Journal of Threatened Taxa

The international journal of conservation and taxonomy

www.threatenedtaxa.org

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

SHORT COMMUNICATION

THE EFFECT OF DAYTIME RAIN ON THE INDIAN FLYING FOX (MAMMALIA: CHIROPTERA: PTEROPODIDAE: *PTEROPUS GIGANTEUS*)

S. Baskaran, A. Rathinakumar, J. Maruthupandian, P. Kaliraj & G. Marimuthu

26 February 2016 | Vol. 8 | No. 2 | Pp. 8499–8502
10.11609/jott.1959.8.2.8499-8502

Journal of Threatened Taxa | www.threatenedtaxa.org | 26 February 2016 | 8(2): 8499–8502

The effect of daytime rain on the Indian Flying Fox (Mammalia: Chiroptera: Pteropodidae: *Pteropus giganteus*)

S. Baskaran [1], A. Rathinakumar [2], J. Maruthupandian [3], P. Kaliraj [4] & G. Marimuthu [5]

[1,2,3,4,5] Department of Animal Behaviour & Physiology, School of Biological Sciences, Madurai Kamaraj University, Madurai, Tamil Nadu 625021, India
[1] baskarmku@gmail.com (corresponding author), [2] rathinacumar@gmail.com, [3] maruthu.mku@gmail.com, [4] pkaliraj07@gmail.com, [5] emailboxgm@gmail.com

ISSN 0974-7907 (Online)
ISSN 0974-7893 (Print)

OPEN ACCESS

Abstract: Excessive water loss during the day due to heat stress in bats of the genus *Pteropus* appears to be inevitable, because these bats are exposed to direct sunlight. Rain also affects the rest pattern of the Indian Flying Fox *Pteropus giganteus* during the day. When rain occurred during the day, most of the bats hung in a slanting position and did not exhibit any movements. After rain, they licked both ventral and dorsal surfaces of the wing membrane and scratched their body with their thumb claws. They also licked the water droplets that remained on the leaves and branches of the tree. Even though their rest had been affected by the rain the bats utilized the water droplets to quench their thirst, cool their body and clean their fur. The construction of water reservoirs near *Pteropus* roosts will help to assure their long-term conservation.

Keywords: Behaviour, licking, *Pteropus giganteus*, rain.

The roosts of bats can be categorized into day roosts, night roosts, maternity roosts and hibernation sites (Barbour & Davis 1969; Humphrey et al. 1977; Kunz 1982; Barclay & Kurta 2007). Social activities like allogrooming, mother-young interactions and mating take place in the day roost (Wilkinson 1986; Kerth et al. 2003). Day roosting sites of bats in caves and buildings are usually well protected from abiotic and biotic factors like sunlight, temperature, thunder, lightning, predators and disturbances from human activities. However, bats of the genus *Pteropus* live as colonies in trees such as *Ficus benghalensis*, *Tamarindus indica*, *Azadirachta indica* and species of *Eucalptus,* where they are exposed to sunlight. During hot summer days, the majority of roosting individuals gently flap their wings, pant heavily, and spread saliva on the wing membrane in order to thermoregulate (Lekagul & McNeeley 1977). As a result of hyperthermia, mass die-offs of the Grey-headed Flying Fox *Pteropus poliocephalus* and the Black Flying Fox *Pteropus alecto* have been recorded in Australia, with juvenile and female bats more affected than male bats (Welbergen et al. 2008). To manage hyperthermia, bats fly to a local source of water, scoop up a drink while still flying and also soak their fur, before returning to the day roost, then lick the wet fur and wing membranes to quench their thirst and cool their body (O'Farrell et al. 1971; Welbergen et al. 2008). In contrast, bats in captivity maintain a constant body temperature (Robinson & Morrison 1957; Bartholomew et al. 1964) and drink water only when they feed (Neuweiler 2000; Taylor & Tuttle 2007). In the wild, daytime rain affects the rest pattern of *P. giganteus* but it also provides an opportunity for bats to manage heat stress. So, in the present study we investigated whether the behaviour of *P. giganteus* was adapted to managing hyperthermia

DOI: http://dx.doi.org/10.11609/jott.1959.8.2.8499-8502

Editor: Paul Racey, University of Exeter, Cornwall campus, UK. **Date of publication:** 26 February 2016 (online & print)

