THE Bee-Files
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Integrated Pest Management for Varroa in the Northeast

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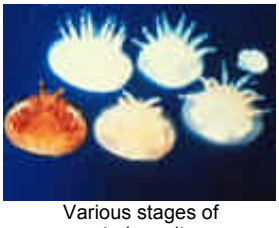

Various stages of maturing mites

"Varroa mites are here to stay – are you?"

1. Mature female mite

Key Words

pest population density: the number of pest in a sample of known size. Mite population density can be measured as the number of mites per 300 adult bees, or the number of mites in a known volume of adult bees, or the number of mite per 100 cells of capped brood.

economic injury level: the lowest pest population density that causes economic damage.

economic threshold: a pest population density that triggers a management action designed to prevent the pest population from reaching the economic injury level.

pesticides: a general term that includes acaricides (= miticides), insecticides, fungicides and herbicides.

pyrethroids: a class of synthetic pesticides with chemical structures similar to the pyrethrins, a group of naturally-occurring substances found in chrysanthemums and possessing pesticide activity. Pyrethroids generally have low mammalian toxicity. Apistan is a pyrethroid used for controlling the varroa mite.

organophosphates: a broad class of synthetic pesticides containing phosphorous and bearing similarities to nerve gases developed during WWII. The OP's, as they are called, generally have a very high mammalian toxicity and can cause cumulative, irreversible nerve damage at sub-lethal doses. CheckMite+ (coumaphos) is an OP registered for control of the varroa mite and the small hive beetle in some states.

organic acids: a group of carbon-bearing acids, including acetic, formic, lactic and oxalic acids. Certain formulations of formic acid are registered in the US for control of the tracheal mite and suppression of the varroa mite.

2. *Varroa* mites are reddish brown and easily seen adhering to sides of a jar after an ether roll.

New beekeepers must confront one overriding reality right from the start – MITES! The *varroa* mite (*Varroa jacobsoni*) and the *tracheal* mite (*Acarapis woodi*) are major risk factors in beekeeping, and both mites will continue to be serious problems in the next century. You can enjoy and profit from beekeeping, but only if you incorporate effective mite control practices into your management program. Of course, that assumes you have a management program. So, before you ever put hammer to nail on your first hive body, put together a seasonal plan for managing your bees, and make mite control a key feature of that plan. Remember! Healthy bees, large honey crops and successful wintering don't just happen. You have to make them happen.

BASIC BIOLOGY

In order to put together an effective mite management program, you must understand the basics of the pest's biology. *Varroa jacobsoni* is an external parasite that feeds on the haemolymph (= blood) of adult and immature bees. *Varroa* mites reproduce solely on the immature stage of the bee, in the capped cells, where they are well-protected from miticides. Mite reproduction is much higher on drone brood because it is capped for a longer period of time than worker brood. This allows time for more offspring to mature. Not surprisingly, *varroa* mites exhibit a clear preference for drone brood. *Varroa* mites winter with the colony, although reproduction is greatly reduced when brood rearing is low.

Identification and Detection

Viewed from the top, the adult female is elliptical in shape, measuring 1.6 mm (= 1/16"), side to side, and 1.1 mm, front to rear (Fig. 1). Mature mites are dark brown or reddish-brown in color, while the immature stages are light brown or off-white. Male *varroa* mites die in the capped cells and are not seen on adult bees. Unlike their close relatives, the 6-legged insects, adult mites have 4 pairs of legs.

