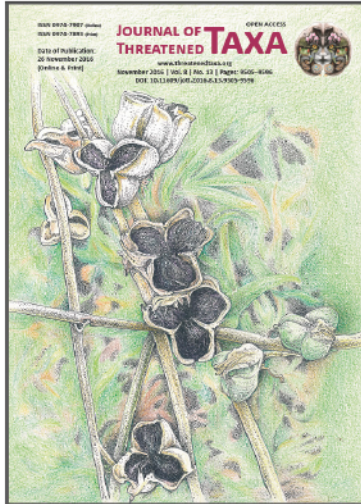


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### SHORT COMMUNICATION

**FORAGING OF THE INDIAN SHORT-NOSED FRUIT BAT *CYNOPTERUS SPHINX* ON BANANA IN SHOPS AND ON THE PIECES DROPPED BY MONKEYS AT A TEMPLE**

A. Rathinakumar, S. Baskaran & G. Marimuthu

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## FORAGING OF THE INDIAN SHORT-NOSED FRUIT BAT *CYNOPTERUS SPHINX* ON BANANA IN SHOPS AND ON THE PIECES DROPPED BY MONKEYS AT A TEMPLE

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**Abstract:** The Indian Short-nosed Fruit Bat *Cynopterus sphinx* fed on the pieces of banana fruit that were dropped by monkeys on the tower of a temple and in nearby shops. The monkeys obtained fruits from devotees and shop owners. The peak number of bat visits occurred during pre- and post- midnight hours at the tower and shops, respectively, coinciding with the lights off situation and reduced human disturbance. The bats landed on bunches of ripe bananas hanging in the front of shops. The number of bat landings on the tower was greater than that in the shops. The overall number of bat visits were higher during October when compared to other periods of the year. This may be due to the occurrence of more festivals during October. Our study is an example of opportunistic feeding, in which banana pieces dropped while monkeys were feeding on them were eaten by the bats.

**Keywords:** Anthropogenic environment, banana, conservation, *Cynopterus sphinx*, monkey, opportunistic feeding, temple.

Habitat degradation due to rapid urbanization, leading to loss of biodiversity and coexistence of wild animals in human-dominated urban environments is a major conservation issue (Ditchkoff et al. 2006). Habitat degradation has led to drastic declines of populations of several species, including many commensal species

(Singh et al. 2011; Erinjery et al. 2015). Animals in anthropogenic environments have to face multiple novel situations such as the presence of humans, artificial illumination, noise, harmful chemicals, altered predator-prey relations, new predators and fragmented habitat (Fisher et al. 2006; Hölker et al. 2010; Rodewald et al. 2011; Sih et al. 2011). Hence, only urban dwelling animals which are capable of adapting to these conditions will survive. Habituation to humans (Rodriguez-Prieto et al. 2009), raiding food from humans (Haag-Wackernagel et al. 1995), changing activity patterns in response to the presence of humans and traffic (Dowding et al. 2010), modulating or changing the time of vocalizations to avoid being masked by anthropogenic noise (Slabbekoorn 2013), reducing predator vigilance and allotting more time for foraging (McCleery 2009) are examples of behavioural plasticity shown in these situations. These animals, however, are forced to take increased risks for obtaining food during periods of resource scarcity.

The Old World bats of the family Pteropodidae are phytophagous (Marshall 1985) and evolved to orient

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and locate food with olfaction and vision (Acharya et al. 1998; Luft et al. 2003). The pteropodid greater short-nosed fruit bat *Cynopterus sphinx* is one among the six species of tent-making bats in the Palearctic region. Male bats construct tents in foliage and form harems (Balasingh et al. 1995). The species is distributed throughout the Indian sub-continent and is commonly found in anthropogenic environments (Bates & Harrison 1997). After resting during the day, the individuals of the harem start to forage about 30 minutes after sunset. They feed mainly on fruits and nectar, which are rich in carbohydrates and water at the beginning of the foraging period, and leaves which are rich in minerals and proteins later in the foraging period (Elangovan et al. 2001). Harem males usually forage closer to their tent (Marimuthu et al. 1998; Gopukumar et al. 2005). The foraging activity at night shows two peaks: one before midnight when bats forage solitarily on “steady state” trees (plants producing a small number of fruits for an extended period, for example: *Polyalthia longifolia*); another post-midnight when they forage in groups on “big bang” trees (plants producing a large number of fruits for a short period, for example: *Ficus religiosa*) (Elangovan et al. 1999). *Cynopterus sphinx* peels off the skin while feeding on mango (Singaravelan & Marimuthu 2008) and banana (A. Rathinakumar pers. obs.). It visits at least 25 species of plants for fruits, leaves, flower and flower products such as nectar and pollen (Singaravelan & Marimuthu 2004).

