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THE DIET OF THE INDIAN FLYING FOX *PTEROPUS GIGANTEUS* (BRÜNNICH, 1782) (CHIROPTERA: PTEROPODIDAE) IN MYANMAR - CONFLICTS WITH LOCAL PEOPLE?

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Abstract: The diet of *Pteropus giganteus* from three roosts in Mandalay Region, central Myanmar was investigated for over two years by examining feeding remains in and around two villages. It consists of 24 species of fruits, six species of flowers and three of leaves. Of these, 13 species of fruits are eaten by the local people, three of which are also marketed. Two are used in traditional medicine and one for stuffing pillows. Most dietary plants are native, mangoes are seasonally superabundant and are eaten in large numbers. Interviews revealed no evidence of conflict between bats and villagers.

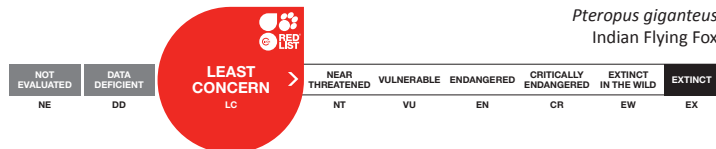
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Flying Foxes (Chiroptera: Pteropodidae; genus *Pteropus*) eat a wide range of flowers, fruits and leaves (Lobova et al. 2009; Fleming & Kress 2011). Although their protein requirements are met by digestion of pollen and leaves (Long & Racey 2007; Kunz & Ingalls 1994, respectively), the energy to power flight is provided mainly by sugars in fruits (Thomas 1984).

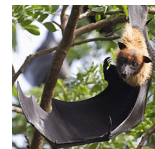
Some studies have suggested that the clearance of land for agriculture has led to a loss of bat's natural foraging habitat and food plants and as a result they feed on commercial fruits (Aziz et al. in press). This often leads to conflict between bats and those who pick and market the fruits. There is little published information on the diet of flying foxes in Myanmar. The aims of this paper are to describe the diet of the commonest flying fox species in the country, *P. giganteus* and to assess the likelihood of its dietary habits leading to conflict with local people.

METHODS

This study was carried out over two years (2004–2005) at Taunginn (22°25.784'N & 096°02.690'E) and Htonegyi villages (22°26.210'N & 096°02.082'E), Sintgu Township, in the northern part of Mandalay Region, Central



Pteropus giganteus
Indian Flying Fox



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Myanmar and on the east bank of the Ayeyarwady River (Fig. 1). There were two *P.giganteus* roosts in Taunginn Village and one in Htonegyi Village. The township has an area of 1409km², the majority of which (997km²) is forested. The study sites lie in the western flat plain of Sintgu Township which is important for agriculture but is inundated during annual rains between July and September (Fig. 2). The uncultivated areas are occupied by mesophytes. Of these, mango (*Mangifera indica*), kapok (*Bombax ceiba*) and the figs *Ficus rumphii* and *F. nervosa* predominate. The climate is typical of tropical savanna. The hottest months are April and May, and the coldest months, December and January. The vegetation is diverse with many fruiting trees and many kapok trees

some of which were roosting sites.

Information on the feeding habits of *P. giganteus* was obtained by collecting fruit remnants, seeds, leaves, flower parts and ejecta pellets (spat out pulp, sometimes containing seeds) dropped directly beneath all three day roosts and feeding trees. Collection of food samples was carried out for three days each month and they were examined by eye. For each specimen of fruit, flower and leaf, colour, odour and plant growth form (i.e., tree or shrub) were recorded. All the plant species were identified at the Botany Department in University of Mandalay. The availability of fruit was determined by checking trees and talking to villagers.

