



Plant dispersal by Indian flying fox *Pteropus giganteus* in Madurai region, India

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ABSTRACT

Pteropus giganteus is a largest fruit bat in India, belongs to the order suborder Megachiroptera and it is widely distributed in Indian subcontinent. Four different day roost sites of *P. giganteus* were surveyed in Madurai district. One single tree roost camp and three multiple trees roost camps were observed in the surveyed roost sites. Among the four roost sites, totally 21 species of plant saplings were identified under the day roost camps. Seed dispersal by this fruit bat shows that they disperse variety of seeds of different plants species in the vicinity of the roosting trees apart from the foraging trees. *Borassus flabellifer*, *Anacardium occidentale*, *Nerium indicum*, *Phoenix dactylifera*, *Prosopis juliflora* and *Madhuca indica* were dominated in the surveyed roost sites and that species saplings were recorded as maximum in the roosting vicinity confirming that *P. giganteus* indeed helps in seed dispersal to maintain the heterogeneity in the Madurai region.

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Introduction

Indian flying fox *Pteropus giganteus* (Brunnich, 1782) is a fruit bat belongs to the order Chiroptera and suborder Megachiroptera. It is also known as largest fruit bat and largest flying mammal in India. Naturally, India is relatively rich in bat fauna comprising approximately 120 species, out of which 14 are fruit-eating (belong to 8 genus) and the remaining are insect-eating bats (Bates and Harrison, 1997). Among fruit bats, the Indian flying fox *P. giganteus*, the fulvous fruit bat *Rousettus leschenaulti* and the short-nosed fruit bat *Cynopterus sphinx* are widely distributed in the Indian subcontinent. Marimuthu (1998) and Vendan (2003) reported that *P. giganteus* is a sacred species in India. The genus *Pteropus* constitutes the largest genus of Megachiroptera, with 57 species, which were distributed from Australia and south-east Asia to the coast of Africa (Mickleburgh *et al.*, 1992). According to our previous studies (Vendan, 2003; Vendan *et al.*, 2008) *P. giganteus* comes under conservation dependent endangered flying mammal in South India.

Generally, *P. giganteus* is a colonial species and they gather in the tree tops (mostly in large trees) during the day (so called day roost) in large groups called 'camps' which often having thousands of individuals. Colonies are usually located in close association with human beings and were observed to be found in cities and villages. Individuals leave their roosts about 20 minutes after sunset and the huge colony broke up into smaller feeding groups (Neuweiler, 1969). *Ficus* trees are the most favoured roosting trees, however they also known to roost on *Eucalyptus globulus*, *Mangifera indica* and *Tamarindus indica* (Vendan, 2003). According to our literature survey, plant or seed dispersal is not extensively studied in *P. giganteus*. And the information on the roosting and foraging behaviour of *P. giganteus* is scarce. Thus the study was aimed to address on the plant dispersal by *P. giganteus* in India.

Materials and methods

We have conducted a field survey in the day roost colony sites of *Pteropus giganteus* in the Madurai district, Tamil Nadu, India. The survey was carried out during the period of February 2010 to May 2010. Day roost colonies of *P. giganteus* in Madurai district were previously reported by Vendan (2003). Accordingly, the four different colony sites viz., Alagarkovil, Kidaripatti, Perungudi and Madurai city were identified and surveyed in the present study. A search was made directly under each roost site for a period of 30 minutes to collect and record the data as could be found on the roosting tree ground. Different species of plant samplings were visually observed and recorded under the *P. giganteus* populated colony sites. Some of the unidentified saplings were brought in to lab for identification. The identified plant species were confirmed with the help of a botanist Dr. P. Kannan, The Madura College, Madurai. Additionally fresh or dried ejecta, dropped fruits, seeds and faeces were collected under the *P. giganteus* colonies for the comparative analysis. Previously, Thomas (1982) and Banack (1998) reported that to obtain veritable information on the diet of frugivorous bats, ejecta pellets and fecal samples serve as the best indicator of the diet use. The collected samples were bagged for initial transport. Plant species were easily identified from ejecta pellets as the fruit, seed, leaf and bark was relatively unprocessed. Faecal samples were examined (Thomas, 1988; Banack, 1998) separately after being rehydrated and teased apart. A sample of faecal matter, including small seeds, fruit, leaf, flower and insect materials, was removed, mounted in water and examined visually. This was carried out alongside reference samples taken from the dried fruit, allowing different types of fruit to be identified. These separated plant materials were identified with the aid of reference materials.

