Nature Watch

Tent-making Bats

N Gopukumar and J Balasingh

Every evening, against the backdrop of a setting sun, scores of both insect and fruit eating bats emerge out in search of food. While most of the bats emerge from pre-existing structures such as caves, crevices and human habitation, some emerge from structures modified by their own efforts. Our interest is particularly in the fruit bats emerging out from modified foliage. Because of their role in the regeneration of tropical forests by dispersing huge numbers of seeds, fruit bats are of profound importance. In this article, we discuss the mating strategy adopted by the Indian short-nosed fruit bat *Cynopterus sphinx*, the mechanics of tent-making in this species, and some recent findings which argue for an alternative breeding strategy.

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The swaying palmyras and mast trees forming the skyline of rural areas of Tamil Nadu may not attract everyone in the same way as they do bat researchers, because bat researchers know that these trees are home to one of the most diverse groups of mammals – the foliage roosting bats. These foliage roosting bats are among the megachiropteran bats that exhibit an astonishingly sophisticated behaviour of tent making, and *Cynopterus sphinx* (*Figure* 1) is one such tent making bat found in India. Though this species is widely distributed in India, tents in the wild are often difficult to detect. To locate a 'tent' of *C. sphinx*, one should go for an early morning walk in an area where trees like *Polyalthia longifolia*, *Borassus flabellifer*, *Caryota urens* and *Washingtonia filifera* are abundant. If an accumulation of rejected fruits, leaf pellets and seeds are seen beneath these trees, it is very likely that just above will be seen a partially enclosed cavity like structure, complete with a handsome entryway. These draping structures made of modified leaves are known as 'tents'

Figure 1. Cynopterus sphinx.

and the architect – a male *C. sphinx* – might well be observed sleeping silently inside the tent after a night's toil (*Figure* 2). In contrast to many bird nests, these bat tents can well be appreciated for the simplicity of their construction. Just by damaging the leaves along the midrib, these bats force the leaves to fold down in the form of a large enclosed tent. This habit of modifying live leaves is a rare phenomenon among mammals and was first observed in the bat *Uroderma bilobatum* by Thomas Barbour in the early 1930s. Since then, research on the tent making behaviour of bats has gathered momentum and fifteen species of neotropical bats and three species of paleotropical bats are now known to either roost in or construct tents in leaves and other parts of around 80 species of vascular plants. Altogether, eight different types of bat tents are now recognized (*Table* 1), and most bats construct tents according to the shapes and sizes of leaves in the plants they use.

The Honeymoon Tent and Harem Males

Although bat tents are helpful in a number of ways like shielding the bats from sun, wind and from predators, these tents also play a crucial role in the mating behaviour of *C. sphinx*. It is essential for a male to construct a tent before making any attempts to court females. Though tent construction had been reported in many bats, nobody had ever seen a bat in the act of tent-making until one day one of us (JB) decided to examine a mysterious hole in a large creeping vine (*Vernonia scandens*) inside the college campus. The cavity turned out to be a bat tent of the size

Figure 2. A male C. sphinx roosting in a tent under a palm leaf.

Tents	Plants
Conical	*Carpotroche platyptera*
Palmate Umbrella	*Prichardia pacifera* *Livistona chinensis*
Pinnate	*Scheclea rostrata* *Astrocaryum murumura* *Cocos nucifera*
Apical	*Pentagonia donnel-smithii* *Dillenia beccariana*
Bifid	*Manicaria saccifera* *Prestoea pubigera*
Paradox	*Musa sp.* *Anthurium sp.*
Boat	*Heliconia sp.*
Stem	*Polyalthia longifolia* *Borassus flabellifer* *Caryota urens* *Areca catechu*

Table 1. Type of tents and plant species whose foliage is used by bats to construct tents.

Figure 3. Entrance of a tent constructed in Washingtonia filifera.
(Photo credit: Suthakar Isaac)

of a big waste paper basket. Further study over a period of two months, allowed the observation of a male actually severing 80 leaves, 30 small branches and three large branches to construct the tent.

