Preliminary assessment of activity pattern and diet of frugivorous bats (*Pteropus giganteus*) in Bethune College campus, Kolkata

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Abstract

There is an existence of perennial roosting colony of Indian Flying fox *(Pteropus giganteus)* in Bethune College campus, Kolkata (an urban ecosystem). *Present study emphasizes the estimation of total population in different roosting sites, dietary habit analysis and tracking the foraging route. These objectives provided us with substantial data on habitat manipulation of these creatures so that important measures can be taken to conserve this endangered species. The population count from March, 2010 to May 2011 shows an increasing trend during winter-spring season and highest count is observed in March. So it was concluded that the population of these frugivorous bats in Bethune College campus could be considered as a metapopulation. Decreasing trend in population is not accompanied by any mortality records. But from January, 2012 their roosting sites in Bethune College showed an abrupt decline due to human interference i.e. new constructions adjacent to their roosting sites. As a result, the number of bats decreased in March 2012.* Roosting sites of bats have great ecological significance in conservation of biodiversity. In this study, flying fox guano with 70% banyan seeds indicates their role in dissemination of an important keystone plant species in our ecosystem. As flying foxes are also dependent on juice and pollen of tree flowers, they play crucial role in the pollination of tree species. Public awareness on the importance of flying foxes in pollination, seed dispersal and the benefits of their excrement (as natural organic manures) may create better understanding to preserve their roosting habitats. This study site comprising of a roosting colony of frugivorous bats gives an insight into developing conservational measures to protect this fauna. History reveals that this colony is more than fifty year old roost. This gives a strong evidence that habitat of their roosting site has remain undisturbed for long. This study will support measures to be taken to maintain this undisturbed habitat and create awareness for conserving their habitat and ecological resources utilized by them in near future.

Keywords

Urban ecosystem; flying fox; frugivorous; pollination; metapopulation;

Introduction

Bats are cosmopolitan in distribution, excepting the Arctic and Antarctic. The Indian subcontinent harbours a variety of chiropterans, including frugivorus bats. Over 200 species of flying foxes are distributed throughout the tropics and being frugivorous they play a major role in pollination and seed dispersal. The Indian flying fox, *Pteropus giganteus* Brunnich commonly roosts on large trees (e.g. *Ficus*). They earned the name 'flying fox', as the head and fur resemble a fox. Their roosting results in the accumulation of substantial amount of guano on the floor. They swallow soft fruits or extract juice and spit out the remains known as bolus, containing the residual fruit pulp of fibrous fruits and seeds. Besides fruits, they are also known to feed on juice and pollen of various tree flowers. Although flying foxes are widespread species, they are facing threats mainly due to loss of roost trees, hunting and pesticide use. A dramatic decline in their population has been seen due to hunting for food and medicine and is thus placed under least conserved and endangered species in South Asia. Investigations pertaining to ecological values and ecosystem services of flying foxes are warranted in biodiversity conservation measures. Bats spend most of their lives in their roosts. By choosing a suitable roost, bats gain important benefits, such as better mating opportunities; improved maternal care; increased social interactions and information transfer; cheaper thermoregulation; reduced commuting costs to foraging sites; and protection from adverse weather and predators. In general, *Pteropus* species tend to roost in large aggregations on exposed branches. The main threats facing colonial, tree-roosting *Pteropus* species world wide, are habitat loss to agriculture (Mickleburgh *et al*. 1992.

The following terms are used accordingly: roost trees refer to the trees used by the bats for sleeping or resting during the day; roost sites are areas of roost trees occupied by the maternity colony, and diurnal home ranges encompass all of diurnal roost sites for the maternity colony.

Next to rodents, bats are the most numerous mammals in the world. According to Mickleburgh et al (2002), there are 1001 species of bats in the world. India's bat fauna is rich and diverse with 114 species (17 megachiroptera and 97 microchiroptera) which is more than 11% of the world's bats (Bates and Harrison, 1997). Among fruit bats, the Indian flying fox *Pteropus*

giganteus, the fulvous fruit bat *Rousettus leschenaultia* and the short-nosed fruit bat *Cynopterus sphinx* are widely distributed in the Indian subcontinent. *Pteropus giganteus* (Indian flying fox) occurs in tropical regions of South Central Asia, from Pakistan to China, and as far south as the Maldive Islands. (Nowak, 1999). These animals can be found in forests and swamps. Large groups of individuals roost in trees such as banyan, fig, and tamarind. The roosting tree is the area in which Indian flying foxes spend the majority of the day. This species, as well as other large species of Pteropus, is reported to travel up to 15 km to find food. *Pteropus giganteus* is frugivorous, as are other species of the Suborder Megachiroptera, otherwise known as the Old World fruit bats. This species has been reported to eat many different species of fruit, including guava, mango, and fig.

These species provide substantial ecological and economic services via pollination, seed dispersal and agricultural pest control (Mistry, 2001). For example, the common species of fruit bats visit over 114 plant species and act as important pollen and seed vectors (Mickleburgh et al, 1992; Molur et al, 1998). Moreover, the credit for boosting the growth of different fruit bearing trees goes to these bats.

