

Influence of moonlight on the foraging behaviour of the Indian short-nosed fruit bat *Cynopterus sphinx*: Radio-telemetry studies

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The foraging activity of the Indian short-nosed fruit bat, *Cynopterus sphinx* was studied using radio-telemetry. The foraging activity gets modulated with different phases of the moon. During bright moonlit nights these frugivorous bats exhibit less activity as against that during new moon nights.

CYNOPTERUS sphinx live solitarily or in colonies. The males construct tents for roosting^{1,2} and they prefer to forage shorter distances to protect the tent from intruders to ensure their position in the colony³. Studies on the foraging and other activities of this species during different phases of the moon are far less numerous. Hence, we carried out field studies in order to understand the influence of moonlight on the foraging behaviour of *C. sphinx* (Figure 1).

Two male bats were captured within the Madurai Kamaraj University Campus (lat. 9°58' N; long. 78°10' E) and were fitted with radiotransmitters (range: 400–500 m) mounted over an aluminium collar with light reflective tape. The light reflective tape allowed us to locate the bats within the dense foliage using a red light source (> 640 nm). We used two sets of Merlin receiver and a collapsible 5-element Yagi antenna (Customs Electronics, USA) for the tracking. One of the bats was radiotagged five days prior to new moon and the other, five days prior to full moon. Their foraging activity was monitored continuously for 14 nights. Bats were followed from the time of emergence until dawn and were monitored for about eight hours every night, thus providing data for 112 h (56 h for each bat).

The home ranges for these bats were also calculated following the method suggested by Kunz⁴. On the first day of our observation, the tagged bat, within a home range of 0.542 km², was active in the feeding area until 2310 h showing a 36.2% activity. After that it returned to the night roost (a place used to ingest transported food from nearby feeding areas and a resting place for bats after one or more feeding bouts) on *Guettarda speciosa*. During the waxing of the moon, the duration of activity got reduced on successive nights and on the full moon night, it returned to the night roost at 2030 h, showing a

mere 11% activity. After the full moon night there was a steady increase in the duration of the activity. Two days after the full moon, the activity reached up to 27.2%. Similarly, the second bat which was radio-tagged 5 days prior to the new moon spent approximately equal hours for foraging and rest within a home range of 0.832 km² during the seven nights of observation. During the new moon night the duration of activity was 52%. We used χ^2 to compare the activity/rest patterns during the full moon and new moon nights. The results show that bats avoid active foraging bouts during full moon nights as against that during new moon nights ($\chi^2 = 26.98$, $p < 0.001$). Similarly, the duration of rest increased during full moon nights than that of new moon nights ($\chi^2 = 12.26$, $p < 0.01$). The reduction in the activity patterns during full moon nights from that on new moon nights could be an anti-predation adaptation against visually-active predators such as owls.

The pronounced effect of moonlight on the modulation of foraging activity of bats and some other nocturnal mammals have been attributed to the direct effect of intensity of light during moon phases^{5–8} and may even be coupled to changes in endogenous factors with the lunar cycle⁹. But, in contrast to earlier suggestions^{10,11} that 'though the activity of bats is reduced in open space they might carry out their foraging activities under the cover of canopies', we observed invariably that the first bat spent long hours resting at its night roost during



Figure 1. A male Indian short-nosed fruit bat *Cynopterus sphinx* feeding on guava (*Psidium guajava*) fruit.

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full moon nights under canopy and that it hardly foraged.

