# Thermal acclimatisation to heatwave conditions is rapid but sex-specific in wild zebra finches

# Supplementary information

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## Identification of the upper critical limit of thermoneutrality ($T_{uc}$)

We investigated thermoregulatory variables (MR, EWL, EHL/MHP and $T_b$) as a function of increasing $T_{a\text{-}chamb}$ over the entire range. We determined if there was a significant inflection point for each of these variables, using the *Davies test* and *segmented* functions from the *segmented* R package (Muggeo, 2008).

We obtained almost identical values for inflection points for MR at $T_{a\text{-}chamb}$=37.6±1.2°C and EWL at 37.8±0.4°C. Inflection points for EHL/MHP and $T_b$ were about one degree lower ($T_{a\text{-}chamb}$=36.8±0.7°C and 36.9±1°C, respectively, Figure S1).

## Supplementary figures

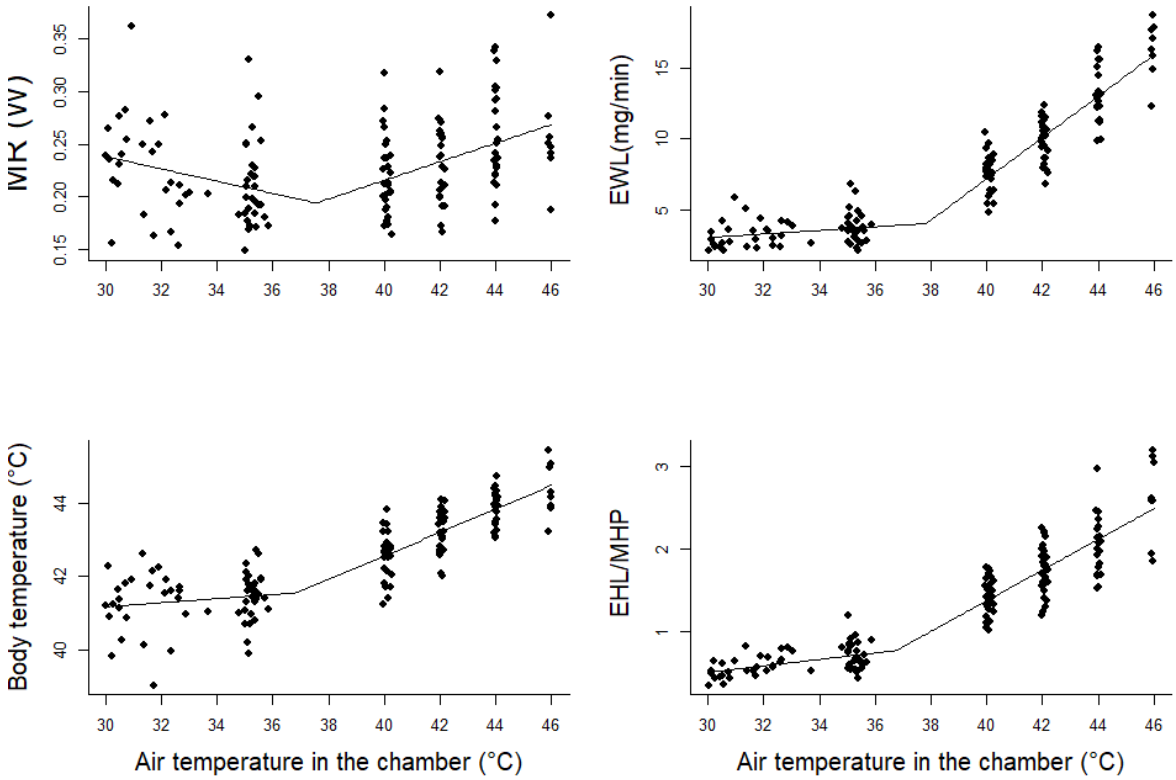


***Figure S1: Broken line regressions as a function of air temperature in the chamber, above and below inflection points, for metabolic rate (MR), evaporative water loss (EWL), body temperature ($T_b$) and evaporative cooling capacity (EHL/MHP).*** *Regressions lines were estimated from the segmented function.*

