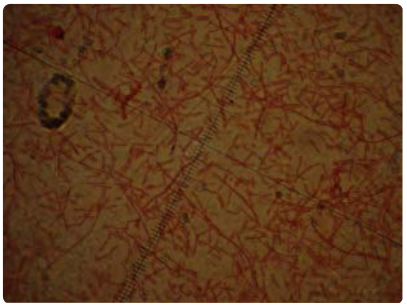
Plant Industry - Plant Protection Section
Apiary Services

The mission of the North Carolina Department of Agriculture and Consumer Services Apiary Program is to promote and protect the state's beekeeping industry. The Apiary Program provides disease and disorder inspections (apiarymp.html) and fumigation services in an effort to control diseases and pests of the beekeeping industry. Additionally, the Apiary Program provides educational workshops to educate the state's beekeepers on the biology and treatment of mite and disease pests of honey bees and africanized bees. Promotional effects are achieved through lectures to county and state beekeeping organizations or any other groups that are interested in apiculture or related topics.



Paenibacillus larvae, the causative organism in American foulbrood

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Session 6 - Diseases

Honey Display at the State Fair

The Apiary Program is also responsible for the bee and honey display at the North Carolina State Fair (http://www.ncstatefair.org/) in Raleigh and the Western Carolina State Fair (http://www.ncagr.com/markets/fairs/mtnfair/index.htm) in Asheville. Apiary Program personnel participate in most of the states county and regional fairs.

The Apiary Program in cooperation with the Food and Drug Protection Division (http://www.ncagr.com/fooddrug/)of the North Carolina Department of Agriculture and Consumer Services provides honey house sanitation inspections.

Additional Apiary Program Sites and Related Links:

- Apiary Inspection Services by Counties (apiarymp.html)
- Report 2008-09 (documents/ApiaryReport2008-09.pdf)
- Bee Linked (../../beeboard/index.htm)
- 2017 Apiary Registration Form (documents/BS2ApiaryRegistrationForm01-2017.pdf)
- Small Hive Beetle (hivebee.html)
- List of Dealers Authorized to Sell Bees in NC (updated - May 8, 2017) (documents/PermitToSell20175-8.pdf)
- How to Sell Bees in North Carolina (../../plant/apiary/sellbees.htm)
- N.C. Bee and Honey Act of 1977 (http://www.ncga.state.nc.us/EnactedLegislation/Statutes/HTML/ByArticle/Chapter_106/Article_55.html)
- N.C. Bee and Honey Act of 1977 (RTF printable) (http://www.ncga.state.nc.us/EnactedLegislation/Statutes/RTF/ByArticle/Chapter_106/Article_55.rtf)
- got to be NC AG POLLINATORS (/pollinators/index.htm)Honey and Bee Industry Regulations (../../Regs/48a0200.htm)
- N.C. Africanized Honey Bee Advisory Task Force - 291 (documents/2011NCAHBActionPlan.pdf)
- Beekeeping, Tracheal Mite Disease, and Varroa Mite Disease (http://entomology.ces.ncsu.edu/apiculture/beekeeping-notes/)
- N.C. Pollinator Information (../../../spcap/bee/)

- Beecheck (/pollinators/Driftwatch.htm)

For Additional Information Contact:
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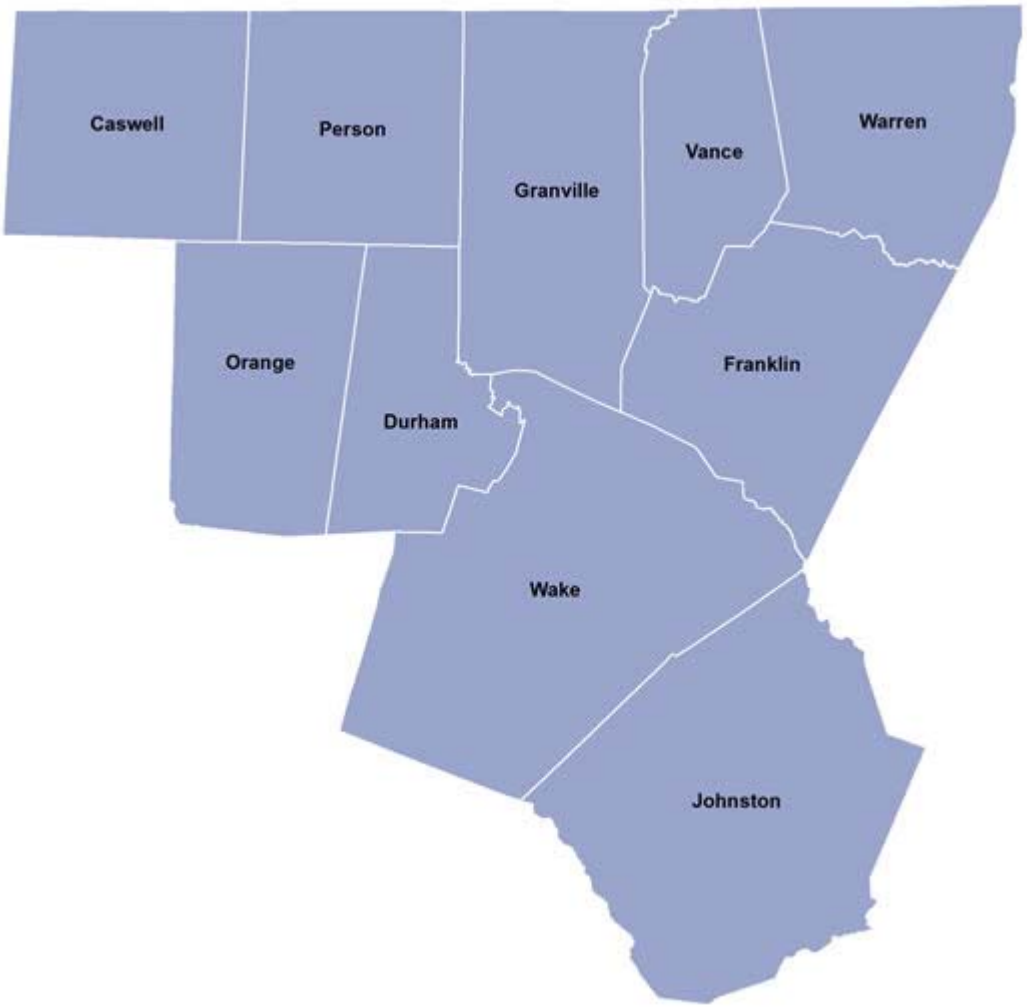
Plant Industry - Plant Protection Section
Apiary Inspection Services



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Return To Apiary Inspection Map Page (apiarymp.html)

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Disease Management and Guidelines for the Honey Bee

Introduction

It is the goal of every beekeeper to maintain healthy, productive colonies. This can only be accomplished by reducing the frequency and prevalence of disease within beehives. The following is an outline of recommendations for detecting and treating colonies for economically important parasites and pathogens of honey bees so that beekeepers may achieve this goal, and do so in a sustainable way for the long-term health of their colonies.

