

# Thermoregulation and microhabitat use in cold-dwelling butterflies

## comparative analysis of the genus *Erebia*



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**b4i**

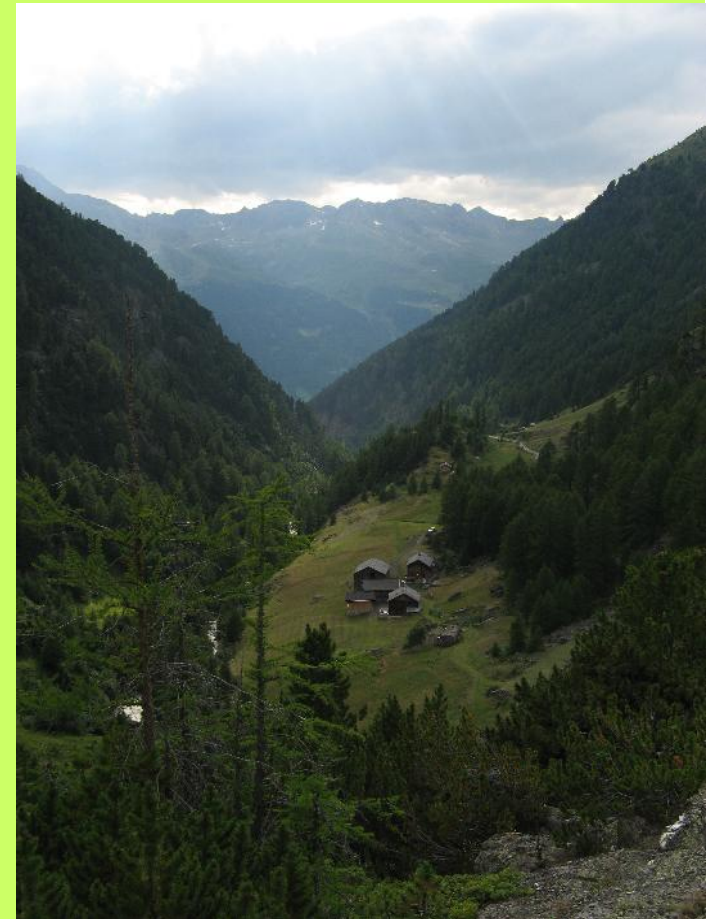
# Mountain invertebrates

- threatened by climate change
- **Range margins**
  - community structure
    - vegetation, predators, competitors
  - **temperature**
    - larvae and **adults**
    - low – inactivity, high – overheating
    - adult **thermoregulation** - behaviour
      - postures
      - microclimate/**habitat** choice



# Study sites and species

- **7 mountain *Erebia* species**  
6 in sympatry (1900 m asl)+1 (2200m asl)
  - similar climate, various habitats
  - Alps, Austria, Tirol
- **2 lowland species**
  - *E. medusa*, *E. aethiops*
  - subxerotherm reserve, Czech Republic



