

**Food preferences (three fruit types) of Sri Lankan short-nosed
fruit bat**

***Cynopterus sphinx* (Chiroptera) in a semi-natural condition**

**Yapa. W.B, Kumarasinghe, J, Digana, P. M. C. B, Randeniya, P. V,
Ratnasooriya, W.D.**

Department of Zoology, University of Colombo, Colombo 3

Corresponding Author

Prof. W. D.Ratnasooriya

Department of Zoology

University of Colombo

Colombo 3

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Abstract

In this study the food preference of Sri Lankan short nosed fruit bat *Cynopterus sphinx* was tested in a seminatural condition as a first step of a long term study of diet and foraging of Sri Lankan fruit bats. Investigations were carried out in an experimental room (4x5x3.5m) using ten male bats (4 adults and 6 sub adults). A single animal was used in each trial. Ten such trials were carried out, each progressing over three consecutive days. To test the feeding preference, known and comparable weights of three fruit types [mango (*Mangifera indica* L: Acardiaceae, amba in Sinhala), guava (*Psidium gujava* L: Myrtaceae, pera in Sinhala) and Indian almond (*Terminalia catappa* L: Combretaceae, Kottamba in Sinhala)] were simultaneously used, where fruits and water were provided ad libitum. Fruits were replaced every 24 hours. All the bats always consumed the three types of fruits provided. The highest preference (as indicated by the amount consumed and the number of fruits attacked) was shown for guava followed by almond and mangoes. Results also showed that *Cynopterus* has a fairly high fruit consumption per day (12-48g). These observations indicate that *Cynopterus* is a generalised feeder and may be functioning as a fruit pest.

Key Words: *Cynopterus*, *Cynopterus sphinx*, bat, chiroptera, megachiroptera, fruit bat, diet, sri lanka, mango, guava, indian almond

1. Introduction

Fruit and nectar-eating bats are vital to the survival of tropical rain forests. It is estimated that in the Old World tropics alone, over 300 plant species depend on bats for seed dispersal and pollination (Bat Conservation International, 1989). These include many economically important plant species such as durian (*Durio zibethinus*), dates (*Phoenix dactylifera*), breadfruit (*Artocarpus communis*), avocados (*Persea americana*), peaches (*Prunus persica*) and mangoes (*Mangifera indica*). The diet of fruit eating bats comprise of several varieties of fruits, pollen, nectar (Bonaccorso 1979, Sosa & Soriano, 1996) and leaves (Kunz & Diaz, 1995).

There are only three species of fruit bats in Sri Lanka; *Pteropus giganteus*, *Rousettus leschenaulti* and *Cynopterus sphinx* (megachiroptera) as opposed to 25 insectivorous (microchiroptera) species (Bates & Harrison, 1997). However, apart from casual records (Phillips, 1980) of the types of fruits such as guava (*Psidium gujava*), soursops (*Annona muricata*), mangoes (*Mangifera indica*) and the fruits of several species of palm trees consumed by Sri Lankan bats, the diet and the dietary preference of these were not investigated. It was brought to the notice by farmers that fruit bats are one of the most notorious frugivores that cause heavy damage to fruits in home gardens as well as in large fruit plantations. Since bats forage in the night, often unseen by any observer, the farmers have become helpless in protecting their fruits from bats. It was also indicated that out of many locally grown fruits such as papaw (*Carica papaya*), banana (*Musa parasidica*), pineapple (*Ananas comasus*) and mangoes, highest attack was observed on mangoes. Furthermore, our observations since 1986 indicate that in certain locations there is as much as a 10 fold increase in frugivorous bats on the island (Ruebsamen et al. 1989; Yapa, 1992).

As fruit market has become a profitable and expanding venture in the recent past, making its mark in both local and export markets, we believe information on the diet and dietary preference of Sri Lankan bats are of value to assess the damage caused by the bats and possibly to identify strategies in minimising this damage. Therefore, as a first step of a long term study on the diet of fruit bats, we examined the feeding preference of *Cynopterus sphinx*, the species which has the widest distribution among the three species of fruit bats in the island (Digana et al., 1998). The specific objective of this study was to examine the food preference and to estimate the average daily fruit intake of *Cynopterus sphinx*. Experiments were conducted under semi natural conditions with a view to extrapolating the data into the field

condition. In this study three types of fruits; mango (cultivated fruit with high economic value) guava (a typical home garden fruit with less economic value), and Indian almond, a wild fruit with no economic value, were used.