Overview

Disease/Pest	Causative Agent	Symptoms
Adult Parasites		
Varroa mites	The parasitic mite *Varroa destructor*	Presence of adult mites, deformed wings
Tracheal mites	The parasitic mite *Acarapis woodi*	K-wings, morbidity
Nosema	The protozoan *Nosema apis*	Diarrhea, distended abdomens
Brood Pathogens		
American foulbrood (AFB)	The bacterium *Paenibacillus larvae*	Discolored larvae, foul smelling brood, ropy remains, scale
European foulbrood (EFB)	The bacterium *Melissococcus pluton* and associated flora	Discolored larvae, foul smelling brood, non-ropy remains, no scale
Chalkbrood	The fungus *Ascophaera apis*	White or black mummies in cells or on bottom board
Sacbrood	A viral infection	Brown larvae in the curled "canoe" shape
Hive Pests		
Wax moths	Larvae of *Galaria mellonella*	Silk cocoons and/or tunnels
Small hive beetle (SHB)	Larvae of *Aethinda tumida*	Wet combs, maggot-like larvae

Varroa Mites

Session 6 - Diseases

Cause

The parasitic mite, *Varroa destructor.*

Symptoms

- Presence of adult mites on adult bees, brood, or hive debris.
- Adults with shortened abdomens, misshapen wings, and deformed legs.
- Dramatic decline in adult population and brood area, with spotty brood pattern.

Means of prevention

- Screened bottom boards.
- Mite-tolerant stocks, such as Russian, SMR, or Minnesota hygienic.
- Drone-brood trapping.
- Treatment of inert dusts.

Methods of detection

- Sugar shake or ether roll.
- Sticky board.
- Alcohol wash.
- Drone-brood inspection or visual inspection.

Treatment recommendations (see flow chart)

Spring (prior to honey flow)

- If varroa levels are equal to or more than **2-3 mites per 100 adult bees** (sugar shake, ether roll, or alcohol wash) or **40-80 mites per 24 hours** per sticky board, treatment is warranted.
- The use of volatile treatments, such as thymol or formic acid, are not recommended since they can result in decreased brood area. Use the appropriate dosage of **Apistan®** or **Checkmite+®** as long the mites have not previously developed a resistance.

Late spring/summer (during/immediately following honey flow)

- Never use any chemical treatments while honey supers are on hives.
- Employ one or more means of prevention, such as screened bottom boards or mite-tolerant stock.

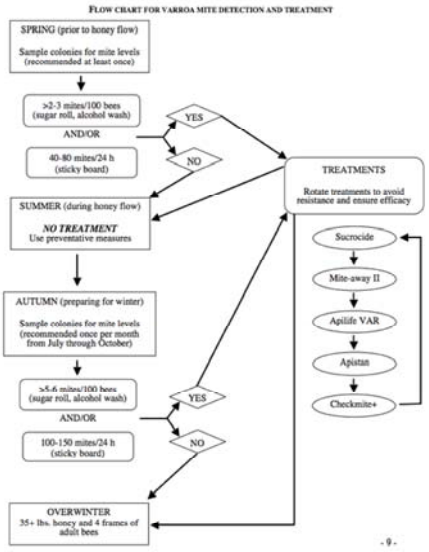
Autumn (preparing for winter)

- Sample frequently for mites, preferably once a month.
- If varroa levels are equal to or more than **5-6 mites per 100 adult bees** (sugar shake, ether roll, or alcohol wash) or **100-150 mites per 24 hours** per sticky board, treatment is warranted.
- Rotate treatments as often as possible to minimize the prolonged exposure of any one chemical for the mites. This will help ensure that the mites do not develop a resistance to the available treatments.

For more information, see NCSU Beekeeping Note 2.03, *Varroa Mites* (http://content.ces.ncsu.edu/managing-varroa-mites-in-honey-bee-colonies), on the biology, detection, prevention, and treatment of varroa mite infestations.

Varroa mite

Varroa mite



Flow chart for Varroa mite detection and treatment.

Tracheal Mites

Cause

The parasitic mite, *Acarapis woodi.*

Symptoms

- There is no one tell-tale sign of this disease.
- Disjointed wings or 'K-wing,' distended abdomen.
- Bees often crawling on the bottom board appearing "morbid."

Means of prevention

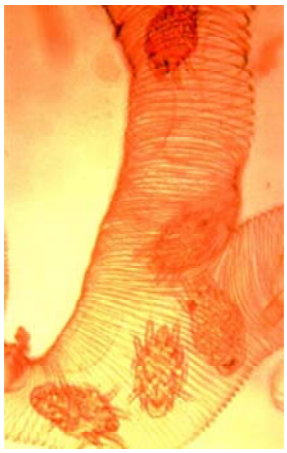
- Resistant stock, such as Buckfast or Russian.

Methods of detection

- Positive identification of tracheal mites can only be made upon microscopic observation of trachea (the breathing tubes of adult bees).
- If you suspect a tracheal-mite infestation, contact your regional NCDA&CS Apiary inspector.

Treatment recommendation

- Verify infestation level whenever tracheal mites are suspected (see above).
- If the percentage of infested adult workers is 10% or greater, treatment is warranted. Treat colonies in the late summer or autumn.
- Recommended treatments:
  - **Mite-a-thol®** (menthol crystals)
  - **Mite-Away II®** (formic acid pads)
  - **Apilife VAR®** (thymol pads) or **Apigaurd®** (thymol gel)



Tracheal mites

Nosema

Cause

The protozoan, *Nosema apis* or *Nosema ceranae*. The latter has largely displaced the former over the last few decades so that *Nosema ceranae* is the most prevalent.

