

## SOLITARY BEHAVIOUR OF INDIAN FLYING FOX *PTEROPUS GIGANTEUS* (BRUNNICH, 1782) FROM SALINGYI TOWNSHIP, SAGAING REGION

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### Abstract

Salingyi is a township in Yinmabin District in the Sagaing Region of Myanmar. The behaviour of *Pteropus giganteus* was conducted for twelve months; from December 2017 to November 2018. The purposes of this study are to quantify directly the daytime behaviours categories and to know solitary behavioural of roosting bats with relating to ambient temperature. Data collection was conducted clearly visible on a single roost tree purposively sampled for studies of daytime behaviour. Focal sampling and scan sampling were utilized according to Martins and Bateson (2007). The number of individual bats counted in *Sizygium jambos* colony ranged between a minimum of 174 individuals and maximum of 566 individuals. The diurnal activity patterns consisted of the solitary activities of roosting, sleeping and grooming, stretching and fanning. Indian flying foxes were found to sleep most in the early morning (20°C-25°C) and became active in the afternoon and evening (30°C-35°C). Fanning was more frequently recorded during the afternoon (30°C-35°C) than other time periods in a day. Grooming and wing stretching were increased with ambient temperature (25°C-30°C). The present study indicates that the ambient temperature has a profound effect on the behaviour of Indian flying foxes.

**Keywords:** *Pteropus giganteus*, solitary behaviour, ambient temperature, Sagaing Region

### Introduction

Bats (order Chiroptera) are unique in being the only group of mammals that have developed sustained flight. Approximately 25% of all chiropteran species (nearly 238 species) are considered threatened by the International Union for Conservation of Nature (IUCN) (Kumar and Kanaujia, 2009). Order Chiroptera includes more than 1,300 extant species and are and unique among mammals in their evolution of powered flight (Kingston and Voigt, 2016). After rodents, the second most diverse group of small mammal is bat (Hutchins *et al.*, 2003). In addition, the suborder Megachiroptera contains one family (Pteropodidae) that includes 186 species of mainly frugivorous bats (Simmons, 2005). At the present, the known bat species from Myanmar is 103 (Bates, *et al.*, 2020). The Indian flying fox is found in Bangladesh, Bhutan, China, India, the Maldives, Myanmar, Pakistan and Sri Lanka and it is widely distributed across most of Nepal (Jnawali *et al.*, 2011).

Nearly all species of bat (except species of the genus *Pteropus*) occupy a wide variety of habitats like caves, crevices, temples, ruined buildings and foliage. Bats living in such habitats are well protected from predators and the abiotic factors like sunlight, ambient temperature, humidity, thunder and rain. Whereas, bats belonging to the genus *Pteropus* live in trees by exposing themselves to these abiotic factors (Bates and Harrison, 1997).

Their diurnal roosts are found in various types of large and tall trees, including *Ficus bengalensis*, *F. religiosa*, *Tamarindus indica*, *Mangifera indica*, *Dalbergia sissoo* and *Eucalyptus* sp (Vendan, 2003). During hot summer days, majority of the individuals gently flap the distal end of one of their wings, which is attributed to thermoregulation (Mathur *et al.*, 2012).

The flying foxes are very conspicuous among tree roosting bats and thus many studies have been carried out on various aspects such as population ecology (Mathur *et al.*, 2012; Manandharet *et al.*, 2017), reproductive behaviour (Maruthupandian and Marimuthu, 2013), roosting ecology

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(Hahn *et al.*, 2014; Gulraiz *et al.*, 2014), distribution (Kumar *et al.*, 2017) and conservations issues (Senthilkumar and Marimuthu, 2012).

The behaviour of *P. giganteus* considered as an interesting phase because it bifurcates the diurnal and nocturnal activities. The nocturnal behaviour of *P. giganteus* begins with the emergence and ends with home flight. During the day, these animals sleep, hanging upside down by their feet with their wings wrapped around themselves. They also fan themselves to aid in thermoregulation, move around in the roosting tree, and communicate with each other (Nowak, 1999).

Bat generally prefers to roost during in diversified roosting habitats. Roosting site selection depends on their abundance, risk of predation, availability and distribution of food resources, body size and physical environment (Kunz, 1982). Similarly, Khan *et al.* (2020) also reported that *P. giganteus* utilizes different feeding and roosting sites including diverse roost. Local climate, seasonal food availability and social interactions among bats are the main factors responsible for evolving solitary or gregarious foliage roosting behavior in bats (Kunz, 1982).

