

ON THE INDIAN FLYING FOX (*PTEROPUS GIGANTEUS*) COLONY IN PERADENIYA BOTANICAL GARDENS, SRI LANKA

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ABSTRACT - In September 2002, the spatial distribution of a colony of Indian flying foxes in Peradeniya Botanical Gardens near Kandy, Sri Lanka, was assessed by counting the roosting bats on two consecutive days. The colony spread over 20 hectares and numbered about 24,480 bats. The number of bats per tree varied between ten and 1200. The median value was low (50 bats per tree), half of the trees containing between 30 and 100 bats. The mean density was *c.* 1200 bats/ha, but along the western margin of the colony up to 3250 bats/ha were recorded. In the evening, bats emerged from the canopy in large flocks, about one third of the total number of recorded bats flying over in five minutes. Currently Peradeniya possibly supports the largest known aggregation of the Indian flying fox.

Key words: Spatial distribution, day-roosts, colony size, emergence time

RIASSUNTO - *Su una colonia di volpe volante indiana (Pteropus giganteus) nei Giardini Botanici di Peradeniya, Sri Lanka.* Nel Settembre 2002, la distribuzione spaziale di una colonia di volpe volante indiana (Giardini Botanici di Peradeniya, Kandy, Sri Lanka), è stata stimata effettuando, in due giorni consecutivi, il conteggio dei pipistrelli durante la fase diurna di inattività. La colonia, formata da circa 24.480 animali, è risultata svilupparsi su 20 ha. Il numero di pipistrelli per albero variava da 10 a 1200, ma metà degli alberi ospitava tra 30 e 100 individui (mediana = 50 ind/albero). La densità media è risultata pari a 1200 ind/ha, con densità fino a 3250 ind/ha lungo il margine occidentale della colonia. Alla sera, i pipistrelli lasciavano la folta vegetazione in stormi numerosi, circa un terzo degli individui veniva osservato emergere nel giro di cinque minuti. Attualmente i Giardini di Peradeniya ospitano probabilmente la più numerosa colonia conosciuta della specie.

Parole chiave: Distribuzione spaziale, rifugi diurni, dimensioni della colonia, orario di emersione

INTRODUCTION

The Indian flying fox *Pteropus giganteus*, one of the largest bats, is widely distributed on the Indian subcontinent. In Sri Lanka, it is particularly abundant in the wet area of the south western

corner of the island (Kryštufek, 2005). Authors reporting on the Indian flying fox in Sri Lanka have almost invariably stated that the species is by far the most numerous in Peradeniya Botanical Gardens, near Kandy. In the mid 19th century, Tennent (1861) wrote that

Peradeniya, where “they hang in such prodigious numbers, that frequently, large branches give way beneath their accumulated weight ... [is the] ... favourite resort” of Indian flying foxes. Later, Wroughton (1915) stated, “The Gardens abound in ... thousands of Flying foxes, which are protected by the Garden authorities”. In a guide to the Gardens, at the beginning of the 20th century, Macmillan (1906) wrote that flying foxes “congregate during the day in enormous numbers.” More recently, Bates and Harrison (1997) similarly reported “thousands of individuals [which] congregate in Peradeniya Gardens”. Also Walton and Trowbridge (1983) found Peradeniya to be one of the three major roosts within 5 km from Kandy.

Although all the authorities agree on the huge numbers of flying foxes roosting in the Gardens, none of them provides an estimate of how many there might be. I report in this communication the results of a bat census that I performed in Peradeniya Botanical Gardens in September 2002. Anecdotal observations about the colony are also added.

STUDY AREA

Peradeniya Botanical Gardens are located at an altitude of 550 m a.s.l., on the north western slopes of the central highlands of Sri Lanka, 6 km southwest of Kandy. This horseshoe-shaped, undulating land is bordered on three sides by a loop of the River Mahaweli Ganga (Fig. 1). Its surface (62 hectares) has not changed since the Gardens have been established in 1821. The climate is moist, hot, and very equable; the mean annual temperature is 26°C. Rain

falls at frequent intervals, on average about 170 days per year, with a total yearly average of 2260 mm. February and March are the driest months, while April and May are the hottest. The vegetation is tropical and the leaves are generally large, thick and leathery (Sumithraarachchi, 1997). Walton and Trowbridge (1983) estimated that in the vicinity of Kandy food sources for frugivorous bats are abundant at all times of the year. Peradeniya is one of the major destinations for tourists, with over one million visitors per year (Sumithraarachchi, 1997).

METHODS

The bat census was undertaken on two consecutive days (September 19-20, 2002). Each tree with bats was plotted on to a map of the Gardens and my attempt was to record all the trees that provided roosts. The number of bats was either counted (< *c.* 100 animals) or estimated as accurately as possible. Direct counts were frequently impossible because either the animals formed too large aggregations, or part of the group was hidden in the canopy or the tree was not visible from all sides (particularly along the river). The spatial distribution of Indian flying foxes was plotted on an arbitrary 50 × 50 m reference grid. Between the 18th and 21st of September, the bats emerging from the colony were counted from the southern margin of the Undawattakelle Sanctuary, Kandy, about 6 km north-east of Peradeniya. According to the residents of Kandy, the bats were from the Peradeniya Gardens, but I was unable to verify this statement. The flock was so huge that it was impossible to count all animals. Consequently, I selected a corridor among the trees and recorded all flying bats every minute, starting from their first arrival. My position remained constant each evening, enabling direct comparison between daily counts.