There are several ways to detect *varroa* mites (reviewed in Morse 1999). These include the ether roll, shaking bees in soapy water, the capping scratcher, and the sticky-board insert. For the ether roll (Burgett et al. 1987), approximately 250 bees are collected from 2 or 3 brood nest combs and placed in a quart glass jar. A 1-2 second burst of automotive starting fluid is sprayed into the jar, which is covered, shaken vigorously for 30 seconds, then, gently rolled 2-3 times along its long axis. Mites, if present, will be seen adhering to the side of the jar (Fig 2). Mite levels are about twice as high on combs with brood as on combs with only honey (Calderone and Turcotte 1999), so, you increase the chance of detecting mites in your colonies by collecting bees from brood combs. The ether roll removes about half of the mites from the bees. The soapy water method (De Jong et al. 1982) is similar to the ether roll, except that you place the bees in a jar with soapy water and shake it for 30 seconds. This method removes nearly all of the mites from the bees, which are then separated and counted.

You can use a bee brush or a plastic laundry scoop to collect the bees, but a portable vacuum device (Fig. 3) will greatly speed up the process and make it easy to collect samples of the same size. Remember! In order to use the information you get from the ether roll, or any other method, it is essential that you always collect samples of the same size.

The sticky board is a passive method for monitoring mite levels. A sticky board with a screen covering is placed on the bottom board for a set period of time, usually 24 hours. The board is then removed and the mites adhering to the board are counted. A sticky-board in conjunction with Apistan strips can also be used to detect mites. The cappings scratcher involves removing some capped pupae, preferably drone pupae, and examining them for mites (Fig. 4). It is good for a 'presence-absence' determination, but is not very good for comparison purposes. Mites can sometimes be seen on the adult bees or walking on the comb, but this is more common when infestation rates are high and should not be relied on as a detection method.


3. Portable vacuum device


4. Capping scratcher

Symptoms

The three most obvious symptoms of varroa are bees with deformed wings walking on combs(Fig. 5), crawling bees at the entrance, and the presence of atypical brood diseases (Fig. 6). These symptoms comprise the key features of 'parasitic mite syndrome' (Shimanuki et al. 1994). Bees with damaged wings are almost always associated with varroa mites. Crawling bees at the entrance may indicate a number of conditions, including varroa mites or tracheal mites. The presence of atypical brood diseases is associated with varroa mites and generally is seen as mite levels rise to moderate and high levels. Atypical brood diseases indicate the end stage of the *varroa* mite infestation. From the time colonies first exhibit symptoms of brood deterioration until the total collapse of the colony can be as little as 2-3 weeks. However, if caught at the earliest stages, an effective miticide can save your colony. Beginning beekeepers will have difficulty distinguishing between American foulbrood (AFB) and atypical brood diseases. Therefore, if you observe this symptom, ask an experienced beekeeper to help you determine whether AFB is present. Unfortunately, all of these symptoms are most apparent when the mite levels have become dangerously high.


5. Bees with deformed wings walking on combs.

6. Parasitic Mite Syndrome has a variety of symptoms

Transmission and re-infestation

Varroa infests colonies in several ways. Moving capped brood among colonies for the purpose of strengthening or equalizing colonies is a common practice among beekeepers and can be a major source of transmission of both mites and disease. Robbing is also a significant source of transmission. Colonies 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. This makes feral colonies a prime source of re-infestation for managed colonies because your bees may rob them when they become too weak to defend themselves. Swarms that you capture are also likely to be infested with mites. Bees often drift among colonies within an apiary, especially when colonies are kept close together in regular patterns. Drifting can spread mites among colonies.

AN IPM PROTOCOL

The goal of an effective mite control program is to impose a cycle on the mite population such that the mite population density is always below the economic injury level. A single spring, late summer or early fall treatment might provide adequate control if you only had to worry about your own bees. However, feral colonies are constantly dying and other beekeepers may not always pay adequate attention to their bees. You must assume that mite levels in your colonies are augmented by mites from nearby infested colonies that are robbed by your bees (Fig. 7), especially when there is a dearth of nectar. Mite levels also seem to be higher in years when there is a strong and sustained nectar flow. Therefore, I recommend you treat twice each year, as spelled out below, unless you determine that the mite levels in your colonies are at a safe level. Check with your local apiculture extension specialist to obtain more information on treatment thresholds and optimal treatment dates for your specific region.

