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PP-450 [Bee Biology]

Primal Bee®

Increasing Honey Bee Populations through Thermodynamic Hive Design

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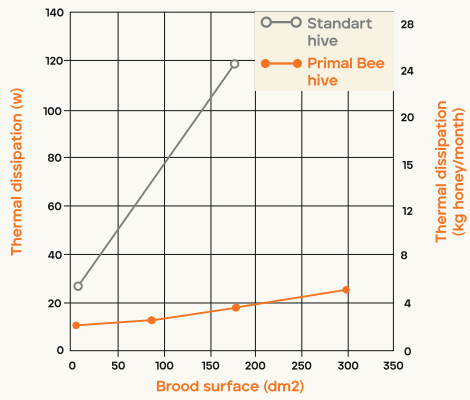
Energy as the Limiting Resource

Honey bee population dynamics are driven by each new generation of brood which develop into workers who fulfill each role allowing the colony to survive and thrive. The cost and effort to grow each new generation of brood has been defined in entomology as the honey to brood equivalence. This can be measured by the quantity of capped food storage available to the colony to produce the equivalent capped brood (next generation) area.

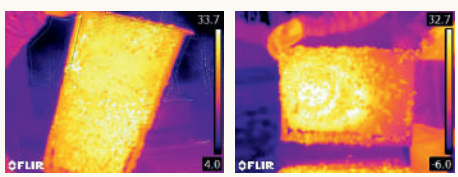


Thermal Regulation and Hive Design

This study, conducted from 2017 to 2024, aimed to develop an internal hive environment which provided honey bee colonies with optimal growth conditions. This was accomplished by applying engineering methodologies to understand 1) the dependencies of honey to brood equivalence to the hive design, and 2) to validate the innovative methodology based on new optimal hive design fulfilling the maximization of the honey to brood equivalence in the field.

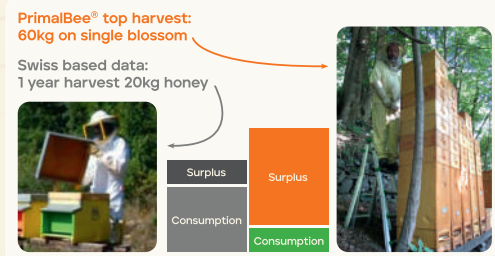
Variable Honey-to-Brood Conversion

First, methods were used to assess and measure honey to brood equivalence and rank these for the existing hives designs. Results show that 1) the honey to brood equivalence is no longer to be considered a constant, but a bee/hive combined parameter; 2) unexplored increase of bee population can be obtained with hive design: an advantage of 25% is found for standard modified hives, while a double population 200% is achieved for innovative, Primal Bee hives, compared to wooden standard hive; 3) the new hive design is fully integrated with the biological needs of honey bees and it is a fully natural solution.



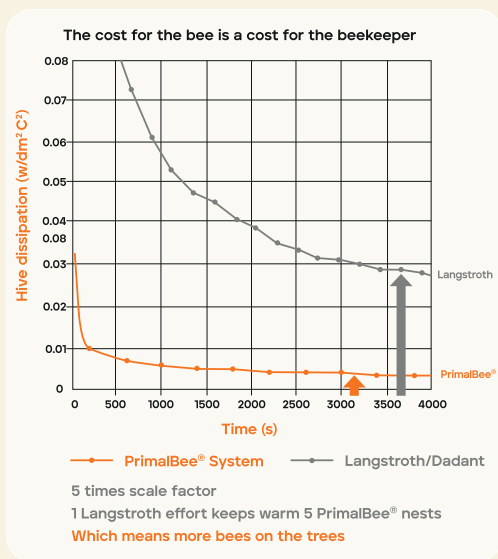
Outstanding Outcomes

Second, pilot tests were put in place in several climatic environments to test the colony response in optimal hive design. Practical advantages were found for the bees and beekeeper, including double (+200%) bee population, early blossom harvest capability, higher flight activity, higher splitting potential, and superior climate adaptability



Implications for Beekeeping Practice

These results provide a fresh perspective demonstrating significant improvements to standard beekeeping methodology resulting in stronger bee populations through enhancement of their hive environment to support their biological processes enabling the colony to overcome challenges while also providing a broad range of economic and operational advantages for beekeepers.



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Increasing Honey Bee Populations through Thermodynamic Hive Design

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The goal of beekeepers should align with the goal of their bees: to develop a strong and productive colony.
The beekeeper has three main stewardship responsibilities that impact the honey bee population: food, health and shelter. The beekeeper insures that the colony has 1) Food: including access to quality forage, provides supplemental feeding to insures food storesl; 2) Health: the beekeeper monitors their colonies and applies treatments or methodology as needed to suppress pathogens and parasites; and 3) Shelter: the beekeeper provides a hive for the colony that allows for inspection, manipulation, transportation, an appropriate volume of space to promote growth and control swarms in a hive that protects the colony from climatic and environmental impacts. This presentation demonstrates how the bee population is strongly dependent on the third responsibility of the beekeeper: Shelter in shape, size and design. To answer to the basic question on the suitability of Langstroth hive to the bee biology, an honeybee population dynamic model dependent to thermodynamic variables was built. Modern mechanical and thermal engineering techniques were used to evaluate how hive design affects heat efficiency and how this last influence the bee population dynamics. In the study, Langstroth hive, other type of standard hives, and innovative hive designs ultimately developed with optimal heat efficiency to maximize bee population growth and success are compared. The trajectories of bee populations housed in different hives were modeled for a variety of hive design characteristics such as geometry, material, heat retention and other parameters. The most important variables were identified and a prototype was built to create the most thermal efficient hive design.The prototype were used to experimentally validate the study.

At the intersection of thermodynamics and biology, the shelter design of the hive has an enormous effect on the population. With optimized heat efficiency and geometry the bee population is capable of up to 200% greater growth compared to that in standard hives. As an outcome, the thermodynamic hive design exhibits the potential to achieve double growth and population with efficient resource economics. For beekeepers, this provides a new hive design to better support their bees.