Analysis of small cell test designs

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ERIK ÖSTERLUND

Smaller cells in the broodnest than what is most common today, does it have any advantages? Particularly – does it have any advantages concerning Varroa resistance for the bee colony? Bees naturally build different sizes of cells depending on where they are built in the nest, smallest downward nearest the entrance where the brood is and biggest upwards and away from the entrance where honey is stored.

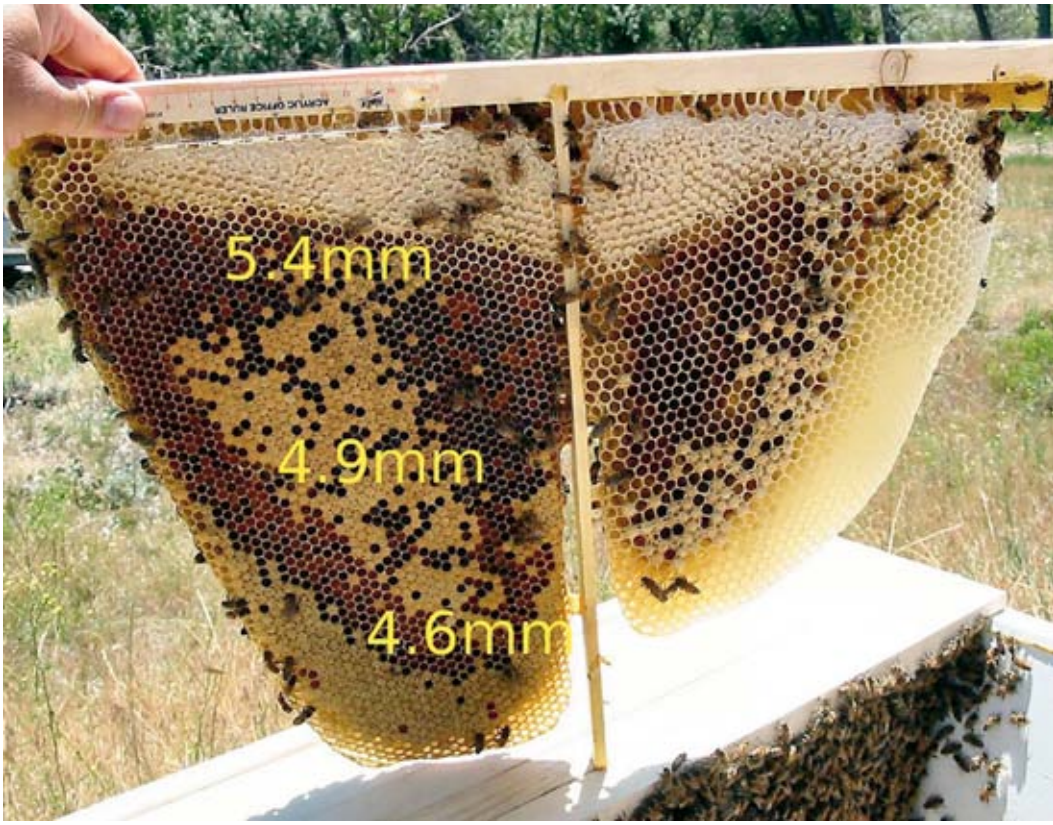


Photo: Dennis Murell

Wax foundation

When wax foundation first was made in a commercial scale, beginning with A. I. Root in USA in 1876, natural comb evidently was measured and an average became the guideline to choose the easily manageable size 5 cells to the inch[1], which is 5.08 mm per cell including one cell wall. This is easiest measured over the parallel sides taking 10 cells at a time and divide by 10. The actual average was said to be somewhat bigger. This meant that in the broodnest the average was still smaller – remember, the average. And the average for honey storage cell sizes were of course bigger.

Small Cells – Natural or Negative

DIFFERENT KINDS OF CELLS IN THE HONEY-COMB.

The bees build two distinct, regular sizes—drone and worker cells. The worker-comb measures very nearly five cells to the inch, on an average. Some specimens average a little larger, and some a little smaller; but

fore this measure has been adopted for the comb foundation.[88] If there are five cells to

Root A I ABC, 1884 s 146

RAISING AND INTRODUCTION OF QUEENS. 315

The last point (size) is one upon which great misapprehension abounds. The idea that it is desirable to increase the dimensions of our bees is all but universal, and, since I have ventured, more than once, to stand alone in condemning it, I must give my reasons for so doing. *Apis dorsata* has been hunted

Frank R. Cheshire, Bees and Bee-keeping, Vol II (1888)
L. Upcott Gill, London

176 BEES AND BEE-KEEPING.

—	Diameter.	Length.
Worker cell	$\frac{1}{5}$in.	$\frac{1}{3\frac{2}{3}}$in.
Drone cell	$\frac{1}{4}$in.	$\frac{9}{16}$in.

Frank R. Cheshire
Vol I (1888)
L. Upcott Gill

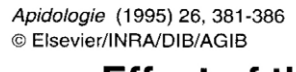
1/5 inch = 5,08 mm

Two early works investigating small cells influence on Varroa mites. Both done in Brazil under circumstances differing from those made in Europe, USA and New Zealand. They showed a significant advantage of small cells.


GMR Genetics and Molecular Research

The influence of brood comb cell size on the reproductive behavior of the ectoparasitic mite *Varroa destructor* in Africanized honey bee colonies

Giancarlo A. Piccirillo[1,2] and D. De Jong[3]


Apidologie (1995) 26, 381-386
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Effect of the size of worker brood cells of Africanized honey bees on infestation and reproduction of the ectoparasitic mite *Varroa jacobsoni* Oud

D Message , LS Gonçalves

Already in 1888 Frank Cheshire in England wrote in his *Bees and Beekeeping, Vol II*[2]: *"The idea that it is desirable to increase the dimension of our bees … I have ventured, more than once to stand alone in condemning it…."* This enlargement was achieved by increasing the size of the cells.

0

A century later

100 years later it was rediscovered by Dee and Ed Lusby that bees naturally build different cell sizes. Bee Culture was among the first to publish works on small cell size in 1990, Erickson et al, *On the size of cells.* Soon there were articles and papers published supporting the idea that smaller cell sizes contributed to varroa resistance, by Erickson[3], Lusbys[4], Message&Goncalves[5] and Piccirillo&DeJong[6]. Also anecdotal reports in forums etc appeared. And many began testing small cells (SC). Small cells are 4.8-5.1 mm. Mostly mentioned is 4.9 mm. Commercial foundation varied between 5.3-5.7 mm in their cell size.