Symptoms

- There is no single symptom of the disease.
- Adults may have distended abdomens and defecate within the hive rather than take cleansing flights.

Means of prevention

- There is no exact means of prevention for nosema.
- Since the disease can be caused by stress, maintaining strong, healthy colonies is the best means of prevention.

Methods of detection

- Infections can only be confirmed by dissecting the digestive tract from individual bees. Diseased individuals have white, soft, and swollen ventriculae rather than brown and tubular.
- Hind gut contents can be examined under a microscope, and nosema spores can be counted using a hemocytometer.

Treatment recommendation

Spring (prior to honey flow)

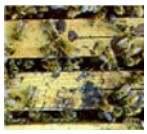
- The only registered treatment for nosema is **Fumadil-B®**. Treat if there are more than **1 million spores per bee**.
- Mix **Fumadil-B®** with sugar syrup according to the label and feed to bees.

Late spring/summer (during/immediately following honey flow)

- No treatment warranted. Maintain strong colonies.

Autumn (preparing for winter)

- Treat if there are more than **1 million spores per bee**.
- Mix **Fumadil-B®** with sugar syrup according to the label and feed to bees.



Honey bees defecating in the hive due to Nosema.

American Foulbrood

Cause

- The spore-forming bacterium, *Paenibacillus larvae larvae*.

Symptoms (see Table 1 below (http://content.ces.ncsu.edu/disease-management-and-guidelines-for-the-honey-bee#table1))

- Brood is dull white, becoming light brown to almost black.
- Age of dead brood is usually older sealed larvae or young pupae.
- Sealed brood is discolored and sunken, often with punctured cappings.

- Heavy infections have brittle, black scales that lie flat on the bottom of brood cells, formed from the dried remains of diseased brood. These scales contain billions of AFB spores and are highly contagious and persistent.

Means of prevention

- Hygienic stocks.
- Avoid robbing by keeping colonies strong.
- Minimize comb swapping between hives.
- Replace three combs in the brood chamber every year with foundation or drawn combs from honey supers.
- Disinfect bee hives or suspect frames and brood boxes at the NCDA&CS fumigation chamber using ethylene oxide.
- It is **not** recommended to preventatively treat colonies with antibiotics, as it masks AFB symptoms (increasing the spread of the disease among hives) and resistant strains of AFB may develop.

Methods of detection

- 'Ropy test.' Since larval remains of AFB-infected brood are elastic, a common field diagnostic is to pull the remains out of the cell with a toothpick or small twig. If the remains are elastic and "rope" out of the cell an inch or two, it is likely AFB rather than another brood disease.
- Holst milk test. This is a simple procedure that can be accomplished in most beekeeping operations. Place a suspect scale or smear of a diseased larva in a glass vial containing 4 ml of 1% powdered skim milk. Place the tube in a warm place (preferably at 37ºC). If AFB is present, the suspension should be clear in 10-20 minutes, since *P. larvae* spores produce proteolytic enzymes.
- Other, more sophisticated tests can be performed in the laboratory. Contact your regional NCDA&CS Apiary inspector for details.

Treatment recommendations

- Verify infestation and distinguish from other brood diseases (see Table 1 (http://content.ces.ncsu.edu/disease-management-and-guidelines-for-the-honey-bee#table1)).
- Contact your regional NCDA&CS Apiary inspector to inform them of an AFB outbreak.
- Burn all frames and euthanize bees.
- Scorch or fumigate empty brood boxes, bottom boards, inner covers, and lids.

American foulbrood disease

European Foulbrood

Cause

- The bacterium *Melissococcus pluton* and associated flora.

Symptoms (see Table 1 below (http://content.ces.ncsu.edu/disease-management-and-guidelines-for-the-honey-bee#table1))

- Brood is dull white, becoming light brown to almost black.
- Age of dead brood is usually younger, unsealed larvae.
- Consistency of remains are rubbery and granular, not elastic.

Means of prevention

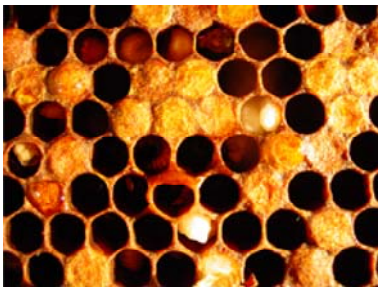
- EFB is largely a disease caused by stress. Thus maintaining a strong, healthy colony is the best prevention of the disease.

Methods of detection

- Visual inspection.

Treatment recommendations

- Verify infestation and distinguish from other brood diseases (see Table 1 (http://content.ces.ncsu.edu/disease-management-and-guidelines-for-the-honey-bee#table1)).
- For colonies with light infections, reduce the area of the brood nest, replace infected combs with foundation, and keep colony population strong.
- For colonies with heavy infections, treat with **Terramycin®** or other approved antibiotic. Feed to colonies in powdered sugar by dusting the appropriate amount on the top bars on the outside of the brood nest. Note that prophylactic use of any antibiotic is never recommended to avoid the evolution of resistance, and should only be applied as a last resort.
- For all cases, maintain a hive quarantine (i.e., do not exchange frames from or into the hive) and be vigilant for re-emergent signs of EFB.



European foulbrood

Chalkbrood

Cause

- The fungus, *Ascophera apis.*

Symptoms (see Table 1 below (http://content.ces.ncsu.edu/disease-management-and-guidelines-for-the-honey-bee#table1))

- Hardened, white or black “mummies” that resemble the consistency of chalk.
- Mummies can be located in capped or uncapped brood cells, or they may litter the bottom board or on the ground directly outside the front entrance of a hive.

Means of prevention

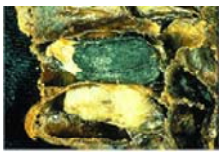
- Chalkbrood is largely a disease caused by stress. Thus maintaining a strong, healthy colony is the best prevention of the disease.
- Chilling may also increase chalkbrood, so ensure that there is an adequate adult population to keep the brood nest warm during cold weather.

Methods of detection

- Visual inspection is fairly obvious, thus the presence of mummies is usually sufficient to confirm infection.

