



The seed dispersal mechanism of *Pteropus giganteus* and *Cynopterus sphinx* in Kerala

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Abstract

The study investigated the foraging mechanism of *Pteropus giganteus* (Indian flying fox) and *Cynopterus sphinx* potential role as a seed disperser in the Kerala. Over 2 years of period, field study was conducted for the identification of food plants and seed dispersal of *Pteropus giganteus* and *Cynopterus sphinx* by direct observations or indirectly by the analysis of eject found on ground. Observation were made on seven colonies of day roost in undisturbed areas, amongst which six of them were in sacred grooves one in the protected area. Over 36 different plant seeds were collected from the ejected materials as chewed fruits, fresh seeds or faecal materials. The result indicates that *Pteropus* is playing a vital role as a seed disperser in plants like *Anacardium occidentale*, *Areca catechu*, *Manilkara achras*, *Mangifera indica* and *Psidium guajava* which are highly demanding plants in the market. The study shows that both *P.giganteus* and *C. sphinx* is important in the forest regeneration and maintenance of sacred grooves and even small disturbance hurt the colonies which tend to shift their roost elsewhere. Here we found that pure bond between plant bat interactions, plant providing food for bat and bat play key role as a seed disperser. *Cynopterus sphinx* unable to carry large seeds it dispersed seeds through faecal materials mainly but small fruits able to carry.

Keywords: Seed dispersal mechanism, foraging mechanism, sacred grooves

Introduction

Chiroptera is one of the most successful mammalian orders and probably the most diverse and second only to the order Rodentia in number (Kunz 1984) [13]. The Megachiropteran bats come under the single family Pteropodidae and almost all of them are phytophagous (feed upon fruits, blossoms, nectar, pollen and leaves). They feed on at least 300 plant species of nearly 200 genera and many of these plants are solely rely on these bats for pollination and seed dispersal (Marshall 1983; Banack 1998 [1]; Knudsen and Kiltgaard 1998) which include many economically important species such as *Ceiba pentandra* (kapok), *Durio zibethinus* (durian), *Eucalyptus* spp., *Ficus* spp. (figs), *Mangifera indica* (mango), *Manilkara zapota* (chicle), *C.religiosum*, *Musa paradisiaca* (wild banana) and *Ochroma lagopus* (balsa) (Fleming 1982) [6]. *Ficus religiosa* *Areca catechu*, *Manilkara achras*, *Mangifera indica* members are used for many of the ayurvedic drugs Bhat. M. R (1997) [4].

Marimuthu (1998) [16] and Vendan (2003) [22] reported that *P.giganteus* is a sacred species in India. According to previous studies of Vendan.et.al, (2008) [21] *P. giganteus* conservation depended endangered flying mammal in South India. *Cynopterus sphinx* feeds heavily on the bananas, *Ficus* spp., *Psidium guajava* and also found nectar feeding habit towards *Ceiba pentandra* during our study. According to our study we found that flying foxes colonised undisturbed areas mainly sacred places while *C. sphinx* colonized mainly on palm trees. So we concentrate our

study on the role of flying foxes and *C. sphinx* role as a seed carrier.

Materials and Methods

The studies were conducted North Malabar region of Kerala, mainly in the sacred grooves found in Kannur and Kozhikode districts. Day roosting colonies of *P.giganteus* and *C. sphinx* were studied. Roosting plants were identified taxonomically. Seven colonies of *P.giganteus* *Cynopterus sphinx* were selected for the observation.

The fruits and leaves ejected by *P. giganteus* and *C. sphinx* were collected from day roost. The collected fruits and leaves were identified taxonomically and also the discarded parts were studied. The excretory matters were collected and seeds were separated for further studies.

Results

We were observed seven day roosting colonies of *P.giganteus* and five colonies of *C. sphinx* in the North Malabar region of Kerala. From first colony Kuthupramba (Kannur Dt) we found 15 different plant species as dispersed. From the second we collected 17 plant seeds. The third colony gives 10 species of plants as from discarded material. The fourth colony we collected 7 different type of seeds. From the fifth colony we collected 12 different plant species as discarded matter. The sixth colony gives the idea about 3 plant species. From the final and last colony we collected 16 plant materials as dispersed (Table 1)

