CORNELL UNIVERSITY MASTER BEEKEEPER PROGRAM

THE Bee-Files
Dyce Laboratory for Honey Bee Studies
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Ithaca, New York

Identification and Management of *Varroa Jacobsoni* in the Northeast

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Modern beekeeping has become especially challenging during the past decade. In addition to traditional bee disease like American and European foulbrood, chalkbrood and nosema, beekeepers must now contend with two parasitic mites, *Acarapis woodi*, the tracheal mite, and *Varroa jacobsoni*, or the *Varroa* mite. Although progress has been made in the management of these mites, a number of factors have prevented the development of reliable control methods, as evidenced by continuing high losses of colonies. Three factors that have made it difficult to develop general recommendations for control are 1) geographical differences in mite population dynamics, 2) region-specific conflicts between nectar flows and optimal treatment times; and 3) the lack of established economic thresholds and reliable sampling techniques.

This bulletin focuses on the management of the *Varroa* mite in the northeastern US. It is intended to provide beekeepers in those states with the information needed to identify the *Varroa* mite and symptoms of *Varroa* infestation:

1. specific recommendations for effectively and safely managing the *Varroa* mite

2. basic information on the biology of the *Varroa* mite that will put you in a better position to manage the mite, to understand why specific treatment recommendations are made, and to understand why failing to follow those recommendations can result in the loss of your bees and your honey crop

Remember! Parasitic mites are an inescapable part of contemporary beekeeping. You can still enjoy and profit from beekeeping, but only if you incorporate an effective mite control program into your management scheme, and only if you implement your mite control program on time, every time. You cannot relax your vigilance, you cannot delay your treatments and hope that things will work out. *Varroa* is unforgiving. Either you manage it on a regular basis,or it will rapidly destroy your colonies. If you are a seasoned beekeeper, this admonition serves to remind you of what you already know to be true. If you are new beekeeper, it serves as a warning that *Varroa* will quickly end your newly found career unless you incorporate an effective mite control program into your management scheme from the very beginning. Take *Varroa* seriously and you can enjoy beekeeping as long as you like.

ORIGINS AND DISTRIBUTION

Varroa is an obligate parasite of certain species of honey bees. Simply put, that means *Varroa* requires a honey bee host for survival. It cannot survive on yellow jackets, wasps, bumblebees or any other species. Prior to the 1950's, *Varroa* was known only in the east and far east where it is a parasite of the eastern honey bee, *Apis cerana*. *Varroa* has coexisted with the eastern honey bee for a long time and apparently causes it little or no damage. During the 1950's, *Varroa* transferred to the western honey bee, *Apis mellifera*, the principal pollinator in many crop production systems and the principal producer of honey worldwide, including the US. Unlike its seemingly benign relationship with the eastern honey bee, *Varroa* is exceptionally virulent on its new host, the western honey bee. *Varroa* was discovered in the US in 1987 in an apiary in Wisconsin. Due to the highly mobile nature of both the honey bee and the US beekeeping industry, *Varroa* quickly became endemic throughout the country. It can now be found in every state in the continental US and in every continent except Australia. Varroa is the greatest single threat to beekeeping worldwide.

LIFE HISTORY

Varroa is an external parasite of the honey bee. A mature, mated female enters a cell containing a worker or drone

larva shortly before it is capped. The female secures herself in the bottom of the cell until the cell is capped and the immature bee pupates. Then, the mite opens a feeding hole in the cuticle of the developing bee. Approximately 60 hours after capping, the mite lays an egg that develops into a male. Then, at approximately 30 hour intervals, she lays additional eggs that develop into females. Mites go through a number of developmental stages: egg, larva, 6-legged protonymph, 8-legged deutonymph, and 8-legged adult. The male develops in approximately 3-7 days. The females develop in 5-9 days. Shortly after a daughter matures, she mates with the male. As additional females mature, the male mates with them in turn.

