

ANNUAL CYCLE OF URINE OUTPUT OF THE GREATER INDIAN FALSE VAMPIRE BAT, *MEGADERMA LYRA*

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ABSTRACT

Individuals of the Indian False Vampire Bat, *Megaderma Lyra*, were maintained in captive conditions to study daily urine output for more than two years. Urine was collected and quantified by placing sheets of absorbant paper on the floor of cages beneath the roosting bats. Seasonality in the urine output is reported.

KEYWORDS

Captivity, Greater Indian False vampire bat, *Megaderma Lyra*, urine output.

Internal water balance has been studied extensively in a number of mammalian species (Chew 1965; Mac Millen, 1972; Heisinger, 1972; Blake, 1977; Van Tets, 2001; Geluso, 1978). Bats living in arid environs face problems of water budget. Especially, with their particular characters like flight, naked flight membrane, smell, size and warm roosts, bats provide an intriguing twist to the water economy of mammals (Basset, 1980; Carpenter, 1986). Generally, urine output is one of the major sources of water loss and additionally through wing membranes and pulmonary activity demanded by flight (Carpenter, 1986). Water loss is compensated by specialized renal functions (Vogel, 1969; Vogel & Vogel, 1972). With exceptions (Studier, 1983a,b), most studies on water conservation have been focused on temperate bats. The paucity of information about the water economy in the tropical bats is due to the assumption that bats from tropical environments are generally subjected to more humid conditions and have access to ample drinking water and, therefore, do not require elaborate renal adaptations.

In spite of the general belief that bats may not be under selective pressure to evolve specialized renal mechanism, recent reports suggest that tropical bats indeed engage in water conservation in order to thrive in the high environmental temperatures that characterize their roost (Rodriguez, 1995; Gaur & Solanki, 1992). However, the difficulties to analyze urine output in wild bats are manifold. Though it is easy to observe urine droppings from non-hibernating bats, it remains difficult to collect urine from bats in the field (Basset & Studier, 1987). Therefore, we carried out the present study on a tropical nonhibernating bat, *Megaderma lyra* in captivity. We attempted to study the water conserving ability of *Megaderma lyra* by assessing the amount of daily urine output for more than two years.

MATERIALS AND METHODS

Study species: The Indian false Vampire bat, *Megaderma*

lyra is an insectivorous bat. These bats commonly roost in human habitations, in the lofts of old houses and under jutting structures on the walls of wells. The adult body mass of ranges between 30 and 40g. The number of individuals in a colony varies from 10 to about 100. This species feeds on frogs, lizards, and small mammals and even eats its own kind (Madhavan, 1993). The bats were, collected and kept in the laboratory conditions for 10-15 days for acclimatization before the commencement of the experiment.

Experimental set up: Experiments were carried out in outdoor cages measuring 124 x 90 x 60cm. Cages were made of wooden frames fitted with sheets of wire meshes on the four sides and the top. Floor of the cage was made of asbestos sheet. These were kept in a semi naturalistic condition. The experiments were conducted from 27 May 2001 to June 2003. Nineteen bats were maintained in captivity for the present study (8 males and 11 females). One bat each was placed in a cage and the urine output was measured along the protocol given below. Throughout the experiment, the bats were fed with measured quantities of frog legs, beef pieces, stunned fish as *Mastacembelus*, and provided with drinking water (200ml).

Experimental protocol: Experiments were conducted from 0600 to 1800hr and from 1800 to 0600hr. During the experiments the cage floor was covered with a sheet of whatman 40 blotting paper mounted on a wooden board. A measured quantity of food and water (200ml) were introduced into the cage at night. Before starting to estimate the amount of urine output by captive bats, we standardized the area of a patch covered by 1.0ml of urine. For this, we collected urine directly from the urinary bladder of several wild specimens of *Megaderma lyra* after sacrificing them. A fully distended urinary bladder of the bat holds about 0.4 to 0.5ml urine. 1.0ml of urine thus collected was dropped from a pipette from a particular height equivalent to bat's perching position. Eighteen such samples of 1.0ml urine were taken and dropped to take concordant values. The outline of urine patches on the blotting paper were transferred to a sheet of a butter paper, and then to a graph paper to calculate the area of the patch. A standard total area spread by 1.0ml of urine was thus calculated and kept as reference point. Urine voided by the bat drops on the absorbent paper and spreads in a specific manner-very similar to a chromatographic picture. Most of the urine drops spread out in a circular manner from the point where the drops exactly land; these leave light yellow tinted patches on the paper.

