Magnitude of depredation on grapes by short-nosed fruit bats *Cynopterus sphinx* Vahl, 1797 in Secunderabad, India

The short-nosed fruit bat *Cynopterus sphinx* Vahl, 1797 is a very common species in many parts of India and Sri Lanka[1]. It lives in small colonies, generally of three to four individuals, although, larger colony sizes have also been observed[2]. Its diurnal roosts include 'tents' formed by leaves of *Polyalthia longifolia*, *Vernonia scandens*[3], *Borassus flabellifer*, *Corypha umbraculifera*, *Corypha* sp., *Livistona chinensis*, *Roystonia regia*[4,5], altered flower and fruit clusters of *Caryota urens*[6] under leaves of *Musa* sp., in the leaf clusters of *Persea gratissima*, clumped leaves of *Philodendron giganteum*[5], stems of *Saraca asoka*[2], in cavities of bark and aerial roots of *Ficus* sp., and in man-made structures[5–12].

It feeds on fruits, flowers and leaves of not less than 23 species of plants[5,9,13–16]. Its depredatory nature to commercial crops, including *Psidium guajava*, *Mangifera indica* and *Musa* sp. is well documented[13]. However, no study has been conducted to assess the extent of damage caused. It is believed that with the availability of a large number of wild food species, damage to orchards is negligible[5].

Although earlier observations have indicated that short-nosed fruit bat feeds on ripening grapes[5,16] in orchards, the magnitude of the depredatory nature has not been assessed. This paper presents the results of such an assessment carried out in a grape orchard in Andhra Pradesh, India.

The present study was carried out between December 1999 and March 2000 in a grape orchard in Gundla Pochampally village in the northern suburb of Secunderabad (17°27′N and 78°27′E) in Andhra Pradesh. The orchard, where the green variety of *Vitis vinifera* L. is grown, has a history of fruit bat damage since long and encompasses four 1-ha plots of grapevines. Damage to grapes in two 1-ha plots by short-nosed fruit bat was assessed by quadrate sampling method. A total of 25 quadrates, each measuring 7.5 sq m (about the size of the canopy cover of one plant) in five sets were chosen for assessment. The first two sets [Outer Square 1 (OS1) and Outer Square 2 (OS2)] consisting of eight quadrates each were fixed on the outer periphery, spaced from each other by three rows of vine plants. The placement of the eight quadrates in each square assured assessment of plants from all the four corners along with those exactly between them. The next two sets [Inner Square 1 (IS1) and Inner Square 2 (IS2)] consisted of four quadrates each and were fixed five rows inside the OS2 with a gap of seven rows between themselves. Both the inner square quadrate placement settings were in a fashion that ensured the first set corresponded to the four corners of the main plot, while the second corresponded to the centre of each side. The last quadrate was placed in the approximate centre of the main plot.

Observations were carried out on 36 nights (8 in pre-ripening, 22 in ripening and 6 in harvesting periods) between 1930 and 0445 h. Bats were observed from randomly selected points; each night a separate spot was selected, using the light sources (200 W tungsten bulbs) that are placed at regular distances in the vineyard.

Student's *t*-test and One-way Analysis of Variance were done to determine differences in percentage of damage caused in relation to the distance of grapevines from the periphery.

Visits of short-nosed fruit bats to the grape orchards began approximately 45 min after sunset and foraging behaviour was observed to continue up to an hour before sunrise, in intermittent feeding bouts. They were observed to depredate only on ripe fruits of the bunch and in their forage search, either in flight or while clinging to the branches, tend to damage the whole bunch and other adjacent bunches too, resulting in greater loss. Bats were observed to forage in groups of 2–8 individuals. During the last stages of the harvest of grapes (late January to early February) when all the grapes ripen, the per cent visits of short-nosed fruit bats increased manifold (72% increase), resulting in increased damage (81%).

Table 1 shows the per cent damaged grape bunches recorded in all the five sets of quadrates assessed in both the plots. The intensity of damage gradually decreased from the periphery to centre. Along the outer squares the damage

Table 1. Range of per cent damage to grape bunches by short-nosed fruit bat

No. of quadrates	OS1 (8)	OS2 (8)	IS1 (4)	IS2 (4)	Centre (1)
Plot I	89.47	73.91	47.36	9.09	
	–	–	–	–	0
	100.00	91.30	60.00	14.28	
Plot II	90.47	73.68	36.36	0	
	–	–	–	–	0
	100.00	90.00	65.21	4.54	

OS, Outer square; IS, Inner square.
Per cent damage was computed from the ratio of damaged grape bunches and the total grape bunches per vine/quadrate.