The location of fruit trees at the foraging sites were determined by recording the flight path of the bats, local villagers' information and the presence of uneaten or partially eaten fruits under fruit trees. Interviews with local villagers were also carried out to obtain additional information on the food resources and foraging habits of *P. giganteus*. Both male and female villagers were asked a series of questions about the bats: how long the roosts had been present, how many bats there were previously, where they foraged and on what plant species, and whether their feeding behavior caused conflicts. Information on monthly rainfall was obtained

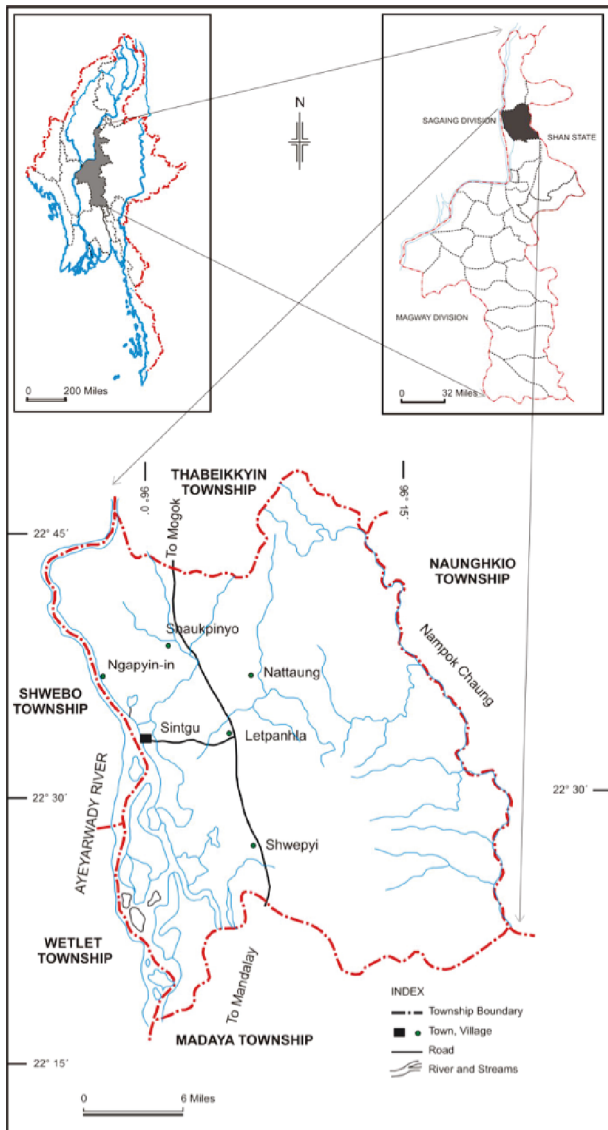


Figure 1. Location map of Sintgu Township, in the Mandalay region of central Myanmar.

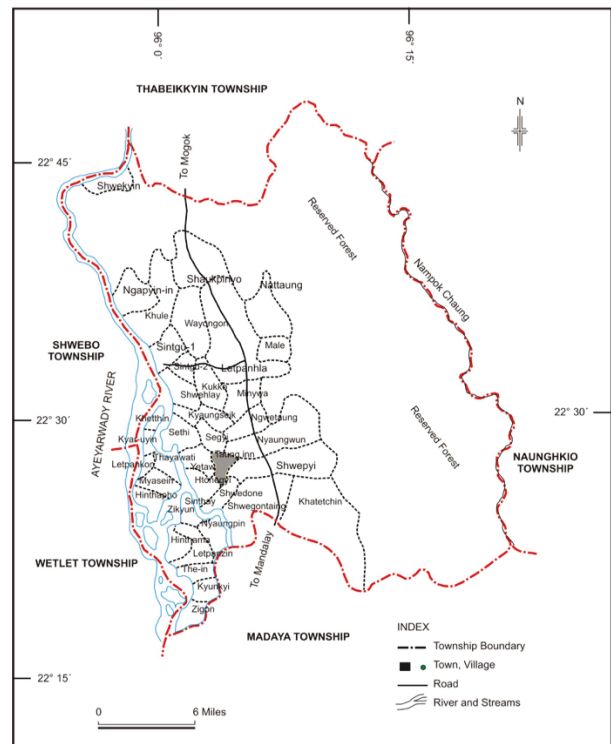


Figure 2. Sintgu Township showing the study villages of Taunginn and Htonegyi in the grey area.

from the meteorological station for Mandalay Region.

