

Heat stupor in arctic bumblebees: physiological resistance along Polar Circle

Baptiste Martinet & Pierre Rasmont



I. Introduction

- ❖ **Climate change** has been recently pointed out as one of the major causes of extinction in several species [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]. They are able to live in the highest-elevation and northern ecosystems which are also the hardest regions hit by climate change [5].
- ❖ Here, we establish a comparative circum-polar map of **hyperthermic resistance** of bumblebees with a **new portable experimental device**. We follow a continental and latitudinal gradient to predict consequences of heat waves on the pollinator fauna in arcto-alpine regions and to identify the potential refuge zones around the Arctic Circle.

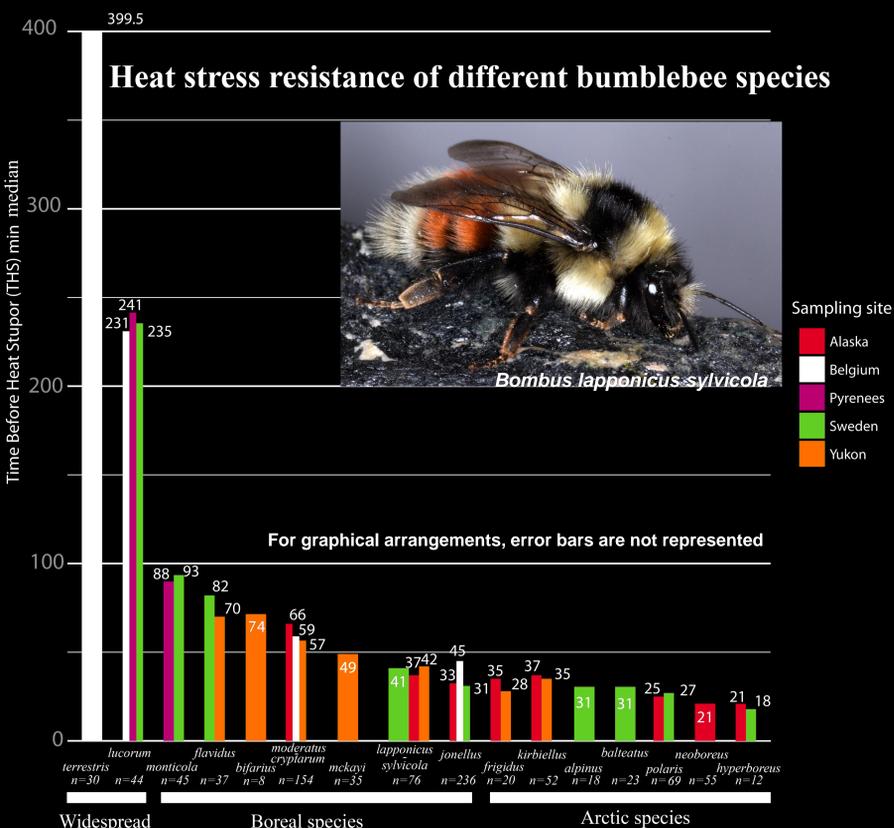
II. Material and Methods

We sampled **1004 males** belonging to **36 taxa** from E-Pyrenees, N-Scandinavia (Abisko), Belgium, Yukon (Kluane) & Alaska (Toolik). After sampling, specimens were stored at 8°C (standby t° [7]) overnight. Then, 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 turn over, and loses its reflexes (muscle spasms), it has been assumed to be in "**Heat Stupor**" [8-12]. The **Time before Heat Stupor** and other physiological parameters (body size, mass, survival rate,...) have been measured. Before thermal stress, phylogenetic and taxonomic relationships was checked by an integrative approach to allow comparison across circum-polar areas.



Fig. 1: Experimental device (HerpNursery II)

Heat stress resistance of different bumblebee species



III. Results

- ❖ **Integrative taxonomy**: At least **two new species in Alaska**.
- ❖ **Heat stress resistance**: **Widespread species** have the **highest THS** and the largest variability. **Boreo-alpine taxa**: **intermediate THS** following a more and more restricted distribution. **Arctic-centered species** (including *Alpinobombus*): **Extreme low heat resistance** (+/- 20 min). No significant difference between the cuckoo *B. flavus*, and its host *B. monticola*.
- ❖ **Sampling site**: For several taxa, our sampling allows taking into consideration different conspecific populations from different eco-climatic regions with **similar continental conditions**.

