



Ecological Roles, Behavioural Patterns and Conservation Concerns of the Indian Flying Fox (*Pteropus medius*)

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Abstract

Pteropus medius, commonly known as the Indian Flying Fox, is among the largest bat species found in South Asia and plays a significant role in tropical and subtropical ecosystems. The species typically roosts in large trees, frequently located near water sources and human habitations. Its diet primarily includes fruits, nectar and tender leaves from a wide range of plant species, emphasizing its ecological importance in seed dispersal, pollination and the maintenance of forest biodiversity. *Pteropus medius* exhibits complex social organization, seasonal movement patterns and interactions with various non-human animals. Although currently categorized as Least Concern by the International Union for Conservation of Nature (IUCN), populations are declining in many regions due to anthropogenic pressures such as deforestation, tree felling, hunting and the installation of electrical transmission lines. This review further highlights major research gaps, particularly concerning migration ecology and human bat interactions. Strengthening research through advanced scientific approaches and promoting public awareness are crucial for the effective long-term conservation of this ecologically important chiropteran species.

Keywords: *Pteropus medius*, Indian Flying Fox, Movement Ecology, Roosting Behaviour, Bat Conservation

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Introduction

Pteropus medius, formerly known as *Pteropus giganteus*, is the Indian flying fox. According to the IUCN Red List, this frugivorous species belonging to the family Pteropodidae (Old World fruit bats) is categorized as Least Concern (Tsang, 2024). The Indian subcontinent is home to five Pteropodidae species; however, *P. medius* is unique to mainland India. Additionally, it is distributed throughout the Indian subcontinent, including Bangladesh, India, Sri Lanka, Nepal, Pakistan, Bhutan and the Maldives. *Pteropus medius* typically has forearm lengths between 152 and 183 mm and head-body lengths between 198 and 300 mm. Its pelage is generally blackish-brown with a few lighter hairs. Leucism is one of the documented rare cases (Mlíkovský, 2012).

The diet of the Indian Flying Fox includes fruits, tender leaves, flowers and nectar. They play a vital role in the ecosystem by aiding in seed

dispersal and pollination of multiple trees and plants, while their bolus and excreta (guano) act as manure for plants. Since they are involved in the pollination of a variety of plants, some plant species exclusively rely on bats for pollination. Till present, there is only one compendium on the distribution, ecology and behaviour of *P. medius*, namely the book *Bats of the Indian Subcontinent*, which is now almost 30 years old. Therefore, this review has gathered research articles from 1997 to 2025 and compiled the data on *P. medius* with a statistical approach. This article provides a comprehensive view of the distribution, ecology, behaviour, population dynamics and future perspectives of *P. medius* studies. They live in colonies that can contain individuals ranging from 10 to a few thousand (Ali, 2010). The largest colony recorded was found in Sri Lanka, with about 24,480 individuals spread over 20 hectares.

Numerous diseases that can infect humans can be found in chiropterans. Nipah virus, coronavirus and other diseases are also associated with *P. medius* populations. All detrimental interactions between humans and bats contribute to spillover events (McEvoy *et al.*, 2021). This literature study also addresses potential conflicts that may arise frequently.

Habitat and Roost Characteristics

Depending on the resources available, different *P. medius* populations may choose different roosts. Roost preference also varies with the season; during summer, they commonly roost on *Ficus benjamina*, *Swietenia mahagoni* and *Syzygium cumini*. In winter, they roost on *Bombax ceiba*, *Eucalyptus* sp. and *Pinus strobus* (Pandian & Suresh, 2021). There were notable seasonal variations in bat populations, with protected sites exhibiting little variation and non-protected locations having greater bat populations during winter. Bat populations were higher and more stable as a result of the more stable environmental conditions seen in protected places such as Periyar Tiger Reserve.

Furthermore, a positive correlation was found between bat abundance and tree height, tree diameter at breast height and canopy cover. Temperature, humidity and vegetation were identified through principal component analysis (PCA) as important environmental factors affecting roost site selection. Numerous anthropogenic activities, such as felling of roost trees, also negatively affect these species. Temporary non-protected sites received the lowest score, whereas protected permanent roosts in natural environments with no human influence received the highest scores. Permanent protected sites in urban areas ranked second (Pandian & Suresh, 2021).

Roosting Behaviour

Strong site fidelity, colonial dwelling and a preference for tall, mature trees near bodies of water or in urban and semi-urban settings are characteristic features of *Pteropus medius* roosting behaviour. Colonies consist of hundreds to thousands of individuals, creating dense clusters that promote social interaction and thermoregulation. Although this species has demonstrated considerable adaptation to anthropogenic contexts, roost sites are usually selected based on features such as canopy structure, microclimatic stability and minimal human disturbance. During the day, individuals hang inverted from branches and engage in behaviours that are crucial to maintaining social

hierarchy and cohesiveness, such as wing flapping, grooming and vocal communication.

Seasonal variations influence roost dynamics, with shifts in colony size and composition occurring in response to reproductive cycles, food availability and environmental conditions (Kumar *et al.*, 2019). Additionally, roosts serve as important centres for information exchange, where individuals may gain cues regarding foraging sites, highlighting the ecological significance of roosting behaviour in the survival and distribution of the species.