# We have plenty of information about *Erebia* representatives

Phylogeny

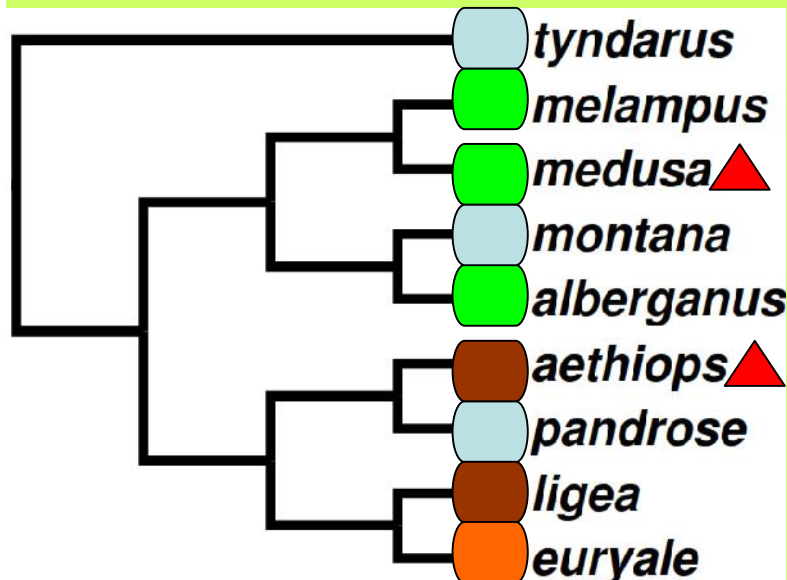
Habitat

Size

Behaviour



Thermal tolerance of larvae

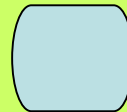


habitat

Small

Large

Rock



*tyndarus*

*montana*,  
*pandrose*

Meadows



*melampus*

*alberganus*  
*euryale*

Woodland



*ligea*

Meadow



*medusa* (red triangle)

Woodland



*aethiops*



# Methods

- Microprobe (Physitemp) - **Tbody**, **Tmicrohabitat**, **Tambient** (1.5 m above ground)



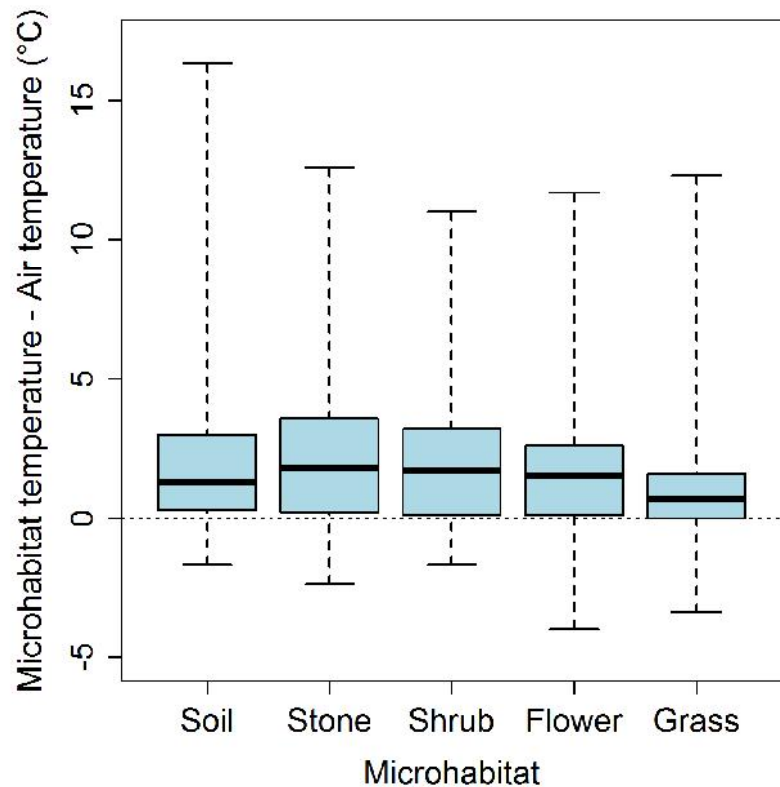


# Questions



- effect of climate warming on adults
  - effect of habitat use on thermoregulation?
- 
- **Inter-specific differences in body temperature?**
    - e.g. species from „warmer“ habitats keep higher  $T_{body}$ ?
    - habitat use vs. phylogeny or morphology
    - effect of altitude?
  - **Reactions of lowland species on high daily temperatures?**