There is an existence of perennial roosting colony of Indian Flying fox (Pteropus giganteus) in Bethune College campus, Kolkata. This roosting site comprises of two Banyan (Ficus benghalensis) trees and one Peepal (Ficus religiosa) tree in the college campus. We can consider this small population as urban wildlife from point of view of its geographical location.

Present study emphasized on the estimation of total population in different roosting sites, foraging sites of the animal, other important ecological resources utilized by these populations, to determine the extent of pollution and contamination of the ecological resources utilized by the Indian flying fox in the urban areas. These objectives provided us with substantial data on habitat manipulation of these creatures so that important measures can be taken to conserve this endangered species.

Material and methods

- ***a.*** ***Survey to discover new roost sites if any and regular monitoring of bats at known roost sites:*** New roosting sites were identified by regular survey. It is relatively simple phenomenon to quantify the amount of time that bats spend in their day roost because time of entry and departure can be recorded easily or observed directly. Placing individual behaviour in a temporal context rather establishing an appropriate relationship between the environmental condition and the roosting activity requires elaborate study of their behaviour. This study was done by construction of an ethogram**.**
- ***b.*** ***Dietary habit analysis:*** *The undigested seeds were collected from the guano and bolus and allowed to germinate for identification of their feeding habits. Indirect evidence identified the foraging site, namely, Bana Bitan, Central Park, Salt Lake. It possesses variety of trees and two water bodies.*
- ***c.*** ***Analysis of water body used by the bats for water consumption:*** *Two water bodies present in their nearest foraging site (based upon indirect evidence) were analysed for various physico-chemical parameters by following the method of APHA, 1984. The objective of this study was to determine the extent of pollution and contamination of the ecological resources utilized by the Indian flying fox in the urban areas.*

Results

- **a.** Two new roosting sites, namely, *Peltophorum pterocarpum* and *Anthocephalus cadamba* were identified in course of time. From our study, we observed that the period immediately following the return of the gregarious species is predominated by cluster formation and settling. Within an hour or two following returns, a lull in activity becomes evident. The day roost period may occasionally be interrupted by bouts of spontaneous activity including self grooming, allogrooming, copulation and flight. Quantification of day roosting activity in bats and analysis of defined behavioural categories (resting, active, grooming, moving and flight) indicate that the day roosting period was predominated by rest when the temperature were low followed by allo grooming behaviour. However, with the increase in temperature the day roosting period was predominated by grooming behaviour such as fanning etc to make them comfortable. (Table 1). Therefore, energy expenditure of the individuals for a particular behaviour can be correlated with the environmental condition of the roost. Grooming occurs primarily following the return from feeding and again before the onset of nightly departure. The short day time flights are due to the changes in roost position in response to intruders and retreat from sunlight. A concrete relationship was established between an environmental factor (i.e. temperature) and time budgeting of daily activities of bats in their roost site. (Figure 1).

- ***b.*** *70% seedlings were of Ficus sp, 20% of Guava and 10% not identified. Indirect evidences revealed that fruit bats chose Bana Bitan, Central Park, Salt Lake as their nearest foraging site and were seen to feed upon Duabanga grandiflora* (Roxb. ex DC.) Walpers (Family: Lythraceae) *in the said foraging site.*

c. *All the physico-chemical parameters quantified were within acceptable limits and are not rendering any hazardous effects on the population of fruit bats which is apprehended to utilize these ecological resources (based on indirect evidence) (Table 2).*

Discussion

The study gives an insight into the time budgeting of bats at their roosting sites. Moreover an effort was made to determine the dependency of their activities on an environmental factor for a short period.

Roosting sites of bats have great ecological significance in conservation of biodiversity. In this study, flying fox guano with 70% banyan seeds indicates their role in dissemination of an important keystone plant species in our ecosystem. As flying foxes are also dependent on juice and pollen of tree flowers, they playa crucial role in the pollination of tree species. Public awareness on the importance of flying foxes in pollination, seed dispersal and the benefits of their excrement (as natural organic manures) may create better understanding to preserve their roosting habitats. Future studies need to address the efficiency of flying fox excrement amendment to soil or other organic manure in plant production. It will be interesting to assess flying fox guano for the presence of plant-promoting and plant-colonizing microbes for their application in agriculture.

Old World phytophagous bats (Megachiroptera: Pteropodidae) number 173 species of which 79% are Asian and 21% African. Bats arose, presumably monophyletically, in the early Tertiary, the Megachiroptera soon diverging from the Microchiroptera. By the Cretaceous-Tertiary boundary the major groups of modern angiosperms were present, some of these probably being pollinated nocturnally by large insects and non-flying mammals and others with seeds dispersed by terrestrial vertebrates. Early bats were perhaps initially attracted to such flowers and fruit by the insects found around them, later finding the plants themselves nutritious. Megabats today feed upon floral resources, fruit and leaves from a total of at least 188 plant genera in 64 families. They may affect both pollination and seed-dispersal, and both bat-flower and bat-fruit syndromes are commonly recognized. Individual species are generally catholic in their feeding, favoured food varying with locality and season. Depending upon roosting habits and season, megabats may travel considerable distances each night to feed and may undertake seasonal migrations. Their feeding in orchards may sometimes require their control, but the future of certain species is more seriously threatened by slaughter for food and particularly by habitat destruction.