Rapid urbanization and habitat degradation, however, have led to the loss of many trees on which *C. sphinx* forages in the urban areas. We expected that this would lead the bats to enter into direct conflict with humans in urban areas to compete for food. Hence, we studied the foraging behaviour of *C. sphinx* in an urban area, which had several shops and a temple. Bats mainly visited the study area to feed on the remains of banana left over by monkeys on roof tops. We expected the bats to forage more in the temple than in the shops since it is relatively undisturbed compared with shops. We also expected them to spend more time foraging when the lights in the temple were switched off.

## MATERIALS AND METHODS

The study was conducted between February 2012 and January 2013 in and around the Murugan temple, Thirupparankundram (TPK), about 12km south of the Madurai Kamaraj University campus, at the western outskirts of Madurai City (9°58'N & 78°10'E). The temple complex abuts a granite rocky hillock (Image 2e). The tower at the entrance of the temple is situated in front



Image 1. Bonnet Monkey visiting the shops to take banana

of a public road, in which hotels and many smaller shops selling bananas, coconut, garlands and tea are found. The shops are open daily for 24 hours. Visual observations were made on Bonnet Monkeys *Macaca radiata* visiting the row of shops (Image 1) from 06:00–08:00 hr and again from 15:30–17:30 hr to take bananas. The number of bat-visits was counted for every 30 min from 20:00–05:00 hr for 43 nights, resulting in a total of 387 observation hours. We observed the bats for approximately the same number of days every month. Whenever an individual bat flew across our visual field once, we referred to it as a bat-visit. In the temple and shops the lights were switched off at 21:00hr and 00:30hr, respectively. We could continue our visual observations with the aid of the nearby street lamps.

## RESULTS

During the daytime the monkeys moved freely in and out of the temple premises. Usually the devotees offered banana and coconut to the monkeys. The shop owners also discarded over-ripe banana for the monkeys. The monkeys collected the bananas, reached the lower areas of the tower and fed on them. The tower is sculptured with a variety of smaller colourful statues. When the monkeys fed on the fruits (Image 2f) pieces of banana sometimes slipped from their hands and fell onto the statues in the tower (Image 2 g1,g2).

Individuals of *C. sphinx* began to arrive in the temple complex at 20:30hr and exhibited circling flights around the front area. Although bat visitation at the tower area occurred throughout the night, the highest number of bats were seen between 22:00hr and 22:30hr, one hour after the temple lights were switched off (Fig. 1). In the shops, the bats landed on hanging bunches of ripe



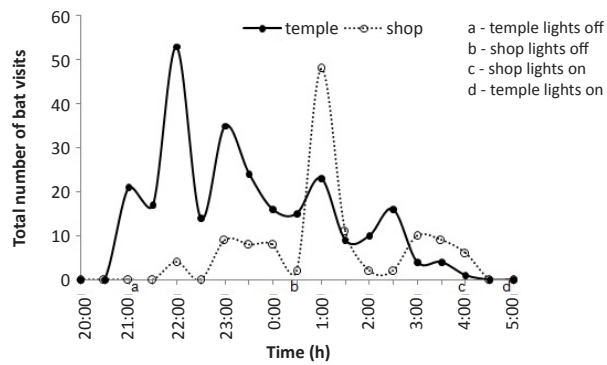


Figure 1. Temporal variations in the total number of bat-visits to the temple tower and the nearby shops

