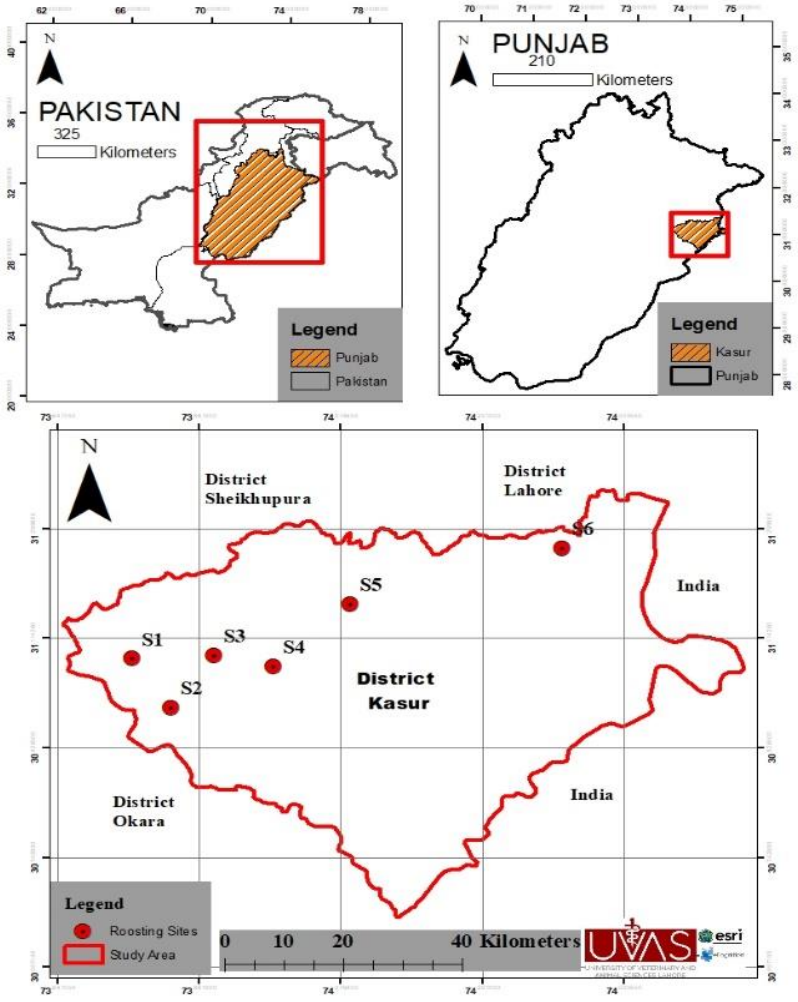

Figure 1. GIS-based map of the roosting sites of Pteropus medius in the district of Kasur, Punjab, Pakistan.

Results

Field surveys were conducted monthly across all six identified roosting sites to gather data distribution and roosting sites of *Pteropus medius*. These sites include S1: Kacha Pakka was in a rural area near agricultural fields with no nearby water bodies or significant roads; S2: Pattoki Nurseries was close to the railway track, GT road, water body, and agricultural fields; S3: Arain modal farm was near to GT road, S4: Changa Manga forest has nearby water bodies, S5: The Kot Radha Kishan was located inside a high school, had nearby water body, agricultural fields and a link road and S6: Mustafaabad was located near water body and major link road to highway (Figure 2). The details regarding the characteristics of roosting sites are mentioned in Table 1. Observations were systematically made and recorded during each visit in a field logbook. The surveys involved detailed monitoring of the number of bats and GPS coordinates of each roosting

site. A total of 9730 individuals of *Pteropus medius* were observed in Kasur district, Punjab, Pakistan, during the present one-year research period. All roosting sites were used year-round except Arain Modal Farm, where bats roosted from September to April. During the mating season from July to October, *Pteropus medius* migrates to the permanent roosting sites at Changa Manga forest. In winter, bats migrate from Changa Manga Forest to other sites due to high vegetation, canopy cover, humidity, and limited sunlight exposure. In the study area, *Pteropus medius* used single-tree and scattered roosts (aggregations on different trees at a site).