Female mites emerge from the brood cell when the adult worker or drone emerges. Mites may leave on their own, either immediately before or after the bee emerges, or they may emerge on the bee. Males do not survive outside the brood cell. After emerging from the brood cell, mites spend a variable length of time on their adult host prior to entering a cell with a new immature host. Estimates of the number of reproductive cycles that an individual female mite goes through ranges from one to as many as seven.

The adult worker bee emerges 12 days after the cell is capped. The adult drone emerges 15 days after the cell is capped. This means that a mite can produce more offspring if she has entered a drone cell because the longer development time of the drone allows time for more daughters to mature. The number of female offspring produced by a mite in a worker cell is between 1.0 and 1.7, while the number of female offspring produced in a drone cell is about 2.4. Mites capitalize on this difference, being found in drone brood between 2 and 30 times as often as in worker brood (when drone brood is available).


1. Varroa mite on worker.

IDENTIFICATION AND DETECTION

The adult *Varroa* mite is oval in shape with a width of 1.5 mm, a length of 1.0 mm, and 4 pair of legs. Typically, mites are light to dark brown in color, although immature stage may be nearly translucent (Fig. 1). The bee louse, *Braula caeca*, is a wingless fly that is infrequently found in colonies in the northeast. The bee louse can be distinguished from *Varroa* by the fact that it has only 3 pair of legs, while the adult mite has 4 pair of legs.

Varroa can be detected several ways. Perhaps the most common method is the ether roll. Approximately 200-300 bees are collected from a comb and placed in a quart glass jar. A 1-2 second burst of an automotive starting fluid (ethyl ether) is sprayed into the jar. The jar is shaken vigorously for 10 seconds, then gently rolled along its long axis 2-3 turns. Mites, if present, will be seen adhering to the sides of the jar. This method generally detects about ½ of the mites actually present in the sample. Since mite levels are about twice as high on combs with brood as on combs with only honey, you maximize the chance of detecting mites in your colonies by sampling bees from the brood nest.

A second method of detection involves removing some capped brood, preferably drone brood, with a cappings scrapper and examining the pupae for mites. This method has been found to be highly effective in detecting low levels of mites.

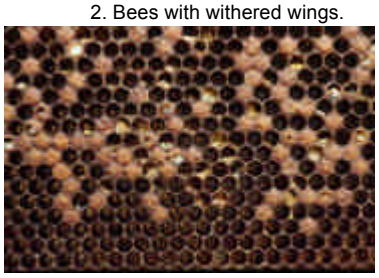
A third method is the sticky-paper collection device. To use this method, you need to build a wooden frame covered on one side with 1/8” hardware cloth. A piece of paper is attached to the other side of the frame and covered with a thin coating of a sticky material (Tanglefoot, PAM, Sticky-Stuff, Vaseline). The device is placed on the bottom board with the sticky surface facing up. The hardware cloth prevents bees from becoming stuck on the paper and from removing the mites. After a week, the device is removed and examined for mites. Mites can sometimes be seen on the adult bees or even walking on the comb, but this is more common when infestation rates are high and should not be used as a diagnostic method.


Ether jar


Pulled drones with varroa.


Sticky Board

2. Bees with withered wings.



3. Atypical brood diseases.

SYMPTOMS AND DAMAGE

There are usually no obvious symptoms at low levels of infestation. Therefore, sampling using the ether roll method or the cappings scratcher method will be the only reliable way to detect the mites at low levels. As the infestation levels climb, emerging adult workers may be seen that have damaged wings, believed to be the result of a viral infestation associated with the mites. As the infestation rate climbs, more damaged workers will be seen, and bees may be seen crawling in front of the hive (although this could also indicate tracheal mite infestation). *Varroa* infestation causes a number of pathologies in the honey bee, including decreased lifespan, damaged wings, physiological abnormalities, and decreased body weight. Eventually, non-specific brood diseases begin to appear (see Parasitic Mite Syndrome below). If you observe any of these symptoms, you should immediately sample your colonies for mites.

