Wolfgang Wimmer

Handbook of heat treatment against the Varroa

3rd edition with new experience reports from commercial beekeeping, apitherapy, Demeter beekeeping and more!

Prologue Prof. Dr. Wolf Engels

With testemonials of beekeepers using hyperthermia and the Duplex-Framebox:

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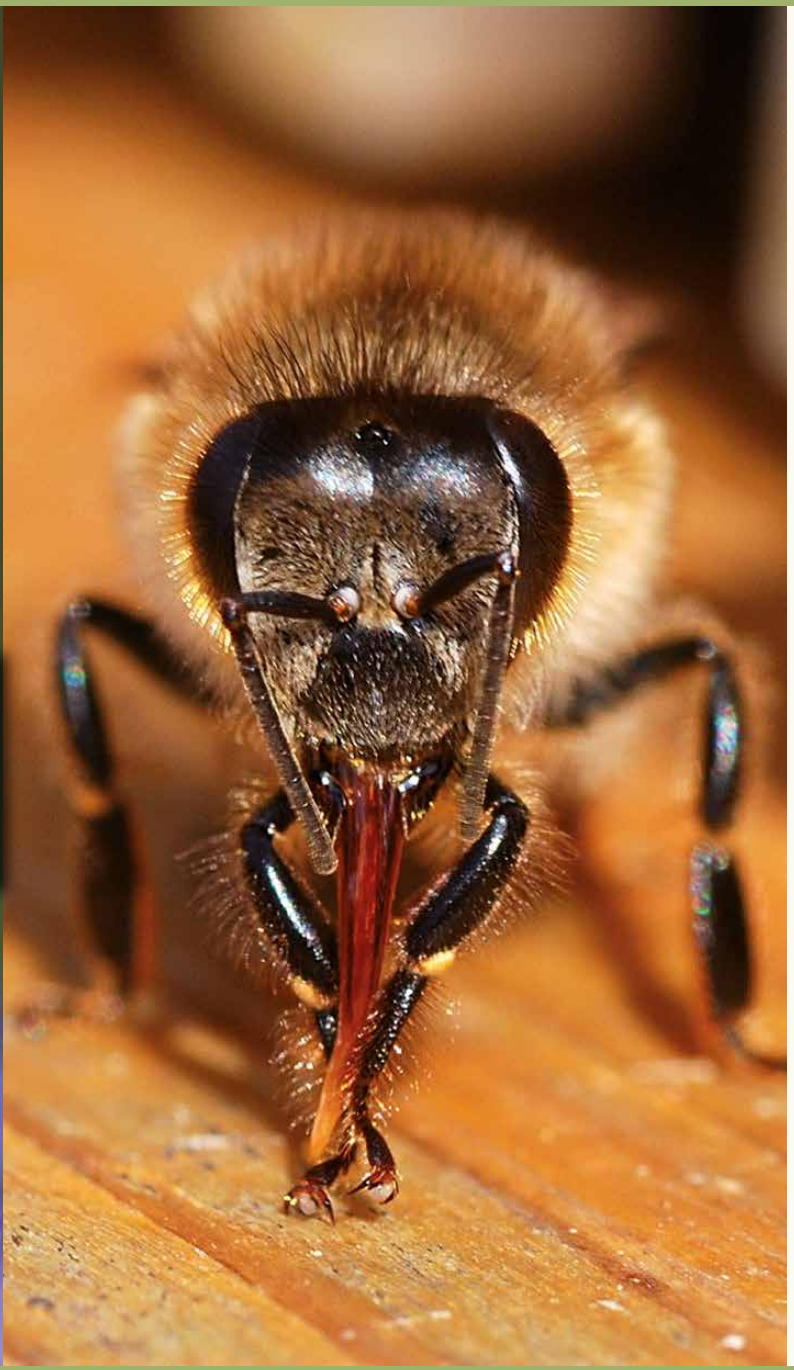

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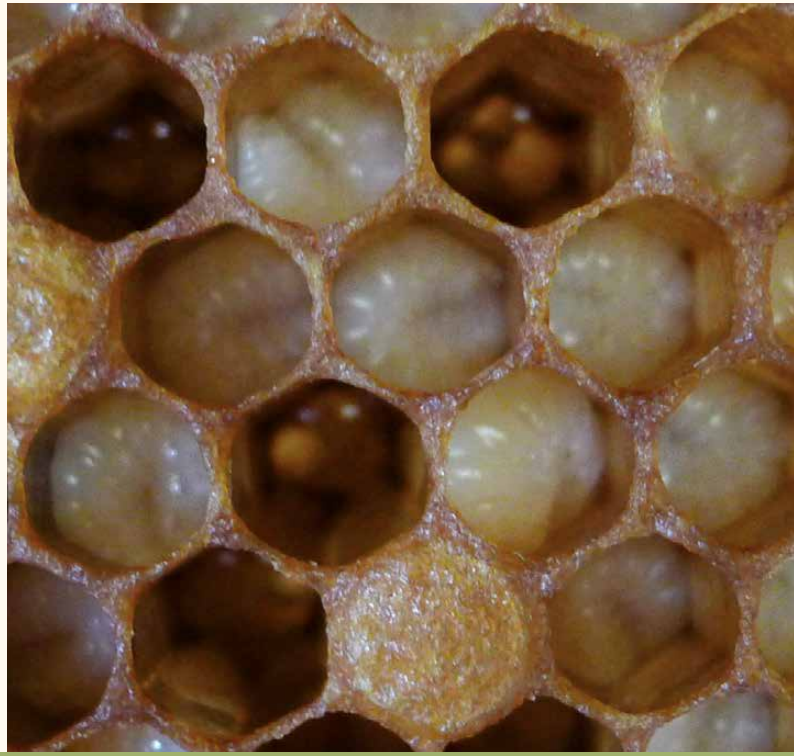


Prologue

The long way of hyperthermia

Prof. Dr. Wolf Engels, Center for Brazil and Latin America, University of Tübingen

In the late 1970s, the Varroa mite arrived in Germany. Here, as well as in some eastern neighboring countries, one tried first to destroy the infested colonies. This had no effect, as the mites were quickly distributed by the bees to many hives in the surrounding area. Next, the large crop protection companies developed chemical control methods based on acaricides.

Of the various applications, the strips with the active ingredient were the easiest to use, and they are used worldwide until today. Two disadvantages soon became apparent: in a few years, the mites developed resistance to the previously effective active ingredients. The second big disadvantage was that toxic residues were found in the wax, where they accumulated over time. The acaricides also got into the honey. Then organic acids were introduced, and they are still the most common form of mite control.

When carefully applied at the right time, the mite infestation can be kept below critical thresholds. The idea to obtain queens with increased hygienic behavior to Varroa mites through targeted breeding has not yet seen significant success, although some progress has been achieved. In recent years, massive colony losses have occurred, especially in the USA. No major cause has been found yet, but Varroa mites often seem to be involved. At the end of the 80s, we were looking for possibilities of biotechnical, chemical-free Varroa control. The first step was an improved method for the removal of drone brood. The edge of the brood nest was identified as the optimal position of the drone frame. While working with two brood chambers, the drone frames were alternately hooked on the right and left positions during the main breeding season and removed every two weeks when capped. Although the mite infestation pressure could be effectively reduced, the removal of the drone brood as the sole control measure was only sufficient in very weakly infected colonies.

As an additional option, we tested how the already known heat sensitivity of Varroa mites could be exploited in an effective procedure. Peter Rosenkranz examined, with a temperature chamber, the ideal temperature ranges the female Varroa mites preferred. We were surprised that they did not choose the brood nest temperature of around 35°C, but rather slightly cooler conditions.

Next, we tested the temperature range that causes damage to the mites. The mites did not survive at 10°C over the normal brood nest temperature. Similar experiments with bee pupae confirmed their significantly lower heat sensitivity. By now, we know specific aspects of the cell biology of mites and honeybees, which cause these differences.

It was impossible to increase the temperature in the hive to the extent that would damage the mites. The worker bees always tried to prevent overheating, especially in the brood nest, by intensive fanning and settling of rapidly evaporating water droplets. The bees managed to avoid the overheating of the hive, and as a result, the mites survived (undamaged) these attempts.

After a number of other experiments, we finally found out how hyperthermia would work against the Varroa mites. In a three-year field test with 50 hives, we were able to prove that, after drone brood removal, the bees treated only with hyperthermia evolved normally, had good honey yields, and became so strong that they could be split into several new colonies.

It was thus shown that effective control of Varroa can be performed solely with hyperthermia. However, this requires constant monitoring of the level of infestation, especially in autumn, and might involve treating hives with hyperthermia again when necessary. In addition, a suitable device is needed to treat frames with the capped brood, free from adult bees (bees are brushed away).

Only a few years ago, Prof. Dr. Wolfgang Wimmer developed a new device for the control of Varroa mites in Vienna. In 2011, this new device, called the Varroa Controller, was introduced to the market. It consists of a thermally insulated housing and runs the treatment program automatically.

An important milestone was reached in the long journey to hyperthermia. The desire of many beekeepers to keep the mite infestation low without the use of chemicals thus became a reality.

Content

Handbook of heat treatment against the Varroa

1 Fascination and motivation

They have populated the Earth for millions of years. They have developed a "business model" that can indeed be called "sustainable." Which other species, besides honeybees, can look back on such a long history of success? Who can claim to be so immensely useful to others? I do not mean to suggest that other living beings are not useful; indeed, many are disappearing every day. However, the bees must not die out, as this would cause substantial damages that would be impossible to compensate for.

We all value honey, propolis, and beeswax, especially from our own beehives. But we also know that the true value of the bees is in their pollination. Ensuring food security through pollination is the added value brought by honeybees, thanks to the professional and many hobby beekeepers who take care of the beehives. In some places around the world, pollination fees are paid when beehives are placed in orchards at flowering time, knowing that with bees in the immediate vicinity, crop yields can be significantly higher. Experts have quantified the value of pollination by honeybees at 22 billion euros in the European Union. This makes honeybees the third most important livestock in agriculture.

And they are masters of adapting, as shown by this bee colony that swarmed in May but was only found in October hanging on a cherry tree. Three brood frames were still reared in the artfully arranged, natural open-air bee colony, even during cold and rainy days.

Despite all their adaptability, bees are in danger—almost every day we read about alarming bee mortality. There are several causes for this. A major cause of bee mortality seems to be the Varroa mite. This parasite harms and threatens the bee colonies. When weakened, they are often no longer able to withstand additional stress factors. Previous attempts to combat the Varroa mite with chemical substances are increasingly less effective. In addition, due to climate change, we are observing completely new weather extremes, especially in the last five years. Unfortunately for the beekeepers (and the bees), this allows the Varroa mites to develop in an optimal way.

Bee colony found in the cherry tree in October

Did you know that...

...the bees can produce their own fuel to fly, food, medicine, and building materials from just three raw materials (pollen, nectar, and water)? And that the colony (as a super organism) is able to continuously maintain a constant temperature and humidity in the hive under various climatic conditions, thereby perfectly mastering heating, cooling, and humidifying? Flying distances are optimized and limited. If a bee flies too far, it will only be able to return with small amounts of food and will therefore look for closer sources of food. This list could continue with more fascinating examples of the bees' adaptation and survival strategies.

pollen-collecting bee

There is a need for a new approach to combat Varroa mites, one that can be used at any time throughout the beekeeping year and effectively controls this dangerous parasite of bees. We have written this handbook to present beekeepers with such a new approach and to introduce the method of heat treatment (Hyperthermia).

It should be noted that heat treatment is not entirely new. In the early 1990s, researchers at the University of Tübingen gained valuable experience with hyperthermia. At that time, Prof. Engels successfully treated 50 bee colonies over three years, exclusively applying hyperthermia against Varroa mites.

A device was also developed during that period to facilitate hyperthermia treatments for bees. However, this device did not penetrate the market. Nonetheless, some of the units produced during that time are still in use.

In 2008, we began developing a new product: the Varroa Controller. We are very thankful for the expertise of Prof. Engels, who supported us throughout this product development process.

Furthermore, I would like to express my gratitude to Dr. Adriana Díaz for her excellent research, which has been instrumental in the creation of this handbook, as well as to Michael Preisel for his wonderful drawings and illustrations. Special thanks also go to the fellow beekeepers who contributed updated testimonials for Chapter 7 or provided new ones for this third edition. I would especially like to mention Mr. Wilfried Ammon, who enriched the handbook not only with his extensive knowledge of beekeeping but also with his excellent photographs.

The aim of this handbook is to explain the topic of heat treatment against Varroa mites and to address the many questions we have received regarding this method. Our goal was to create an easily understandable manual that translates research findings into practical information. It should not be regarded as a scientific work; rather, the scientific findings are presented in a manner that allows for practical application. We welcome your feedback, suggestions for improvement, and ideas, which you can send to us at:

info@varroa-controller.com

One chapter in this handbook focuses on the Varroa Controller. This product has been available for rental (in various EU countries) since the spring of 2011 and can still then be purchased worldwide. Still, it was more important for us to write about the method of hyperthermia than about the Varroa Controller itself.

What else can I do now?

More and more beekeepers are encountering this situation: after the honey harvest, a treatment with formic acid was immediately carried out, and perhaps a second one as well. However, after a few weeks, the natural Varroa fall was again very high. The bees were still raising brood, which made an oxalic acid treatment impossible. Moreover, the nights were too cold or too humid to perform another formic acid treatment. In this case, a different method for controlling Varroa mites is needed. Such a method is now available: heat treatment, also known as hyperthermia.