During the present study, *Pteropus medius* used 103 trees representing 11 species as roost trees. These tree species include Peepal (*Ficus religiosa*), Semal (*Bombax ceiba*), Safeda (*Eucalyptus microtheca* and *Eucalyptus rudis*), Bans (*Dendrocalmus strectus*), Jamun (*Eugenia jambolana*), Bhor (*Ficus benjamina* and *Ficus retusa*), Neem (*Azadirachta indica*), Sagwan (*Tectona grandis*), and Mango (*Mangifera indica*). The bats at Kacha Pakka roosting sites used only single tree species to 11 tree species in the Changa Manga forest. Among the 103 roost trees, *Eucalyptus* was most frequently used (n = 33), followed by *Ficus* (n = 29), *Bombax ceiba* (n = 15), *Eugenia jambolana* (n = 8), *Tectona grandis* (n = 6), *Mangifera indica* (n = 5), *Azadirachta indica* (n = 4), and *Dendrocalmus strectus* (n = *3).* The height of roost trees ranged from 15 m (*Azadirachta indica)* to 25 m (Eucalyptus), with a mean height of 25 m. The mean DBH of roost trees was 53.58 cm, ranging from 1.2 m (*Delonix regia*) to 1.14 m (*Ficus benghalensis*).

Table 1. The details and characteristics of roosting sites occupied by *Pteropus medius* in the study area.

Site No.	Location of roosting site	GPS coordinates	Roost Status	Number of roost trees	Condition of tree	Average tree height (m)	Diameter at breast height (m)	Average canopy spread (m)
S1	Kacha Pakka	N31°4’52.38 E73°45’32.76	Permanent	1	Alive	15	1.27	15
S2	Pattoki Nurseries	N30°59’52.1 E73°49’08.9	Permanent	5	Alive	25	1.14	16
S3	Arain Modal farm	N31°05’11.8 E73°53’01.0	Temporary	11	Alive	23	0.76	13
S4	Changa Manga Forest	N31°04’04.7 E73°58’25.7	Permanent	60	Alive	21	1.01	17
S5	Kot Radha Kishan	N31°10’24.36 E74° 5’24.35	Permanent	17	Alive	19	0.89	13
S6	Mustafaba d, Kasur	N31°16’5.28 E 74°24'44.98	Permanent	9	Alive	25	1.2	18

The Pearson correlation analysis indicated a significant positive correlation between bat abundance and tree height (m) (0.466, $p < 0.005$) and Canopy cover (%) (0.838, $p< 0.005$). The details are given in table 2. The large size of the trees may offer protection and more space to accommodate a large colony size. This shows that *Pteropus medius* prefers large-sized trees for roosting.