Treatment recommendations

- There are no chemotherapies for chalkbrood. Requeening may be beneficial.



Chalkbrood

Sacbrood

Cause

- A viral pathogen of bee larvae.

Symptoms (see Table 1 below (http://content.ces.ncsu.edu/disease-management-and-guidelines-for-the-honey-bee#table1))

- Dead larvae appear watery and granular with a thick skin that forms a sac.
- The head of an infected larva is lifted toward the top of the cell, resembling the shape of a canoe.

Means of prevention

- Sacbrood is largely a disease caused by stress. Thus maintaining a strong, healthy colony is the best prevention of the disease.

Methods of detection

- Visual inspection.

Treatment recommendations

- There are no chemotherapies for sacbrood. Requeening may be beneficial, and maintaining a strong colony often the best cure for the disease.

Sacbrood

Wax Moths

Cause

- Larvae of the *Galeria mellonella* moth.

Symptoms

- Large, 1.5 inch larvae tunneling through the wax combs of weak hives or stored bee equipment.
- Silk cocoons, typically found on the side bars or top bars of frames in infested hives or equipment.

Means of prevention

- Maintain strong colonies and inspect weak colonies often.
- Cycle combs through the freezer for 1-2 days before storing.
- Place **Paramoth® crystals** on stacks of stored combs according to the label.

Methods of detection

- Visual inspection.

Treatment recommendations

- Store unused combs with PDB crystals. ***Never*** place crystals on a living colony, as the fumes are highly toxic to adult bees and brood.
- If heavy infestations are found, freeze combs for 1-2 days before reusing.

Session 6 - Diseases

Wax moths

Small Hive Beetle (SHB)

Cause

- Larvae of the beetle *Aethinda tumida.*

Symptoms

- Presence of adult beetles ***and*** eggs or larvae (presence of adults only does not necessarily indicate a problem).
- Watery, fermenting comb with small white grubs eating the wax.
- Larvae crawling out of the front entrance of the hive and burrowing into the soil.

Means of prevention

- There are no chemical products that deter SHB infestation. Researchers are currently working on a SHB lure, but the technology is not yet available for use by beekeepers.
- Beekeeping supply stores sell SHB traps that are inserted between the bottom board and brood chamber.

Methods of detection

- Visual inspection and verification of SHB larvae.
- Young wax moth larvae can sometimes be mistaken for SHB larvae. The two can be distinguished since SHB larvae have dorsal spines, whereas wax moth larvae do not.

Treatment recommendations

- If adults are present, tape ½ a strip of **Checkmite+®** beneath a square of corrugated cardboard placed on the bottom board of the hive. The beetles often seek a refuge below the cardboard and come into contact with the pesticide. NOTE: the presence of **Checkmite+®** strips for the control of varroa mites does not simultaneously confer control for SHB.
- If larvae are present and crawling out of the hive:
    - Replace infected combs with foundation, then burn them or freeze them if salvageable.
    - Apply **GuardStar®** soil drench around the perimeter of the hive to kill developing pupae in the ground around the hive.

- There are currently no in-hive chemical treatments for SHB larvae.

For additional information about SHB biology, identification, prevention, and treatment, see NCSU *Beekeeping Note* 2.05, *The Small Hive Beetle (http://content.ces.ncsu.edu/the-small-hive-beetle-a-pest-of-honey-bee-colonies)*.

Small hive beetle larvae

Symptom of dead brood	**American foulbrood**	**European foulbrood**	**Chalkbrood**	**Sacbrood**
Appearance of comb	Sealed brood is discolored and sunken, often with punctured cappings	Sealed brood is discolored and sunken, often with punctured cappings	Mummies found in sealed and unsealed brood	Scattered sealed brood with punctured cappings
Age	***Usually older sealed larvae or young pupae***	***Usually young, unsealed larvae***, but occasionally older coiled larvae	Older larvae in upright cells	Usually older sealed larvae upright in cells
Color	Dull white, becoming light brown, coffee brown, dark brown, then almost black	Dull white, becoming light brown, coffee brown, dark brown, then almost black	***Chalk white or black***	Grayish or straw-colored, becoming brown or darker
Consistency	***Soft, becoming sticky to ropy***	Watery and ***granular***; rarely sticky or ropy	Hard and rocklike	***Watery and granular; tough skin forms a sac***
Odor	Slight to pronounced odor of gym socks	Slightly sour to penetratingly sour	Slight, non-objectionable	None to slightly sour
Scale characteristics	Hard, brittle, and black. Uniformly lies flat on lower side of cell. Adheres tightly. ***Fine, threadlike tongue of dead pupae*** may be present.	Usually twisted in cell. Does not adhere to cell wall. ***Rubbery*** and black.	Does not adhere to cell wall. ***Brittle and chalky***, white to black in color.	Head prominently ***curled toward center of cell like a canoe***. Does not adhere to cell wall.

Table 2. A list of products that are currently registered for the treatment of honey bee parasites, pathogens, and pests.

Brand name	Type(s) of chemical	Varroa mites	Tracheal mites	Nosema	AFB/EFB	Wax moths	SHB
Apigaurd	Thymol, an essential oils	X	X	-	-	-	-
*Apilife VAR	Blend of essential oils, particularly thymol	X	X	-	-	-	-
Apistan	Fluvalinate, a synthetic pyrethroid	X	-	-	-	-	-
Apivar	Amitraz, a synthetic miticide	X	-	-	-	-	-
*Checkmite+	Coumaphos, an organophosphate	X	-	-	-	-	X
Fumadil-B	Fumigilin, an antibiotic	-	-	X	-	-	-
GardStar	Pemethrin, a synthetic pyrethroid	-	-	-	-	-	X
Mite-a-thol	Menthol, an essential oil	-	X	-	-	-	-
Mite-Away II	Formic acid, an organic biopesticide	X	X	-	-	-	-
Paramoth	PDB crystals, a fumigant	-	-	-	-	X	-
Sucrocide	Sucrose octanoate, a synthetic biopesticide	X	-	-	-	-	-
Terramycin	Oxy-tetracycline, an antibiotic	-	-	-	X	-	-

* - These products are registered as a Section 18 Emergency-use pesticide, and therefore require a

private applicators pesticide license to purchase and apply.