Manuscript details: Ms # 1959 | Received 18 April 2015 | Final received 08 February 2016 | Finally accepted 10 February 2016

Citation: Baskaran, S., A. Rathinakumar, J. Maruthupandian, P. Kaliraj & G. Marimuthu (2016). The effect of daytime rain on the Indian Flying Fox (Mammalia: Chiroptera: Pteropodidae: *Pteropus giganteus*). *Journal of Threatened Taxa* 8(2): 8499–8502; http://dx.doi.org/10.11609/jott.1959.8.2.8499-8502

Funding: This work was supported by UGC (University Grants Commission) as given of individual fellowship to S. Baskaran [F.14-2(SC)/2008(SA-III) dated on 29 June, 2009].

Conflict of Interest: The authors declare no competing interests.

Acknowledgments: We thank the various funding agencies that supported us with fellowships such as UGC-RGNF (SB), CSIR (AR), UGC-Major Research Project (J.M.), UGC-Meritorious Fellowship (PK), and INSA-Senior Scientist (GM). We are all also grateful to the reviewers and subject editor for having given valuable suggestions and comments.

during day-time rain.

Materials and Methods

Study site

The study was carried out during 23 days (673hr) over seven months from July 2010 to January 2011 in the biodiversity garden of Kamaraj University (MKU), located 14km from Madurai City ($9^0$58'N & $78^0$10'E). Nearby water resources of a lake and a pond were located 3km from the east and west sides of the day roost respectively. We studied the behaviour of a colony of *P. giganteus* roosting in three Banyan trees *Ficus benghalensis* of varying canopy diameter (40.4m, 30.6m and 27.0m) and an *Albizia lebbeck* tree with a canopy diameter of 12.5m. The number of bats in the colony was about 1500.

Behavioural Observations

A small tent was constructed in the garden from which observations were carried out during and after daytime rain. We reached the study site a few minutes before or at the beginning of rain. As it is very difficult to observe the behaviour of all bats in the colony concurrently, a number were randomly selected for instantaneous time sampling (Altmann 1975; Kunz 1998). We recorded the duration of post-rain activities (PRA) in a single bat visually for a specific time. The behavioural repertoire was also videographed with a digital camera (Sony α58) and video recordings were analyzed later to calculate the duration of PRA.

Results

Thermoregulatory behavior

When rain occurred during the day, most of the bats hung in the branches of a tree, in a slanting position, at an approximately 30–45^0 degree angle to the vertical, without any body movement (Images 1a–c). They usually covered their body and head with their wing membrane during rain. As a result, most of the rain droplets fell on their wing membrane and some fell on the dorsal side of the body, leading to wetting and clumping of hairs. After the rain, the majority of the individuals opened their wings and shook their body for a few seconds (9.1±1.0 sec; n=22) to shed the water. They licked the ventral and dorsal sides of their wing membranes (Image 1e) for 13.3±0.6 min (n=22) to remove the water and scratched their body (Image 1d) with their thumb claws for 56.0±6.0 sec (n=22) (Fig. 1). A few individuals moved around the branches of the tree, stretched their long tongue (Image 1j) and licked the water droplets that remained on the surface of the leaves and branches (Image 1f) (Video 1). Each individual licked a mean of 13±0.8 (n=19) leaves.

Mating attempts after rain

On occasions male bats licked their own penis (n=26)

Image 1. *Pteropus giganteus* exhibits various behaviours during and after rain.
a - ventral side; b - dorsal side; c - lateral side; d - scratching the body; e - licking their wing membranes; f - licking the water droplets that remain on leaves; g - licking the genitalia; h - copulation; i - urination; j - stretching the long tongue). © S. Baskaran

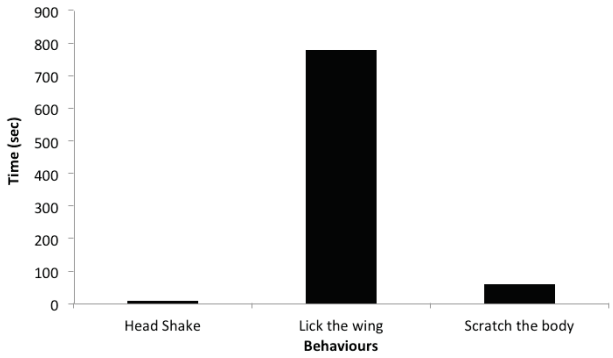

Figure 1. Duration of bat activities after rain stopped during day time.

