SmallCellFoundation And Varroa Mites

In three independent experimental replicates, we compared biometrics of *Varroa* mite and honey bee populations in bee colonies housed on one of two brood cell types: small-cell or conventional-cell.

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I can't imagine being a beekeeper when *Varroa* mites first landed on our shores and began their destructive march across the U.S. What a feeling of hopelessness it must have been knowing there was little to nothing you could do to protect your colonies from the onslaught that was about to occur. Aware of reports that mites were just a state or county away and within days or weeks your healthy colonies were about to encounter a pest they would have no defense against would have been maddening. These blood sucking ecto-parasites rampaged colonies from sea to shinning sea and by 1991, Kentucky, the last state thought to detect their presence, finally surrendered.

Within a year of *Varroa's* arrival, Apistan®, a fluvalinate based product, was quick to emerge as the cure-all against mites. In 1993 Miticur®, an amitraz formulation became available on the market. However, shortly following its introduction came a lawsuit charging the product damaged numerous colonies in central Florida. Therefore, it was pulled from shelves disappearing almost as quickly as it appeared. This left only one registered chemical available to beekeepers. Hence, it was only a matter of time before the effectiveness of this chemical began to diminish. As reports of mite resistance became increasingly numerous, a coumaphos based chemical treatment arrived on the scene in the late 90s. At the time chemicals may have been necessary but we all knew this was not the long-term solution.

Since their arrival beekeepers have been experimenting with a variety of non-chemical or "soft" methods for ridding colonies of mites and their destructive behavior. Garlic powder and tea tree oil, camphor and wintergreen tinctures, foggers and smokers stuffed with sumac, grapefruit leaves, mineral oil and tobacco were some of the ideas tested. Researchers across the country were also diligently exploring alternatives to chemicals using Integrated Pest Management strategies – resistant stock, drone trapping, powder sugar and bottom screens.

Several years ago a good friend, Bill Owens, and I were talking about never again dumping chemicals into our colonies. He informed me about something he had been reading on the internet, small cell foundation. He was so influenced by the success stories being told he started to regress his colonies down to the smaller 4.9 cell size. Providing nothing other than small cell combs, it became his only method for *Varroa* control. Over time as he watched his colonies thrive without chemical intervention he was convinced, small cell was the answer. So we decided to test this assumption here at the UGA bee lab. Over a three-year period we compared small cell to conventional cell comb to see if it impeded *Varroa* mite population growth in honey bee colonies. The following is a condensed version of our paper which has been submitted for publication in *Apidologie*.

Mite reproduction is limited to the brood cells of its host bee, and it is clear in free-choice studies that *Varroa* preferentially enter comparatively larger brood cells. When Message and Gonçalves (1995) compared brood reared in small worker cells produced by Africanized bees with brood reared in large cells produced by European bees, they found a two-fold increase in mite infestation rates in the larger cells. When Piccirillo and De Jong (2003) compared *Varroa* infestation rates in three types of brood comb with different cell sizes (inner width), 4.84 mm, 5.16 mm, or 5.27 mm, they found that the percentage of cells infested was significantly higher in the largest cells compared to the other two groups.

These kinds of observations have led to an interest among beekeepers in downsizing comb foundations as a cultural control against *Varroa*. In North America, the resulting "small-cell" foundation measures 4.9 mm (Dadant & Sons, Hamilton, IL, USA) compared to that of conventional foundation measuring between 5.2 mm and 5.4 mm. These numbers are derived by measuring the width of 10 cells in a straight line, inclusive of wall widths. In this study we challenged a null hypothesis of no difference in *Varroa* and bee population metrics between bee colonies housed on combs of small-cell or conventional-cell foundation.

