APIMONDIA SCANDINAVIA 2025
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PP-149 [Bee Health]

Thermotolerance of the honey bee: differences between three subspecies of *Apis mellifera* living in Mediterranean basin

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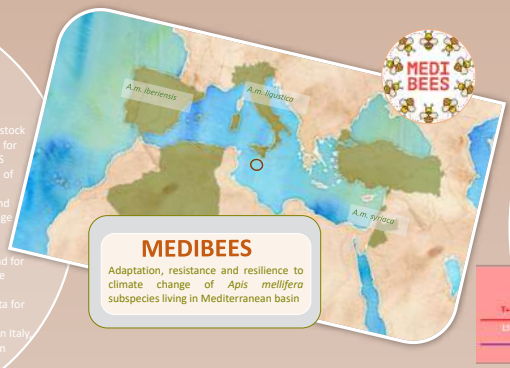
INTRODUCTION

Thermotolerance is defined as the temperature range between the coldest (critical thermal minimum, CT_{min}) and the warmest (critical thermal maximum, CT_{max}) temperatures at which an organism can maintain muscle control. The limits of heat tolerance are already known for several livestock species, but they have not yet been defined for the honeybee, *Apis mellifera*. The MEDIBEES project aims to shed light on the adaptation of the different *A. mellifera* subspecies in the Mediterranean basin and their resistance and resilience to climate change Today, knowledge of the thermal tolerance limits of *Apis mellifera* is essential for inferring the consequences of climate change on bees and for taking timely action to make the appropriate decisions in beekeeping.

This study presents thermotolerance data for three subspecies of *Apis mellifera* from the Mediterranean basin: *A. mellifera ligustica* in Italy, *A. m. syriaca* in Jordan and *A. m. iberiensis* in Spain. The data takes into account the bees' age and sex.



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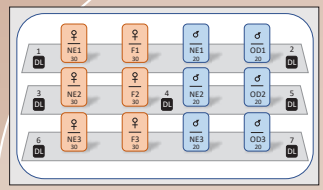
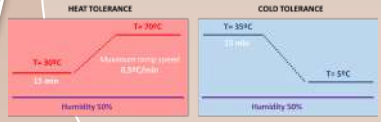
MATERIAL & METHODS



Workers n= 30 NE: Newly emerged OD: Older drones
Drones n=20 F: Foragers DL: Data Logger



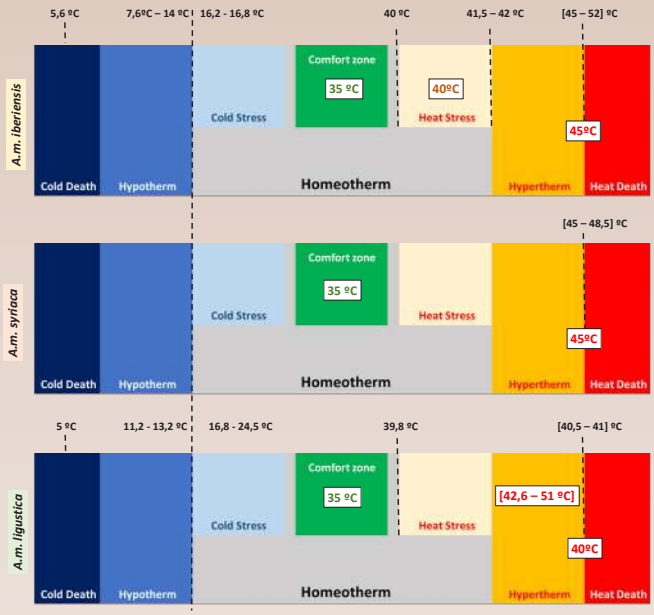
The thermotolerance experiments involved exposing the bees to controlled temperature ramps (from 30°C to 70°C for heat and from 35°C to 5°C for cold). Newly emerged and older workers and drones collected in spring were used for the heat tolerance assay. Newly emerged and older workers collected in autumn were used for the cold tolerance assay. Drones could only be tested in autumn for *A. m. ligustica*. The observed differences in behaviour throughout the process were noted in order to create a thermotolerance graph. Mortality stablised when the dorsal turning effect was negative.