Later tests did not verify the first research papers from Brazil. It seemed to become common among researchers to dismiss the first positive results as associated with Africanized bees. Especially those whose own tests didn't show any advantages for SC. In 2008 and 2009 there were some tests published that have been used to make a "final" statement that "the case is closed" concerning difference in influence on varroa resistance from small (SC) or large (LC) cells.

If there had been only one positive test showing SC had positive influence on Varroa resistance it wouldn't had been strange to dismiss it in the light of later tests. It's often said that one time is no time in research context. But the first paper by Message & Goncalves in Apidologie 1995 was verified by Piccirillo & De Jong in Genetics and Molecular Research in 2003, even if it wasn't a true replication test.

The natural response to later tests that did not verify these two papers would have been to investigate what was in common between the two positive papers and what differed between the positive and the not positive ones. But no such investigation has been able to be found. Why not? It is a natural scientific response to do so. I will try to do this here.

Differences between the first Brazilian and most later tests

1. The tests were done in **South America**

2. **Africanized** bees were the common bee

3. Bees in the test were **resistant** to Varroa

4. The test bees were normally living **on small cells** (SC)

5. **No** or few **large cell** (LC) bees were in the neighbourhood

6. The bees had **never** or very little **been treated** with chemicals for anything

7. The **wax** in the comb were **free from chemical** residues

8. **Epigentic** differences due to the mentioned environment differences.

Important differences

In the context of scientific research these differences may be crucial and should not be taken lightly. They could be the explanation for the differing results and should be taken in account for new research before the conclusion ”case is closed” could be made.

It must be of uttermost interest to investigate the differences in test context for theses positive tests and tests not being positive. Note that there are no tests showing it’s negative to use SC!

1. Could the results be dismissed because these tests were made in South America?
No, climate may influence, but no research verifies any hypothesis that all bees in the tropics are resistant to the Varroa mite. Not resistant bees are kept in similar climate.

2. Could the results be dismissed because the bees in these tests were Africanized?
No, There is no research showing any such differences between African and European honeybees. On the contrary these types of bees are both *Apis Mellifera*, closely related and interbreed easily.

3. Bees in other tests have not been resistant to Varroa. This is an interesting difference. Today there are reports of quite some beekeepers in different places not treating at all for Varroa mites and bees seem to tolerate the presence of mites and still produce normally. There are SC and other bees among those. There are tests showing most probable reasons

for the resistance are changes in the behaviour of the bees. Could these changes in behaviour in some way have effects on the bees' relation to an SC environment?

4. When bees are born in SC they may well have been fed differently. And bees born in SC may well be feeding larvae differently. Differences in feeding behaviour have been shown in SC-colonies. Different feeding has influence on the phenotype of bees. How big behaviour differences are resulting? In the Brazil tests the nurse bees have been born in SC and fed by SC-bees. In most of the other tests the nurse bees have been born in LC and fed by LC bees.

5. There is a growing awareness of the influence of the exchange of bees between bee colonies. It can be quite big under certain circumstances. Two of the causes are drifting and robbing. Robbing can be slow, almost not noticeable, and it can be intensive. This exchange of bees can be destructive for the possibilities to get an accurate test result. Even 1.5 km can be too short distance to avoid significant not wanted influence.[7]

6. When bees are treated with something that kills parasites or microbes, they are loosing also beneficial microbes. This can influence their immune system and their behavior. In the short perspective of course it's understandable if a beekeeper chooses to save his bees from dying.

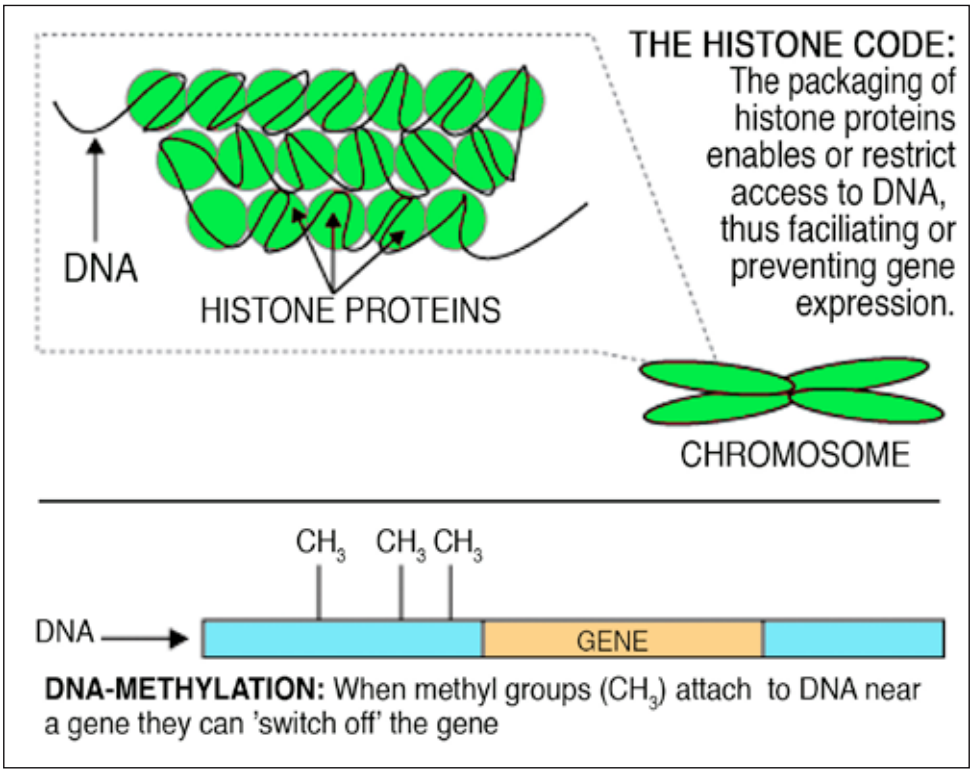
7. Wax in combs has been found to contain a substantial amount of different chemical residues from varroa treatments, AFB treatments and plant protection sprays. That of course applies for such environments where such a result is possible, which applies for many areas in North America and Europe. Chemicals in sublethal doses are known to influence immune system and bee behavior in a negative way.