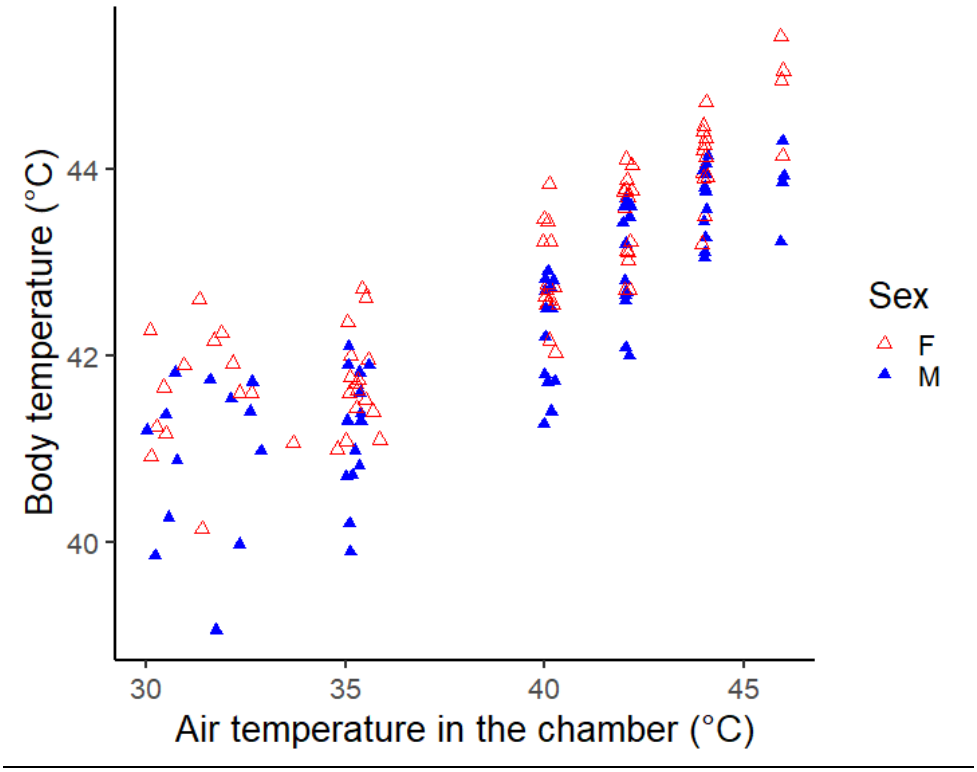


***Figure S2: Body temperature $T_b$ as a function of air temperature in the metabolic chamber.*** *Colours correspond to the sexes (open red triangles: females; filled blue triangles: males). Females had a higher $T_b$ than males both below and above the $T_{uc}$ (see main text).*

## Supplementary tables

### 1. Method tables

| **Model set** |
|---|
| *0. Null model* |
| *Base model* |
| 1. Mass + $T_{a\text{-}chamb}$ + capture time |
| *Effects of temperatures at different timescales* |
| *2.* base model + $T_{0day}$ |
| *3.* base model + $T_{\text{-}1day}$ |
| *4.* base model + $T_{\text{-}3days}$ |
| *5.* base model + $T_{\text{-}1week}$ |
| *6.* base model + $T_{\text{-}2weeks}$ |
| *Effects of short term temperature deviation* |
| *7. base model* + $\Delta T_{0\text{-}1}$ + $T_{0day}$ |
| *8.* base model + $\Delta T_{1\text{-}2}$ + $T_{\text{-}day1}$ |
| *Effects of sex* |
| *S1-S8. Models 1 – 9 + sex* |

***Table S1: Description of the model set used to identify the best predictors explaining variation in heat tolerance and thermal physiology***.

## 2. Result tables

***Whole dataset***
***Base model selection***

| **Thermoregulatory variables** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | ***Below the $T_{uc}$*** | | | | ***Above the $T_{uc}$*** | | | |
| | ***Best base model*** | *df* | *LL* | *AICc* | *w* | *df* | *LL* | *AICc* | *w* |
| **MR** | Null | 3 | 103.7 | -201.0 | 0.795 | - | - | - | - |
| | $T_{a\text{-}chamb}$ | - | - | - | - | 4 | 172.2 | -366.0 | 0.955 |
| **EWL** | Mass | 4 | -79.2 | 167.3 | 0.380 | - | - | - | - |
| | $T_{a\text{-}chamb}$ + mass | - | - | - | - | 5 | -136.9 | 284.5 | 0.653 |
| **$T_b$** | $T_{a\text{-}chamb}$ | 4 | -49.6 | 108.0 | 0.376 | 4 | -40.2 | 88.8 | 0.639 |
| **EHL/MHP** | Null | 3 | 20.1 | -33.8 | 0.524 | - | - | - | - |
| | $T_{a\text{-}chamb}$ | - | - | - | - | 4 | -0.142 | 8.8 | 0.735 |
| **Heat tolerance** | | | | | | | | | |
| | | *df* | | *LL* | | *AICc* | | *w* | |
| **$T_{a\text{-}max}$ = 46°C (yes/no)** | Capt. time | 3 | | -19.76 | | 46.4 | | 0.363 | |
| **Trial completion** | Capt. time | 3 | | -19.58 | | 46.1 | | 0.425 | |

***Table S2: Base model selection (before adding weather predictors): best base model explaining metabolic rate (MR), evaporative water loss (EWL), body temperature ($T_b$), evaporative cooling capacity (EHL/MHP) above and below the $T_{uc}$ (n=29 birds), and heat tolerance variables on the full dataset (n=31).*** *The covariates mass, $T_a$ and capture time (Capt. time) were considered.*

***February-only data (no seasonal variation)***
***Base model selection***

| **Thermoregulatory variables** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | ***Below the $T_{uc}$*** | | | | ***Above the $T_{uc}$*** | | | |
| | ***Best base model*** | *df* | *LL* | *AICc* | *w* | *df* | *LL* | *AICc* | *w* |
| **MR** | Null | 3 | 66.7 | -126.7 | 0.848 | - | - | - | - |
| | $T_{a\text{-}chamb}$ | - | - | - | - | 4 | 122.2 | -325.6 | 0.965 |
| **EWL** | $T_{a\text{-}chamb}$ + mass | 5 | -53.8 | 119.4 | 0.360 | 5 | -92.9 | 196.9 | 0.605 |
| **$T_b$** | $T_{a\text{-}chamb}$ | 4 | -35.1 | 79.4 | 0.564 | 4 | -22.1 | 52.9 | 0.715 |
| **EHL/MHP** | $T_{a\text{-}chamb}$ | 4 | 12.1 | -14.9 | 0.701 | 4 | 8.3 | -7.9 | 0.739 |
| **Heat tolerance** | | | | | | | | | |
| | | *df* | | *LL* | | *AICc* | | *w* | |
| **$T_{a\text{-}max}$ = 46°C (yes/no)** | NULL | 2 | | -14.01 | | 32.7 | | 0.602 | |
| **Trial completion** | NULL | 2 | | -14.01 | | 32.7 | | 0.607 | |

