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Research Article

SOME OBSERVATIONS ON THE POPULATION OF NAKED-RUMPED TOMB BAT (*TAPHOZOUS NUDIVENTRIS* CRETZSCHMAR) AT THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA CAMPUS, GUJARAT

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ABSTRACT

A study of Naked-Rumped tomb bat (*Taphozous nudiventris)* in the Maharaja Sayajirao University of Baroda campus was undertaken to examine habitat associations, activity patterns and the distribution of bats in relation to landscape structure. The study was conducted during 2006 and 2007. Mist-nets and bat detectors were used to capture bats and to monitor their presence respectively. The *T. nudiventris* was observed to be background-cluttered space foragers. Bats of the background-cluttered space guild foraged over a variety of habitats. In both years, season had a significant effect on bat activity. A change in the foraging and roosting timing between summer and winter was very apparent. The study was also extended to know the temporal variation in number of colonies, the species richness of individual colonies and also to gain insight into some of the physiological variables.

Key Words: *Tomb Bat, Morphometry, Population Size, Roosting Sites and Haematology*

INTRODUCTION

There are approximately about 1,100 species of bats worldwide, accounting for nearly 20% of all mammalian species. About 70% of bats are insectivores. Of the remainder, most feed on fruits, nectar and tender leaf juices; three species sustain themselves with blood and some prey on vertebrates. These bats include the leaf-nosed bats (Phyllostomidae) of Central America and South America, and the related bulldog bats (Noctilionidae) that feed on fish. At least two known species of bat feed on other bats: the Spectral Bat, also called the American False Vampire bat, and the Ghost Bat of Australia (Gary, 1994).

India is renowned for her majestic wildlife, and studies of its natural history abound, but the bats of India are scarcely ever mentioned, and very little is known about them. South Asia has 123 species of bats, and almost all of them reside in India (Mistry, 1995). They account for one-fourth of India's mammal fauna and more than one-tenth of the world's bat species. With at least 109 species, India has an incredible diversity of bats. This includes one of the largest in the world, the Indian flying fox (*Pteropus giganteus*); one of the most colorful, the orange and black painted bat (*Kerivoula picta*); and one of the rarest, Salim Ali's fruit bat *(Latidens salimalii).* The habits of Indian bats are as diverse as the habitats they live in. From high in the Himalayas, to the deserts of the Northwest, to the tropical forests of the East and South, there are bats that feed on fruit, nectar, insects, frogs, and even other bats (Mistry, 1995).

Bats as a general rule are nocturnal, preferring to rest during the day and leave their roosts at night in search of food. During the day they remain hidden from predators, choosing roosts in caves, man-made structures such as homes and bridges, or in trees. Some species of bat are solitary, while others, especially those that roost in large caves, may live in colonies with thousands or even millions of individuals (Mistry, 2003). In addition to being very unique animals, bats play important ecological roles. Some bats pollinate night blooming plants, while other bat species are important in dispersing the seeds of certain fruit trees. Insect-eating bats can be important in reducing insect populations by eating up to four times their weight of insects in a single night. Since, bats eat tonnes of insects per year they are susceptible to poisoning by pesticides (Mistry, 2003).

Role of bats in pollination, seed dispersal, and pest control remains mostly non-documented although their economic benefits must be enormous in a largely agrarian country like India. Bats are represented as

one of the most diverse group of mammals. Data on their population studies being made are helpful in deriving its importance, as these bats are ecologically very beneficial to agricultural ecosystems.

Objective

A study of Naked-Rumped tomb bat (*Taphozous nudiventris)* in the campus of the Maharaja Sayajirao University of Baroda was undertaken to examine gross morphology, population dynamics, patterns of foraging flight, food preference, period of reproduction, haemogram and serum glucose.

Study Area

After a reconnaissance survey in the Maharaja Sayajirao University of Baroda Campus, a Breeding colony of *T. nudiventris* was identified in the Sayaji Jubilee Institute (Figure 1).