In this way urine output by a captive bat was calculated by measuring the total area of individual patches and comparing it with reference readings. A total of 428 patches (214 times during the day time and 214 times during the night time) of voided urine were retrieved on sheets of blotting paper kept on the floor of the cage. Distorted urine patches due to coalescence of adjacent urine patches, falling of remnants of food and faecal pellets over the urine were not included in the analysis.

Quantity of water intake and food consumed were also calculated during the experiments. A measured quantity of food and water (200ml) were placed inside the cage at night. A similar quantity of water was kept inside an empty cage, and after every 12 hours, reading for evaporation was recorded from these dishes. Deducting the quantity of water lost through evaporation in the vacant cage from that lost from the cage holding the bat gave the quantity of water consumed. Mass of food consumed during the experiment was also recorded; discarded food was removed and weighed.

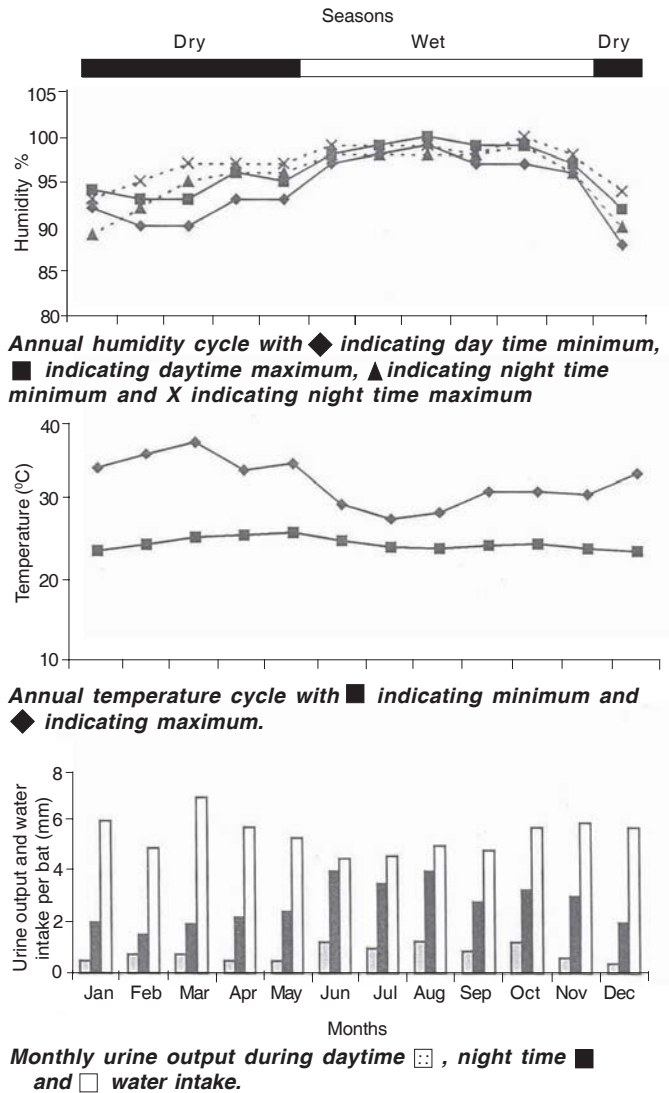
RESULTS

The seasonal changes in the urine output of *Megaderma lyra*, the respective annual temperature and humidity cycle are given in Fig. 1. The temperature cycle in the study area showed an annual fluctuation. During the months from June to November, the temperature difference was not too high (max. $30.15^{\circ}\text{C} \pm 1.3$; min $24.38^{\circ}\text{C} \pm 0.31$), whereas, during the dry season (December-May) the temperature fluctuated heavily (Max: $35.02^{\circ}\text{C} \pm 1.67$; Min: $24.86^{\circ}\text{C} \pm 1.55$). The data on the annual humidity cycle showed a minimum of $97 \pm 1.47\%$ and a maximum of $98 \pm 0.98\%$ during the day hours of wet season. In the nights, the minimum humidity was $98 \pm 0.84\%$ and the maximum was $99 \pm 0.52\%$. Similarly, during the dry season, minimum humidity by day was $91 \pm 2.1\%$ and the maximum was $94 \pm 1.55\%$. During nights the maximum humidity was $94 \pm 2.32\%$ with minimum at $96 \pm 1.47\%$.

Urine output of *Megaderma lyra* showed seasonal changes with maximum output during June (3.9ml) and minimum during February (1.92ml). The urine output during nights was significantly higher than during the day time ($t = -5.909$, $P < 0.001$). Generally urine output was high in the months of June to November, as against low urine output observed during the months of December to April. The months from June to November and December to May are generally classified as wet and dry season respectively in Kerala (Menon & Rajan, 1989). During the wet season, the water lost as urine was in par with the amount of water intake. Especially during the months of June and July, there was no significant difference between the amount of urine output and amount of water intake (June $t = -0.883$, $P = 0.470$, July $t = -0.796$, $P = 0.498$). However, during the dry season, urine output was significantly low compared to the amount of water intake (Dec $t = -3.22$, $P = 0.009$, Jan $t = -2.33$, $P = 0.052$, Feb $t = -3.112$, $P = 0.008$, Mar $t = -5.022$, $P < 0.001$; May $t = -3.197$, $P = 0.004$).

