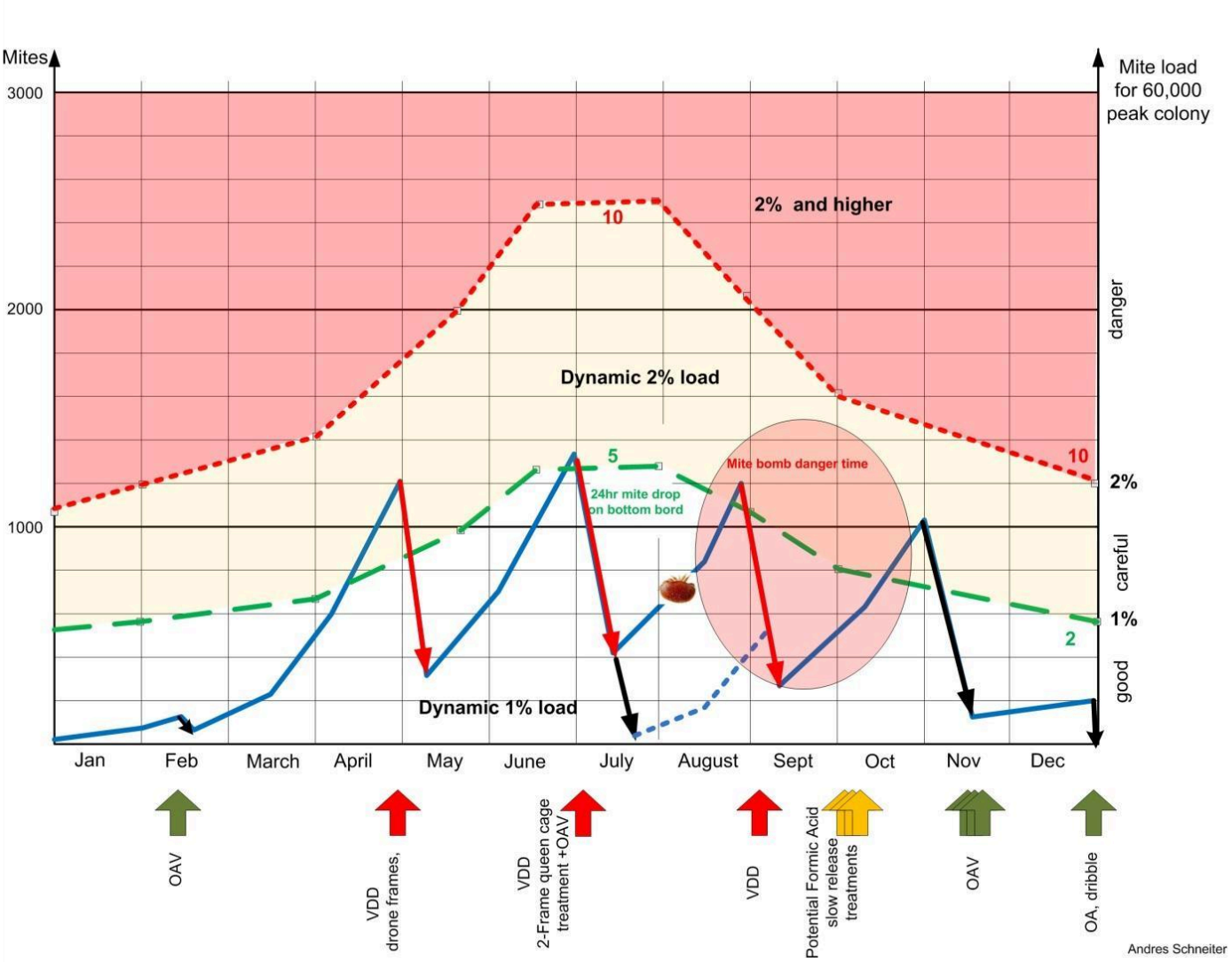
Recommended Varroa Mite treatment plan with VDD

An optimal control methodology would combine cultural, hyperthermal and acid based treatments. This plan will be influenced by local conditions. The Lower Mainland in BC, particularly the Fraser Valley would see a different treatment schedule and intensity plan than say northern BC or the Prairies.