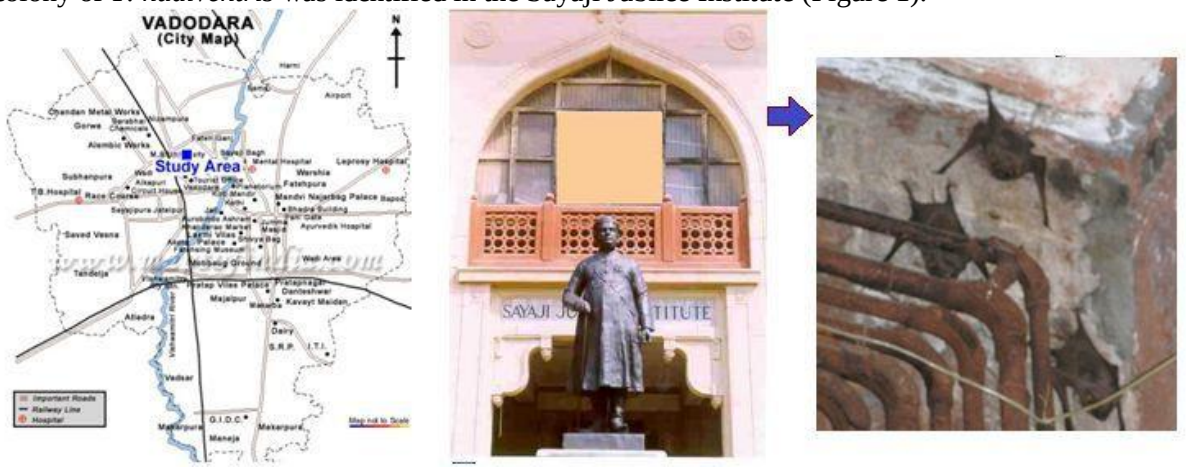

Figure 1: Study site

MATERIAL AND METHODS

The present study was conducted during May 2006 to February 2007, covering all the major seasons. Adult male and female bats were located in the study site with the help of bat detector. Mist nets were deployed at the site after observing the pattern and time period of its foraging and roosting activities. The animals were captured with the aid of mist net of the mesh size (10mm). After capturing the bats, they were clipped with sterile scissors to mark the animal. Marking was done to obtain the average size of colony existing at roosting place using Lincoln's Index. For the purpose of handling the bats, surgical gloves were used. Gloves of thicker quality were used for handling the larger and aggressive females.

Soon after capture, the animals were weighed on the electronic weighing balance (Sartorious). Notes on pelage colouration and external measurements were taken immediately after capturing the bats. Measurements were recorded with the help of calibrated digital Caliper (Mitutoyo, Japan). Specific measurements taken are HB – Head and Body length, from tip of the snout to the base of the tail; T – Tail length, from the base of the tail to the tip of the tail; HF – Hind foot length, from the extremity of the heel to the end of the longest claw; FA – Forearm length, from oleocranon process of ulna to outside edge of the wrist; E – Ear length, from bottom of notch at the base of the ear to distal most edge of pinna; GTL – Greatest skull length, from anterior most point of snout to posterior most part of occipital; CCL – Condylocanine length from anterior alveolus of canines to exoccipital condyle; ZB – Zygomatic breadth, greatest width of the skull across the zygomatic arches; BB – Braincase breadth, greatest width of the braincase at the posterior roots of the zygomatic arches; IC – Interorbital constriction, narrowest width across the constriction posterior to the orbits. Identification was done using standard monograph (Bates and Harrison, 2000). Without causing any injury to the animals they were released back to the sites as soon as work was completed.

Absolute count and Lincoln's Index were used to estimate the population size. Gut content analysis (from dead animals accidentally found) and Guano (droppings) that the bat generated were also used to understand the food preference. Blood was drawn from brachial vein, without hurting the animal, so as to

study different haematological parameters and serum glucose level by using auto analyzer (Beckman Ex-5). Raw data were analyzed to give mean and standard deviation using GraphPad Prism version 3.0 for Windows, GraphPad Software, San Diego California USA (Motulsky, 1999).