2 Why do we need something new?

In recent years, it has become evident that autumn weather conditions are significantly warmer. Temperatures between 15° and 20°C are no longer rare. At such temperatures, bees may break up or may not even form their winter cluster, leading to increased flying activity, almost resembling spring. While this is pleasant to observe, it can have dangerous consequences.

Additionally, the cultivation of oilseed rape, mustard, phacelia, and other crops provides a rich supply of pollen very late in the year when bees are still active due to the warmth.

This results in the bees continuing to breed or starting to breed again. Even if the breeding is not vigorous, it is sufficient to give the Varroa mite the opportunity to reproduce further. Experienced beekeepers in various locations confirm that there have been no breaks in breeding during past winters, and that bees have reared their brood well into the winter months. Under such unusually warm autumn conditions, the Varroa mite can develop to a level that endangers bee colonies. By that time, summer treatments are long past, allowing the mite population to grow unchecked.

The so-called "treatment of the remaining mites," which is typically conducted in December, cannot be completed because it requires a broodless colony; otherwise, it is ineffective. Consequently, beekeepers are left to resort to last-minute measures to create a broodless colony, such as violently unsealing the remaining brood using a honey uncapping fork.

Flying bee and Blue Tansy
(Phacelia)

Foehn storm, tropical night, and drought

A completely atypical and far too warm November is coming to an end

The golden October lasted until the end of November this year. View of the hamlet of Duvin, at the entrance of the Val Uastg.
(Image: Keystone/Arno Balzarini)

The November of 2011 was not a typical one. Although there were many foggy days in the central region, temperatures exceeded the usual long-term average everywhere, and in many places, not a drop of rain fell.

Clipping form the NZZ
29.11.2011
(Source: NZZ)

Opening the bee brood with a honeycomb uncapping fork (Source: Imkerfreund, November 2011)

The situation clearly shows that there is an urgent need for a new method to effectively counteract these mites that cause damage to the bees. This method should work at any time during the beekeeping year: during the warm autumn weeks, as described before; early in spring; and even in the summer, if necessary. Ideally, this new method should leave no residues in honey, wax, or propolis, and at the same time, should not cause stress to the bees, as they are already more than challenged (e.g., with taking care of the brood in the autumn-winter season).

The heat treatment with the Varroa Controller is such a method. It can be used at any time during the beekeeping year, provided there is still sealed brood and the outside temperature is at least 18° Celsius.

To understand how the Varroa Controller works and its effects, one should know more about the life cycle of the Varroa mite itself.

The following chapters also explain how the heat treatment (hyperthermia) against the Varroa mite works and why it is successful by "only" treating the capped bee brood.

How shall it continue?

By now, an autumn treatment is necessary. Will there be broodlessness in December or not yet? If not, then the winter treatment will not be effective, and another treatment will be necessary in the coming spring. The previous approach of relying solely on a summer treatment and a „residual mite treatment" can no longer be continued in many places or is highly risky.

3 The beauty and the beast

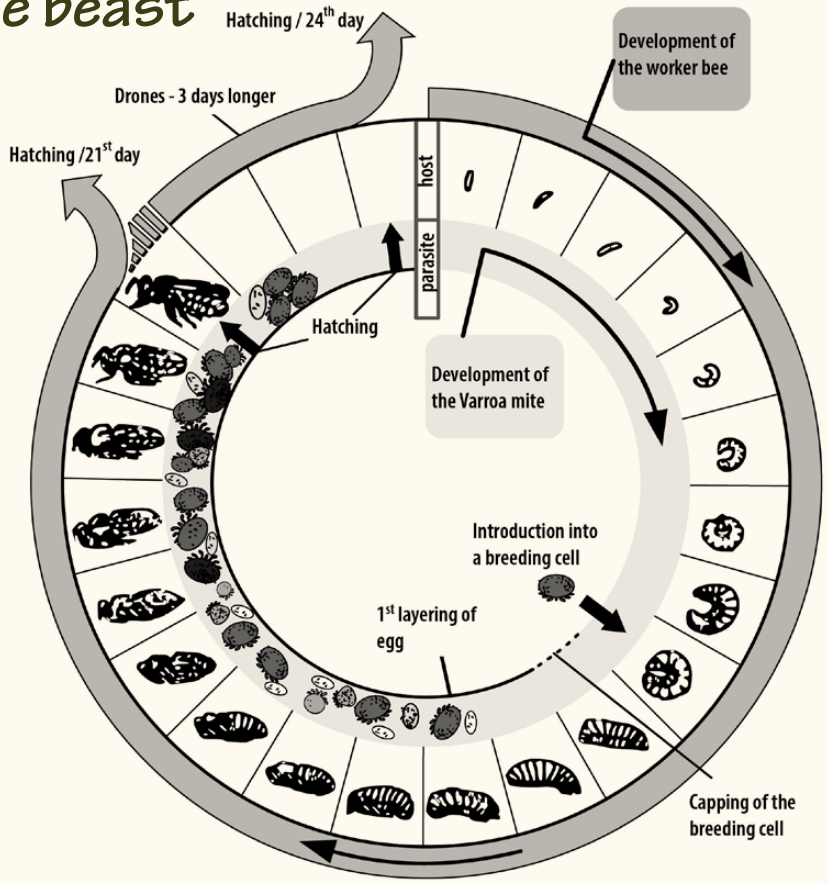
As a beekeeper, one understands how the development of honey bees occurs. Nevertheless, this development process is briefly presented here, with a particular focus on the aspects that relate to the development of the Varroa mite.

3.1 The development process of the bee

Stages of development of a worker bee – a quick review:

- 3-day egg stage: The egg is standing, inclined, and then lying flat.
- 6-day larval stage: A larva hatches on the fourth day, is fed royal jelly, and thereafter receives only a mixture of honey and pollen.
- 12-day pupal stage: On the 10th day, the larva stretches and spins a cocoon. The adult bee emerges on the 21st day

The Varroa mite inhabits the hive in two primary ways: first, it attaches to adult bees, preferably the nurse bees; second, it resides inside capped worker and drone brood, where it reproduces.



Joint development process of a bee and a Varroa mite
(Source: Bieneninstitut Kirchhain, 2012)

How about the Varroa mite - when does it come into play?

On the 9th day, the bee brood is about to be capped. The female Varroa mite enters the brood cell and is trapped inside with the bee larva on the 10th day. Convenient, right? Now we know exactly where the mites are and can remove them easily. That's exactly what we will do - more on that later.

"Stop," I hear you saying, "there are still the Varroa mites that sit on the bees. What about them?" I say, "Patience, we will take care of these too." How to do that comes later on.

What happens when the Varroa mite leaves the bee and goes inside a breeding cell?

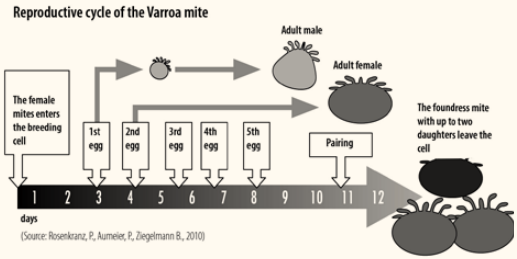
This is a very important question in terms of combating the mite and is closely related to the development of the bee itself. The formation of eggs in the ovary of the foundress Varroa mite is stimulated when the bee larva emits a volatile chemical stimulus through its cuticle. This process is called „oogenesis." As long as the mite parasitizes the adult bees, egg formation is on hold. We will be able to use this insight later.

3.2 The development process of the Varroa mite

First, the female mite (also called the foundress mite) goes into the breeding cell and hides "submerged" inside the larvae food between the bee larva and the bottom of the cell. The bee larva uses up the food a few hours after capping the cell. The foundress mite then uses her mouthparts to pierce the larva, causing a wound to feed on the hemolymph and the bee's fat body—a vital organ much like the liver in humans. The larvae just before the stage of capping, especially larvae of the winter bee generation, have a large fat body that forms nearly 100% of their body weight.

The fat body has nine important functions:

- It is a reservoir of energy and mobilizes nutrients.
- It detoxifies pesticides.
- It assists with osmoregulation.
- It helps the immune system function.
- It regulates temperature.
- It participates in metabolic activities.
- It helps synthesize functional proteins and fat.
- It is a reservoir of the protein vitellogenin, which regulates hormonal dynamics of the worker bees with regard to different roles in a hive, immune functions, and the longevity of the worker honeybees and queens.
- It is a reservoir of juvenile hormone that directly influences the development and metamorphosis of a honeybee.



Later on, its offspring will also feed in the same way. The damage caused by the female mite and its offspring disturbs the further development of the larva. Mites parasitizing on the larva compromise its immune system and make it vulnerable to diseases and viruses transmitted by the mite. Without Varroa, the larva's strong immune system would be quite capable of coping with pathogens. But the Varroa mite greatly reduces the larva's ability to do so.

During the period of about three days (about 70 hours) after the brood cell is capped, the female mite is eating and building her strength from the larva's fat body. Then she starts laying eggs, and every 30 hours an egg follows. In doing so, she manages to lay five eggs inside a worker brood cell and six eggs inside a drone brood cell. The first egg is always a male progeny. The development of the young mite progresses in various stages. At first, the egg turns into a so-called protonymph, then into a deutonymph. The total development time is 5.8 days for a female mite, and 6.6 days for a male offspring. As a result, the male descendant is the

First row: Three nymph stages of the female mite
Second row: Newly hatched female mite, foundress mite (dark), and male mite

What would be the population of Varroa mites in July if there were 100 mites in the beehive in February?

Assuming 100 mites in February, this number will increase to 200 mites in March, 400 mites in April, 800 mites in May, 1600 mites in June, and 3200 mites in July. These are theoretical figures under the assumption that nothing is done to control the propagation of the mites. More details will be provided in the next chapter.

first to be completely developed. Since mite reproduction can occur only in the brood cell, the male descendant begins to mate with the first female offspring. This sibling pairing takes place several times. After 20 hours, another female offspring is fully developed, and the male continues mating with it. Only fully developed mites are viable in this process of development. In total, there are 1.3 to 1.45 new fertilized female mites in the worker brood (on average) when infested by a single foundress mite. In the drone brood, however, this is significantly more—on average 2.2 to 2.6. Both figures refer to infected brood cells with one foundress mite. For infested brood cells with multiple foundress mites, figures might be higher.

With the hatching of the bee, fertilized young female mites leave the brood cell, and unfertilized female mites and male mites die. The foundress mite also leaves the cell and completes an average of three to four reproduction cycles during her entire life. Now it is clear why the drone brood is important because it is five to ten times more infested with mites than the worker brood. The chances of the Varroa mite to better mate are clear. This knowledge of the biology of the mite is important, especially concerning colony treatments during the year.

Inside the hive: The reproduction of mites is exponential. The development described before explains why the Varroa mite proliferates very quickly within a short time. The dynamics of the growth of the mite population depend on many factors and require complex modeling, but observations have shown that the population of Varroa mites in the bee colony doubles each month.

Externally: The incoming of Varroa mites from outside—the re-infection.

A summer treatment would usually be required when there is a high number of Varroa mites in the hive. Depending on the effectiveness of the treatment, one could expect a significant reduction of the mites in the hive. However, weeks later, it might be observed that the Varroa infestation is high again, which cannot be explained by the normal population growth in that short period. Often there are untreated or poorly treated hives in the vicinity, which are already weakened by the mite. Foraging bees that go into such weak hives during summer robberies carry back Varroa mites from these weak hives into their own.

Studies have shown that up to several hundred mites per week can enter the hives this way. This often destroys the results of the previous treatment. Once in the hive, the mite can continue to reproduce in the brood and damage the bee colony during the sensitive phase of late summer to early autumn.

At this point, it is almost impossible to completely eliminate the Varroa mite from the hives. It can only be kept under control. Therefore, it is important to ensure that a certain amount of Varroa mites is not exceeded. These thresholds depend on various factors, such as the strength of the colony, the season, and breeding activity. The English Ministry of the Environment - the Food and Environment Research Agency

Why do we find both bright and dark Varroa mites in the hive debris?

Well, these are the male and undeveloped female offspring that died when the bee hatched. As long as we find them, we know that the Varroa mite continues to propagate in the hive. This is an important sign for the watchful beekeeper!

Bee damaged by the Deformed Wing Virus (Source: Rosenkranz, P., Aumeier, P., Ziegelmann B., 2010)

(FERA) - defines 1000 mites in a normal hive in spring and early summer as the threshold. Below that level, the condition of the hive might not be critical. However, the threshold is much lower during the colony population decrease in late summer, as Varroa mites transmit and activate various bee viruses. Towards the end of the beekeeping season, viruses often become more virulent, probably due to the sibling mating among Varroa offspring. Therefore, we recommend following the results of the German research project, which defines 300 mites in a hive with about 10,000 winter bees - thus 3% - as the threshold.

It is certainly not just about being able to determine a specific number of mites but rather about performing permanent control of the infestation level of Varroa in the bee colony. Those who know the status of the mite population can take timely countermeasures to control the mite.

3.3 The damage caused by the Varroa mite

How does the mite harm the bee? There are two types of harm: on the one hand, the direct damage to the individual bee, and on the other hand, the long-term damage to the entire bee colony. This is called varroasis - a disease of the bee brood.

Damage to the individual bee

The Varroa mites perforate and feed mainly on the bee's fat body. This causes various pathologies observed in the later life of the affected bees, such as early onset foraging, reduced overwintering success, reduced lifespan, viral transmission, difficulties with metabolic functions, ability to navigate properly, low immune system, weight reduction, behavioral changes such as poor navigation, and changes in breeding and collective performance.