As always, use of non-approved chemical treatments is strictly prohibited, as are any applications of chemicals that do not follow the registered label.

Contact Information

North Carolina Department of Agriculture & Consumer Services, Apiary Inspection (http://www.ncagr.gov/plantindustry/plant/apiary/apiarymp.html)

North Carolina State University Apiculture Program (http://entomology.ncsu.edu/apiculture)

For more information on beekeeping, visit the Beekeeping Notes website (http://entomology.ces.ncsu.edu/apiculture/beekeeping-notes/).

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Managing Varroa Mites in Honey Bee Colonies

Introduction

The varroa mite (Varroa destructor) is the most serious pest of honey bee colonies worldwide. This parasite was first detected in North Carolina in 1990, having been introduced to the United States just three years earlier. Virtually all feral (or “wild”) honey bee colonies have all but been wiped out by these mites, and beekeepers continue to struggle with varroa infestations in their hives. In North Carolina alone, the number of managed beehives has dropped by an estimated 44 percent since the invasion of the mites. It is vital, therefore, to understand the varroa mite and the options available for its control.

Mite Biology

The mite is an external parasite which attacks both adult bees and the developing honey bee larvae. The adult mites have a flattened oval shape, are reddish-brown in color, and are about 0.06 inches wide (about the size of the head of a pin). The mated female mite enters the cell of a developing bee larva and lays up to six eggs. The developing mites feed on the pupae and, depending on the number of mites, may kill it, cause it to be deformed, or have no visible effect. While the males die in the cell, the adult daughter mites climb onto an adult worker bee and feed on its hemolymph (bee “blood”). The female mite can then repeat the cycle by entering cells of other developing larvae. Mites prefer drone larvae over worker larvae, but they will infest worker larvae and eventually kill the colony if preventative measures are not taken.

The mites can harm the bees indirectly as well. In addition to the obvious effects of mites feeding on developing and adult bees, the mites can also serve as vectors of several viruses that can kill bees. These secondary infections, facilitated by the mites compromising the bees’ immune systems, can cause a condition known as Parasitic Mite Syndrome (PMS), which can kill colonies within months of infestation.

Detection methods

Many colonies that succumb to varroa infestations will do so in the late summer or fall. It is difficult to simply inspect a colony and determine if it has a high level of mites. It is important, therefore, to sample bee hives to estimate the degree of infestation.

Sugar Shake Method. This method estimates the mite prevalence within the colony (the percentage of adult bees with mites).

1. Obtain a clear 1-pint jar or other container with a lid made from ⅛-inch hardware cloth or similar mesh material. If you can't find a jar with a mesh lid, make a mesh lid for your container.
2. Brush or shake approximately 200 adult bees from a frame with emerging brood into the jar.
3. Close the mesh lid on the jar and add 2 to 3 tablespoons of 6x powdered sugar through the lid.
4. Set the jar aside for several minutes to allow the bees (and mites) to be covered in sugar.

5. Shake the sugar (and dislodged mites) out of the jar onto clean, flat surface (preferably white). The bees, although covered in sugar, are not killed and can be returned to the colony. If 10 or more mites are found per 200 bees, then appropriate measures should be taken to control the mite population. A magnifying glass may be necessary to see the mites.

Sticky Board Method. This method estimates the total mite load of the colony (total number of mites in the hive).

1. Purchase a commercial sticky board from a beekeeping supply company, which has a pre-applied adhesive and sampling grid drawn on the surface. Alternatively, sticky boards may be constructed by placing a stiff sheet of white paper.
2. Spray the upper surface of the paper (facing the bees) with an aerosol cooking spray, or apply a thin layer of petroleum jelly to the upper surface of the paper to create a homemade sticky board.
3. Please the board or paper between two 8-mesh wire covers (with one cover on the top and one on the bottom) so that the bees do not adhere to the sticky surface.
4. Place the sticky board on the bottom floor of the hive. A portion of the mites will fall off the bees, fall through the the mesh screen and stick to the white board.
5. Remove the board 24 hours later and count the total number of mites on it. If the number of mitets is between 60 and 190 (depending on the size of the colony), then appropriate control measures shoud be taken.

Alcohol Wash Method. Similar to the sugar roll, this method requires that the beekeeper brush or shake adult bees into a clear container to measure the prevalence of varroa mites.

1. Pour 1 to 2 inches of rubbing alcohol (isopropyl alcohol) into a clear 1-pint jar or container with a solid lid.
2. Brush or shake approximately 200 adult bees from a frame with emerging brood into the container.
3. Vigorously shake the container for at least 30 seconds, and then examine the container for dead mites sinking to the bottom. If you see 10 or more mites per 200 bees, then you should treat the colony.

Drone Brood Inspection. Because of the variation in sampling, this method is not always a reliable indicator of mite levels in a colony. However, it can be used to verify the relative degree of varroa infestation.

1. Find any capped drone brood within the hive, which is typically located on the periphery of the brood nest.
2. Uncap the cells and gently remove the pupae.
3. Closely inspect the drone pupae for adult varroa mites. If 10 percent or more of the drones are infested, then you should take appropriate measures to reduce the mite population.

Current recommendations are to monitor all honey bee colonies for varroa mite infestation, preferably numerous times over the course of a season, to determine if and when treatment is necessary. It is also recommended that multiple sampling techniques are employed to make sure that an accurate measure is obtained for each hive.

Size comparison of a varroa mite.

Controlling Varroa Mites

Traditional methods for varroa mite control have been to hang plastic strips impregnated with chemical pesticides between the wax combs of bee hives (see below). Unfortunately, and perhaps inevitably, the mites are rapidly developing resistances to many of the common treatments, which has prompted researchers to develop numerous alternative methods to prevent and treat varroa mite infestations. These methods range from structural or mechanical changes to bee hives, to new stocks that are more tolerant of mites, to new bio-pesticides that are valuable alternatives to the standard synthetic treatments.

Mechanical control

Certain control methods involve changes in the management practices of beekeeping. The benefit of such mechanical control measures is that they do not use chemicals to reduce mite levels, thus they may be employed even during times when the bees are collecting and producing honey. They may, however, be more laborious or require new equipment, and they may not be as effective as other control measures.

