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Foraging behavior of the Indian short-nosed fruit bat *Cynopterus sphinx*

By N. Gopukumar Nair, V. Elangovan, K. Sripathi, G. Marimuthu, and R. Subbaraj

Department of Animal Behaviour and Physiology, School of Biological Sciences, Madurai Kamaraj University, Madurai, India

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The Indian short-nosed fruit bat *Cynopterus sphinx*, one among the old world bats (Pteropodidae), inhabiting the tropics, roosts solitarily or in small groups in the foliage (Bhat and Kunz 1995). *C. sphinx* exhibits elaborate tent-roosting behaviour (Balasingh et al. 1995). The data collected to date on the foraging behaviour of *C. sphinx* are more biased to male individuals since these tent-roosting harem males exhibit several behavioural repertoires (Balasingh et al. 1993; Marimuthu et al. 1998). We carried out radio-telemetry studies on the foraging behaviour of male and female *C. sphinx* from the same habitat.

The study area, Madurai Kamaraj University campus and adjoining areas in Madurai, South India (lat 9°58′ N; long 78°10′ E) is surrounded by tall trees including *Polyalthia longifolia*, *P. pendula*, *Azadirachta indica*, *Ficus bengalensis*, *F. religiosa*, *F. benjamina*, *Bassia latifolia*, *Cocos nucifera*, *Caryota urens*, *Borassus flabellifer*, and *Mimusops elengi*. Five males and five females were radio-tagged. The foraging studies were carried out for 640 night hours (for 81 nights). Male *C. sphinx* (47 ± 3 g) chew and clip the twigs of the interior of the foliage of trees such as *P. longifolia, B. flabellifer*, and *C. nucifera* and thus make tent-roosts. Bats were captured from their tent roosts using mist nets (Avinet-Dryden, NY. 13053-1103, U.S.A.). Their body mass was recorded to the nearest 1.0 mg with a spring balance (Avinet-Dryden, NY. 13053-1103, U.S.A.) Length of forearm was measured to the nearest 0.1 mm with the help of vernier calipers. The radiotracking studies were conducted between May 1997 and March 1998. Each bat was fitted with a radio-transmitter (2.6 g) covering a range of 400–500 m, mounted over an aluminium collar covered by a light reflective tape. The transmitter along with the collar weighed only 5.5 % of the average body weight of *C. sphinx*. We used two sets of receivers and collapsible 5-element Yagi antennae (Customs Electronics, Urbana, Illinois, U.S.A.). Radiolocations were triangulated from three tracking units. Bearings were taken in as short a time interval as possible and locations with a minimum angle of interaction $<30°$ were discarded. The time duration between the first and last bearing used to estimate a bearing was usually <9 min. Where ten or more locations of a bat could be triangulated, the size of the foraging area of the individual was calculated by the 'minimum range method' (Mohr 1947). Theoretical centres of activity within the foraging areas were estimated (Hayne 1949), and the distance between these centres of activity and the day roost was calculated. The study area map (Fig. 1) was divided into 20 grids of 1 km^2 area each. Horizontally it is marked 'a' to 'e' and vertically it is marked '1' to '4'. This would facilitate nam-

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Fig. 1. Typical representative triangulated foraging areas of a male, M4 (○) and a female, F1 (□) *C. sphinx*, in a grid map of the study area in Madurai, Southern India, Each grid covers 1 km^2.

Table 1. Distance between centres of foraging area and day roost for five males and five females of *C. sphinx*. FA – Foraging Area, FA1 – First foraging area, FA2 – Second foraging area, FA3 – Third foraging area.

Bat No.	Distance between the day roost to FAs (km)		
	FA1	FA2	FA3
M1.	0.12	–	–
M2.	0.10	–	–
M3.	0.09	–	–
M4.	0.20	–	–
M5.	0.10	0.50	–
F1.	2.10	0.20	0.75
F2.	1.20	0.50	0.20
F3.	1.80	0.20	0.70
F4.	2.20	0.40	–
F5.	0.20	NF	NF

ing specific foraging areas and day roost of each bat. The activity of the bats was monitored with the night vision sniperscope (Litton Precision Product, Germany, M-972) and their activity budget was calculated by monitoring the fluctuations of beep pulses from the receiver. The constant beep signals were considered as 'rest'.