In addition, viral infections are transmitted through the wounds that the mite causes to the bee larvae while feeding on the fat body. The following viruses are transmitted by the Varroa mite:

- DWV (Deformed Wing Virus)
  ABPV (Acute Bee Paralysis Virus)
- SBV (Sacbrood Virus)
- KBV (Kashmir Bee Virus)
- IAPV (Israeli Acute Paralysis Virus)

A known visible damage is caused by the Deformed Wing Virus. In general, there is no treatment against the viruses; therefore, the Varroa mite has to be combated to avoid virus infections.

Damage to the bee colony

The injured individual bees are part of an entire bee colony, which consequently also suffers damage. These damages to the whole population have a special effect during the population decrease phase when the number of bees declines but the number of mites continues to increase. If the decreasing brood is then massively infested, the entire bee colony is at risk. The infestation of brood cells with many mites often causes the colony to collapse.

There are damages to the bee colony even with low Varroa loads. The colony shows the following symptoms:

- Reduced increase in bee population and thus less honey production
- Brood with holes and lower bee replacement rates
- Deformed bees, not able to fly
- Bees with shorter lifespans
- Drones with less chance of mating

The Varroa population must be kept below the "damage threshold" to limit these negative effects. This damage threshold, as indicated before, strongly depends on various factors, such as the overall strength of the colony and breeding conditions, the season, environmental factors, and the presence of viruses. **The only factor that the beekeeper can handle is limiting the population of Varroa mites.**

This handbook advocates for a very low damage threshold to ensure the viability of the bee colonies. It is possible to maintain this damage threshold by means of controlled heat treatment, as will be shown in the next chapters.

When do I need to control the natural fall of Varroa mites?

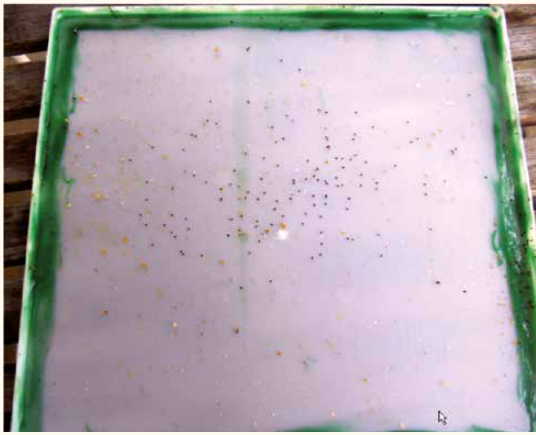
Experience has shown that it is smart to monitor mite fall throughout the entire bee year. It is not sufficient to wait until August to insert the bottom (Varroa) tray in the hive. Constant observation is an important element of an effective treatment against the mite.

4 Trust is good, control is better

The Varroa mite has become a major threat in beekeeping, and this is why we need to control it and keep its population within limits. This is an essential requirement for successful beekeeping. Today, observing the hives only once or twice per year is not enough anymore. Constant monitoring is needed, especially in autumn.

Monitoring the level of infestation within the bee colony can be simplified by the right choice of hive, with the bottom board being particularly important. An open mesh floor, allowing the debris and dead mites to fall onto a mite-catching tray below, can significantly ease the monitoring work. This open bottom board and catch tray allow the monitoring of the natural mite fall without opening the hive or disturbing the bees. An experienced beekeeper can draw conclusions about the colony's state from monitoring the mite fall. Therefore, assessing the mite fall represents a central element of mite treatment. It is important to know the level of infestation to decide how and when to act against the mite.

One can estimate the total population of mites within the hive by counting the fallen mites in the debris. The counting should be done daily over a period of at least one week; 10 days are even better to make sound conclusions. Average daily mite fall can then be calculated per colony. Shorter observation periods may result in uncertain estimates.



Bottom tray with insect lime at the edges, for a reliable count of dead Varroa mites (Photo: Wolfgang Wimmer)

What could go wrong when monitoring the mite fall?

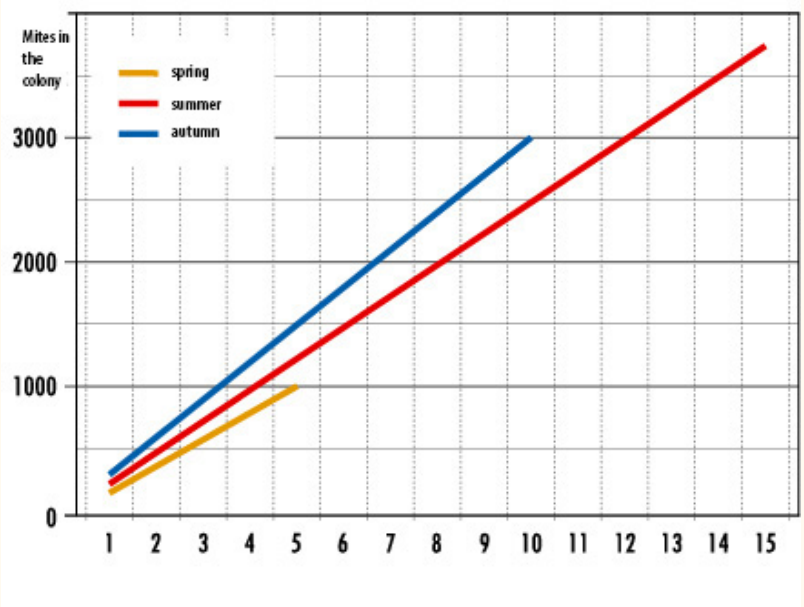
Many insects, such as ants, are attracted to protein-rich debris. They can get onto the bottom (mite) tray where the dead mites fall and carry them away, altering the result of the mite counting. By painting the sides of the bottom tray with sticky insect lime, one can avoid this problem. Three to four cm wide lines of lime at the tray's edges are enough. Insect lime, origi-nally used for the protection of trees, is available in the gardening section of do-it-yourself shops. There are also bee-friendly limes in organic quality. Without such help, e.g., the insect lime in the bottom tray, a reliable counting of the Varroa fall (and estimation of the population in the hive) is not possible. Caution: Vaseline or other fats, which are often recommended for the purpose of keeping ants away, do not actually hinder the ants from taking away the dead mites from the bottom tray!

4.1 The conversion factor

Once the average of the natural mite fall per day has been assessed, one can derive an estimate of the Varroa population inside the hive by means of a conversion factor. The value of this conversion factor depends on the season: in spring it is about 200, in summer it is 250, and in autumn it is around 300-500, depending on the size of the colony, if it is still breeding, and whether it is located in lowlands, mountains, or in the vicinity of poorly treated hives.

Monitoring the daily mite fall and extrapolating to the total population using the corresponding conversion factor, as shown below, are the first steps to understanding the level of mite infestation in the hive. This knowledge is necessary for avoiding mite damage to the bees and successfully keeping healthy hives.

Natural mite fall per day



How precise is the counting and the extrapolation to the total number of mites?

Indeed, these calculated figures are estimates and depend on different conditions (e.g., the hatching of drones). Nevertheless, the method is sufficient to provide guidance for effective mite treatment. In this case, we can say, "It is approximately right and not exactly wrong."

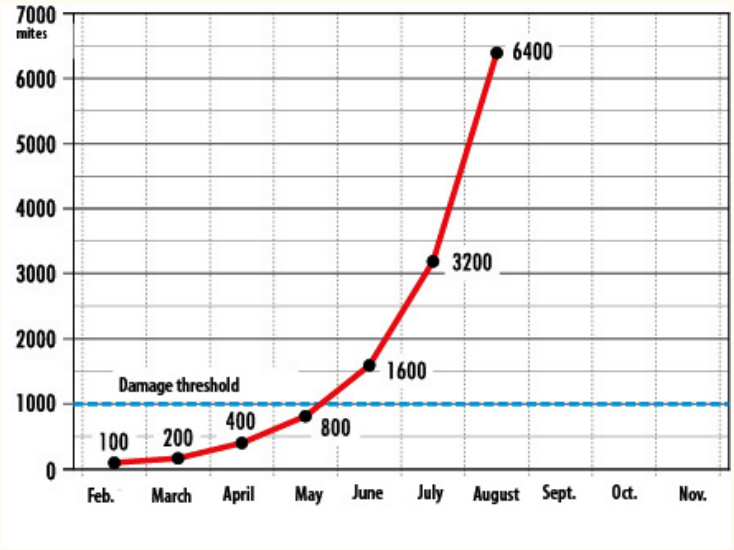
4.2 The reproduction rate

Knowing the total population of mites within the hive at a certain time is important, but not sufficient. It is necessary to recall the information from Chapter 3, which deals with the reproduction rate of the mites. Without going into too many details concerning the biology and reproduction of the mites, the most important fact is that the mite reproduction rate doubles each month; in other words, the number of Varroa mites doubles every month.

This monthly doubling means that the reproduction rate is non-linear, as shown in the graph below. Each mite in month 1 will become 16 mites in month 4, 32 mites in month 5, and 64 mites in month 6. If there are 100 mites in the bee colony in February and no measures are taken against these mites, the population will grow to 6,400 mites by September. This would mean in practice that the colony might collapse shortly before July or between July and August due to varroasis—the end of the colony.

One must intervene to prevent this from happening, but when and how?

Uncontrolled mite reproduction in a bee colony – doubling per month



As discussed previously, there are different views on the tolerance (threshold value) of mites within a bee colony. Many experienced beekeepers have observed that their bee colonies can endure fewer mites over time. The threshold seems to decrease progressively. Caution is advised with respect to the different mite tolerance figures. We follow the British Environmental Ministry, which estimates a threshold of 1,000 mites. This means that a bee colony can endure about 1,000 mites without being seriously threatened.

The threshold during the colony's population decrease in late summer is defined as even much lower. The beekeeper should aim to keep the hives below this threshold (e.g., 3% of mites in relation to the number of bees) to avoid damage, especially before and during the overwintering period. Later in Chapter 6, we will explain different strategies to stay below this threshold.

4.3 The places to find the mites

So far, we know the reproduction rate of the mites, how to calculate their total population, and the recommended damage threshold for the colonies. Is this enough to decide on a treatment strategy? The answer is no; one piece of information is still missing.

Where is the mite actually?

It is essential to know the location of the mite and when it is present. This information is crucial for deciding on the appropriate treatment and can significantly impact the success of that treatment. However, it's also important to recognize that the mite is not always where one might expect it to be.

In principle, the mite can be found in only three different locations within the bee hive. As mentioned in Chapter 2, the mite reproduces in the worker and drone brood. The mite needs to be sealed into the brood cells to reproduce, making these two clear places to find the mites. The third location is a result of the natural cycle of mite reproduction. The mites also parasitize the bodies of adult bees.

It is not very useful to treat the adult bees against the mites when the majority of the mites are inside the bee brood. The distribution of mites changes between these three locations throughout the beekeeping year. This is the third important piece of information for a successful treatment strategy.

In **spring**, 80% of the mites are inside the bee brood. Of these, one-quarter (25%) are in the drone brood, while the majority (55%) are found in the worker brood. One-fifth (20%) parasitize on the adult bees.

This distribution changes over the year. In **summer**, 70% of the mites stay inside the bee brood, with one-fifth (20%) in the drone brood and 50% in the worker brood. Thirty percent of the mites stay on the adult bees. In **autumn**, there are no drones anymore, so only 60% of the mites are inside the bee brood, while 40% stay on the adult bees.

Summarizing the Four Important Findings:

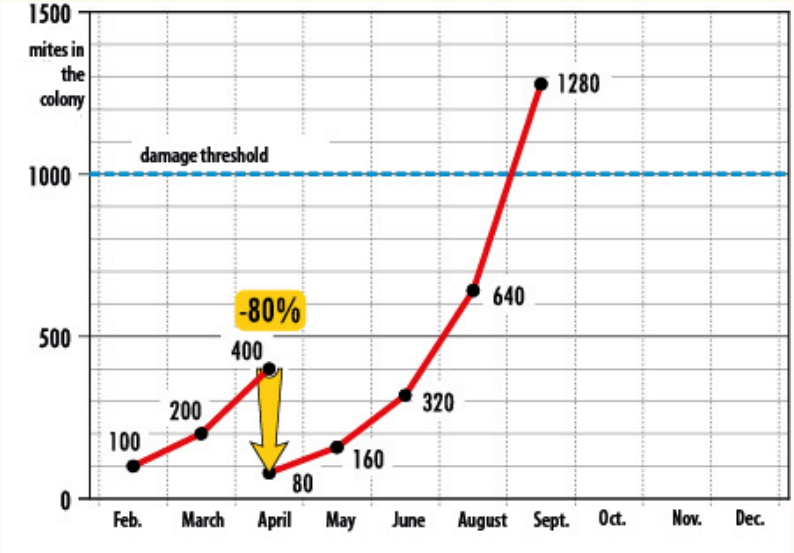
1. The Exponential Reproduction Rate: Mites double in population per month.
2. The Average Mite Fall Per Day and Conversion Factors: These are used to estimate the total population of mites inside the bee colony.
3. The Damage Threshold: 1,000 mites per hive when the number of bees is increasing, and 3% of mites per hive when the number of bees is decreasing.
4. The Distribution of Mites: Mites are found in the worker brood, the drone brood, and on adult bees.

As long as these four findings are considered, there are no limits to creativity in developing strategies and methods for treating mites.

With this knowledge, anyone can create their own treatment strategy. Strategies to keep the mite population below the threshold value are discussed in Chapter 6.

4.4 The principle of hyperthermia

Now, looking again at the example starting from 100 mites in February, and with the doubling each month (exponential rate), what would be the mite infestation level in September (after a spring treatment)?



Mite reduction effect of a heat treatment in spring

When does it make sense to treat the bee brood?

It makes sense to treat the bee brood in the spring. At this time, four-fifths (80%) of the mites are present in the capped brood. They are enclosed in the breeding cells and thus are easier to extract.