Screened bottom boards. Research has shown some benefit of replacing the wooden bottom of a standard bee hive with a wire-mesh screen or other non-solid surface. Several studies have shown numerical decreases in mite levels of colonies using screened bottoms compared to solid bottoms. While the reasons for this decrease is unknown, it may be due to better hive ventilation or to the loss of mites inadvertently dropping through the floor of the hive. The benefits of bottom screens are minimal, however, and usually require additional methods of treatment.

Drone-brood trapping. Varroa mites prefer to infest drone brood, which are the developing pupae of male honey bees. This is because drones are larger and take longer to develop, so that female mites can produce more offspring per generation. Beekeepers may take advantage of this preference by placing special combs with drone-sized cells in their hives to attract mites to the brood. These combs can then be removed before the drones—and the mites—emerge from their cells. Depending on the time of year, this practice can dramatically reduce the mite populations within colonies.

Inert dusts. Adult mites move through the hive by clinging to the backs of adult bees. Some research has shown that covering all the adults in a colony with fine dust particles, such as powdered sugar or talc, can cause the mites to lose their grips and fall off their hosts. This technique can be laborious and quite disruptive to a colony, but it requires no chemical pesticides.

Mite-tolerant stocks

Some of the more exciting advances in varroa mite control has been in honey bee genetics. In recent years, much work has been done with the development of particular strains of honey bees that have shown tolerance to the varroa mite. Though the mechanisms are not completely understood, some behavioral and physiological traits likely play a role in varroa resistance. Today, several strains of bees are available that have been shown to reduce the number of varroa mites within their colonies.

Russian strain. Researchers at the USDA Honey Bee Research Lab in Baton Rouge, Louisiana have imported bees from the Primorsky region in far-eastern Russia because they co-exist with the original host species of varroa (the sister honey-bee species, *Apis cerana*). Because these Russian bees have been exposed to the mite for a longer period compared to other strains, it follows that they may have developed a resistance to the mite. Indeed, research has shown that they are over twice as resistant to varroa as other commercial stocks. Moreover, for reasons that are yet unclear, this stock appears to be highly resistant to the tracheal mites, a second parasitic mite that infests honey bee colonies. The Russian strain has been made available for commercial purchase in the U.S. after a protracted period in quarantine.

VSH stock. Standing for Varroa Sensitive Hygiene, this trait was selected for by USDA researchers using classical bee breeding and instrumental insemination techniques. The bees have been selected to detect varroa mites in the cells of developing pupae and remove them before the mites can reproduce. This stock has been crossed with other, more common commercial stocks in an attempt to integrate this useful trait into other bee strains.

Hygienic behavior. Many queen breeders have actively bred for colony brood-nest “cleanliness” or hygienic behavior. Much research has demonstrated lower levels of numerous diseases in colonies selectively bred to uncap and removed diseased or parasitized brood (e.g., the Minnesota Hygienic stock). While these stocks are not immune to varroa parasitism, they may significantly reduce the need for other control methods.

Bio-pesticides

Biopesticides are defined as naturally occurring organisms or their by-products, and several have been registered for controlling varroa mites in honey bee colonies. The efficacy of many biopesticides can equal to that of conventional chemical pesticides. However, the delivery of these chemicals can be quite different, and understanding these differences is important to insure successful control of varroa.

Apilife VAR®. This product—containing a combination of the essential oils thymol, eucalyptol, and menthol—has been approved by the US Environmental Protection Agency (EPA) for its use in North Carolina to treat both varroa and tracheal mites. Several studies have shown between 65% and 97% effectiveness at killing varroa mites. The delivery medium of this product is a vermiculite tablet, which must be broken into four pieces and placed in the four corners of the hive between the brood chambers. Each section must be wrapped in wire mesh to prevent the bees from chewing it and removing it from the hive prematurely. New tablets must be used every week for three weeks for complete effectiveness. The effectiveness of Apilife VAR® is temperature dependent and can only be used effectively in temperatures above 60°F and below 90°F. The product may cause significant mortality of bee brood, thus it may be most useful as a fall treatment when brood rearing naturally declines. Though Apilife VAR® is considered an organic pesticide, it is a restricted-use chemical and can only be purchased and applied by those individuals who have a valid NC Pesticide Applicators License.

Formic acid. The EPA has recently permitted the use of formic acid for the control of varroa mites in the United States. This method has been used by beekeepers in Canada and Europe for many years, and it is the only chemical pesticide that can be used for organic honey production. There are several delivery methods for formic acid, such as placing pads soaked with liquid formic acid on top of the hive (by the

trade name Mite-Away II®). The product cannot be used during a honey flow, and the daily high temperatures must be between 50°F and 79°F. If temperatures exceed 82°F during the first week of treatment, it must be removed from the hive as it may result in a significant loss of brood and adult bees. Small colonies (fewer than 6-20 frames of bees) can themselves be overwhelmed by the fumes. Care must also be taken by the beekeeper while applying formic acid, as it is highly corrosive and poisonous to humans, thus proper precautions must be taken to avoid exposure.

Chemical (Synthetic Pesticide) Treatments

Conventional means of varroa control involve synthetic pesticides being administered to a colony by placing plastic strips impregnated with the active chemical within the hive. While these treatments have traditionally provided very high levels of control, there is an increasing prevalence of resistance to these chemicals which makes them less reliable in some areas.

Apistan®. One of the first pesticides to be registered by the EPA for the control of varroa mites was Apistan®, the trade name for fluvalinate (a synthetic pyrethroid). It is sold as a plastic strip impregnated with the active pesticide, and the strips are hung between the frames of a hive just outside of the brood nest. Fluvalinate is a contact pesticide and provides up to 100% control of varroa mites when properly used. In recent years, however, there has been increasing reports of varroa mites developing resistance to this pesticide. It is highly recommended, therefore, that Apistan® be rotated with other treatments to reduce the development of resistance to chemical control by the mites and to ensure its efficacy.

Apivar®. Using the chemical amitraz, this is a relatively new product available to beekeepers for mite control. It works in much the same way as Apistan®, but the mites have not yet developed a resistance.

