Cold hardiness of mountain and lowland butterflies

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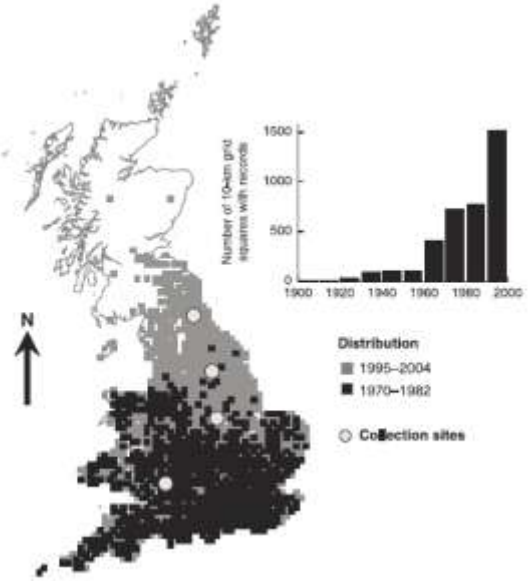
Background

- Climate change is causing shifts of ranges of many species
- Butterflies: many shifts to higher latitudes and altitudes documented
- Potential threat to mountain fauna



Braschler & Hill, 2007

Background

- Insect ecophysiology is widely investigated topic, especially cold tolerance
- 2 basic strategies for surviving low temperatures („freeze tolerance“ vs. „freeze avoidance“)
- Supercooling point, lethal temperatures

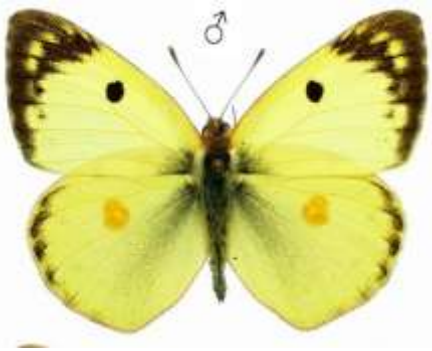
Aims

- Comparing cold hardiness of lowland and mountain butterflies at various levels

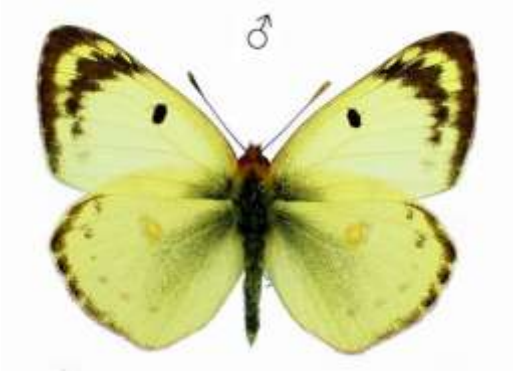
- Supercooling point, lower lethal temperature, lethal times of hibernating larvae