RESULTS AND DISCUSSION

Taphozous nudiventris are small or medium sized sheath tailed bats. They are widespread in the Indian subcontinent found throughout the more arid areas where rainfall is less than 1275 mm per annum. The adult male and female individuals of naked rumped tomb bat *Taphozous nudiventris* are common species of bat in Vadodara. Though it has been recorded from Vadodara by Sinha in 1981, there is no description on the morphology of this species. A detail study on different morphological features in addition to the cranial and dental characters of these bats was taken into account (Table 1).

Table 1: Morphometric measurements of the adults of *Taphozous nudiventris* (in mm)

Morphometric Parameters	Male (n=10)	Female(n=10)
Head and Body length (HB)	96.2 ± 2.32[@]	86.6 ± 1.72
Tail length (T)	30.5 ± 5.34	26.3 ± 1.05
Hind foot length (HF)	13.75 ± 1.44	11.8 ± 0.6
Forearm length (FA)	76.875 ± 3.07	76.1 ± 2.2
Ear length (E)	20.75 ± 2.47	17.9 ± 1.1
Greatest skull length (GTL)	25.6 ± 2.78	21.5 ± 1.0
Condylocanine length (CCL)	22.65 ± 2.78	20.4 ± 1.1
Zygomatic breadth (ZB)	15.95 ± 1.41	15.6 ± 0.9
Braincase breadth (BB)	11.375 ± 0.92	10.8 ± 0.6
Interorbital Constriction (IC)	7.55 ± 0.26	7.4 ± 0.3
Wing span (WS) in cm	48.75 ± 2.50	46.4 ± 4.2
Tibial length (TIB)	31.35 ± 1.41	31.1±1.3
Weight (gm)	62.35 ± 3.06	67.6 ± 3.3

[@] *Values are expressed as mean ± standard deviation*

Distribution

With some 47 species, the Sheath-tailed bats (*Taphozous nudiventris)* are a diverse and geographically widespread group (Koopman, 1993). They occur throughout the tropical regions of the Old World from the islands of the Pacific Ocean through Australia, Indonesia, the Philippines and the Indian Subcontinent to Arabia, Egypt and sub-Saharan Africa; they are also found in the New World, including Central and South America. They are distributed widely in many parts of Pakistan, Afghanistan and Northern Myanmar. The genus includes 17 species in three subgenera (*Taphozous*, *Liponycteris* and *Saccolaimus*) with a geographical range that extends from Africa to Australia (Corbet and Hill, 1992). Six species are present in the Indian Subcontinent.

Distribution in India: Rajasthan, Maharashtra, Karnataka, Tamil Nadu, Madhya Pradesh, Uttar Pradesh, Bihar, West Bengal

Distribution in Gujarat: Bhuj (Wroughton, 1912); Rajkot; Keshod; Junagadh; Vankaner (Ryley, 1913); Deesa (Ryley, 1914); Ahmedabad; Anand; Vedtal; Bochasan (Brosset, 1962); Baroda; Broach (Sinha, 1981).

External Characters

This is a medium-sized species with an average forearm length of 76mm (71.0-80.0 mm) (Table-1). It is characterized by its naked rump, which may contain copious fat reserves, especially in the post-monsoon period. Males have a large gular sac which is about 10 mm in breadth; additionally there is a deep circular gland in the upper part of the chest (Figure 2). In females, the gular sac is less visible and the gland is absent. The chin and throat are essentially naked in both sexes. The head is flattened in appearance whilst

the jaws are extremely powerful. The ears are long and rather narrow, blackish brown in colour and semitranslucent. They are widely separated from each other and the tips bluntly rounded off. The tragus is narrowed above its base and then expanded distally to form a club-shaped extremity with a rather flat top.