Checkmite+®. Largely in response to fluvalinate resistance, the EPA registered another synthetic chemical as a Section 18 emergency-use pesticide for varroa control. Checkmite+®, the trade name for coumaphos, is also sold as a plastic strip impregnated with the active pesticide that, when the bees and mites into contact with it, can provide up to 100% control when used properly. Coumaphos is a member of the organophosphate group of pesticides, and residues can accumulate in wax and be harmful to bees at high levels. Just as with Apistan®, there have been documented cases of varroa mites developing resistance to this pesticide, so it is important to use it according to label directions and to alternate its use with other approved treatments. Checkmite+® is also registered for the control of the small hive beetle (*Athena tumida*), and its sale in North Carolina is restricted to those individuals who have a valid NC Pesticide Applicators License.

Apilife VAR

Summary

1. Varroa mites are currently the greatest threat to beekeepers and their colonies, and infested colonies will probably perish if action is not taken to control mite levels. Thus, they are a significant threat to a beekeeper's income and satisfaction.
2. Monitoring hives for mite levels enable beekeepers to determine whether treatment is necessary and to make informed decisions about when to take action.
3. The exclusive and continual use of one chemical product is more likely to result in the development of resistance by the pest. Several different products should be used on a rotating basis.
4. Do NOT, under any circumstances, experiment with non-approved chemical treatments. Such practices are illegal and may result in bee death, the contamination of honey and wax, and severe harm to the beekeeper.
5. Because of the inherent risks with the use of chemical pesticides, and the fact that some of the available treatments can only be obtained by individuals with a current pesticide certification, it is recommended that all beekeepers receive training and certification through the NCDA&CS Pesticide Licensing Program.
6. For additional information or assistance, contact your local NCDA&CS bee inspector (http://www.ncagr.gov/plantindustry/plant/apiary/index.htm), your local county Cooperative Extension center (http://www.ces.ncsu.edu/local-county-center/), or the Apicultural Program at NCSU (http://entomology.ncsu.edu/apiculture).

Table 1. Management practices for varroa mites in honey beehives.

Management Method	Chemical (if applicable)	Relative Effectiveness	Degree of Manipulation	Other Pests Controlled	License Required
Screened bottom board	-	Low	Low	-	-
Drone brood trapping	-	Moderate	Moderate	-	-
Inert dusts	-	Moderate	High	-	-
Mite-tolerant stocks	-	Moderate	Low	TM‡	-
Apilife VAR®	Thymol	Moderate-High	Moderate	TM	Yes
Sucrocide®	Sucrose octanoate	Moderate-High	High	-	-
Mite-Away II®	Formic acid	High	Moderate	TM	-
Apistan®	Fluvalinate	High*	Low	-	-
CheckMite+®	Coumaphos	High*	Low	SHB	Yes

* In areas where resistance has not developed; TM = tracheal mite; SHB = small hive beetle
‡ For Russian strain only

Ths project received support from the Golden LEAF Foundation (http://www.goldenleaf.org/).

Contact Information

North Carolina Department of Agriculture & Consumer Services, Apiary Inspection (http://www.ncagr.gov/plantindustry/plant/apiary/apiarymp.html)

North Carolina State University Apiculture Program (http://entomology.ncsu.edu/apiculture)

For more information on beekeeping, visit the Beekeeping Notes website (http://entomology.ces.ncsu.edu/apiculture/beekeeping-notes/).

Oxalic Acid FAQs

WHAT IS OXALIC ACID?

Oxalic Acid is a *naturally occurring acid* found in plants. It became popular in Europe & Canada for treating Varroa Mites in a honey bee hive.

IS IT A LEGAL VARROA TREATMENT IN THE UNITES STATES?

Oxalic Acid has been approved by the EPA to treat honey bee colonies in the United States. It must pass state approval before it may legally be sold in each state. This is a continuing process and a list of states that have been approved can be found on our website.

Versions of Oxalic Acid can be found in hardware stores but those have various additives mixed with them that can cause issue with the bees. Also it is illegal to use them for hives.

WHEN IS THE BEST TIME TO USE OXALIC ACID TO TREAT?

The most effective time to treat a hive with Oxalic Acid is when a hive has little to no sealed brood. It cannot penetrate capped brood so it will have no effect on the next generation of mites that were left in capped brood. You can treat in the spring and summer but research shows that Oxalic works best in the fall/winter.

WHEN WILL MY HIVE BE BROODLESS?

The best time for a broodless hive is during late fall through the winter. You can also manipulate the hive by caging the queen for 14 days. That keeps her from laying and capping any more brood. 14 days provides enough time to treat your hive and allow the treatment residue to subside before returning the queen to lay brood.

CAN YOU TREAT IN THE SUMMER?

While some studies say you can treat honey bees in the summer, there are too many variables that can cause issues during summer treatments. Summertime is usually when the hive is full of capped brood so it could take multiple treatments to reduce all the mites concealed with the brood. *Continuous multiple treatments can affect the bees severely.*

CAN YOU TREAT DURING A HONEY FLOW?

It has not been approved for use during a honey flow. If you have honey supers on the hive you must remove them before treating and leave them off for at least 14 days to give the Oxalic Acid treatment time to be fully cleansed from the hive to avoid contamination of the honey.

HOW CAN IT BE USED TO TREAT?

There are three approved methods to treat with Oxalic Acid:

Solution Method:

Note: To completely dissolve Oxalic Acid Dihydrate, use warm syrup.

Dissolve 35g of Oxalic Acid Dihydrate in 1 liter of 1:1 sugar water (weight : volume). Smoke bees down from the top bars. With a syringe or an applicator, trickle 5 ml of this solution directly onto the bees in each occupied bee space in each brood box. The maximum does is 50ml per colony whether bees are in NUCs, single, or multiple brood chambers.

Under certain unfavorable conditions (e.g. weak colonies, unfavorable overwintering conditions), this application method may cause some bee mortality or overwintering bee loss.

A complete kit is available with all the parts you will need for Solution Method (35 grams Oxalic Acid, nitrile gloves, protective goggles, 60mm syringe, and instructions)

Session 6 - Diseases

Vaporizer Method:
Apply only to outdoor colonies with a restricted lower hive entrance. Seal all upper hive entrances and cracks with tape to avoid escape of Oxalic Acid vapor. Smoke bees up from the bottom board. Place 1g Oxalic Acid Dihydrate powder into vaporizer. Follow the vaporizer manufacturer's directions for use. Insert the vaporizer apparatus through the bottom entrance. Apply heat until all Oxalic Acid has sublimated.

