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## Science behind an Insulated Inner Cover

There have been a lot of articles over the years about Darwinian beekeeping, the best way to mimic the environment of wild hives, and common/traditional ways to minimize stress on managed bees. Since there is nothing natural about keeping bees in wooden boxes, understanding the science is crucial for maintaining healthy hives. Unfortunately, although many articles are based on the science of the wild hive, biology, earth science or physics, many are not; these are based on traditional or non-verifiable, anecdotal, methods/techniques or commonly held beliefs. Without utilizing basic science and research findings in hive management, many beekeepers may be stressing their bees instead of helping them; this can lead to colony failures throughout the year, low winter survival rates, poor brood rearing, summer losses and reduced honey yields.

The following addresses the concerns and misinformation about both over-wintering, spring build up, summer management and reducing stress on the colony along with winter feeding using basic biology, physics and earth science; not anecdotal observations.

We will show how insulating the roof of the hive year-round can help with hive survival by minimizing the energy load and maintaining a more uniform colony environment, micro-climate, with regard to temperature and humidity; homeostasis is the key. Of course everything assumes that Varroa is under control since without proper testing, treatment and follow up testing, your bees are most likely doomed.

### Basic Science

- *Bees, like all living beings, need water to metabolize food, proteins, carbohydrates and fats.*
- *Bees need water to thin out honey so it is available for consumption.*
- *Bees, like all living creatures, need water to survive since they lose water through respiration and metabolism.*
- *Bees can self-regulate and optimize colony temperature and humidity by fanning and/or generating body heat to maintain homeostasis.*
- *Bees require a humidity level of 50-70% to survive and raise brood.*
- *Bees require a temperature range of 93°-97° to raise healthy brood. If not, the nurse bees will abandon the brood.*
- *During warm weather, bees require water to cool the hive when heat stressed. Evaporation of water requires heat energy and acts to cool the hive; evaporative cooling.*
- *During cool weather, bees need to maintain heat. Condensation of water vapor creates latent heat, helping to maintain micro-climate.*
- *Bees work to maintain a tight temperature range and frames of honey act as insulators and create thermal mass; similar to how Adobe houses control temperature.*
- *Insulation slows down the transfer of heat, the higher the R-value the better the insulation and the lower the rate of heat transfer in or out of the hive.*
- *EPS (Expanded Poly Styrene) insulation does not break down or absorb moisture over time while many common expanded foam insulation materials (pink and blue foam) lose their R-value rating over time due to outgassing of blowing agents that can be released into the hive.*
- *Most non-EPS insulations absorb moisture since they are open cell.*
- *A hive in the wild, in a hollow tree, has infinite insulation above the colony and less insulation on the walls, plus a small entrance near the bottom of the colony.*
- *Adding an upper entrance or vent above the colony creates a draft through the hive that removes heat and moisture during the cool weather, plus may redistribute hive odors.*
- *Removing moisture or heat through artificial means (top ventilation, quilt boxes, etc.) adds stress to the colony since the bees need to do additional work to maintain their optimal temperature and humidity.*

## WINTER

- *Bees create a cluster to keep warm and this cluster expands or contracts to maintain a constant optimal, interior temperature for the queen and brood.*
- *The cluster moves around the hive consuming honey, staying near the center of the hive where it is the warmest and moving up as honey is consumed.*
- *Bees generally start their overwintering in the lower portion of the hive and move upwards as the winter progresses and honey is consumed.*
- *Bees Do Not heat the whole hive, just the cluster. Some heat does escape and rises so an insulating board above the inner cover helps to keep heat in the hive and prevents heat loss.*
- *Heat from the cluster rises and accumulates under an insulated inner cover to form a heat bubble.*
- *The movement of the warm, moist air creates a micro-climate with warm moisture laden air rising to the top of the hive where it condenses on the walls, cool air then drops to the bottom.*
- *The coldest part of the hive is the outer walls which are the furthest from the cluster.*
- *Moisture condenses on the coldest surfaces, the walls of the hive, away from the bees and rolls down the sides; when enough builds up, it will drain out the bottom.*
- *Excess moisture on the outer walls is available for the bees to use to thin out honey.*
- *Any hole in the inner cover, or box, acts like a chimney allowing vital heat and humidity to escape while also allowing cold air to enter from the entrance creating a dangerous draft.*
- *A sealed inner cover lets natural convection take place so the bees can maintain the optimal hive temperature and humidity, allowing brood to be effectively raised.*
- *Using any type of upper entrance creates a chimney which destroys the micro climate; this creates stress on the bees and causes them to expend energy to maintain a uniform colony environment.*
- *Brood needs to be reared in a high humidity environment, 50%-70%; drying out through ventilation or use of an absorbent material, quilt box, is detrimental.*
- *Mites do not do well in high humidity or high CO2 environments, according to recent research, while bees can tolerate both. The high CO2 actually may quiet the bees down; sealed hives create this environment.*
- *Making emergency food available during cold weather is critical for keeping hives alive when the cluster cannot move side to side within the hive to get to the stored honey.*
- *Providing food at the center of hive, below the inner cover, allows bees to access it since it is at the top of the heat column in the nest where it is readily accessible and available.*
- *Dry sugar requires a lot of energy to utilize and damages the bees tongue while syrup does not.*
- *Anything that retains heat in the hive helps to reduce the consumption of resources; i.e., Honey.*