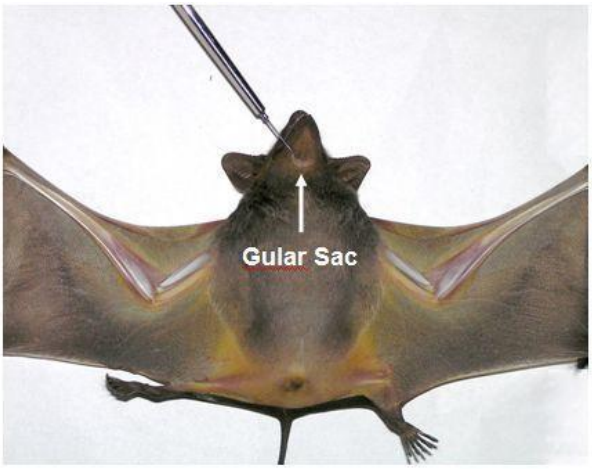

Figure 2: Distinguishing character of male *T.nudiventris* – the Gular sac

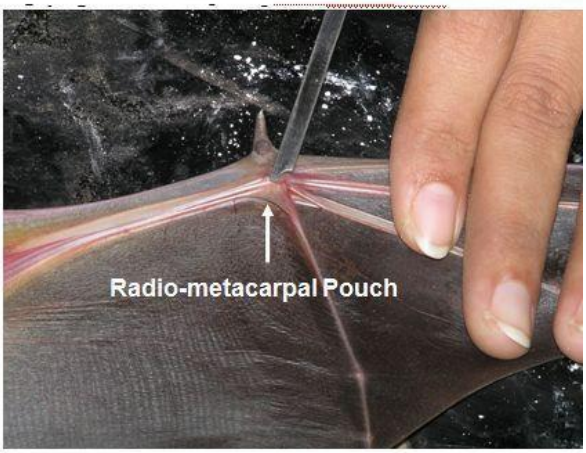

Figure 3: Key identifying character of the species *T.nudiventris* - the Radio metacarpal pouch

The pelage is short, fine and dense. It is dark brown on the dorsal surface, with pale grey hair bases; it is paler brown on the ventral aspect. The pelage does not extend on to the wing membranes on the dorsal surface and the humerus and forearm are quite naked. It is also absent from both aspects of the interfemoral membrane, the posterior back, lower abdomen and legs. The wings, which are long and narrow, are attached to the tibiae; the radio-metacarpal pouch is moderately developed (figure 3). The feet have a few characteristically long, pale hairs arising from the backs of the toes. This species has a particularly strong and unpleasant odor.

Cranial Characters

The skull with an average condylo-canine length of 21 mm (18.6-25.4 mm) is robust and strongly ridged in adult specimens; the interorbital region is broad and squared with prominent lachrymal projections. It is comparable in size to *T. saccolaimus* and *T. theobaldi* but can be distinguished from *T. saccolaimus* by the structure of the tympanic bullae. It is been reported in *T. nudiventris*, that the antero-internal border of each bulla is incomplete, with the main body of the cochlea readily visible (Koopman, 1993). According to other study, in *T. saccolaimus*, the tympanic bullae are completely ossified internally and in consequence the main body of cochlea is obscured. In contrast to *T. theobaldi*, the zygomata are relatively broad and the lambda usually forms the most backwardly projecting part of the skull; the lambda is especially pointed in adult males and projects backwards over the occiput; the lambdoid ridges are strongly developed (Brosset, 1962). The sagittal crest is absent in some specimens, usually females and well developed in others, for example older males. Koopman (1993) observed that the basisphenoid pits of *T. nudiventris* are less developed than those of *T. theobaldi*. The mandible is robust with the horizontal rami deep. The coronoid process of each half mandible is tall with its anterior border almost vertical.

Dentition

Upper tooth-row length (cm3) averages 10 mm (9.5 -11 mm). It is similar in morphology to that of *T. longimanus* but distinctly more robust. In contrast to *T. saccolaimus*, the first upper premolar (pm2) is small, scarcely exceeding the height of the cingulum of the canine and with a crown area of little more than 10-15% that of the second premolar (pm4). In *T. saccolaimus*, pm2 is relatively large, with a crown area of 30-50% of pm4 (Bates and Harrison 2000).