(Image 1g) and after some time they moved towards the female and attempted to copulate (n=22) (Image 1h). But the female bats invariably rejected the male bats with strong vocalizations. During these copulation attempts, frequent urination was observed among most of the bats (Image 1i). After these activities, they closed their wing membranes and appeared to rest as confirmed by the absence of vocalization and other activities.

Discussion

Pteropus giganteus roosts on the open branches of large trees in which it forms colonies and is safe from predators (Pierson & Rainey 1992; Rainey & Pierson 1992; Richmond et al. 1998; Brooke et al. 2000). Nevertheless these open trees offer little protection from the sun and rain; hence the rest pattern of *P. giganteus* is usually affected by day-time rain. As the rain ceases, *P. giganteus* exhibit grooming activity (scratching and licking) to remove the water from their body and this self-grooming also serves to remove ectoparasites (Wilkinson 1986). When bats rub their noses into the wing membranes during grooming they transfer sebum secreted by the sebaceous glands (Richards et al. 2012; Baskaran et al. 2015). This serves as a water-proofing agent and also has antimicrobial activity.

We found that a few individuals also licked the water droplets, which remained on the leaves and branches of trees. Generally bats lose up to 50% of their body weight in a single day as a result of evaporation so they become thirsty (Taylor & Tuttle 2007). They have to expend more energy to obtain water from local sources (O'Farrell et al. 1971). So this species utilizes the rainwater to quench its thirst and reduce the need for flight to a source of standing water by licking rain droplets from its wing membrane as well as from leaves and branches of the roost tree. After rain most of the male bats licked their own penis and attempted to copulate with females. The frequent urination observed among most of the bats during these copulation attempts (Image 1i) suggests that they were not severely dehydrated during the daytime compared to days when no rain fell.

Usually copulation peaks of *P. giganteus* occur at 07.00–09.00 hr (Maruthupandian & Marimuthu 2013) but Koilraj et al. (2001) reported that copulation also occurred at 15.00hr during rain. So the weather conditions during day time rain may induce copulation of *P. giganteus*. In southern Tamil Nadu about 18% of *P. giganteus* roosts are located inside temples, courts, educational institutions and hospitals where no standing water is available compared to roosts near rivers and ponds (Senthilkumar & Marimuthu 2012). Thus we suggest that water reservoirs should be constructed beside *Pteropus* roosts to facilitate the long-term conservation of the bats. About 284 plant species depend on these fruit bats for seed dispersal and pollination and about 500 economically valuable products are derived from these plants (Marshall 1983, 1985; Fujita & Tuttle 1991), and their conservation is vital.

References

Barbour, R.W. & W.D. Davis (1969). *Bats of America*. The University of Kentucky Press, Lexington, Kentucky, 286pp.

Barclay, R.M.R. & A. Kurta (2007). Ecology and behaviour of bats roosting in tree cavities and under bark, pp. 17–59. In: Lacki, M.J., J.P. Hayes & A. Kurta (eds.). *Bats in Forests: Conservation and Management*. John Hopkins University Press, Baltimore, Maryland, USA.

Baskaran, S., P. Kaliraj, J. Maruthupandian & G. Marimuthu (2015). Influence of rain activity of the Indian Flying Fox *Pteropus giganteus*. *Indian Journal of Science* 15(44): 6–12.

Brooke, A.P., C. Solek & A. Tualaulelei (2000). Roosting behaviour of colonial and solitary flying foxes in American Samoa (Chiroptera: Pteropodidae). *Biotropica* 32: 338–350; http://dx.doi.org/10.1111/j.1744-7429.2000.tb00477.x

Fujita, M.S. & M.D. Tuttle (1991). Flying foxes (Chiroptera: Pteropodidae): Threatened animals of key ecological and economic importance. *Conservation Biology* 5: 455–463; http://dx.doi.org/10.1111/j.1523-1739.1991.tb00352.x

Kerth, G. & K. Reckardt (2003). Information transfer about roosts in female Bechstein's bats: an experimental field study. *Proceeding Royal Society B* 270: 511–515; http://dx.doi.org/10.1098/rspb.2002.2267

Koilraj, B., G. Agoramoorthy & G. Marimuthu (2001). Copulatory behaviour of Indian Flying Fox *Pteropus giganteus*. *Current Science* 80(1): 15–16

Kunz, T.H. (1982). Roosting ecology of bats, pp. 1–55. In: Kunz, T.H. (ed.). *Ecology of Bats*. Plenum Press, New York.