PARASITIC MITE SYNDROME

Varroa is associated with a variety of brood diseases that characterize the end phase of the mite infestation. The symptoms associated with *Varroa* have collectively been designated parasitic mite syndrome. The deterioration in the brood usually occurs at moderate to high levels of mite infestation, although it occasionally occurs in colonies with lower levels. The deterioration in the brood is believed to be a result of infection with a variety of pathogens, presumably viruses and bacteria. Although the symptoms superficially resemble AFB and EFB, these organisms have not been identified from infected larvae or pupae, and treatment with antibiotics such as terramycin does not eliminate this condition. From the time that colonies first exhibit symptoms of brood deterioration until the total collapse of the colony can be as little as 3 weeks. If you notice a few cells of brood with disease that you can not identify, you should sample your colony for mites immediately, and if mites are present, you should immediately remove any marketable honey and begin treatment. Procrastination at this stage insures the loss of your colony.

Varroa's role in the transmission of pathogens is not well understood. Mites may introduce pathogens directly to developing pupae as they feed on them in the capped cell, or the feeding hole that the mother mite makes in the developing pupa could simply open a pathway for pathogens already present in the environment to enter the developing bee. Similarly, mites feeding on adults could introduce pathogens to their host, or they could simply open a pathway for pathogens to enter the adult host. Infected nurse bees may feed pathogens to developing larvae, and infected adults may transmit pathogens during trophallaxis. The exact relationship between *Varroa* and honey bee pathogens is not well defined and needs to be studied more thoroughly.

TRANSMISSION

Varroa infests new colonies in several ways. Moving brood among colonies for the purpose of strengthening or equalizing colonies is a common practice among beekeepers and a major source of transmission. When a beekeeper moves brood from an infested colony to another colony, mites are transferred with the brood. Robbing is also a significant source of transmission. Colonies that are allowed to become weakened by mites or disease are unable to defend themselves and are usually robbed by stronger colonies. In the process, the robber bees take home more than just a free load of honey. Swarms from infested colonies establish new nests with mites already present and are not likely to survive more than a year or two in the wild. This makes feral colonies prime sources of re-infestation for managed colonies. Drifting bees, especially in apiaries where colonies are kept close together, can also spread mites among colonies.

RATIONALE FOR CURRENT CONTROL MEASURES

Optimizing a treatment program for a pest requires good information about the pest's population cycle. However, since *Varroa* is so virulent, there is no natural population cycle. Rather, once a colony is infested, the mite population simply builds up until the colony dies. Population cycles in managed colonies are a result of the constant battle between beekeepers applying treatments to control the mites and mite populations rebounding after treatment have been applied. Similarities in mite cycles from one beekeeper's operation to the next reflects similarities in treatment patterns and local environments.

The object of an effective mite control protocol is to time the treatments so that the mite population never builds up to the point where it causes economic damage. We can take advantage of what we know about *Varroa's* seeming preference for drone brood as its host. Because *Varroa* can reproduce much more rapidly on drone brood, mite populations can expand rapidly during the drone rearing season which occurs in the spring and early summer. This is the reason that an effective spring treatment is important in the management of *Varroa*. By keeping the mite population low during this optimal build-up period, the mite population can be kept low throughout the summer.

Beyond that, population cycles of *Varroa* are difficult to generalize. Many factors affect the mite levels in your colonies, including when the colony became infested, the level of the infestation, the frequency with which the colony is infested, and when the colony was last treated. A single spring treatment might be adequate to control *Varroa* if each colony only had to worry about its own mites. However, an effective treatment protocol must assume that the mite population in each colony is augmented by mites from heavily infested colonies that are susceptible to being robbed by your bees. This is not generally under the control of the beekeeper. The only way to minimize this threat is to make sure that you treat all of your colonies at the same time, and that your neighboring beekeepers treat all of their colonies as well.

