The Benefits of Providing Good Hive Insulation but No Upper Entrance in Winter

by
JOHN A. GAUT

In Northeastern USA, the conventional recommendation is to provide an upper entrance to reduce condensation at the top of the hive. Using a FLIR camera, I have observed significant heat loss through the upper entrance of my insulated hives. Dr. Tom Seeley referenced work by D. Mitchell suggesting an upper entrance was not needed! To compare hives with and without an upper entrance, I constructed clear inner covers so the cluster and condensation could be observed (Figure 1).

In the winter of 2019-2020, I compared the amounts of condensation on the inner covers of two hives, one with and one without insulation on top of its inner cover. In both hives, the inner cover had a small notch (3/8" x ¾") for a top entrance and ventilation. I also had two hives with inner covers that did *not* have the notched top entrance; again, one hive was insulated on top and one was not.

I expected to find more condensation on the inner covers of the hives that did not have a top entrance. Instead, I found that the top entrance did not make much of a difference. I also found that insulation above the inner cover did make a significant difference. **Inner covers without insulation had plentiful condensation. Inner covers with insulation had minimal condensation.**

John A. Gaut

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Fig. 1 Left: *Uninsulated inner cover: Condensation is plentiful and has frozen on the underside of this clear inner cover.* **Right:** *Insulated inner cover: Condensation is sparse and has not frozen, even on the outer edges of this clear inner cover. When the cluster expands, some bees will drink this condensation and store it in their honey stomachs (crops).*

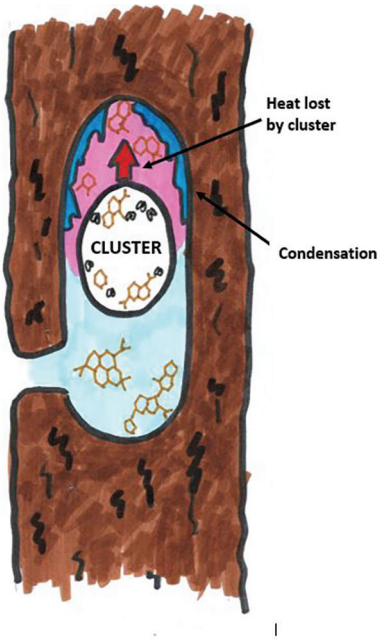
This past winter (2020-2021), I configured more colonies with insulation on the tops and the sides and without upper entrances. I have monitored the hives of these colonies for condensation on the inner covers, and have found none in the centers and either none or a very little around the perimeters of the inner covers. Looking through the clear inner covers, I could see that the winter clusters were at the tops of my hives (where it is warmest), and that the bees were not starving or wet!

Some beekeepers may have concerns if a hive does not have an upper entrance during the winter, because a top entrance gives the bees a way to get outside if the bottom entrance becomes blocked by snow or dead bees.

Over the years, I have observed that my colonies do not have problems with blocked bottom entrances. The colonies do not suffocate when the bottom entrance is blocked by snow. Heat loss from the cluster gradually melts any snow accumulation at the bottom entrance. If the snow is not melting, then this tells me that I have a "deadout." I place the hives about 8" off the ground and also configure the bottom entrance reducer with the notch up so that any accumulation of dead bees does not plug it. On warm days, the colonies without a top entrance fly as much as the colonies with a top entrance, they just use the bottom entrance instead.

A colony thermoregulates only its cluster in winter. The colony does not try to control the temperature of the entire hive interior. However, some heat is continuously lost from the cluster, and this lost heat raises the

Carolynn Gaut



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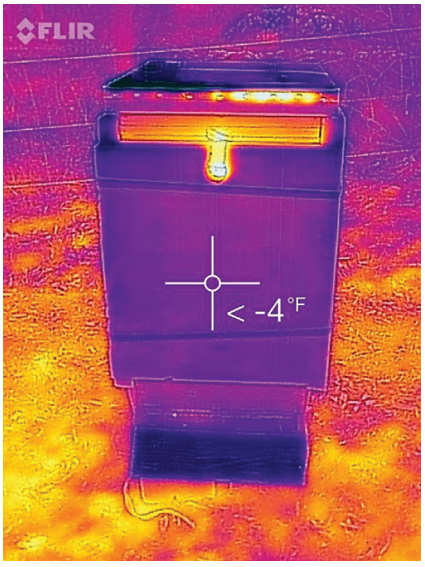


Fig. 3 Left: *An overwintering colony in a tree typically clusters at the top of the cavity. Swarms tend to select cavities with entrances at the bottom. Without an entrance at the top, the cavity retains the heat lost from the cluster. The cluster does not try to heat the cavity but some heat and moisture are lost from the cluster. If the heat lost from the cluster is retained in the cavity, then the cluster needs to work less (and consume less honey) to maintain its core temperature. Condensation is also minimized by the insulating properties of the wood. Any condensation is often collected and stored by "water bottle bees" for later use by thirsty nurse bees. From: Seeley, T. D., Morse, R. A., 1976. The nest of the honey bee (*Apis mellifera *L.). Insectes Sociaux 23: 494-512.* **Right:** *Using a FLIR camera, I have found that the continuous heat loss from a top entrance is apparent. Cold outside air enters the hive's bottom entrance as warm moist air escapes through its top entrance. The cluster must work hard to make up for this lost heat, consuming more honey. This hive has 2 inches of foam insulation (R10) on its top and sides to minimize heat loss from the hive.*

temperature of the air inside the hive that is near the cluster. By insulating the top and sides of a hive, and by eliminating the top entrance, most of the heat that is lost from the cluster is retained in the hive. If, however, there is a top entrance, then much heat escapes from the hive, the air temperature around the cluster is lowered, and the cluster must work harder to maintain cluster temperatures. Figure 2 shows the beneficial effects of using hives with insulation and without a top entrance. The air in an insulated hive is warmer than the air in an uninsulated hive. Eliminating the top entrance further raises the warmth of the air in an insulated hive. (From Derek Mitchell, "Honey Bee Engineering: Top Ventilation and Top Entrances," American Bee Journal, August 2017, pp 887-889)