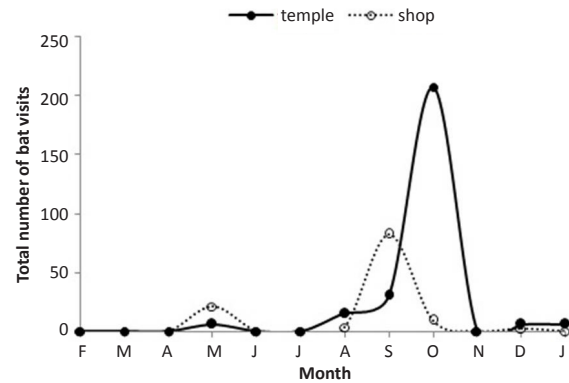


Figure 2. Monthly variations of bat-visits over the period of a year in the temple tower and shops

bananas (Image 2b) and flew away after removing a small piece (Image 2c). There were more bat-visits in the temple area ( $n=122$ ) than at the shops ( $n=71$ ). When we analyzed the cumulative number of bat-visits over the seasons, we found that the highest number of bat visits occurred during September in the shops and October in the temple (Fig. 2), when compared to other months of the year. We presumed that during each landing, the bats picked up pieces of banana. In addition, we noticed that the bats carried banana peel six times (S1).

