NORTHERN PALM SQUIRREL

Thermoregulatory behaviours of *Funambulus pennantii* in Rajasthan, India

A small group of Northern Palm Squirrels basking on a tree trunk during winter in Keoladeo Ghana National Park, Rajasthan, India (© Swati Kittur)

IUCN Red List:
Least Concern (Nameer & Molur 2016)

Mammalia
[Class of mammals]

Rodentia
[Order of rodents]

Sciuridae
[Family of true squirrels]

Funambulus pennantii
[Northern Palm Squirrel]

Species described by Wroughton in 1905

Squirrels maintain their core body temperature at approximately 37–38 ^{0}C. As a result, body temperature maintenance is the primary thermoregulatory problem for many squirrels, especially in areas where the ambient temperature varies daily or seasonally (Walsberg 2000). Heat and energy regulation can vary due to pelage colouration in some species (Rowland 2009). Squirrels have developed physiological adaptations to enable body heat to remain optimal against suboptimal ambient temperatures (Muchlinski et al. 1998; Dausmann et al. 2013). Northern Palm Squirrels (NPS), *Funambulus pennantii*, have a classic pelage with countershading (with the darker side exposed most to lighting; Rowland 2009) that suggests a strong camouflage function. In this note, two behavioural observations of NPS are described,

one of which suggests that countershading also has a thermoregulatory function, while the other is a novel thermoregulatory behaviour for the species.

NPS is widely distributed in northern India ranging from the dry Thar Desert in Rajasthan State to the subtropical and wet lower Himalaya (Thorington et al. 2012). In Rajasthan, they are exposed to strong daily and seasonal variations in temperatures, ranging from -5^{0}C in winter to about 50^{0}C in summer (Prakash & Ghosh 1975; Prakash 1997; Sikka 1997; Sharma et al. 2013). NPS are semi-arboreal and inhabit a range of habitats; they are strongly synanthropic even in large cities (Prater 2005). NPS are, therefore, exposed to a very large range of temperatures due to seasonal and environmental conditions, and thermoregulation is likely a very important component of the species' survival. Here we provide two behaviours where the dorsal and ventral sides were used in different seasons in different ways for thermoregulation.

Global Distribution: Native: Iran, Afghanistan, Pakistan, Northern India, Nepal and Bangladesh (Nameer & Molur 2016)

In the Keoladeo Ghana National Park (27.355N & 74.641E), Bharatpur District, Rajasthan, on several occasions over two decades (1998–2018), we observed small groups of NPS basking in the morning and afternoon sun during winter (November–February). NPS basked on tree trunks, head down, splaying their feet with their dorsal side facing the sun. Some individuals were observed basking for over an hour, especially in the coldest months (January & February; 10–16 ^{0}C). Frequently, three to five NPS huddled together during the basking bouts.

One observation was made on 25 June 2017 of a NPS apparently cooling itself on damp soil that was shaded by the canopy of a clump of *Prosopis juliflora* trees. This observation was made while birding in Nehru Talai Wetland (25.355N & 74.641E) in Bhilwara, Rajasthan. The NPS was lying down flat on the ground splaying its limbs such that the entire ventral surface of its body, limbs, and tail were in contact with

A Northern Palm Squirrel cooling itself on damp soil during summer in Rajasthan, India (© Anil Tripathi).

the ground. The ground was damp and was beside a temple at a site where pilgrims washed their hands. The squirrel was disturbed only momentarily when pilgrims used the area and quickly ran back to the damp ground to lay down flat after the pilgrims left. The ambient temperature during the observation was 40^{0}C and a few rain showers on the preceding days had created a very humid condition.

Squirrels in cold areas were observed to use a variety of tactics to maintain their optimal body temperature, including basking, huddling, and torpor (Mills & Hes 1997; Thorington & Ferrell 2006; Angilletta 2009). Observations on NPS in the Keoladeo-Ghana National Park suggest that basking is a very common thermoregulatory behaviour during winter in this species. Countershading appears to be important in maximizing winter thermoregulation in the species while basking.

Squirrels are assumed to avoid heat stress by remaining in shaded areas and increasing foraging bouts during the coolest hours of the day (Wilson & Ruff 1999), while daily torpor (Angilletta 2009), use of tail (Fick et al. 2009), reducing midday activity (Bennett et al. 1984), and use of burrows at midday (Angilletta 2009) were also reported for many squirrel species from hot areas. Thermoregulatory behaviours in NPS are poorly documented from southern Asia. Basking appears to be a very common and widespread behaviour, but documentation from different areas and seasons is missing. Using damp soil to cool the body is a novel observation for the NPS. A similar behaviour, however, is known from desert-dwelling squirrels that dig shallow pits in wet soil to cool themselves. Like the observed NPS, some arboreal squirrels are known to use cool surfaces such as rocks in shade and tiles in homes to help dissipate body heat when the ambient temperature is high (Thorington & Ferrell 2006). Our observation shows that the diversity of ways in which squirrels cool themselves are likely to be higher than those currently known. More observations on NPS during the hot summer and cool winter months are likely to yield other overlooked behaviours that can aid in understanding the natural history of the species.

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