Lekagul, B. & J.A. McNeeley (1977). *Mammals of Thailand*. Shankarnbhat, Bangkok, 758pp.

Maruthupandian, J. & G. Marimuthu (2013). Cunnilingus apparently increases duration of copulation in the Indian Flying Fox *Pteropus giganteus*. *PLos One* 8(3): e59743; http://dx.doi.org/10.1371/journal.pone.0059743

Marshall, A.G. (1983). Bats, flowers and fruit: evolutionary relationships in the Old World. *Biological Journal of the Linnean Society* 20: 115–136; http://dx.doi.org/10.1111/j.1095-8312.1983.tb01593.x

Marshall, A.G. (1985). Old World phytophagous bats (Megachiroptera) and their food plants: a survey. *Zoological Journal of the Linnean Society* 83: 351–369; http://dx.doi.org/10.1111/j.1096-3642.1985.tb01181.x

Neuweiler, G. (2000). *The Biology of Bats*. Oxford University board. Oxford, United Kingdom, 310pp.

O'Farrell, M.J., E.H. Studier & W.G. Ewing (1971). Energy utilization and water requirements of captive *Myotis thysanodes* and *Myotis lucifugus* (Chiroptera). *Comparative Biochemical Physiology* 39A: 549–552.

Pierson, E.D. & W.E. Rainey (1992). The biology of flying foxes of the genus *Pteropus* a review, pp. 1-17. In: Wilson, D.E. & G.L. Graham (eds.). *Pacific Island Flying Foxes. Proceeding of an international Conservation Conference*. USFWS Biological Report Series 90, Washington D.C.

Rainey, W.E. & E.D. Pierson (1992). Distribution of Pacific island flying foxes, pp. 111–121. In: Wilson, D.E. & G.L. Graham (eds.). *Pacific Island Flying Foxes. Proceeding of an international Conservation Conference*. USFWS Biological Report Series 90, Washington D.C.

Richards, G., L. Hall & S. Parish (2012). *A Natural History of Australian Bats: Working the Night Shift*. CSIRO publishing, Collinwood, Victoria, Australia, 184pp

Richmond, J.Q., S.A. Banack & G.S. Grant (1998). Comparative analysis of wing morphology flight behaviour and habitat use in flying foxes (Genus: *Pteropus*). *Australian Journal of Zoology* 46: 283–289; http://dx.doi.org/10.1071/ZO97059

Robinson, K.W. & P.R. Morrison (1957). The reaction to hot atmospheres of various species of Australian marsupial and placental mammals. *Journal of Cellular and Comparative Physiology* 49: 455–478.

Senthilkumar, K. & G. Marimuthu (2012). Tree roosting fruit bat (Chiroptera: Pteropodidae) in southern Tamil Nadu. *International Journal of Applied Bioresearch* 14: 4–10.

Taylor, D.A.R. & M.D. Tuttle (2007). Water for wildlife. Bat Conservation International 1–17. Wilkinson S.G. 1986. Social grooming in the common vampire bat, *Desmodus rotundus*. *Animal Behaviour* 34: 1880–1889.

Welbergen, A.J., S.M. Klose, N. Markus & P. Eby (2008). Climate change and the effects of temperature extremes on Australian flying-foxes. *Proceeding of Royal Society B* 275: 419–425; http://dx.doi.org/10.1098/rspb.2007.1385

Wilkinson, S.G. (1986). Social grooming in the Common Vampire Bat, *Desmodus rotundus*. *Animal Behaviour* 34: 1880–1889; http://dx.doi.org/10.1016/S0003-3472(86)80274-3

Journal of Threatened Taxa

OPEN ACCESS

ISSN 0974-7907 (Online); ISSN 0974-7893 (Print)

February 2016 | Vol. 8 | No. 2 | Pages: 8421–8540
Date of Publication: 26 February 2016 (Online & Print)
DOI: 10.11609/jott.2016.8.2.8421–8540
www.threatenedtaxa.org

zooh! ZÜRICH

WILD ZOO Threatened Taxa