The purposes of this study are to quantify directly the daytime behaviours categories of *P. giganteus* and to know solitary behavioural patterns of roosting bats with relating to ambient temperature

## Materials and Methods

### Study area

Salingyi is a township in Yinmabin District in the Sagaing Region of Myanmar. Bonsanwaddy monastery, Kyardet village, Salingyi Township was chosen as the study area. It is located at 21° 50' 29.58" N and 94° 56' 10.57" E and situated at South-West from Salingyi Township (Plate.1).



**Plate 1** Location map of study area

### Study period

The study was conducted for twelve months; from December 2017 to November 2018.

### Identification of the specimens

The identification of the specimen was according to Bates and Harrison (1997).

### Data collection

The population of Indian Flying Fox, *Pteropus giganteus* roosted on 11 trees, *Sizygium jambos* (one) and *Tamarindus indicus* (10). Among the 11 roosting trees, countings were only conducted in *Sizygium jambos* roosting tree. The behaviors of roosting flying foxes were recorded three times in a month. Observation days were spread across three times (morning, afternoon and

evening). Observation started at (8:00 hr) and ended at (17:00 hr). Focal sampling and scan sampling were utilized according to Martins and Bateson (2007).

Data collection was conducted on a clearly visible single roost tree purposively sampled for studies of daytime behaviour. The ambient temperature at the study locations was recorded from morning to evening using a thermometer.

## Results

The number of individual bats counted in *Sizygium jambos* colony ranged between a minimum of 174 individuals and maximum of 566 individuals. The numbers of bat increased to peak population in April 2018 but the decreasing of bat population was observed in January 2018 (Fig. 1).

### Solitary behaviours of *P. giganteus*

#### Sleeping

Sleeping bats hung claws at the twig while their wing membranes or patagium were wrapped up and covering the head and ventral parts of the body but sometimes it was also seen even with an open arms or wings (Plate 2 A).

#### Grooming

Bats used their hindclaw, foreclaw, mouth, tongue and teeth for grooming. This behaviour was manifested by licking the fur and inner and outer membrane, licking genitals, licking mouth, scratching body, cleaning ears. Actually, the grooming behaviour was observed after the bat perching on the twigs during the field observations (Plate 2 B).

#### Stretching

Flying foxes did stretching by spreading out their wings one after the other or even simultaneously (Plate 2 C and D).

#### Fanning

Flying foxes were observed to do fanning in afternoon during fair weather conditions. An individual was observed to cling its hind feet on to the branch and flapped its wing membranes towards the bodies (Plate 2 E).

### Daytime behaviours

Bats behavior is of different kind, however, here 13 type of behavior were observed and recorded. Among the 13 observed behaviours, sleeping was the most frequent behaviour (18.28%) followed by stretching (18.09%), grooming (14.68%) and fanning (14.29%). Other activities, such as locomotion, aggression, searching, courtship, flying, copulating, and urinating, defecating and maternal care were much less frequently observed (Fig. 2).

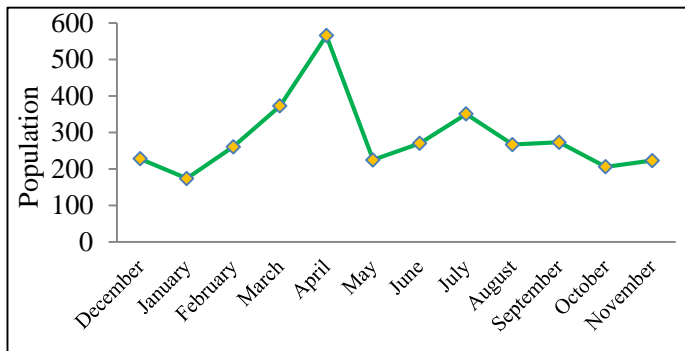
The diurnal activity patterns of *P. giganteus* consisted predominantly of the solitary activities of roosting, sleeping and grooming, stretching and fanning. Most frequently, Indian flying foxes were seen sleeping throughout the day. In October, grooming was recorded at higher frequencies (20.25%) than in other months. Wing stretching was higher frequently recorded in April (22.83%) and lowest in August (9.47%). The frequency of wing fanning was found to be highest in April (22.83%) and decreased in October (2.53%) (Fig.3).