## SUMMER

- *Bees need to maintain a uniform hive temperature and humidity to raise brood.*
- *Traditional wood covers, with or without metal tops, absorb and radiate heat into the hive while White covers reflect heat.*
- *Hives need to be cooled when the temperature rises and bees cool the hive by fanning water or nectar brought in from foraging.*
- *Reducing the heat gain with an insulated inner cover reduces the water demand on foragers and the amount of fanning needed to cool, along with reducing environmental stress.*
- *When hives get too hot, this can damage drone sperm and the sperm stored by the queen in the spermatheca which may result in brood issues and reduced queen longevity.*
- *The increased energy load from foraging for water for cooling consumes more honey while also reducing nectar foraging for a net loss of stored honey; an insulated inner cover reduces this issue.*
- *Increased honey yields are a result of stronger brood build up and reduced water foraging thanks to an insulated inner cover providing colony homeostasis.*
- *Conversion of nectar to honey requires heat energy that helps cool the hive; evaporative cooling.*
- *The faster the bees can remove the excess moisture from the nectar, the fewer cells they need to store nectar before capping and the more nectar that can be brought in.*
- *By stabilizing the hive's micro climate, there is less stress and a lower energy demand on the hive.*

### Packages/Nucs

- Packages and nucs need a stable nest environment, and food, to rapidly build comb for the queen to lay.
- Bees need to maintain uniform hive temperature and humidity ranges to raise brood.
- Reducing heat loss and maintaining nest humidity allows for a healthy brood.
- Direct feeding from the nest insures maximum food uptake and comb building without disturbing the micro-climate of the nest.
- Nipple style feeders through the inner cover hole insure direct access to syrup 24/7.
- Indirect feeding from above the nest, from a hole in the inner covers limits access to syrup since bees need to go into a cold box; bees are prone to drowning with open feeders.
- Feeding through an open hole in the inner cover allows critical heat and humidity to escape; nurse bees will abandon brood that becomes chilled even though the queen continues to lay.
- Open vents and top entrances dry out the hive which stresses young brood and act as a chimney to cool hive and chill brood.
- Condensing hives with closed top vents and entrances create a uniform micro-climate with consistent temperature and humidity in the nest to insure rapid build-up of the colony.

### Queens

- Queens continue to lay eggs continuously from Spring to Fall.
- Eggs require a fairly tight range of temperature 91°-95° and humidity 50%-70% for survival.
- Nurse bees will not raise brood if conditions are not optimal to conserve resources; reducing heat loss and maintaining nest humidity is essential for a healthy brood.
- Many brood issues may be related to environmental issues rather than queen issues.
- Homeostasis is the key for survivability of brood.

### Bee Smart Insulated Cover Benefits

- The Ultimate Insulated Inner Cover creates a more stable and uniform hive environment which translates into less stress on the bees for healthier hive that conserves resources year-round.
- The DUO™ Cover/Insulated Inner Cover System reduces heat loss during the winter and heat gain during the summer while maintaining optimal nest conditions and homeostasis year-round.
- The Ultimate Insulated Inner Cover pairs perfectly with the Ultimate Cover to create a perfect system that works on any 8-frame or 10-frame Langstroth hive.
- The Ultimate Insulated Inner Cover is designed to work in conjunction with the Ultimate Direct Feeder for Spring, Fall and Winter feeding, plus fast package and nuc build-up.
- The Ultimate Insulated Inner Cover is part of the Bee Smart System that also includes the Ultimate Cover, Ultimate IPM Bottom Board, Ultimate Robbing/Moving Screen with mouse guard and the Super Grip® Detachable Hive Handle, plus Ultimate Hive Stand.

## **Bee Smart Designs**

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