Demography, Population Dynamics and Behavioural Ecology of Indian Flying Fox, *Pteropus giganteus*

SUMMARY

of

THESIS

SUBMITTED IN FULFILMENT FOR THE AWARD OF THE DEGREE OF

Doctor of Philosophy

IN

APPLIED ANIMAL SCIENCES

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Enrollment no: 252/09

Year 2018

Flying foxes exhibit a combination of features such as sustained flight, sophisticated olfection, seed dispersal abilities and pollination which makes them a typical creature than other mammals. Indian flying fox, *Pteropus giganteus* gregariously assembles at roosts during daytime. The roosts are the fundamental sites of social interaction and exhibit various behavioural activities among the roost mates. Presently, flying foxes have become a growing area in ecological studies. However, information regarding distribution, behavioural ecology including details of roost selection, foraging strategies, and demographics are scanty. Therefore, the proposed research work was designed to investigate the natural history of Indian flying fox, *P. giganteus* in Uttar Pradesh.

In terms of geographical area, Uttar Pradesh considered as fourth largest state and possibly it might be a reason of roost abundance of *P. giganteus*. Over the study period, a total of 84 roost sites of *P. giganteus* was observed from the 34 districts of Uttar Pradesh.

A total of 84 roost sites of *P. giganteus* was observed from the 34 districts of Uttar Pradesh. *Pteropus giganteus* independently roosts on larger trees such as *Acacia nilotica* Linn., *Albizia lebbeck* Linn., *Alstonia scholaris* Linn., *Artocarpus integrifolia* Linn., *A. lakoocha* Roxb., *Azadirachta indica* A. Juss., *Bamboo* spp., *Bassia latifolia* Linn., *Bombax ceiba* Linn., *Borassus flabellifer* Linn., *Cassia senna* Linn., *Dalbergia sissoo* Roxb., *Delonix regia* Hook., *Eucalyptus* spp., *Ficus racemosa* Roxb., *F. religiosa* Linn., *F. tinctoria* Bl., *F. virens* Linn., *F. benghalensis* Linn., *Grevillea robusta* A. Cunn., *Holoptelea integrifolia* Planch., *Leucaena leucocephala* Lam., *Limonia acidissima* Linn., *Mangifera indica* Linn., *Neolamarckia cadamba* Roxb., *Phoenix silvestris* Roxb.,

Polyalthia longifolia Sonn., *Prosopis juliflora* Sw., *Syzygium cumini* Linn. and *Terminalia arjuna* Roxb.

Pteropus giganteus prefers to occupy a large number of wide-canopy trees (71.4% trees) such as *F. benghalensis, F. racemosa, F. religiosa, F. virens, M. indica, S. cumini, B. latifolia, D. sissoo, D. regia* and *A. indica* while they occupied a few narrow-canopy trees (28.6% trees) like *Eucalyptus* spp., *T. arjuna* and *P. longifolia*. *Pteropus giganteus* seldom roosts in discrete trees, instead the colonies were observed in groves with a large number of trees.

The results of present study showed that the distribution of *P. giganteus* was wide spread and roost selection was influenced by roost tree characteristics such as dbh, height and canopy width of roost trees. The roost trees chosen by bats had wide canopy and out of reach to human and predators. The selection of wider canopy roost trees provides ample of roosting area to fulfill their life history needs especially reproduction. The topographic feature of large and long living trees provide many advantages to the bats like protection, thermoregulation, aerodynamic benefits such as easy take-off and landing and suitable conditions for their reproductive behaviour.

The colonies were observed nearer to the non-roost dependent characters such as water bodies, human habitations and arterial road but it didn't influence significantly. Further, it was also observed that *P. giganteus* drinks water nearby water sources during day hours. Roost adjacent to water bodies provides water facilitates, humid environment and thermal balance during hot seasons while human habitation offers diverse food items which are possibly inaccessible in the natural forests.

During day times, the individuals of *P. giganteus* actively involved in various diurnal behaviours such as wing fanning (3%), grooming (6%), roost shifting (22%) and screaming (14%) until afternoon. However, they did not actively involve on wing fanning (8%), instead, they spent more time on grooming (26%), roost shifting (20%) and screaming (19%) during pre-emergence hours.

Bat emergence was recorded from the vantage point while time and number of bat emergence were recorded between the emergence of the first to the last bat in the colony. They actively involved in body worm up, sensing of weather and suitability of emergence. Grooming and wing stretching make them ready for emergence while vocalization synchronizes their wake up. *Pteropus gigantesus* makes a few circling flights around their roosts before emergence, presumably to assess the light intensity and predation risk.