The graph clearly shows a different picture. Instead of the total burden of 3,200 mites in July and 6,400 in August, there are only 640 mites in July and 1,280 mites in August.

What was done?

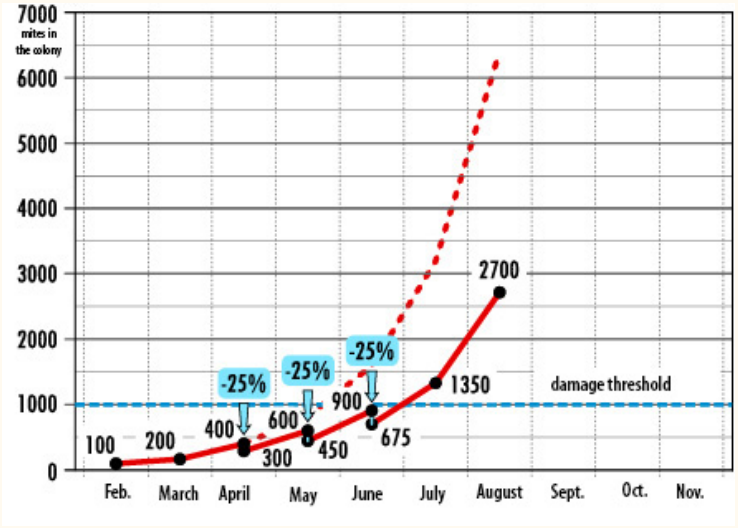
A heat treatment was carried out with the Varroa Controller in April. Since February, the mite population had time to double each month (for two months), increasing from 100 mites to 400 mites. We know that 80% of these mites, or 320 mites, are in the bee brood (worker and drone brood). Assuming that both brood types were treated with heat, only 80 mites remained attached to the adult bees. These mites cannot be eliminated through brood treatment alone.

This example underscores the importance of a spring treatment. It interrupts the doubling reproduction rate and targets the majority of mites present in the brood.

It is crucial to act rather than wait too long. Delaying treatment until the mite population is at full strength and endangering the bee colony is not advisable. Timely countermeasures are key to success. With heat treatment, you can intervene against high Varroa pressure well before the bee colony is seriously threatened.

4.5 Drone brood removal

The previous findings can also be applied by removing the drone brood. Taking the example of 100 mites in February with uncontrolled growth as the starting point, one can remove drone brood three times in a row to achieve good results in reducing Varroa pressure. This technique slows down the mite population growth. It is important to address the drone brood either by removing it or by treating it with heat.



Mite Reduction Effect by Removing Drone Brood Three Times in Spring

5 The course of a heat treatment

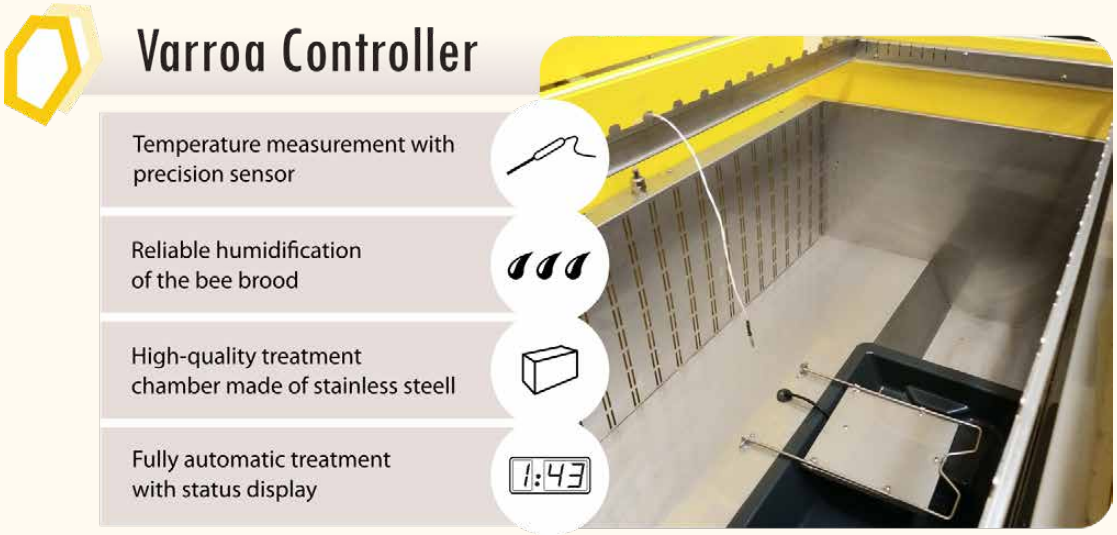
This chapter describes the process of heat treatment using the Varroa Controller and provides tips and hints for operating the machine. The Varroa Controller is specifically developed for heat-treating the brood frames of honey bee colonies.

5.1 The Varroa Controller

The Varroa Controller features computer-controlled electronics for the heat treatment process and utilizes a high-precision sensor for accurate temperature measurement. This combination of precise program control and accurate temperature measurement ensures even warming of the bee brood and prevents overheating. The multi-layer housing provides optimal thermal insulation and allows for energy-efficient heating.

Similar to the natural humidity of the hive, the treatment chamber of the Varroa Controller maintains humid air during treatment, generated by an ultrasonic humidifier. A robust, powerful fan ensures the targeted distribution of warm, moist air.

The Varroa Controller is user-friendly: the beekeeper simply needs to insert the frames with capped brood, place the temperature sensor into the brood frame, position the



The main elements of the Varroa Controller (Source: www.varroa-controller.com)

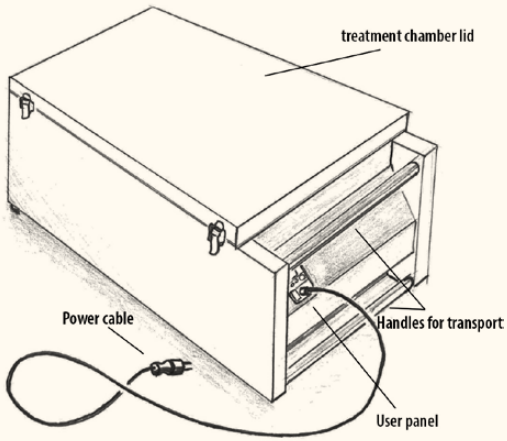
frame in the center of the treatment chamber, close the lid, and press the start button to run the program. The treatment runs fully automatically, and the remaining treatment time is displayed on the screen. At the end of the treatment, a sound signal indicates that the process is complete, and the brood frames can be returned to their original colonies.

The Varroa Controller is designed for on-site use at the apiary. In locations without a mains power connection, it can be powered by a generator.

5.2 The seven steps of heat treatment

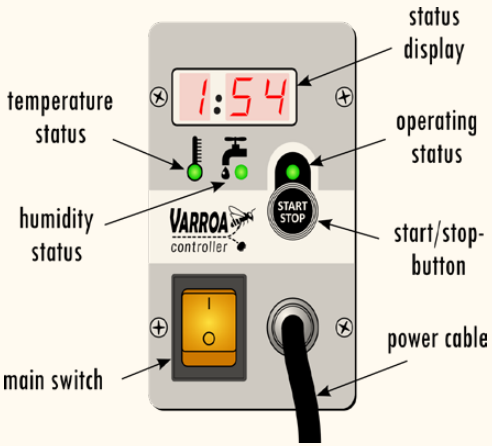
Step 1

The first step is to place the Varroa Controller horizontally at the treatment location. The device must be protected at all times from direct sunlight and rain. The ambient temperature during treatment should be at least 18°C.



Using the device is straightforward in a stationary apiary, but often the hives are located in fields without electricity. The Varroa Controller is designed to operate with minimal power, so it can be used with a small generator if necessary. The generator should provide at least 800 W of continuous power. (Please note that manufacturers sometimes specify only the maximum power; ask for the continuous power rating of the generator.) Before using a generator, ensure it is properly grounded according to the manufacturer's instructions.

The control panel of the Varroa Controller is user-friendly. It features a main switch and a start button. When the main switch is turned on, the Varroa Controller begins to operate, adjusting the temperature and humidity in the treatment chamber to mimic hive conditions.

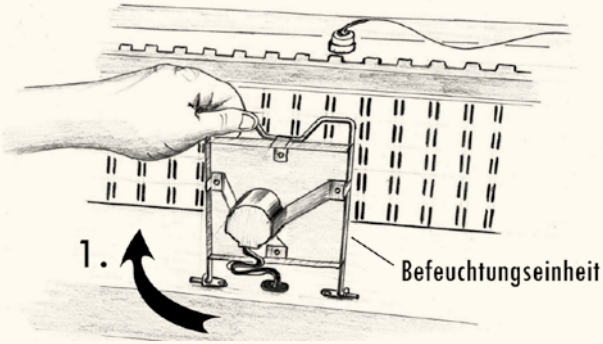


What happens if something goes wrong?

If the treatment is started and someone accidentally trips over the cable, causing the Varroa Controller to become unplugged, what should be done? Does the treatment need to be restarted from the beginning? No, it does not. The device is equipped with a memory feature that allows it to "remember" its progress in the program. When plugged back in, it will resume reliably from the point it was interrupted. However, if the device remains unplugged for more than 20 minutes, it is recommended to stop the treatment and restart it from the beginning.

Water must be added to the device before it can be turned on using the main switch.

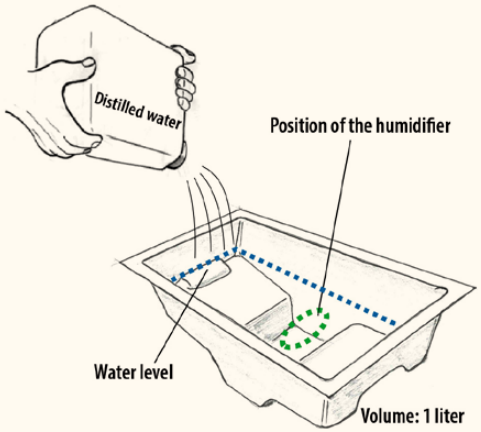
Step 2
To fill the water, open the lid of the machine and lift the humidifier (1) to remove the water container.



Fill the container with distilled water up to the indicated water level. Return the water container to its original position inside the treatment chamber and reposition the humidifier horizontally.

The volume of water in the tank is sufficient for at least two consecutive treatments.

Once the water tank is filled and properly in place, and the lid is closed, the heat treatment can begin.



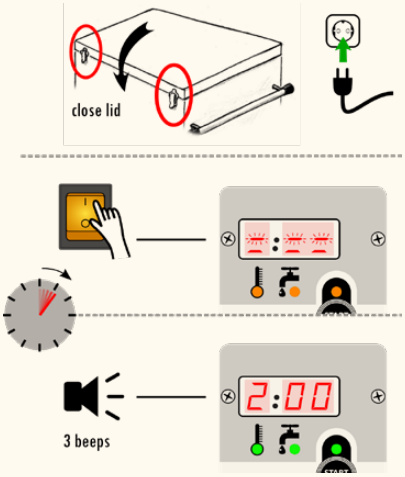
Filling the water tank
Source: www.varroa-controller.com

Caution:
Always use distilled water, as hard water can cause scale buildup on the membrane of the ultrasonic atomizer. This can result in reduced water mist being released into the treatment chamber, potentially causing the bee brood to dry out during treatment.

One more tip before starting the device:
Line the bottom of the treatment chamber with two strips of paper towels. Some honey may drip, or individual bee larvae may come from the unsealed cells, so it is very beneficial for cleaning if you place paper towels on the bottom of the treatment chamber beforehand. If you have a spray bottle with water, dampen the paper slightly so it stays flat on the bottom. Now you can begin the treatment.

Step 3

Ensure that the device is correctly set up and filled with distilled water. Place the sensor holder on top of an empty frame in the middle of the treatment chamber and close the lid. Turn on the Varroa Controller by pressing the (orange) main switch. The machine will now start preheating. This is indicated by the three status LED lights illuminating in orange

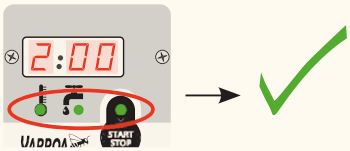


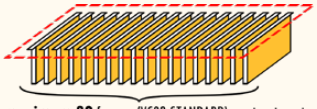
and the upward-moving beams on the display. **During preheating and while filling, the temperature sensor must remain on the empty frame.**

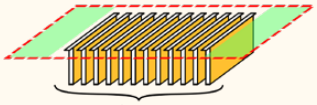
Do not insert any brood frames into the machine until you hear three short beep signals. These signals indicate that the machine has reached the correct temperature to begin treatment. Simultaneously with the beep signals, the display will show the planned treatment duration (e.g., 2:00 for two hours). This is your cue that you can now place the brood frames inside the machine.

Step 4

Once the Varroa Controller has reached the treatment conditions, you can place up to 20 brood frames inside. **Ensure that** these frames are prepared by being free of nursing bees and take them directly to the Varroa Controller.







Removal of the capped brood frames
(Source: www.varroa-controller.com)

What's going on?

You follow the instructions in the user manual exactly, but the device does something completely different. As soon as you switch on the main switch, a program runtime is shown on the display. What should you do? It's quite simple: reset the machine by pressing the start button for five seconds. Then the device will be ready to start again and will behave exactly as described here.

Can I mix different frame sizes for one treatment?

