SUNNY HIVE AS A TOOL FOR SUPPRESSION OF VARROA MITES IN HONEYBEE COLONIES

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Abstract: The well-known method of thermal action on Varroa mites has proven itself more or less successfully only in thermal chambers. In apiaries, not a single design of a hive or device for treating bees from Varroa mites has taken due to its low efficiency, labor intensity and cost. The method of combating Varroa mites in a hive that we have developed is based on suppressing the development of the mite population by regularly destroying eggs and nymphs of mites in the sealed brood of bees. This method does not destroy adult female mites, but gradually reduces the infestation of families by the gradual death of adult females under the influence of temperatures and their own age, while significantly reducing the arrival of a younger generation to replace them. The so-called depopulation process occurs. The usage of Sunny Hive, built to implement this method in practice, make possible a multiple reduction in the chemical load on bees without worsening their condition and, ideally, is capable of ensuring the maintenance of bee colonies without any treatment and, at the same time, without significant damage of them by Varroa mites.

Keywords: mites, Varroa, hive, bees, diseases

The so-called "thermal" method of combating Varroa mites has long been known and has found some application in bee-treatment thermal chambers. However, due to its labor-intensive nature, it is rarely used. Numerous attempts have been made to treat bees for mites directly in the hive. Numerous patents exist on this topic, including CA2916599A1, EP2789227A1, EP2915424A1, RU2296465C2, US5069651, US6475061B1, US9363984B2, US11122781B2, and US11129370B1. However, the complexity and high cost of the equipment, as well as the poorly thought-out nature of the technology, have meant that this equipment has not been used for practical work in apiaries. What is the main problem with this method and these patented devices? The problem is that they all believed they could kill the Varroa mite females by heating the hive interior to 38-43°C. This was their main mistake. Varroa females don't die at such temperatures, but are more or less significantly weakening. Varroa mites population's development, after a slight pause, continues after a while.

We turned to the research of Soviet scientists Akimov and Piletskaya, as well as Muravskaya [1], [2], [3], [4], [5], who in the 1980s conducted crucial studies proving that the most effective treatment can be applied to that portion of the Varroa mite population that seemed most immune to the effects of chemicals and natural acids—to the Varroa mites brood in sealed honey bees brood cells.

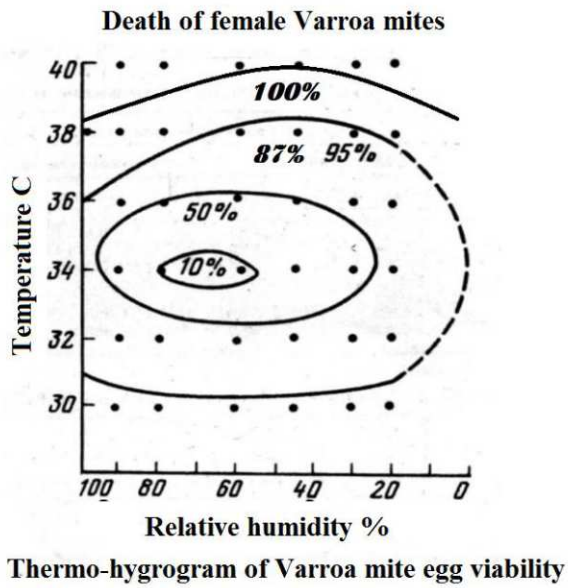


Figure 1. Thermogram of Varroa mite egg viability from Akimov and Piletskaya's paper "On the Viability of Varroa Mite Eggs." The percentage of Varroa mite eggs that die under given temperature and humidity conditions is indicated.

They showed that elevated temperatures, starting at 36°C (96°F) in the bee nest, significantly inhibit the development of mites brood. At temperatures above 37°C (97°F), almost complete mortality of Varroa mite eggs and nymphs is observed, while at 43°C (113°F), partial mortality of the females themselves in brood cells is observed (Fig. 1). Moreover, the greatest impact is on mites in drone brood, which is known to be a powerful accelerator of mite population growth, especially during the pre-swarming period.

However, what works flawlessly in the laboratory works quite different in reality. A single high-temperature treatment of the combs does not completely kill the mites in the combs and some mites remain on the bees and also survive. All of them reenter the next brood and quietly make up for lost time. The effectiveness of such a method is low.