We recommend the following:

1. One Oxalic Acid Vapourizing (OAV) treatment in February to eliminate surviving phoretic mites as much as possible before significant spring colony build-up starts.
2. Knowing that mites prefer drone brood, use “green drone brood frames” in early May (two per hive). When drone frames are fully capped, kill mites by using VDD. After the hyperthermal treatment, return frames to colony but place the frames into a **two-frame queen isolation cage**. This will allow the drones to emerge with the dead mites but prevent the queen from laying new eggs in those frames. The drones can now continue to live their useful lives without being frozen or fed to the chickens and the beekeeper will have clean drawn-out frames for future use. Important is that the emerging drones in the cage are freed since they would not be able to escape through the queen cage.
3. Depending on the measured mite load, a hyperthermal treatment cycle should take place in June by selecting suitable capped brood frames and treating them for two hours at 41.5C
4. Depending on local conditions and honey flow timing, a special treatment should be undertaken in mid-July. See details below. This treatment, combined with a single OAV cycle would result in a very low to practically non-existent mite load going into fall.
5. In most areas, a further treatment in September, followed by a Formic Acid slow release treatment in October would suffice to reduce mite loads to an acceptable level for safe and successful overwintering of the colony. However, in the Fraser Valley, which is prone to “mite bombs” due to the return of large colonies from other parts of BC and the prairies, coinciding with the start of robbing behaviour and “mite fostering” winter bee rearing, special attention is warranted and an extra VDD treatment in late August may be important. We have witnessed situations where mite loads explode from less than 1% at the beginning of August 10% in a matter of a few weeks!

Recommended integrated VDD control plan through the year:

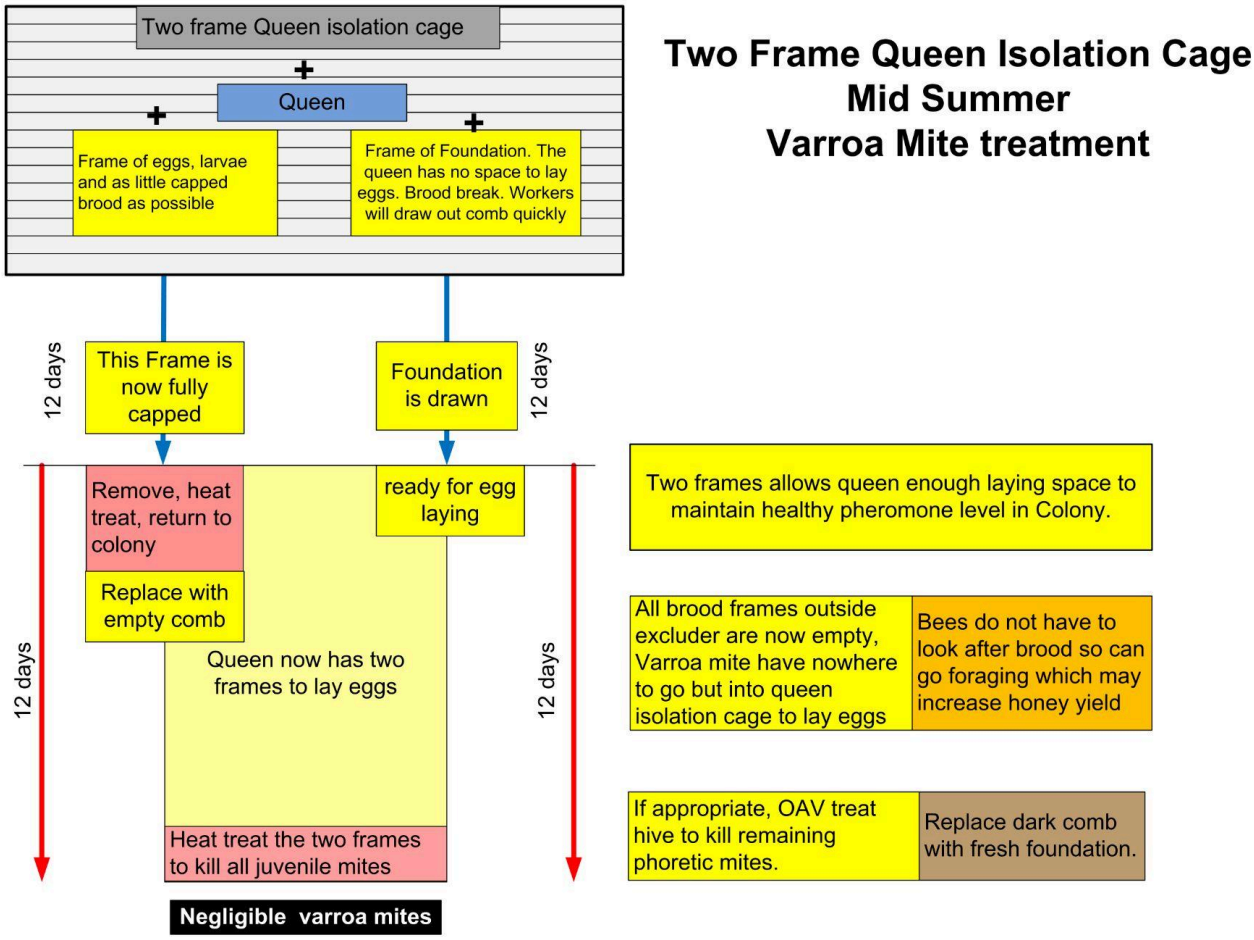


Mid-July special treatment

It has been a practice by some bee keepers to sacrifice brood in mid-July and create a brood break resulting in significant varroa destructor mite reductions. To achieve this, the queen and frames with eggs or foundation are placed in a one or two-frame queen isolation cage. This forces mites into frames in the queen cage as well since there is no brood outside the cage where mites can lay their eggs. The beekeeper then disposes those frames or freezes them before returning them to the colony.

