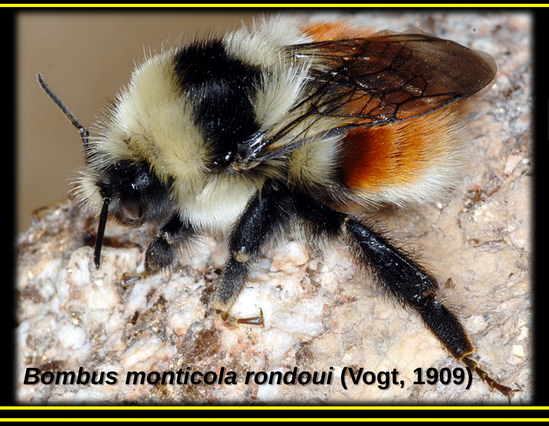
Climate change: Overheating of Bumblebees

Baptiste Martinet & Pierre Rasmont

UMONS Université de Mons



Bombus monticola rondoui (Vogt, 1909)

Résumé

Récemment, les changements climatiques ont été identifiés comme l'une des causes majeures d'extinction. Les changement climatiques sont reliés à une augmentation de la fréquence et de l'intensité d'évènements extrêmes comme les canicules. Pour cette étude, nous avons développé un nouveau dispositif expérimental portable pour évaluer directement la résistance au stress thermique, estimée par le «Time before Heat Stupor». Nous avons étudié un groupe de pollinisateurs particulièrement exposé au risque de déclin: les bourdons. Nos résultats indiquent que cette résistance hyperthermique est spécifique et particulièrement très faible chez les bourdons.

Introduction

Climate change has been recently pointed out as one of the major causes of extinction in several groups of organisms [2]. Climate change is related to an increase of frequency of extreme event such as heat waves [3].

Bumblebees are robust and hairy bees with hetero-endotherm metabolism [4] that enable them to live in some of the highest-elevation and most northern ecosystems. Which are also the hardest regions hit by climate change [5].

The goal of this study is to assess the heat resistance of different bumblebee species in field lab with a new experimental device to predict consequences of heat waves on the pollinator fauna.

Material and Methods

We sampled 161 males belonging to five different species from Eastern Pyrenees, North of Scandinavia and Belgium: two *Alpinobombus* arctic species [6]: *B. alpinus* [n=18] and *B. balteatus* [n=23]; two boreo-alpine species: *B.(Pyrobombus) monticola* from Sweden *and* Pyrenees [n=45] and *B.(Psithyrus) flavidus* [n=31] and one widespread and ubiquitous species *B. (Bombus s.s.) lucorum* [n=44] from Pyrenees, Belgium and Scandinavia.

Fig. 1: Experimental device (HerpNursery II)

After sampling and one day at 8°C (standby temperature [7]) , insects were placed in the incubator (Fig.1) at 40°C with 50-60% of humidity. When the specimen falls on its back, is unable to return, and loses its normal reflexes (muscle spasms; Fig. 3), it has been assumed to be in "Heat Stupor" [8-12].The Time before Heat Stupor (THS) has been measured for each specimen tested.

Results

The most widespread studied species (*B. lucorum*) has the highest value of THS (median= 250 min) and also the largest variability. Then, we have *B. flavidus* (a cuckoo species) and its host *B. monticola* (median =90 min). These two species have a large boreo-alpine distribution. The last group is composed of *Alpinobombus* species (*B. alpinus* and *B. balteatus)* which have the lowest heat stress resistance (median = 30 min) and the smallest distribution (Fig. 2).

For *B. monticola* and *B. lucorum*, our sampling allows taking into consideration different conspecific populations from different eco-climatic regions (Fig. 3).