Discussion

The results of the experiment show that urine output in *Megaderma lyra* seems to be influenced by environmental factors



like temperature and humidity.

During the dry season there may be additional water loss through perspiration, and this probably necessitates additional consumption of water to compensate the loss of water.

Generally, bats have greater urine concentrating abilities than other mammals (Lawler & Geluso, 1986). The ability to conserve urine in mammals is generally dependent on the habitats they live in. Especially, bats living in arid habitats tend to have kidneys with more prominent medullas than those from humid regions (Lalwer & Geluso, 1986; Geluso, 1980; Vogel, 1969; Geluso, 1978). This ecophysiological relationship is exceptionally well defined in insectivorous bats. As a result of this consistent adaptation, many desert mammals have been known to exist without drinking water (Mac Millon, 1972).

Compared to the arid living insectivorous bats, *Megaderma lyra* are less likely to face extreme climatic conditions compelling them to conserve urine. The findings that even the dry environs of day roosts could cause water expenditure (Rodriguez-Duran, 1995), is what prompted us to initiate this preliminary study on *Megaderma lyra*. Further more, though it usually lives

in places where water sources are plenty, the possibility of these water sources going dry are high in the dry season. The fact that during dry season urine output was low supports the view that the bat engages in water balance. The low urine output during dry season, therefore, can well be an adaptation to overcome the constraints of dry season.

Other comparative studies have shown that species of insectivorous bats with more efficient kidneys are able to cope with water stress experiments better, and are independent of drinking water than species with relatively poor urine concentrating abilities (Carpenter, 1969; Vogel & Vogel, 1972).

Though the present results showed that *Megaderma lyra* exhibits a seasonal fluctuation in the urine output, the role of kidneys in the regulation of water balance is not exactly known. The ability to conserve urine is considered as an effective adaptation to counter water loss during flight and through urine, currently studies are underway to assess this mechanism in this tropical carnivorous bat. The renal adaptation behind water regulation is important to understand the ecophysiological aspect of water balance in *Megaderma lyra*.