Results

P. giganteus camps were surveyed in the four different sites of Madurai district, Tamil Nadu, India. Table 1 shows the *P.*

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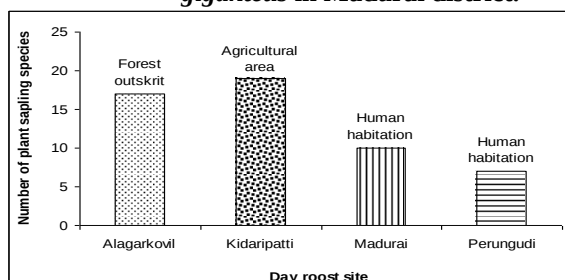
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giganteus populated day roosts and their different roost tree species in the surveyed sites. Among the four different camps, three camps are recorded as multiple tree roost camps and remaining one is recorded as single tree roost camp. In the multiple tree roost camps 18 different plant species were used for roosting and in single tree roost the umbrella tree species *F. bengalensis* was used for roosting. Totally, 21 species of plant saplings were recorded with the reference of ejecta pellets, dropped fruits, fecal samples and seeds under the *P. giganteus* day roost camps in the surveyed sites (Table 2). The recorded plant saplings were belonged to 16 families. Among the different plant saplings 18 species were trees, 2 species were shrubs and 1 species was climber. Table 3. shows the recorded plant saplings at different roost sites. More saplings were observed in the forest outskirts area and agricultural area of Alagarkovil and Kidaripatti respectively and in the human habitation areas of Madurai and Perungudi plant saplings were less (Figure 1). The following six plant species were found to be the predominant plant saplings under the surveyed day roost camps of *P. giganteus*; *Borassus flabellifer*, *Anacardium occidentale*, *Nerium indicum*, *Phoenix dactylifera*, *Prosopis juliflora* and *Madhuca indica*.

Table 1. Day roost tree species of *P. giganteus* in the Madurai district, Tamil Nadu, India.

Roost site	Roost type	Tree species
Alagarkovil	Multiple trees roost	Albizia lebbek
		Artocarpus integrifolia
		Eucalyptus globulus
		Eugenia jambolana
		Ficus benjamina
		F. glomerata
		Mangifera indica
		Peltophorum ferrugineum
		Tamarindus indica
		Toona ciliata
Kidaripatti	Single tree roost	Ficus bengalensis
Madurai	Multiple trees roost	Ficus bengalensis
		Peltophorum ferrugineum
		Diloxylon regia
		Tamarindus indica
		Azadirachta indica
		Toona ciliata
		Polyalthia longifolia
		Terminalia cattapa
Perungudi	Multiple trees roost	Millingtonia hortensis
		Cocos nucifera
		Ficus bengalensis
		F. religiosa
		Tamarindus indica
		Peltophorum ferrugineum

Figure 1. Habitat used and number of plants dispersed by *P. giganteus* in Madurai district.



Discussion

Bats in the genus *Pteropus* are characterized as requiring a variety of geographic and ecological habitat characteristics (Pierson and Rainey 1992; Palmer and Woinarski 1999). Fruit bats are animals of extraordinary ecological and economic importance throughout the Old World tropics. Roosting sites of bats have great ecological significance in conservation of biodiversity. Flying foxes typically roost openly on the branches

of emergent trees or within the forest canopy (Pierson and Rainey 1992). Likely, in the present study we observed that *P. giganteus* was choose the more canopy tree *F. bengalensis* in single tree roost and more canopy surrounded multiple trees (or tree species) in multiple trees roost. Approximately, in the surveyed each camp sites more than five hundred individuals were found.

Table 2. Dispersed plant species recorded under the day roost camps of *P. giganteus*.

S.No.	Species	Family	Plant habit
1.	Anacardium occidentale L.	Anacardiaceae	Tree
2.	Azadirachta indica Adr. Juss.	Meliaceae	Tree
3.	Borassus flabellifer L.	Arecaceae	Tree
4.	Calophyllum inophyllum L.	Clusiaceae	Tree
5.	Carcia papaya L.	Caricaceae	Tree
6.	Coccinia indica Wight & Arn.	Cucurbitaceae	Climber
7.	Eugenia jambolana	Myrtaceae	Tree
8.	Ficus sp.	Moraceae	Tree
9.	Madhuca indica J.F.Gmel.	Sapotaceae	Tree
10.	Mangifera indica L.	Anacardiaceae	Tree
11.	Murraya koenigii (L.) Sprengel	Rutaceae	Tree
12.	Nerium indicum	Apocynaceae	Shrub
13.	Phoenix dactylifera L.	Arecaceae	Tree
14.	Pithecellobium dulce (Roxb.)Benth.	Fabaceae	Tree
15.	Polyalthia longifolia (Sonn.) Thwaites	Annonaceae	Tree
16.	Prosopis juliflora (Sw.) DC.	Fabaceae	Tree
17.	Psidium guajava	Myrtaceae	Tree
18.	Tamarindus indica L.	Fabaceae	Tree
19.	Terminalia arjuna	Combretaceae	Tree
20.	Terminalia cattappa L.	Combretaceae	Tree
21.	Ziziphus sp.	Rhamnaceae	Shrub

Table 3. Saplings of different plant species recorded under the surveyed four day roost camps of *P. giganteus*.

