CORNELL UNIVERSITY MASTER BEEKEEPER PROGRAM

THE Bee-Files
Dyce Laboratory for Honey Bee Studies
Department of Entomology
Cornell University
Ithaca, New York

Drone Brood Removal for the Management of *Varroa destructor*

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Fig. 1: *Varroa destructor* on worker bee.

January in the North Country always raises concerns about winter losses; and once again, we are hoping that winter will not be too harsh on our bees. Of course, successful wintering depends on many things, two of the more important being the strength and health of a colony's worker population in the fall. In Ithaca, NY we like to see healthy bees boiling out of two deeps or bearded up on the fronts of the hives after removing the crop at the end of the goldenrod flow. One of the biggest obstacles to the maintenance of strong, healthy colonies is the parasitic mite *V. destructor.*

Mite damage can occur for several reasons, including pesticide resistance in the mite population, heavy re-infestation pressure from nearby colonies, failure to monitor mite levels, and failure to treat often enough or at the right time. When mite populations rise to dangerous levels, a number of symptoms become apparent. These include deformed wings, deteriorating brood, bees crawling at the entrance, unable to fly and declining worker populations. These symptoms, collectively designated parasitic mite syndrome (Shimanuki et al. 1994), are largely the result of elevated virus levels associated with *V. destructor*. Unfortunately, by the time you see them, your colonies have already been damaged, and their ability to survive the winter may be compromised.

Symptoms of parasitic mite syndrome typical with high levels of *V. destructor*

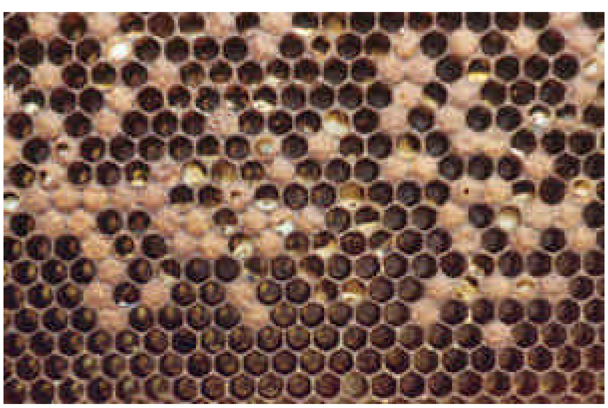

Fig. 2a: deteriorating brood

Fig. 2b: worker with deformed wings

One of the most important tools in the fight against *V. destructor* is scheduled maintenance in the form of regular colony inspections for signs of parasitic mite syndrome and regular monitoring of mite levels. Whenever you observe a colony with high mite levels or with any evidence of parasitic mite syndrome, you should remove all marketable honey and apply an effective miticide. If this occurs in mid-summer, the colony has time to recover because it can still produce several generations of healthy workers in a low-mite environment before going into winter. However, in the north, these symptoms often occur during or just prior to the fall flow, a time when most beekeepers are reluctant to treat, as that means contaminating the fall crop. As a result, affected colonies often die during the fall flow or shortly thereafter, even if an effective miticide is eventually applied. Some colonies with less serious damage may persist through the winter, only to emerge the following spring as grossly sub-standard units.

So, while monitoring can play an important role in limiting mite damage, you should also consider adopting preventative management practices that keeps mite levels low throughout the summer and early fall. That way, you don't have to worry about colonies collapsing in the fall or dying over the winter. Drone brood removal is one method that will dramatically suppress the growth of the mite population during the brood-rearing season and ensure that you have strong, healthy colonies going into winter.

Biological basis: Drone brood removal is based on three aspects of the mite's biology. First, mites spend most of their time in capped brood cells. Second, they can be found 5 -12 times as often in cells with drone brood as in those with worker brood. Third, mites using worker brood as a host average 1.3 – 1.4 offspring, while those using drone brood average 2.2 – 2.6 offspring. So, by removing capped drone brood from an infected colony, you remove a disproportionately large number of mites without affecting the worker population, and you remove those mites with the highest fecundity. As a result, you suppress the growth of the mite population during the brood rearing season.

In Europe, where drone brood removal has been used for many years, the practice typically involves the construction of special combs, the destruction of drone brood with the requirement that colonies build replacement drone comb, and short replacement intervals. Other methods combine drone brood removal with labor intensive techniques such as a heat treatment, swarm control measures, or a short broodless period created by temporarily caging the queen. While effective, the extra time required to implement these methods has limited their widespread adoption by beekeepers in the US, although some positive findings have been reported in US bee journals. Recently, I conducted a study to determine if a simple implementation of the drone brood removal method using commonly available equipment would maintain mite populations at low levels until the end of the fall flow and the beginning of a legal treatment window. Here is how I did it.