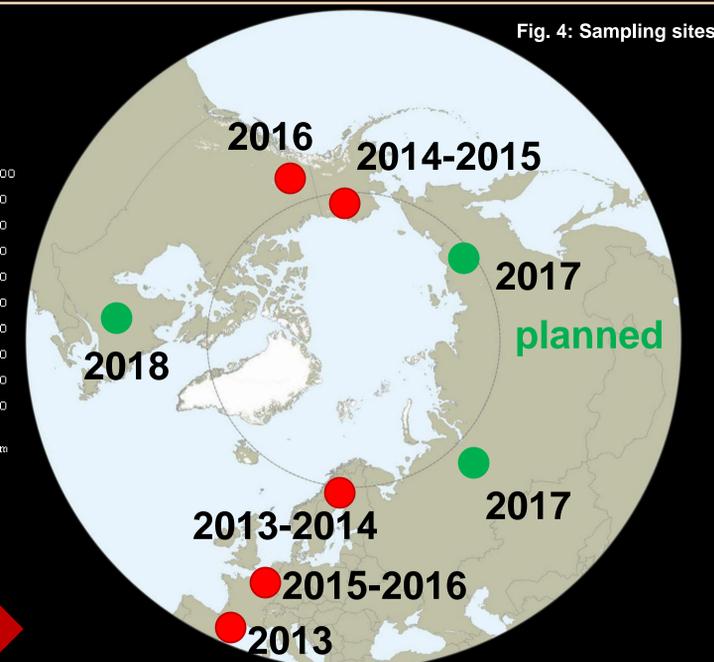


Fig. 4: Sampling sites

Fig. 2: Histograms of the time before heat stupor for 30 bumblebee taxa.

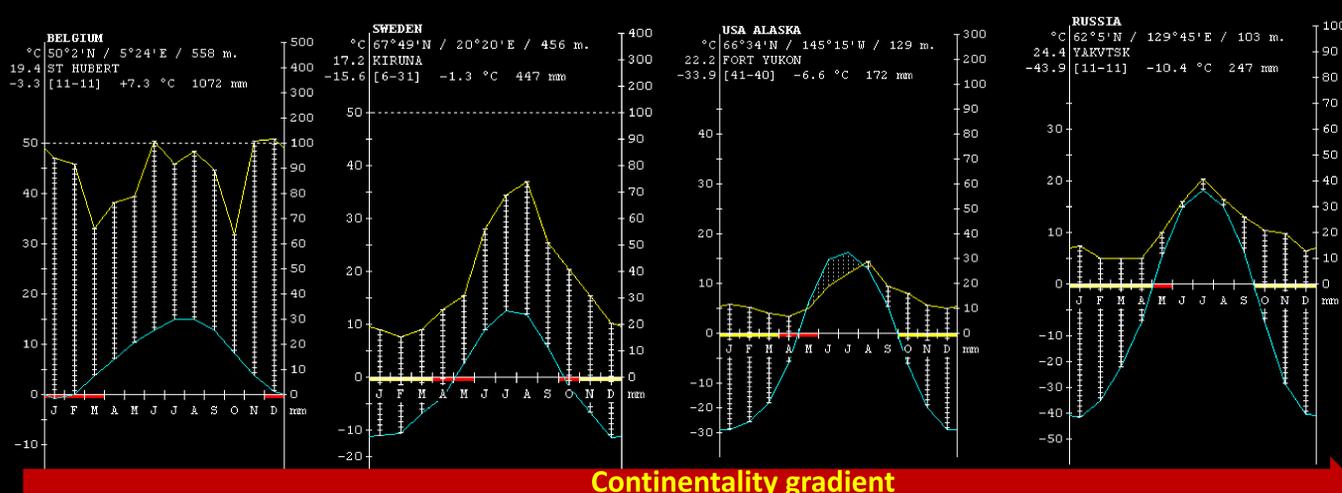


Fig. 3: Ombrothermic diagrams of Brussels (Belgium), Kiruna (Sweden), Fort Yukon (Alaska) & Yakutsk (Russia)

IV. Discussion & Perspectives

- ❖ The more the geographic distribution is restricted to the North, the more the hyperthermic resistance is low. The extreme similar low heat resistance between *Alpinobombus* could result from their closely phylogenetic relationship [6] and/or from their near eco-climatic requirements. These results suggest that heat waves could very quickly lead to fatal consequences for bumblebees.
- ❖ There are no differences in heat resistance between studied allopatric populations along a latitudinal gradient or between Sweden and Alaska, Yukon (same continental conditions). We plan now to test if high continental conditions would have selected resistance to extreme temperatures. Siberian locations, with their highest continental conditions are greatly expected to complete our circumpolar assessment compared to N-Europe & Alaska stations. In the context of current climate change we can expect a movement of these continental species toward "maritime" areas.
- ❖ In a second step, we also assess other physiological parameters such as sperm viability, sexual attractiveness, fat bodies replenishment, effect on colony's development & multiple heat stresses.