RESULTS

The study species was confirmed as *P. giganteus* by netting two individuals on the flight path between a roost and the foraging areas (Images 1 & 2). The total number of bats counted at all three roosts during the present study was 1005 in 2003–2004 and 1513 in 2004–2005.

Food resources

Pteropus giganteus fed on the fruits of 24 plant species, the leaves of three species and the flowers of six species (Tables 1 and 2). The dominant families in the fruits eaten by *P. giganteus* were Moraceae (four species) and Myrtaceae (three species). Of the leaves and flowers consumed by the bats, the dominant family was Bombacaceae (two species). This was followed by leaves of Mimosaceae, and flowers of Bignoniaceae, Asteraceae, Caesalpiniaceae and Lauraceae.

Fruits of three species, namely *Ficus rumphii*, *Carica papaya* and *Morinda angustifolia* were available to bats throughout the year. Other plant species that had a long fruiting season were *Ziziphus jujuba*, *Ricinus communis*, *Psidium guajava* and *Ficus racemosa* (Table 1). *Mangifera indica* was found abundantly in the study area and was a dominant food source for *P. giganteus* in the months of April, May, June and July, which was the major local fruiting season.

Characteristics of food resources

Pteropus giganteus consumed fruits of a variety of different colours (Table 3). However, the majority of

fruits observed in this study were yellow and green. All leaves were green. Six floral food resources were white, yellow and red.

Fruit species except *M. angustifolia* did not produce an odour strong enough for the tree to be detected by a human observer in the field (Table 3). However, most of the fruits consumed by bats had a pleasant odour when they were held close to the observer's nose. All the flowers eaten by bats also had a pleasant fragrance.

Of all the food plants, four were small trees, three were shrubs and the remainder were larger trees (Table 3). Flowering and fruiting frequencies did not correlate with rainfall (Pearson's correlation coefficient).

Feeding behaviour

Fruits predominated in the diets of bats throughout the year (Table 1) and leaves and floral parts of plants formed only a small proportion of the diet (Table 2). Soft fruits were either totally or partially consumed. At one foraging site (Taunginn Village), the fruit pulp of *M. indica* was consumed totally and the pericarp was spat out onto the ground. The bare seed was left attached to the tree by its stalk. However, it was quite common for some fruits of this species to be dropped under the tree with a little bite mark. Bats visited these mangoes in Taunginn Village and other fruiting trees near their roosts as long as they remained productive. When there were large numbers of fruits in the trees, groups of five or six bats came to them, although the number of visiting bats dwindled to one or two by the end of the fruiting season. Most bats made several flights to individual trees during the fruiting season when the village was quiet at night. Villagers believed that the bats seemed to know whether the fruits were ripe or not. If *M. indica* fruits were marked with tooth scratches, they become ripe the following day, and the bats ate only ripe and



Image 1. *Pteropus giganteus* from Bagan



Image 2. *Pteropus giganteus* from Bagan

Table 1. Fruit remnants collected beneath day-time roosts and feeding roosts of *P. giganteus*.