Monitoring Mite Levels

A key feature of an IPM program is pest monitoring. IPM principles dictate that you only treat when you need to treat. Not only does this reduce pesticide residue

7. Avoid situations that lead to robbing. Weak colonies are happy to share their mites.

levels in hive products, it reduces the rate at which the mites become resistant to the pesticide you are using. Sampling each colony prior to treatment allows you to determine whether or not you need to treat. Treatment should only be applied if the pest population density has reached a level known as the economic threshold. If the mite levels are below the threshold, you do not need to treat. Monitoring involves more work – I figure it takes an additional 7 minutes to perform an ether roll during your normal fall inspection - but, you save between $3.00 and $4.50 for each colony not treated.

Unfortunately, the development of economic thresholds is in its infancy. Thresholds will vary among geographic regions and on the time of year when you measure the pest population density (Delaplane and Hood 1997). Thresholds may even vary from beekeeper to beekeeper within the same region. Nonetheless, there are mite levels at which it makes no sense to treat. I take a conservative approach. If I obtain an ether roll count of zero during the last week of September - that's right when our fall flow is ending - I do not treat for varroa that fall.

Determine your own thresholds

Determining threshold levels is something many beekeepers, or beekeeping groups, can do for themselves. You must adhere to a consistent method of monitoring mite levels. This means that you monitor mite levels at the same time each year, and you monitor all colonies exactly the same way. For the ether roll, this means collecting your sample from the same place in each colony (2-3 brood nest combs), collecting the same number or volume of bees in each sample, applying the same amount of ether, and shaking the jar in the same manner. For the sticky-board, it means leaving each board in for exactly the same length of time.

A few colonies set aside for evaluation each year will be a wise investment in the long run. In the fall, place 10 or more colonies with similar populations of bees and the same mite levels – say 2 on an ether roll - in the same apiary. Treat half the colonies with Apistan, and let the others go without treatment. If the untreated colonies are as strong as the treated colonies the following spring, you will not have to treat colonies with ether roll counts of 2 or less the following fall. Now, you can raise your threshold to 3 for the next test. Continue this process until you start seeing some reduction in the productivity of your untreated colonies. Of course, you must maintain meticulous records and be prepared to lose a few colonies.

Late-spring and summer protocol

Come springtime, you need to kill off ALL of the mites in your colonies. Fumigants will not do this. You need to use Apistan, or CheckMite+ if you have Apistan-resistant mites. The reason for this is simple. The further you get from a 100% kill, the more rapidly the mite population will build up over the summer, and the greater the chance that your bees will succumb before the fall treatment window - which opens when the fall crop if removed. Late summer and early fall colony meltdown is probably the biggest problem associated with mite management in the northeast. Spring treatments should be put on six weeks prior to supering for honey production and removed when you place supers on the colonies. Delay putting on supers until the last possible moment.

Fall protocol

Apply your late summer or early fall treatment when you harvest your honey crop. In the northeast, the ideal target period is between August 15th and October 15th, depending on when the nectar flow ends in your area. The goal is to treat your colonies while there are still a few weeks of brood rearing left, but after the honey crop is harvested. This will ensure that your colonies have lots of healthy bees for the winter. The earlier in the target period that you harvest your honey crop and begin treatment the better. Leave your late summer or early fall Apistan treatment in your colonies for 8 weeks, then remove the strips.

If you are going to use thresholds as a decision-making tool in the northeast, I recommend monitoring your mite levels when the goldenrod is about 80 % done. If your mite levels exceed your economic threshold, remove your fall crop and begin treating for varroa mites. Even if you choose not to use economic thresholds, I recommend that you remove your crop and start to treat at this time. The advantage to removing your crop early is that you move the treatment date up, thereby reducing the chance of colony collapse. You will also have fewer problems with robbing if you remove your crop while the flow is still on. Remember! The risk of colony collapse increases steadily from mid-August through mid-October. The earlier you can treat during that period, the better. Treat as late as possible in the spring and as early as possible in the fall. This will minimize the time between treatments and reduce the chance of a late summer collapse.