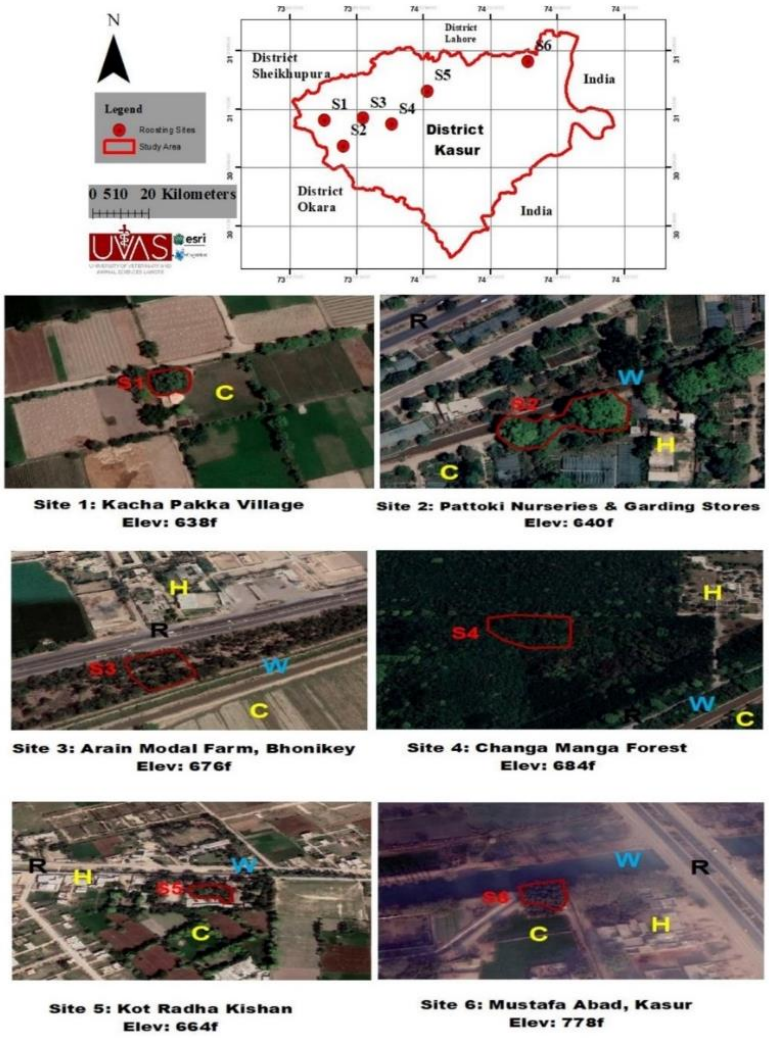

Figure 2. The details of the roosting sites in Kasur district Punjab, Pakistan.

Table 2. Pearson correlation between colony size, tree characteristics, and environmental factors.

Traits	Bat Abundance	Significance
Tree Height (m)	0.466	0.351
Tree DBH (m)	-0.047	0.930
Canopy Cover (%)	0.838	0.037*
Temperature ^{o}C	-0.0923	0.009*
Humidity %	0.733	0.097*

*Correlation is significant at $p \leq 0.05$

Table 3 details the roost and habitat preferences of Pteropus medius in the study area. A Pearson correlation analysis assessed the linear relationships between the number of bats counted and various non-roost tree-dependent factors, including the distance to the nearest water body, human settlement, road, railway track, and fruit orchard.

Table 3. Roost and habitat preferences of *Pteropus medius* in the study area.

Site	Number of bats (n)	Nearest water body (m)	Nearest human settlement (m)	Nearest road (m)	Nearest railway track (m)	Fruit orchard (m)
S1	545	12	180	110	70	200
S2	355	62	90	40	4000	334
S3	450	50	500	1200	10000	25
S4	7270	330	320	332	2070	200
S5	800	2	10	5	1000	2000
S6	310	30	125	43	840	1000

The results are presented in Table 4. There was a robust positive correlation ($r = 0.973$, $p = 0.001$) between the no. of bats counted and the distance to the nearest water body. This suggests that bats prefer to roost near water bodies. A weak positive correlation ($r = 0.300$, $p = 0.281$) was observed between the number of bats counted and the distance to the nearest human settlement, and this relationship was not statistically significant. The correlation between the number of bats counted and the distance to the nearest road was fragile and positive ($r = 0.037$, $p = 0.472$), indicating no significant relationship. A weak negative correlation ($r = -0.139$, $p = 0.397$) was found between the number of bats counted and the distance to the nearest railway track, though this relationship was insignificant. There was a weak negative correlation ($r = -0.239$, $p = 0.324$) between the number of bats counted and the distance to the nearest fruit orchard, but this relationship was also not significant. These findings indicate that only the distance to the nearest water body showed a significant positive correlation with colony size among the variables examined. At the same time, the other factors did not exhibit statistically significant correlations.

Table 4. Pearson correlation between the number of bats and various non-roost tree dependent factors.