All the five radio-tagged males (M1 to M5) had their respective day roost and foraging area in grid 2 b, whereas, the fifth male (M5) had an additional foraging area in 3 c (Fig. 1). Throughout our study only one male (M4) was found to have night roost fidelity and *Guetterda speciosa* was used as night roost constantly. But the other tagged bats of both sexes used more than one night roost. Each individual had used more than one tree species such as *Areca catechu, P. longifolia, A. indica, C nucifera, Achras sapota*, etc. The mean travelling distance for males was 0.22 ± 0.19 km and the mean size of the foraging area was 0.75 ± 0.27 km^2. All the females were found to be utilising more than one foraging area. Among these, one area lies far from the day roost and the other area (s) lies nearer to the day roost. For instance, F2 and F3 foraged in grids 2 b, 2 c, and 3 b; and 2 a, 2 b, and 2 c respectively, while F1 foraged in grid 2 c and two sites in 4 d. During the observation, F1, F2, and F3 regularly utilised the three different foraging areas every night. But the sequence of visits to different areas changed every night. F4 foraged only at two different foraging areas (4 b and 2 b). Interestingly, F5 roosting in grid 2 b spent < 20 % of night time (n = 68 hours observation) foraging in 2 b. The other foraging area of this bat could not be located as the foraging area was beyond 4 kms. The mean travelling distance for females was 2.1 ± 1.0 km and the mean size of the foraging area was 0.83 ± 0.12 km^2. The males and females exhibit a high level of activity during the early hours of night soon after emergence and another activity peak during pre-dawn hours (Fig. 2).

Our study shows that the foraging pattern of *C. sphinx* is similar to that of *Artibeus jamaicensis, Phyllostomus hastatus*, and *Carollia perspicillata* (August 1981; Fleming 1988; McCracken and Bradbury 1981; Morrison 1978). Bats leave the day roost shortly after sunset and fly to foraging areas while they begin to search for ripe fruits. The harvested fruits were transported to the "night roosts" for consumption. These "night roosts" might promote digestion and energy conservation, offer retreat from predators, serve as centres for information transfer about the location of fruit patches and facilitate social interaction (Kunz 1982). A regular travel path exhibited by M 4 between day roost and foraging area may be attributed to the constancy of resource availability. Such a "trap-lining" behaviour minimizes search distances and energy cost (Kunz 1982).

It seems clear that the male *C. sphinx* restricts its foraging areas closer to the day roost. Since the males involve in tent construction, harem formation and defence, a short distance foraging area would promote harem defence near the day roost (Fleming 1988; Marimuthu et. al., 1998). This observation of short distance foraging flights of males is consistent with observations of the harem males of *A. jamaicensis*, *P. hastatus* and *C. perspicillata* where feeding predominantly occurs in the vicinity of their day roost (Fleming 1988; Hardley and Morrison 1991; McCracken and Bradbury 1981; Morrison 1979; Morrison and Morrison 1981). The foraging areas of males are overlaping because the day roost of most of the males lies within a rich food patch. The reasons for the commutation to longer distances, spending more time and utilization of several foraging areas of female bats are not clearly known. One of the reasons for long distance commutation by females might be search for potential male tent roost and to assess the harem male's parental ability. Furthermore, they change their primary foraging area in an unpredictable fashion as observed in *C. perspicillata* (Kunz 1982). Since not every foraging area contains the same potential food source, one reason for such unpredictable "visits" might be to increase dietary diversity. In the usual bimodal pattern of activity, maximum foraging bouts occurred in the early hours of the night and lesser activity during the pre-dawn hours (Fleming 1982). *C. sphinx* also shows a similar pattern of activity.