Special case - parasitic mite syndrome
Anytime you notice the development of parasitic mite syndrome, you should immediately sample your colony for mites. If mites are present, remove all marketable honey and begin treatment at once. Procrastination at this stage ensures the loss of your colony and poses a serious threat to your neighbor's bees. After the proper treatment period, remove the strips and resume honey production.

CHEMICAL TREATMENTS

Apistan (fluvalinate) and CheckMite+ (coumpahos)

Apistan and CheckMite+ are the two products registered for control of varroa mites in the US. Unless you have mites that are resistant to Apistan, that is your safest and most effective treatment. Use one new Apistan strip for every 5 full-depth combs of bees in the brood nest. For most colonies, that means 1 strip in the spring and 2-3 strips in the late summer or early fall. Place strips so that they will be in contact with the bees when they cluster (Fig. 6). Always read the label for the latest instructions.

Resistance to Apistan is becoming common throughout the US, especially in migratory operations. You should be monitoring for resistance by checking the effectiveness of your Apistan treatments. This can be difficult because you do not know if Apistan is working until after the treatment period is over. Partial resistance can add to this problem. Nonetheless, if you find mites in your colonies after the 6-8 week treatment period, assume that you have Apistan resistant mites and switch to CheckMite+. You can also check your mites for Apistan resistance before treating them using the methods developed by Pettis et al. (1998a, b). Then, if you have resistance, you can start treatment with CheckMite+.

Formic acid
Formic acid has been approved for control of tracheal mites and for suppression of varroa mites. This is because formic acid treatments generally results in 50% to 80% mortality of varroa mites, which is not generally thought to be sufficient as a stand alone treatment. I believe this will soon change, as the delivery methods and dosage for formic acid treatments are optimized.

Never apply APISTAN, CHECKMITE+ OR FORMIC ACID during a nectar flow or while honey supers are on your colonies.


7. Apistan strips need to be applied safely and correctly.

MANAGEMENT PRACTICES

There are a number of management techniques that you can employ that will help in your efforts to keep varroa mites under control. Most of these methods will not protect your colonies by themselves, but they will help slow the rate at which the varroa population grows. This can be very important during the late summer and early fall when mite populations may soar and you are caught in between legal treatment windows. You can obtain more details on many of these methods from the references listed below.

Brood nest management - maintain high quality combs
Cull combs with more than a fist-sized patch of drone cells. This may reduce the rate at which the mite population grows by reducing the amount of drone brood in the colony. Regular culling of older, poor quality combs will also reduce the incidence of pathogens in the brood nest and will reduce the chance of contaminating your hive products with pesticides. You can maintain high quality combs by using plastic foundation or crimp-wire foundation that has been properly wired in the frame. Culled combs can be rendered or sold to a wax processor. There are two ways to maintain high quality combs:

1. Draw foundation in the bottom honey super, then, move combs from the honey supers to the brood nest on an 'as-need' basis. Cull combs from the brood nest when they are no longer fit for service.

2. Draw out your brood nest combs in the second story of the brood nest (do not put foundation in the bottom story, as the bees will usually neglect it) and your honey storage combs in the honey supers. Cull from each area independently.

Remember! Always draw foundation during a strong nectar flow. Never move combs from the brood nest to the honey supers. This will increase the chance of pesticide contamination and will darken your honey.

Isolation
Isolation is a standard practice in many IPM programs. If you can locate apiaries 3-5 miles from other beekeeper's apiaries, you stand a good chance of avoiding contact with a number of problems, including Apistan resistant mites, as well as mites and diseases from other beekeepers colonies.

Swarm prevention
Swarms issuing from your colonies are likely to serve as reservoirs for mites. Eventually, they will weaken and may be robbed by your bees. This will result in an increase in mite levels in your colonies. Follow an effective swarm prevention program to reduce the number of feral colonies in the vicinity of your apiaries.