As shown in Figure 3, some moisture does condense in the cavity. Dr. Thomas Seeley has observed that liquid condensation is often imbibed by the bees to quench their thirst or dilute honey to make brood food. I have observed the same behavior in my hives while observing the cluster under the clear inner cover. When there is water at the edge of the inner cover, a few bees will suck up water and store it in their honey stomachs. Dr. Seeley calls these "water reservoirs" or "water bottle bees (Figure 4)." The water bottle bees will hold the water until it is needed by nurse bees to thin the stored honey and feed the brood. Likewise, in the summer, bees will forage for water and once the demand for water in the hive is met, the water bottle bees will fill up and hold the water until needed. If the colony does not have enough water, bees will forage outside the hive for water; a very dangerous task on cold winter days.

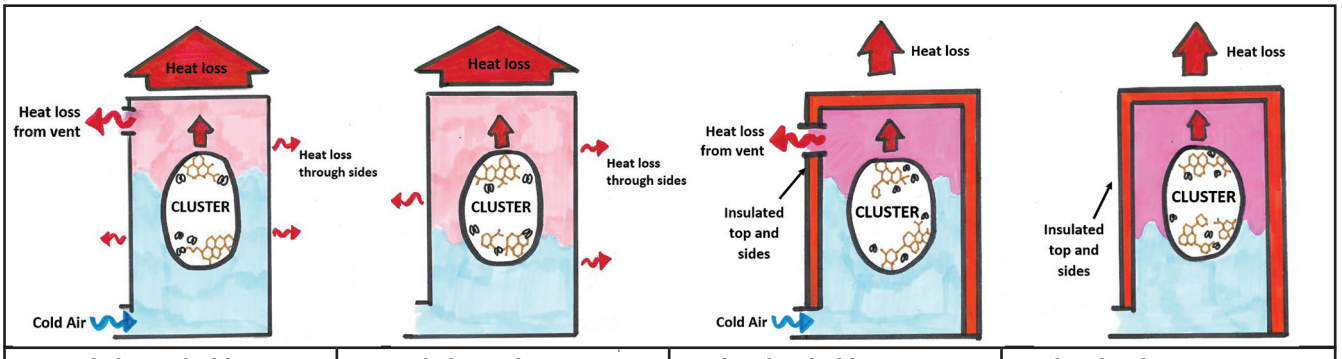
Not venting moisture from the top of the hive and allowing the humidity to increase may also result in lower mite populations. Research has shown that mite reproduction drops significantly when the relative humidity is high. Kraus and Velthuis found that at 59-68% relative humidity, 53% of mites produced offspring, whereas at 79-85% relative humidity only 2% of the mites produced offspring. ("High humidity in the honey bee (*Apis mellifera* L.) brood nest limits reproduction of the parasitic mite *Varroa jacobsoni* Oud." 1997). **By trying to keep hive interiors "dry", we may be helping the mites and stressing the bees!**

The advantages to insulating hives and eliminating the top entrance include:

- Top insulation significantly reduces condensation on the inner cover

Fig. 2

Carolynn Gaut



No Insulation and with a Vent Heat is lost through the hive sides, top, and vent.	**No Insulation and No Vent** Heat is lost through the hive sides and top only.	**Insulated and with a Vent** Heat is lost through the vent; heat losses though hive sides and top are minimized.	**Insulated and No Vent** Heat is not lost through the vent; heat losses through hive sides and top are minimized.

Movie and Photograph by John A. Gaut, January 2021

Fig. 4 Water bottle bees filling up: *This hive has a clear inner cover without a top entrance. There is insulation above the inner cover that minimizes condensation. There were a few bees filling up with water! Dr. Seeley calls these "water bottle bees." They will store water for the colony. The water is needed to dilute the honey and produce brood food. The water bottle bees would forage outside the hive if there were no condensate available in the hive, a much more dangerous task in the cold weather.*
While too much condensation is not good for a colony, a little condensation is beneficial. Watch video at ***http://www.nnjbees.org/wp-content/uploads/2021/02/Water-Bottle-Bees.mov***

- Top and side insulation keeps the upper part of the hive warmer, and thus the cluster looser
- The cluster is better able to move to food stores
- **No heat loss from the upper entrance/vent hole**
- **Colony consumes less honey because the cluster does not need to work as hard to maintain core cluster temperature**
- **Colony recycles condensation to thin honey and produce brood food**

Insulating the top of the hive and eliminating the top entrance can be very beneficial for the wintering colony.

I would like to thank Dr. Thomas D. Seeley for suggesting I write this article. I also greatly appreciate his input!

Note: I first heard Dr. Seeley use the term "water bottle bees" in one of his presentations. In his recent book, "The Lives of Bees," he uses a similar term "water reservoirs," referring to bees with their honey stomachs full of water standing quietly on the combs.

John A. Gaut, an EAS Certified Master Beekeeper, has a decades-long relationship with honey bees, having managed a dozen hives on his family's dairy farm in Pennsylvania when he was in high school.

John is a graduate of The Pennsylvania State University with an Agricultural Engineering degree, and applies engineering principles to beekeeping. As a result, John is a data-driven beekeeper and strives to practice precision apiculture.

He now has hives in multiple locations in northern New Jersey. Honey from his production hives is sold at a local farm store. John also raises queens from his own locally-adapted stock for other beekeepers in his area.