Research Article

Ecology

Habits and Temporal Activity Pattern

This is a widespread species in the Indian subcontinent found throughout the more arid areas where rainfall is less than 1275 mm (50 inches) per annum. It is mainly absent from the Konkan, Ghats and Kanara regions where the humidity is relatively high (Brosset, 1962 a). Diurnal roosts include caves, temples, tombs, barns, houses, crevices in rocks (Brosset, 1962 b) and underground tunnels (Advani, 1980). In Gujarat, it was found in ruined houses and old mosque and is known to associate with *Rousettus leschenaulti* and *Hipposideros speoris* (Sinha, 1981). Prakash (1961) reported that it occupied the nests of swifts. Colony size is generally restricted to a few individuals although Brosset (1962 c) observed several hundred in the cave complexes of Ellora. Activity is reduced during November and December in Gujarat, when individuals probably rely on their large fat reserves (Brosset, 1962 a, b). According to Advani (1980), it migrates on a seasonal basis in Rajasthan and may spend the winter in a state of torpor. Its flight is strong, fast and straight. In the present study it was observed that the bats were quite active during the premonsoon and postmonsoon period and were seen roosting in the crevices of buildings wherein the area received less light. Individuals were found occupying the walls close to the insulated electric pipes found on the corridors of the building (Figure 1).