# Data and results



1398 records/ 8 species

Body temperatures **20.9 – 39.2 °C**

T microhabitat 11.2 – 32.6 °C

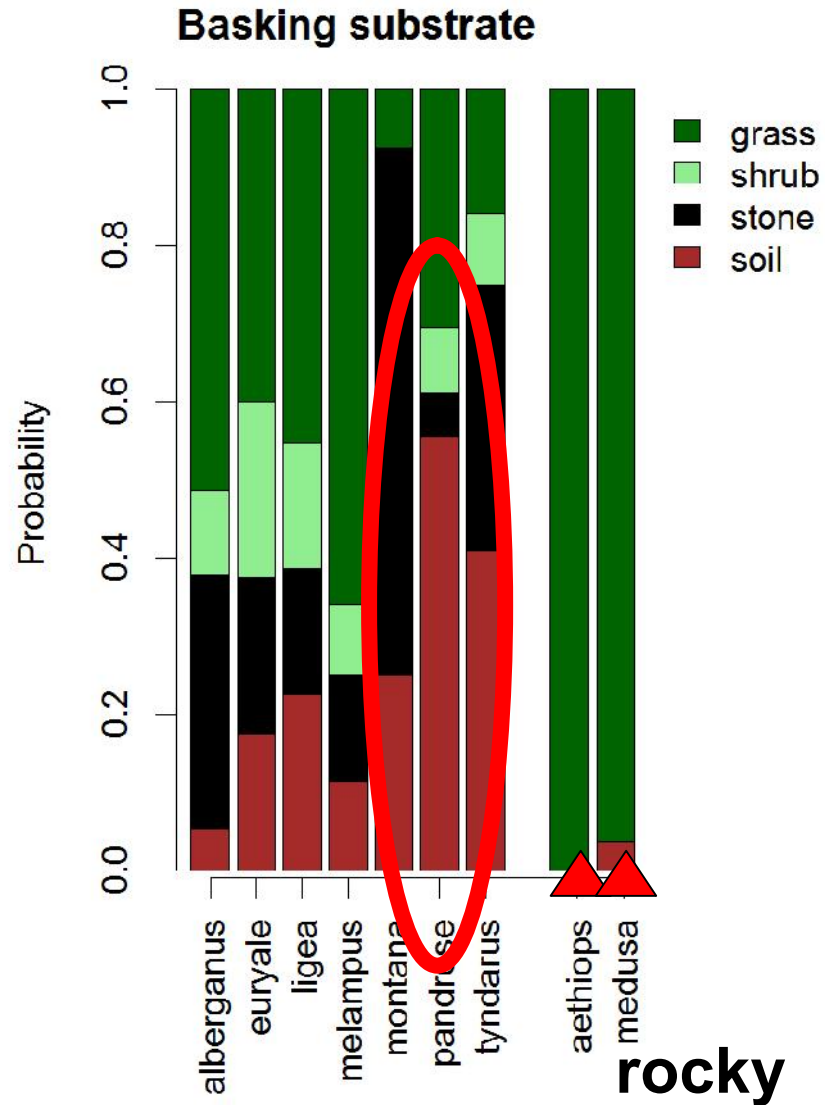
T ambient 12 – 32°C

**Mountain – T amb. 12°- 31°C**

**Lowlands – T amb.17°- 32°C**

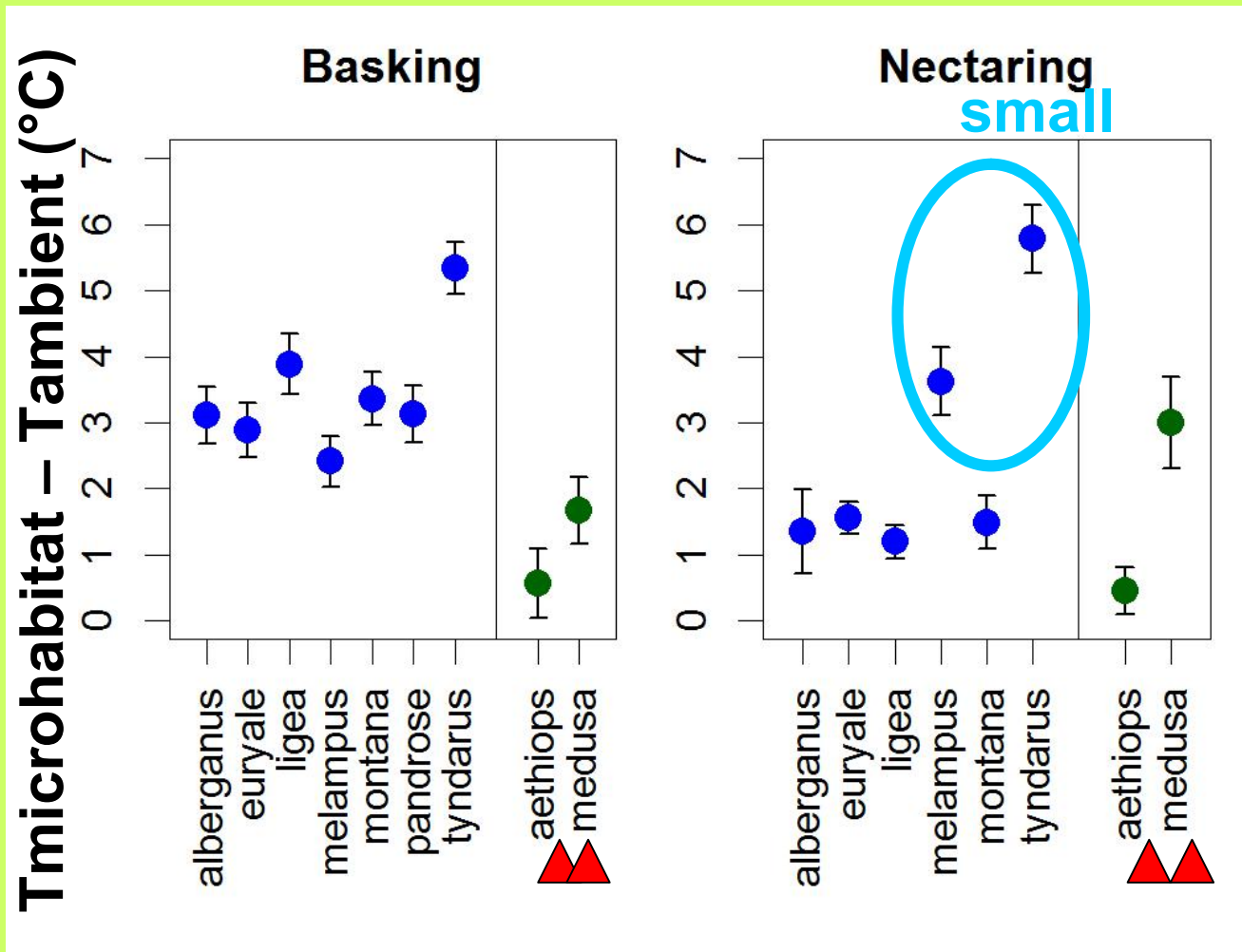