This leads to the solution: the temperature effect on young Varroa mites must be achieved through a combination of three factors: the most effective temperature, the optimal duration of a single exposure, and the mandatory periodicity of exposure during the active season of bees life. It was the attempt to combine these three factors that led to the birth of our new hive - - Apivox Sunny Hive. Testing continued for apprximately six years, and the hive design is now close to optimal (Fig. 2). In the 2025 season, a temperature logger was installed in the latest modification of the hive, providing us with a continuous stream of data on the temperature in the bees' nest between the brood frames. At the end of March was performed the first alcohol wash of Varroa mites from worker bees.

Figure 2. Experimental apiary consisting of prototypes of the Solar Hive and the latest models. The objective is to study temperature regimes inside the hives under various weather conditions, as well as the response of bees to temperature effects of varying levels.

April results: with air temperatures ranging from +20C to 23°C, temperatures in the bee nest ranged from +36C to +38°C. Temperatures in the hive were not so high and had a depressing rather than lethal effect on the mites brood (Fig. 3).

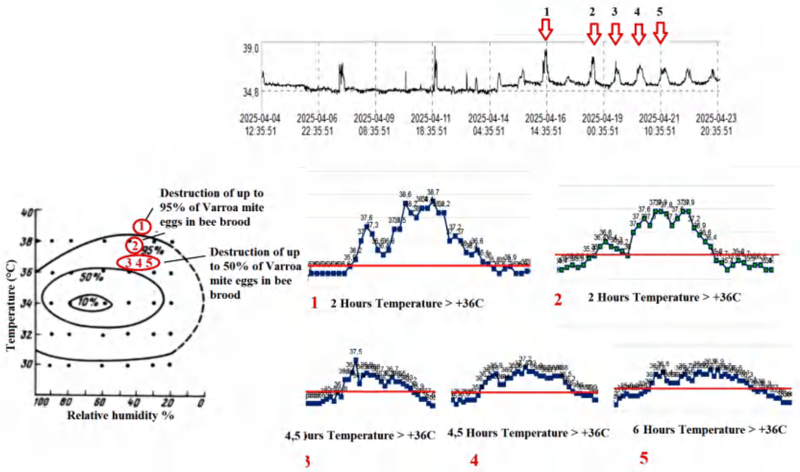


Figure 3. Temperature achievements in April 2025.

In May, sunshine and air temperatures between +26C and 28°C allowed nest temperatures to reach +38-39°C for a week. Under these conditions, most of the Varroa mites eggs and deutonymphs in the bees brood should have to die (Fig. 4).

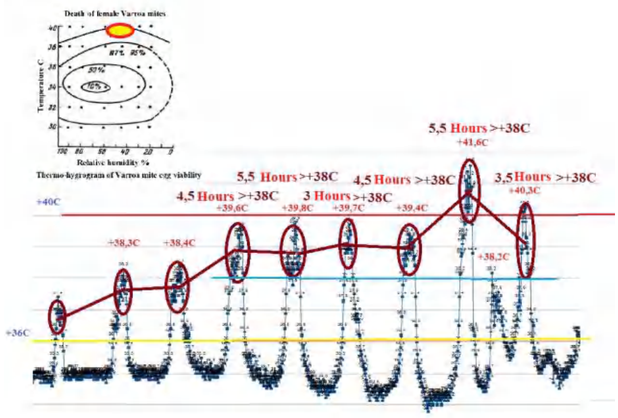


Figure 4. Temperature achievements of the end of May 2025.

It should be noted that no negative impact of high temperatures in the nest on the brood or queens was observed. The brood did not die, and the queens continued laying eggs.

June was very cold and rainy. The June honey flow was virtually lost. There was no significant impact on the mites. In early July, an intermediate mites wash was conducted on worker bees.

July saw periods of very high temperatures (32-33°C), sometimes reaching 36°C in the afternoon. During this period, as an experiment, we left the hive body and heating element uncovered to determine the temperature range of the interior of the hive containing combs. Monitoring showed that the air in the center of the nest heated up to 46°C (Fig. 5), and the combs apparently even more so, especially those located closer to the sunny side of the hive. There, the combs melted and sometimes collapsed, indicating temperatures of around 50-60°C. The queens stopped laying eggs due to the dry air, and in some single-hull hives, they died. However, surprisingly, the bees laid queen cells, indicating that the young brood survived.