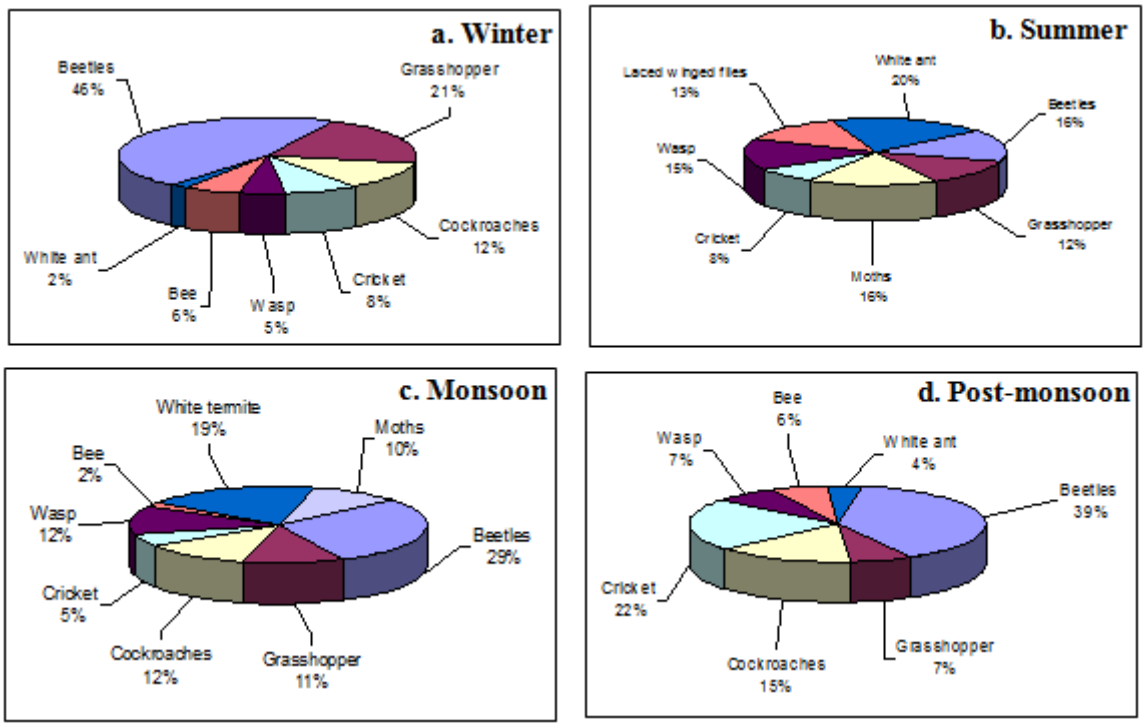

Figure 4: Food composition of *T. nudiventris* during various seasons

In the current study it was observed that many bats used more than one night roosts to rest and digest food. Before moving out of the colony for foraging, the squeaking sounds of the individuals are heard out clearly as might be the starter or as sign of indication for departure. During the summer these bats moved out of the colony in groups by 2000 hrs and used to return back the next morning between 0600 to 0730 hrs (Figure 5). Observations on the exodus of these species of bats were made from a closer distance. Larger bats moved out of the colony with large squeaking sounds they were then followed by other bats. Some of the bats used to stay back in the colony and departed for foraging at the later hours. During winter, when the temperature dropped below 18^{o}C they were found hibernating in the crevices of the building and preferred to come out when the temperature was normal.

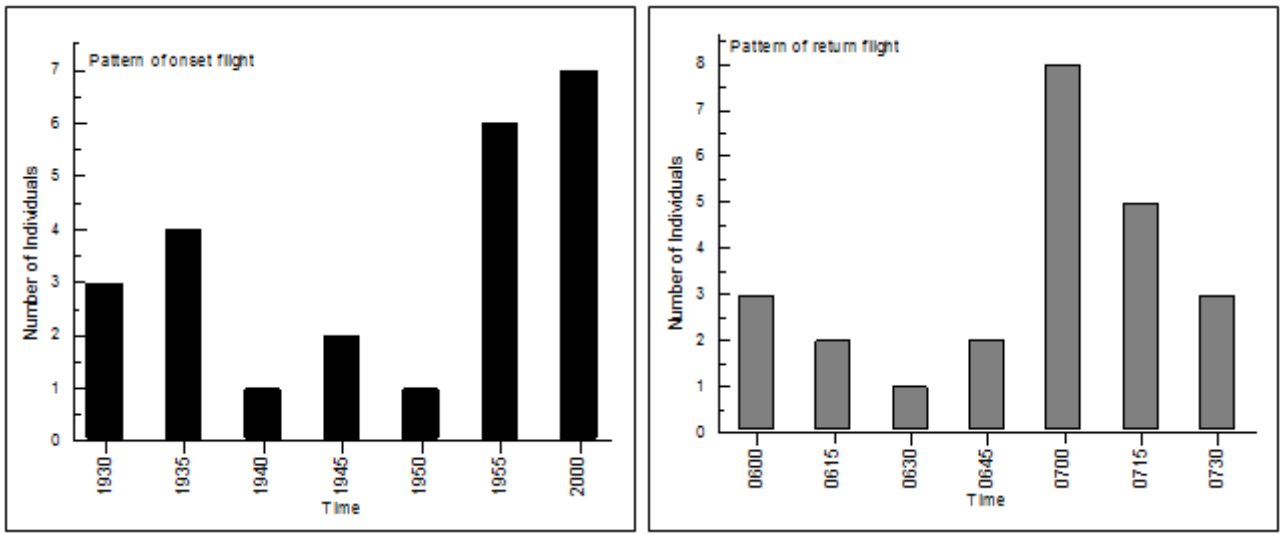

Figure 5: Pattern of onset and end of the nightly foraging flight of members of the colony of *T.nudiventris*. Actual numbers flying out and returning do not tally since the bats took different routes, especially during the onset of foraging flight

During the premonsoon and postmonsoon periods it was observed that the bats were quite active and the number of individuals averaged between 20 and 26 hanging in well lit area. But soon after September the colony shifting was observed amongst these bats and isolated smaller groups of 4-5 individuals were observed (Table 3).