RESULTS

Heat tolerance		Workers		Drones	
		Critical T	Final T	Critical T	Final T
A.m. iberiensis	Newly emerged	45 ºC	47,9 ºC	51,9 ºC	54 ºC
	Older	47,9 ºC	49,5 ºC	48,6 ºC	55,1 ºC
A.m. syriaca	Newly emerged	45 ºC	53,5 ºC	45,5 ºC	57 ºC
	Older	45,5 ºC	58 ºC	48,5 ºC	54,5 ºC
A.m. ligustica	Newly emerged	41 ºC	48,5 ºC	41 ºC	56 ºC
	Older	41 ºC	55,5 ºC	40,5 ºC	55,5 ºC

Cold tolerance		Workers			
		Cluster	Lethargy	Nº dead bees	% Mortality
A.m. iberiensis	Newly emerged	16,2 - 16,8 ºC	13,9 - 14,1 ºC	0	0
	Older	16,7 - 16,8 ºC	13,9 - 14,4 ºC	14	15,55 %
A.m. syriaca	Newly emerged	No signs	No signs	0	0
	Older	No signs	No signs	0	0
A.m. ligustica	Newly emerged	16,8 - 24,5 ºC	11,2 – 13,2 ºC	8	8,88 %
	Older	10,6 - 13,8 ºC	8,7 – 10,2 ºC	0	0
		Drones			
A.m. ligustica	Newly emerged	24,7 – 26,2 ºC	15,8 – 16,3 ºC	6	10 %
	Older	18,1 -18,5 ºC	15,1 – 16,8 ºC	10	16,66 %

RESULTS



CONCLUSIONS

HEAT

- **Age and sex affect to heat tolerance in the subspecies of the honey bee, *Apis mellifera*:** drones usually show higher heat tolerance than workers, and newly emerged workers show slightly lower final threshold than foragers
- **The death by heat starts at 40,5ºC in *A.m. ligustica*, and 45ºC in *A.m. iberiensis* and *A.m. syriaca***
- *A. m. ligustica* showed the lowest tolerance to heat, suggesting a lower level of adaptation to hot environments

COLD

- **The level of cold tolerance varies between subspecies:** *A. m. iberiensis* higher than *A.m ligustica*
- **In terms of age:** newly emerged workers showed higher tolerance than foragers in *A. m. iberiensis*, whereas the opposite was true in *A. m. ligustica*.
- **Drones of *A.m. ligustica* showed lower cold tolerance than workers**
- **The highest level of cold tolerance was observed in *A.m. syriaca*,** with no signs of cold stress and hypothermia

Acknowledgements

Thanks to Teresa Corrales, Virginia Albendea , Carmen Uceta, María Gajero, Jesús García, and David de la Plaza, from CIAPA´s team, for their fantastic work in the laboratory and in the hives.

This project is part of the PRIMA programme supported by the European Union

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Italy, Jordan and Spain are three Mediterranean countries, where different local subspecies of Apis mellifera live, highly adapted to different environments. The Mediterranean is a worryingly vulnerable area in the face of climate change, and today bees are trying to adapt to new and increasingly extreme climatic environments. Both thermal tolerance and the degree of plasticity play key roles in determining the geographical distribution of species. Within the MEDIBEES project, thermal tolerance assays have been carried out comparing Apis mellifera ligustica in Italy, A.m. syriaca in Jordan, and A.m. iberiensis in Spain. Thermotolerance is defined as the temperature range between the coldest temperature (critical thermal minimum, CTmin) and the warmest temperature (critical thermal maximum, CTmax) at which an organism can maintain muscle control. From the 3 subspecies, workers and drones of different ages were exposed to two different temperature ramps: from 30 to 70ºC (heat study), and from 35 to 0ºC (cold study). Our results showed differences in both heat and cold tolerance between subspecies, as well as sex and age-related differences within all of them. In heat assay, the Iberian bees showed signs of thermal stress up to 40ºC, and both A.m. iberiensis and A.m. syriaca individuals showed hyperthermia up to 45ºC, where mortality was detected in some ages or castes. Contrastingly, A.m. ligustica showed lower heat tolerance with a mortality threshold at 41ºC in all the groups. Regarding cold-tolerance, the 3 subspecies showed different effects: while no signs of cold stress or hypothermia were detected in A.m. syriaca, all of them appeared in A.m. iberiensis and A.m. ligustica, but at different temperature ranges. In the Iberian bees, mortality occurred in foragers below 6ºC, while Italian foragers was the only group which did not show mortality by cold. Further experiments are actually carried out within MEDIBEES to property understand the molecular bases of the differences founded. These results are under the project 2011-MEDIBEES, which is part of the PRIMA programme supported by the European Union.