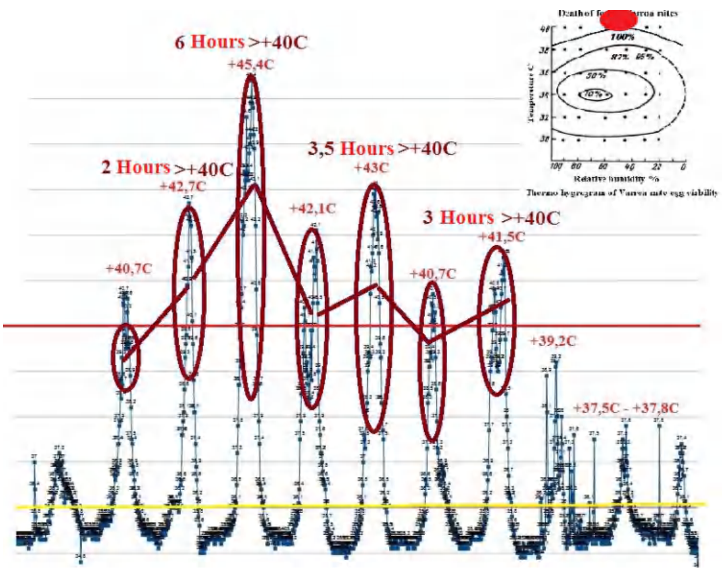


Figure 5. Temperature achievements at the beginning of July 2025.

In conditions of high outdoor temperatures, it is necessary to give the bees a break from the heat inside the hive. This will prevent a decrease in the queen's egg production and even partial death of the brood. An experiment monitoring the temperature in the Sunny Hive with the body and heater shields closed and an outside temperature of 28-30°C (82-86°F) and partly cloudy skies showed that the temperature in the nests of all colonies was around 34-35°C (94-95°F). At the same outside temperature and full sun, the temperature in the nest reached 38°C (Fig. 6).

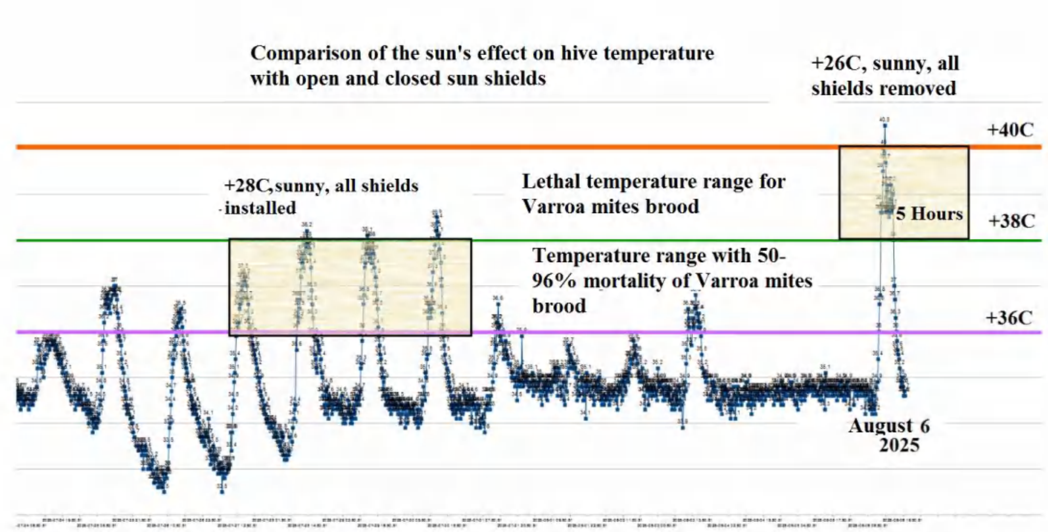


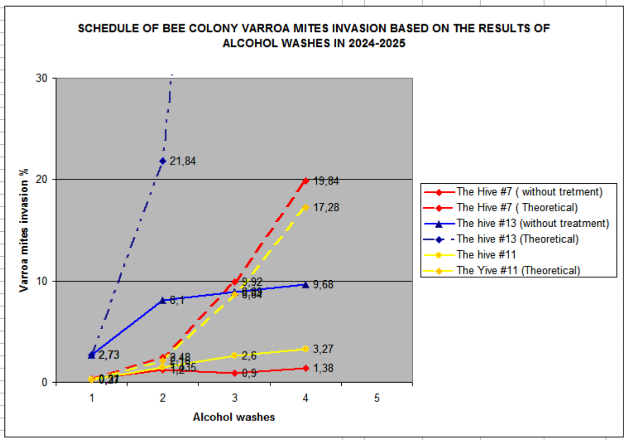
Figure 6. Temperature experiments at the end of July and beginning of August 2025

Thus, for 3-4 hours, the hive temperature was maintained in the range of +37-38°C, which provides a moderate effect on the young mites while causing minimal harm to the bees. Under this same regime, with outdoor temperatures of +30°C or higher, the hive temperature would remain at +40-43°C.