In three independent experimental replicates, we compared biometrics of *Varroa* mite and honey bee populations in bee colonies housed on one of two brood cell types: small-cell or conventional-cell. Small-cell foundation was drawn out by colonies containing honey bees which had themselves been reared in small-cell

combs. Conventional foundation was similarly drawn out by colonies whose bees were derived from conventional combs. Once combs were drawn we determined realized cell width (walls inclusive) by counting the number of cells in 10 cm linear (*n*=60 samples each cell type). Cell width from small-cell combs was 4.9 ± 0.08 mm and from conventional- 5.3 ± 0.04 mm. Ten of the hives each contained 10 frames of drawn small-cell comb, and the other 10 contained drawn conventional-cell comb.

Bees were collected from a variety of existing colonies (irrespective of rearing history) and combined in large cages to achieve a homogeneous mixture of bees and *Varroa* mites. Twenty screened packages were made up then transported to a test apiary in Oconee County, Georgia where each was used to stock one of 20 single-story deep Langstroth hives. One alcohol sample of *ca* 300 bees was collected from each package to derive starting mite:adult bee ratios and, by extrapolation, beginning mite populations (colonies were broodless so all mites were phoretic on adults). Queens from a single commercial source were introduced into colonies. All colonies received sugar syrup and pollen patties. Colonies were removed from the experiment if they died or their queens failed.

We collected the following ending parameters: daily mite counts on bottom board sticky sheets (72-h exposure), average mites per adult bee recovered from alcohol samples (*ca*. 100-300 bees), mites per 100 cells of capped brood, and brood area (cm^2). A measure of ending bee population was made by summing the proportions of whole deep frames covered by bees (after Skinner *et al.,* 2001) then converting frames of adult bees to bee populations with the regression model of Burgett and Burikam (1985). Brood area (cm^2) was converted to cells of brood after determining average cell density as 3.93 per cm^2 for conventional-cells and 4.63 for small-cell. From cells of brood we calculated the number of cells sealed by applying the multiplier of 0.53 derived by Delaplane (1999). From mites on adult bees and mites in brood we could derive ending mite populations and percentage of mite population in brood – a positive indicator of the fecundity of a mite population (Harbo and Harris, 1999). Finally, for the Aug 2006 colonies we sampled adult bees in Oct 2006 for average body weight

Although a significant and favorable trend for small-cell colonies was indicated for ending bee populations the chief interest in small-cell technology resides in its potential as a non-chemical limiter of *Varroa* population growth. By this criterion, the present results are not encouraging. The ending number of mites in brood, percentage of mite population in brood, and mites per 100 adult bees were significantly higher in small-cell colonies (Table 1). Moreover, with all remaining ending *Varroa* population metrics, mean trends were unfavorable for small cell as well (Table 1). We conclude that small-cell comb technology does not impede *Varroa* population growth. This null conclusion is reinforced by the facts that: (1) the experiment was replicated independently three times with start dates varying between spring and fall and test periods ranging from 12-40 weeks, (2) there were no interactions between start date and treatment for ending *Varroa* metrics, showing that responses were consistent across experiments, (3) the question of *Varroa* population growth was examined holistically with six dependent variables, and finally (4) the bar for performance should be high before a candidate technology is recommended for field use. It is worth noting that *Varroa* densities in this study (3.3 – 5.1 mites per 100 bees, Table 1) were not within the action threshold of *ca*. 13 mites per 100 bees shown for the region by Delaplane and Hood (1999).

Interest in small-cell foundation has been fueled in part by observations of Martin and Kryger (2002) that conditions which constrict the space between the host pupa and male protonymph mite promote male mite mortality. However, as these authors point out, "reducing cell sizes as a mite control method will probably fail to be effective since the bees are likely to respond by rearing correspondingly smaller bees." Our study supports this deduction directly, and its premise indirectly: average bee live weight in October was numerically smaller in small-cell colonies than conventional (Table 1).

Ours is not the only lab to examine small cell foundation as an IPM tool for managing *Varroa* mites. This year the Florida Department of Agriculture and Consumer services published their small cell study in *Experimental and Applied Acarology* (2009) 47:311-316.

Other than a few differences in the methods and materials each study was fairly similar. First they had a one-year trial with 30 experimental colonies (15 small cell- 15 conventional cell). Second, all colonies were located in the same area however to discourage horizontal transmission of mites between groups, small cell and conventional cell colonies were in separate apiaries.