Factors		Pearson Correlation					
		Number of bats (n)	Nearest water body (m)	Nearest human settlement (m)	Nearest road (m)	Nearest railway track (m)	Fruit orchard (m)
Pearson Correlation	Number of bats (n)	1.000	.973	.300	.037	-.139	-.239
	Nearest water body (m)	.973	1.000	.388	.121	.001	-.386
	Nearest human settlement (m)	.300	.388	1.000	.928	.754	-.716
	Nearest road (m)	.037	.121	.928	1.000	.905	-.517

	Nearest railway track (m)	-.139	.001	.754	.905	1.000	-.461
	Fruit orchard (m)	-.239	-.386	-.716	-.517	-.461	1.000
Sig. (1-tailed)	Number of bats counted		.001	.281	.472	.397	.324
	Nearest water body (m)	.001		.223	.410	.499	.225
	Nearest human settlement (m)	.281	.223		.004	.042	.055
	Nearest road (m)	.472	.410	.004		.007	.147
	Nearest railway track (m)	.397	.499	.042	.007		.179
	Fruit orchard (m)	.324	.225	.055	.147	.179	

Discussion

Distribution, roost selection, and habitat preferences of Pteropus medius are influenced by many factors, such as canopy cover, human settlement, and nearby water bodies (Gulraiz *et al.*, 2015). Indian flying foxes heavily depend on canopy cover because it provides them shelter and protection for their survival and reproduction. Tree height helps them to avoid human interference. Furthermore, canopy cover helps them to resist heavy rain. The current study's results support previous findings from Kumar and Elangovan (2019) that bats depend on larger trees for roosting. Nearby roads have not significantly influenced the distribution, roost selection, and habitat preferences of Indian flying foxes. The present study's findings revealed that tree height and canopy cover influenced roost tree selection by Pteropus medius. The positive correlation between grove and colony size suggests that *Pteropus medius* prefer to roost in more giant trees, which protects their survival and reproduction. Our study's findings align with Granek (2002) and Gulraiz *et al.*, (2015). There was considerable variation in the height of roost trees and the number of bats counted on each roost. The findings show that this is an essential factor for *Pteropus medius* colony size. Our data is similar to the results presented by Elangovan *et al.* (2018).

Furthermore, the larger tree canopy provides shadow bats shelter during hot days and a proper environment for reproduction. The same behavior was observed for other species of the genus Pteropus, such as *P. livingstonii* (Granek, 2002), *P. seychellensis* (Palot, M.J et al., 2005), *P. vampyrus* (Gumal, 2004) and *P. poliocephalus* (Parry-Jones & Augee, 1992). All the roosting sites have nearby water canals that facilitate a humid environment and thermal sensitivity. *Pteropus medius* prefers to roost near water bodies, as previously reported by Gulraiz et al. (2015). The

larger and taller trees also offer aerodynamic benefits, such as easy take-off and landing on the roost.

Conclusion

The results of the present study revealed that *Pteropus medius* is preferred for larger trees for roost, particularly Eucalyptus and Ficus, which provide adequate canopy cover to support large colonies. The colony size and the distance to the nearest water body have a significant positive correlation, suggesting that *Pteropus medius* may prefer roosting sites near water bodies. Conversely, other factors, i.e., proximity to human settlements, roads, and railway tracks, seem to have slight or no influence on colony size. It is recommended that further studies should focus on diverse regions and seasonal variations in scattering patterns of Pteropus medius to understand the species's adaptability to different environmental conditions.

References

Ali, W., Javid, A., Khan, W. A., Hussain, A., Rizwan, M., Ameer, M., & Sajid, A. Q. (2017). Diversity and habitat preferences of herpetofauna at Kalabagh game reserve, District Mianwali, Punjab, Pakistan. Russian Journal of Herpetology, 24(4), 267-274.

Chakraborty, S. K., & Chakraborty, S. K. (2021). Diversity and conservation of wildlife associated with rivers: An eco-ethological analysis. Riverine Ecology Volume 2: Biodiversity Conservation, Conflicts and Resolution, 287-441.

DDMP-Kasur. District Disaster Management Plan. 2022. (1): 1-96.

Elangovan, V., Mathur, V., Kumar, M., & Priya, Y. S. (2018). Diversity and Conservation of Chiropteran Fauna. Indian Hotspots: Vertebrate Faunal Diversity, Conservation and Management Volume 1, 57-87.

ESRI. 1996. Arcatlas: Our earth. Environmental Systems Research Institute, Inc, Redlands, California.

Granek, E. (2002). Conservation of *Pteropus livingstonii* based on roost site habitat characteristics on Anjouan and Moheli, Comoros islands. Biological Conservation, 108(1), 93-100.