Now, with the VDD, the frames can be saved by treating them hyperthermally.

The following flow chart explains this process in more detail:



“Bonus” recommendation

For the “working backyard beekeeper” with family responsibilities inspecting and treating colonies during the week can be challenge. Weekends can be rained-out. An ideal day after work may not have enough daylight hours left.

The following process offers a solution:

1. On day 1 select and mark the appropriate frames for treatment, cage the queen in the two-frame queen isolation cage along with unmarked frames that will not be treated and close the hive(s).

2. On day 2 remove the marked frames, shake or brush off the bees and treat as described before. Release the queen and return the treated frames to the colony.

Explanation and History of Hyperthermal Mite Treatment

Hyperthermia is a relatively old concept, first reported in the 1970s. Since then, successful thermotherapy has been reported from many parts of the world. Various methods and technology used to heat treat varroa destructor developed independently. Among other researchers, Professor Engels at the University of Tuebigen in Germany observed in 1995 that juvenile mites suffer lethal damage at temperatures above 41°C whereas bees and pupae survive 44°C.

The following are only a few references of among over 80 papers dealing with this subject

(Eric Tihelka, History of Varroa Heat Treatment in Central Europe (1981-2013) Beeworld, 2016

(Engels W. Efficiency of Biotechnical Control of Varroasis by means of Hyperthermia. Apiacta. 1998;33:49–55.)

(Arne Kalau etal, Short-term hyperthermia at larval age reduces sucrose responsiveness of adult honeybees and can increase life span, Apidologie, 2020

(Hang Zhao, Guilin, etal: Response mechanisms to heat stress in bees, Apilogie, 06 January 2021)

Treatment of capped brood housing juvenile Varroa Mites on bee larvae treated for two hours at a temperature of between 41 and 42°C will safely kill those mites with a success rate of over 95%

The cause of the Varroa Mites' death can be explained as follows: heat shock proteins which protect cells from high heat no longer offer protection after a certain temperature is exceeded. They get damaged, leading to the lethal destruction of the mite's cells.

Several studies, (*including at UBC by Prof. Leonard Foster*) noticed that at temperatures above 42.5°C, the sperm of drones and those stored in the spermatheca of the queen may suffer damage.

The temperature in a bee hive is around 36°C with an average Relative Humidity (RH) of 75%. It is important to maintain a humid environment during treatment to prevent pupae from drying out. It is also imperative that the temperature is raised slowly so that bee pupae are not shocked, especially larvae in the pre-pupa stages during the first 3 days after capping.

These factors, in addition to the requirement that the temperature is kept constant for 2 hours with very low spatial variability in the chamber during the treatment (no cold or hot spots), proved to be challenging in the design of cost effective products. In addition, many attempts to treat whole hives with living bees have led to failures and a risk to queen and drones. Heating a hive full of bees is also counterproductive as bees want to lower the temperature by fanning.

This resulted in products that treat only fully capped frames from which all bees have been removed.

The more successful commercial products and interesting designs were developed in Europe and achieved wide acceptance with claims of over 3000 installations.