Movement Ecology of *P. medius*

Pteropus medius is a highly mobile and ecologically significant species because of its movement ecology, which demonstrates a complex relationship between resource availability, landscape structure and behavioural adaptation. Depending on seasonal variations in food resources such as fruits and nectar, this megachiropteran bat can undertake long-distance nighttime foraging flights, frequently travelling 20–50 km or more between roosting and feeding locations (McEvoy *et al.*, 2021). In order to maximize foraging efficiency, individuals often revisit specific feeding trees in a trapline-like pattern. These movements are generally non-random and demonstrate a high degree of spatial memory (Murugavel *et al.*, 2023).

Regional and seasonal fluctuations in colony dispersion have been noted, although they are not technically migratory. These changes are driven by phenological variations in the flowering and fruiting cycles of preferred plant species. In addition to highlighting its resilience, the species' extraordinary adaptability in traversing fragmented landscapes—often crossing metropolitan areas, plantations and agricultural fields—also increases interactions with habitats altered by humans. Movement patterns are further influenced by social dynamics, since individuals may be directed toward productive foraging regions through information sharing within colonies. Flight distances and timing can also be influenced by variables such as reproductive state, weather and predation risk. *P. medius* plays an important role as a pollinator and seed disperser, promoting gene flow and maintaining ecosystem connectivity across extensive spatial scales due to its remarkable flight capabilities and wide-ranging movements.

Pteropus medius demonstrates significant temporal organization and individual variation in its movement patterns, influenced by both

internal and external factors. Although secondary foraging sessions may occur before dawn, emergence from roosts generally takes place shortly after sunset, with peak activity concentrated during the early night hours (Murugavel, Kelber, & Somanathan, 2021). Different movement behaviours are displayed by individuals; some remain within relatively stable home ranges, while others respond to fluctuating resource distribution through opportunistic or exploratory flights.

Compared to experienced adults, juveniles and subadults frequently exhibit broader exploratory movements, indicating a learning component in resource mapping and spatial navigation. Traditional movement corridors can be altered by environmental constraints such as habitat fragmentation, urban expansion and climate variability. This can occasionally result in increased energy expenditure and changes in foraging behaviour. Furthermore, instead of relying heavily on echolocation, which is relatively diminished in megabats, the species primarily utilizes visual and olfactory cues together with spatial memory for navigation.

Although less frequent, roost switching can also contribute to landscape-level movement dynamics when there is disturbance, resource depletion or seasonal breeding requirements. Collectively, these movement traits demonstrate the ecological adaptability of *P. medius* and its sensitivity to environmental change, emphasizing the need to incorporate movement ecology into conservation planning and habitat management (Murugavel *et al.*, 2023).

Conclusion

The current analysis concludes by highlighting the ecological, behavioural and conservation significance of *Pteropus medius* as a keystone species throughout the tropical and subtropical regions of the Indian subcontinent. *P. medius*, one of the largest frugivorous bats, is essential in maintaining ecosystem dynamics through efficient pollination, seed dissemination and nutrient redistribution, thereby greatly enhancing plant diversity and forest regeneration. Its feeding ecology, which includes a broad array of fruits, flowers, nectar and leaves, enables interaction with many plant species, some of which rely heavily on bats for successful reproduction. The species demonstrates intricate behavioural patterns that improve survival through group alertness, thermoregulation and information sharing, particularly in relation to colonial roosting, social organization and communication. Although there is increasing evidence of

adaptation to urban and semi-urban settings, roosting sites are carefully selected based on environmental stability, canopy structure and proximity to water sources. Additionally, the movement ecology of *P. medius* demonstrates exceptional spatial flexibility, with individuals exhibiting high levels of spatial memory and environmental awareness through long-distance nocturnal foraging flights and seasonal adjustments in response to resource availability.

Despite these adaptive characteristics, the species is increasingly threatened by human activities such as hunting, habitat fragmentation, roost tree degradation, electrocution from power lines and deforestation. Negative attitudes regarding disease transmission, particularly in relation to zoonotic viruses such as the Nipah virus, further intensify conflicts between bat populations and humans. In addition to threatening bat survival, these interactions disrupt ecological processes that are critical to ecosystem health. Despite the current IUCN Red List classification of "Least Concern," habitat disturbances and regional population declines underscore the need for reassessment and more focused conservation strategies. This review also highlights important knowledge gaps, particularly concerning long-term population monitoring, migration behaviour, large-scale movement patterns and the ecological effects of human-induced environmental changes. The integration of advanced research techniques such as satellite telemetry, GIS-based habitat analysis and molecular tools for disease surveillance will be essential for addressing these gaps.

To promote human bat coexistence, conservation initiatives should prioritize the protection of important roosting sites, particularly mature trees in both natural and urban settings, alongside community-based awareness programmes. Policy-level interventions, scientific research and public participation will be crucial for minimizing threats and ensuring long-term conservation outcomes. Ultimately, conserving *P. medius* is essential not only for the survival of a single species but also for maintaining broader ecological integrity, as the loss of such a significant pollinator and seed disperser could trigger cascading impacts on biodiversity and ecosystem resilience across the region.

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