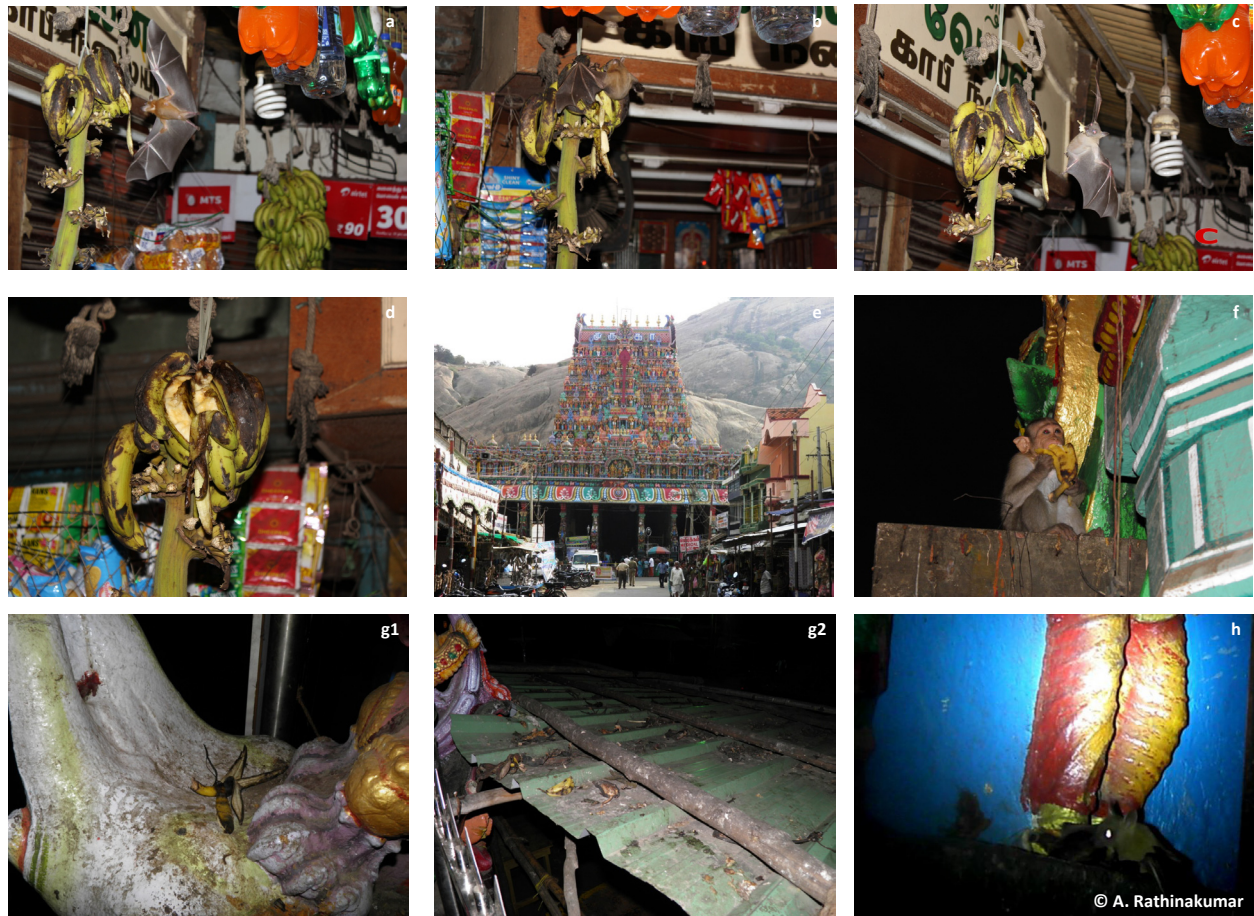
## DISCUSSION

Usually fruit bats including *C. sphinx* foraged upon fruits, nectar and leaves on trees situated either in urban or wild areas. For example, there are reports that *C. sphinx* feeds upon fruits of *Ficus religiosa*, *Annona squamosa*, *Terminalia catapa*, nectar from *Musa paradisiaca*, *Bassia latifolia* and *Ceiba pentandra* and leaves of *Cassia fistula*, *Mimusops elengi* and *Coccinia indica* (Elangovan et al. 2001; Singaravelan & Marimuthu 2004; Nathan et al. 2009). In addition, *C. sphinx* visits orchards and forages on *Mangifera indica*, *Psidium guajava*, *Vitis vinifera* and *Achras sapota* and a non-commercial fruit *Muntingia calabura* (Singaravelan & Marimuthu 2006). The bats have to actively locate the fruits at the trees. In all such foraging sallies, the bats exhibit either in situ or ex situ feeding if the fruits are larger (e.g., *M. indica*, *P. guajava* and *A. sapota*) or smaller (e.g., *Ficus religiosa*, *M. calabura*), respectively. The bats have to expend energy on location, processing and handling the fruits in either mode (Dumont 2003; von Helversen & Winter 2003).

Because pieces of banana are already available in the temple and whole banana fruits in the shops, the bats may not need to spend energy searching for food. They land and directly pick up the fruit pieces in the temple,

and remove pieces from whole fruit in the shops. However, it is not known how fresh the fruit is, especially at the tower. A series of festivals are celebrated during September–October in the present study site. Hence, monkeys get more offerings during this season. Also, shopkeepers bring and keep a lot of fruits during this season. This may presumably be the reason for the higher number of bat-visits during this season. In addition, the dropped pieces may be relatively fresh due to the wet season. The increase in the number of bat-visits soon after the lights were switched off suggests that darkness and reduced human disturbance facilitates more bat-visits. Because movements of people at the tower area are less when compared to those at shops, the number of bat-visits was greater at the tower, as expected. The fact that the bats never landed on unripe bunches in shops clearly indicates that *C. sphinx* prefers mainly ripe fruits. Conflicts between fruit growers and fruit bats have been reported in several countries across the world (Aziz et al. 2016), and the present study reveals the conflict between the fruit seller and the fruit bats foraging in urban area. The shopkeepers in the study area usually cover the ripe banana bunch with cloth (Image 3) to protect it from the shop-visiting bats.

The present study is an example of opportunistic feeding (Fenton & Morris 1976). The remnants of the food dropped by the monkeys are fed upon by the individuals of *C. sphinx*. Such flexibility in foraging might help urban fruit bats to successfully exploit available food resources. In Tamil Nadu (southern India), temples with towers with similar facilities are abundant and apparently the temple areas are less disturbed and less illuminated soon after their closure at night. Thus temple areas could serve as foraging grounds for urban bats. Moreover, temples also provide roosting sites for many species of bats (Mathivanan 2013; Senthilkumar



**Image 2.** Sequence of events in the foraging activity of *Cynopterus sphinx* in the bunch of banana kept hanging in front of a shop and pieces of fruits dropped by monkeys at temple tower area (a) An individual *C. sphinx* approaches a bunch of over-ripe bananas; (b) An individual *C. sphinx* lands on the bunch of over-ripe bananas; (c) An individual *C. sphinx* collects a piece of banana; (d) Peeled banana after the foraging activity of *C. sphinx*; (e) Front view of the TPK Murugan Temple; (f) A bonnet macaque feeds on a banana in the temple tower area; (g1 & g2) Dropped fruit pieces in temple tower area; (h) An individual of *C. sphinx* feeds on disposed fruit.



**Image 3.** Ripe banana bunch covered with cloth to avoid bats feeding on it

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2014); hence temples may prove to be promising sites for bat conservation in India.



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