REFERENCES

- Basset, J.E. (1980)** Control of post prandial water loss in *Myotis luncifugus*. *Comparative Biochemistry and Physiology* 65A: 497-500.
- Basset, J.E. & E.H. Studier (1987)**. Methods for determining water balance in bats, pp. 373-386. In: Kunz, T.H. (ed.). *Ecological and Behavioural Methods for the Study of Bats*. Smithsonian Institution Press, Washington, D.C. 533pp.
- Blake, B.H. (1977)**. the effects of kidney structure of the kidney and the annual cycle on water requirements in golden-mantled ground squirrels and chipmunks. *Comparative Biochemistry and physiology* 58: 413-302.
- Carpenter, R.E. (1969)**. Structure and function of the kidney and the water balance of desert bats. *Physiological Zoology* 42: 288-302.
- Carpenter, R.E. (1986)**. Flight physiology of intermediate-sized fruit bats (Pteropodidae). *Journal of Experimental Biology* 120: 79-103.
- Chew, R.M. (1965)** Water metabolism of mammals, pp.43-178. In: W.V. Mayer and R.G.Van Gelder (eds.), *Physiological Mammalogy*. Vol. 2, Academic Press New York.
- Gaur, R.S. & R. Solanki (1992)** Seasonal fluctuation in the urine concentration of certain desert bats. IX International Bat Research Conference, Madurai, 16pp.
- Geluso, K.N. (1975)**. Urine concentrations cycles of insectivorous bats in the laboratory. *Journal of comparative Physiology* 99: 309-319.
- Geluso, K.N. (1980)**. Renal form and function in bats: an ecophysiological appraiser, pp.403-414. In: Wilson, D.E. & A.L. Gardnem (eds.). V International Bat Research Conference. Texas Tech Press Lubbock, 434pp.
- Heisinger, J.F., T.S. King, H.W. Halling & B.L. Fields (1972)**. Renal adaptations to macro and micro habitats in the family Cricetidae. *Comparative Biochemistry and Physiology* 44: 767-774 .
- Lawler, R.M. & K.N. Geluso (1980)**. Renal Structure and body size in hetromyid rodents. *Journal of Mammalogy* 67: 367-372.
- Mac Millon, R.E. (1972)**. Water economy of nocturnal desert rodents. *Symposium of the Zoological Society of London* 31: 147-174.
- Madhavan, A. (1993)**. Feeding habit of the Great Vampire Bat, *Megaderma lyra lyra* (Geoffroy, 1810). Observations on the food and feeding habit of *Megaderma lyra* in laboratory condition. *Trends in Life Sciences India* 8: 27-31
- Menon, P.A. & C.K. Rajan (1989)**. *Climate of Kerala*. Classic Publishing House, Cochin, 328pp.
- Rodriguez-Durant, A. (1995)**. Metabolic rate and thermal conductance in for specious neotropical bats roosting in hot cafes. *Comparative Biochemistry and Physiology* 110: 347-355.
- Studier, E.H., B.C. Boyd, A.J. Feldman, R.W. Dapson & D.E. Wilson (1983a)**. Renal function in the neotropical bat *Artibeus jamaicensis*. *Comparative Biochemistry and Physiology* 74a :199-209.
- Studier, E.H., A. Wisniewski, A.T. Feldman, R.W. Dapson, B.C. Boyd & D.E. Wilson (1983b)**. Kidney structure in Neo tropical bats. *Journal of Mammalogy* 64:445-452.
- Van Tets T.G., C. Corine, L. Rosburg & B. Pinshow (2001)**. Change in the composition of the urine of the Yellow-vented Bulbuls (*Pycnonotus xanthopygos*) the effect of ambient temperature, nitrogen and water intake. *Physiological and Biochemical Zoology* 74: 853-857
- Vogel, V.B. (1969)**. Vergleichende untersuchungen uber den Wasserhaush alt, Van Fledermausen (Rhinoloma, Rhinolophus, and Myotis). *Zeitschrift fur Vergleichh Physiology* 64: 354-345.
- Vogel, V. & W. Vogel (1972)** Uber das Konzentrationsverm oger der Nieren Zwier. Fledermausarten (*Rhinopoma hardwickei* und *Rhinolophus ferrumequinum*) mit unterschiedlich langer Ninerepapille. *Zeitschrift fur Vergleich Physiology* 76: 358-371.

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