Fig. 3: Comb of capped drone brood being removed from colony

Experimental: Experimental colonies (n = 42) were treated with CheckMite+ in the fall of 2002. The following spring, quantities of bees and brood were equalized, but colonies were not retreated. The brood nest of each colony consisted of 18 full-depth worker combs and 2 full-depth drone combs housed in two, 10-frame hive bodies. Each worker comb had = 2.0 in^2 of drone cells. Drone combs were kept 2 or 3 combs in from either side of the upper brood chamber. Standard management practices were used throughout the season, including the addition of honey supers above a queen excluder. Colonies were randomly assigned to one of three apiaries, and within each apiary, to one of two groups: control or treatment. In the control groups, drone combs remained in place throughout the season. In the treatment groups, drone combs (Fig. 3) were removed on 16 June, 16 July, 16 August and 16 September and replaced with empty drone combs (16 June) or with drone combs removed on the previous replacement date. Combs were kept in a freezer when not in a colony.

Results: An average of over 7,000 cells of capped drone brood was removed from each treatment colony over the course of the summer. On 7 October, 2003 the average mite-to-bee ratio in the control group was 0.109 ± 0.017 (lsmean ± SE), compared to 0.025 ± 0.016 in the treatment group (Fig. 4), about a 5-fold difference. However, the differences varied among apiaries. In two of the three apiaries, differences were highly significant ($P < 0.0001$), being about 5-fold in one and 10-fold in the other. In the third apiary, mite populations were low in both the treatment and control groups. The reason for the low levels in the control colonies in that yard are not known, but presumably reflect environmental effects on population growth rates. (Note: A ratio of 0.10 translates to 1/10 of a mite per bee or 10 mites per 100 bees. A ratio of 0.01 translates to 1/100 of a mite per bee or 1 mite per 100 bees.)

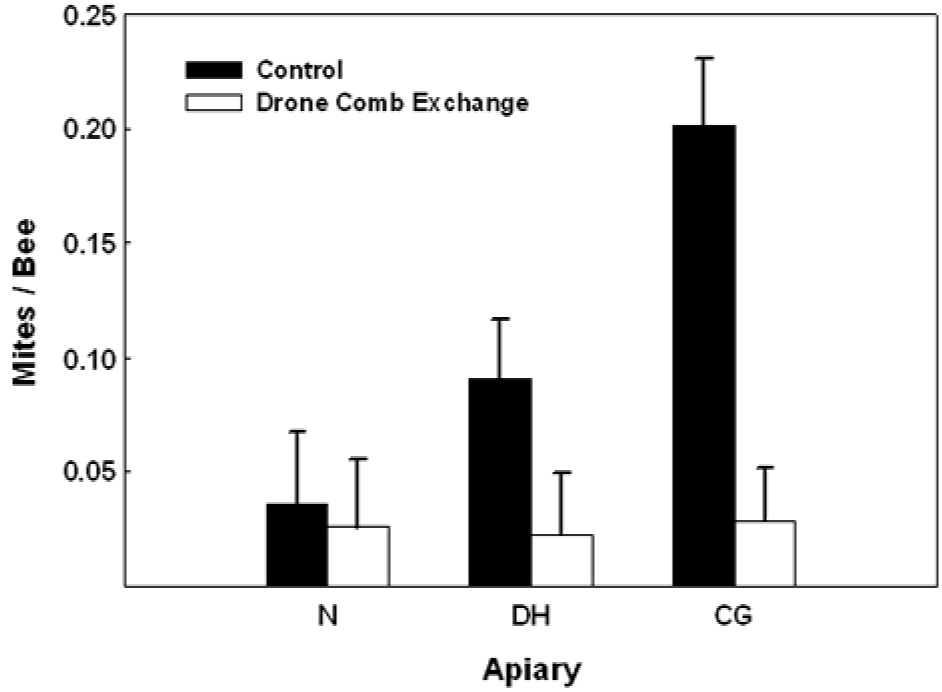

Fig. 4: Mite-to-bee ratios on 7 October in colonies with and without drone brood removal in three apiaries. Ratios were significantly different ($P < 0.001$) in the DH and CG apiaries.

