A METHOD OF DESTROYING TROPILAELAPS MITES IN BEEHIVES WITHOUT USING ACARICIDAL PREPARATIONS, AND THE POSSIBILITY OF USING THE APIVOX PROJECT SUNNY HIVE FOR THIS.

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Abstract: Tropilaelaps mites are currently one of the most important enemies of bees, destroying large apiaries in a few months. Effective control of them, based on knowledge of the characteristics of their life and reproduction, can lead to the suppression of the uncontrolled development of the Tropilaelaps mite population in honey bee families. Meta-analysis of works of scientists around the world over the past 70 years, and our own studies of the impact on the Varroa mite population through regular destruction of their brood in sealed combs using such a parameter as elevated temperature, led to the understanding that there is a real possibility of suppressing the development of the Tropilaelaps mite population due to the temperature effect on the brood and these mites. The concealment of mites from all types of treatments in brood cells becomes in this case a factor of the success of the fight against them. The experiment allowed not only to confirm the effectiveness of temperature effects on the brood of Tropilaelaps mites to suppress the development of their population as a whole, but also to confirm that the Apivox Sunny Hive is capable of creating conditions for the gradual elimination of the Tropilaelaps mite population in the bee colony living in such a hive, and the widespread use of this type of hive is capable of clearing apiaries and entire regions of Tropilaelaps mites despite the presence of wild bees and apiaries in the vicinity infected with Varroa and Tropilaelaps mites.

Keywords: mites, Tropilaelaps, hive, bees, diseases

Introduction

Tropilaelaps mites, which have now become the second most powerful threat to beekeeping in southern Europe, have long been known in the countries of Southeast and Central Asia. Its homeland is the same as the homeland of the Varroa mite, and of the bees themselves - in Southeast Asia. Its development cycle in bee families is also well known to scientists. [1] (Fig. 1)

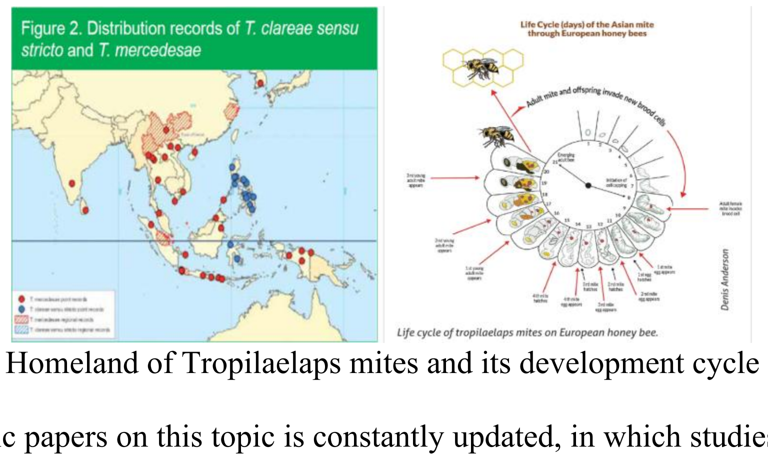

Figure 1 Homeland of Tropilaelaps mites and its development cycle on a bee

The list of scientific papers on this topic is constantly updated, in which studies are conducted on the ability of mites to survive in conditions where there is no brood suitable for feeding, that is, in open brood on eggs, on pupae and on adult bees [2], [3]. The results that scientists obtain, in general, have been known since the 70s of the last century - mites do not survive on adult bees for more than 2-3 to 10 days. They survive on pupae partially, and do not survive more than 2-3 days on bee eggs. They also cannot feed on them. These seemingly very promising results concentrate the attention of one part of scientists, creating a certain euphoria of the possibility of an easy victory. In reality, they do not give a practical effect. None of the practicing beekeepers, for whom beekeeping is a business, will leave the apiary without brood for 21 days necessary for its complete cleansing. Moreover, there is always someone nearby who did nothing, and whose apiary becomes a source of new infestation, making all efforts useless.