8. Heritable changes take place in the genom of all living beings, also bees, depending on changes in the environment. It's been more and more discussed among genetics. It's called epigenetics as the changes is not taking place in the composition of the DNA in the chromosomes, but in how the genes and even fractions of genes are expressed, "turning them on' or 'turning them off'. This effects the production of proteins and thus the phenotype of the bee.[8]

Epigenetics

Epigenetic adjustments are inheritable to the next generations and when environment changes again there will be new epigenetic changes. This is a powerful way for animals and plants to adapt to new environments. Actually there is no other way to explain the formation of resistant Apis

Changes in the Histone Code and DNA-methylation are made due to changes in the environment which causes changes in the production of proteins. These are two epigentic processes. The changes are inherited, until the environment changes again.



mellifera bees in South America in the 1980s and in South Africa in the 2000s[9]. In both cases it took about 5 years for Apis mellifera bees to develop resistance, and without masses of bees dying from the Varroa mites. What was seen was a decrease of a 50 % mite infestation (one mite on every second bee) to about 5 % mite infestation (one mite on every 20th bee). And this was achieved with the conditions described in paragraphs 2, 4, 5, 6 and 7.

Not the natural host

The paragraph describing a difference of the composition of the bee itself with European bees are no 2 of course, the somewhat different genetics. Most prominent difference was probably the more varied genom. But remember the African bee is not the natural host of Varroa mites either. A

595.42A
BOOT, W.J. - CALIS, J.N.M. - BEETSMA, J. et al.
Natural selection of Varroa jacobsoni explains the different reproductive strategies in colonies of Apis cerana and Apis mellifera. Experimental and Applied Acarology, 1999, p. 133-144. - 2 fig., 1 tab., many ref.
In colonies of Apis cerana Varroa jacobsoni invades both drone and worker brood cells,but reproduces only in drone cells. Absence of reproduction in worker cells is probably crucial for the tolerance of Apis cerana towards Varroa jacobsoni. The mite population can so only grow in times when drones are reared. In the experiment mites from bees in Apis mellifera colonies were artificially introduced into A. cerana worker brood cells and vice versa. About 80 % of the mites from A. mellifera colonies reproduced in naturally infested worker cells of A. mellifera. Absence of reproduction in worker cells is due to a trail of the mites. A. cerana bees removed 84 % of the worker brood that was artificially infested with mites from A. mellifera colonies.Brood removal started 2 days after artificial infestation. The bees responded to behaviour of the mites. The findings are important for selection programmes to breed less-susceptible bee strains.

prominent difference of African bees compared to European is probably a bigger genetic variation contributing to the adaptation process. But the 5 years are way to short to give time for genetic selection after recombination of nucleus DNA to form a resistant bee. The only powerful process (rather processes) that can explain such a short successful adaptation is epigentics.

These epigentically changes in the Brasilian bee adapted to small cells and later also changed into resistance may well have contributed to the different reactions to small and large cells compared to the European bees used in the other tests.

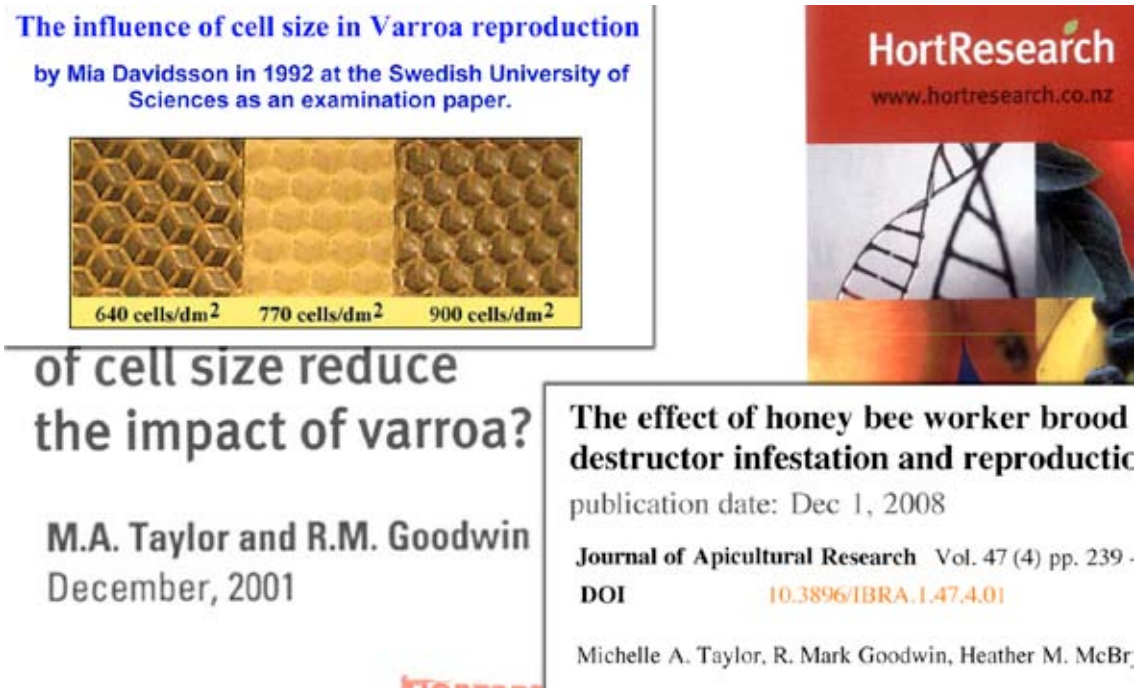
A Cerana bee. Photo: Charles Lam/Wikipedia.

Epigenetics actually explains more than quick build up of Varroa resistance. All kind of adaptations to new environments that takes place we understand depend on epigenetic processes. Next step (or at the same time) is the genetic changes taking place through selection.

Early studies with different cellsizes in the same colony

Some early studies designed in a similar way as those of Message&Goncalves (1995) and Piccirillo&DeJong (2003) are one by Davidson&Fries (1992)[10] in Sweden and another by Taylor&Goodwin (2001) in New Zealand[11]. The later one was reorganized and republished by Taylor, Goodwin, McBrydie & Cox (2008)[12]. This later publication was one of the publications of three referred to as 'closing the case' of SC (small cell) compared to LC (large cell).

Two works investigating small cells eventual effects on Varroa mite reproduction in a similar fashion as those in Brazil, but made under quite differing circumstances that well may have influenced the results.



Both Davidson & Fries and Taylor & Goodwin have all the 8 differences described above compared to Message & Goncalves and Piccirillo&deJong. Also, their LC bees had difficulties drawing SC foundation evenly following the SC imprints. And Davidsson didn't test 4.9 mm as SC but rather 5.1 mm (900 cells/sq dm).

Their tests were performed with bees that probably were not adapted, that is epigentically changed, in a maximum way to the altered environment that the precense of the Varroa mite resulted in. Varroa was detected on the island Gotland in the Baltic 1987 and in southern Sweden 1991. The mite was detected 2000 in New Zealand.