***Table S3: Base model selection (before adding weather predictors): best base model explaining metabolic rate (MR), evaporative water loss (EWL), body temperature ($T_b$), evaporative cooling capacity (EHL/MHP) above and below the $T_{uc}$ during February 2020 and 2021 (n=19 birds), and heat tolerance variables on the February dataset (n=21).*** *The covariates mass, $T_a$ and capture time (Capt. time) were considered.*

## *February-only data*
## *Weather predictor effects*

### Thermoregulatory variables

| | | *Below the $T_{uc}$* | | | | | *Above the $T_{uc}$* | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Metabolic rate** | ***(A)** Model* | *df* | *LL* | *AICc* | *ΔAICc* | *w* | *df* | *LL* | *AICc* | *ΔAICc* | *w* |
| | Null | 3 | 66.7 | -126.7 | 0 | 0.827 | | | | | |
| | $+T_{-1day}$ | | | | | | 5 | 123.8 | -236.4 | 0 | 0.545 |
| | Base | | | | | | 4 | 122.2 | -235.6 | 0.7 | 0.376 |
| | ***(B)** Predictors* | *Est.* | | *SE* | *CI* | | *Est.* | | *SE* | *CI* | |
| | *Intercept* | 0.222 | | 0.010 | **0.20 ; 0.24** | | 0.238 | | 0.007 | **0.22; 0.25** | |
| | $T_{a\text{-}chamb}$ | | | | | | 0.039 | | 0.005 | **0.03; 0.05** | |
| | $T_{\text{-}1day}$ | -0.043 | | 0.012 | **-0.07 ; -0.02** | | -0.042 | | 0.012 | **-0.07; -.0.02** | |
| **Evaporative water loss** | ***(A)** Model* | *df* | *LL* | *AICc* | *ΔAICc* | *w* | *df* | *LL* | *AICc* | *ΔAICc* | *w* |
| | Base | 5 | -53.8 | 119.4 | 0 | 0.182 | | | | | |
| | $+T_{0day}$ | 6 | -52.7 | 120.2 | 0.7 | 0.127 | | | | | |
| | $+T_{-1week}$ | 6 | -53.0 | 120.7 | 1.3 | 0.097 | | | | | |
| | $+ T_{-1day}$ | 6 | -53.0 | 120.7 | 1.3 | 0.095 | | | | | |
| | $+T_{-2weeks}$ | 6 | -53.1 | 120.9 | 1.4 | 0.089 | | | | | |
| | $+ T_{-3days}$ | 6 | -53.1 | 120.9 | 1.5 | 0.086 | | | | | |
| | $+T_{-1week}$ + sex | | | | | | 7 | -88.0 | 192.2 | 0 | 0.315 |
| | ***(B)** Predictors* | *Est.* | | *SE* | *CI* | | *Est.* | | *SE* | *CI* | |
| | *Intercept* | 3.449 | | 0.190 | **3.06 ; 3.84** | | 10.486 | | 0.249 | **10.03 ; 10.94** | |
| | *mass* | 1.178 | | 0.405 | **0.35; 2.00** | | 1.631 | | 0.482 | **0.75; 2.51** | |
| | $T_{a\text{-}chamb}$ | 0.157 | | 0.051 | **0.05; 0.26** | | 5.406 | | 0.262 | **4.87; 5.91** | |
| | $T_{0day}$ | -0.591 | | 0.409 | -1.42 ; 0.24 | | | | | | |
| | $T_{\text{-}1week}$ | -0.496 | | 0.382 | -1.27; 0.28 | | | | | | |
| | $T_{\text{-}1day}$ | -0.498 | | 0.409 | -1.33; 0.33 | | | | | | |
| | $T_{\text{-}2weeks}$ | 0.469 | | 0.389 | -0.32; 1.26 | | | | | | |
| | $T_{\text{-}3days}$ | -0.455 | | 0.386 | -1.24; 0.33 | | | | | | |
| | $T_{\text{-}1week}$ | | | | | | -1.190 | | 0.503 | **-2.11; -.027** | |
| | *Sex* | | | | | | 1.250 | | 0.505 | **0.32; 2.18** | |
| **Evaporative cooling capacity** | ***(A)** Model* | *df* | *LL* | *AICc* | *ΔAICc* | *w* | *df* | *LL* | *AICc* | *ΔAICc* | *w* |
| | Base | 4 | 12.1 | -14.9 | 0 | 0.571 | 4 | 8.3 | -7.9 | 1.9 | 0.103 |
| | $+T_{0day}$ | | | | | | 5 | 10.4 | -9.7 | 0 | 0.263 |
| | $+\text{-}T_{-1day}$ | | | | | | 5 | 10.1 | -9.0 | 0.7 | 0.183 |
| | $+T_{-1day}$ + sex | | | | | | 6 | 11.3 | -9.0 | 0.8 | 0.179 |
| | ***(B)** Predictors* | *Est.* | | *SE* | *CI* | | *Est.* | | *SE* | *CI* | |
| | *Intercept* | 0.6426 | | 0.029 | **0.57; 0.68** | | 1.764 | | 0.056 | **1.65; 1.88** | |
| | $T_{a\text{-}chamb}$ | | | | | | 0.636 | | 0.036 | **0.56; 0.71** | |
| | $T_{0day}$ | | | | | | 0.308 | | 0.110 | **0.09; 0.53** | |
| | $T_{\text{-}1day}$ | | | | | | 0.309 | | 0.106 | **0.10; 0.52** | |
| | *sex* | | | | | | 0.245 | | 0.103 | **0.04; 0.45** | |