Understanding this, another part of scientists is focused on testing the possibility of using chemicals used to combat Varroa mites, to combat Tropilaelaps mites [4]. Different methods are being tested, but in general the results are about the same. The preparations kill the mites when they move around the honeycombs, and are not effective if the mites are in sealed cells. Hence, various attempts to create methods for combating Tropilaelaps mites appear. But, judging by the results that have taken place all over the world, no method rids bee colonies of Tropilaelaps mites with a sufficient degree of reliability. The mites quickly make up for the lag. If up to 5 females can emerge from a cell when infected with Varroa mites, then up to 14 females can emerge from a cell when infected with Tropilaelaps mites. And this is a fact verified by scientists. Thus, they reproduce almost three times faster than Varroa mites, and are much less noticeable. Therefore, if a beekeeper notices them, the bee colony is already close to collapse.

So, let's see where Tropilaelaps mites are common today and where they may appear in the near future according to scientists and try to understand the reasons for such a picture [1]. (Fig. 2) First of all, these are the zones of Southeast Asia, China, and partially the countries of Central Asia, in particular, Pakistan and India. There is information about the spread of mites in the south of Russia - in the Krasnodar and Stavropol Territories [5], as well as in Georgia [6]. In all cases, the scale of bee losses is colossal.

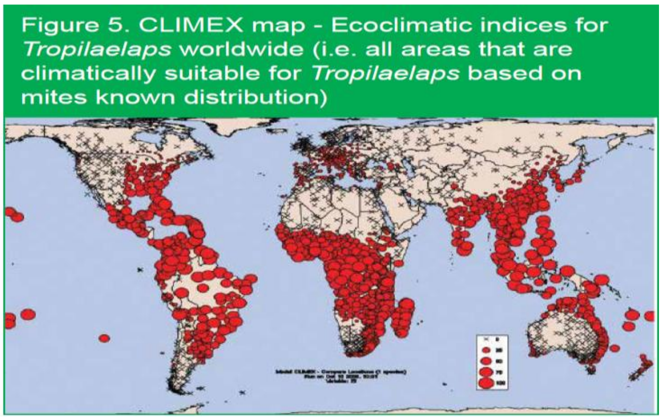

Figure 2 - Potential areas of honey bee infestation by Tropilaelaps mites

The figure clearly shows which zones scientists have designated as potentially dangerous - these are warm and humid zones where bees do not stop breeding process. In cold regions of Europe, Asia, and South and North America, there is a winter broodless period that mites are unable to survive. Moreover, this happens in all apiaries at the same time. The same thing happens in too hot and dry regions of Africa, Asia, Australia, and Europe, where brood is absent during the hottest time of the year. Can we say on this basis that high temperatures not only affect the reduction of brood in bee colonies, but also the fertility of the mites themselves? Scientists from Pakistan have suggested such a possibility [7]. This can be said with certainty about the Varroa mite. Yes, high temperatures suppress the development of mites, and this has been proven by the Apivox project, not only by conducting a meta-analysis of scientific papers over the past 70 years, but also by conducting their own experiments with the developed hive design, which allows the theory to be transferred to practice - to apiaries. The Sunny Hive which we developed has proven its effectiveness in combating Varroa mites over three beekeeping seasons in several apiaries.

All this led us to believe that Tropilaelaps mite populations, like Varroa mites, would be suppressed by the death of their brood and maybe the mites themselves in sealed brood cells under the influence of elevated temperatures. This seemed all the more likely to us because Tropilaelaps mites are physically more "delicate" than Varroa mites, which are well-hidden in a thick chitinous shell. However, to be completely certain, a full-scale experiment was required.

Materials and methods of the experiment

It was decided to conduct the experiment using our methodology in Georgia, involving Caucasian bees and Georgian apiveterinary specialists. The experiments were conducted in two different locations under the supervision of bee disease expert Nino Kipiani, DVM, a representative of the National Food Agency of Georgia, and representatives of the Georgian Bee Preservation Association, the F. Benton International Beekeeping Association. The choice of Georgia as the starting point for the experiments was no accident—the country's beekeeping industry suffers severely from a combined infestation of Varroa mites and a relatively new pest to the region, the Tropilaelaps mite.