Study species

***Colias alfacariensis* Ribbe, 1905**

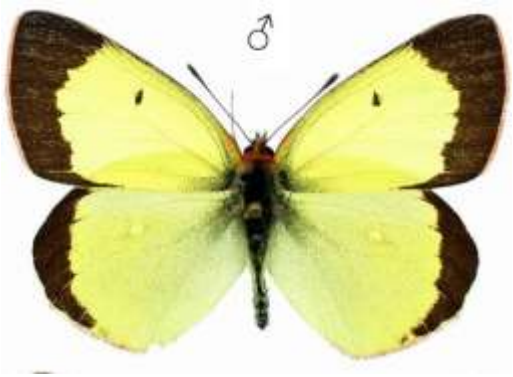


***Colias hyale* (Linnaeus, 1758)**



Study species

Colias palaeno **(Linnaeus, 1761)**



Colias phicomone **(Esper, 1780)**

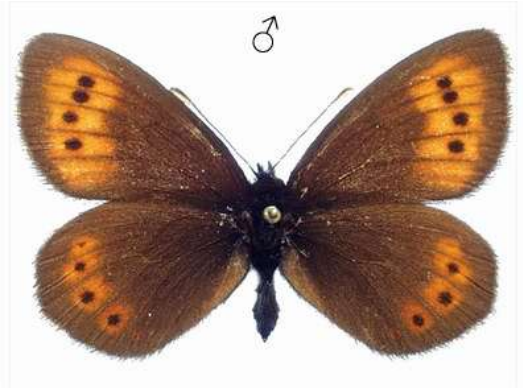
Study species

Erebia medusa **(Knoch, 1783)**

Erebia sudetica **(Staudinger, 1861)**

Study species

***Erebia epiphron* (Knoch, 1783)**



***Erebia tyndarus* (Esper, 1781)**

Methods

- **Captive rearing of larvae until hibernation**
- **Acclimation in 5°C**





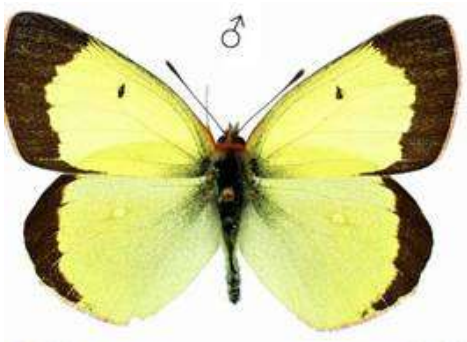

Methods

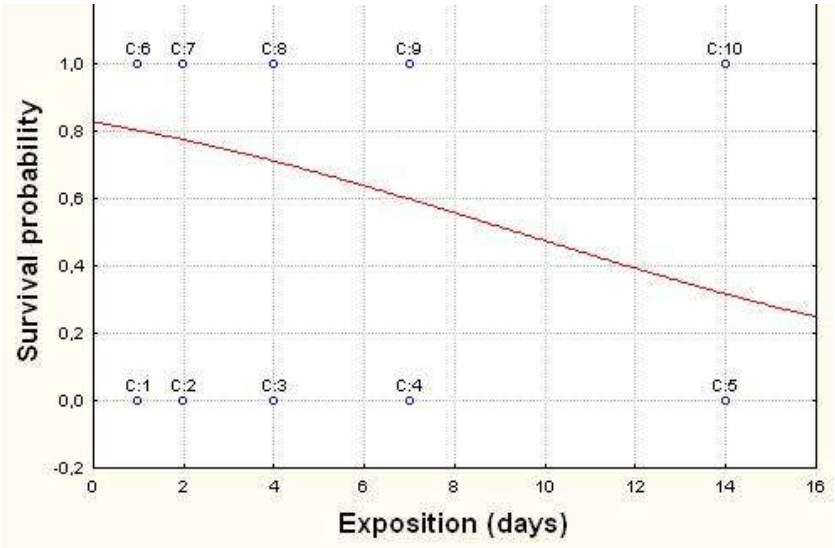
- **Supercooling point – gradual cooling above liquid nitrogen**
- **Highest lethal temperature exposing groups of caterpillars at a series of constant low temperatures slightly above (or below) the SCP for 24 hours**
- **Prolonged expositions at selected temperatures**

E. medusa

E. epiphron

Colias palaeno (Linnaeus, 1761)