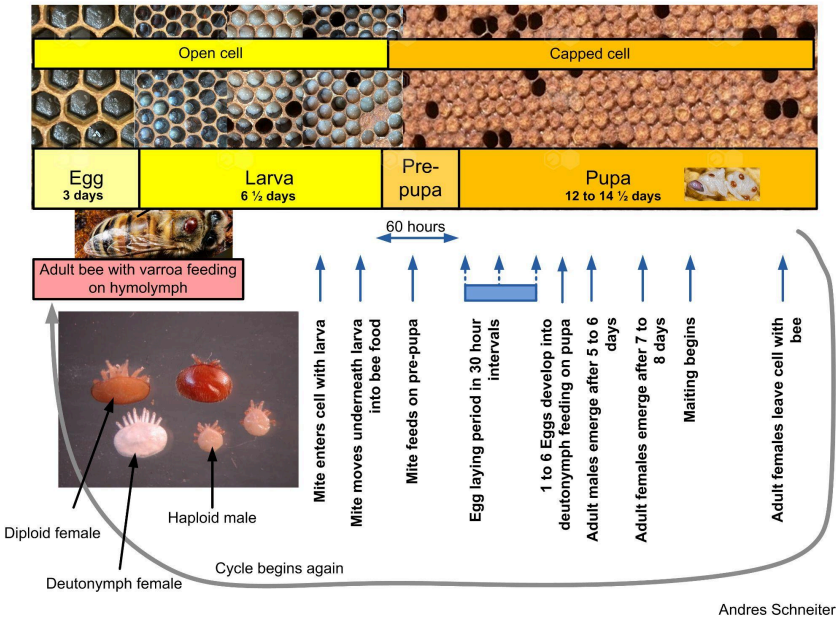
Ideal Applications for the VDD

- Backyard beekeepers
- Medium seized commercial apiaries with up to 100 colonies
- Sellers of NUCs
    - NUC production is an ideal application for the VDD. NUCs sold in May/June generally have 3 frames of fully capped brood. Treating those frames with OAV has limited effect. Yet treating them hyperthermally combined with one application of OAV would result in NUCs having a mite load approaching 0! A NUC buyer's dream!

Essentials of Varroa mite biology and infestation vs Hyperthermia

It is important to understand mite biology and behaviour for effective hyperthermal varroa destructor treatment.

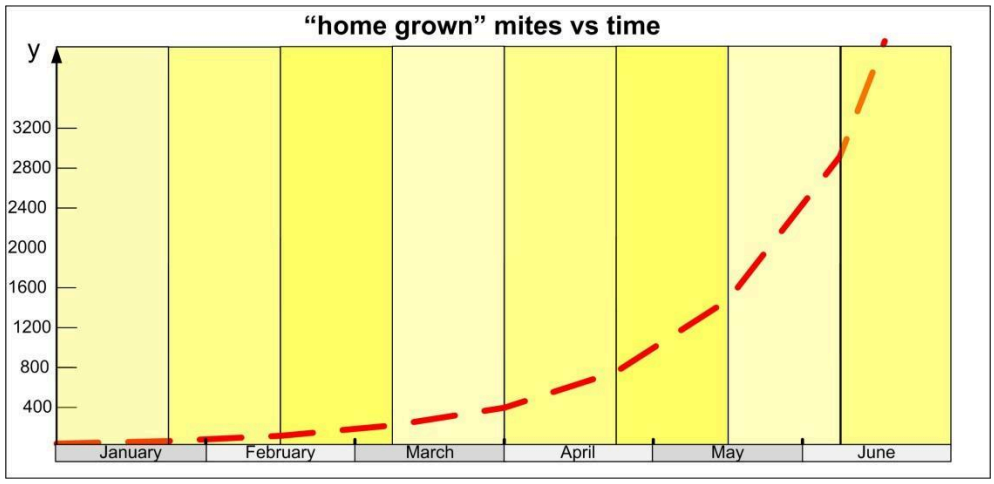
Varroa destructor and bee reproduction occurs at the same time during the capped brood stage as shown in the diagram. Female mites lay their eggs on bee larvae before bees cap the cell. Mites will then feed on larvae's fat body. Mating between the first born male and his sisters occurs in the cells.



Up to 6 mites can emerge with the bee and then continue the breeding cycle resulting in exponential mite population growth. This formula defines mite growth

$y = a \times 2^{n/3}$

where
y = number of mites at a given time
a = Mite count at beginning of period
n = number of weeks from start



A treatment that kills the mites in the capped cells is the most effective way of reducing varroa destructor loads

Mite populations start growing early in the spring and generally double every three to four weeks. Within about 12 weeks a mite population in a beehive will have grown about 12 times. In other words, an acceptable mite load of 1% in early spring would have grown to about 8.5% by August in an untreated colony. Left unchecked, this hive would die before winter.

Mites live for 2 to 3 months on summer bees, up to 11 days on an individual bee, 5 to 6 months on winter bees and can survive up to 5 days without a bee host. Varroa destructor mites cannot survive without bees.

A female varroa destructor can reproduce 3 to 4 times in her life. The male mite dies after copulation. Because the mite incubation period is similar to the drone development cycle, mites prefer drone brood. They also prefer the richer protein food fed to drone larvae resulting in larger fat bodies when compared to worker food and brood. Winter bees also have larger fat bodies which helps to increase mite populations in the fall among other factors such as mite transmission through robbing.

Impacts

Mites reduce proteins and enzymes in bees. For the individual bee, this results in reduced body weight and a reduced lifespan, especially for winter bees which can be catastrophic during spring colony build-up. In the colony, mites introduce DWV (deformed Wing Virus) through vector transmission, Sac brood, ABPV (acute Bee Paralysis Virus) and KVB (Kashmir Bee Virus). The colony then collapses.