1. Balasingh, J., John Koilraj, A. and Kunz, T. H., *Ethology*, 1995, **100**, 210–229.
2. Balasingh, J., Isaac S. S. and Subbaraj, R., *Curr. Sci.*, 1993, **65**, 418.
3. Marimuthu, G., Rajan, K. E., John Koilraj, A., Suthakar Isaac, S. and Balasingh, J., *Biotropica*, 1998, in press.
4. Kunz, T. H., in *Ecological and Behavioral Methods for the Study of Bats* (ed. Kunz, T. H.), Smithsonian Institution Press, Washington D.C., 1988.
5. Bower, M. A., *Ecology*, 1990, **71**, 2334–2344.
6. Kotler, B. P., Brown, J. S., Smith, R. J. and Wirtz, W.O., *Oikos*, 1988, **53**, 145–152.
7. Longland, W. S. and Price, M. V., *Ecology*, 1991, **72**, 2261–2273.
8. Julien-Laferriere, D., *J. Mammal.*, 1997, **78**, 251–255.
9. Morrison, D. W., *Anim. Behav.*, 1978, **26**, 852–855.
10. Vaughan, T. A., *Afr. Wildl. J.*, 1977, **15**, 237–249.
11. Usman, K., Habersetzer, J., Subbaraj, R., Gopalakrishnaswamy, G. and Paramanandam, K., *Behav. Ecol. Sociobiol.*, 1980, **7**, 79–81.

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Sex attractants in male preputial gland: Chemical identification and their role in reproductive behaviour of rats

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We report here the structural elucidation of three hitherto unreported pheromonal components unique to male rats. The structures are (i) 2,6,10-dodecatrien-1-ol,3,7,11-trimethyl (Z, E); (ii) Di-*n*-octyl phthalate, and (iii) 1,2 Benzenedicarboxylic acid, diisooctyl ester. Of these, the first two attract the opposite sex while the third compound attracts the same sex.

CHEMICAL signals appear to play an important function in the overall social behaviour and reproductive behaviours of rodents^{1–3}. The rat, *Rattus norvegicus*³ has a variety of known and potential sources of sex attractants such as various integumentary glands including preputial glands and excretory substances namely urine and

faeces². However, the excretory material gets the pheromonal compounds from the secretions of subcutaneous glands. The glandular secretions might be bye-passed into the urinary tract and/or external genitalia. For instance, the preputial glands situated between the dermis and body wall anterior to the penis in males and to clitoris in females seem to be a source of pheromones and release part of their secretions through urine⁴.

These glands are prominent in males but are comparatively smaller in females⁵. The degree of male preputial gland activity is apparently related to social experience, particularly aggression⁶. Preputial gland secretions are known to attract the opposite sex in white-tailed deer⁷. They may also regulate anogenital licking and aid in maternal discrimination of the sex of pups⁸. de Catanzaro *et al.*⁹ reported that male preputial and salivary glands are sources of pheromones that stimulate oestrus in female mice, but preputial gland secretions are not involved in the male-induced pregnancy block⁹.

Chemical identity of mammalian pheromones such as the urinary compounds of mice¹⁰, tiger¹¹, and elephant¹² is available. The significance of male preputial glands in social and sexual behaviour of rats has been investigated and the involvement of the preputial odour in eliciting females' or intermales' aggression has been reported⁷. However, chemical identification of pheromonal compounds of preputial gland secretion in male rats and their functions in social and sexual behaviour are still obscure. The present report deals with the chemical nature of male preputial glands in rats.

Sexually matured and reproductively active laboratory rats, *Rattus norvegicus* weighing 200–250 g were maintained on a 12:12 light:dark cycle in the laboratory. The animals were given rat feed and tap water *ad libitum*. The animals were killed by cervical dislocation. As sufficient quantity of the preputial secretion of rats was difficult to collect, the preputial glands were removed from 20 rats and ground well in a mixture of solvents (methylene chloride and *n*-hexane 1:1 v/v) at room temperature. The supernatant was then filtered through silica gel column (60–120 mesh) and concentrated under vacuum (temperature <30°C) for fractionation and chemical identification using gas chromatography-linked mass spectrometric (GC–MS) analyses by comparison with standard compounds. The GC–MS analyses were made in a Nermag R-10-10C instrument under computer control at 70 eV. Chemical ionization was performed by using ammonia as reagent gas at 95 eV (ref. 13). Then the chemical mixtures were subjected for fractionation to separate the compounds.

Assuming the importance of the fractionated compounds in pheromonal activity, Y-Maze odour preference test was conducted by following the procedure of Ferkin and Seamon¹⁴. In three different sets of same and

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