Table 1: Showing the roosting colonies of *P. giganteus*

Si No	Colonies	Roosting Plants	Eject Collected
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1	Kuthupramba (Kannur Dt)	<i>Macaranga peltate Cocos nucifera</i>	<i>Mangifera indica Artocarpus heterophyllus Psidium guajava Psychotria curviflora Manilkara achras Anonna squamosa Anacardium occidentale Areca catechu Terminelia catappa Basia latifolia Cucurbita species Szygium jambos Cycas circinaalis Ficus religiose Carica papaya</i>
2	Mattanur (Kannur Dt)	<i>Tectona grandis Adenanthera pavonina Strychonos nux-vomica</i>	<i>Passiflora edulis Mimusops elengi Mangifera indica Artocarpus heterophyllus Psidium guajava Psychotria curviflora Carica papaya Cucurbita species Terminelia catappa Terminelia bellirica Areca catechu Manilkara achras Szygium cumini Tamarindus indicus Cycas circinaalis Bridelia retusa Ficus benghaliensis</i>
3	Pandakkal (UT, Mahe)	<i>Alstonia scholaris</i>	<i>Cucurbita species Terminelia catappa Terminelia bellirica Areca catechu Manilkara achras Szygium cumini Tamarindus indicus Cycas circinaalis Mangifera indica Ficus religiosa</i>
4	Payyoli (Calicut Dt)	<i>Ficus benghaliensis Mangifera indica</i>	<i>Basia latifolia Cucurbita species Terminelia catappa Terminelia bellirica Areca catechu Manilkara achras Ficus benghaliensis</i>
5	Panoor (Kannur Dt)	<i>Szygium cumini</i>	<i>Ficus religiosa Szygium cumini Ficus benghaliensis Mangifera indica Basia latifolia Terminelia catappa Terminelia bellirica Areca catechu Manilkara achras Tamarindus indicus Cycas circinaalis Bridelia retusa</i>
6	Vellai (Kannur Dt)	<i>Albizia sp Mangifera indica</i>	<i>Manilkara achras Psidium guajava Anacardium occidentale</i>
7	Paral (Kannur Dt)	<i>Adenanthera pavonina Szygium cumini Tectona grandis Abrus precatorius Swietenia macrophylla</i>	<i>Theobroma cacao Mangifera indica Artocarpus heterophyllus Psidium guajava Psychotria curviflora Manilkara achras Anonna squamosa Anacardium occidentale Areca catechu Terminelia catappa Basia latifolia Cucurbita species Szygium jambos Cycas circinaalis Carica papaya Ficus benghaliensis</i>

Above result shows that *P. giganteus* playing very important role as a seed disperser. We collected more than 30 different seeds. Among this ejected seeds *Mangifera indica* is the biggest one. Because of their large size *Pteropus* bats can carry and transport fruits weighing more than 200g (Marshall 1983). Other small seeds; *Ficus religiosa* and *Psidium guajava* are found through faeces. Mega bats are almost entirely frugivorous feeding mostly on fruit pulp, juices, nectar, and occasionally leaves. *Ficus* spp is one the important food taxon for them and *Terminalia catappa* has also been regarded as an important food plant. Some of the important plant families visited by these bats are *Moraceae*, *Myrtaceae*, *Sapotaceae*, *Areceaceae*, *Piperaceae*, *Solanaceae*, *Anacardiaceae*, *Gutiferae*, *Leguminosae* and *Combretaceae* (Fleming 1987; Banack 1998; Corlett 1998)^[1, 7]. These bats eat mostly juicy berries with high water content and eject the fibrous pellet remains. The fruits eaten by the bats mostly have a strong odour, which can be related to the bats

olfactory senses for locating the food. Besides good smell, the flying foxes have also developed vision by having large eyes which might further help them to fruits at night (Marshall 1983). Other than fruits they also visit flowers for nectar and so they are helpful for the long distance transport for the seeds and pollen. Fruits and flowers are less diverse and more in space and time in the Old World than in the New World (Fleming 1993)^[8]. Resource densities and distribution patterns appear to significantly influence many aspects of foraging behaviour and more specially the group sizes of foraging bats. When plants produce flowers or fruits for prolonged periods, bats learn the locations of such plants and return to them regularly. These plants present only few fruits or flowers per night and hence bats usually either travel alone or in smaller groups (Heithaus *et al.* 1974)^[12]. Conversely, when plants produce many fruits or flowers over for a few nights (big bang – Gentry 1974)^[11], food becomes unpredictable. Under these conditions bats forage relatively in larger groups.