# Basking substrate





# Passive behaviour

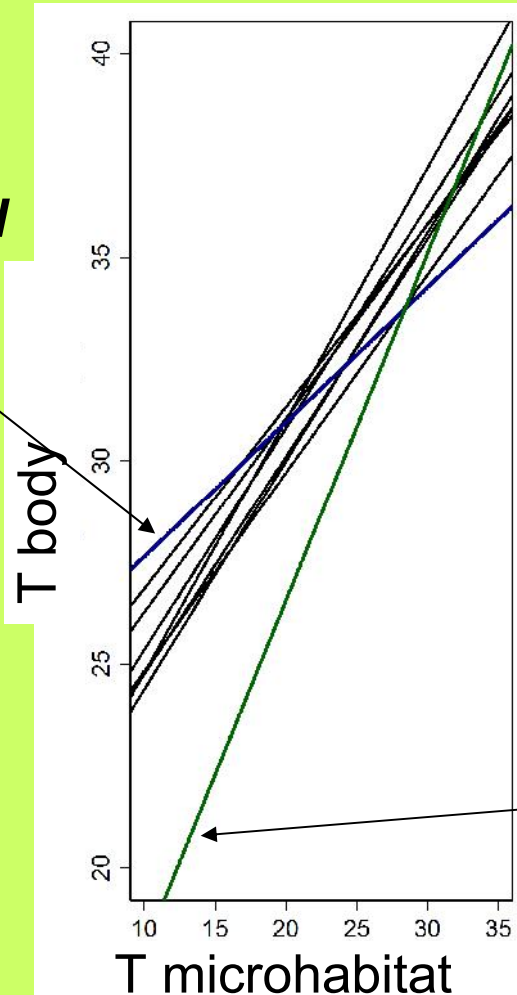


- Passive behaviour –  $T_{\text{microclimate}} > T_{\text{ambient}}$
- Basking – active searching for warmer microclimate (except *aethiops*)

