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Thermo regulation of honeybee (*apismellifera l.*) Hives under extreme temperatures

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Introduction

Honeybees (*Apismellifera* L.) like all insects are poikilotherm organisms, although hives as a whole behave like an homeotherm, to achieve that condition, they have developed mechanisms to regulate hive temperatures within a 33 to 36°C.[1] therefore the hive acts like a superorganism.[2] To raise the temperature within the brood chamber worker bees, produce endothermic heat by a series of involuntary quick contracting/liberating thoracic movements, liberating heat.[3,4] On the other hand, evaporating cooling mechanisms are used to decrease temperatures. It consists in carrying water towards the hive, while another group of worker bees create circular air movements by ¨fanning¨with their wings. These behaviors acting simultaneously create and active circulation of fresh humid air throughout the whole chamber, lowering its temperature.[5,6] However, it may not be sufficient enough and may cause a negative effect when the beehive is under extreme temperature conditions, since energy waste causes exhaustion.[7] It must be considered that several studies suggest that Langstroth hives, traditionally used around the world, lack insulating capacity, which directly affect microclimate and makes thermoregulation more difficult.[8-10]

Hive design for low temperatures

Low winter temperatures may represent a serious threat to beehives,[11] being the main cause of colonies losses around the world.[12] Some low-costalternatives used to improve hive temperatures has been wrapping with insulating materials to avoid energy waste by using protecting materials to decrease the loss of the heat generated by bees. Alburakiand Corona[13] demonstrated that hives wrapped with polyurethane sheets are better isolated keeping temperature and humidity within lower ranges as compared with non-isolated hives at temperatures ca. 0°C. Isolated brood chambers temperatures were around 10.20 ± 0.04 °C, while non-isolated chambers´s temperatures were 9.73 ± 0.05°C. Both conditions are far from the optimum mentioned before of (33-36°C). Nonetheless has been speculated that there is a clear potential for higher regimes. Unfortunately, such study did not evaluate bee mortality caused by thedegree of exhaustion caused to maintain such temperatures. St. Clair et al.[4] found that covering hives with 4mm thick black corrugated polypropylene plastic sheets reduced bee mortality and food consumption in commercial apiaries of Carniolan (*Apismelliferacarnica*) and Italian (*A.m.ligustica*) honey bees. Floris et al.[14] evaluated cork thermoregulation capacity finding that isolated hives kept temperatures in an adequate range of 34.7 ± 0.34, while non isolated wood hives remain at 31.49 ± 2.18. Isolated chambers kept optimum temperatures for longer periods. Evidence shows that isolating hives during the cold spell weather common in the temperate zone is a good alternative.[4,14]

Materials such as polyurethane, polystyrene and cork show lower thermal conductivity as compared with conventional wood. Building modified hives suggest that combining materials may synergistically improve their regulation capacity.[15]

Beehive design for high temperatures

Comparatively, fewer reports are available in regards of hives and materials appropriate for hot weather. At present it is known that global summer honey production has decrease.[12] Because global warming and the increase in hot spells, this situation should be taken into account.[16,17] Abou Shaara et al.[7] evaluated different types of hives under arid conditions and the most efficient in thermoregulation was equipped with refrigeration and ventilation and was capable of lowering internal hive temperature in 9.78 ± 0°C. Under such conditions, bees are not needed to thermo regulate. However, the high-costs associated with such investment and maintenance most likely will not be feasible for commercial apiaries, should rentability be taken into account. Hygroregulation is yet another mechanism bees can use with capability close to the isolated types. It consists of adding a box full of water close to the hide back side, which can decrease temperatures in the brood chamber at 8.26 ± 0.39 °C. Interestingly enough, such an approach is restricted to dry places (where water is scarce), since humid places may create sanitary risks.[18] Simultaneously, Erdoğan[19] evaluated hives using the same approach, although excluding the water box and achieved better results than those made of polyurethane and wood.

Conclusion

Indeed, more research is required to achieve appropriate designs for diverse situations, considering above all, its economic feasibility for commercial beekeepers on all scales of their activity. Although highly mechanized even robotized models are real, their adoption for commercial beekeepers still goes a long way.

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Conflicts of interest

The authors declare no conflicts of interest regarding the publication of this paper.

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