Table 2. Magnitude of damage to grape bunches by short-nosed fruit bat *vis-à-vis* distance from the periphery

	OS1 vs OS2	OS2 vs IS1	IS1 vs IS2	All squares[a]
Plot I	95.70 ± 4.19 vs 81.62 ± 6.58***	81.62 ± 6.58 vs 54.40 ± 5.69***	54.40 ± 5.69 vs 5.84 ± 7.07***	***
Plot II	95.67 ± 3.33 vs 81.34 ± 5.12***	81.34 ± 5.12 vs 53.20 ± 12.11*	53.20 ± 12.11 vs 1.13 ± 2.27**	***
Both plots	95.69 ± 2.57 vs 81.48 ± 4.02***	81.48 ± 4.02 vs 53.80 ± 7.45***	53.80 ± 7.45 vs 3.48 ± 4.49***	***

a, One-way Analysis of Variance; Significance levels: ***< 0.001, **< 0.005, *< 0.01; OS, Outer square; IS, Inner square.

ranged between 74 and 100 per cent, while it was between 0 and 65 per cent along the inner squares. Almost no damage was evident in both the centre quadrates. In both the plots the Student's *t*-test and Analysis of Variance showed that the mean damaged grape bunches were significantly higher in outer quadrates than in the inner quadrates (Table 2).

As the grapevines are grown on net mesh supported by vertical poles, the canopy tends to form a continuous complex of leaves and branches that are sometimes impenetrable. When gaps exist due to poor branching of the vines, attempts of entry through these were also observed. Moreover, large numbers (5–16 individuals) of foraging short-nosed fruit bats preferred to feed on grape bunches that are not very far from the margins, ensuring quick escape on disturbance. The only disturbance the foraging bats encounter during nights is the presence of human beings guarding the crop. The non-random foraging techniques followed by depredatory species in crop-ecosystems are under the influence of strategies favouring predator avoidance[17]. A similar trend was also noted among our study bats.

During the 36 observation nights, a total of 1576 grape bunches, each weighing on an average 750 g, were damaged by short-nosed fruit bats amounting to a yield loss of 1182 kg of grapes. At a rate of Rs 20 per kg, the revenue loss due to short-nosed fruit bat depredation accounted to Rs 10,683 per hectare. Grape growers, usually, suffer heavy loss in yield due to bird damage[18,19] and also due to smaller fruit bats (including short-nosed fruit bat and Fulvous fruit bat *Rousettus leschnaulti*). In order to avoid bats and birds, the grape growers use a variety of control methods (mostly control netting and fire crackers) to reduce the loss.

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Copulatory behaviour of Indian flying fox *Pteropus giganteus*

Chiroptera is the second largest order of mammals that comprises about 950 species of bats in which the suborder Megachiroptera contains one family (Pteropodidae) that includes 175 species of mainly frugivorous bats[1]. Most of the fruit-eating bats roost in groups on branches of trees, leaves[2,3] and tents[4]. During mating season, both male and female bats in the colony move in tree branches and are often restless[2,5,6]. More information and data are available on the ecological aspects of bat reproduction[1,2,6] and sexual maturity of the fruit-eating bat, *Cynopterus sphinx*[7,8]. However, a little information is available on the behaviour of the Indian flying fox *Pteropus giganteus* even though this is the biggest and most conspicuous of all fruit bats[9,10]. This note presents data on the copulatory behaviour of *P. giganteus* in its natural habitat in Tamil Nadu, India.

A colony of about 150 individuals of both the sexes of *P. giganteus* was found on a *Ficus bengalensis* tree near a rice field at Chenniyanallur village, about 14 km from the town of Sirkali in Nagai District, Tamil Nadu. We have been monitoring the population size of the colony since March 1997 and found that the population is stable. Local people protect the bats from hunters. We visited the bat colony from 2 to 4 of October 1999 and accidentally observed copulatory behaviour of this species. Since our visit was unexpected, we were unable to photograph the mating behaviour. A field binocular (Minolta 10x40) was used to observe the copulatory behaviour and data were recorded using *ad libitum* sampling technique[11]. The number of copulations in *P. giganteus* was observed during the day, on the day roosting tree and was statistically analysed.

A total of 51 copulations was observed in the *P. giganteus* colony. The male bat was considerably larger than the adult female. The male frequently approached