# Species differ by their thermal niche

*E. tyndarus*

*Mountains, rocks, small*



*E. aethiops* ▲

*Lowlands, woodlands, big*

**GLM**,  $T_b \sim (T_{\text{microhabitat}} - \text{mean}(T_{\text{microhabitat}})) * \text{species}$   
( $F = 6.285$ ,  $df = 8, 1379$ , \*\*\*)

# Thermal niche corresponds to habitat

| Species            | F     | N   | p   | slope |                                                                                      | Habitat   |
|--------------------|-------|-----|-----|-------|--------------------------------------------------------------------------------------|-----------|
| <i>tyndarus</i>    | 65.9  | 133 | *** | 0.33  |   | Rock      |
| <i>montana</i>     | 67.4  | 146 | *** | 0.45  |   | Rock      |
| <i>pandrose</i>    | 78.4  | 102 | *** | 0.48  |   | Rock      |
| <i>ligea</i>       | 115.0 | 194 | *** | 0.49  |   | Forest    |
| <i>medusa Alps</i> | 16.2  | 25  | *** | 0.53  |   | Meadow    |
| <i>melampus</i>    | 78.4  | 156 | *** | 0.53  |   | Meadow    |
| <i>alberganus</i>  | 69.0  | 114 | *** | 0.55  |   | Meadow    |
| <i>euryale</i>     | 244.4 | 253 | *** | 0.56  |   | Tim. line |
| <i>medusa</i> ČR   | 297.6 | 161 | *** | 0.63  |   | Meadow    |
| <i>aethiops</i>    | 146.3 | 103 | *** | 0.85  |  | Forest    |

GLM, dependence of Tb on Tmicrohabitat, each species tested separately

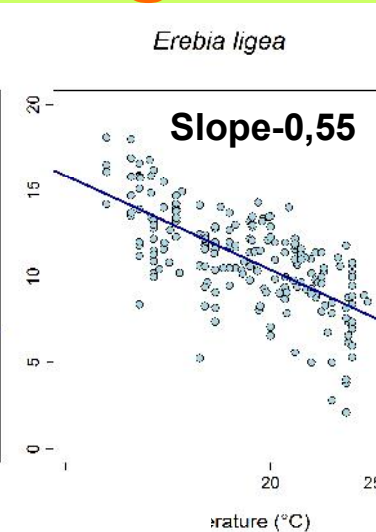
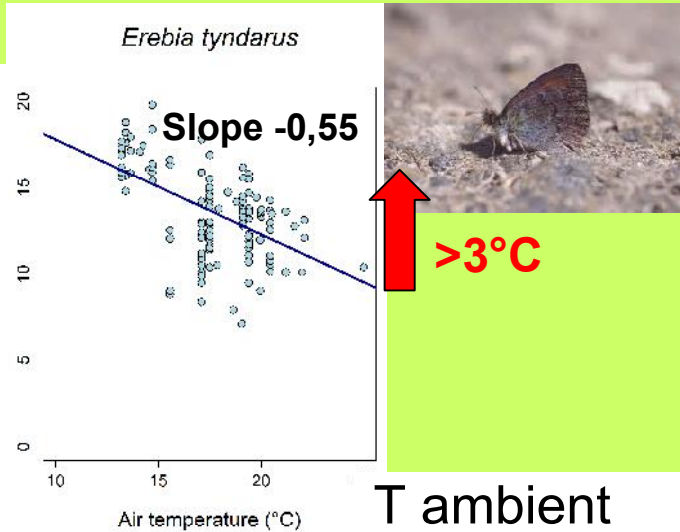