Adaptation time

The adaptation process to resistance to the mite took about 5 years in South America and South Africa. After about the same number of years with big varroa populations in the colonies, many beekeepers in Sweden reported a noticeable drop in size of the seasonal population peaks of the mite. In some cases where the beekeepers are quite isolated from bees of other beekeepers and use more resistant bees, they don't use any treatment help for the bees to deal with the mite.

Survivability

Focus in most varroa mite resistant studies, also with cell size involved, have been reproduction rate or population growth of the varroa. For the practical beekeeper, survival of bee colonies and good honey production is what matters. Of course the speed with which the mite population grows, is of some interest. Anyway one of the most important traits for fighting the mite is what is called VSH (Varroa Sensitive Hygiene)[13,14], detection of mites in capped brood,

This colony has been very active in cleaning out infested capped drone brood. This seems to be very unusual according to some tests, but not in this colony. Could cellsize play a role? All the brown empty cells have apparently contained pupae and the bees are actively continuing uncapping and chewing out. The still capped cells has their first batch of capped drone pupae. The drone cellsize is about 6.4 mm.

especially those with offspring, and uncapping, often followed by cleaning out the infested pupa. This important trait is not a surprise. Even if the reproduction rate of Varroa is low, it will grow, but more slowly. At last the mite population will be too high for the bees, and they must do something active to survive, which is to fight them physically. And they have to start already when the mite population is low.

Additional differences to the eight

9. Avoid **drifting and robbing**

10. Chemical **residue free wax**

11. **What feed** when feeding

To start the VSH-trait, the number of mites probably will have to reach some density level to trigger the bees to chase them. This threshold needs to be small enough to keep the mite population enough small throughout the season, even if some reinvasion occurs.

Differences explained

9. One thing that is seldom talked about in design of tests, is which precautions were taken to avoid drifting and robbing during registering the data for all the figures in tables and graphs! I know through experience (when nectar flow is low) that if these kind of thorough lifting up of combs and measures taken in a yard is done continously during even less than half an hour, it doesn't take long before you have a robbing going on, which makes any measures of figures more or less worthless. And once the bees have learned to rob, the next day (if nectar flow is low) the bees develop a robbing mode even quicker.

10. We don't know anything about the chemical residues in the wax combs used. Recent tests of wax in combs have shown alarmingly high residue levels from miticides and agricides in brood nest combs. We know too little about the effects of this on the immune system (RNAi, peptides, hemocytes, microbe-balance, etc.) and defense system (defense behaviour like VSH, grooming, cleaning out virus filled bees from the hive) in the bee colony. We do know that a test made by Randy Oliver with HSC (fully drawn plastic small cell combs)[15], which have no such residues, gave a much slower varroa buildup than on large cell size (drawn on plastic foundation).

11. When a drought is at hand, nectar availability is often scarce. To help the bees they might be fed. We don’t know from the description

Robbing inferno at data collection in a Varroa test.

of the tests what is fed and how much. Is it honey, high fructose corn syrup (HFCS) or sucrose solution fed? Are proteins low in colonies and therefore pollen or pollen substitutes supplied? We know that there is a discussion concerning the nutrition value, or rather lack of, in HFCS.[16, 17] What you feed can influence the performance and behaviour of your bees. This could be part of the explanation why the ending bee populations in some tests were remarkably low in my view.

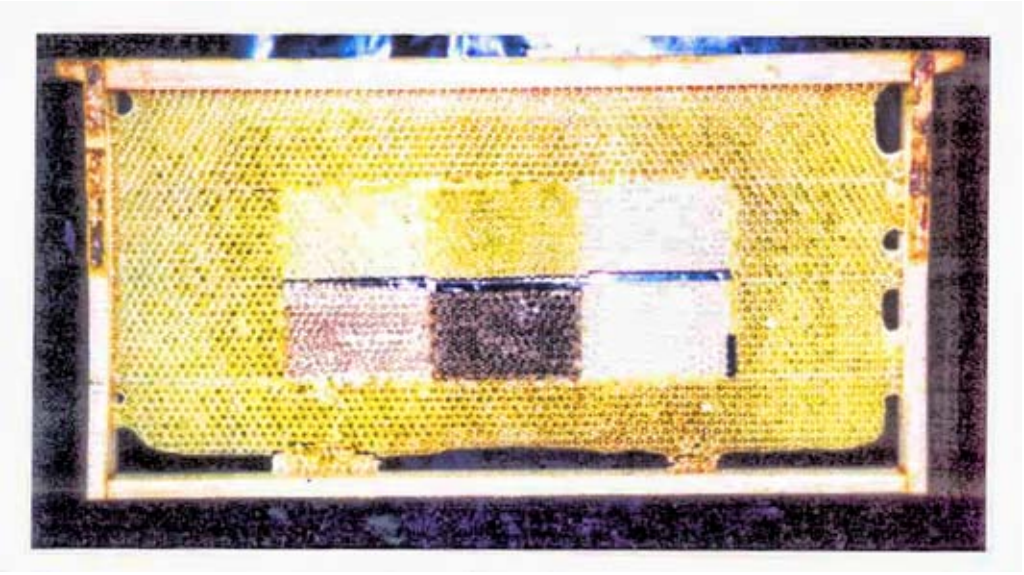
The three 'case is closed-papers' (CCP)

In the November issue of Bee Culture 2009 there was an article by Jennifer Berry[18], with the message that there is no value in small cell size as a tool against Varroa mites. The article covers three investigations of small cell effect on varroa population build up during a short period of time, half a year to a year. The article ends with a clear message that her article is the final word concerning small cells against Varroa and ends with words she thinks applies:

> *"…the so-called enlightenment of the 17th and 18th 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."*

The conditions listed in paragraphs 3-8 above describe differences compared to those in these three CCP-tests. Actually most small cell tests, at least outside South America are differing the same way.

