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ORIGINAL PAPER

Effects of reproductive status and high ambient temperatures on the body temperature of a free-ranging basoendotherm

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Abstract Tenrecs (Order Afrosoricida) exhibit some of the lowest body temperatures (T_b) of any eutherian mammal. They also have a high level of variability in both active and resting T_bs and, at least in cool temperatures in captivity, frequently employ both short- and long-term torpor. The use of heterothermy by captive animals is, however, generally reduced during gestation and lactation. We present data long-term T_b recordings collected from free-ranging *S. setosus* over the course of two reproductive seasons. In general, reproductive females had slightly higher (~32 °C) and less variable T_b, whereas non-reproductive females and males showed both a higher propensity for torpor as well as lower (~30.5 °C) and more variable rest-phase T_bs. Torpor expression defined using traditional means (using a threshold or cut-off T_b) was much lower than predicted based on the high degree of heterothermy in captive tenrecs. However, torpor defined in this manner is likely to be underestimated in habitats where ambient temperature is close to T_b. Our results caution against inferring metabolic states from T_b alone and lend support to the recent call to define torpor in free-ranging animals based on mechanistic and not descriptive variables. In addition, lower variability in T_b observed during gestation and lactation confirms that homeothermy is essential for reproduction in this species and probably for basoendothermic mammals in general. The relatively low costs of maintaining homeothermy in a sub-tropical environment might help shed light on how homeothermy could have evolved incrementally from an ancestral heterothermic condition.

Keywords Evolution of endothermy · Parental care · Thermoregulation · Reproduction · Heterothermy · Torpor · Madagascar · Tropics · *Setifer setosus* · Tenrec

Abbreviations

T_a	Ambient temperature measured via a black body apparatus
T_b	Core body temperature
T_{soil}	Ambient temperature measured at a depth of 250 mm below the surface
T_{tree}	Ambient temperature measured in a tree cavity
ΔT	Temperature differential ($T_b - T_a$)
T_{bmax}	Average of the 5 highest T_b data for each day
T_{bmin}	Average of the 5 lowest T_b data for each day
ΔT_b	Difference between the daily maximum and minimum T_b

Introduction

The reconstructed mammalian ancestor is postulated to have been small bodied, nocturnal and insectivorous (Crompton et al. 1978; Luo 2007; Gerkema et al. 2013; O'Leary et al. 2013), and is hypothesised to have possessed the capacity for prolonged periods of metabolic downregulation, torpor (Lovegrove 2012a). The plesiomorphy of

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