T microhabitats - differed between species (GLM,  $F = 11.1254$ , d.f. = 1, 1118, \*\*\*)

**Rocky  
small**

**Woodland  
large**

**Tb-Tamb.**



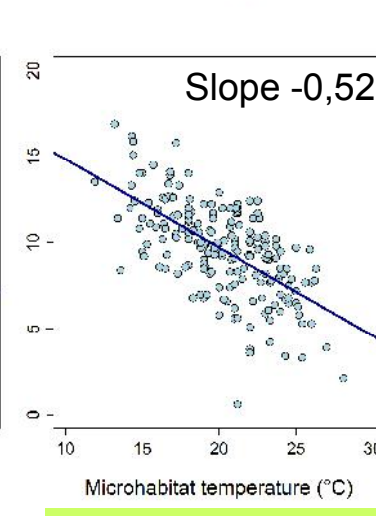
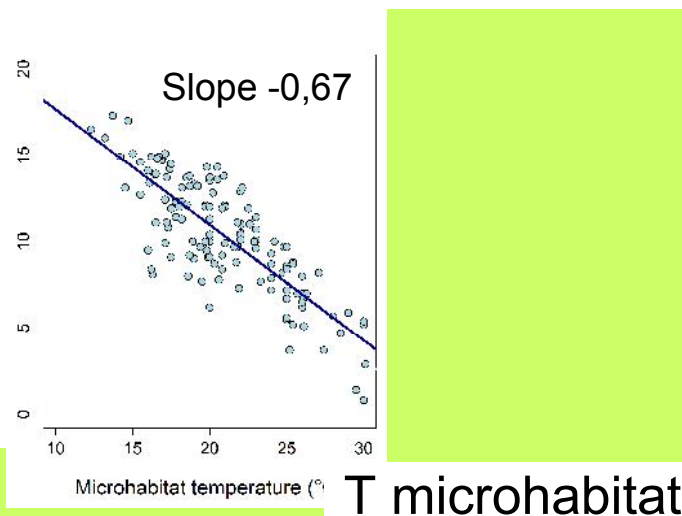
**Expectations:**

**Low T ambient**

- smaller – heat loss
- lower Tb

- Microclimate –  
similar effect on both

**Tb-Tmicrob.**



**higher Tbody (+3°C)**





*E. medusa*

- heat tolerance,  
Tb max 39.2°C

*E. aethiops*

- heat avoidance

Tb 5° above T microhabitat

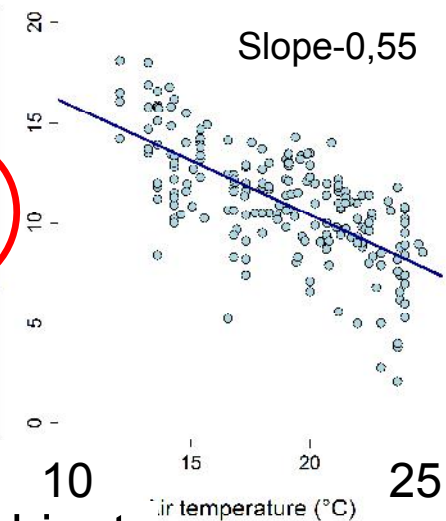
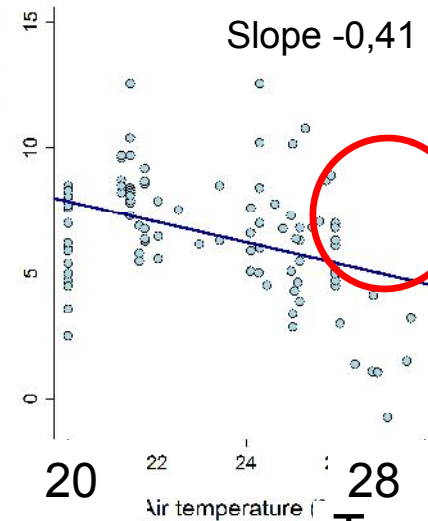
Lowland  
Large