It was decided to conduct three experiments with different objectives. The first experiment was to determine whether temperatures of +40°C or higher would have a negative impact on Tropilaelaps mites located outside worker bee brood cells, i.e., simply on the comb. The second experiment was to demonstrate the effect of the same temperature on Tropilaelaps mites and their brood inside sealed worker bee brood cells. The third experiment was intended to yield a statistically significant result if the second experiment was successful. To avoid "waiting for nature's favor" and not wait for sunny days to warm the Sunny Hive to the required temperature, a thermostatic chamber was used. A Thermo ELECTRON CORPORATION device was used in the experiment.

The first experiment was conducted at the Tbilisi State Veterinary Laboratory. A sample of infected honeycombs was collected from an apiary consisting of four bee colonies in Tbilisi, owned by beekeeper Vakhtang Kakhniashvili. The thermostat was set to working condition by Tamar Tagilauri, chief specialist in animal disease diagnostics at the Laboratory of Virology and Serology. The thermostat control panel was set to 40°C. We thought the results would be what we expected, so it was conducted only once. The honeycomb containing brood and Tropilaelaps mites on the surface was sealed in a paper envelope and placed in the thermostat for two hours. After two hours, the honeycomb was returned to the laboratory, and the heating results were visually analyzed by specialists (Figure 3).

Figure 3. Placing honeycombs with brood infested with Tropilaelaps mites in a heat chamber during the first experiment and analysis of the condition of Tropilaelaps mites on the surface of the honeycomb after heating in a thermostat at +40C.

The second experiment was conducted in Western Georgia, at the Zugdidi Veterinary Laboratory. Larisa Chkadua, chief specialist at the Zugdidi State Veterinary Laboratory, prepared the thermostat in working order. The thermostat control panel was set to +42°C. The remaining thermostat settings were the same as in the first experiment. A comb containing worker bee brood infested with Tropilaelaps mites was heated for three hours. Afterward, the cells containing the brood were quickly opened using heated wax and a piece of paper. The contents of the cells were removed, and their condition was analyzed by specialists (Fig. 4).

Figure 4. Opening a comb with Tropilaelaps mite-infested worker bee brood removed from a thermostat and analysis of the content of the brood cells.

It should be noted that preliminary inspection of brood cells revealed the presence of some dead larvae even before the experiment due to severe mite infestation. Up to eight Tropilaelaps mites were found in such cells at any one time (Fig. 5).

Figure 5 Tropilaelaps mites from cells with infected worker bee larvae

The third experiment was conducted using a heat chamber containing 46 frames of brood infested with Tropilaelaps mites. The temperature in the chamber was maintained at 42-44°C. The heating duration remained the same—three hours. After the heating period was complete, the cells were opened and the dead mites were shaken out of the frames onto paper.

Experimental results

The experiments fully met our expectations.

The first experiment finished with a negative result. A temperature of +40°C did not harm the Tropilaelaps or Varroa mites. Their motility was quite high, and no signs of damage or weakening were observed in either mite species.

The second experiment finished with a positive result. After warming, we found dead Tropilaelaps mites of all types in all opened cells (Fig. 6).

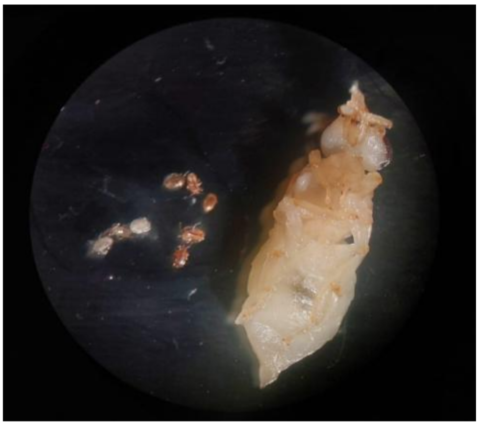

Figure 6. Dead Tropilaelaps mites, mature and immature forms, from a cell with a worker bee pupa, removed after warming the comb with brood for 3 hours at a temperature of +42C.