The results showed that if temperatures do not exceed +40-41°C, even prolonged exposure, up to a week, it does not harm the brood or queens. Colony development is not impaired. Temperatures above +40°C (i.e., +42-43°C) can be used, but it is best to limit the exposure to one day, repeating the exposure every 2-3 days to allow the brood and queen to rest from overheating. If the hive temperature can then drop to +39-40°C, the exposure can be continued for another 1-2 days. However, after this, the colony should also be given a rest period. If stable sunny weather with outdoor temperatures of +35-40°C is expected, in addition to installing standard shields, the hives should be given substantial shade. This can be achieved by using either a shared shelter or individual sun-reflecting covers.

Bee colony mite infestation was controlled by alkaline washes using a 3-5% solution of sodium hydroxide. The results were quite good (Fig. 7). It should be noted that these colonies were used in the apiary as usual, producing offshoots and commercial honey.

Beehive number	Date	27.10.2024 before bipin	30.03.2025	05.07.2025	31.08.2025	02.10.2025	30.03.2025 Expected calculated result	05.07.2025 x2x2x2	31.08.2025 x2x2	02.10.2025 x2	Comments
№7 has not been treated with acaricides since 2023 (new hive 2024)		0,32	0,31	1,2	0,9	1,38	0,31	2,48	9,92	19,84	
№13 has not been treated with acaricides since 2023 (new hive 2025)		3,8	2,73	8,1	8,89	9,68	2,73	21,84	87,36	174,72	Blue color is the calculated value
№11 treatment with bipin in October 2024		3,54	0,27	1,435	2,6	3,27	0,27	2,16	8,64	17,28	Blue color is the calculated value
№3 treatment with bipin in October 2024		4,47			1,8		0	0	0	0	
№6 treatment with bipin in October 2024		5,55			4		0	0	0	0	
№1 offshoot from №13 made in april 2025				12,3	5						



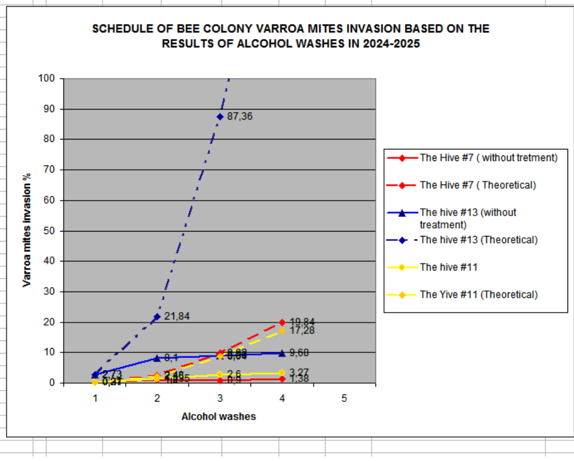


Figure 7. Graphs of actual mite infestation (solid line) and theoretical calculated value (dashed line) with a doubling of Varroa mites population per month.

The results are as follows:

1. With an estimated mite population growth rate of 64 times per season from late March to early October, the increase in mite infestation in the experimental hives was 3.5-4.5 times, which is 14-18 times less! Meanwhile, the colony in the standard hive showed a 4.1-fold increase in mite infestation only from August to September, i.e., over one month.

2. Taking into account one fall treatment with bipin (amitraz), which is quite sufficient, the fall24/fall25 ratios range from 0.9 to 2.5 in new 2025-model hives, and up to 4.3 in 2024-model hives.

3. Taking into account one fall treatment with bipin (amitraz), in some colonies the fall24/fall25 ratio is less than one, indicating a negative trend.
4. It's clear that the final mite infestation level in a colony depends on its initial level in spring. Therefore, one fall treatment is highly recommended, if not mandatory. This will allow the colonies to safely survive the winter and the entire following summer season without any more treatment.

Thus, it can be stated that Sunny Hive has everything necessary to actively suppress the development of Varroa mites, especially in the moderate climate.

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