

by small size (2.2–2.3 cm) and diameter, more or less circular in shape and seeds with small groove on one side are also known from the Deccan Intertrappean beds of Mohgaon-Kalan, Chhindwara and Mandla districts of Madhya Pradesh^{13–16}. However, other records from Lower Middle Eocene of Northeast India and Miocene of Himachal Pradesh are also known^{13–19}.

Coprolites provide direct evidence of solid food intake comprising pteridophytes, gymnosperms as well as angiosperms, and micro-biota through ingested water has been recorded by earlier workers^{4–8}. Occurrence of the diatom (*Aulacoseira*) representing the oldest non-marine records from the Deccan Intertrappean and from Upper Cretaceous coprolites themselves is striking evidence for this^{6–8}.

Arecoïd plants are well established in tropical regions of the world. They are entirely absent in the Arctic and hot or cold deserts, except the Arabic deserts and are related to hydrophilic soil properties, while some are restricted to limestone^{9–12,20}. Phoenicoid palms chiefly grow in western Asia, Arabia and throughout India from the desert to the Himalayan region¹⁰.

The present paper constitutes the first record of a fossil phoenicoid seed in a coprolite from the Upper Cretaceous at

Pisdura, Maharashtra. It also indicates that these plants were growing in the region and were consumed by the dinosaurs.

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Population size, feeding, forearm length and body weight of a less known Indian fruit bat, *Latidens salimalii*

India is one among the 25 hotspots of the richest and highly endangered eco-regions of the world¹. It also harbours diverse chiropteran species numbering over one hundred, including 12 fruit bats^{2,3}. The status, distribution and ecology of several bat species are still poorly known³. Here, we present data on the population, feeding and forearm length and body mass of Salim Ali's fruit bat, *Latidens salimalii*, considered to be one of the world's rarest bats and the only species found in the genus *Latidens*^{3,4}. This medium-sized bat was first collected in 1948 by a British naturalist, Angus Hutton⁵, who misidentified it as the commonly occurring short-nosed fruit bat, *Cynopterus sphinx*. The specimen was re-examined by Kitty Thonglongya, who recognized it as a new

species and named it in honour of the legendary Indian ornithologist, Salim Ali⁶.

Between 5 July 1997 and 30 December 1999, we conducted field surveys to investigate the population, distribution and diversity of fruit bats such as flying fox, *Pteropus giganteus*, short-nosed fruit bat, *Cynopterus sphinx* and *L. salimalii* in Tamil Nadu, South India^{7–11}. During the surveys we discovered a cave roosting site of the *L. salimalii* for the first time^{7,8} and estimated the population size using roost counts¹². In addition, visual counts were carried out while the bats emerged by positioning two or three observers. Mist net was used to capture and release bats and for each capture, we attached a wing band and recorded the location, habitat type, date, time, sex, age class, forearm length

and body weight. Nocturnal observations of bats were done by moonlight as well as using dim red lights and data were recorded using the all-occurrences sampling method¹³. We presented all mean values ± 1 standard deviation. We conducted all statistical analyses through Statistical Analysis System (SAS) software¹⁴. We used analysis of covariance (ANCOVA *F* test) within General Linear Models to test the effects of independent variable (forearm length) and categories (sex and age) on body mass¹⁴.

A total of 46 individuals (19 males and 27 females) were captured near a coffee and cardamom estate, at an altitude of about 1000–1175 m, adjacent to Megamalai Forest Reserve. Body weight and forearm measurements were taken from all the

captured bats (Table 1). Bats were released within 5 min after capture to minimize stress. More bats were captured between midnight and before dawn and another small peak of capture occurred right after sunset (Figure 1). Majority of the juveniles were captured between 03:00 to 05:59 h. Adult sex ratio was 1 : 1.19 (16 adult males/19 adult females), which was not significantly different from 1 : 1 ratio (χ^2 goodness of fit test, $P > 0.05$).