2. Methods

The study was carried out from May to July 1998. Bats were captured in the Boralasgamuwa, Piliyandala area with mist nets (12x3m) in open areas, 1m above the ground using aluminium poles. The nets were set by 18.00 hrs. to coincide with the onset of activity periods of the bats (Yapa, personal observation). Ten male *Cynopterus* were captured on 10 different nights. Once a bat was entangled in the net it was immediately removed and the sex was determined by external examination. Mist netting was stopped as soon as a male was captured. Captured bats were put into a small wire mesh cage (25 x 40 x 15cm) and kept overnight. The following morning they were transported to the Department of Zoology, University of Colombo and were kept in the cage for a further period of 12 hrs for acclimatisation. In the cage, the bats had free access to banana and water. Prior to the introduction of these bats into the experimental room, their maturity, fore arm length and weight were recorded. The bats were weighed using an electronic balance (Shimadzu Libror EB 3200H; $\pm 0.01g$, Kyoto, Japan). The relative age groups of sub adults and adults were determined by fur coloration (Phillips, 1980). In adults the fur of the dorsal area is bistre-brown with the fur of the neck region varying from yellowish to bright chestnut. The fur on the belly and breast is usually greyish. The fore arm length of the adults were above 61mm. The sub-adults are greyish olive both on the dorsal and the neck region and fur on the under side is of a rather lighter grey.

The experiment was carried out in a large room (4 x 5 x 3.5m) and several potted plants and dried branches were kept inside. Special wire mesh was fixed to the wall which served as places for hanging for the bats. The room included a wooden bench (0.5 x 3 x 1m) for and a sink. A minimum and maximum thermometer was placed in the room to monitor the fluctuation of daily temperature. The room was under natural day - night cycle (approximately 12 hours light, 12 hours dark). The trial began in the evening at 18.00 hrs. with the introduction of the bats into the cage. Fresh fruits were purchased daily from a nearby fruit stall. In each trial, known and matching weights ($\pm 50g$) of all the 3 fruit types (mangoes 2-3; guava, 3-4, almond 10-12 fruits) of different sizes were randomly hung on a branch in the experimental room. The ripeness of fruits (raw, half-ripe) was established by external observation. The fruits were removed stat the following morning (07.30 hrs.- 08.30 hrs.) and weight loss and the numbers of fruits attacked,

of each fruit type, were recorded. The room was cleaned daily during day time. One trial with a single animal lasted for three consecutive days (72 hours) and ten such trials with ten different animals were made. At the end of each trial, animals were released. Throughout the experiment water was provided ad libitum. The results are given as means \pm SEM. Statistical comparisons were made using Mann-Whitney U-test. Probability values less than 0.05 were considered as significant.

3. Results

During the study, on each day, all the bats ($n=10$) consumed all the three fruit items provided (guava, almond and mango). However the amounts consumed of the three fruit types varied considerably in the case of adults (see Table 1) as well as in sub adults (see Table 2). The highest consumption as indicated by the weight loss was observed in guava (adult: 48.1g, sub adult: 33.6g) followed by almond (adult: 19.9g, sub adult: 20.6g) and mango (adult: 12.1g, sub adult: 10.2g). In both age categories these differences were statistically significant (guava vs. almond: $p<0.05$, guava vs mango: $p<0.001$ and almond vs. mango: $p<0.01$; Mann Whitney U-test).

The highest number of attacks by bats were seen in almond (6-8 fruits per day). On the other hand, in mango and guava, only a single fruit was attacked during a given trial. In all three types of fruits, it appeared that numbers of bitings per fruit were highest in the fully ripe fruits compared to mildly ripe fruits. Further there seemed to be no correlation between the number of bitings and the size of the fruits.

During the study none of the bats showed any overt signs of physical weakness and abnormal behavioural patterns such as increased restlessness continuous flight inside the experimental room until fully exhausted etc. The weight of all the bats used in the study appeared to be unaltered.

4. Discussion

In the present study, all three types of fruits (guava, mango and almond) were provided in excess so that, bats could have satisfied their dietary requirements even by consuming their fruit of choice. Yet on each day all 10 animals always consumed all three types of fruits, indicating that *Cynopterus* is a generalised feeder. This type of feeding strategy was reported for phyllostomid bat, *Glossophaga logirostris* in Venezuela (Sosa & Soriano, 1996). According to the present study, guava was the most preferred fruit, followed by almond and mango in both adults and subadults.

This mixed diet of *Cynopterus* could simply be a response to the simultaneous availability of fruits. Alternately, the bats may be consuming different types of fruits so as to meet the energy demand and to satisfy the nutritional and mineral requirements. The comparison of the composition of guava (most preferred food) and mango (least preferred fruit) indicates that guava is high in energy (51 vs. 44 kcal); protein (0.9 vs 0.7g), fat (0.3 vs. 0.1g) and carbohydrate (11.2 vs. 10.1g) while mango is rich in vitamins such as carotene, thiamine, riboflavin, niacin and vitamin C (Perera et al. 1979; all values are per 100g of edible portion). Therefore, it can be assumed that the mixed diet of *Cynopterus* is a profitable way of maintaining the energy and nutrient requirement of bats. It has been shown that the diet of fruit bats constitute of fruits, seeds, pollen, nectar, leaves and sometimes insects too to meet the nutrient requirement in diet (Sosa & Soriano, 1996; Kunz & Diaz, 1995). Uieda *et al.* (1998) reported that the diet of fruit eating bat *Artibeus literatus* consists of 23 fruit types.