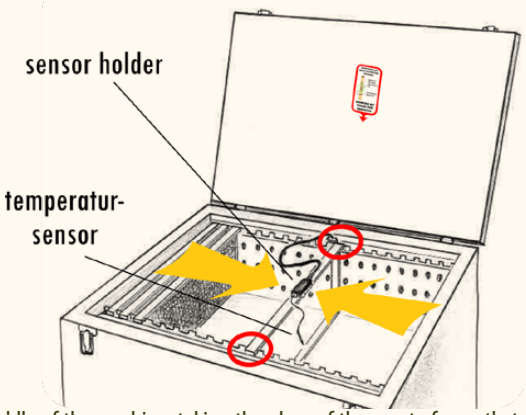
You use frame sizes such as Zander, Breitwabe, Langstroth, Dadant, or other types of frames, but have narrow frames in the honey super. Working without a queen separator might result in breeding that extends up to the honey super. Now you want to treat the large and narrow brood frames at once – is that possible?

No, that will not work. You should not mix diferent frame sizes! Large brood frames need more heat than small ones. The device only regulates correctly if equal-sized frames are treated. What can be done is to run a treatment with only narrow frames – that works fin. Mixing frame sizes is not possible.

You do not need to treat all 20 frames at once; you may also treat fewer frames if preferred.

Now you can hang the bee-free frames with the capped brood. Open the lid and hang the brood frames one by one. Make sure that the brood is placed in the preheated Varroa Controller immediately to avoid cooling of the frames.

The last frame removed from the hive should be placed in the

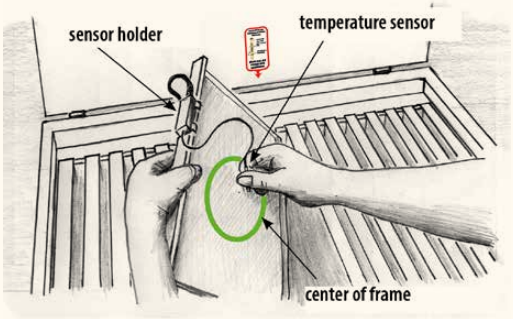


middle of the machine, taking the place of the empty frame that was holding the temperature sensor before. This is the frame where you will insert the temperature sensor.

Step 5

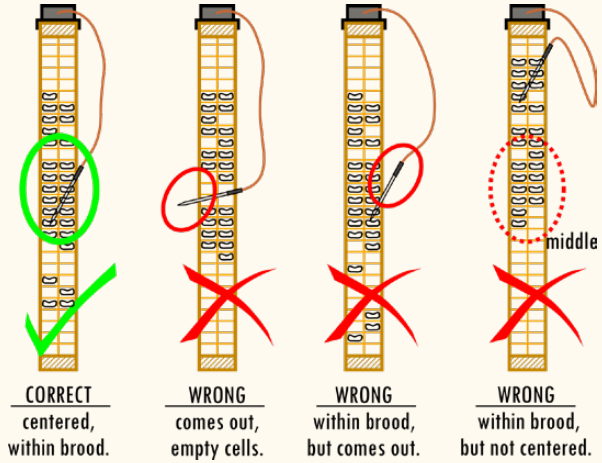
Inserting the temperature sensor is a delicate step that determines the success of the treatment. If the temperature sensor is inserted incorrectly, the heat treatment will not work properly.

Positioning of the temperature sensor
source: www.varroa-controller.com



There are 4 points to pay attention to:

1. A well-developed capped brood frame
2. The frame with the sensor is in the middle of the Varroa Controller
3. The temperature sensor is in the middle of this capped brood frame
4. The sensor is completely inserted but does not pierce through the brood frame.



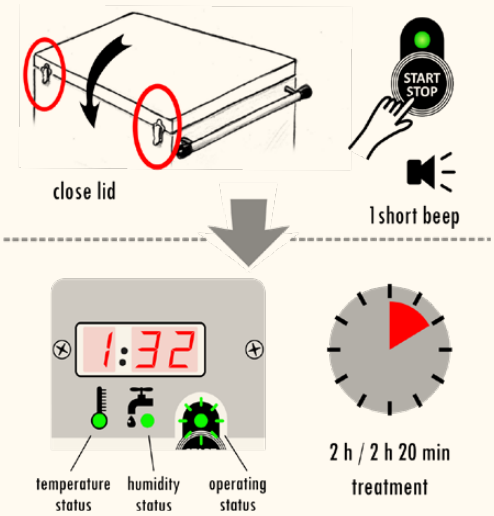
Filled device before program start
(Quelle: www.varroa-controller.com)
Done! Now the program can start.

Step 6

Once the temperature sensor has been inserted, check all the brood frames again to ensure they hang straight downwards and not crooked, allowing air to flow freely between the frames. If a thick comb is a hindrance, the frame must be adjusted or even turned over. The air flows from the front to the back, and it is important that it can flow freely and unhindered between the frames.

After all the frames have been correctly positioned, close the lid and start the program by pressing the start button. A short beep will sound, and the countdown will be shown on the display. You can read the remaining treatment time in hours and minutes. The status LEDs will now be green, indicating that the program is working and the beekeeper can take a break.

The treatment lasts two hours with the VC Standard model, and 2 hours and 20 minutes with the XLarge model (for the large frames Dadant, Jumbo, etc.). During this time, the lid must always be closed. Even short-term opening is not allowed.



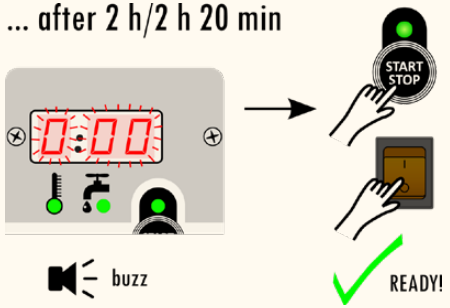
Label brood frames on the top bar?

When removing brood, it is not necessary to mark the brood frames. It is sufficient to open the colonies either clockwise or counterclockwise, take out the capped brood frames, treat them together in the Varroa Controller, and then return them to the colonies in the same order. This ensures that each colony gets its own frames back.

After the two hours, a continuous sound (buzz) will indicate that the treatment is complete. Now, briefly press the stop button to silence the continuous tone.

The warm brood frames can be returned to the hives. The nursing bees will immediately take care of the brood, and with that, the treatment is over. Usually, some bees hatch during the treatment.

Step 7

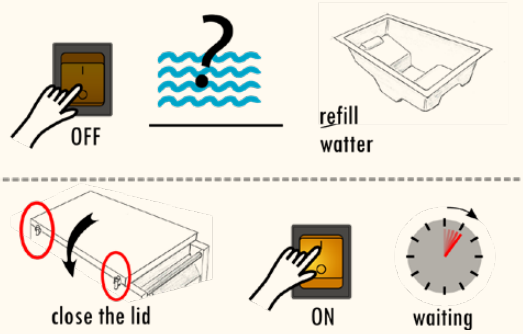


You now have to decide if you want to continue with another treatment or not. The water tank holds enough water for at least two treatments. So if you want to follow up with a second treatment, you can do it immediately. After the second treatment, however, you should check and refill the water tank. When you have finished your treatment(s), you need to clean the treatment chamber.

You must then **empty the water tank!** The Varroa Controller must never be moved with a filled water tank - not even a few meters. Whenever you want to move the device, the water tank **must** be removed first.

It is advisable to run the device briefly with the water tank removed, the treatment chamber empty, and in the drying mode according to the instructions in the user manual.

The Varroa Controller is easy to clean, but the rails used to hang the frames can collect wax and propolis. Therefore, you can easily remove these rails to clean them outside the machine. For devices that are rented by beekeepers to other beekeepers, they should be cleaned and disinfected after every completed treatment cycle to avoid the transfer of diseases.



What happens if I forget to refill the water between the second and third treatment?

The water level is permanently monitored. If the water level is low, the machine will display an error message. To continue with the treatment, simply turn off the main switch, open the machine, refill the water tank, close the lid, and then turn the main switch back on to resume the treatment.

Why is there still water?

After completing two treatments and finishing your work, you remove the water tank and notice that there is still a lot of water in the tank. Did the humidification not work? Do not worry—the humidification has certainly worked properly, as the humidity is permanently monitored.

The Varroa Controller VC03 in Practical Use – Watch the Video Here!

5.3 After the treatment

The brood frames are back in the hives. It will take some time for the bees to hatch, and consequently, for the dead mites to fall off these open brood cells. It is now necessary to clean the Varroa catching trays that have been treated with insect lime and to insert them to observe the success of the treatment. Depending on the development of the treated bee brood, the hatching may occur faster or slower. However, within a maximum of twelve days, the entire treated bee brood will have hatched. Experience shows that there may be an additional two days with higher mite fall, as the cells are still being cleaned and cleared of dead mites.

From the 14th day after the treatment, the normal, though now significantly reduced, natural mite drop will resume.

What if I want to know right away?

If you want to partially open the treated brood immediately after the treatment to check if the mites are actually dead, please note that the mites are not dead right away. The heat causes the formation of heat shock proteins, which lead to permanent cell damage and eventually kill the mites. This process takes between 25 to 50 hours after the treatment. Therefore, if you want to check, please wait; otherwise, you might still find living mites.

6 Use of heat treatment in the bee year

In this chapter, the three main treatment strategies for hyperthermia—spring, summer, and autumn—are presented. By following these heat treatment protocols in the respective seasons, you will minimize the risk of losing hives to mites.

In principle, it is possible to perform heat treatment at any time when there is bee brood. However, the following indications highlight specific times in the beekeeping year when the treatment is particularly effective for safely controlling mites.

6.1 Spring: clarity from the beginning

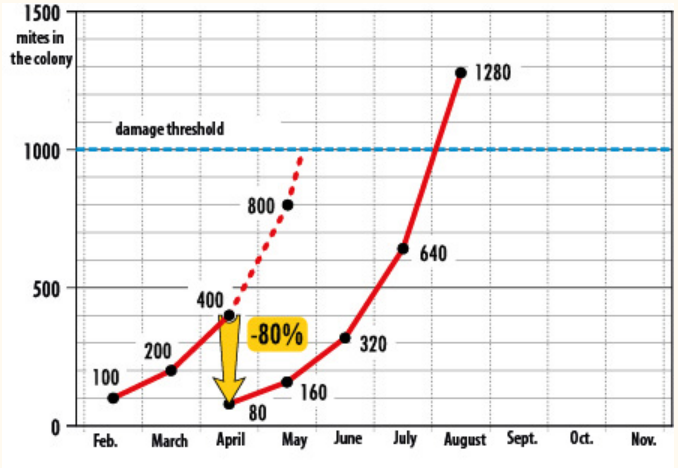
In spring, the Varroa mite develops within the brood. We understand its development and growth rate: the mite population doubles each month. This proliferation can be effectively disrupted through heat treatment, which kills the fertilized, reproductive female mites in the brood. It is known that 80% of the mites are found in capped brood cells, so this portion of the mite population can be easily targeted with heat treatment. For instance, starting with 100 mites in February, heat treatment will impact the 80% of mites located in the capped brood.

Under normal conditions, 100 mites would increase to 400 mites by April, and the Varroa population would grow to 800 mites by May. However, by treating the capped worker and drone brood with heat, the Varroa population can be reduced from 400 mites to 80 mites (the remaining 20% of mites attached to the adult bees will persist and continue to reproduce). Consequently, by May, there would be 160 mites rather than 800. This significant reduction is crucial for managing the bee colony throughout the year.

Typical food off er in the spring
Source: Wolfgang Wimmer

Without additional Varroa treatments, these 160 mites in May would increase to 1,280 mites by August. Without any heat treatment, the mite population could reach 6,400 mites by August. This high mite load would likely lead to the collapse of the bee colony and potentially infect other colonies.

When treating sealed brood, it is important to choose a time when there is minimal brood but a relatively high concentration of mites in the brood. The goal should be to treat



The impact of the heat treatment in spring

a maximum of two to three frames per colony to ensure a high concentration of mites in these frames and to minimize treatment time. The Varroa Controller can accommodate up to 20 frames. Thus, 10 hives can be treated in two hours with a maximum of two brood frames per colony. In April, if there are already many frames with capped brood in the apiary, heat treatment should be conducted earlier. Heat treatment can be performed at any time, which is advantageous later in the beekeeping year, especially in autumn. The only requirement for heat treatment is an ambient (outside) temperature of at least 18°C.

Can one also treat the drone brood?

Literature suggests that heat treatment may damage the sperm quality of drones, but these concerns typically involve a sudden temperature increase just before the drones hatch. The warming process in the Varroa Controller is gradual, and no problems have been identified to date. In fact, some bee breeding stations in Austria and Bavaria use the Varroa Controller to treat the drone colonies.

To ensure the quality of the drones, you can count back six weeks (40 days of drone lifespan plus the capping stage from the day the queens are introduced to the breeding station). The last day for heat treatment should be calculated based on this timeframe. This approach ensures that the drones available for fertilization have developed with the lowest possible number of Varroa mites and have not been subjected to the heat treatment. This method effectively leverages the benefits of heat treatment for the drone colonies as well.

6.2 Summer: work very efficiently with the Duplex-Framebox

Many beekeepers who are interested in hyperthermia can now imagine that they can efficiently perform a heat treatment with the Varroa Controller on a relatively small number of brood frames. Normally, the heat treatment is performed when the newly developed capped brood is spread over two to three frames. Depending on the location, this might be around the middle to the end of March, but in some locations, it can also be earlier. The important thing is that you do not overlook this timing. With the normal capacity of the Varroa Controller for 20 frames, you can easily treat the capped brood of ten colonies in only two hours.

But what about summer?

Strong colonies build up a lot of brood during the spring. A bee colony increases fivefold to sixfold from winter to midsummer. In this time of expansion, a heat treatment would be very time-consuming, as a lot of capped brood would need to be treated. An exception is removing part of the brood for creating new colonies. The capped brood is removed and can be immediately treated with heat before forming new nucleus colonies. These new colonies will have an optimal start without mites.