Prevent Robbing
Do not accept robbing at anytime as an inevitable consequence of keeping bees. Robbing can result in the transfer of mites and disease among your colonies and can also weaken or kill the colony being robbed. Robbing bees also pose a danger to people and livestock in the area because they are aggressive and tend to sting. If you keep bees on someone else's land, you will wear out your welcome very quickly if you allow robbing to develop.

Like most problems, robbing is best prevented, as 'curing' it is difficult. Adopt anti-robbing practices as core components of your management system. Keep the size of colony entrances proportional to their strength. From mid fall through early spring, colonies are weak and should have entrance reducers in place. In the late spring, summer, and early fall, colonies are strong and need ventilation. Remove the reducers during those times. Replace reducers as the fall flow wanes, temperatures drop and the bees become snoopy. Always start packages, splits and nucs with reducers in place. Maintain your equipment in good condition. Repair damaged areas that allow bees to enter the supers. Do not bore holes in your hive bodies. If you want a upper entrance in the fall, slide your top super back about 3/8".

Minimize the time you spend inside your colonies during a nectar dearth. If you must work a colony at that time, keep all of your equipment tightly stacked together and keep all of the combs covered. Use an anti-robbing cage whenever the bees are snoopy (Fig.8).


8. Anti-robbing cage

Never leave combs or bits of burr comb in the apiary. Carry a feeder pail w/lid with you when working bees and use it to store all of your burr comb and scrapings. You can accumulate quite a bit of this over a few years and then sell it to a wax buyer. When removing honey, especially during a dearth, crack your supers apart, then, set them back in place and let the bees clean up the honey released from the burr comb. Stack supers on pallets and keep each stack tightly covered. Feeding bees can start bees robbing. Syrup should be fed in the evening, as it is likely to promote robbing. Capped honey can generally be fed at anytime without getting robbing started. It is never a good idea to let bees rob out extracted supers. Not only can this start robbing when done near an apiary, it contributes to the spread of disease and mites.

If robbing gets started, close all colonies in the yard, tape off all cracks and holes in the hive bodies, and place loose grass over the entrances. Make sure that there are no combs or pieces of comb in the yard to excite the bees. Never smoke entrances during a dearth, as this reduces a colony's ability to defend itself. A colony that cannot defend itself should be moved to a separate yard and allowed to rebuild.

Mite resistant stocks of bees
The most desirable solution to the mite problem is the development of mite resistance in the bee population. Resistance to the tracheal mite is now common, although certainly not universal. Resistance to the varroa mite has been more elusive. There are, however, several encouraging developments in this area. The USDA-ARS Honey Bee Breeding, Genetics and Physiology Lab in Baton Rouge, LA has two ongoing projects. One involves selection for resistance in bees already in North America. The other involves the importation of bees from Russia that are believed to be somewhat resistant to varroa. The USDA-ARS Carl Hayden Bee Research Lab in Tucson, AZ has also made progress in this area. Researchers at the University of Minnesota are examining the role of hygienic behavior in mite resistance. Even a modest level of resistance would be a welcome development. Partially resistant stocks of bees would reduce the occurrence of late summer and fall colony collapse, allowing beekeepers to treat healthy colonies after the honey flow is over for the year. They may also allow beekeepers to use fewer chemical treatments. Try resistant stocks when they become available and decide for yourself if they work.

Trap comb methods
There is good evidence from Europe that trapping varroa mites with drone combs can keep mite levels below the economic injury level. The method involves the use of several drone combs per colony in conjunction with other colony manipulations. You can learn more about this by reading one or more of the articles listed below. You may want to try a modified trap method in which you provide colonies with drone combs throughout the spring and summer, removing them whenever they are filled with capped drone brood. This may reduce the chance of late summer colony collapse. Be sure to remove drone combs before the drones emerge; otherwise, you will actually be increasing your mite populations. You can make drone combs by simply cutting out the center portions of your low quality combs and letting the bees repair them with drone comb.