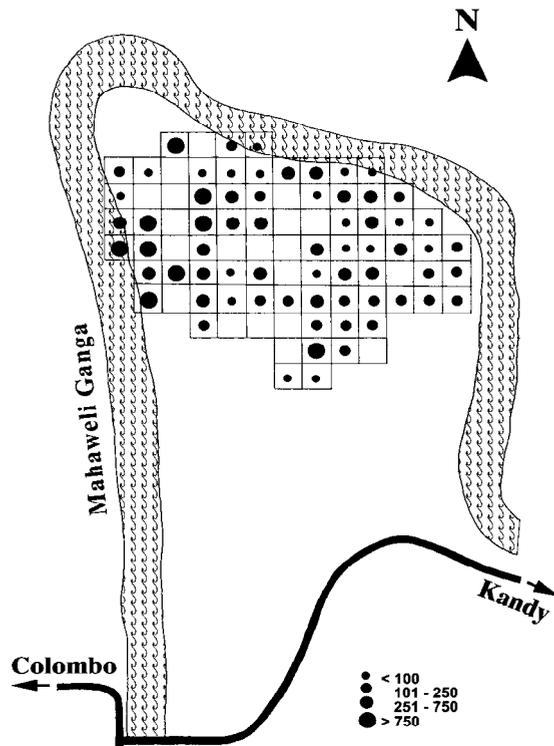


Figure 1 - Spatial distribution of Indian flying foxes in Peradeniya Botanical Gardens within 50×50 m squares. Bats numbers are grouped according to four classes.

The spatial distribution of bats was analysed by the χ^2 test and Mann-Whitney test. For the latter the value of Z was reported, the sample being larger than > 20 and sampling distribution approaching the normal one. Both statistical tests were run in Statistica 5.5 (StatSoft Inc., 1999).

RESULTS

In the Peradeniya Botanical Gardens I counted in total about 24,480 bats on 279 trees. The number of bats per tree varied between 10 and 1200. The median value was low (50 bats per tree) and one half of trees showed between 30 and 100 bats. Only two trees had a thousand bats or more, but, altogether,

ten trees with 350 bats or more each sheltered 7200 animals, i.e. about 30% of the colony's total. The frequency curve was thus heavily skewed towards low values.

The colony stretched over an area of about 20 ha, which is approximately one third of the Gardens' total area, being restricted to the north of the Great Circle, more specifically to the ancient arboretum (*cf.* also Macmillan, 1906, for the plan of the Gardens at the turn of the 19th into the 20th century). Bat density distribution across the arboretum was far from being even and deviated significantly from the random one ($\chi^2 = 178$, d.f. = 278, $P < 0.001$).

The densest concentration (on average: 3250 bats/ha) was on the western border of the colony, along the banks of the Mahaweli Ganga, where approximately 7100 bats congregated. All the trees with more than 350 bats each were in this high-density area. Furthermore, six of them were located within a single 1 ha square on the south-western margin of the colony, where 6100 bats congregated (25% of the colony's total). A lower concentration was observed along the eastern border (about 550 bats/ha). Mean density was c. 1200 bats per hectare, being significantly higher (Mann-Whitney $Z = 2.812$, $P = 0.005$, $N = 57$) along the west-south-western border of the colony.

From the 18th to the 20th of September the bats arrived to the Undawattakelle Sanctuary (Kandy) at the same time (between 18:41 and 18:42 h.), whilst were earlier on the 21st (18:32 h.). The duration of bats flight was fairly similar among the four nights and varied between 27 and 34 minutes, the peak

remaining pronounced each evening with roughly a third of the bats flying over in merely five minutes (Fig. 2). The number of bats counted was more prone to variation, ranging between 2310 (median and central interquartile range, respectively: 58 and 12-125) and 3540 (75 and 17-190) per evening.

DISCUSSION

Most flying foxes (genus *Pteropus*) that have been studied are moderately or strongly colonial (Rainey and Pierson, 1992). Some *Pteropus* colonies (camps) still contain up to a few hundred thousand bats and once may have had millions of individuals (Nowak, 1999). Camps of *P. vampyrus*, a species that is allopatric and probably conspecific with *P. giganteus* (Corbet and Hills, 1992), in the 1920s numbered up to 100,000 specimens in the Philippines but have recently declined to 500-1000 (Mickleburgh *et al.*, 1992).