But back to the productive hives—here there are more brood frames. The pressure of the mites rises dangerously if you wait too long. How can one elegantly solve the issue of treating soon, and not having too much capped brood at the time of treatment?

In beekeeping, we are used to thinking in longer timelines. An action today will only show results in two to three weeks. In addition, we are also challenged to use resources in a smart way to get the best out of the bees and ourselves. The issue described above is not much different. If I want to have a small amount of brood at a specific time, I have to take action and lay the foundations for it some weeks before.

The theoretical background

As we already know, most of the mites are in the capped brood. It would be particularly clever if we could have colonies with minimal brood at the time of honey harvest. Then we would know that the mites have no other option than to go into this limited brood to reproduce. That's exactly what we're going to do, reducing the brood to a minimum at the time of honey harvest. We want the bees to use all their energy to collect honey and not continue breeding at the time when it has already reached the peak of its strength. In old times, beekeepers used to kill the queens so that the colonies gathered more honey and reared a new queen. But we do not want to go that far.

Essentially, this is about making our bee colonies fit so that they can take care of the brood after the honey harvest (e.g., mid-July) without the Varroa mite being dangerous to them. The changing climatic conditions demand this type of summer treatment since bees find blossom until the end of November. In some places, soil-enriching plants such as oilseed rape and mustard are blooming even until December due to unusually warm temperatures. Under these conditions, the bees continue to breed, and the Varroa mites continue to reproduce. Therefore, the aim must be to "turn around" the bee year by eliminating most of the mites in the hives at the time of the honey harvest, thus ensuring that the colonies are fit for the coming increase in the mite population from July onwards—a doubling of the mites up to mid-August, a quadrupling up to the middle of September, an eightfold increase up to mid-October, and a sixteenth-fold increase in mites up to mid-November.

Under such new climatic conditions, the complete removal of mites must take place at the time of the honey harvest, at the latest by the middle of July. The successful wintering will be decided in mid-July. Those colonies that have a low Varroa population by mid-July can better resist the massive increase of the mite population until the end of the year. Otherwise, it is almost certain that these colonies will collapse.

How can you significantly reduce the mite population in the hives by the middle of July? In the following section, we show how to do that and how you can get five more benefits out of the proposed procedure.

The Duplex-Framebox

As you might have guessed, to reduce the bee brood, you have to restrict the egg-laying activity of the queen. For this purpose, you can use a frame box where you can lock the queen for a specific period of time. We developed the Duplex-Framebox as a clever accessory to use in combination with the Varroa Controller.

This Duplex-Framebox is made entirely of a thin aluminum sheet, is very durable, and holds two frames. The lid closes tightly, preventing the escape of the queen when placed inside the frame box. The aluminum sheet is laser-cut, rounded at all edges and holes, so that the wings of the bees are not damaged when going through. This aluminum construction allows the Duplex-Framebox to be cleaned with steam (e.g., in the wax melter) after its use. This is a decisive advantage, as the bees might seal part of the frame box with propolis and wax.

Why a Duplex-Framebox and not a simple queen caging box? This is easily explained: because we want to give the queen enough space for laying eggs; otherwise, the transition from full to reduced breeding activity would be too strong. In addition, it should be ensured that there are enough open brood cells for the mites to go in. The mite finds the cells through the smell emanating from the open brood. This is another important argument for offering space for at least two brood frames. In Zander size, two brood frames contain around 12,000 cells. When the queen is caged in the Duplex-Framebox for a period of 24 days, she will have in total three or four (Zander) frames with a total of about 18,000 -24,000 cells for laying eggs. Considering that under optimal conditions, a queen can lay up to 2,000 eggs a day, the cell availability in the Duplex-Framebox is certainly constrained, but it is still more than enough to prevent colonies from rearing new queen cells outside the Duplex-Framebox.

The new Duplex-Framebox
Source: www.varroa-controller.com/dwt

The actual application

The four breeding frames are indeed sufficient because the Duplex-Framebox is used beginning from mid-summer onwards, when the bee colony is at the peak of its strength and is still collecting honey. A Duplex-Framebox is assembled for each managed hive. Then one removes the honey super and sets it aside. The next step is to find the brood frame where the queen is laying eggs (usually a brood frame where there are fresh eggs and small larvae). One takes out this frame carefully, makes sure that the queen stays on it, and puts it inside the Duplex-Framebox. A second frame, one with only

a wax foundation, is also placed inside the Duplex-Framebox. Alternatively two empty frames can be used. Then one places the lid on top and puts this filled Duplex-Framebox in the middle of the brood super. If you work with two brood supers, then the Duplex-Framebox should be placed in the middle of the upper super. Then the honey super goes back on top of it. This procedure goes very fast, provided you have experience in finding the queen, and of course, when you work with marked queens.

After this, you wait exactly twelve days and come back to check the hives and remove the Duplex-Framebox. You open it carefully and take out the brood comb on which the queen was originally laying eggs. This brood comb is now fully capped, and the frame with the wax foundation next to it has been built, and very likely there are also eggs in it. In place of the original capped brood frame, you put an empty frame (not a wax foundation) so that the queen can lay eggs right away. Alternatively both frames are capped and you exchange both. You make sure that the queen stays in the Duplex-Framebox and close it again to put it back in the same place inside the hive.

The breeding frame that was removed will be treated with the Varroa Controller. After the heat treatment, it is best to give these frames to nucleus colonies for their reinforcement.

Now you leave the Duplex-Framebox in the hive for another twelve days. At this point, the two brood frames inside the Duplex-Framebox are the only open brood in the hive. Consequently, the mites can be "trapped" in these two brood frames. The honey is harvested at the end of the second round of twelve days, namely on the 24th day after the first placing of the Duplex-Framebox in the hive.

The bees from the honey supers and from the breeding nest are swept into a box or container. The dark, old frames are sorted out, and the frames with stored pollen are placed back in the hive, together with new frames with fresh wax foundations. One can do this work quickly because the queen is still inside the Duplex-Framebox. Finally, the Duplex-Framebox is opened, the queen is placed in a smaller caging-clip or box, and the bees from the Duplex-Framebox are also swept into the box. The two brood frames are placed in the preheated Varroa Controller. Then the adult bees in the box are treated against the mites parasitizing on them and then put back into the hive. Last but very important, the queen is released and placed inside the hive, and the colony is immediately fed with sugar syrup. The whole procedure takes a few minutes per hive and achieves perfect conditions for the following weeks and months of the bee year.

The advantages of the system

The combination of using the Varroa Controller and the Duplex-Framebox is optimal for the beekeeper because, at the time of the honey harvest, the hatched brood of about ten colonies can be easily heat treated in two hours. This is a great advantage, especially when dealing with a large number of colonies. Other benefits can be achieved aside from the time efficiency.

It is very important and decisive to replace the frames where breeding has taken place over many cycles, namely the dark wax frames outside the Duplex-Framebox. These frames can be removed and melted out, and the hive can get frames with new wax foundations, which the bees can immediately build up and expand. Starting mid-July, the colony has completely fresh combs, which is also very important in terms of keeping healthy bee colonies. As there is no care of the brood for 24 days when using the Duplex-Framebox, the bees collect more honey, and beekeepers can profit from about 20% more harvest.

Another advantage is certainly that the two heat-treated brood frames per hive can be used for the reinforcement or building of nucleus colonies. The small colonies used to rear queens in May, which probably have small breeding nests in

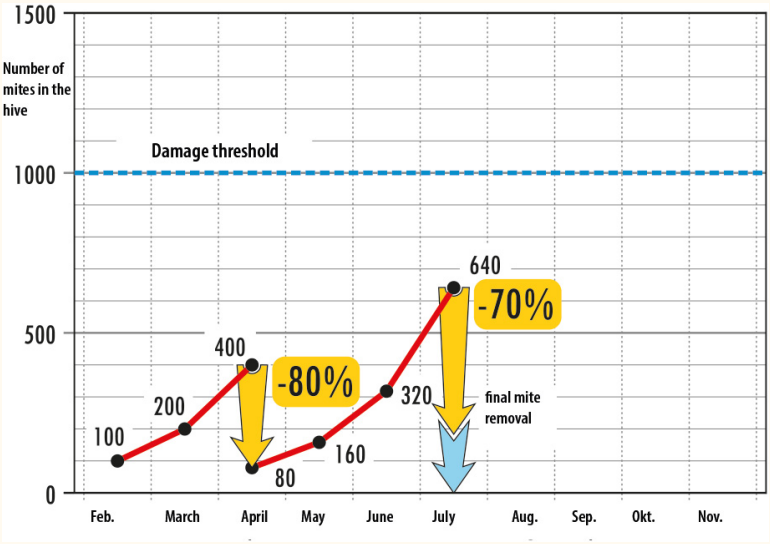
The application of the Duplex-Framebox – here is the video

mid-July, could be strengthened with two such heat-treated brood frames. This means 12,000 new bees are added (in the case of Zander frames) within a period of 12 days. Such a small colony becomes a strong one—this is a real joy to observe.

The key advantage is that, due to the fact that all the breeding frames outside the Duplex-Framebox did hatch during the two consecutive periods of twelve days and the two breeding frames inside the Duplex-Framebox have also been removed, the colony is brood-free. This allows the beekeeper to remove the remaining mites from the adult bees. The honey has already been harvested, and so the few mites can be treated with the known and permitted methods (depending on the country, e.g., with lactic acid).

Do not be surprised if you do not find many mites because the majority are trapped in the removed capped bee brood, which was successfully treated with the Varroa Controller. This is the cornerstone for the healthy development of the winter bees. The mites were removed, the fresh wax foundations are in place, and the queen can start laying eggs as there was also appropriate feeding. Now the hives are fit for more months of breeding.

Attention: it is important that you continue monitoring the natural mite fall, as some hives in the surrounding areas might have bees that will bring mites into your treated hives in the next months. As such, it is likely that an additional heat treatment will be done towards the end of September or even October in bee-densely populated locations. This treatment can be done relatively fast, just like the heat treatment performed in spring.



Removal of mites in July by using the Duplex-Framebox

6.3 Autumn: react on time to dangerous threats

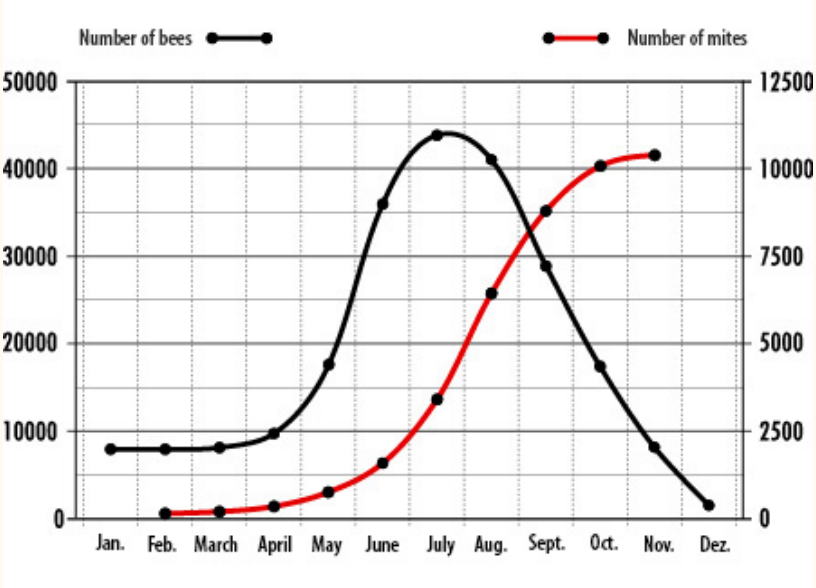
The honey harvest is long over, as is the successful summer treatment with a drastic reduction of the mites. Now, one is done with the mites, right? Certainly not. **Autumn is a critical time, and one must be extremely vigilant. Those who do not control and act during autumn may lose everything.**

The number of bees in a colony is sharply reduced in autumn. However, when the weather stays warm, the bees will continue to breed, although not as much as in the spring, but still enough to give the mites a chance to continue reproducing. In extreme cases, the mites continue to double their population each month, while the number of bees in the colony declines. This means that the concentration of mites is higher relative to the total number of bees. This is very dangerous because, unlike in the spring, when the number of bees increased faster than the mite population, the situation is different now. Although the mite population doubled each month, the faster and larger increase in the bee population during spring led to a "dilution" of the mite concentration in the hive.

The bees, therefore, deserve our attention in autumn because they might face a three-fold danger:

1. Warm weather favors further breeding activity in the hive, thus enabling the continuous reproduction of mites.
2. The number of bees drops sharply, while the number of mites continues to double each month.
3. The re-invasion of mites from collapsed and/or robbed hives in the surroundings can also lead to a sudden increase in the mite load within a few weeks (i.e., unexpected and uncontrollable re-infection).