The emergence was initiated by a few individuals which were occupied the peripheral canopy of the tree, followed by other individuals emerged from the roosts. An average bat emergence was observed 0:32 ± 0:10 h:m after the sunset. The time of peak emergence was varied throughout the year and seasons. The emergence behaviour of *P. giganteus* was observed during winter (17:30 – 18:37 h:m) than monsoon (18:37 – 20:04 h:m) and summer (18:38 – 19:46 h:m).

The emergence of bat was entirely based on group size and their reproductive conditions, perhaps lactating females exhibit prepone emergence while males at the end. The shortest day length was observed during winter (10:48 h:m) while longest day length observed during the summer season (13:02 h:m). Hence, bats altered their time of

emergence according to the day length, i.e. shorter the day length, earlier the emergence and longer the day length, later the emergence.

After the home flight, the individuals of *P. giganteus* were actively engaged in roost alteration which facilitated them for finding suitable mates. The male bats made many circling flights around the roost and exhibited quadrapedal movement until finding a suitable mating partner. The reproductive behaviour such as pair bonding, courting the females, licking the face and genitalia of females by males were observed throughout the year. The successful male undergone pair bonding and subsequently copulated with the females and the unsuccessful males kept on shifting the roost over the day. The segregated mating partner grooms patagium, toes and genital organs independently which presumably enhanced reproductive fitness in *P. giganteus*.

A visual count method was used for the estimation of population size of *P. giganteus* while branch estimation, binocular and photographic method was extensively applied in inaccessible roost. The population size of *P. giganteus* increased dramatically due to gathering of immigrants during reproductive season possibly male individuals for availing mating opportunities and colony size decreases proportionally at the end of mating season due to the dispersal of emigrants. It was observed that the population of *P. giganteus* fluctuated over the study period. The colony size of *P. giganteus* increased exponentially during reproductive season due to aggregation of immigrants (Aug – Nov) and the most abundant population was recorded in the month of September (n = 1495). Due to the abundance of population size, the individuals roosting over the grove and colony was observed as noisy. The dispersal of migrant individuals during non-reproductive season caused dramatic changes in the population size of *P. giganteus*.

Throughout the study period, the highest ambient temperature was recorded in June (42.4 °C) and lowest in January (4.9 °C) but the colony size decreased with increasing temperature in summer season and remains stable during winter season because of pregnancy.

During ambient temperature, *P. giganteus* shifted roost from canopy to trunk and leafy area and made a well shape cluster due to heat waves. However, it also observed that a number of bats died due to heat shock and it was recorded form the various roosts. An unforeseen death case of *P. giganteus* observed from a colony in Kanpur (n = 84). During foggy nights, a number of dead bats were observed from Ambedkar Nagar, Bareliey, Faizabad, Lucknow, Shajahanpur and Sitapur districts.

It was observed that *P. giganteus* gives single pup in a reproductive season. However, pups were exclusively cared by mother for a couple of days until they can roost and fly independently. It was also noticed that pups carrying mother generally made solitary roost either at the peripheral branch or trunk region of the roost trees. The lactating females actively involved in wing fanning during sunny hours which make them maintain thermoregulation with ambient temperature.

It was found that the study area of Uttar Pradesh has a wide range of resource availability and presumably it might be a reason that *P. giganteus* reproduces and maintains maternal colonies for many decades. It was noticed that *P. giganteus* are the mobile feeder hence, they altered foraging sites based on the food availability. However, *P. giganteus* actively forage on selective plants such as *Ficus benghalensis*, *F. religiosa*, *F. racemosa*, *F. virens*, *Psidium guajava*, *Syzygium cumini* and *Neolamarckia cadamba* due to the abundance in the study area.

The individuals of *P. giganteus* started to arrive in the grove at 19:04 ± 0:29 h:m. In the beginning, only a few individuals arrive at the foraging site but within a couple of minutes, the population size increased dramatically. *Pteropus giganteus* actively engaged in the circling flight over the fruiting trees for scanning for food availability, foraging suitability and predation risk. They highest circling flight was recorded at 20:00 h:m but once they involved in the foraging, the frequency of circling flight decreased steeply. The number of circling flight was higher in pre-midnight than post-midnight.

It was observed that *P. giganteus* forages on the upper and peripheral canopy of the tree. They start biting until buccal cavity fills up with sufficient amount of bolus. As chewing is initiated, the succulent portion of the bolus is sucked and spitted out the fibrous portion as rinds.

The characteristics of foraging trees were measured and the result suggests that tree height and canopy width have a significant role as it offers feasibility of resource identification, fruits scanning and social interaction while dbh have no substantial role in the foraging behaviour of *P. giganteus*.

The outcome of this study may pave various novel approaches on the behavioural and population ecology of *P. giganteus*. Further, the protection of larger trees which were reported in this study would help to conserve the habitat and thus the Indian flying fox, *Pteropus giganteus*.