Recommendations of the Proper Use of Apistan
Based on the above discussion, the following recommendation are made for managing *Varroa* in New York using APISTAN (tau-fluvalinate), the only EPA registered pesticide for control of Varroa.

1. First, read the pesticide label. Remember, THE LABEL IS THE LAW.

2. **ALWAYS** wear gloves (latex, surgical, nitrile) when handling Apistan or any other pesticide. Use gloves whether you are applying or removing the strips.

3. There are three approved formulations. One is the 10% strip that is used to treat full sized colonies. The second is the 1.0% tab that is approved for queen mailing cages. The third is a 2.5% strip formulation used in package shipments. They are all sold under the name of Apistan. Be sure you use the proper formulation for your specific application.

4. Colonies must be treated twice each year to insure protection from mite damage - once in the spring and once in the fall. Use one new Apistan strip for every 5 full-depth combs of bees in the brood nest. For most colonies, that means 2 strips in the spring and 4 strips in the fall. The spring treatment should be timed to begin 6-8 weeks before you will super your colonies for honey production. This means that you can treat between March 1sth and April 1st , depending on the nectar flow patterns typical for your part of New York. Take the strips out when you super between April 15th and May 15th and dispose of them. The fall treatment should begin as soon as you remove your honey supers. Ideally, this should take place between September 15th and October 1st. Leave the fall treatment in your colonies for 8 weeks, then remove the strips for the winter and dispose of them. Always place strips so that they are within the brood nest and so that they will be in contact with the bees when they cluster.

5. Do not leave your strips in your colonies over the winter. It is illegal! It also increases the amount of time your hive parts are in contact with a pesticide, thereby increasing the chance of contamination of hive products! It may also increase the chance of the mite population developing resistance to the pesticide. Do not use formulations of fluvalinate or other pesticides that are not registered for use against *varroa*. It is illegal!

APISTAN FACTS

Active ingredient
The active ingredient in Apistan is a contact insecticide. The active ingredient is slowly released from the strip and as the bees contact the strip they pick up a small dose of the active. The mites must come in contact with the active to receive a lethal dose. Basically, the bees spread the active around the hive by contacting the strip and contacting other bees within the hive. This lateral transfer takes some time that is why it takes six to eight weeks of treatment time.

Mode of action
The mode of action is by contact and as with most pyrethroids in it's class, fluvalinate is a peripheral nerve toxicant. The mites are much more susceptible to the active than the bees. As the old adage goes "dose makes the poison". Fluvalinate works on the cation exchange potential of the sodium channel causing rapid nerve firing and then paralysis.

Apistan as formulated is neither water or oil soluble. Though you may be able to remove small quantities of fluvalinate with water or oil, the strip is unaffected by either oil or water.

Shelf life and storage
Data confirms three years of shelf life on the strip in the unopened package. If the package is opened and then re-sealed the shelf life will remain the same, it is important that the strips remain in the original package once opened. This is a good practice not only for shelf life but to keep the label with the product and to prevent cross contamination with other insecticides. The cross contamination issue is important, some pesticides are volatile, so storage in the original package away from other pesticides is recommended.

Ideal storage conditions would be less than 80° F out of direct sunlight. Any typical chemical storage facility will be adequate as long as the potential for cross-contamination is limited. The label recommendations for disposal are somewhat vague. If there is a certified waste disposal site nearby, that is the optimal location. However, most people do not have access to those type facilities. For the generally user, disposing of the used strip at the site or simply wrapping in a piece of newspaper and throwing it away in household trash is sufficient. Incineration is not recommended.

Safe handling
Latex gloves of any kind will provide sufficient protection when applying or removing the strips. Playtex gloves or surgical gloves are fine. Just throw the gloves away after handling the strips. If you have a lot of strip to apply, you might invest in some nitrile gloves that can be cleaned and reused (but only for pesticides!).

