DETERMINING RECAPTURE PROBABILITY OF FREE-RANGING WOOD MOUSE USING INFRARED THERMOGRAPHY

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INTRODUCTION

Rodents' physiological response to emotions experienced during stressful stimuli is characterized by elevated core body temperature (T_b) and is frequently associated, with radiated heat loss from their thermoregulatory body anatomical regions (Vinkers *et al*., 2009). Measuring T_b is challenging due to the invasiveness of common techniques (McCafferty *et al*., 2015). Estimating heat loss from the non-insulating areas can be used as a proxy of handling stress and can be detected via non-invasive methods, such as infrared thermography (IRT) (Tattersall & Cadena, 2010). Although IRT has been systematically used to detect stress in captive or laboratory animals, only a few studies have been performed in the wild. In this study, we estimated changes in the surface temperature of a free-ranging small mammal, the Wood Mouse, *Apodemus sylvaticus*. Our hypothesis is that the mild stressful challenge in first capture occasions, estimated non-invasively with IRT, can explain recapture probability.

MATERIALS & METHODS

Trapping: Wood mice were live-trapped using standard-sized collapsible Sherman traps (LFATDG, 7.6 x 8.9 x 22.9 cm) at two sites in the island of Lesvos, Greece. At each site, trapping was carried out over two periods of five consecutive nights, with a week's interval in between. Traps were activated 30 minutes before sunset and inspected before sunrise.

Experimental procedure: Each animal was subjected to a fixed handling procedure, taking a series of body measurements (Phase 1), followed by a five-minute stay in a large wooden box (Phase 2) in order to overcome the previous stressful challenges. Thermal images were taken at intervals throughout the procedure (**Figure 1, Figure 2**).

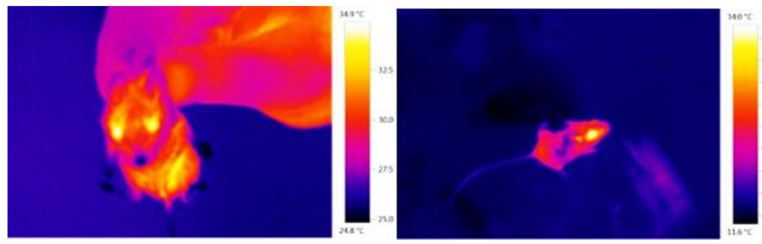

Figure 1: Sample of a thermal image of an *A. sylvaticus.* Left: during handling, Right: in the dark box, before release.

Figure 2: Process of obtaining surface temperature values of an *A. sylv*aticus during the two phases, in field conditions.

Thermal image processing: The raw thermal images were calibrated and processed using the TESTO IRSoft® software (v. 4.3), according to meteorological data obtained from the field sites. Subsequently, the area of interest for six thermoregulatory regions (eye, ear, nose, feet, tail, and body) of each animal was separated from the background.

Thermal image analysis: To estimate the potential differentiation of the physiological state of each animal due to the handling procedure, the study of extreme temperature values for both phases was required. Thus, for each of the six body regions of each animal two maximum temperature values were obtained: the T_{max} during handling and the T_{max} before release. The difference between the (relative) calm state in the wooden box (Phase 2) and the stressed state (Phase 1), i.e., $\Delta T_{max} = T_{max}$ (Handling) - T_{max} (Releasing), was used as an index of the animal's response to acute stress.

RESULTS & DISCUSSION

From the pool of mature individuals we selected those captured only once (n = 8) and those with at least one recapture (n =11). Paired sample t-tests showed statistically significant differences for most regions of the body between the two phases of the experimental procedure (**Table 1**).

Table 1: Descriptive statistics and paired t-tests concerning temperature data from six thermoregulatory anatomical regions of each animal

Anatomical regions	T_{max} (°C) Phase 1	T_{max} (°C) Phase 2	95% CI for Mean Difference	r	t	p - value
Eye	34.4±1.28	31.0±1.92	2.87, 3.92	.842	13.586	.000
Ear	25.5±2.87	24.6±4.19	-.86, 2.61	.530	1.053	ns
Nose	22.9±1.97	24.8±3.62	-2.86, -.89	.898	-4.018	.001
Feet	20.5±2.97	21.9±3.92	-2.63, -.31	.791	-2.681	.015
Tail	23.2±2.86	20.2±3.44	2.11, 3.89	.846	7.119	.000
Body	27.0±3.18	29.0±2.04	-3.06,-.83	.686	-3.673	.002

We used a binary logistic regression to test the hypothesis that the physiological response to capture and handling affects recapture probability. The ΔT_{max} of all anatomical regions of each animal were used as predictor variables; final models were reached with backward stepwise elimination. Nagelkerke's R^2 was used as an indication of the amount of variation explained by the model while the overall significance of the model was tested with the Hosmer & Lemeshow goodness of fit test. To assess the discrimination ability of the model, a classification table of observed and predicted values regarding the capture probability was computed and evaluated by receiver operating characteristic (ROC) curve analysis (**Figure 3**).

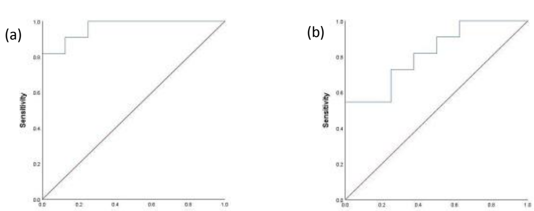

Figure 3: ROC curve analysis of the different anatomical regions of *A. sylvaticus*: (a) ΔT_{max} of *A. sylvaticus* eyes - AUC = .966, S.E. =.036, 95% CI .895-1.000, p = .001; (b) ΔT_{max} of *A. sylvaticus* body - AUC = .818, S.E. =.097, 95% CI .628-1.000, p = .021.

Results showed that the BLR model identified ΔT_{eye} as the most important factor which best separates recaptured from non-recaptured individuals (**Table 2a**, p < .05), followed by ΔT_{body} (**Table 2b**, p < .05), with a predicted classification accuracy of 89.5% and 73.7 respectively. The models explains 78.7% of the total variance for ΔT_{eye} and 46.2% of the total variance for ΔT_{body} (**Table 2a, 2b**).

Table 2: Logistic regression models for estimating recapture propability. B = logistic coefficient; S.E. = standard error of estimate; Wald = Wald chi-square; df = degrees of freedom; sig. = significance; e^B = exponentiated coefficient.

a. Predictor	B	S.E.	Wald's χ^2	df	Sig.	e^B (odds ratio)	95% CI for EXP(B)
ΔT_{eye}	-2.34	1.01	5.28	1	.021	.096	.01, .70
Constant	13.47	5.96	5.11	1	.024	712407.1	
b. Predictor	**B**	**S.E.**	**Wald's χ^2**	**df**	**Sig.**	**e^B (odds ratio)**	**95% CI for EXP(B)**
ΔT_{body}	.69	.37	3.42	1	.064	1.99	.96, 4.15
Constant	2.85	1.56	3.32	1	.068	17.37	

In conclusion, changes in the surface temperature of *Apodemus sylvaticus* during a stressful challenge in first capture occasions (a) can sufficiently explain its recapture probability as individuals with higher ΔT were less likely to be trapped again, (b) provides remarkable insights into the effects of handling procedures and (c) can lead to a standardized sampling protocol for handling rodents. This study provides a primary assessment of the importance of small mammals' thermal window measurements in the field, in order to assess the effect of handling stress in the capture occasions.

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