Moreover, in cells with a complex infestation—in which both Tropilaelaps and Varroa mites were present—all forms of Tropilaelaps mites were dead, and adult Varroa mites were severely depressed and inactive, although not dead. Their numbers were so numerous that it might have appeared as if they had fallen onto a sticky board. In fact, after opening the cell caps of the brood comb with heated wax and paper, a sheet of paper was placed on the table, and the frame with the removed cell caps was struck against the table. All these Tropilaelaps mites fell dead from the opened cells. And there were indeed a great many of them.

During the experiment, after warming the comb, larvae were removed from the brood cells, and most of them were dead. We wondered whether the Tropilaelaps mites might have been dead before the experiment, as the larvae they were feeding on had died. To answer this question, we left a second comb containing brood from the same hive in the laboratory. We found that, as in the first comb, the larvae died from exposure of the mass of mites. I would like to point out once again that, this comb was not heated in a heat chamber. As a result, by opening several cells containing dead larvae on the second comb every day, we found several living Tropilaelaps mites in them. This continued for approximately 10 days. Therefore, it can be concluded that the death of the larvae was not the cause of the Tropilaelaps mites' death from starvation. It is safe to say that the death of the mites was caused by heating brood comb up to +42°C (107°F) for three hours.

The third experiment was completely identical to the second, and its results were identical. All Tropilaelaps mites of all ages that fell from opened brood cells were dead. Temperatures during this experiment reached +44°C (113°F), but no serious damage to the bee brood was observed.

Discussion

The first experiment once again confirmed that temperatures around +40°C are not critical for all mite species outside of brood cells. This is not news for Varroa mites, which are known to die in heat chambers at temperatures above +50°C. However, for Tropilaelaps mites, this is new, albeit negative, information. The experimental results once again demonstrated that attempting to destroy mites on combs or bees in a hive by heating the hive to moderate temperatures is impossible. This also demonstrates why Tropilaelaps and Varroa mites do not die in hot regions: because the temperatures in light-colored hives made of sufficiently thick wood and located in the sun or shade do not reach temperatures critical for mite brood in sealed combs, nor for foundresses on combs or bees outside of brood cells, and sometimes even outside the hive on clustered bees (Fig. 7).

Figure 7. Experiments in the subtropical zone near Islamabad. Integrated Pest Management Institute, National Agricultural Research Centre, Pakistan

The second experiment confirmed and even exceeded our expectations for suppressing Tropilaelaps mite population growth by heating infested worker bee brood to moderate temperatures, specifically 42-44°C, which is achievable in a hive with a certain design, such as the Apivox Sunny Hive. The experiment demonstrated that Tropilaelaps mites can be controlled directly in the honeybee nest by overheating their brood in sealed comb cells. Furthermore, we believe this has once again confirmed that temperatures higher than those typically found in the nest, i.e., 33°C to 35°C, negatively impact both mite species and their brood. It was somewhat surprising, but a pleasant surprise, to find that at these temperatures, not only Tropilaelaps mite brood in the brood comb cells dies, but also the foundresses themselves. This means that elevated temperatures have an even greater impact on Tropilaelaps mites than on Varroa mites, as not only does the rate of reproduction slow down due to the death of future generations, but the foundresses themselves also die, and they will not begin a new stage of reproduction when temperatures drop.

The results we received also indicate that the effectiveness of Sunny Hive on Tropilaelaps mites will be higher than on Varroa mites, on which it has a quite satisfactory effect, significantly reducing the viability of their population in a honey bee colony.

Conclusion

The following can be concluded from these experiments:

1. Confirmation of the feasibility of active influencing on Tropilaelaps mites population using elevated temperatures, without the use of any chemicals, leading to a radical suppression, and even to complete elimination of it.

2. Confirmation of the feasibility of using special heat chambers for one-time heating of brood combs in apiaries with the goal of suppression of development of Tropilaelaps mites population in bee colonies.

3. Confirmation of the feasibility of using hives such as the Sunny Hive for the continuous suppression of Tropilaelaps and Varroa mites populations present in bee colonies, as well as mites of both species introduced by bees from outside apiaries affected by mite infestations. This is a distinct advantage of the hive over heat chambers, as a single treatment does not prevent the introduction of mites from neighboring apiaries or the re-infestation by the mites of bee colonies.

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