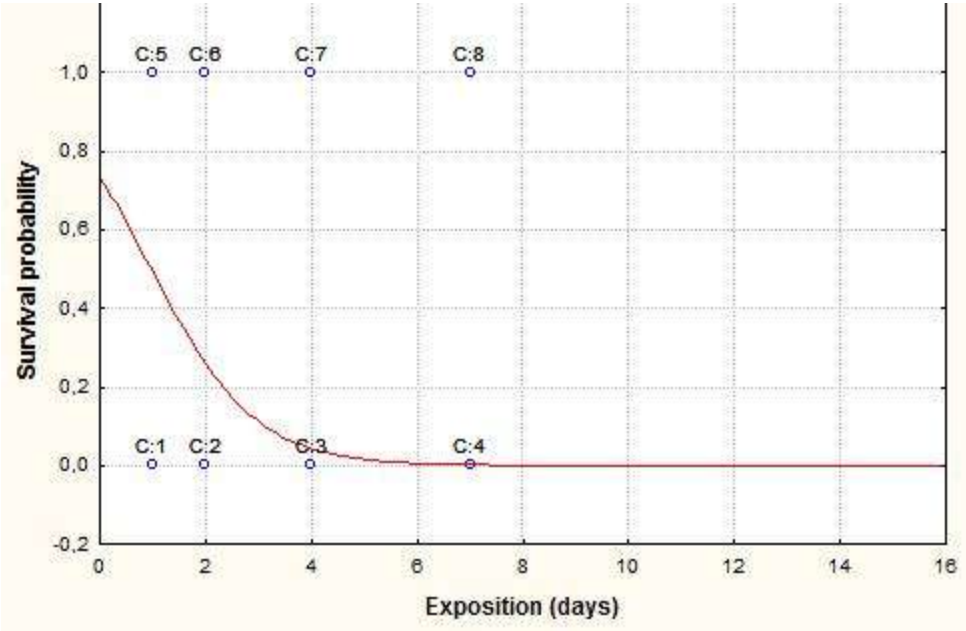




-26°C

- **Supercooling point: -26°C**
- **Highest lethal temperature: -26°C**
- **Freeze – sensitive species**
- **Strong cold hardiness, very good adaptation for cold thermal regime in winter**

Erebia medusa (Denis & Schiffermüller, 1775)



- **Supercooling point: -17°C**
- **Highest lethal temperature: -21°C**
- **Freeze – tolerant species**
- **It appears adapted to warmer, but less predictable microclimate of lower altitudes**

-21°C

Erebia spp. – reverse altitudinal trend in cold hardiness

species	original locality	altitude [m]	SCP [°C]	LLT [°C]
Erebia medusa	**Cesky Krumlov, Czech Republic**	**600**	**–17.0** ±2.3	**–21**
Erebia sudetica	**Praded Mt., Czech Republic**	**1320**	**–15.1** ±4.4	**–15**
Erebia epiphron	**Praded Mt., Czech Republic**	**1460**	**–22.0** ±3.2	**–17**
Erebia tyndarus	**Austrian Alps**	**1950**	**–8.4** ±2.8	**–8**

ANOVA: $F(3) = 47$, $p<0.001$

Tukey HSD: *E. epiphron x E. medusa* p=0.36

Vrba *et al*., in press.

Colias spp.

species	original locality	altitude [m]	SCP [°C]	LLT [°C]
Colias alfacariensis	**Cesky Krumlov, Czech Republic**	**600**	**–18.9** ± 8.3	**-**
Colias hyale	**Ceske Budejovice, Czech Republic**	**400**	**–14.5** ± 4.0	**-**
Colias palaeno	**Sumava Mts., Czech Republic**	**970**	**–26.0** ± 3.9	**–26**
Colias palaeno	**Italian Alps**	**1950**	**– 27.5** ± 2.7	**-**
Colias phicomone	**Italian Alps**	**2000**	**–14.5** ± 6.5	**-**

ANOVA: $F(3) = 11.7$, $p<0.001$

Tukey HSD: C. phicomone x C. alfacariensis p=0.25
C. phicomone x C. hyale p=0.99
C. alfacariensis x C. hyale p=0.23

Conclusions

- Species cold hardiness is highly individual, significant differences among species occuring in similar climatic conditions
- Overwintering larvae have to be adapted to thermal conditions on their habitats, but many other aspects than ambient temperature seem to be responsible for their survival
- Role of snow cover and microhabitat choice

Thank you for your attention

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