Females were smaller than males (Table 1) and there was significant difference in the adult body mass of males and females (Wilcoxon rank test, $P < 0.001$). However, there was no significant difference in the forearm length of adult males and females (Wilcoxon rank test, $P > 0.80$). There was a positive correlation between the forearm length and body mass of all bats (Spearman correlation coefficient = 0.559, $P < 0.001$, Figure 2). The General Linear Model through the analysis of covariance revealed that sex, age and forearm lengths had significant effects on the body mass of *L. salimalii* ($R^2 = 0.71$, $F_{3,42} = 33.79$, $P < 0.001$). The interaction of sex and age did not play a significant role ($P > 0.15$) in the body mass therefore the interaction was deleted from the final analysis model (Table 2). In the least square mean of body mass between adult males and females after adjusting the forearm length of sex and age, the difference was still significant and body mass of males was larger than that of females (male 75.87 ± 1.47 compared to females $68.46 \text{ g} \pm 1.31$, $P < 0.001$).

These bats were seen during the day inside a funnel-shaped cave that measured 10 m in its greatest depth and the entrance was 7 m in its greatest breadth that slowly narrowed to 1 m at the interior end. We counted a total of about 250 individuals of *L. salimalii* when they emerged from the cave at dusk. The bats were seen plucking forest fruits and bringing them into the caves for consumption. Each individual was spaced within 10 cm radius, apparently to avoid confrontation with other bats. One of the ringed bats showed a special preference for the feeding site and came back with fruits to the same spot about six times within 2 h. We also observed these bats plucking fruits and eating them outside the cave, while resting on a tree. Direct observations and analysis of fruit remains found underneath the roost sites revealed the presence of at least three species of figs such as *Ficus daldotii*, *F. macrocarpa*, and *F. racemosa*, as well as other plants such as *Eleocarpus oblongus*,

Diospyros ovaliflora and *Prunus ceylanicus* in their diet. We also noted nuts of an unidentified plant scattered underneath the roost sites, with deep canine holes on both sides of the relatively large nut apparently to dig out its soft inside parts. The nuts possibly crushed by *L. salimalii* measured 22.4–32.2 mm in length, 17.4–24.9 mm in width and had a coat thickness up to 4.1 mm – the nuts were extremely hard and difficult to penetrate, even with a knife.

According to earlier reports, the dentition of these bats closely resembles that of *Penthetor lucasi* from Southeast Asia, a species that is known to feed on a wide variety of hard fruits and seeds. Similarly, *Thoopterus nigrescens* from Indonesia that feeds on wild figs, appears to be similar to *L. salimalii*¹⁵. In addition to eating soft fruits such as figs, *L. salimalii* might also feed on the hard-shelled nuts but further observations are needed to substantiate this. Previous capture data for this species showed only 3 adult females and 22 adult males with an adult sex ratio of 1 : 0.14, which was male biased^{16,17}. Furthermore, the highest capture record for the previous study concentrated around 20:00 h and then gradually decreased and no activity was found after 02:00 h^{16,17}. In contrast, our data indicate that the bats were active between 02:00 and 04:00 h and the adult sex ratio of captured bats was close to 1 : 1, which is the norm for mammalian species. The body mass of bats in our study was also slightly heavier than the previous

study^{16,17}, but the data on the forearm length and diet were similar to previous studies^{3,18}.

In the past, plantation workers used to catch these bats as well as Nilgiri langur, *Trachypithecus johnii* and lion-tailed macaque, *Macaca silemus* for food since bat and monkey meat is believed to have medicinal properties to cure respiratory illnesses. We saw both species of the monkeys near the cave roost site. Nevertheless, plantation owners and workers realized the importance of conservation of these rare species and vowed to protect them. The site is well hidden, away from tourists and other villages, and has restricted access, which naturally gives protection to the endangered bats and monkeys – we do not foresee any immediate threats for their survival. Moreover, a single specimen of *L. salimalii* was collected from a different location in the Kalakkad–Mundanthurai forest in Tamil Nadu¹⁹, indicating that this species may occur in other areas in South India. Therefore, it is crucial to conduct thorough surveys to assess the exact population and precise distribution of this rare bat.