**Daytime behaviour in response to time of day**

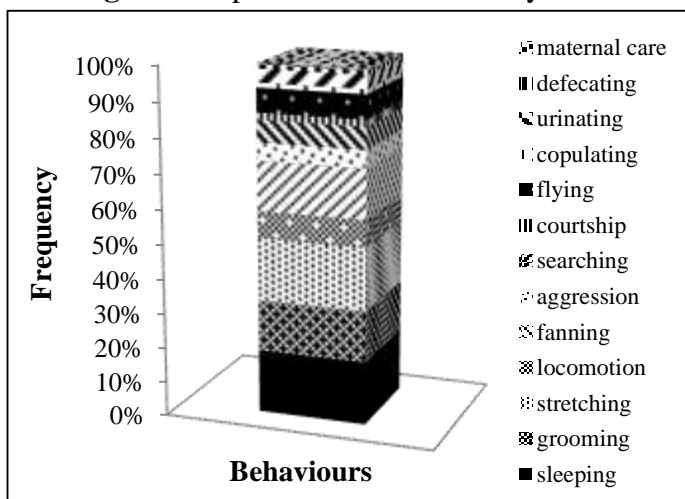
Indian flying foxes were found to sleep most in the early morning and became active in the afternoon and evening. Sleeping behaviour was recorded least frequently during morning in April (4.90%) and higher frequency from December to March and June, July, September and October (8.82%) respectively (Fig.4). Grooming was more frequent in the morning in December, January, February, March, July, October and November (10%) each and less frequent during the afternoon and evening in August (3.84%) and November (2.17%) (Fig.5). Stretching was more frequent in the morning from February to July (9.37 %) each and least during afternoon (4.47%) and evening (3.03%) in August (Fig.6). Fanning was more frequently recorded during the afternoon than other time periods in a day. It was recorded maximum during morning September (16.36%) while maximum flapping activity was observed in the afternoon from February to May (10.97%). However, the least frequency was found in the morning in December (10.81%) and lack of activity was recorded in October (0%) (Fig.7).

**Daytime behaviour in response to ambient temperature**

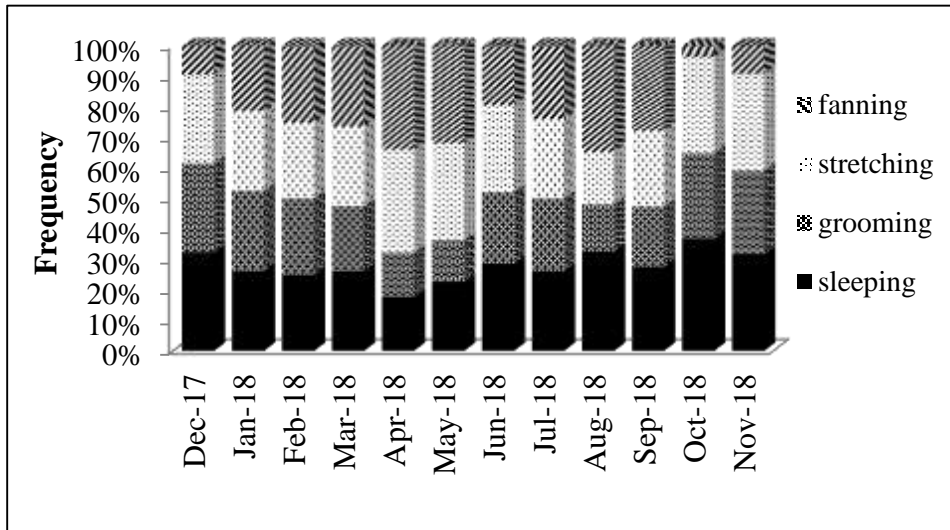
Changes in behaviour of bats in response to ambient temperature showed that the behaviour relied on ambient temperature. Sleep occurred frequently in all the temperatures in the study area. The frequency percentage of sleep gradually decreased with rising in temperature up to (30°C-35°C) but it increased at (20°C-25°C). And also the frequency percentage of groom gradually decreased with rise in temperature up to (30°C-35°C) and increased at (25°C-30°C). Wing stretching increased with ambient temperature (25°C-30°C). Fanning was recorded more frequently in raised temperature (30°C-35°C) and least frequently in temperature (20°C-25°C) (Fig. 5). Other activities were mostly recorded in temperature (25°C-30°C) and (30°C-35°C) (Fig.8).



