Measuring Thermal Profile of Reptiles in Laboratory and Field

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Introduction

Studying and measuring thermo-regulatory behavior of reptiles is central to understanding many aspects of their life history including but not limited to their growth rates [1, 2], physiological performance [3], reproductive patterns [4, 5, 6]. Monitoring thermal profiles and thermo-regulatory behavior of reptiles is becoming crucial for understanding impact of climate change on various species of reptiles and also for predicting whether they will adapt to local warming trends or not. Recently Sinervo et al. [7] reported reduction of lizard biodiversity due to local warming trends and altered thermal niches. The study also proposed a mathematical model to predict local extinctions of lizard populations. Data on thermal profiles of lizards is a crucial parameter for validating such models [7]. We have developed a simple, yet comprehensive approach to measure thermal profile of lizards in laboratory as well as in field. This protocol allows us to continuously monitor thermal profiles of lizards for extended periods of time for getting picture of their thermal microhabitats and thermo-regulatory behavior in unprecedented details.

Laboratory measurements

We monitor body temperature (Tb) of lizards in the lab continuously for two hours using T type thermocouple probes attached to an automated data logger (Eltek Squirrel model 1035). The ultra-thin probe is inserted in the cloaca or taped to lizard's belly during the run. The length of the wire attached is long enough to allow the lizard free movement in the laboratory thermal gradient. This method of continuous monitoring gives us a time-series of Tb with fine resolution (1 min.) for lizards instead of snapshots as done in earlier studies. The automated recording reduces amount of handling time which can influence Tb measurements. A detailed picture of movements of lizards in the thermal gradient and how they actively regulate their Tb emerges from the continuous record. From these data we can calculate temperature preference (Tp) and time spent at various temperatures. This method is safe for monitoring gravid females as well. In addition to monitoring adult lizards, this method can be adopted for estimating Tp of small hatchlings by attaching the probe to their ventral surface. The cloacal and belly temperature readings are comparable (data not shown). We, thus, successfully monitored Tb for both adult and hatchling lizards and calculated heritability of Tp (Paranjpe et al., in preparation). The Tb monitoring set up of data logger, probes and particle board tracks with lamps for creating thermal gradient is simple and portable enough to be used in field as well (see Figure 1). The lamps can potentially be replaced with

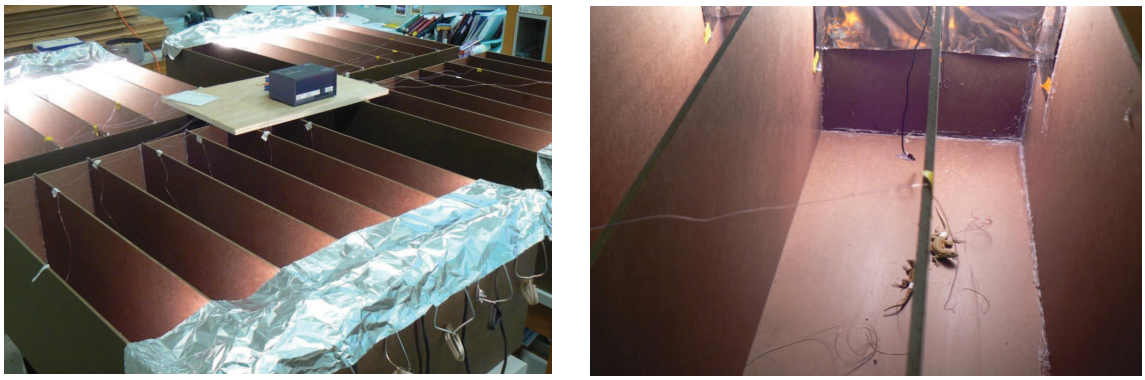

Figure 1. Experimental set up for recording Tb in laboratory using Eltek squirrel automated data logger. Up to 24 lizards can be recorded simultaneously in parallel tracks which are illuminated using lamps to create thermal gradients.

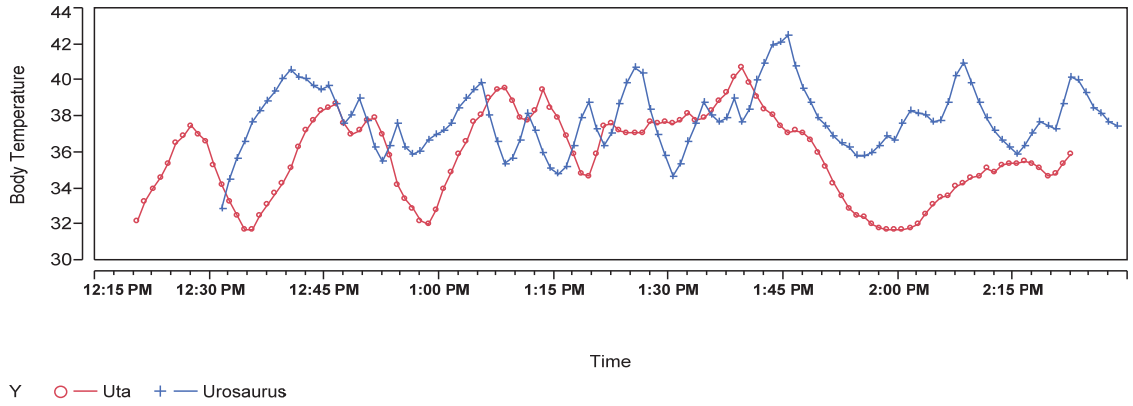

Figure 2. Body Temperature data of two species of lizards recorded using Eltek squirrel automated data logger.

heating tapes in the laboratory if we need to separate the effects of light and heat on Tb. We can record Tb of 24 lizards simultaneously using this set up. We have monitored Tb of various species such as *Uta stansburiana*, *Urosaurus*, *Elgaria* (see Figure 2) using varying lengths and thickness of the T type probe wires without causing any harm to the lizards.

Field measurements

To supplement this information with actual thermal niches available in the field we deploy external temperature data loggers in various lizard habitats. The HOBO external temperature data loggers (hobos henceforth) have two probes for measuring surrounding temperature. Each probe is embedded inside a lizard model made from PVC pipe of appropriate length and diameter, painted to mimic the lizard species under investigation. The hobos along with the lizard models are then deployed to actual habitats such that one of the probes is in the sunniest part while the other one is in the shaded part of the microhabitat. The data are gathered every minute or at longer intervals depending on how long we want to record the external temperature. With periodic download of data we were able to record detailed temperature profile of lizard's microhabitat year around. Using these detailed temperature profiles we could estimate not only the range of temperatures available for thermo-regulation but also the number of hours the lizards could be actually active (h restriction) in their micro-habitat. Such estimates are crucial for predicting potential extinction of the populations. In addition to hobos, we also use custom built "web" with type E thermocouple probes to monitor temperature of micro-habitats at even finer scale. The web consists of 6 radial arms each with 9 probes extending out attached to a data logger and multiplex reading board. Each of these probes has a lizard model attached that is placed in various attributes of a selected lizard territory. Models are placed in bushes and burrows, on rocks, trees and logs etc. so that recorded operative temperatures give a thorough representation of all available sites that can be used for behavioral thermoregulation. The web can also be adopted to monitor temperature of snakes and even amphibian models (Bufo sp.) in field.

Summary

This is a simple yet effective method of monitoring temperature profiles of lizards. The comprehensive approach of laboratory and field Tb monitoring gives a detailed picture of thermo-regulatory behavior in various lizard species. This approach can go a long way in gathering extensive data with relative ease for predicting effects of climate change on various species. Note: All protocols involving live animals were approved by Institutional Animal Care and Use Committee (IACUC).

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