The current largest aggregations of *P. vampyrus* consist of more than 15,000

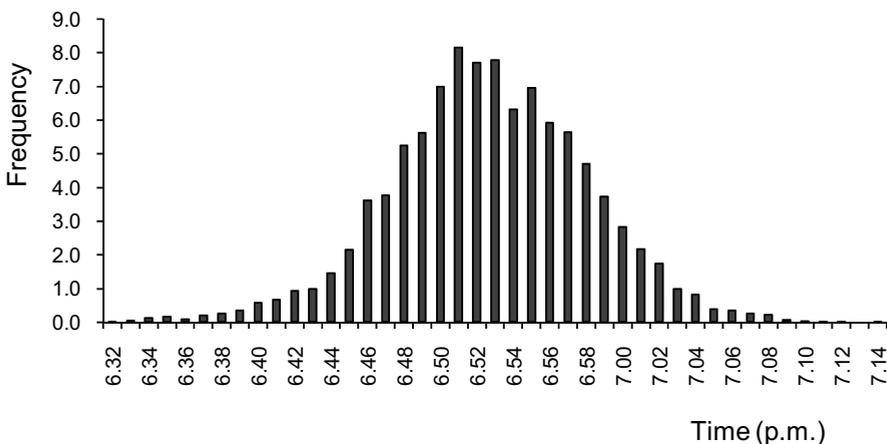


Figure 2 - Number of Indian flying foxes on their evening flight to feeding grounds. Numbers (expressed as per cent frequency, $N=11,154$) refer to four counts (September 18-21, 2002) combined.

individuals in Borneo and 9,000-21,000 on the island of Palau Rambut (Kunz and Jones, 2000). Such numbers have apparently never been reported for the Indian flying fox. The majority of authors confine themselves to general statements such as “large, noisy, squabbling colonies on trees” (Prater, 1971), “huge noisy colonies of many hundreds” (Banks and Banks, 1995), and so on. Fairly small colonies are reported for India: 500 (Mickleburgh *et al.*, 1992), 800-1000 (Neuweiler, 1969), up to 6000 individuals (Smith, 1998). Khan (1985) claims that the largest colony he saw in Bangladesh contained 2500 bats. Blincow (2000) reports an unbelievable 50,000 for the area of Bundala (southern Sri Lanka), but I was unable to verify this assertion. The camp in Peradeniya Gardens is thus possibly the largest known aggregation of the Indian flying fox.

Old World fruit bats are of considerable conservation concern (Mickleburgh *et al.*, 1992). Seven out of 64 *Pteropus* species (Simons, 2005) are believed to have become extinct and a further 17 species are considered endangered (Mickleburgh *et al.*, 1992). The Indian flying fox, however, seems to be safe, and the nominate subspecies, which is widespread on mainland India and Sri Lanka, is not threatened either. Accordingly, in Sri Lanka this bat is not included in the list of threatened species (IUCN Sri Lanka, 2000). Considering, on the one hand, that huge numbers of Indian flying foxes have been continuously reported from Peradeniya Gardens from the 19th century and, on the other hand, the tolerant attitude of Srilankans towards these

animals, this large colony appears not to be in danger.

Direct human-caused mortality in the Gardens is evidently negligible since people do not kill or molest flying foxes. Only once in Peradeniya (July 1995) was I offered a young flying fox by a local. Bat carcasses are regularly seen on the ground and I came across them during every visit to Peradeniya (July 1995, March 1999, September 2002). All carcasses that allowed age estimation were juveniles. On September 21, 2002, I systematically searched the arboretum for bat carcasses and found, in hour and a half, seven bodies or their remnants (wings). All the carcasses were on the eastern, low-density side of the arboretum. Only two out of the seven carcasses were fresh. Crows (particularly *Corvus megarhynchos*) were invariably seen scavenging on dead bats. Anyway, carcasses are also evidently removed by humans together with the litter, making the estimation of the actual extent of mortality a difficult task.

Power lines can evidently be a deadly obstacle to flying foxes on their coming and going between the roost and main feeding area. Dead flying foxes hanging from the power lines are regularly seen in Sri Lanka. The largest number I came across, however, was on September 22, 2002, along the railway from Kandy towards Peradeniya, where over a distance of approximately 3 km I counted 74 carcasses in various stages of decomposition. It was noted that all dead bats were on old power lines, consisting of five wires stretched one above the other between wooden poles. Altogether, the wires formed a 1 m

high barrier. Higher concrete poles did not have any dead bats nearby. Since many flying foxes killed by power lines presumably fell onto the ground, I searched for carcasses but unsuccessfully. I was informed by local people that stray dogs, which are abundant on the island, scavenge on dead bats.

As revealed from observations at the Undawattakelle Sanctuary, bats emerge with astonishing synchronicity in the evening and in dense flocks. Considering the distance of my observation point from Peradeniya, as well as the speed of flying bats (up to 30 km/h; Walton and Trowbridge, 1983), the actual time of emergence was approximately 10 minutes earlier. Some delay was probably caused by the bats which, after dropping from branches, first visit a water surface for drinking (Andersen, 1912). For October, Walton and Trowbridge (1983) reported that the time of departure from the roost was 18:00 h, matching my observations fairly closely.

On their morning flight back to Peradeniya, bats are much more diffused and consequently also more difficult to monitor. On September 22, from the Kandy railway station I observed bats flying towards the Botanical Gardens from twilight (05.55 h) until 06.15 h. They were flying alone or in small groups of 20–25 individuals, and were chased by crows.

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