Gulraiz, T. L., Javid, A., Mahmood-Ul-Hassan, M., Maqbool, A., Ashraf, S., Hussain, M., & Daud, S. (2015). Roost characteristics and habitat preferences of Indian flying fox (*Pteropus giganteus*) in urban areas of Lahore, Pakistan. Turkish Journal of Zoology, 39(3), 388-394.

Gumal, M. T. (2004). Diurnal home range and roosting trees of a maternity colony of *Pteropus vampyrus natunae* (Chiroptera: Pteropodidae) in Sedilu, Sarawak. Journal of Tropical Ecology, 20(3), 247-258.

Gunnell, G. F., Smith, R., & Smith, T. (2017). 33 million year old Myotis (Chiroptera, Vespertilionidae) and the rapid global radiation of modern bats. PLoS One, 12(3), e0172621.

Heldbjerg, H., Pedersen, C. L., Therkildsen, O. R., Bregnballe, T., Ettrup, H., Kahlert, J., & Fox, A. D. (2023). The lure of the big city: smaller Danish rookeries are increasingly associated with urban land cover. Urban Ecosystems, 26(5), 1355-1366.

Kerth, G., Almasi, B., Ribi, N., Thiel, D., & Lüpold, S. (2003). Social interactions among wild female Bechstein's bats (*Myotis bechsteinii*) living in a maternity colony. Acta Ethologica, 5, 107-114.

Kingston, T., Florens, F. V., & Vincenot, C. E. (2023). Large Old World Fruit Bats on the Brink of Extinction: Causes and Consequences. Annual Review of Ecology, Evolution, and Systematics, 54(1), 237-257.

Kumar, R., & Elangovan, V. (2019). Effect of tree characteristics on roost selection of the Indian flying fox, *Pteropus giganteus*. Journal of Bat Research & Conservafion Volume, 12, 1.

TH, K. (1996). Observational techniques for bats. Measuring and monitoring biological diversity. Standard methods for mammals, 105–114.

Leverett, B., & Bertolette, D. (2015). Measuring guidelines handbook. American Forest. American forests.org/wp-content/uploads/2014/12/AF-Tree-Measuring-Guidelines LR.

Li, J., Li, L., Jiang, H., Yuan, L., Zhang, L., Ma, J. E., & Chen, J. (2018). Fecal bacteriome and mycobiome in bats with diverse diets in South China. Current Microbiology, 75, 1352-1361.

Mahmood-ul-Hassan, M., & Salim, M. (2011). Public perceptions about the fruit bats in two horticulturally important districts of Pakistan. Journal of Animal and Plant Sciences, 21(2).

Leverett, B., & Bertolette, D. (2014). American forests champion trees measuring guidelines handbook. American Forests.

Agnoletti, M., Santoro, A., Fiore, B., Piras, F., Romano, F., & Bazzurro, A. (2023). Agricultural Heritage Systems in Europe, Asia, Africa, Central and South America. Springer.

Palot, M. J., & Radhakrishnan, C. (2005). Faunal diversity of a laterite hill system at Madayipara, Kannur District, Kerala, India.

Parry-Jones, K. A., & Augee, M. L. (1992). Movements of grey-headed flying foxes (*Pteropus poliocephalus*) to and from colony site on the central coast of New South Wales. Wildlife Research, 19(3), 331-339.

Peel, M. C., Finlayson, B. L., & McMahon, T. A. (2007). Updated world map of the Köppen-Geiger climate classification. Hydrology and earth system sciences, 11(5), 1633–1644.

Simmons, N. B. (2022). Cirranello AL Bat Species of the World: A taxonomic and geographic database. Accessed on August 21, 2023. https://batnames.org/

Tsang, S. M. (2020). *Pteropus giganteus* (errata version published in 2021). The IUCN Red List of Threatened Species.

Devi, R., & Kumar, P. (2024). Distribution status and roost characteristics of Indian Flying Fox *Pteropus medius* Temminck, 1825 (Mammalia: Chiroptera: Pteropodidae) in Kurukshetra district, Haryana, India. Journal of Threatened Taxa, 16(2), 24694–24706.