The heat treatment of Varroa proves to be particularly suitable in such typical autumn situations, especially because it is already too cold and/or too humid for a formic acid treatment during the autumn months, and the oxalic acid treatment is not effective due to the still-present capped brood. In autumn, only heat treatment can effectively kill the mites in the brood. Although, in autumn, there are more

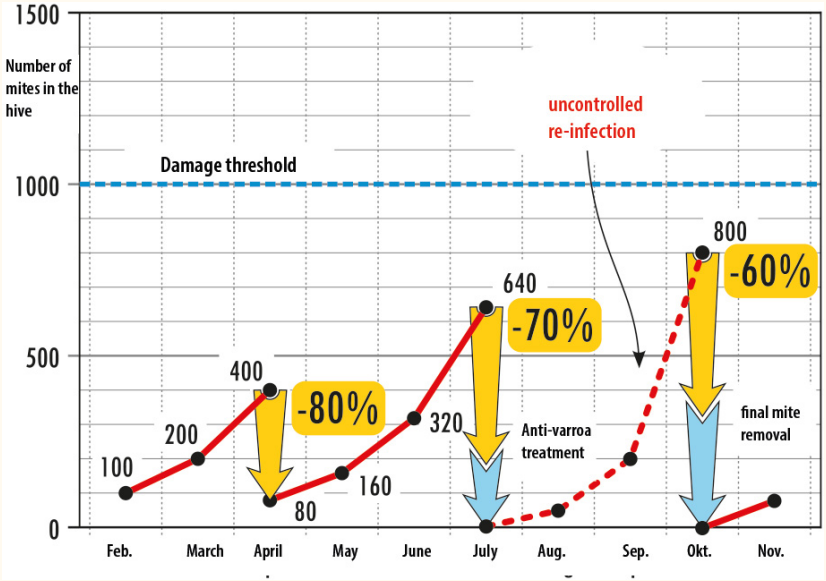


Development of bees and mites throughout the year

Re-infection: entry of mites attached to bees
Source: Wolfgang Wimmer

mites attached to the adult bees, 60% of the mites are still in the brood. One can simultaneously treat with heat the mites in the brood and take action against the remaining parasitizing mites on the (winter) bees, aiming to have no more than 3% of mites per colony in October.

Assuming 15,000 bees in a colony in October, 3% corresponds to a total of 450 mites. Thus, there may be a need to perform another heat treatment, provided the weather conditions in autumn allow for it. This strategy prepares you well for the further breeding activity of the bees well into autumn and winter.



Heat treatment in autumn after re-infection

The following procedure has proven to be very effective: At the end of September, treat 2 capped brood frames and mark the open brood at that time—usually also 2 frames. 11–12 days later, perform a second treatment with exactly these two (now capped) marked frames. This is very efficient because the mites that were present on the two open brood frames are trapped.

7 Testimonials - after several years of application of heat treatment

I would like to thank all beekeepers who have accepted my invitation to write about their personal experience with heat treatment. I was happy to get some colleagues who were willing to report their experience, after working with the Varroa Controller for several years now.

7.1 Renate and Kurt Tratsch

I have been an enthusiastic beekeeper for over 30 years and turned my passion into a profession in 2005. Together with my wife Renate, I care for around 200 colonies across 11 different apiaries in Styria and Lower Austria. Additionally, I breed queens. As a commercial beekeeper and queen breeder, ensuring the health of my bee colonies without using chemicals is absolutely essential.

In 2014, I conducted my first tests with the Varroa Controller. At one apiary, I treated half of the colonies conventionally and the other half with heat treatment to compare the effectiveness. Due to the positive results, I decided to purchase a second device in 2015. With Duplex-Frameboxes as an add-on, I was able to implement my year-round plan for varroa treatment. This concept has been very successful, and I continue to achieve positive results and gain valuable experience.

As part of the award-winning Blesabee project, I supported the initiative as a bee expert in hyperthermia by providing experience reports in the form of short and long training videos, which are available free of charge on the Internet. I felt the need to share my positive experience with other beekeepers. Since 2018, I have offered practical

Master beekeepers Renate and Kurt Tratsch, experts in hyperthermia and speakers on bee health

Number of bee colonies: approx. 200
Location of the bee colonies: Eisenerz in northern Styria, southern Lower Austria
Frame size: Zander
Beekeeping since: more than 30 years

Renate and Kurt Tratsch

With the Varroa Controller, **commercial beekeepers and queen breeders** have successfully ensured the health of their bees for years.

courses at my apiaries, giving others the opportunity to learn how to operate and handle the Varroa Controller and the Duplex-Framebox. These practical days have been very well received, and since then, I have shared my expertise at several beekeeping schools in Austria. The content has also been incorporated into the vocational training for beekeeping specialists and master beekeepers. In 2019, the Styrian beekeeping school in Graz decided to expand their full-year program to include hyperthermia and Duplex-Framebox. I also give lectures on bee health there, covering these topics.

Due to the positive experience and the increasing interest in hyperthermia, I decided in February 2020 to set up the Facebook group „Friends of Hyperthermia." With the creation of this platform, interested parties can gather and share their experiences. Within a year, I succeeded in acquiring 350 members for the group.

Due to the coronavirus pandemic, my Tyrolean colleague Klaus Farthofer, also a user of the Varroa Controller, and I decided to hold online webinars to fill the gap left by the lack of face-to-face presentations and seminars. These online webinars have been a great success and are now known internationally (Netherlands, Belgium, Germany, Switzerland, and of course Austria).

I also pass on my knowledge in practice and support companies in the use of the Varroa Controller and the Duplex-Framebox by conducting training courses at their own apiaries. As a result, I have succeeded in convincing larger beekeepers of the usefulness of the year-round plan. For example, the professional beekeeper Wolfgang Stebegg, who has around 500 bee colonies, is now convinced that this treatment method is feasible for medium-sized and large operations.

For my business, this method of control is ideal. Due to the different locations of my apiaries, the breeding season and harvest start at different times, which gives me an advantage in timing the necessary work. This allows me to delay the spring treatment somewhat, using 3-4 devices for all of my approximately 200 bee colonies without significant time pressure. Together with my wife Renate, we manage to treat around 40 bee colonies per day in the spring.

During the summer treatment, we use the Duplex-Framebox to catch the mites in the brood frames. These brood frames are then heat-treated in the Varroa Controller. From these heat-treated brood frames, I create new brood frames using 3-4 brood frames, a queen, and around 750 g of bees. The resulting offshoots develop into robust young colonies by the fall, serving as reserve colonies for the following year or for sale.

In this way, I am able to reduce Varroa pressure throughout the entire bee year, particularly through treatment in the fall, so that we no longer experience winter losses in our bee colonies due to the Varroa mite. The fact that heat treatment can be successfully implemented on apiaries with a large number of colonies is demonstrated by my colleagues Wolfgang Stebegg from Styria, with over

500 colonies, and Klaus Farthofer from Tyrol, with around 300 colonies, as well as on my own apiary with around 200 colonies.

However, hyperthermia is also economical and effective on small farms in terms of working time. In my opinion, hyperthermia is the way forward in modern beekeeping and an absolute must for certified organic farms. I highly recommend it!

I am always available for information and training at any time.

7.2 Jürgen Schmiedgen

A few years ago, I began studying the positive effects of beehive air out of personal motivation. Beehive air therapy has been proven to alleviate respiratory diseases and allergies. Unsatisfied with the available inhalers, I developed my own medically certified apitherapy station for the inhalation of beehive air.

The inhalation device gently draws in the soothing beehive air and directs it through a heated tube to the inhalation mask without disturbing the bees. A grid in the lid prevents bees from entering the tube. The specially developed valve ensures that the exhaled air does not return to the hive.

Jürgen Schmiedgen, Certified Organic and Apitherapy Beekeeper

Number of Bee Colonies: 20-25
Location of Bee Colonies: Ore Mountains, Saxony
Frame Size: Langstroth, EHM
Beekeeping Since: 53 Years

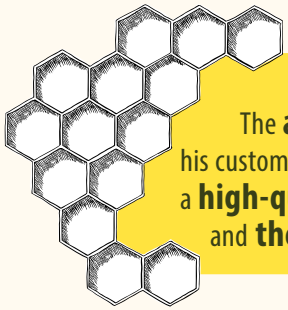
There are several strict requirements for the therapeutic use of beehive air, which also apply to beekeeping practices and colony management. It is essential that the bee colonies are of organic quality. Among other things, hives must be made exclusively from natural materials, and a separate wax cycle is required.

During the period when beehive air is being collected, no organic acids should be used for Varroa mite control. Even outside of this period, I do not recommend using acids, as any residues can compromise the high quality of the therapy. For this reason, my beekeeping friend and I have been successfully using a Varroa Controller since 2013. Since adopting this method, I have kept the Varroa mite under control. In the past, when we had to use formic acid or other treatments on the production colonies due to time constraints, we often faced Varroa damage and colony losses. Now, we use three Varroa Controllers and rely solely on this method. The Varroa Controller, with its chemical-free heat treatment, is ideal for apitherapy. This applies not only to the use of beehive air but also to the harvesting of other bee products such as propolis.

Our beeswax and wooden hives retain the memory of every misstep made by the beekeeper. For instance, during a spring test, we detected plasticizers in the air. This was due to a plastic feed bag that had been left hanging in the hive throughout the fall.

We follow the methods of master beekeeper Kurt Tratsch. If a seasoned professional with over 200 colonies, who must carefully manage time and costs, has found success with these practices over the years, then it is wise for us to emulate his approach. In our area in Germany, the spring development of bees is generally about 14 days later than at the colony locations of Kurt Tratsch. Typically, we begin our first treatment in April by removing 2-4 capped brood combs from the colonies for heat treatment using the Varroa Controller. Around the summer solstice, we utilize the Duplex-Framebox. In October, we conduct another round of treatment with the Varroa Controller, effectively achieving residual mite removal that lasts until spring.

For us, the Varroa Controller represents the optimal method for chemical-free Varroa treatment, ensuring high-quality hive products suitable for apitherapy.



Jürgen Schmiedgen

The **apitherapy beekeeper** enables his customers thanks to the Varroa Controller a **high-quality beehive air** and **the best therapeutic effect.**

7.3 Olga Cadosch

Olga Cadosch

The **Swiss expert** for **honey quality** appreciates the Varroa Controller for its **residue-free and effective treatment results.**

As a former honey inspector for the Swiss Beekeepers' Association, I have dedicated years of intensive work to understanding the factors that influence honey quality. A significant focus of my research has been on Varroa control. During this endeavor, I received invaluable support from Dr. Christina Kast, a honey expert and researcher at the Center for Bee Research at the Swiss Agroscope Research Station, from whom I gained extensive knowledge.

Driven by the goal of finding a control measure that preserves the quality of valuable bee products without compromising effectiveness or harming bees, I embarked on this journey.

In 2012, after a year-long search through various recommended treatments, I discovered the Varroa Controller. This exceptional device has allowed me to stay one step ahead of the mites right from the beginning of the season. What I appreciate most is that it enables me to fully utilize the honey production period without the constant worry of reaching a damage threshold. Even in the most challenging weather conditions, there's always a window of opportunity for treatment, including during the increasingly hot summers of recent years.

The additional effort required is minimal and easily integrated into my regular hive management practices. For me and my bees, this represents an efficient and effective control strategy.

To promote this chemical-free Varroa treatment method in Switzerland and ensure honey bee pollination, I founded the Swiss Varroa Hyperthermia Association (www.varroahyperthermie.ch) in November 2012, where I serve as President. Alongside fellow members, we provide a central hub for beekeepers interested in hyperthermia.

For me, beekeeping without the Varroa Controller is now inconceivable.

Olga Cadosch, beekeeper and president of the association Varroa Hyperthermia Switzerland

Number of bee colonies: up to 20
Location of the bee colonies: Mountain area in the beautiful canton of Graubünden
Frame size: Dadant and Swiss measure
Beekeeper since: grew up with hobby beekeeping

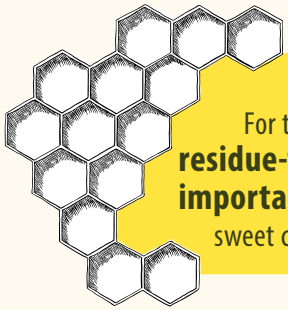
Thomas Klepp, Master Confectioner and Specialist in Beekeeping

Number of bee colonies: 40
Location of bee colonies: Manhartsberg in Lower Austria
Frame size: Zander
Beekeeping since: Seven years

7.4 Thomas Klepp

I have been involved in food-related work since completing my compulsory schooling. Right from the start, I learned the importance of treating resources and raw materials with utmost care.

Especially in the era of climate change, there is a renewed focus on understanding the origin and production of our raw materials, as well as on animal welfare. Each raw material has its own narrative, and it is essential to reconnect consumers with these stories.



Thomas Klepp

For the **master confectioner, residue-free honey quality is of utmost importance for further processing** in his sweet creations.

Below, I would like to share the story of my bees and their honey. My honey originates from bee colonies in the Manhartsberg region. It features early blooms such as apple, rape (canola), and chestnut blossom. One of my primary honeys is acacia. Additionally, I specialize in late-season honeys like sunflower and buckwheat. The honey season typically extends until mid-August.

Since I started beekeeping, I have treated my bee colonies for Varroa mites without using non-hive or chemically produced products. For Varroa control, I utilize the Varroa Controller in combination with the Duplex-Framebox. The spring treatment and the use of the Duplex-Framebox around the summer solstice enable me to manage the honey season until August without experiencing significant Varroa pressure. Thanks to the autumn treatment in October and diligent Varroa monitoring, I can avoid the need for winter residual treatments with oxalic acid.

I exclusively propagate my colonies using brood combs treated in the Varroa Controller, whether for cupping during the rapeseed blossom or from the Duplex-Framebox at the beginning of July. This practice ensures a very low mite load,

providing an excellent foundation for my future productive colonies. Based on my own positive experiences and conviction in this method, I have recently acquired a second device.

Using the Varroa Controller and the Duplex-Framebox offers several advantages that I appreciate. One significant benefit is their resilience against the challenges posed by climate change. The Varroa Controller ensures that even with prolonged summer temperatures extending into fall and mild winters that favor Varroa reproduction, my bees remain protected.