Table I. Mean values (± se) for bee and *Varroa* population metrics in bee colonies housed on conventional- sized brood cells or small cells. Colonies of both cell types were set up in August 2006 (15966 bees), March 2007 (11612 bees), or April 2008 (10886 bees). Ending data were collected in June 2007 (August 2006 and March 2007 colonies) and August 2008 (April 2008 colonies). A one-time measure of adult bee live weight was made October 2006 for August 2006 colonies. The occurrence of significant treatment effects (á ≤ 0.05) is indicated by *.

Variable	Conventional-cell	Small-cell
Beginning Colony mite population	303.1 ± 61.4	308.6 ± 54.1
Adult bee weight (mg) Oct 2006	141.3 ± 6.7	129.3 ± 5.7
Ending cm^2 brood	6320 ± 681	5627 ± 490
Ending cells of brood	24838 ± 2675	26053 ± 2271
Ending mites per 24 hr sticky sheet	17.4 ± 5.0	28.3 ± 6.0
Ending mites per 100 brood cells	0.9 ± 0.2	2.8 ± 0.6
Ending colony mite pop.	409.7 ± 93.4	670.5 ± 112.5
Ending mites in brood	134.5 ± 38.7	359.7 ± 87.4*
Ending % mite pop. in brood	26.8 ± 6.7	49.4 ± 7.1*
Ending mites per 100 adult bees	3.3 ± 0.5	5.1 ± 0.9*

Variables measured were also the same with results again being very similar. To summarize their findings; cm^2 total of brood, total mites per colony, mites per brood cell and mites per adult bee had statistically similar averaged values with some of those values being identical in both of the treatment groups (small and conventional cell). Also, by the end of the study mite levels in both treatments had surpassed the economic threshold. Hence, they concluded that no evidence was found to support anecdotal claims that small cell foundation will reduce *Varroa* mites and without further data cannot recommend it as a method for controlling *Varroa* mites.

Last year researchers at the Ruakura Research Centre in Hamilton, New Zealand also examined the effects of worker brood cell size on *Varroa* mite infestation and reproduction levels. The original research article has been published in the *Journal of Apicultural Research* and *Bee World* 47(4): 239-242 (2008). Their methods and materials were much different than the two studies previously mentioned.

Five different foundations with widths of 4.7, 4.8, 5.0, 5.1, and 5.4 mm were used. Six sheets of each foundation type were drawn out in honey supers I'm assuming to avoid brood being reared in the comb. Then 50 x 80 mm rectangular sections were cut out from each foundation type and randomly inserted into the center of newly drawn deep frames that measured 5.4 mm. The sections were held together in the deep frames with melted wax.

The trouble with experiments is that they have a knack for demolishing good ideas. Aristotle was full of good ideas. In fact, his ideas about the natural world were so reasonable that they held unquestioned authority for over a millenium until the so-called enlightenment of the seventeenth and eighteenth centuries engendered investigative methods that mitigate against bias and presupposition. From this point on, arm-chair science was doomed, and many a brilliant idea has since been ship-wrecked by the unforgiving objectivity of the scientific method.

A total of ten nucleus colonies each were set up with two of the above mosaic frames, a frame of worker brood infested with Varroa, a frame of honey, adult bees infested with Varroa and a mated sister queen. Colonies were monitored to insure queens were laying well in each of the foundation sections.

For each of the foundation types between 234 and 440 evenly drawn cells were uncapped and the internal width of each cell measured for a grand total of 1636. Number of adult female *Varroa* mites and female *Varroa* deutonymphs were recorded along with the age of the pupae (determined by eye color).

Mite infestation ranged from 28% to 47%. The 4.8mm foundation size had a significantly higher infestation (46.6%) of mites than the others with the 5.4mm coming in with the lowest infestation of 27.7%. In this particular mite choice study the mites preferred the smaller cells than the larger ones. They too concluded that small cell does not reduce infestation by *Varroa* and therefore offers no solution to the mite issues in New Zealand.

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