Plant Species	Local name	Family	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
* <i>Ficus rumphii</i> Blume	Nyaung-byu	Moraceae	+	+	+	+	+	+	+	+	+	+	+	+
* <i>Carica papaya</i> L.	Thin-baw	Caricaceae	+	+	+	+	+	+	+	+	+	+	+	+
# <i>Morinda angustifolia</i> Roxb	Ye-yo	Rubiaceae	+	+	+	+	+	+	+	+	+	+	+	+
* <i>Ziziphus jujuba</i> Lam.	Zi	Rhamnaceae	+							+	+	+	+	+
<i>Ricinus communis</i> L.	Kyet-su	Euphorbiaceae	+	+	+	+					+	+	+	+
* <i>Psidium guajava</i> L.	Mar-la-ka	Myrtaceae	+						+	+	+	+	+	+
<i>Ficus racemosa</i> L.	Ye-thaphan	Moraceae		+	+	+	+	+	+					
* <i>Artocarpus heterophyllus</i> Lam.	Pein-ne	Moraceae								+	+	+	+	+
* <i>Cajanus cajan</i> (L.) Millsp	Pe-sin-ngon	Fabaceae	+	+								+	+	+
* <i>Mangifera indica</i> L.	Tha-yet	Anacardiaceae				+	+	+	+					
* <i>Punica granatum</i> L.	Tha-le	Punicaceae				+	+	+	+					
<i>Calophyllum inophyllum</i> L.	Pon-nyet	Clusiaceae							+	+	+	+		
* <i>Tamarindus indica</i> L.	Ma-gyi	Caesalpiniaceae				+	+	+	+					
* <i>Areca catechu</i> L.	Kunthi	Arecaceae										+	+	+
# <i>Azadirachta indica</i> L.	Tama	Meliaceae						+	+	+				
* <i>Syzygium jambos</i> (L.) Alston	Zabu-thabye	Myrtaceae					+	+	+					
* <i>Syzygium cumini</i> (L.) Skeels	Tha-bye-byu	Myrtaceae					+	+	+					
<i>Ehretia acuminata</i> R.Br.	Zi-byin	Ehretiaceae										+	+	+
<i>Neolitsea umbrosa</i> (Nees) Gamble	Ondon-bo	Lauraceae						+	+	+				
* <i>Oroxylum indicum</i> (L.) Kurz	Kyaung-shur	Bignoniaceae								+	+			
<i>Bombax ceiba</i> L.	Let-pan	Bombacaceae			+	+								
<i>Nauclea orientalis</i> L.	Ma-u	Rubiaceae								+	+			
<i>Ficus nervosa</i> Roth.	Nyaung-peinne	Moraceae						+	+					
+ <i>Ceiba pentandra</i> (L.) Gaertn	Thin-baw-let-pan	Bombacaceae			+									

(* eaten by local people) (# used in traditional medicine) (+ used to stuff pillows)

Table 2. Chewed leaves and flowers (ejecta) collected beneath day roosts of *P. giganteus*. Plus sign indicates months in which flower or leaf was collected.

Plant Species	Local name	Family	Food type	Colour	Odour	Habit	J	F	M	A	M	J	J	A	S	O	N	D
<i>Bombax ceiba</i> L.	Let-pan	Bombacaceae	F/L	Red/ Green	PF	Tree	+	+	+									
<i>Helianthus annuus</i> L.	Nay-kya	Asteraceae	F	Yellow	PF	Shrub		+	+	+								
<i>Albizia lebbek</i> (Benth.)	Anyakokko	Mimosaceae	L	Green	-	Tree			+	+	+							
<i>Ceiba pentandra</i> (L.) Gaertn	Thin-baw-let-pan	Bombacaceae	F/L	White/ Green	PF	Tree	+	+										
<i>Tamarindus indica</i> L.	Ma-gyi	Caesalpiniaceae	F	Yellow	PF	Tree				+	+							
<i>Neolitsea umbrosa</i> (Nees) Gamble	Ondon-bo	Lauraceae	F	White	PF	Tree					+	+						
<i>Oroxylum indicum</i> (L.) Kurz	Kyaung-shur	Bignoniaceae	F	White	PF	Tree							+					