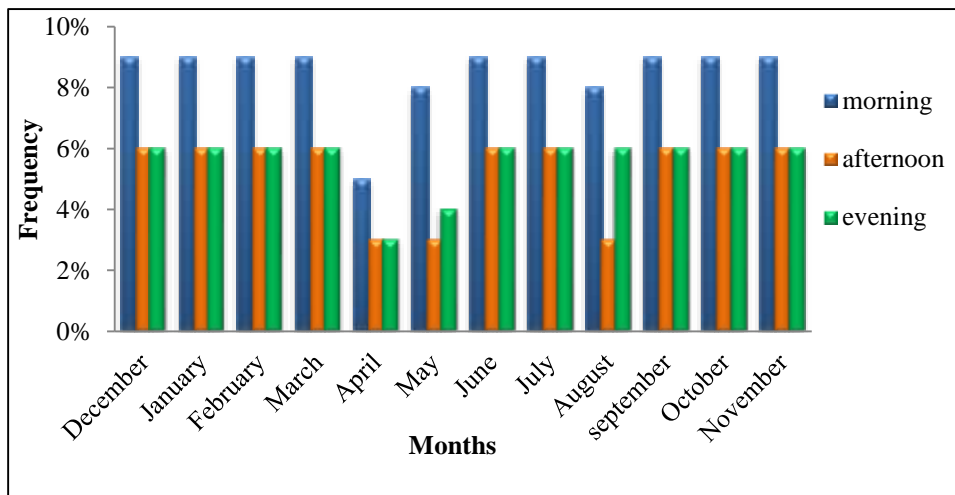
**Figure 1** Population of bats in study area



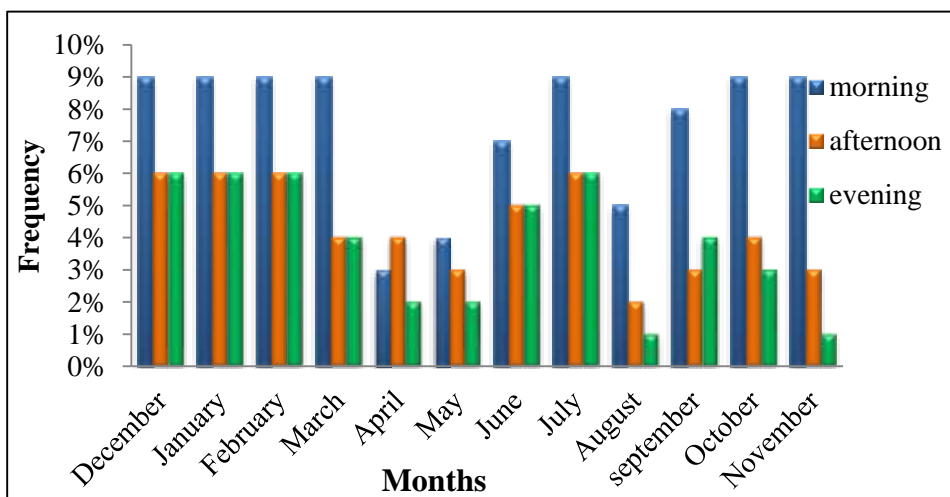
**Figure 2** Daytime behaviour of Indian Flying Fox (*P. giganteus*)