Preparation for the breeding season does not end with the construction of a tent by a male *C. sphinx*. Equally demanding tasks like tent maintenance and defence have to be attended to by the male. The males take special care to maintain the entry way by trimming the plant regrowth so as to provide an unimpeded access to and from a tent cavity (*Figure* 3). Furthermore, they lick the stems on the interior crown until they glisten, and researchers have hypothesized that the saliva contains some chemical signal identifying the architect of each tent. Similarly, in an apparent indication of tent defence, harem males forage nearer to their tents to avoid tent usurpation. However, inspite

Figure 4. A harem of C. sphinx roosting in a tent constructed in Polyalthia longifolia.
(Photo credit: Suthakar Isaac)

of such commendable efforts like tent construction, maintenance and defence, only some males succeed in recruiting a reasonable number of females (*Figure* 4), while some are able to recruit only one female. What precisely are the qualities of bats/tents which attract maximum number of females and hold them together in a harem is not yet known. While this aspect of the mating systems of *C. sphinx* remains a mystery, this is further confounded by the bizarre behaviour of some adult males roosting alone during the breeding season.

The Non-harem Males

Why do some males roost alone? In 1977, S T Emlen and L W Oring suggested that resource-defence mating systems evolve because critical resources essential for females to reproduce are unevenly distributed in nature. This increases the potential for some males to control a larger quantity or better quality of resource and, thereby, access to females, than other males. This hypothesis leads to the suggestion that it is shortage of resources that forces some male *C. sphinx* to roost alone. If this is indeed so, what should they do? Should they do nothing, and let the fortunate males alone engage in breeding activities. This was a major question we sought to answer, and to begin with we started a year long study of the day roosts and roosting patterns

Box 1. Mating Systems in Bats

Bats probably show more forms of mating behaviour than any other mammalian order. At one extreme lies the *monogamous* pairing, as found in *Hipposideros beatus, Rhinolophus sedulus, Lavia frons, Vampyruss spectrum, Taphozous peli* and *Rhinolophus luctus*, where a male mates with a single female in a given season. At another extreme, bats like *Myotis lucifugus* are promiscuous, where both sexes have multiple partners. In some bats, males own and defend a 'resource' to recruit females. This resource can either be a roosting site (*Cynopterus sphinx, Artibeus jamaicensis, Ectophylla alba, Uroderma bilobatum, Vampyressa numphaea*) or foraging site *(Saccopteryx leptura, Peropteryx kappleri*). This strategy is called *resource defence polygyny*. In *Phyllostomus hastatus*, females are usually found in groups. Therefore, males can easily defend them, resulting in female defence polygyny. In *Hypsignathus monstrosus, Nyctalus noctula* and *Miniopterus* spp., males are more closely packed with very small territories. Therefore, it is easier for females to visit such groups and choose a mate for copulation leading to *Lek breeding*, where females can choose mates from among a group of males gathered at one place.

of *C. sphinx*. The survey was carried out in places close to Madurai and Palayamkottai (in Tamil Nadu). Every week, 4-6 tents were surveyed irrespective of the number of incumbents (solitary or harem). Group composition, sex ratio, morphological variables and roosting patterns were recorded.

Predictably, we captured lot of non-harem males. But we found no evidence that harem and non-harem males differed in body size or forearm length, suggesting that some trait other than size may be instrumental in deciding the reproductive status (harem or non-harem) of adult males. Interestingly enough, when we analysed the roosting pattern of non-harem males, we found that more than 90% of the non-harem males preferred to stay nearer to a harem. Moreover, our capture-mark-recapture and radio-telemetry studies showed that some non-harem males attained harem male status within a very short period. Moreover a recent study by T H Kunz and co-workers from Boston University revealed that the paternity of harem males is limited to about 65% of the pups born to the harem females. The possible movement of females between harems was suggested as one of the reasons for this observation, but mating access of non-harem males to harem females is also not ruled out.

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Clearly, much more work remains to be done to fully understand the mating system of *C. sphinx*, and to ascertain whether the roosting pattern of non-harem males is to avoid the cost of tent construction and defence or not? We are presently studying the reproductive tactics of non-harem males, and the movement of harem females during the breeding season, by continuously monitoring them through radio-telemetry.

Suggested Reading.

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