CCP1: New Zealand test



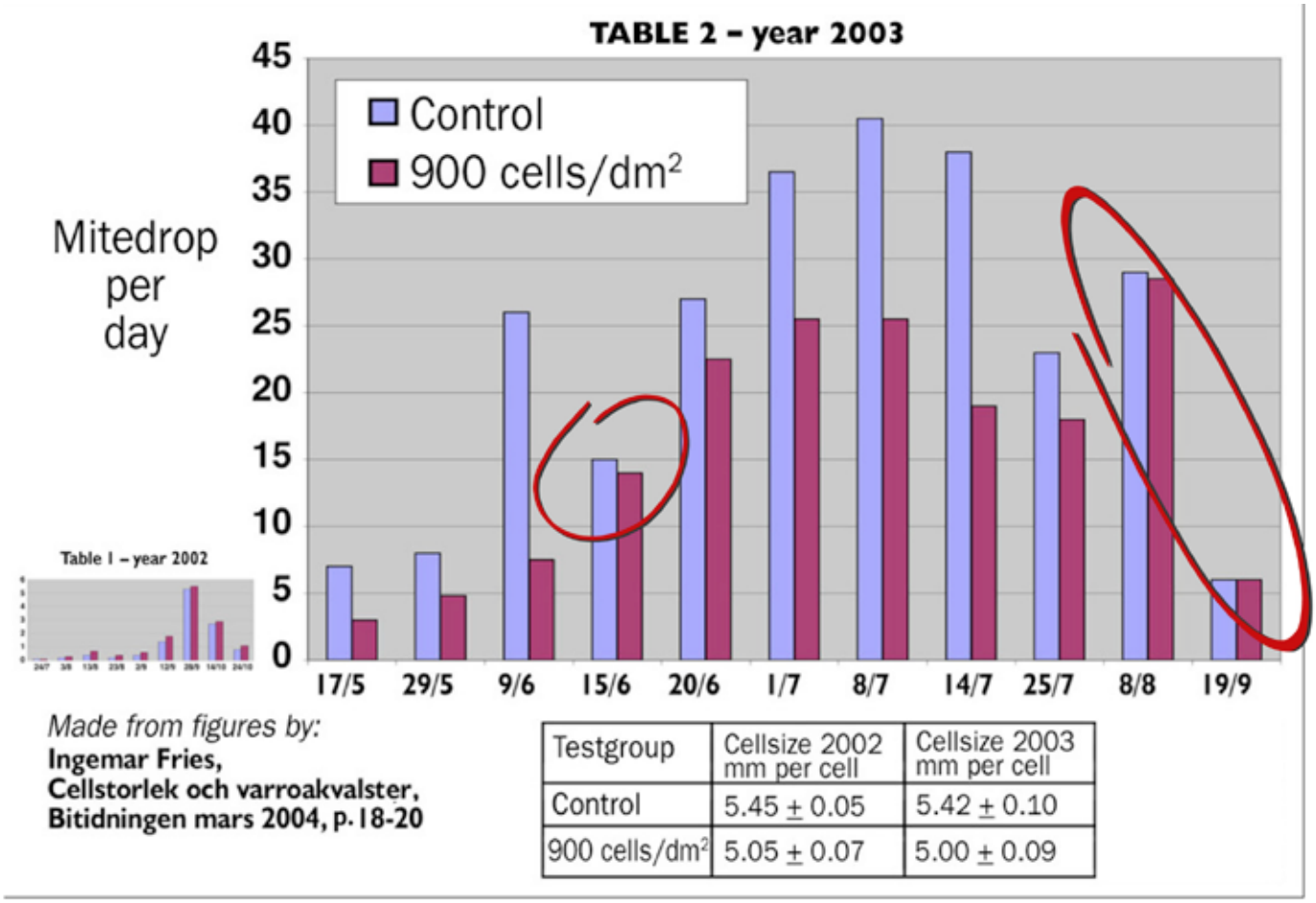
One of the papers mentioned in the Berry BC-article is the Taylor & Goodwin-paper. And the result, similar to that of Davidsson&Fries, arrives at no advantage for small cells. As has been already mentioned there are at least 8 conditions that differ from the tests done in Brazil. The Brazilian tests are showing positive influences for small cells concerning varroa reproduction. (Survivability is though not investigated in any of these tests.)

Alternative test design:
The results of the NZ and Davidsson tests, creates the need for finding out if these differing conditions compared to the Brazilian, have significance for the differing results. To find out that we need a test which use 2 apiaries separated by a distance of about 3 km. One apiary having only bees adapted since maybe 5 years on small cells supplied with pieces of combs according to the test set up. With no LC bees within 3 km. The other test apiary having only LC bees set up the same way. The queens must likewise belong to a stock of adapted SC and LC bees respectively. To overcome the disadvantage of differing genetics in the two apiaries the number of hives in each apiary should be more. Maybe 2-3 of each and no sisters. Residue free wax for the foundation in the combs should be used (or plastic foundation). High fructose corn syrup or pollen substitutes should not be used if feeding is necessary.

CCP2: Berry test

The second CCP-paper is one of her own, Berry, Owens & Delaplane, Apidologie (2009)[19]. She began the test with bees from a beekeeper successfully keeping bees on 4.9 mm cell size without using treatments. That is note-worthy. But she mixed them with LC-bees and made packages. She kept the test (SC) and control colonies (LC) in the same yard. The resulting mite populations were too small to show any differences in ending mite population sizes. Compare with the first year result presented in a small cell size test by Prof Fries in Sweden (se graph).

Her goal was though not to measure ending mite population sizes but reproduction rate, which she meant was enough with the short time used. For this decision she leaned on only one paper saying a duration



Testgroup	Cellsize 2002 mm per cell	Cellsize 2003 mm per cell
Control	5.45 ± 0.05	5.42 ± 0.10
900 cells/dm²	5.05 ± 0.07	5.00 ± 0.09

Highlightning circles showing testing dates when periods of low or no nectar flowes have contributed to averaging out mite loads due to robbing and drifting, as the control and "small cell" (SC) groups were placed in the same apiary.

of 10 weeks was enough for this.[20] A onetime test should be repeated to give better assurance of the result. This paper does not take in consideration that eventual VSH trait may not start to work until a kind of threshold level is reached. Interesting that this paper is authored by Harbo, who meritoriously bred VSH-bees (first called SMR-bees).

Ending colony bee population	**Conventional cell**	**Small cell**
	August 2006	
	5653 ±1082 (3)	14994 ±2494 (3)
	March 2007	
	10960 ±2115 (6)	13717 ±1309 (9)
	April 2008	
	14629 ±1111 (9)	12461 ±2177 (9)

Data from one of the tables. Number of surviving colonies in brackets.