Table 2: Haematological and Biochemical parameters of adult male and female *T.nudiventris*

Parameters	Male	Female
Haemoglobin [gms%]	13.4 ± 0.83[@]	13.1 ± 0.91
Total RBCs [mill./cmm]	5.88 ± 0.34	5.14 ± 0.36
Total WBCs cmm.	4,500 ± 120	3,000 ± 102
Erythrocyte sedimentation rate (ESR) [m.m]	7-15	8-15
RBC. Morphology	Normocytic, normochromic	Normocytic, normochromic
Platelet count cmm.	1, 68,000 ± 1203	1, 72,000 ± 1652
Mean corpuscular volume (MCV) [Fl]	85.2 ± 3.5	83.2 ± 5.6
Mean corpuscular haemoglobin (MCH) [Pg]	28.0 ± 1.8	29.5 ± 2.6
Mean corpuscular haemoglobin concentration (MCHC) [%]	32.8 ± 2.16	30.8 ± 1.92
P.C.V [vol%]	43.8 ± 1.96	43.7 ± 2.12
Serum Glucose [mg/dl]	80.8 ± 4.86	95.0 ± 4.66

[@] *Values are expressed as mean ± standard deviation; n=6*

Table 3: Temporal variation in mean population size (adult/subadult) and number of roosting sites of *T.nudiventris* during 2006-2007

Season	Population size	Number of roosting sites
Summer	24 ± 3	2
Premonsoon	22 ± 4	3
Post monsoon	24 ± 4	3
Winter	16 ± 3	5

Feeding

According to Advani (1980), the diet varies on a seasonal basis. In the present study during winter (December-February), 46% of food comprised of beetles, followed by grasshopper (21%), whilst cockroaches (12%) and house crickets (8%) were also favored (Figure 4a). In summer (May-June), the percentage of beetles fell to 16.2% and was replaced by winged white ants, moths, grasshoppers, crickets, wasps and lace winged flies; there was also a high occurrence of the bat's own fur in stomach contents (Figure 4b). In the monsoon season (July-September), the percentage of winged termites increased, along with beetles, cockroaches and moths (Figure 4c). In the post monsoon period (October-November), the percentage of beetles increased to 38.7%, house crickets and cockroaches were also favoured (Figure 4d). In general, it is apparent from the observations that this species is economically beneficial since they keep a check on the abundance of harmful insects.

Haemogram and Serum Glucose

Several haematological and biochemical parameters were analyzed in adult male and female bats of *T. nudiventris* by taking blood samples from live animals during the period of their activity. Haematological parameters in male and female bats differ only marginally with respect to number and volume of blood cells (Table 2). Red blood cell count and white blood cell count in adult male bat was more as compared to that of the females. Haemoglobin levels and haematocrit values were almost similar in both the sexes. Similar observation was also made by Wolk and Bogdanowicz (1987) in bat *Myotis daubentoni*. *T.nudiventris* showed blood characteristics well adapted to carrying the increased oxygen demands of flight. The values of different haematological parameters and blood glucose in male and female bats were similar to that of other species of bats studied (Wolk and Bogdanowicz, 1987).

Reproduction

Copulation and fertilization takes place during the last week of March and the first week of April (Sapkal and Deshmukh, 1985 and Brosset, 1962c). There is usually a single embryo in the right cornua of the uterus (Sinha, 1986). In the present study, during breeding season it was observed that the maternity roost comprised only of females. Individuals in the colony were found breeding during May/June. Pregnancy in *T.nudiventris* lasted for about 87 days and the parturition occurred by August/September, while lactation continued till the end of September. A single young one was born to female (Figure 6).

Figure 6 A lactating mother with a single young one

A period of sexual quiescence was observed from December to February. Concomitant observations were made by Sapkal and Deshmukh (1985) give credence to the current observation. The infant of *T.nudiventris* in the present study reached to full adult size in 9 months which is a longer duration as compared to other bats (Brosset, 1962 a); females are sexually mature at nine months and males at twenty months.

Conservation status
Worldwide: a widespread species in northern Africa and Asia. Indian subcontinent: formerly abundant, in India (Brosset, 1962b), however a survey suggests that there has been a significant decline in population size in many of its former roosts (Bates *et al*., 1994).