| | *(A) Model* | *df* | *LL* | *AICc* | *ΔAICc* | *w* | *df* | *LL* | *AICc* | *ΔAICc* | *w* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Body temperature** | +sex | 5 | -32.9 | 77.7 | 0 | 0.198 | 5 | -20.6 | 52.3 | 0 | 0.218 |
| | $+T_{0day}$ + sex | 6 | -31.7 | 78.2 | 0.5 | 0.154 | | | | | |
| | $+T_{-2weeks}$ + sex | 6 | -32.3 | 79.3 | 1.6 | 0.090 | 6 | -20.1 | 54.0 | 1.7 | 0.095 |
| | $+T_{0day}$ | 5 | -33.7 | 79.3 | 1.6 | 0.090 | | | | | |
| | Base | 4 | -35.1 | 79.4 | 1.7 | 0.083 | 4 | -22.1 | 52.9 | 0.6 | 0.164 |
| | $+T_{-1week}$ + sex | 6 | -32.4 | 79.5 | 1.8 | 0.079 | | | | | |
| | $+T_{-1day}$ + sex | | | | | | | | | | |
| | ***(B)** Predictors* | *Est.* | | *SE* | *CI* | | *Est.* | | *SE* | *CI* | |
| | *Intercept* | 41.318 | | 0.160 | **40.99; 41.64** | | 43.254 | | 0.108 | **43.04; 43.47** | |
| | $T_{a\text{-}chamb}$ | 0.078 | | 0.19 | **0.04; 0.12** | | 1.357 | | 0.062 | **1.23; 1.48** | |
| | *Sex* | -0.721 | | 0.316 | **-1.36; -.0.08** | | -0.447 | | 0.208 | **-0.86; -0.03** | |
| | $T_{0day}$ | -0.561 | | 0.323 | -1.22; 1.10 | | | | | | |
| | $T_{-2weeks}$ | 0.418 | | 0.317 | -0.23; 1.06 | | 0.307 | | 0.207 | -0.11; 0.72 | |
| | $T_{-1week}$ | 0.386 | | 0.322 | -0.27; 1.04 | | | | | | |

***Table S4: (A) Top model set (ΔAICc≤2 from best model), and (B) model-averaged estimates of predictors included in the top models, explaining variation in metabolic rate, evaporative water loss, evaporative cooling capacity and body temperature, below and above $T_{uc}$ on the February dataset (n=19 birds).*** *A predictor has a significant effect (bold) if CI excludes 0. Female is the reference group for sex. Abbreviations: 'df': degree of freedom, 'LL': log-likelihood, 'ΔAICc': difference in AICc scores between the best model and the model being compared, 'w': model weight, 'Est.': parameter estimate, 'SE': standard error, 'CI': 95% confidence interval.*

***February-only data***

***Weather predictor effects***

| **Heat tolerance** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **$T_{a\text{-}max}$ = 46°C (yes/no)** | | | | | **Trial completion** | | | | |
| ***(A)*** | | | | | | | | | | |
| *Models* | *df* | *LL* | *AICc* | *ΔAICc* | *w* | *df* | *LL* | *AICc* | *ΔAICc* | *w* |
| *Null* | **1** | **-13.4** | **28.9** | **0** | **0.207** | **1** | **-13.4** | **28.9** | **0** | **0.194** |
| $+\Delta T_{0\text{-}1}+ T_{0day}$ | **3** | **-11.2** | **29.7** | **0.8** | **0.140** | | | | | |
| $+T_{0day}$ | **2** | **-12.9** | **30.4** | **1.5** | **0.100** | **2** | **-12.8** | **30.3** | **1.3** | **0.100** |
| $+T_{-1week}$ | **2** | **-12.9** | **30.6** | **0.4** | **0.092** | **2** | **-12.4** | **29.5** | **0.6** | **0.145** |
| $+T_{-1day}$ | **2** | **-13.1** | **30.8** | **1.9** | **0.081** | **2** | **-12.6** | **29.9** | **1.0** | **0.118** |
| $+T_{-3days}$ | **2** | **-13.1** | **31.0** | **2.0** | **0.076** | **2** | **-13.0** | **30.6** | **1.7** | **0.084** |
| ***(B)*** | | | | | | | | | | |
| *Predictors* | *Est.* | | *SE* | *CI* | | *Est.* | | *SE* | *CI* | |
| *Intercept* | 0.766 | | 0.510 | -0.30; 1.83 | | -0.737 | | 0.484 | -1.75; 0.28 | |
| $\Delta T_{0\text{-}1}$ | -2.556 | | 1.675 | -6.07; 0.96 | | | | | | |
| $T_{0day}$ | -0.768 | | 1.105 | -3.08; 1.55 | | 1.048 | | 1.027 | -1.10; 3.20 | |
| $T_{-1week}$ | 0.873 | | 0.969 | -1.15; 2.90 | | 1.416 | | 1.107 | -0.90; 3.73 | |
| $T_{-1day}$ | 0.715 | | 0.943 | -1.26; 2.69 | | 1.352 | | 1.250 | -1.10; 3.20 | |
| $T_{-3days}$ | -0.656 | | 1.014 | -2.78; 1.47 | | 0.890 | | 1.052 | -1.31; 3.09 | |