Mountains  
Large

Tb-Tamb.

aethiops

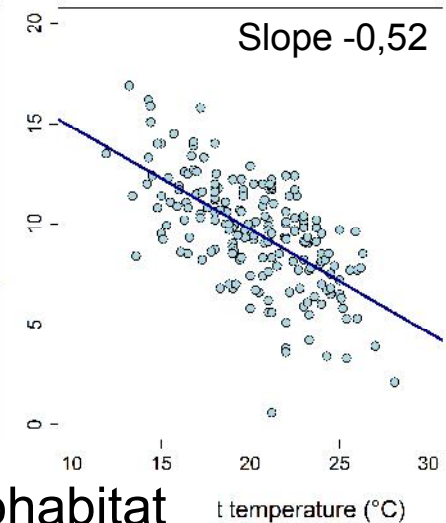
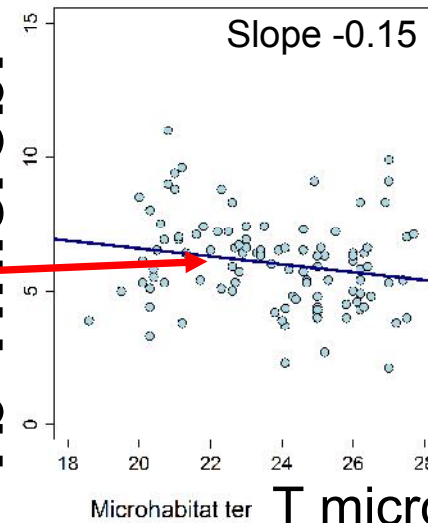
ligea



Tb-Tmicrob.

Slope -0.15

Slope -0,52



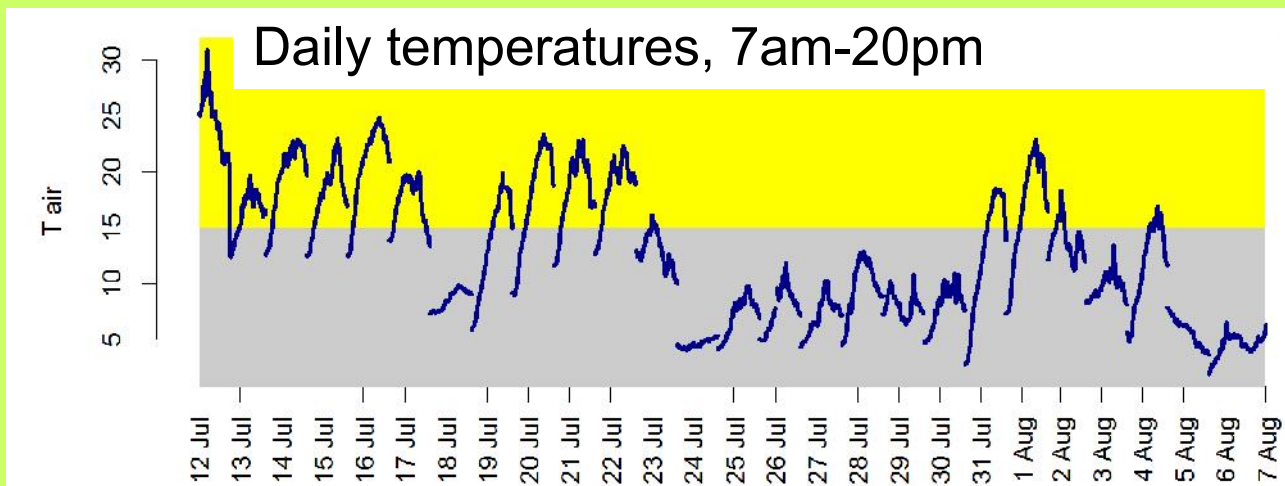
# Conclusions

**Thermal niches** - species habitat

Closely related - differ in thermoregulation and microclimatic requirements

**Heat avoidance**

- not noticed in mt. species
- in lowlands – *E. aethiops* – shaded habitats, potentially threatened?



# Thank you for your attention

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