Conclusion
Bats are represented as one of the most diverse group of mammals. The present study confirms existence of *Taphozous nudiventris* in man-made structures. The morphometric measurements were found to be in accordance with the reported records. The species richness was found to be more or less uniform throughout the season however, during winter a drop in the population size and splitting of colony was observed. The present bat species is entomophagous found feeding on a variety of insects and a large proportion of which is identified as pest to major agricultural crops. A study on their foraging behaviour would pave the way for identifying the frequency of feeding. Such proposals invite future studies which are important not only to protect *T. nudiventris* but also the crops which rely on these bats.

REFERENCES
Adora Thabah, Stephen J Rossiter, Tigga Kingston, Shuyi Zhang, Stuart Parsons, Khin Mya Mya, Akbar Zubaid, and Gareth Jones (2006). Genetic divergence and echolocation call frequency in cryptic species of *Hipposideros larvatus s.l*. (Chiroptera: Hipposideridae) from the Indo-Malayan region. *Biological Journal of the Linnean Society* **88** 119-130.
Advani R (1981). Seasonal fluctuations in the feeding ecology of the Indian false vampire, *Megaderma lyra lyra* (Chiroptera: Megadermatidae) in Rajasthan. *Zeitschrift fur Saugetierkunde* **46** 90-93.
Agrawal PK, Pandey OP, Negi JG (1992). Madagascar: a continental fragment of the paleo-super Dharwar craton of India. *Geology* **20** 543-546.
Bates PJJ, Harrison DL, Thomas NM and Muni M (1994). *Bonn Zoological Bulletin* **45** 89-98.
Bates PJJ and Harrison DL (2000). *Bats of the Indian Subcontinent*. (World Biodiversity Database CD-ROM Series) CD-ROM Springer.
Brosset A (1962a). The bats of central and western India Part 1. *Journal of the Bombay Natural History Society* **59** 1-57.
Brosset A (1962b). The bats of central and western India Part 2. *Journal of the Bombay Natural History Society* **59** 583-642.
Brosset A (1962c). *The bats of central and western India Part 3. Journal of the Bombay Natural History Society* **59** 706-746.
Corbet GB and Hill JE (1992). *The Mammals of the Indomalayan Region: A systematic review*. Oxford: Oxford University Press.
Dobson PASB (1872). *Cynonycteris amplexicaudata*, P*eters, MB. Akad, Berlin 1867,* **865** 154.
Dulic B and Felten H (1962). Säygetiere (Mammalia) aus Dalmatien Senckenberg. *Biology* **43** 417-423.
Gary L Graham (1994). *Bats of the World* St. Martin's Press.
Harrison DL (1964). Some systematic and anatomical observations on the Formosan tailless leaf- nosed bat, *Coelops frithi formosanus* Horikawa 1928. *Mammalia* **28** 88-93.
Koopman KF (1993). Order Chiroptera 156-161. *In*: DE Wilson and DM Reeder (Eds). *Mammal species of the world: A taxonomic and geographic reference* Washington Smithsonian Institute Press.
Mistry S (1995). The Bats of India. *BATS* **13**(2) 11-15.
Mistry S (2003). Protecting the Bats of India. *BATS* **21**(2) 08-11.
Motulsky HJ (1999). *Analyzing Data with GraphPad Prism*. GraphPad Software Inc., San Diego CA.
Prakash I (1961). Taxonomic and biological observations on the bats of the Rajasthan Desert. *Records of Indian Museum* **59** 149-170.
Ryley K (1914). Scientific results of the Mammal Society. *Journal of the Bombay Natural History Society* **22** 658-664.

Sapkal VM and Deshmukh AH (1984). Breeding habits and associated phenomena in some Indian bats-Part X-*Taphozous kacchenis* (Dobson)-Emballonuridae. *Ibid* **82** 61-67.
Sinha NK (1981). *Checklist of Mammals of India* Zoological Survey of India, Kolkata 289.
Wolk E and Bogdanowicz W (1987). Hematology of the hibernating bat: *Myotis daubentoni*. *Comparative Biochemistry and Physiology* **88**(4) 637-639.