***Table S5: (A) Top model set (ΔAICc≤2 from best model), and (B) model-averaged estimates of predictors included in the top models explaining variation in $T_{a\text{-}max}$ (maximum $T_{a\text{-}chamb}$ reached = 46ºC or less) and trial completion (i.e. stayed 15 minutes at $T_{a\text{-}chamb}$=46°C) on the February dataset (n=21)****. A predictor has a significant effect (bold) if CI excludes 0. Abbreviations as in Table 1.*

## *Male and female datasets*
## *Base model selection*

| Thermoregulatory variables | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | ***Below the $T_{uc}$*** | | | | ***Above the $T_{uc}$*** | | | |
| | ***Best base model*** | *df* | *LL* | *AICc* | *w* | *df* | *LL* | *AICc* | *w* |
| ***MALES*** | | | | | | | | | |
| **MR** | Null | 3 | 50.54 | -94.1 | 0.969 | - | - | - | - |
| | $T_{a\text{-}chamb}$ | - | - | - | - | 4 | 81.30 | -153.5 | 0.866 |
| **EWL** | Null | 3 | -34.42 | 75.8 | 0.428 | - | - | - | - |
| | $T_{a\text{-}chamb}$ + mass | - | - | - | - | 5 | -61.51 | 134.7 | 0.478 |
| **$T_b$** | Null | 3 | -25.21 | 57.5 | 0.477 | - | - | - | - |
| | $T_{a\text{-}chamb}$ | - | - | - | - | 4 | -14.99 | 39.1 | 0.648 |
| **EHL/MHP** | Null | 3 | 11.78 | -16.6 | 0.789 | - | - | - | - |
| | $T_{a\text{-}chamb}$ + mass | - | - | - | - | 5 | 1.65 | 8.4 | 0.689 |
| ***FEMALES*** | | | | | | | | | |
| **MR** | Null | 3 | 50.46 | -94.0 | 0.637 | - | - | - | - |
| | $T_{a\text{-}chamb}$ | - | - | - | - | 4 | 85.45 | -161.9 | 0.580 |
| **EWL** | Mass | 4 | -44.00 | 97.6 | 0.368 | - | - | - | - |
| | $T_{a\text{-}chamb}$ + mass | - | - | - | - | 5 | -71.71 | 155.0 | 0.634 |
| **$T_b$** | Null | 3 | -22.29 | 51.5 | 0.628 | - | - | - | - |
| | $T_{a\text{-}chamb}$ | - | - | - | - | 4 | -22.17 | 53.3 | 0.433 |
| **EHL/MHP** | Null | 3 | 6.97 | -7.0 | 0.811 | - | - | - | - |
| | $T_{a\text{-}chamb}$ | - | - | - | - | 4 | 0.905 | 7.2 | 0.814 |

***Table S6: Base model selection (before adding weather predictors): best base model explaining metabolic rate (MR), evaporative water loss (EWL), body temperature ($T_b$) and evaporative cooling capacity (EHL/MHP) above and below the $T_{uc}$ when considering males (n=14) and females (n=15) separately.*** *The covariates mass, $T_a$ and capture time (Capt. time) were considered.*