CULTURAL METHODS OF CONTROL

A number of non-chemical techniques have been suggested for *Varroa* control. Unfortunately, there is very little evidence with which to distinguish effective methods from ineffective ones. One cultural method that shows promise is the use of drone comb as a mite trap. This method takes advantage of the fact that *Varroa* is found more often in drone brood than in worker brood. To turn this preference to the bees advantage, one or two full depth combs of drone comb are inserted into the brood nest during the beginning or middle of the drone rearing season. After the queen has laid eggs in the drone cells and the workers have reared and capped the larvae, the combs are removed from the colony and the drone brood is destroyed. This can be done by freezing the comb and then returning it to the colony for clean-up, or by placing the drone combs in a super and placing the super in an location where any emerging drones will not drift back into any colonies. An easy way to do this is to seal up the supers containing the drone comb so that the drones cannot escape.

The effectiveness of the drone trap method and the best time to use the drone trap method have not been determined, so, you will have to experiment to find the best time for your location. The goal is to trap before the mites build up and become a problem, but as late as possible during the drone rearing season to produce the shortest possible interval between the time when the drone traps are removed from the colony and the end of the fall honey flow when colonies are treated with Apistan. Colonies that have been treated properly in the fall of one year, but not during the following spring, often start to exhibit high mite counts toward the end of the following summer. By trapping drones in May or June, the mite population is knocked down at a time that may prevent it from becoming a late summer problem. This may allow one to safely delay treating with Apistan in the fall until after the honey crop is removed from the colony. This techniques is in use in parts of Europe, but it is only now being rigorously evaluated in the US. If you can afford to, try this technique on a few colonies, but do not rely on it to control *Varroa*. Keep in touch with your local beekeeping organization and state inspection services for updates on the effectiveness of this technique.

ECONOMIC THRESHOLDS

The best strategy for the use of any control measure is to use it only when the pest population reaches an economic threshold, that is, the level at which you must treat or expect to experience damage to your colonies in excess of the cost of control. Unfortunately, there are no established economic thresholds for *Varroa* in the northeast. One reason for this is the constant threat of infestation from other colonies. You may have a ‘safe’ level in the spring, only to have your colony rob out a dying, heavily infested colony in the summer. All of a sudden, the mite population in your colony starts to grow faster than anticipated, and you run into trouble before the next scheduled treatment.

You should sample your colonies on a regular basis. If you detect *Varroa*, begin a treatment program at the first available treatment window (fall or spring). Thereafter, you should assume that mites are present in your colonies and adhere to a regular spring and fall treatment program. If further research is able to identify economic thresholds before this bulletin is revised, or if new treatments receive EPA approval, those thresholds and treatment recommendations will be communicated to you through your local bee organizations and state inspection programs.

WARNINGS - SAFETY AND CONTAMINATION

Remember! It won't do you much good to save your bees if you injure yourself in the process. Apistan works because it is a highly toxic poison! That means that you want to minimize your contact with the chemical. You can do this by wearing gloves (latex, surgical, or nitrile) whenever you handle Apistan strips. When you finish installing the strips, throw the gloves away. If you are using a heavy rubber or nitrile glove, you may reuse them. First, wash the gloves with soap and water while they are still on your hands, then remove them and store them for future use for pesticides only! When removing strips, collect them into a group and dispose of them in a sanitary landfill - ***DO NOT REUSE THEM!***

RESISTANCE TO APISTAN

The resistance issue is a complicated one. There are confirmed cases of resistance in Italy and some other locations in Europe. Most of the problem stemmed from the illegal use of Mavrik in the hives. Resistance is a difficult problem to overcome so reducing the potential is the optimum way to prolong the life of a product. As with any product, proper management is necessary to provide long product life. Overuse, use of old strips, use of Mavrik, and failure to follow label directions have all had an influence on the resistance issue. The manufacturer is developing literature that may help in educating customers but in some instances users are often unaware of the impact they may have when using product off-label. There are no other registered products for the control of *Varroa*, so it is in the best interests of our users to be cognizant on the judicious use of Apistan. For the present, if Apistan would go away, then the whole bee industry would suffer. Education on the proper use of the product is the most practical way to prolong the life the product. The best way to prevent the development of resistance is to follow the label instructions to the letter.