As yet data on consumption of fruit of Sri Lankan bats are not available and this is the first study to provide such data. The daily consumption of bats used in this study was almost double their body weight. This far exceeds the daily food intake of some of the other species of bats (common vampire bat: 132% of the body weight: fruit bat- Egyptian Dog bat :45% of body weight: Gizimek's Encyclopedia of Mammals, 1990). There could be several reasons for this high intake of food. It has been reported that bats consume a great quantity of fruits or feed selectively on protein rich fruits as many fruits are low in protein content (Kunz & Diaz, 1995). Secondly, this may be partly due to their method of fruit processing. Bats consume only the fleshy parts of the fruits and after thorough mastication, juice is swallowed and the rest is discarded as a fibrous wad, so that only a fraction of fruits enters into the gut. Since our calculations on the food consumption of *Cynopterus* were based on the weight loss of the fruits provided, parts dropped during feeding as well as food pellets discarded by the bats after mastication were also included as fruits consumed. Finally it should be recognised that very high moisture content (70% to 80%) is found in fresh fruits (Perera et al. 1979).

It was evident that a single *Cynopterus* attacked about eight fruits per night and if this is so in the field conditions, they are most likely to cause considerable damage to fruit plantations. *Cynopterus* is one of the commonest fruit eating bats in Sri Lanka. This is evident by the fact that in a three year island wide survey during which eight species were caught by mist netting (58 sites) 53% were *Cynopterus sphinx* (unpublished observation). This indicate that these bats alone can cause considerable damage to locally grown fruits. This is in agreement with the claim made by fruit growers that bats cause heavy damage to their fruits (mango, rambutan). *Cynopterus* thrive in

human dominated landscapes (Corlet, 1998) and thus could be a major "fruit pest." However, it should be recognised that attack on fruits per night may be much higher than the estimated values since there are two other fruit eating bat species in Sri Lanka. Although mango was the least preferred fruit in this study, damage on mango may be higher in a mono-culture plantation.

In the present study, whenever ripe fruits were used, animals preferred these to raw fruits, specially in the case of mango and guava. Therefore, damage by bats, at least partly, may be reduced by plucking fruits raw. The results of this study also showed that bats prefer almond (which is not a commercial crop in Sri Lanka) over mango and guava. Therefore, it is worthwhile to examine whether the attack on mango would be reduced if there are several other fruit types such as almond.

In conclusion this study demonstrates that *Cynopterus* has a fairly high fruit consumption per day (12-48g) and as such is capable of causing heavy damage to fruits. Results also show that a single meal of *Cynopterus* consisted of several types of fruits and there exists a preference for certain fruits over others. Although at this stage, it is premature to suggest that the application of the dietary preferences of *Cynopterus* can be exploited to minimise the damage to economically important fruits, it is worthwhile to carry out a further in-depth study on the feeding preferences of fruit eating bats in Sri Lanka.

Table 1: Average daily consumption of adult *Cynopterus* for guava, almond and mango. (means \pm SEM for three nights)

Animal No	Fruit type			total(g)
	guava (g)	almond(g)	mango	
1	59.5 \pm 20.2	11.0 \pm 6.3	2.4 \pm 3	72.8
2	50.0 \pm 12.7	22.0 \pm 3.7	13.3 \pm 2.7	85.4
3	30.4 \pm 6.7	12.9 \pm 2.5	8.1 \pm 1.9	51.3
4	52.6 \pm 8.5	33.7 \pm 4.4	24.6 \pm 0.3	111.0
Mean consumption	48.1 \pm 6.4	19.9 \pm 3.1	12.1 \pm 2.5	
(per animal)				
Avg. Consumption	1.1	0.44	0.28	1.75
/gram body wt				

Table 2. Average daily consumption of sub adult *Cynopterus* for guava, almond and mango (means \pm SEM for three nights)

Animal No	Fruit type			
	guava (g)	almond(g)	mango(g)	total(g)
1	18.5 \pm 3.8	26.7 \pm 1.7	2.6 \pm 0.6	47.8
2	34.5 \pm 8.1	10.8 \pm 1.1	7.9 \pm 2.9	53.2
3	35.3 \pm 9.2	21.0 \pm 4.4	5.7 \pm 2.1	62.0
4	28.0 \pm 8.3	18.5 \pm 4.1	15.3 \pm 5.1	61.8
5	39.3 \pm 9.8	29.5 \pm 6.1	18.8 \pm 4.3	87.6
6	45.1 \pm 2.8	17.4 \pm 1.7	11.0 \pm 3.0	73.5
Mean consumption (per animal)	33.4 \pm 3.0	20.6 \pm 1.9	10.2 \pm 1.7	
Avg. Consumption /gram body wt	0.79	0.48	0.24	1.5

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