S.No.	Species	Alagarkovil	Kidaripatti	Madurai	Perungudi
1.	Anacardium occidentale	+	+	-	-
2.	Azadirachta indica	+	+	+	+
3.	Borassus flabellifer	+	+	+	-
4.	Calophyllum inophyllum	+	+	-	-
5.	Carcia papaya	-	+	+	+
6.	Coccinia indica	-	+	-	+
7.	Eugenia jambolana	+	+	+	-
8.	Ficus sp.	+	+	-	+
9.	Madhuca indica	+	+	-	-
10.	Mangifera indica	+	+	-	-
11.	Murraya koenigii	+	+	+	-
12.	Nerium indicum	+	+	-	-
13.	Phoenix dactylifera	+	+	-	-
14.	Pithecellobium dulce	+	+	-	+
15.	Polyalthia longifolia	-	+	+	-
16.	Prosopis juliflora	+	+	+	+
17.	Psidium guajava	+	+	+	-
18.	Tamarindus indica	+	+	+	+
19.	Terminalia arjuna	-	-	+	-
20.	Terminalia cattappa	+	-	+	-
21.	Ziziphus sp.	+	+	-	-

Most species of flying fox are highly social, forming colonies that range in size from hundreds to over a million individuals (Ratcliffe 1931; Nelson 1965; Eby 1991; Parry-Jones and Augée 1992). Most information on roosting sites of flying foxes comes from Australia where colonies roost near food sources and migrate seasonally to follow fruit and flower resources (Parry-Jones 1986; Eby 1991; Richards 1990; Spencer et al. 1991).

Fruit bats play a pivotal role as pollinators and seed dispersers for a diverse array of plants (Fleming and Estrada 1996; Banack 1998; Shilton et al. 1999; Godinez-Alvarez et al. 2002). At least 300 plant species of nearly 200 genera mainly rely on large populations of Old World fruit bats for their propagation (Marshall 1983; Fujita and Tuttle 1991). Furthermore, these plants produce approximately 500 economically valuable products (Fujita and Tuttle 1991). Yet, the role of bats in the propagation of numerous plant species remains uninvestigated (Fujita and Tuttle 1991). In the present study we are reporting that 21 species of plants might be spread by *P. giganteus* in the surveyed roost sites of Madurai district of Tamil Nadu, India. Thus the identified saplings were correlated with food plant species of *P. giganteus* according to the previous reports. Further, we found that *Borassus flabellifer*, *Anacardium occidentale*, *Nerium indicum*, *Phoenix dactylifera*, *Prosopis juliflora* and *Madhuca indica* are predominant plant saplings under the surveyed day roost camps. These major plant saplings were also known as to the important food sources of flying foxes. Generally bats in the genus *Pteropus* are generalist feeders, and eat the potentially available fruits, selective species of leaves and flowers. The compilation of more up-to-date list shows that observations of feeding habits of genus *Pteropus* had increased to include fruits of 136 genera, flowers of 97, leaves of 25 and bark/twigs of 9 (Courts, 1998). Recently, Vendan (2003) identified the 25 food plant species of *P. giganteus* from Tamil Nadu, India.

Pteropodids are the most to species which are involved in seed dispersal. The most studied in seed dispersal are extensively carried out in Old World fruit bats. In the present study, the seeds of the following species were found to be dispersed by *P. giganteus* namely *Anacardium occidentale*, *Borassus flabellifer*, *Calophyllum inophyllum*, *Carcia papaya*, *Eugenia jambolana*, *Ficus* sp., *Madhuca indica*, *Mangifera indica*, *Murraya koenigi*, *Nerium indicum*, *Phoenix dactylifera*, *Pithecellobium dulce*, *Polyalthia longifolia*, *Prosopis juliflora*, *Psidium guajava*, *Tamarindus indica*, *Terminalia arjuna*, *Terminalia cattappa* and *Ziziphus* sp. Among these *M. indica*, *T. cattappa*, *M. indica*, *P. longifolia*, *B. flabellifer*, *A. occidentale*, *P. juliflora*, *N. indicum*, *C. nucifera*, *T. indica*, *A. indica* and *P. dactylifera* are large-seeded fruits (which were half-eaten) and the rest are small-seeded fruits were dispersed of beneath the day roosts.

Interestingly, the seed are dispersed near their roost trees, besides their foraging area. Goveas et al., 2006 reported that *P. giganteus* has nearly 70% banyan seeds in their guano that indicates their role in dissemination of an important keystone plant species in our ecosystem. Generally, frugivorous bats are mobile foragers (Webb and Tidemann 1996) and move genetic material, as either pollen or seeds, between isolated fragments of vegetation that would reduce further negative effects (Young et al. 1996). Small bats like *Cynopterus sphinx* can carry large fruits much to their own size while, large fruit bats can carry more than 200 grams. But it seems most of the larger fruit bats like to process the fruit in the fruiting trees (Richards, 1990). Thus, they appear to play an important role in secondary

succession as well as in maintaining the compositional heterogeneity of tropical forests (Fleming and Heithaus 1981; Wang and Smith 2002). In the present study we observed that *P. giganteus* was dispersed more plants in the forest outskirts area of Alagrakovil and agricultural area of Kidaripatti. Because of that human disturbance was less in Alagrakovil and Kidaripatti, where as in human habitation area (i.e., Madurai and Perungudi) plant dispersal was lower. These results indicate that *P. giganteus* was dispersed 21 plant species in the studied region with the habitat nature of roost sites.

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28. Table 1. Day roost tree species of *P. giganteus* in the Madurai district, Tamil Nadu, India.