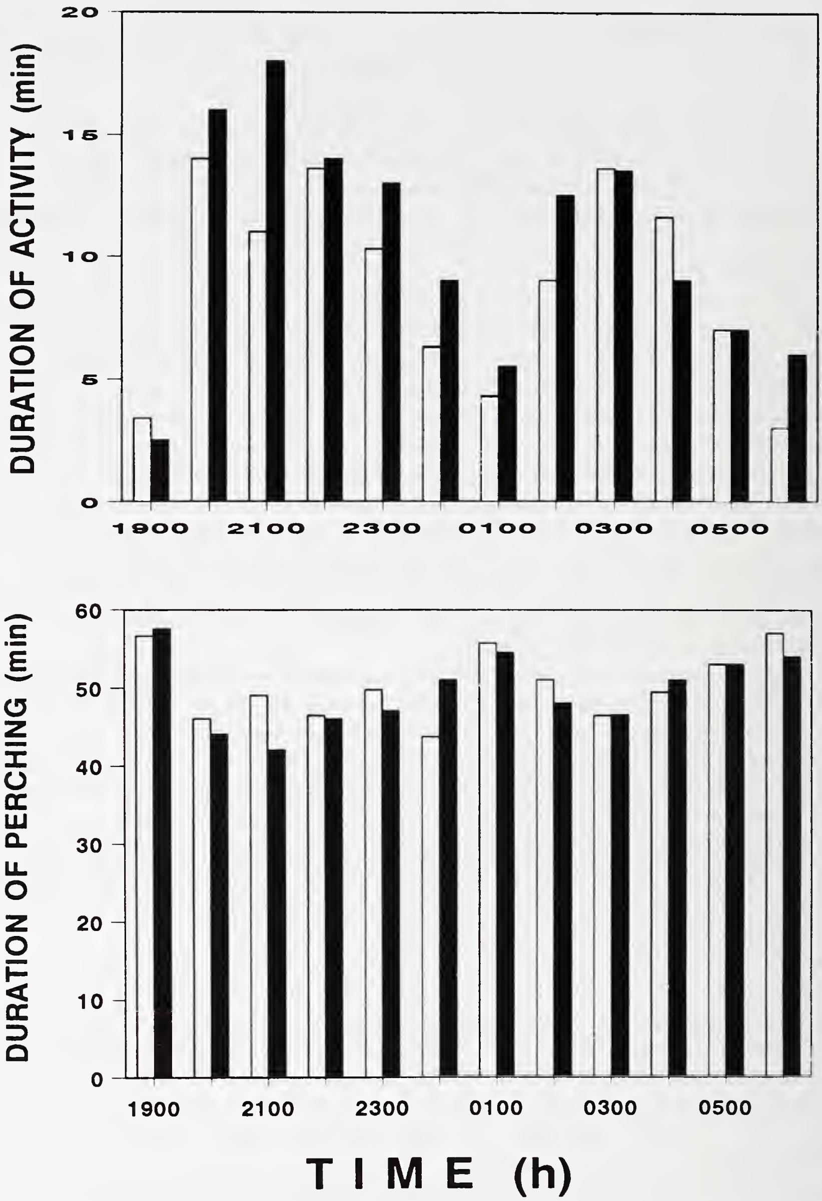

Fig. 2. *a)* Duration of activity and *b)* duration of perching for radio-tagged *C. sphinx* (□ – Male and ■ – Female)

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References

August, P. V. (1981): Fig fruit consumption and seed dispersal by *Artibeus jamaicensis* in the Ilanos of Venezuela. Reprod. Bot. Suppl. Biotropica **13**, 70–76.

Balasingh, J.; Isaac, S. S.; Subbaraj, R. (1993): Tent-roosting by the frugivorous bat *Cynopterus sphinx* (Vahl, 1797) in Southern India. Curr. Sci. **65**, 418.

Balasingh, J.; John Koilraj, A.; Kunz, T. H. (1995): Tent construction by the short-nosed fruit bat, *Cynopterus sphinx* (Chiroptera: Pteropodidae) in Southern India. Ethology **100**, 210–229.

Bhat, H. R.; Kunz, T. H. (1995): Altered flower/fruit clusters of the kitul palm used as roosts by the short-nosed fruit bat, *Cynopterus sphinx* (Chiroptera: Pteropodidae). J. Zool. (London) **235**, 597–604.

Fleming, T. H. (1982): Foraging strategies of plant visiting bats. In: Ecology of Bats. Ed. by T. H. Kunz. New York: Plenum Publ. Corp. Pp. 287–325.

Fleming, T. H. (1988): The short-tailed fruit bat. Chicago, London: Univ. Chicago Press.

Hardley, Jr. C. O.; Morrison, D. W. (1991): Foraging behaviour. In: Demography and Natural History of the Common Fruit Bat, *Artibeus jamaicensis*, on Barro Colorado Island, Panama. Ed. by C.0. Handley; D. E. Wilson, and A. L. Gardner. Washington, D. C.: Smithsonian Institution Press. Pp. 137–140.

Hayne, D. W. (1949): Calculation of size of home range. J. Mammal. **30**, 1–18.

Kunz, T. H. (l982): Roosting ecology of bats. In: Ecology of Bats. Ed. by T. H. Kunz. New York: Plenum Press. Pp. 1–55.

Marimuthu, G.; Rajan, K. E.; John Koilraj, A.; Isaac, S. S.; Balasingh, J. (1998): Observation on the foraging behaviour of a tent roosting megachiropteran bat *Cynopterus sphinx*. Biotropica. **30**, 321–324.

McCracken, G. F.; Bradbury, J. W. (1981): Social organization and kinship in the polygynous bat *Phyllostomas hastatus.* Behav. Ecol. Sociobiol. **8**, 11–34.

Mohr, C. O. (1947): Table of equivalent populations of North American small mammals. Am. Midl. Nat. **25**, 196–233.

Morrison, D. W. (1978): Lunar phobia in a Neotropical fruit bat, *Artibeus jamaicensis* (Chiroptera: Phyllostomidae). Anim. Behav. **26**, 852–855.

Morrison, D. W. (1979): Apparent male defence of tree hollows in the fruit bat, *Artibeus jamaicensis.* J. Mammal. **60**, 20–29.

Morrison, D. W.; Morrison, S. H. (1981): Economics of harem maintenance by a neotropical bat. Ecology **62**, 864–866.

Authors' address: N. Gopukumar Nair, V. Elangovan, K. Sripathi, G. Marimuthu, and R. Subbaraj, Department of Animal Behaviour and Physiology, Madurai Kamaraj University, Madurai 625 021, India.