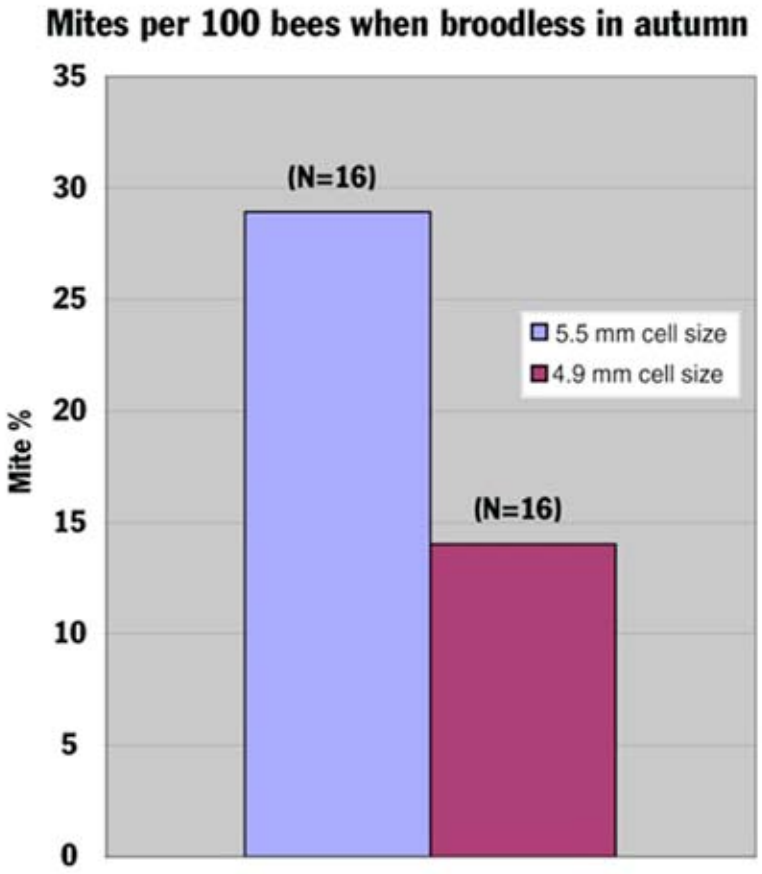
The number of failing colonies in her test is striking. How come? The first batch of 10 + 10 colonies set up in August 2006 should have been enough. But already in October there were only 3 + 4 left. Something went wrong, maybe with the introduction of the queens. So another 10 + 10 colonies were started in March 2007. In June 2007 these two

batches were ended. Why not let them continue? Next April in 2008 a third batch of 10 + 10 colonies was set up and run till August 2008. And these are called three separate tests, but done the same way. All figures were pooled except the end populations of bees. Why? The tests were not done the same way. The first one lasted six months. The second began with foundation instead of drawn combs and lasted three months. The third began with drawn comb like the first and lasted four months. Were they replicates of each other?

Alternative test design:
She had a great opportunity to use a stock adapted to small cells and as well resistant to varroa mites (no treatments were used on those bees). But she missed it. Instead of pooling SC and LC bees, two separate apiaries should have been set up, one with SC and one with LC bees, 3 km apart, with no other bees in the neighbourhood. To overcome the disadvantage of having a separate apiary for the control colonies, the number of colonies in both groups should be increased. Even better had been to set up 2 apiaries for each group, totaling 4 apiaries. Residue free wax for comb foundation or plastic foundation should have been used. And no HFCS or pollen substitutes for feeding, but real honey or sucrose solution and real pollen. Also the test period should be long enough to enable the mite population to grow over the ”normal” amount of mites for varroa resistant bees[21], which it probably would after a couple of seasons in the LC apiary.

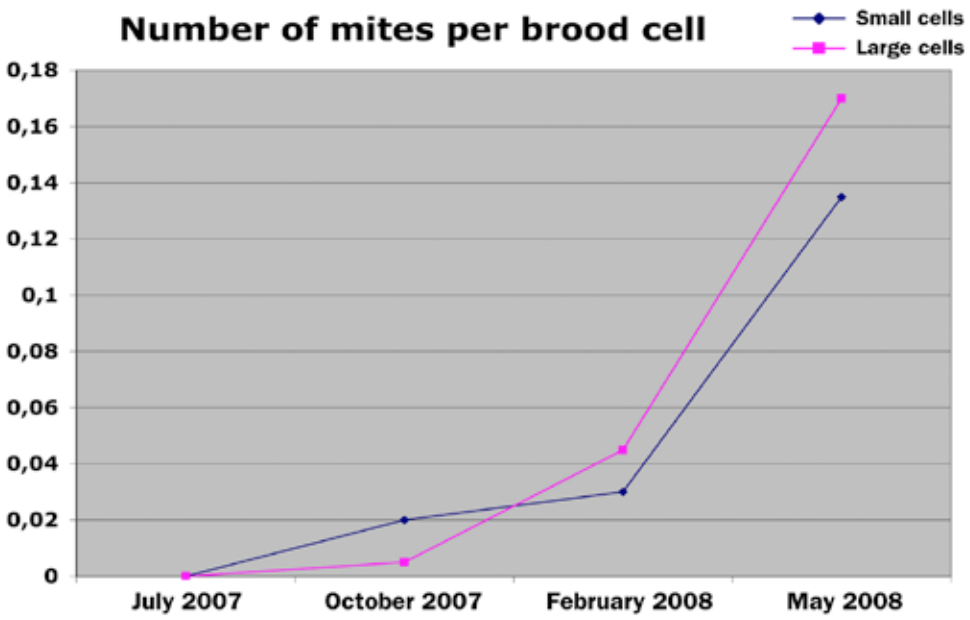
CCP3: Ellis2 & Hayes test[21]

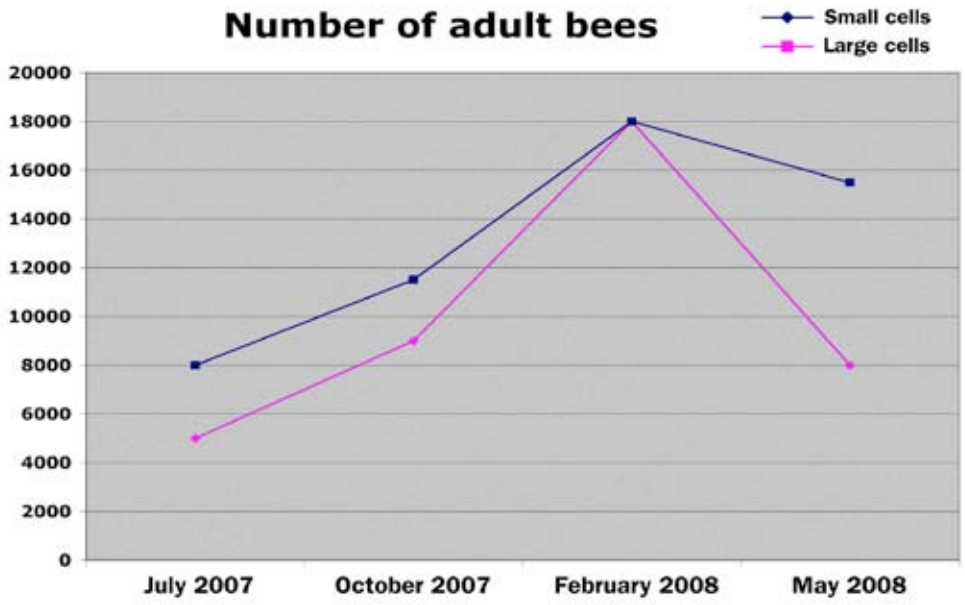
The authors have made efforts to design their test to avoid interferences, for example by establishing the SC colonies with SC packages and placing the LC colonies 680 m away from the SC colonies. Maybe the authors had read the article of Hans-Otto Johnsen in Bee Culture May 2005[22] in which he describes a test running over several years. His different apiaries were 700 m apart. The result gives small