Screen inserts, dusts and smokes
A number of observers have noted that a considerable number of varroa mites fall to the bottom of the hive, even when there is no treatment being applied. Dusts and certain smoke treatments have been shown to increase the rate at which mites fall from adult bees. These observations have led to the idea that natural mite drop, or natural drop augmented by some other means, might provide some protection from the varroa mite. So far, this has not proven to be the case. At Dyce Laboratory in Ithaca, NY, we have tried this method in conjunction with periodic smoke treatments, but we have not found it to be effective. However, additional research needs to be done in this area.

Splits
It has been my experience that colonies that are split in the spring have lower mite levels in the fall than colonies that are not split. Of course, if you follow this method, you will fill the known universe with beehives within 64 years.

Start new every year
You can remove all of the honey from your bees in the fall and sell the bees to another beekeeper. This way you are not wintering any bees, and you will not ever need to treat your bees for mites. Use the money from the extra honey to purchase a nuc or package in the spring.

Special plastic combs (ANP)
Don't confuse these with plastic frames and foundation. ANP combs are entirely plastic with plastic cell walls. Evidence on the benefits of these combs as a mite control technique is sparse and mixed. One problem is that they have only about half the number of cells per comb as regular wax combs. However, plastic comb has not been the subject of extensive research.

Hyperthermia
There is not a lot of information on this either. Mites can be treated with heat, but the method is time consuming, requiring separation of adult bees and brood and a special heating apparatus.

USE PESTICIDES PROPERLY – WORKER SAFETY AND CONTAMINATION

Apistan, CheckMite+ and formic acid work because they are highly toxic substances. You must prevent any contact with any of these pesticides. Wear latex gloves (or, for better protection, nitrile rubber) whenever you handle Apistan or CheckMite+ strips. When you finish handling strips or gel packs, throw the gloves away. You may reuse nitrile rubber gloves of at least 14 mils thickness. First, wash the gloves with soap and water while they are still on your hands, then, rinse well, remove and store for future use - BUT ONLY FOR PESTICIDES! You can obtain nitrile rubber gloves from your bee supply store – buy some! If you employ people to apply pesticides, be sure that you are in compliance with all relevant worker safety regulations. You may be financially liable for pesticide related injuries to employees.

Do not leave strips in your colonies for more than or less than the time indicated on the label. Not only does this practice increase the risk contamination of hive products, it also increases the chance of the mite population developing resistance to the pesticide. When removing strips, collect them into a group and dispose of them according to label instructions - **DO NOT REUSE STRIPS!** Never use formulations of fluvalinate or other pesticides that are not registered for use against varroa. Always refer to the current label to obtain the latest instructions for proper use.

REFERENCES
Join a local beekeeping group. Beekeeping groups often have libraries for members, which is a great, low cost way to share information. If your group doesn't have a library, organize one. The references below should be in every beekeeping library.

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Links

You can obtain copies of the Calis et al. 1999 JAR article on the drone trap method by logging onto IBRA's web site at http://www.cf.ac.uk/ibra/photo-fm.shtml. Copies are a bit expensive, but it's the best way to get all the details. The cost excluding delivery is £0.60/$US1.08 per page, but with a minimum charge of £6/$US10.80 per item. Delivery by post to rest of the world (i.e. not the UK) is £0.20/$US0.36 per page, £2$US3.60 minimum charge. IBRA members receive 50% discount on these charges. You can email your order to IBRA@cardiff.ac.uk.

You can order a suitable vacuum device for sampling your colonies from BIOQUIP Products, INC., 17803 LaSalle Ave., Gardena, CA 90248 (310-324-0620). Ask for DC INSECT VAC Model 2820B (designed for 12vdc). Ask about spare parts when ordering.

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