## *Male and female datasets*
## *Weather predictor effects*

### Thermoregulatory variables

| | | MALES | | | | | FEMALES | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **METABOLIC RATE** | | | | | | | | | | | |
| **Below the $T_{uc}$** | **(A)** Model | df | LL | AICc | ΔAICc | w | df | LL | AICc | ΔAICc | w |
| | Null | 3 | 50.5 | -94.1 | 0 | 0.829 | 3 | 50.5 | -94.0 | 0.4 | 0.326 |
| | $+T_{-1day}$ | - | - | - | - | - | 4 | 52.0 | -94.4 | 0 | 0.400 |
| | $+T_{-3days}$ | - | - | - | - | - | 4 | 51.3 | -92.9 | 1.4 | 0.194 |
| | **(B)** Predictors | Est. | | SE | CI | | Est. | | SE | CI | |
| | Intercept | 0.214 | | 0.009 | **0.19; 0.23** | | 0.223 | | 0.010 | **0.20 ; 0.24** | |
| | $T_{-1day}$ | - | | - | - | | -0.060 | | 0.017 | **-0.10 ; -0.03** | |
| | $T_{-3days}$ | - | | - | - | | -0.057 | | 0.018 | **-0.09 ; -0.02** | |
| **Above the $T_{uc}$** | **(A)** Model | df | LL | AICc | ΔAICc | w | df | LL | AICc | ΔAICc | w |
| | Base | - | - | - | - | - | 4 | 85.5 | -161.9 | 0 | 0.338 |
| | $+T_{-1day}$ | 5 | 86.5 | -161.3 | 0 | 0.938 | 5 | 85.8 | -160.0 | 1.9 | 0.133 |
| | $+T_{-3days}$ | - | - | - | - | - | 5 | 86.4 | -161.2 | 0.7 | 0.242 |
| | $+T_{-1week}$ | - | - | - | - | - | 5 | 86.3 | -161.0 | 0.9 | 0.212 |
| | **(B)** Predictors | Est. | | SE | CI | | Est. | | SE | CI | |
| | Intercept | 0.231 | | 0.005 | **0.22 ; 0.24** | | 0.241 | | 0.009 | **0.22 ; 0.26** | |
| | $T_{a\text{-}chamb}$ | 0.035 | | 0.007 | **0.02 ; 0.05** | | 0.049 | | 0.007 | **0.04 ; 0.06** | |
| | $T_{-1day}$ | -0.057 | | 0.010 | **-0.08 ; -0.04** | | -0.047 | | 0.016 | **-0.08 ; -0.01** | |
| | $T_{-3days}$ | - | | - | - | | -0.049 | | 0.015 | **-0.08 ; -0.02** | |
| | $T_{-1week}$ | - | | - | - | | -0.048 | | 0.015 | **-0.08 ; 0.02** | |
| **EVAPORATIVE WATER LOSS** | | | | | | | | | | | |
| **Below the $T_{uc}$** | **(A)** Model | df | LL | AICc | ΔAICc | w | df | LL | AICc | ΔAICc | w |
| | Null | 3 | -34.4 | 75.8 | 0.2 | 0.247 | 3 | -46.0 | 99.0 | 1.4 | 0.129 |
| | Base | - | - | - | - | - | 4 | -44.0 | 97.6 | 0 | 0.255 |
| | $+T_{-2weeks}$ | 4 | -33.0 | 75.7 | 0 | 0.268 | - | - | - | - | - |
| | $+T_{-1week}$ | 4 | -33.3 | 76.3 | 0.6 | 0.195 | - | - | - | - | - |
| | $+T_{-1day}$ | - | - | - | - | - | 5 | -43.0 | 98.6 | 1.0 | 0.156 |
| | $+T_{-3days}$ | - | - | - | - | - | 5 | -43.4 | 99.3 | 1.7 | 0.111 |
| | **(B)** Predictors | Est. | | SE | CI | | Est. | | SE | CI | |
| | Intercept | 3.301 | | 0.194 | **2.90 ; 3.70** | | 3.619 | | 0.240 | **3.12 ; 4.11** | |
| | mass | - | | - | - | | 0.852 | | 0.508 | -0.19 ; 1.90 | |
| | $T_{-1day}$ | - | | - | - | | -0.605 | | 0.497 | -1.63 ; 0.42 | |
| | $T_{-3days}$ | - | | - | - | | -0.432 | | 0.541 | -1.55 ; 0.68 | |
| | $T_{-1week}$ | 0.604 | | 0.392 | -0.21 ; 1.41 | | - | | - | - | |
| | $T_{-2weeks}$ | 0.678 | | 0.382 | -0.11 ; 1.47 | | - | | - | - | |
| **Above the $T_{uc}$** | **(A)** Model | df | LL | AICc | ΔAICc | w | df | LL | AICc | ΔAICc | w |
| | Base | - | - | - | - | - | 5 | -71.7 | 155.0 | 1.6 | 0.158 |
| | $+T_{-3days}$ | 6 | -58.8 | 132.0 | 0 | 0.351 | - | - | - | - | - |
| | $+\Delta T_{1\text{-}2}+T_{-1day}$ | 7 | -58.3 | 134.0 | 1.9 | 0.133 | - | - | - | - | - |
| | $+T_{-1week}$ | - | - | - | - | - | 6 | -69.6 | 153.4 | 0 | 0.350 |
| | **(B)** Predictors | Est. | | SE | CI | | Est. | | SE | CI | |
| | Intercept | 10.829 | | 0.227 | **10.37 ; 11.29** | | 10.290 | | 0.330 | **9.62 ; 10.96** | |
| | $T_{a\text{-}chamb}$ | 5.776 | | 0.282 | **5.20 ; 6.35** | | 5.571 | | 0.289 | **4.99 ; 6.16** | |
| | mass | 1.025 | | 0.483 | **0.05 ; 2.00** | | 1.741 | | 0.694 | **0.34 ; 3.14** | |