**Figure 3** Frequency of solitary behaviours at Salingyi Township



**Figure 4** Monthly frequency of sleep in different hours of day



**Figure 5** Monthly frequency of grooming in different hours of day

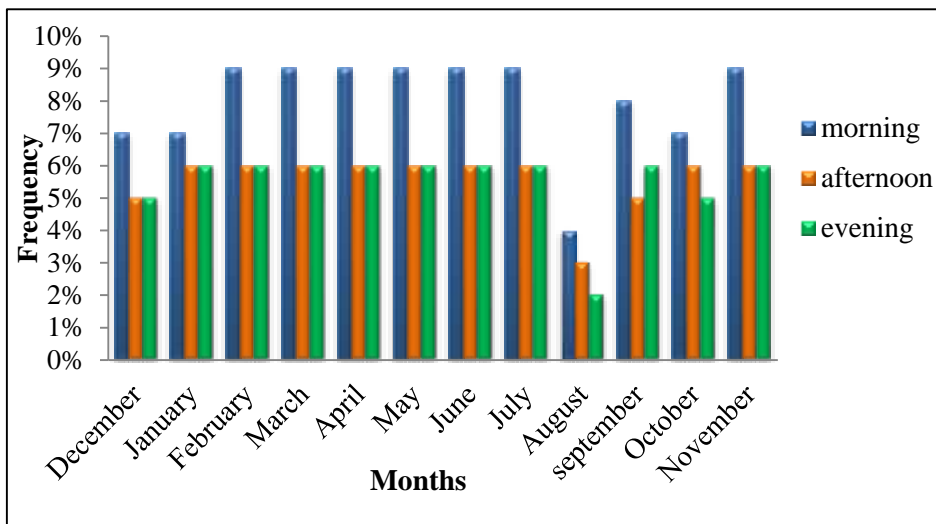


Figure 6 Monthly frequency of stretching in different hours of day

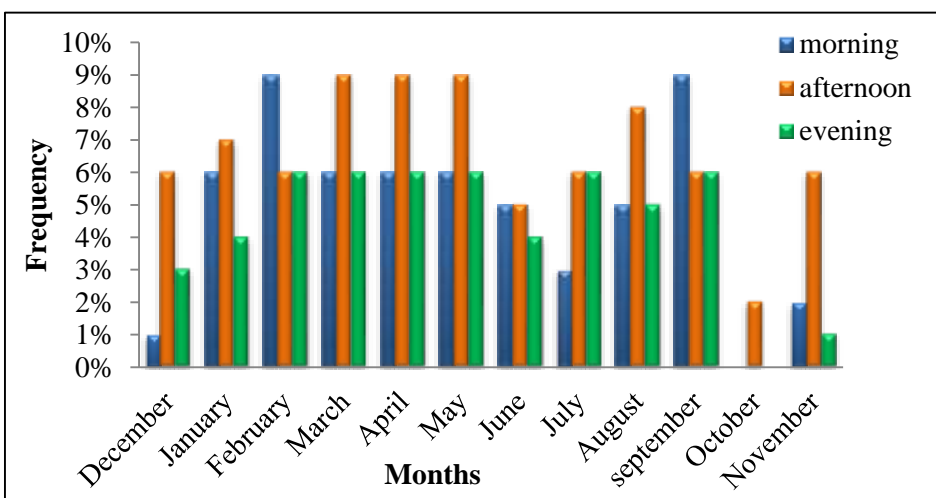


Figure 7 Frequency of fanning in different hours of day

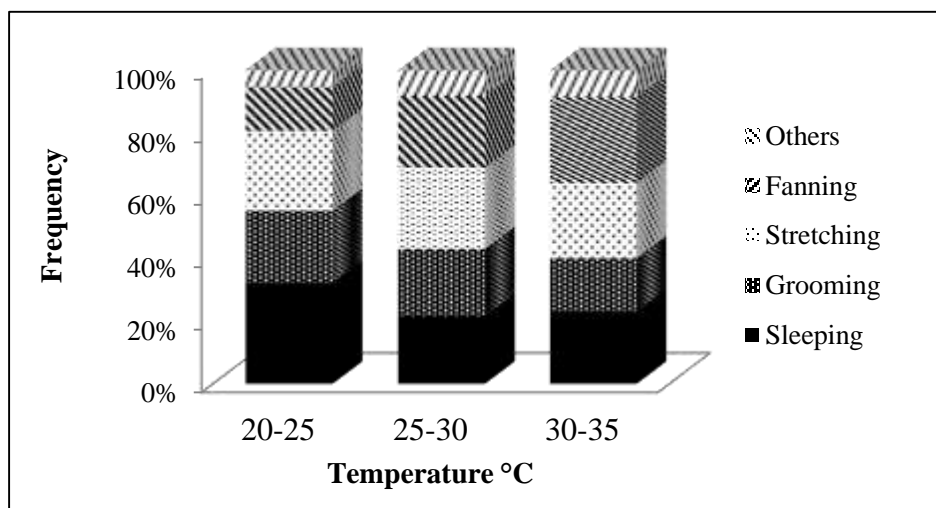


Figure 8 Frequency of behaviours at different temperatures



A. Sleeping



B. Grooming



D. Stretching (one wing)



C. Stretching (both wings)



E. Fanning

**Plate 2** Solitary behaviour of *Pteropus giganteus*

### Discussion

Indian flying fox exhibited various behaviours during daytime with fluctuation in the frequency. Sleep and stretch behaviours were recorded as frequently observing activities while courtship, copulation and defecation were less than two percent of behavioural composition but the maternal care was the least, 0.17% in the present study. Sleep, groom, mate/courtship and wing