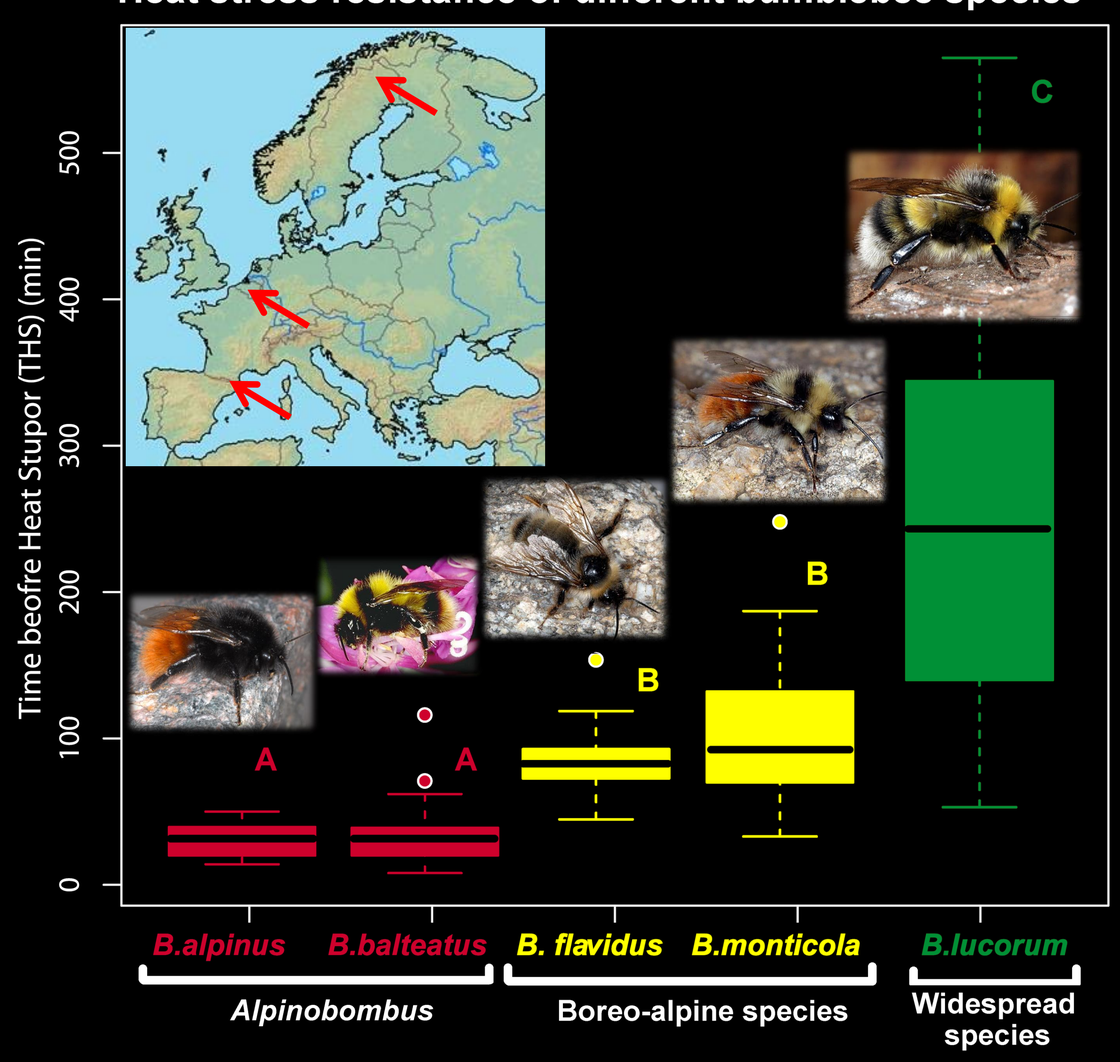


Fig. 2: Boxplots of the time before heat stupor (THS) for five bumblebee species: Arctic centred species (A): *Bombus alpinus* and *Bombus balteatus*; Boreo-Alpine species (B): *Bombus flavidus* and *Bombus monticola;* Widespread species (C): *Bombus lucorum*. Circles = extreme values