Table 2: Showing the roosting colonies of *C. sphinx*

Si no	Colonies	Roosting plants	Eject collected
1	Villiappally	Palm tree (<i>Borassus</i> sp.)	<i>Psidium guajava Manilkara achras Anonna squamosa Cucurbita species Szygium jambos Cycas circinaalis Ficus religiosa Carica papaya</i>
2	Vadakara	Palm tree	<i>Cycas circinaalis Ficus religiosa Carica papaya</i>
3.	Orkateri	Palm tree	<i>Manilkara achras Anonna squamosa Cucurbita species Szygium jambos</i>
4.	Ayancheri	Palm tree	<i>Szygium jambos Szygium cumini Cycas circinaalis</i>
5.	Katakmeri	Palm tree	<i>Cucurbita species Szygium jambos Cycas circinaalis Ficus religiosa</i>

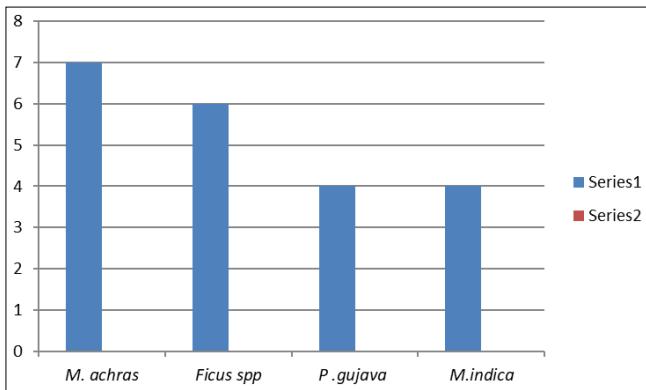


Fig 1: The plant species and colonies *P. giganteus*. (Graph. 1)

During the field observation of *C. sphinx* (day roosting colonies) we found in the 8 dispersed seeds or partially eaten fruit, in the second colony we collected 3 materials, third colony we found four plant particle, fourth colony observed 3 plant material and finally fifth colony resulted 4

plant particle. Mainly we collected from *C. sphinx* day roosting colonies *Psidium guajava*, *Manilkara achras*, *Annona squamosa*, *Cucurbita species*, *Syzygium jambos*, *Cycas circinaalis*, *Ficus religiosa*, *Carica papaya* and *Syzygium cumini*.

The diet of *P. giganteus* consisted predominantly the fruits of fig trees. During the lean period it also consumed the leaves of *Ficus religiosa* and *Erythrina indica*. Most of the fruiting trees visited by these bats are tall. However it also feed on fruits from small trees like *Manilkara achras*, *Psidium guajava* and *Musa sp.* which are mostly grown in the orchards. In the tall trees like *F. religiosa*, *F. bengalensis*, *Syzygium cumini* these bats forage in groups of about 10 to 12 individuals. But in shrubby trees it forages solitarily. We observed nectar feeding habit of flying foxes on *Cochlospermum religiosum*. After sunset small group of flying foxes regularly visit on *C. religiosum*. It's a small tree produce many flowers in the flowering season (February-April). The flower of *C. religiosum* large and attractive, produce copious amount of nectar (Plate 1).