Fruit bats are excellent seed dispersers, pollinators and indicators of habitat diversity^{7–10}. Although fruit bats seem to damage orchards, quantitative data on the extent of damage done by bats to cash crops in India are still lacking. In the South Indian States of Tamil Nadu and Kerala, elephants and wild boars were reported to cause significant damage to agricultural

Table 1. Forearm length and body mass of *Latidens salimalii*

Sex	Age	Forearm length (mm)		Body mass (g)		n
		Mean	SD	Mean	SD	
Male	Adult	69.38	1.54	77.50	6.83	16
	Sub-adult	66.33	2.89	59.67	6.81	3
Female	Adult	68.95	2.20	69.58	4.13	19
	Sub-adult	63.75	3.41	55.38	8.18	8
Total		68.02	3.06	69.22	9.97	46

Table 2. Source of variations of body mass of *Latidens salimalii* from analysis of covariance (ANCOVA, the general linear model of SAS)

Source of variance	Degree of freedom	Mean square	F value	P value
Sex	1, 42	409.0	13.11	***
Age	1, 42	502.1	16.09	***
Forearm	1, 42	279.6	8.96	**
Total	3, 42	31.2	33.79	***

*** $P < 0.001$, ** $P < 0.005$.

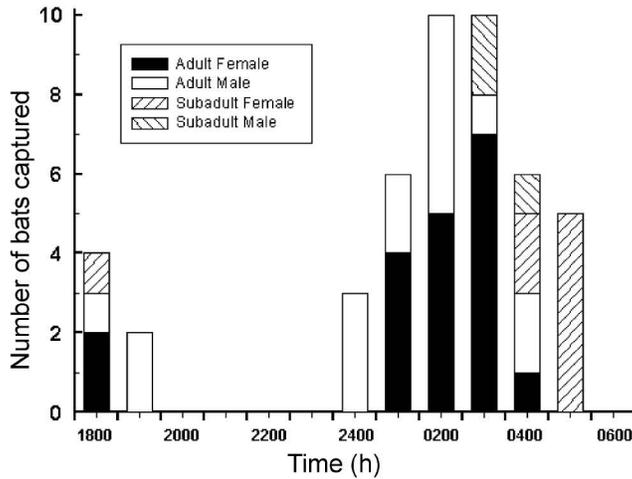


Figure 1. Number of *Latidens salimalii* captured with mist nets near Megamalai Forest Reserve, South India.

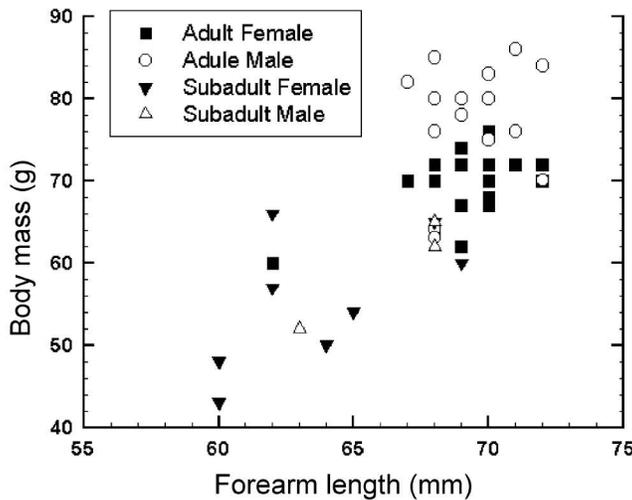


Figure 2. Relationships of forearm length and body mass of *Latidens salimalii* among sex and age groups.

crops, in addition to minor damage caused by species such as the Hanuman langur, bonnet macaque, porcupine, gaur, barking deer, mouse deer, blacknaped hare, Malabar giant squirrel and pea fowl^{20,21}. Large mammals such as elephants, rhinos, lions and tigers have been given considerable conservation attention in India over the last three decades²², but the less attractive bats have been thus far overlooked⁷⁻⁹. Due to restricted distribution and small population size, *L. salimalii* deserves more attention in terms of protection as well as

to bring conservation awareness among local communities in South India.

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