| | $T_{-1day}$ | -1.411 | | 0.620 | **-2.67 ; -0.15** | | - | | - | - | |
| | $\Delta T_{1\text{-}2}$ | 0.929 | | 0.639 | -0.37 ; 2.23 | | - | | - | - | |
| | $T_{-3days}$ | -1.113 | | 0.470 | **-2.07 ; -0.16** | | - | | - | - | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | $T_{-1week}$ | - | - | - | | -1.223 | 0.645 | -2.53 ; 0.080 | | | |
| **EVAPORATIVE COOLING CAPACITY** | **Below the $T_{uc}$** | ***(A) Model*** | *df* | *LL* | *AICc* | *ΔAICc* | *w* | *df* | *LL* | *AICc* | *ΔAICc* | *w* |
| | | Null | 3 | 11.8 | -16.6 | 0.3 | 0.255 | 3 | 7.0 | -7.0 | 0 | 0.781 |
| | | $+T_{-1day}$ | 4 | 13.3 | -16.9 | 0 | 0.303 | - | - | - | - | - |
| | | $+T_{-2weeks}$ | 4 | 12.9 | -16.0 | 0.9 | 0.191 | - | - | - | - | - |
| | | $+T_{0day}$ | 4 | 12.4 | -15.0 | 1.9 | 0.119 | - | - | - | - | - |
| | | ***(B) Predictors*** | *Est.* | *SE* | *CI* | | | *Est.* | *SE* | *CI* | | |
| | | *Intercept* | 0.626 | 0.026 | **0.57 ; 0.68** | | | 0.656 | 0.033 | **0.59 ; 0.72** | | |
| | | $T_{0day}$ | 0.125 | 0.052 | **0.02 ; 0.23** | | | - | - | - | | |
| | | $T_{-1day}$ | 0.143 | 0.050 | **0.04 ; 0.25** | | | - | - | - | | |
| | | $T_{-2weeks}$ | 0.135 | 0.051 | **0.03 ; 0.24** | | | - | - | - | | |
| | **Above the $T_{uc}$** | ***(A) Model*** | *df* | *LL* | *AICc* | *ΔAICc* | *w* | *df* | *LL* | *AICc* | *ΔAICc* | *w* |
| | | Base | 5 | 1.6 | 8.4 | 1.5 | 0.192 | 4 | 0.9 | 7.2 | 0 | 0.577 |
| | | $+T_{0day}$ | 6 | 3.8 | 6.9 | 0 | 0.402 | - | - | - | - | - |
| | | $+T_{-1day}$ | 6 | 3.0 | 8.4 | 1.5 | 0.193 | - | - | - | - | - |
| | | ***(B) Predictors*** | *Est.* | *SE* | *CI* | | | *Est.* | *SE* | *CI* | | |
| | | *Intercept* | 1.891 | 0.050 | **1.79 ; 1.99** | | | 1.689 | 0.66 | **1.55 ; 1.82** | | |
| | | $T_{a\text{-}chamb}$ | 0.733 | 0.054 | **0.62 ; 0.84** | | | 0.587 | 0.051 | **0.49 ; 0.69** | | |
| | | *mass* | 0.259 | 0.111 | **0.03 ; 0.48** | | | - | - | - | | |
| | | $T_{0day}$ | 0.302 | 0.101 | **0.10 ; 0.51** | | | - | - | - | | |
| | | $T_{-1day}$ | 0.262 | 0.104 | **0.05 ; 0.47** | | | - | - | - | | |
| **BODY TEMPERATURE** | **Below the $T_{uc}$** | ***(A) Model*** | *df* | *LL* | *AICc* | *ΔAICc* | *w* | *df* | *LL* | *AICc* | *ΔAICc* | *w* |
| | | Null | 3 | -25.2 | 57.5 | 0 | 0.311 | - | - | - | - | - |
| | | $+T_{0day}$ | 4 | -24.1 | 58.0 | 0.5 | 0.239 | 4 | -19.5 | 48.6 | 0 | 0.372 |
| | | $+T_{-1day}$ | - | - | - | - | - | 4 | -20.1 | 49.8 | 1.1 | 0.214 |
| | | $+T_{-3days}$ | - | - | - | - | - | 4 | -20.4 | 50.4 | 1.7 | 0.155 |
| | | ***(B) Predictors*** | *Est.* | *SE* | *CI* | | | *Est.* | *SE* | *CI* | | |
| | | *Intercept* | 41.050 | 0.190 | **40.66 ; 41.44** | | | 41.670 | 0.116 | **41.43 ; 41.91** | | |
| | | $T_{0day}$ | -0.569 | 0.354 | -1.30 ; 0.16 | | | -0.646 | 0.229 | **-1.12 ; -0.18** | | |
| | | $T_{-1day}$ | - | - | - | | | -0.597 | 0.239 | **-1.08 ; -0.11** | | |
| | | $T_{-3days}$ | - | - | - | | | -0.565 | 0.245 | **-1.07 ; -0.06** | | |
| | **Above the $T_{uc}$** | ***(A) Model*** | *df* | *LL* | *AICc* | *ΔAICc* | *w* | *df* | *LL* | *AICc* | *ΔAICc* | *w* |
| | | Base | - | - | - | - | - | 4 | -22.2 | 53.3 | 0 | 0.524 |
| | | $+T_{d0}$ | 5 | -12.6 | 36.9 | 0 | 0.404 | - | - | - | - | - |
| | | ***(B) Predictors*** | *Est.* | *SE* | *CI* | | | *Est.* | *SE* | *CI* | | |
| | | *Intercept* | 43.020 | 0.118 | **42.78 ; 43.27** | | | 43.547 | 0.111 | **43.32 ; 43.77** | | |
| | | $T_{a\text{-}chamb}$ | 1.350 | 0.067 | **1.21 ; 1.49** | | | 1.333 | 0.088 | **1.16 ; 1.51** | | |
| | | $T_{0day}$ | -0.637 | 0.247 | **-1.14 ; -0.14** | | | - | - | - | | |