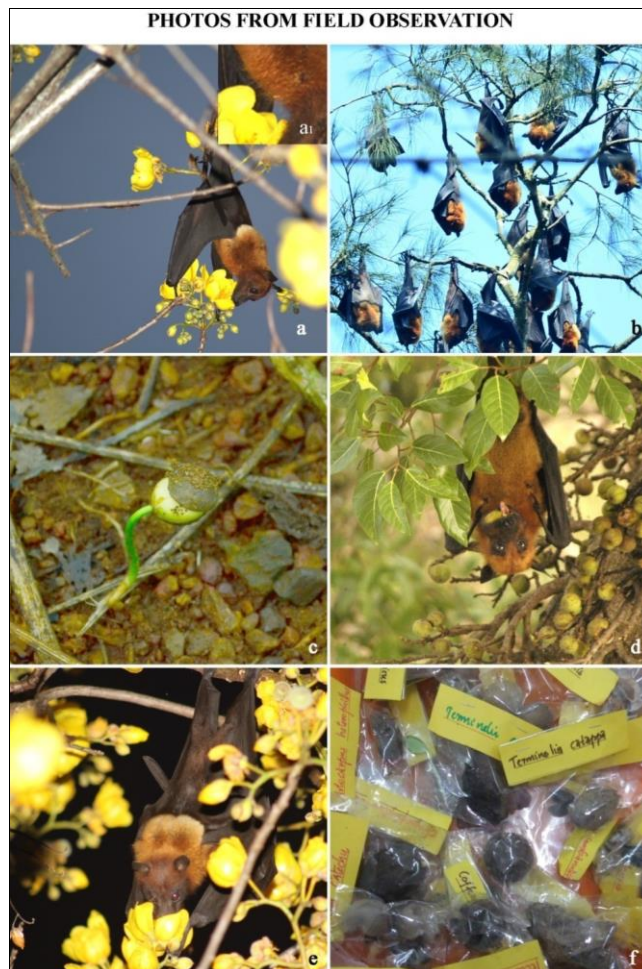


Plate 1: a&e. Flower visitation on *C. religiosum*; a1. Showing another parts; b. Day roosting colony; c. Generating seeds from the roosting colony; d. Foraging on fig species f. Preserved seeds

Discussion

According to above observation we found that seed dispersal of *M. achras* chiefly done by flying foxes. We collected this *M. achras* seed from 6 out of 7 colonies. Other plant seeds like *Ficus spp*, *Psidium gujava* and *Mangifera indica* also very common (graph 1).

While compare to *P. gaiganteus* small fruit bat *C. sphinx* mainly dispersed small seeds unable to carry large fruit like

mango. *C. sphinx* dispersed small seeds like *Ficus spp* and *Psidium gujava* through fecal mater. But *Cycas* seeds were found as partially bitten.

Bats may provide several advantages to the plants on which they feed. Separation of pulp from seeds by frugivores may increase survival by reducing seed predation and microbial attack (Willson and Traveset, 2000) [23]. Potentially, fruit of any plant species eaten by *P. giganteus* may have its seeds

dispersed by bats in flight – even those with the size of a mango (M. Burgess, pers. commun.). Dispersal by ejecta is limited to species with medium-sized or small seeds, and dispersal by faeces is limited to very small seeds such as those of *Ficus* and perhaps of *Psidium*. This study demonstrated that *P. giganteus* disperses intact seeds in ejecta and therefore, the size of the ejecta seed loads is important in terms of seed dispersal. Fig fruits dominated the diet consumption of *P. giganteus*. Various species of pteropodid bats have been reported foraging on the fruits of more than 30 fig species in tropical and subtropical Asia, Africa and Australia (Bhat 1994; Fujita and Tuttle 1991; Marshall and McWilliam 1982; Thomas 1984) [3, 17]. *P. giganteus* chews the fruits and spits out the fibrous remains along with the seeds in the same tree and sometimes consumes the whole fruit and defecates the seeds. Food transit time in frugivorous bats are relatively rapid; generally less than 30 minutes (Laska 1990; Tedman and Hall 1985) [14, 20].

Other than seed dispersal mechanism we observed flower visiting strategy of flying foxes *Cochlospermum religiosum* (Plate 1). The flower is large and orange yellow coloured. For the pollination study we found that *P. giganteus* visit flowers with above average size, produce good odour and with bright coloured. Feeding nectar gives extra energy for *Pteropus* during the flights and the bat visiting flowers produce are found producing copies amount of nectar. The *Pteropus* is playing a vital role as a seed disperser in plants like *Anacardium occidentale*, *Areca catechu*, *Manilkara achras*, *Mangifera indica* and *Psidium guajava* which are highly demanding plants in the market.

Conclusion

According to our study we found that *Pteropus giganteus* and *Cynopterus sphinx* both have different seed dispersal mechanism flying foxes able to carry large seeds like mango in to large distances while small fruit bat *C. sphinx* dispersed small fruits. Flying foxes are interacted with more plant species compare to small fruit *C. sphinx*. The Indian flying fox *P. giganteus* is the largest fruit bat in south India for forest regeneration and maintenance this animal playing potential role. It helps many plant species for wide distribution. Several studies have demonstrated that seed germination was either enhanced or unaffected after passage through the digestive tract of bats (Figueiredo and Perin 1995; Fleming and Heithaus 1981; Liberman and Liberman 1986) [10, 15].

The flying foxes have a very important role for wide distribution of our native plant species but *C. sphinx* is a small animal its travel only short distances so its dispersal also found as very short range. Our study concluded that both fruit bats are playing vital role in the seed dispersal mechanism So conservation of these animals is very much important for save our plant species.

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