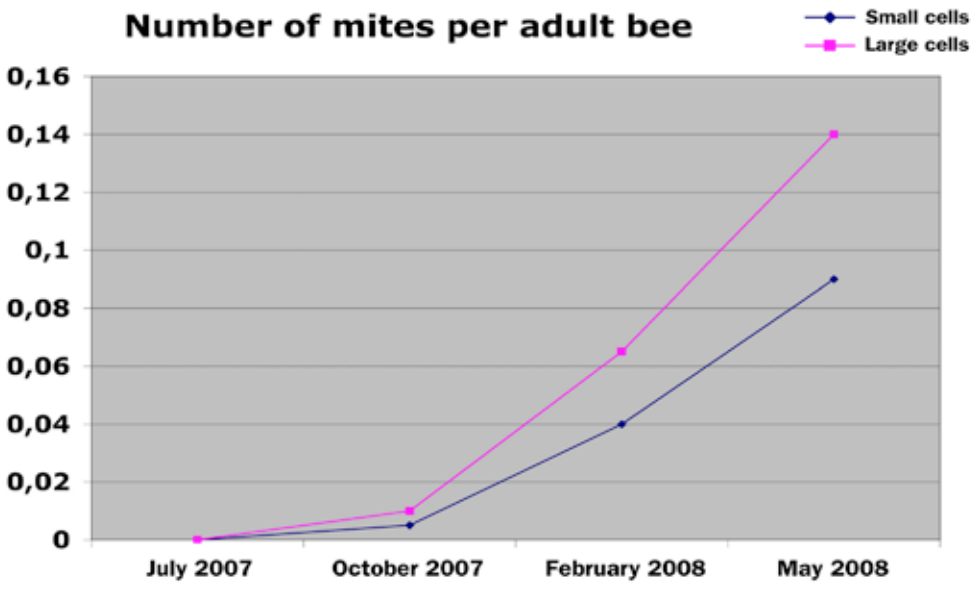
One of the graphs from the test of Hans-Otto Johnsen after a couple of season of the test. It was performed with stock unselected for Varroa resistance. See his article online.[20]

cells an advantage in fighting the Varroa mite. But Johnsen knew that robbing, slow or intense, is easily aroused if you keep your hives open long enough, which is not long at all during nectar drought. Therefore he worked the hives late in the day close to dusk. And he worked the hives quickly and had entrances restricted in size. And when harvesting he kept the combs and boxes harvested closed from bees. He didn't feed the colonies but complement feeding for winter with sucrose solution. The wax in the combs was free of chemical residues.





We don't know how data were collected by Ellis2&Hayes. 700 m is no hinder for robber bees, especially during a drought. If robbing is started, even only slightly and once, the test may well have been ruined, through mites being distributed and evened out mite populations with the



help of robbers. I've myself seen a test yard roaring of robbers in the middle of the day while data collection was going on during a drought.

Sister queens were used to all colonies. Queens from SC- or LC-stock? Probably LC-stock. Their genom is not epigentically adapted to small cells. We don't know how much that interfere with the result. To overcome that SC-queens could have used in SC-colonies and LC-queens in LC-colonies.

We don't know what kind of feed that was used. HFCS is suspected of just keeping colonies alive but not making it possible for them to thrive and grow. Pollen substitutes should not be used more than a couple of brood cycles. The bees need real pollen for a lengthy protein feeding. Lack of protein may lead to lowered immune and defense system mechanisms.

Ellis2 & Hayes had a test period of one year. The ending total number of mites indicates that the test period was just about too short. It had reached 3600-4000 mites, lowest with the LC-bees. But the LC-colonies were only half the strength of SC-ones. About 7000 bees compared to 15000. According to the findings of Mondragón, Spivak and Vandame (2005)[23] the mite population in resistant bees (AHB) in Mexico varied during the season and averaged almost 4000 mites in the colony. This tells us the test should have been running for at least another season.

Notable is the low bee populations in all bee colonies. Are the apiary surroundings almost void of nectar sources? Were the bees fed HFCS instead of honey or sucrose solution? Is the wax in the combs loaded with chemical residues? The SC colonies were more than doubled in strength at the end of test year in May 2008 compared to one year earlier. The LC colonies are just slightly bigger than the starting size. Another season would have produced an interesting continuation.

There are in spite of not optimal design of the test some interesting trends that would have been interesting to follow another season. Maybe the benefit of small cells is to provide a bigger visible variation of varroa resistance making a better selection possible for breeding?

In May 2008 mites per adult bee was 35 % lower in SC-colonies (9 % and 14 % respectively). Mites per brood cell 23 % lower in SC-colonies (13 % and 17 % respectively).