spread were the most frequently occurring behaviours of Grey-headed Flying Fox (Connell *et al.*, 2006). In the present study, behaviours of *Pteropus giganteus* also revealed similar results.

The frequency of sleep changed significantly throughout the day, the sleep behaviour was recorded largely in the early morning than other periods of the day time and it seems to be the bats has just arrived back from foraging. However, the sleep behaviour continued in other parts of day since it saves energy to fly out in the evening for foraging (Manandhar, *et al.*, 2017). During the study period, sleeping behavior was most occurred in the morning.

Bats are nocturnal animal and day times are expected to be the inactive period for them. The lowest percentage sleeping behavior was recorded with rises temperature (30°C-35°C) and higher frequency in (20°C-25°C) were recorded. Funakoshi *et al.*, (1991) reported that sleeping duration is closely linked with the ambient temperature.

The Indian flying fox were found involved in grooming during the early morning in study area. Morning grooming activity was often triggered by the first rays of sun reaching bats in the tops of trees and comprised of extensive and thorough cleansing of all body surfaces (Markus and Blackshaw, 2002). Nelson (1965) suggested that it is important to keep the wing soft and flexible by spreading the lipid droplets around wing membrane, in addition it is a behavioral strategy for reducing the ectoparasite density. During the entire field observation, individual self- groom was also documented several times a day.

In the present study, the highest occurrence of wing stretching was observed in the morning. Wing stretch activity had begun with sunrise and continued to the afternoon when it was hot. Brooke (2000) described bats roosting on prominent and exposed branches of trees that opened one or both wings as sunlight first fell on them, faced towards the sun and slowly rotated back and forth. Previous workers also reported that the roosting trees provide a great protection from environmental perils and also protection from predators (Richmond *et al.*, 1992, Altringham, 2011 and Khan *et al.*, 2020). Therefore, the wing stretching behaviour seems to be associated with thermoregulation or energetic savings during roosting.

During the study period, wing fanning was mostly observed during afternoon as compared to other parts of day. Wing flap of Indian flying fox was frequently observed during the maximum temperature (25°C-35°C). However, this behavior was relatively decreased with temperature (20°C-25°C) in the day time. It may be assumed that when the air temperature rises, intensity of heat of the sun becomes higher, so in order to keep them cool, they flap their wings. Neuweiler (2001) also stated that fanning and also stretching are probably strategies to lower the body temperature by creating convection currents of the air that can help cool down the body of the bats.

Although *P. giganteus* was a nocturnal flying mammal but daytime roosting has to rest or sleep because the bats spend most of their lives in their roosts (Altringham, 2011). They performed some other activities at daytime roosting which included grooming, fanning, aggression, stretching, flying, mating, occasional daytime defecation, but still then resting or sleeping was the main activity at daytimes. The present study indicates that the high temperature has a profound effect on the Indian flying foxes. The temperature has been recorded to range from maximum of 35°C to minimum of 20°C. Neuweiler (2001) described in the active state, fruit bats could maintain their body temperature between 31°C and 39°C.

## Conclusion

*Pteropus* species live mainly on trees exposing themselves to the daylight. All other species live in closed areas such as caves, crevices, unused buildings etc. Hence individuals of *Pteropus* must adapt themselves to hot and cold temperatures. The current study provides baseline information for future investigations on the behaviours of *P. giganteus*. Among the different



daytime behaviour of this species, sleeping, grooming and wing stretching were more active in morning than fanning. This is followed by a lull in activity in afternoon and evening. During the study period the average temperature in roosting tree was a maximum 35°C and minimum 20°C. Observed that the environmental factor like temperature is important factor to determine roosting behaviour in *P. giganteus*.

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