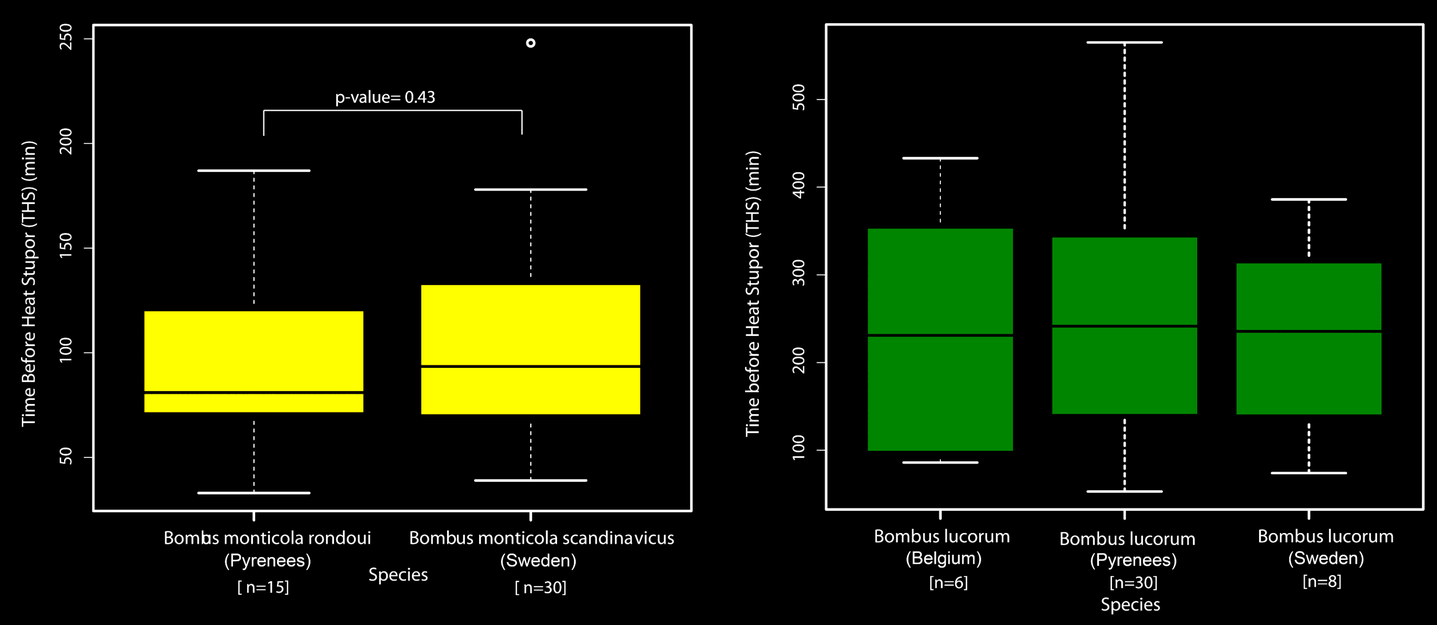


Fig. 3: Boxplots of the time before heat stupor (THS) for five bumblebee species: Arctic centred species (A): *Bombus alpinus* and *Bombus balteatus*; Boreo-Alpine species (B): *Bombus flavidus* and *Bombus monticola;* Widespread species (C): *Bombus lucorum*. Circles = extreme values

Discussion

Heat resistance gradient: The more the geographic distribution of a species is restricted to the North, the more its hyperthermic resistance is low (Fig.2).

The similar low heat stress resistance between *B. alpinus* and *B. balteatus* could result from their closely phylogenetic relationship [6] or from their identical eco-climatic constraints. The heat stress resistance of the cuckoo species *B. flavidus*, is not significantly different of its host (*B. monticola*).

Our results show that there is no difference in heat stress resistance between the allopatric populations of both *B. monticola* and *B. lucorum* (Fig. 3)

Conclusion

This experimental device allows an assessment of the heat stress resistance of insects *in natura.* This provides a pragmatic protocol, especially in the context of the current climate changes.

These results suggest that heatwaves could very quickly lead to fatal consequences for bumblebee species (e.g. *Alpinobombus*).

Fig.4: Scan this QR-code to access the video of Heat Stupor in bumblebees

Fig.5: Scandinavian arctic landscape

References: [1] **Novacek M.J., Cleland E.E (2001)**. Proceedings of the National Academy of Sciences 98: 5466–5470. [2] **Parmesan C., Root T.L., Willig M.R (2000)**. Bulletin of the American Meteorological Society 81(3): 443–450. [3] **Meehl G.A., Tebaldi C (2004)**. Science 305: 994-997. [4] **Heinrich B (1975)**. Journal of Comparative Physiology 96: 155–166. [5] **Franzén M., Ockinger E (2011)**. Journal of insect conservation 16: 227-238. [6] **Cameron S.A, Hines H.M., Williams P.H (2007)**. Biological Journal of the Linnean Society 91: 161–188. [7] **Heinrich B (1972)**. Journal of Comparative Physiology 77: 49-64. [8] **Bodenheimer F.S., Klein, H. Z (1930)**. Zeitschrift für vergleichende Physiologie 11 : 345-385. [9] **Uvarov B.P (1931)**. Transactions of the entomological Society of London 79(1): 1-232. [10] **Huang S.-P., Hsu Y., Tu M.C (2006)**. Journal of Thermal Biology 31: 378–385. [11] **Martinez-Porchas M., Hernandez-Rodriguez M (2010)**. Tropical Zoology 23: 139-146. [12] **Lutterschmidt W.I., Hutchison V.H (1997)**. Canadian Journal of Zoology 75: 1561–1574.

CONTACT : baptiste.martinet@umons.ac.be, University of Mons, Laboratory of Zoology, Place du Parc, 20, 7000 Mons Belgium