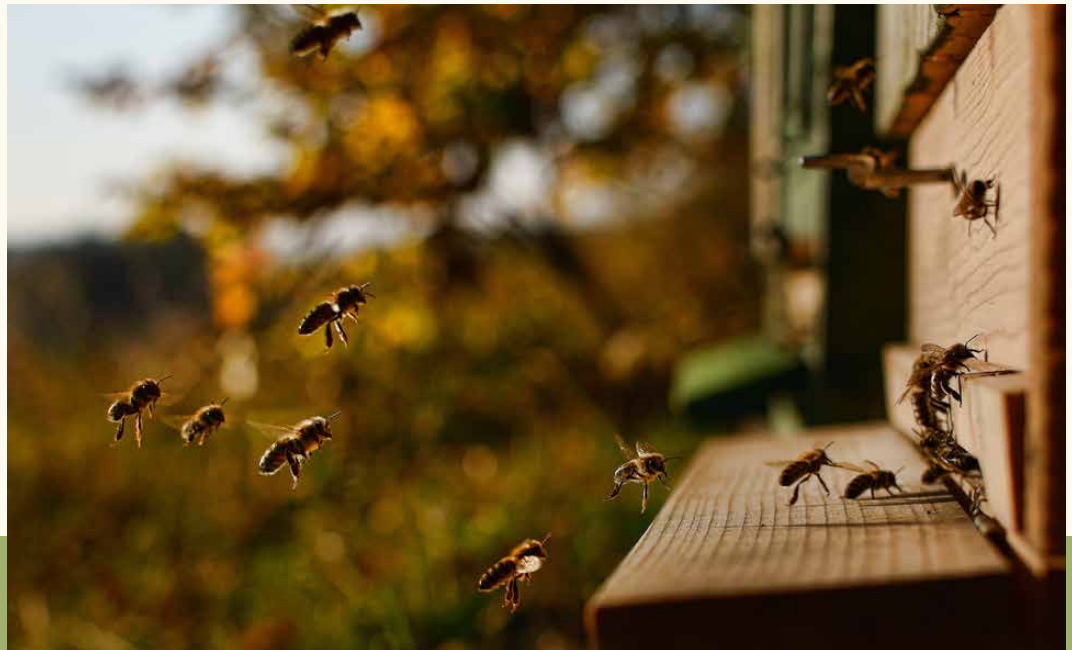
Another strength is the flexibility of heat treatment, which allows me to conduct treatments even during the honey harvest without leaving any residues that could affect the quality of hive products.

Since I adopted the narrow frame in the brood chamber for beekeeping, transitioning to the Zander full frame with the Duplex-Framebox in brood-free colonies has been straightforward. This transition does not require the destruction of drone or worker brood, which simplifies management and supports colony health.

Here are some tips I've found helpful:

- When transitioning to a different hive size, ideally introduce the new frames into the honey chamber in spring or early summer, if the frame size allows. This preemptive step avoids that the bees need to built foundations during the changeover in July. It also allows the queen to immediately utilize her full laying capacity.
- Regular queen marking is essential. This practice facilitates easier identification and provides a clear understanding of the age and egg-laying performance of each queen. When queen replacement is necessary, a marked queen is generally well accepted by the colony.

This approach has allowed me to maintain robust and healthy bee colonies for years using the Varroa Controller. As a result, I consistently produce one of my most prized raw materials: residue-free, high-quality honey, which is essential for my work as a master confectioner.



7.5 Helena Proková

In January 2011, I became the first beekeeper in Slovakia to adopt the Varroa Controller. Since then, I have remained steadfast in my belief that hyperthermia is the only ecological and effective solution among the known Varroa treatment methods.

After using the Varroa Controller for three years with positive results, I began promoting the concept of an annual plan with hyperthermia among beekeepers in Slovakia and the Czech Republic. Three years later, I completed a two-year course in professional beekeeping at the Slovak Vocational School of Beekeeping, Pod Bánošom. Following this, I started teaching courses on hyperthermia at the school and participated in numerous beekeeping conferences and meetings to further advocate for this method.

From 2017 to 2019, I coordinated the BLESABEE project (www.blesabee.online) in collaboration with partners from Austria, Slovakia, and the Czech Republic. This initiative was supported by the European Erasmus+ funding program and involved vocational beekeeping schools and beekeeping associations.

The BLESABEE project, conducted from 2017 to 2019, led to significant changes in Slovak and Czech veterinary legislation. Hyperthermia was incorporated as a recommended method for professional beekeeping, resulting in the establishment of numerous hyperthermia training courses across various locations.

Additionally, the project produced a manual for chemical-free bee management, which was published in three languages. This manual received acclaim, earning a gold medal at the prestigious beekeeping trade fair Apimondia, held in Canada in September 2019.

In addition to my efforts in Slovakia to promote hyperthermia with the Varroa Controller, I am also active in southern France, where annual losses of bee colonies have escalated to as much as 70% in recent years. There is a growing demand for effective treatment methods like the Varroa Controller, prompting the development of guidelines for hyperthermia in French beekeeping practices.

Our award-winning BLESABEE book is also available in English!

Another success story involving the Varroa Controller is that of Rastislav Pavlisin, co-owner of the NH Bratislava Gate One seminar hotel. Rastislav began beekeeping in 2017 and, in 2018, together with veterinarian and beekeeper Svetozár Ružička, established an apiary on the roof of the NH Bratislava Gate One. Their efforts bore fruit when Rastislav won two gold medals for the honey produced on the hotel roof at the international beekeeping congress Apislavia in Moscow in 2018.

After their early success, the two began searching for chemical-free Varroa control methods and discovered the Varroa Controller. After two years of successful Varroa control using the Varroa Controller, Rastislav's honey, „Honey Bunny," not only passed the Nuclear Magnetic Resonance (NMR) test—an advanced test for verifying honey quality and purity—at Apimondia 2019 but also won the silver medal. Over 40% of submitted honey samples that year did not pass the NMR test due to residues from Varroa treatment, whereas the hotel's own honey brand, Honey Bunny, distinguished itself with its unique taste and quality, prevailing over hundreds of competing honey samples.

Helena Proková

The **Slovak beekeeper** has been **internationally recognized** for her educational work on hyperthermia and high-quality beehive products.

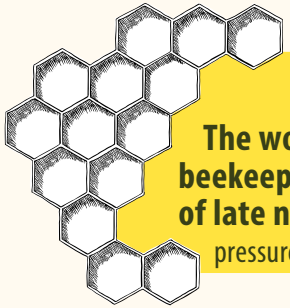
Helena Proková, Expert in Hyperthermia and Lecturer at the Slovak Vocational School of Beekeeping
(Photo with Rastislav Pavlisin and Svetozár Ružička)

Number of beehives: 14
Location of beehives: Devin-Bratislava, Slovakia
Frame size: B-size (traditional Slovak frame size)
Beekeeping experience: 9 years

7.6 Günter Friedmann

The Varroa issue remains a critical question for the survival of our bee colonies and the continuity of beekeeping. Treating Varroa mites with organic acids imposes stress and often severe health impacts on our bees.

Over the past 15 years, we have more or less successfully practiced the long-term vaporization of formic acid, albeit with increasing skepticism. Firstly, formic acid's effectiveness heavily depends on external conditions such as temperature, rain, etc. Secondly, it causes significant damage to bee brood. Older queens, in particular, poorly tolerate formic acid vapors, resulting in queenlessness and a high incidence of drone-laying colonies. Realistically speaking, long-term treatment with formic acid resembles brood removal: almost all open brood is removed, and even capped brood often suffers damage.



Günter Friedmann

The world's largest Demeter beekeeper can now **take advantage of late nectar flows** without high Varroa pressure, thanks to the Varroa Controller.

These collateral damages were accepted because they were still more bearable than colony losses without treatment. This repeatedly piqued my interest in alternative methods.

Increasing dissatisfaction with formic acid led me to discover the Varroa Controller in winter 2019. Due to its positive treatment outcomes, I soon decided to acquire a second Varroa Controller. The bee colonies tolerate the heat treatment very well, and beekeepers regain a lot of freedom! What do I mean by that?

In principle, we treat at the wrong time. With summer and autumn treatments, we are always chasing after the Varroa mite because we are no longer allowed to use acids during the spring when colonies are building up.

Thanks to the Varroa Controller, I can treat in spring and delay the critical point well into late summer, even after the main nectar flow has ended.

The race between beekeepers and the Varroa mite, where every day often counts, is now a thing of the past. Colonies enter summer with few mites, and everyone gains time. It's no longer the Varroa that dominates our thoughts and actions; instead, we regain autonomy.

When late spruce blossom occurs, beekeepers face a dilemma: should we treat beforehand, risking honey contamination, or harvest the honey and risk colony loss? Here, the Varroa Controller offers a wonderful alternative.

The fact that the race between beekeepers and Varroa is mitigated is an incredible advantage. Regarding the use of the Duplex-Framebox from the perspective of a Demeter

Master Beekeeper Günter Friedmann,
Operator of the world's largest Demeter beekeeping operation
Number of bee colonies: 400
Location of the bee colonies: Allgäu, Germany
Beekeeping since: More than 40 years

beekeeper like myself, the following points can be made: Normally, the duplex framebox is designed for two brood combs. However, since natural comb construction is not as uniform as comb foundation-based frames, usually only one natural comb fits into the Duplex-Framebox. Using just one comb leads to oversized comb gaps and stress for the bees regarding their thermal regulation.

Therefore, I use two honey super frames for the Duplex-Framebox, which can later be placed in the honey super of spruce colonies or nucleus colonies. The downside of this method is certainly the required time investment, but compared to multiple acid treatments, it is justified and ultimately requires less time per colony. Additionally, it ensures chemical-free beekeeping! This gives us beekeepers a good feeling, ensures the well-being of the bees, and offering guaranteed residue-free honey is a strong selling point.

8 Everyone profits

The heat treatment against Varroa mites offers a number of benefits to beekeepers, bees, and ultimately consumers. The most obvious benefit is that we now have a device and a method that can be used against mites at any time during the beekeeping year (whenever there is brood, whether in spring or even in fall).

Late honey flow: sunflower
Source: Wilfried Ammon

The second major advantage of this treatment is that it is done without chemicals. This means there is no risk of occupational injuries, and the bees do not come into contact with any chemical products.

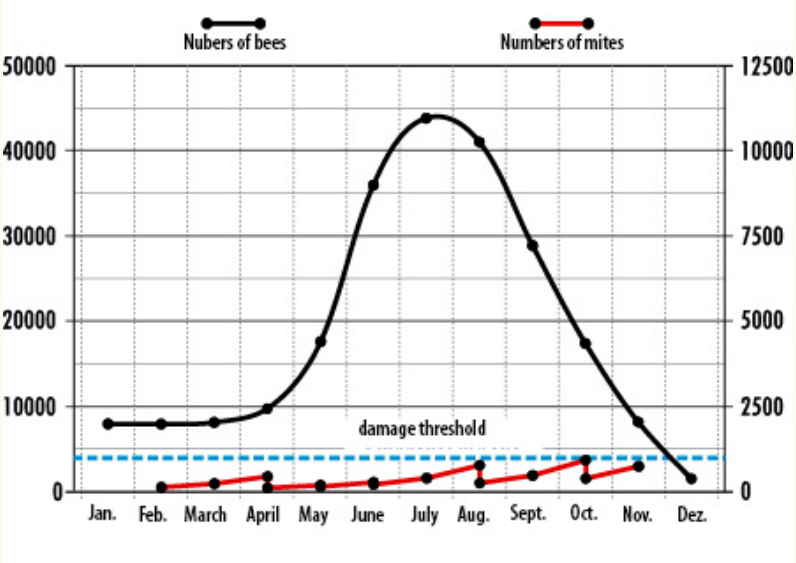
For the bees, this means no growth of resistant mites. For honeybee products, it ensures that no residues of chemicals remain in the wax, propolis, or honey.

A third advantage relates to the method itself, as heat treatment against Varroa mites provides guaranteed results after each treatment. Formic acid treatment is often difficult to predict, as it depends significantly on external temperature and humidity, while oxalic acid treatment may show results only after several weeks. Heat treatment, on the other hand, provides reliable results within 12 days. Additionally, heat treatment can be repeated at any time, whereas chemical treatments have limitations. Repeated use of formic acid can lead to queen losses, and multiple applications of oxalic acid on the same generation of bees can cause poisoning.

Most importantly, heat treatment is highly effective where most of the mites are found: on the bee brood.

From an economic perspective, another advantage is the ability to secure a late honey harvest. If colonies with a small brood size are treated in spring, there is still enough time to wait before summer treatment and to harvest late honey flows. Conventional beekeepers using organic acids often have to harvest much earlier due to higher mite pressure.

I hope that you find a way for you and your bees to take advantage of heat treatment against mites and give



The ideal course of a successful Varroa management strategy using heat treatment is to keep the Varroa population below the threshold that causes damage to the hives.

them no chance! In this manual, we have explained the successful strategies to stay below the damage threshold throughout the beekeeping year.

However, staying below this threshold can only be achieved if you interrupt the reproduction of the mites by using heat treatment at the optimum time. By doing so, you can keep the mites under control. It is also imperative that the entire population of mites is constantly monitored and controlled, as described in this handbook.

With this in mind, I wish you joy in beekeeping with healthy and cemicalfree colonies!

Have you inserted a Varroa mite monitoring tray?

Wait! Do not forget to put insect lime down against the ants!

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Here you will find
all the models!

www.varroa-controller.com

A new method was needed to give Varroa mites no chance to harm the colonies, and which would be easy to use anytime during the entire beekeeping season.
This publication allows the beekeepers to get familiar with heat treatment - a new method against the Varroa mites without the use of chemicals.

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