Fruit bats enrich the ecosystem they inhabit by seed dispersal and pollination of flowering shrubs, herbs and trees. Indian fruit bat is protected under the Schedule-V of the Wild Life Protection Act, 1972, but the creatures have a high mortality rate because of hunting and changes in climate. Of late their population has dwindled to a considerable extent in various parts of the country.

Flying foxes play a pivotal role on multifarious ecosystems. They act as seed-dispersal agents as they feed on small Eucalyptus flowers, mangoes, guavas and other fruits. They assist pollination of more than 114 species of plants which are of economical, ecological, medicinal and even religious importance. Wild varieties of bananas and guavas are dependent on bats to maintain their population.

Despite playing such an important role in the natural cycle, bats are deprived of any kind of official protection in most of the places. *Flying foxes* are brutally netted out and killed for meat by some tribes also. Their number is also affected by regular use of pesticides by farmers to protect their orchards from these Flying foxes.

About 12 fruit bats have been classified as vermin under the Wildlife Protection Act. No monitoring of their population has been done in the near past, thus little is known about their actual status.

While emphasizing about the conservation status, this species is listed in CITES Appendix II, meaning it is not currently threatened, but could become so if protective measures are not taken.

Due to loss of habitats and conflicts between bats and fruit growers (Jacobson and Duplessis, 1976), there is a population decline of bats in the recent years. Therefore, without a thorough documentation of their ecological value, it is difficult to convince government for their protection.

The study of behavior and ecology of fruit bats invite future studies which are important not only to protect these creatures but also the plants which rely on these bats for pollination, dispersal and propagation of seeds. Thus this study will aid in understanding plant-animal interactions.

This study site comprising of a roosting colony of frugivorous bats gives an insight into developing conservational measures to protect this fauna. History reveals that this colony is more than fifty year old roost. This gives a strong evidence that habitat of their roosting site has remain undisturbed for long. The above study will support measures to be taken to maintain this undisturbed habitat and create awareness for conserving their habitat and ecological resources utilized by them in near future.

As the temperature increases time spend for resting decreases				
	19.2.2010	02.3.2010	16.3.2010	29.3.2010
Temperature	31.5°C	37.1°C	39.6°C	38.1°C
Resting time	8hr 46m 20s	5hr48m45sec	5hr 50m	5hr 51m
As the temperature increases, movements of patagium like flapping, fanning increases				
Movement of patagium	1hr1min30sec	2hr57min45sec	3hr 10min	3hr7min30sec
As the temperature increases time spend in allogrooming decreases				
Allogrooming	57min	30min	25min	27min
As the temperature increases time spending for different activities (like vocal activity, movement etc) decrease				
Other activities	24 min	23min 30 sec	22 min	16min 30 sec

Table 1: Time budgeting of daily activities of bats in their roost site

	Pond 1	Pond 2
Dissolved Oxygen (mg/l)	8.50	13.56
Free Carbon di oxide (mg/l)	14.00	12.00
Hardness (mg/l)	152	200
Alkalinity (mg/l)	67.89	85.41

Table 2: Quantification of physico-chemical parameters

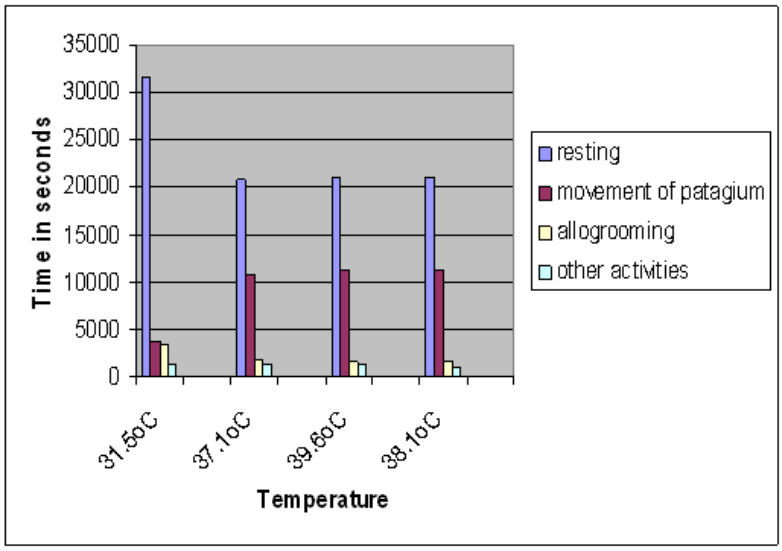

Figure 1: Relationship between temperature and daily roosting activities of bats.

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