Overall, mite-to-bee ratios in the control colonies ranged from 0.012 to 0.441; but only from 0.000 to 0.070 in the treatment colonies. Strange and Sheppard (2001) reported that colonies with an early October ratio < 0.01 (that's = 2 mites on a 300-bee ether roll) did not require a fall treatment. Their study was done in the northwest, near the WA-ID border, where the duration of the winter and winter temperatures are similar to those in the northeast. In my study, several of the treatment colonies had mite levels below the 0.01 threshold. Mite levels in the other treatment colonies were not high enough to have caused any damage, but they exceeded the 0.01 threshold and required treatment to prevent damage over the winter. The important point is that the mite levels in the treatment colonies (all = 0.07) were not yet high enough to have affected colony strength, health or wintering success, even though the colonies had not received a miticide treatment for an entire year.

To assess possible adverse affects of this method on colony health, I also measured fall worker populations and seasonal honey production. Worker populations were statistically indistinguishable in the two groups. Honey production in the treatment group was greater than or equal to that in the control group. See the pdf file of Calderone 2005 at masterbeekeeper.org for more details.

Implementation: You will need four drone combs per colony (plus a few extra). You can purchase drone foundation from a bee supply house and wire it into frames. Use four horizontal wires, as drone foundation has no vertical crimped wires. One-piece plastic drone combs are also available. Between 26 and 30 days before anticipated apple blossom, place two drone combs in the upper brood chamber of your hive, one or two combs in from each side. From apple blossom until the end of the goldenrod flow, visit your bees every 26-30 days, remove the drone combs, and replace them with empty drone combs or with drone combs that you removed on the previous replacement date. Keep the combs you remove in a freezer until you are ready for your next exchange, but let them warm up right before returning them to your colonies.

You can shorten the interval between comb exchanges, but do not extend it beyond 30 days or you may have too many drones with mites emerging in your hive. If a drone comb becomes filled with honey, you will need to replace it with an empty drone comb and extract the honey from it before reusing it. In the north, you can exchange combs up to eight times a season using the 26-30 day interval between exchanges. To attain the efficacy I observed in my study, you will need to cull worker combs with more than two square inches of drone cells (Fig. 5). Remember! The goal is to get a colony to consolidate its drone production in the removable drone combs.

Summary: Drone brood removal will not completely eliminate the need for miticides; however, it will allow you to treat once a year and still maintain strong, healthy colonies that can successfully survive the winter. We are working on fine tuning this method. Specifically, we want to know how many times you need to exchange drone combs during the season to ensure strong, healthy fall colonies going into winter. The four exchanges used here may be more than are needed. Presumably, the fewer times you need to do this, the greater the number of beekeepers that would be willing to do it.

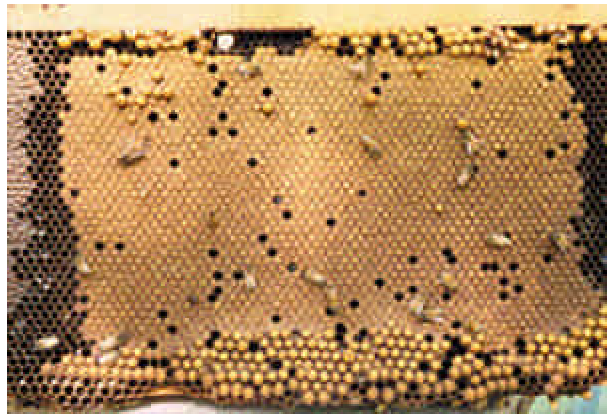

Fig. 5: Worker comb with excessive drone brood along the bottom. This comb should be removed from the colony and replaced with a better comb

- The maximum 30 day interval for exchanging drone combs differs from the 24 day development period for drones. There are several reasons for this. First, workers must spend 1-2 days cleaning out combs after they are returned to the hive before they can be reused. Second, the queen takes 2-4 days to fill the drone combs with eggs. So, a few drones may emerge in the hive with a 30 day interval, but not too many.
- Keeping the drone combs frozen between exchanges keeps the brood fresh and provides the bees with a tasty protein meal when they are returned. This may allow the colony to recoup much of its investment in the drone brood, thereby helping to keep the colony strong. Do not feed combs of decayed brood to your bees.
- Some concern has been voiced over the possibility that this method will select for mites that prefer worker brood. While I have learned to 'never say never', there are several reason why this is unlikely to be a problem. First, efforts to select for mites that prefer worker brood have not been successful. Further, if there were to be a problem, one could stop using the method, and the mite population would likely revert to its 'preferred' state.
- Another concern is that this method will reduce the number of drones available for mating. This could be a problem. However, this method does not eliminate all drones from a colony, and if there are feral colonies in the area, there should be more than enough drones for virgins to mate with. However, without further refinements, this method would not be desirable for managing mites in a queen rearing operation.
- As with any new management protocol, evaluate this method on a few of your colonies to determine how well it works for you. As you become more comfortable with the method, you can expand it to more of your operation.

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