We still have a lot to learn about the management of *Varroa*. In the future, recommendations may call for the use of less pesticide, fewer treatments, alternative treatments, or some combination of these changes. For now, follow the above recommendations to insure the health and safety of both you and your bees, and to insure the purity of your hive products.

Here is some additional information to help you make the safest and most effective use of Apistan:

1. There are three formulations registered for the control of *Varroa*. The Apistan strip for use in hives contains 10% tau-fluvalinate in a plastic matrix. There are two smaller versions of the Apistan strip for use in queen cages and package bees. The queen tabs are small and contain 1.0% tau-fluvalinate and used when shipping queens. The package bee strip is larger than the queen tabs and contains 2.5% tau-fluvalinate. The brand names for all products is Apistan with the differentiation as queen tabs, etc. These are the only registered products available for *Varroa* control.

2. There are really no special use regulations regarding Apistan as a survey or detection tool. As per the label, surveying can be conducted up to a seven day period. Surveying is accomplished by placing a white sticky paper on the floor of the hive and evaluating at various periods over seven days, whereas for treatment, the strips remain in the hive for up to eight weeks .

3. The active ingredient in Apistan is a contact insecticide. The active ingredient is slowly released from the strip and as the bees contact the strip they pick up a small dose of the active. The mites must come in contact with the active to receive a lethal dose. Basically, the bees spread the active around the hive by contacting the strip and contacting other bees
within the hive. This lateral transfer takes some time that is why it takes six to eight weeks of treatment time.

4. The mode of action is by contact and as with most pyrethroids in it's class, fluvalinate is a peripheral nerve toxicant. The mites are much more susceptible to the active than the bees. As the old adage goes "dose makes the poison". Fluvalinate works on the cation exchange potential of the sodium channel causing rapid nerve firing and then paralysis.

5. Apistan as formulated is neither water or oil soluble. Though you may be able to remove small quantities of fluvalinate with water or oil, the strip is unaffected by either oil or water.

6. Data confirms three years of shelf life on the strip in the unopened package.

7. If the package is opened and then reclosed the shelf life will remain the same, it is important that the strips remain in the original package once opened. This is a good practice not only the label with the product and to prevent cross contamination with other insecticides. The cross contamination issue is important, some pesticides are volatile, so storage in the original package away from other pesticides is recommended.

8. Ideal storage conditions would be less than 80° F out of direct sunlight. Any typical chemical storage facility will be adequate as long as the potential for cross-contamination is limited.

9. The label recommendations are somewhat vague. If there is a certified waste disposal site nearby, that is the optimal location. However, most people do not have access to those type facilities. For the generally user, disposing of the used strip at the site or simply wrapping in a piece of newspaper and throwing it away in household trash is sufficient. Incineration is not recommended.

10. Latex gloves of any kind will provide sufficient protection when applying or removing the strips. Playtex gloves or surgical gloves are fine. Just throw the gloves away after handling the strips. If you have a lot of strip to apply, you might invest in some nitrile gloves that can be cleaned and reused (but only for pesticides!

11. The resistance issue is a complicated one. There are confirmed cases of resistance in Italy and some other locations in Europe. Most of the problem stemmed from the illegal use of Mavrik in the hives. Resistance is a difficult problem to overcome so reducing the potential is the optimum way to prolong the life of a product. As with any product, proper management is necessary to provide long product life. Overuse, use of old strips, use of Mavrik, and failure to follow label directions have all had an influence on the resistance issue. The manufacturer is developing literature that may help in educating customers but in some instances users are often unaware of the impact they may have when using product off-label. There are currently no other registered products for the control of *Varroa*, so it is in the best interests of our users to be cognizant on the judicious use of Apistan. For the present, if Apistan would go away, then the whole bee industry would suffer. Education on the proper use of the product is the most practical way to prolong the life the product.

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