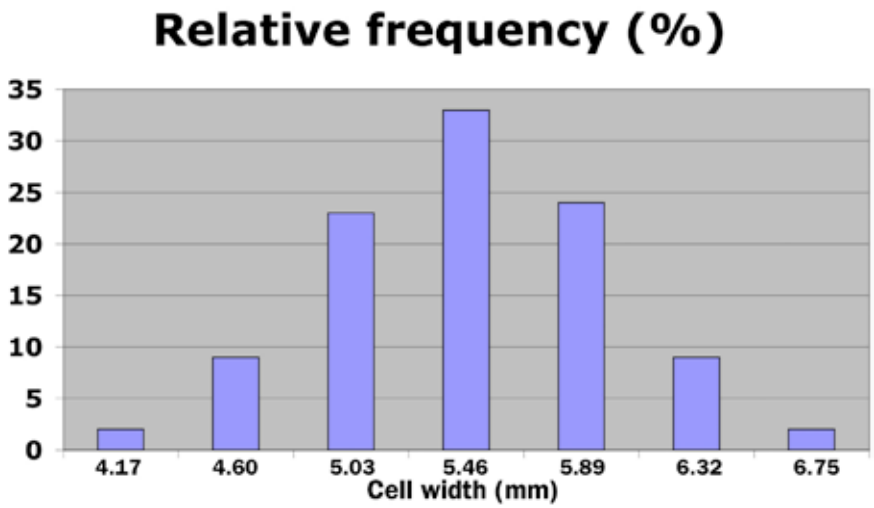
Alternative design:

Establish 4 instead of 2 apiaries. Locate them 2-3 km apart. One SC-apiary and one LC-apiary with SC sister queens. (Queens bred from a queen in a SC colony. Her mother and grandmother have also been from SC colonies.) One SC-apiary and one LC-apiary have LC sister queens. Feed when needed in first place with honey and real pollen (best with pollen dust outside the hives protected from rain), if not possible with sucrose and pollen substitutes. The test period should be at least two years.

Other tests

The three CCP-tests are covered because of the extraordinary brave conclusion in the Bee Culture article by Jennifer Berry. I felt there was a need to challenge that conclusion. More papers on small cells have been published after the three CCP-ones. I will mention a few. One comes to the conclusion that small cells are beneficial for the bee colony in fighting the mite. Another that they are not. Both are focused on reproduction of the mites in first place as a result of how much fertile progeny the mites can produce. No consideration seems to be taken to eventual actions of the bees.

The first one is authored by Matías Maggi et al, published in Experimental and Applied Acarology 2010 and entitled *Brood cell size of Apis mellifera modifies the reproductive behaviour of Varroa destructor.*[24] The test is conducted in Argentina at the coast well south of Buenos Aires. One whole frame with capped worker brood was analyzed from 5 colonies. Every cell with mites was measured in size. They vary in size from much smaller than 4.9 mm to much bigger. The stock of bees was European. They hadn't been treated with miticides for 18 months and the infestation in brood was in average 30 %. (Some info comes from personal communication.) One of the conclusions was: 'We found that brood cell width in *A. mellifera* colonies affected the invasion and reproduction rate of *V. destructor* under natural conditions.'



Relative frequency distribution of worker brood cells width (class intervalls) in which a mother mite was found. Cell size is inside measurement not including one cell wall. Graph made with data from the article of Maggi et al.

The second is authored by T Seeley and S Griffin, published in Apidologie 2011 and entitled *Small-cell combs does not control Varroa mites in colonies of honeybees of European origin*.[25] The test was done in New York State. Two apiaries with 7 colonies each were established from packages from 7 colonies highly infested by Varroa mites. They were placed 120 m apart in which the colonies were spaced 5 m apart. All this to avoid drifting. The colonies were established June 2, 2009, and ended in October the same year. All bees were LC-bees. All queens were LC-queens from the same commercial source. The SC-colonies got fully

drawn plastic SC-combs. The LC-colonies drawn LC wax combs. Colony strength was always somewhat smaller in SC-colonies. Probably due to the repellent effect plastic and especially fully drawn ones have on acceptance and queens laying in them in the beginning they are given to the bees. That gives an unfair comparison between the groups concerning colony performance.

Date	Mites/sticky board/48 h		Mites/sticky board/48 h/frame of bees	
	standard cell	*small cell*	*standard cell*	*small cell*
June 10	11.2	13.4	5.12	4.65
July 13	21.9	15.9	7.33	6.19
Aug 10	27.1	23.4	3.61	4.04
Sept 17	46.1	39.0	4.13	7.50
Oct 16	55.6	52.1	5.24	10.65

Data from one of the tables in the article. They show that in spite of lower mite drops in total, the mite drops per frame is higher. It shows that the small cell colonies are much smaller in size, most probably due to the fully built plastic combs. They are not accepted as well by the bees and queens to lay in.

The main goal of the test was to find out if bees reared in small cells would create an environment for the mites inside the small cell, so that they would reproduce with less success. The first conclusion is that mites can repdoduce well in small cells. I think that is correct.

With the original host of Varroa mites, *Apis cerana*, VSH and grooming activities of the bees are of great importance. But of course, all kinds of resistance characteristics are of importance, as less successful reproduction in worker brood. However, it seems scientists, with the exception of VSH-scientists, put too little attention to the importance of adult bees resistance activities.

The authors didn't stop at the first conclusion, but they went on to say that small cells do not control Varroa mites in bee colonies. It seems they meant under all kinds of circumstances. That's an extrapolating that the test design denies.

Not SC-adapted bees and queens were used in the SC-colonies. The distance between the apiaries were not big enough. Too different character of the combs (wax visavi fully drawn plastic). The initial mite infestation was too big for somewhat resistant bees to have time to take control over the mite population through eventual hygienic behaviour. The test period was too short (well, with that big initial mite load it was maybe about maximum).

There exists varroa resistant bees on large cells

It has to be said that small cells are not needed to achieve varroa resistant bees. There are examples in both America and in Europe. One is a friend of mine in southern Sweden who has had an apiary placed at least 3 km from other bees, which he hasn't treated for varroa for more than 10 years. The bees are on 5.4 mm cellsize, but the stock was bred for

varroa resistance before the establishment of that apiary.

I know also of other beekeepers that have achieved resistant bees, on small cells, with the same stock of bees. They have them in isolation from LC- bees and/or nonresistant bees. This isolation of about 3 km to non-resistant bees is evidently very beneficial.

It has to be a reason for naturally living bees to form mostly smaller cells in the brood nest, and also with a variation of cellsizes. Natural selection favors fitness. So there's no reason not to acquire more fit bees, even if it's for something else than resistance against Varroa mites. One of the reasons could be economical. In the 1960s the owner of one of the biggest bee equipement companies in Sweden, Evert Svensson, also a commercial beekeeper, tried out bigger cells compared to his 5.1-5.2 mm cellsize. He used the bigger cells on about 50 colonies in one apiary for a couple of years. His conclusion was that bigger cells gave less money in the pocket.

Thore Härnkloo in Sweden has never ever had the need to treat in his isolated apiaries against Varroa. He is using beestock selected for resistance against Varroa mite and he is using small cells. One contributing factor may well be that the honeyflow in the forested area does not allow big colonies and big honeycrops. The 5 story design is not considered big with this bee in areas with richer honeyflows.

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