***Table S7: (A) Top model set (ΔAICc≤2 from best model), and (B) model-averaged estimates of predictors included in the top models explaining variation in MR, EWL, EHL/MHP and $T_b$ below and above $T_{uc}$, in males (n=14, left) and females (n=15, right) considered separately.*** *A predictor has a significant effect if CI excludes 0 (bold). 'df' is degree of freedom, 'LL' is log-likelihood, 'ΔAICc' is the the difference in AICc score between the best model and the model being compared, 'w' corresponds to the model weight, 'Est.' to parameter estimate, 'SE' to standard error and 'CI' to the 95% confidence interval.*

## *Male and female datasets*
## *Weather predictor effects*

### Heat tolerance

**$T_{a\text{-}max}$ = 46°C (yes/no)**

***(A) Top models***

| *Models* | *df* | *LL* | *AICc* | *ΔAICc* | *w* | *df* | *LL* | *AICc* | *ΔAICc* | *w* |
|---|---|---|---|---|---|---|---|---|---|---|
| | **MALES** | | | | | **FEMALES** | | | | |
| *Null* | 1 | -10.6 | 23.5 | 0.8 | 0.177 | 1 | -9.5 | 21.4 | 0.4 | 0.173 |
| *Base* | - | - | - | - | - | 2 | -8.0 | 21.0 | 0 | 0.216 |
| $+T_{-1week}$ | 2 | -8.9 | 22.6 | 0 | 0.268 | - | - | - | - | - |
| $+T_{-1day}$ | 2 | -9.4 | 23.8 | 1.2 | 0.150 | - | - | - | - | - |
| $+T_{-2weeks}$ | 2 | -9.5 | 24.0 | 1.3 | 0.137 | 3 | -6.4 | 21.0 | 0.1 | 0.207 |
| $+T_{-3days}$ | 2 | -9.7 | 24.4 | 1.8 | 0.110 | 3 | -7.2 | 22.5 | 1.5 | 0.101 |
| $+ T_{0day}$ | - | - | - | - | - | 3 | -7.2 | 22.7 | 1.7 | 0.092 |
| $+\Delta T_{1\text{-}2}+T_{-1day}$ | | | | | | 4 | -5.5 | 22.9 | 2 | 0.081 |

***(B) Model-averaged estimates of predictors included in the top models***

| *Predictors* | *Est.* | *SE* | *CI* | *Est.* | *SE* | *CI* |
|---|---|---|---|---|---|---|
| *Intercept* | 0.574 | 0.561 | -0.63 ; 1.78 | 0.879 | 0.701 | -0.64 ; 2.40 |
| *mass* | - | - | - | 1.740 | 2.051 | -2.71 ; 6.19 |
| $T_{0day}$ | - | - | - | -1.580 | 1.402 | -4.63 ; 1.47 |
| $T_{-1day}$ | 1.783 | 1.304 | -1.01 ; 5.58 | - | - | - |
| $T_{-3days}$ | 1.558 | 1.330 | -1.29 ; 4.41 | -2.169 | 2.053 | -6.64 ; 2.30 |
| $T_{-1week}$ | 2.407 | 1.593 | -1.01 ; 5.82 | - | - | - |
| $T_{-2weeks}$ | 1.766 | 1.350 | -1.13 ; 4.66 | -3.008 | 2.035 | -7.44 ; 1.43 |
| $\Delta T_{1\text{-}2}$ | - | - | - | 4.967 | 3.611 | -2.98 ; 3;82 |

**Trial completion**

***(A) Top models***

| *Models* | *df* | *LL* | *AICc* | *ΔAICc* | *w* | *df* | *LL* | *AICc* | *ΔAICc* | *w* |
|---|---|---|---|---|---|---|---|---|---|---|
| | **MALES** | | | | | **FEMALES** | | | | |
| *Null* | - | - | - | - | - | 1 | -9.5 | 21.4 | 0 | 0.258 |
| $+T_{-1week}$ | 2 | -6.7 | 18.3 | 0 | 0.325 | - | - | - | - | - |
| $+T_{-2weeks}$ | 2 | -6.8 | 18.6 | 0.3 | 0.274 | 2 | -8.5 | 22.1 | 0.7 | 0.186 |
| $+T_{-1day}$ | 2 | -7.3 | 19.6 | 1.3 | 0.166 | 2 | -9.1 | 23.2 | 1.8 | 0.104 |
| $+T_{-3days}$ | - | - | - | - | - | 2 | -8.8 | 22.6 | 1.2 | 0.139 |
| $+\Delta T_{0\text{-}1}+T_{0day}$ | - | - | - | - | - | 3 | -7.6 | 23.3 | 1.9 | 0.098 |

***(B) Model-averaged estimates of predictors included in the top models***

| *Predictors* | *Est.* | *SE* | *CI* | *Est.* | *SE* | *CI* |
|---|---|---|---|---|---|---|
| *Intercept* | -0.894 | 0.758 | -2.51 ; 0.72 | -0.799 | 0.624 | -2.14 ; 0.54 |
| $T_{0day}$ | - | - | - | -0.483 | 1.402 | -3.54 ; 2.57 |
| $\Delta T_{0\text{-}1}$ | - | - | - | 3.468 | 2.274 | -1.49 ; 8.42 |
| $T_{-1day}$ | 4.455 | 2.764 | -1.47 ; 10.38 | -1.125 | 1.279 | -3.89 ; 1.64 |
| $T_{-3days}$ | - | - | - | -1.578 | 1.467 | -4.75 ; 1.59 |
| $T_{-1week}$ | 5.702 | 3.219 | -1.20 ; 12.61 | - | - | - |
| $T_{-2weeks}$ | 3.763 | 1.801 | -0.10; 7.63 | -1.859 | 1.448 | -4.99 ; 1.27 |

***Table S8: (: (A) Top model set (ΔAICc≤2 from best model), and (B) model-averaged estimates of predictors included in the top models explaining variation in $T_{a\text{-}max}$ (maximum $T_{a\text{-}chamb}$ reached = 46°C or less) and trial completion (i.e. stayed 15 minutes at $T_{a\text{-}chamb}$=46°C) in males (n=16, left) and females (n=15, right) considered separately****. A predictor has a significant effect if CI excludes 0. For both $T_{a\text{-}max}$ and trial completion the base model was the null model. 'df' is degree of freedom, 'LL' is log-likelihood, 'ΔAICc' is the the difference in AICc score between the best model and the model being compared, 'w' corresponds to the model weight, 'Est.' corresponds to estimate, 'SE' to standard error and 'CI' is the 95% confidence interval.*

## References

Muggeo, V. M. 2008. Segmented: an R package to fit regression models with broken-line relationships. *R news,* 8**,** 20-25.