F = Flower; L = Leaf; PF = Pleasant fragrance

Table 3. Colour of fruits eaten by *P. giganteus*

Plant Species	Colour	Habit
<i>Ficus rumphii</i> Blume	Yellow	Tree
<i>Carica papaya</i> L.	Yellow	Small tree
<i>Morinda angustifolia</i> Roxb	Pale yellow	Small tree
<i>Ziziphus jujuba</i> Lam.	Pale green	Tree
<i>Ricinus communis</i> L.	Green	Shrub
<i>Psidium guajava</i> L.	Yellow	Tree
<i>Ficus racemosa</i> L.	Yellow	Tree
<i>Artocarpus heterophylla</i> Lam.	Yellow	Tree
<i>Cajanus cajan</i> (L.) Millsp	Green	Shrub
<i>Mangifera indica</i> L.	Yellow	Tree
<i>Punica granatum</i> L.	Reddish-yellow	Small tree
<i>Calophyllum inophyllum</i> L.	Yellow	Tree
<i>Tamarindus indica</i> L.	Brown	Tree
<i>Areca catechu</i> L.	Yellow	Tree
<i>Azadirachta indica</i> L.	Yellow	Tree
<i>Syzygium jambos</i> (Linn.) Alston	Dark purple	Tree
<i>Syzygium cumini</i> (L.) Skeels	Green	Tree
<i>Ehretia acuminata</i> R.Br.	Green	Small tree
<i>Neolitsea umbrosa</i> (Nees) Gamble	Reddish-brown or Green	Tree
<i>Oroxylon indicum</i> (L.) Kurz	Green	Tree
<i>Bombax ceiba</i> L.	Yellow	Tree
<i>Nauclea orientalis</i> L.	Yellow	Tree
<i>Ficus nervosa</i> Roth.	Green	Tree
<i>Ceiba pentandra</i> (L.) Gaertn	Green	Tree

over-ripe fruit.

In the Ye Chan foraging site, the bats consumed all the pulp of *Calophyllum inophyllum* fruit and clean round seeds were observed on the ground beneath the tree during October, 2005. In April 2004, black guano containing rough fibres was encountered under the study tree (*Bombax ceiba*) in Taunginn Village although the fruit responsible could not be determined. In Shwe Done Village, other partially eaten fruits such as *Psidium guajava* and *F. racemosa* were observed under a *F. nervosa* tree. Seedlings of *Nauclea orientalis* and *P. guajava* were also found under the roost tree in Taunginn Village. Chewed leaves and flowers whose soluble contents had been extracted by the bats were collected under the day roosts. Moreover, guano with different colours reflecting the colour of the fruit pulp consumed and different coloured ejecta pellets were also found each day under the bats' roost.

Attitude of villagers

The bat roosts had been present in the villages for as long as local people could remember, although

numbers fluctuated from year to year. The villagers had a positive attitude towards the bats and no conflicts were apparent.

DISCUSSION AND CONCLUSION

Of the 24 species of fruits eaten by flying foxes, 13 were also eaten by local people, and of these, only three were sold in local markets—guava, mango and tamarind (*Tamarindus indica*). Two species (*Morinda angustifolia* and *Azadirachta indica*) were used in traditional medicine and one (*Ceiba pentandra* - the source of kapok) was used to stuff pillows.

In many countries the extent to which flying foxes eat fruit which is harvested and sold leads to conflict between bats and those picking and marketing the fruit. This often results in persecution of the bats (Aziz et al. in press). In the two years of this study, there has been no indication that such a conflict exists and villagers reported no conflict in previous years either. In the study area in Myanmar, a few of the fruits which the bats eat are sold commercially, and the superabundance of mangoes means that local people tolerate the fact that bats eat some of them and damage others.

In an experimental study, Andrianaivoarivelo et al. (2012) showed that *Rousettus madagascariensis* preferred the fruits of native plants to introduced commercial species. In the present study most plants in the diet of *P. giganteus* were native, and this together with the fact that there was little local marketing of species in the diet of bats may explain the absence of conflict between the bats and local people.

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