Spraying Package Method:
Ensure bees are clustered before applying.
Spray broodless package with 1:1 sugar water solution (without Oxalic Acid mixed) at least 2 hours before spraying with Oxalic. This fills their stomachs to reduce ingestion of Oxalic Solution.
Mix 1:1 ratio sugar water with 35 grams of Oxalic Acid (same ratio as Solution Method). For a 2 lb package, use 21mL of solution. For a 3 lb package use 31mL solution.
Store bees in a cool darkened room for 72 hours before hiving.

HOW MANY HIVES CAN OXALIC ACID TREAT?

**All totals calculated from dosage amounts listed in treatment methods above.*
Solution Method: 20 hives
Vaporizer Method: 35 hives
Spraying Package Method: 47 2lb packages & 30 3lb packages

WHAT SAFETY MEASURES SHOULD I TAKE WHEN USING OXALIC ACID?

***DO NOT* let Oxalic Acid make contact with skin, eyes, or be ingested.** Wear proper personal protective equipment (rubber gloves, safety goggles, long sleeve shirt) when mixing or distributing Oxalic Acid. If exposure to skin or eyes does occur consult directions and safety sheet for instructions. If severe reaction occurs, call 911. Wash hands, exposed skin, and PPE directly after treatment to avoid contamination.

HOW EFFECTIVE IS OXALIC ACID?

The effectiveness of Oxalic Acid treatment can be in excess of 95%, but solution method have a higher efficacy.

HOW MANY TIMES SHOULD I TREAT MY HIVE?

You will only want to treat your hive ONCE during the fall/winter. Honey bees have a low tolerance to Oxalic Acid. Overexposure can cause issues and death in the hive.

As with any other treatment, some bee mortality may occur, especially if hive is already weak. **Check your mite count and strength of hive before applying any treatment.** If you are uncertain of hive's strength, you can get a second opinion by asking a local beekeeper or your local bee inspector.

CAN I USE OXALIC ACID WITH OTHER MEDICATIONS?

Since it is a naturally occurring chemical, it can be used in conjunction with other non-varroa treatments. DO NOT mix directly with other chemicals while treating.

Session 6 - Diseases

HOW DO YOU STORE OXALIC ACID?

Dried, unmixed Oxalic Acid should be kept in a cool dry place will not expire.
Mixed solution can last up to a week at room temperature and a few months if kept in the fridge.

IF THE SOLUTION STARTS TO TURN TAN/BROWN OR SMELL FUNNY DISCARD IMMEDIATELY. DISCOLORATION MEANS AN ALTERNATE CHEMICAL [HYDROXYMETHYLFURFURAL] IS FORMING AND IS TOXIC TO BEES. DISCOLORATION CAN BE CAUSED BY LONG EXPOSURE TO THE SUN.

*Some information gathered from Randy Oliver's "Oxalic Acid: Questions, Answers, and More Questions: Part 1 of 2 Parts"; http://scientificbeekeeping.com/oxalic-acid-questions-answers-and-more-questions-part-1-of-2-parts/

Posted by Brushy Mountain Bee Farm at 11:34 AM

The Small Hive Beetle: A Pest of Honey Bee Colonies

Introduction

The small hive beetle, *Aethina tumida*, was first detected in the United States in 1996 near Charleston, South Carolina. In the spring of 1998 in Fort Pierce, Florida, a scientist with the Florida Department of Agriculture and Consumer Services positively identified this beetle as the small hive beetle (SHB), a destructive pest of honey bee colonies. Prior to its detection in the United States, the only recorded sightings of this insect occurred in the southern regions of Africa.

During the summer of 1998, the beetle was blamed for the loss of more than 20,000 honey bee colonies in Florida. The beetles spread quickly. That same year, beekeepers and inspectors also reported occurrences in Georgia, South Carolina, and North Carolina. Since 1998, the small hive beetle has become established in most counties in North Carolina as well as across most of the United States. This demonstrates its remarkable ability to disperse by flight and human transport.

Description

Adults

An adult small hive beetle is 5 to 7 millimeters long and brown to black in color (Figure 1A). The SHB is a member of the beetle family Nitidulidae and, therefore, has the club-shaped antennae that are common within this family. For instance, the picnic beetle, which is often mistaken for the SHB, has similar antennae. Other distinguishing characteristics include a shield-shaped thorax and broad, flattened legs. Adult beetles tend to hide on the bottom of the hive or just under the inner cover, and they scatter quickly once the hive is opened. This behavior can make them difficult to locate. Therefore, they may go unnoticed at low levels of infestation.

Larvae

SHB larvae are small, white, worm-like, and approximately 10 to 12 millimeters long (Figure 1B). The larvae appear similar to wax moth larvae, but SHB larvae are distinguished by their dorsal spines.

Life Cycle

As long as a colony of bees remains strong, adult SHBs are not generally destructive and may live in the hive as adults in large numbers for long periods of time without causing problems. If a colony becomes stressed or weakened, however, the beetles will take advantage of this opportunity and begin to lay

eggs. Within 24 hours, these eggs hatch into very small larvae that begin to feed immediately. The larvae feed on the honey and pollen stores, as well as on the developing brood. In doing so, they tunnel through the comb and cause stored honey to run out, creating a sticky mess that, in extreme cases, causes the adult honey bees to abandon the hive.

Under ideal conditions, SHB larvae feed for 7 to 10 days. Then they leave the hive, crawl on the ground to a suitable location, dig into the soil, and pupate. Pupation takes three to five weeks (or longer during cooler temperatures), after which the new adults emerge from the soil and seek out a beehive to start the cycle all over again. The new adult beetles can survive a winter within the cluster of bees inside the hive.

Figure 1A. Adult beetle.

Figure 1B. SHB larvae in hive debris.

Impact and Future Outlook

When the SHB was first detected in North Carolina, the NC Department of Agriculture & Consumer Services (NCDA&CS) set up a quarantine with the goal of minimizing its spread and possibly eradicating it. The quarantine was lifted in July 2003 because the beetle had successfully established itself across the state and thus eradication was no longer an option. Although entomologists originally believed that SHBs could survive only in sandy soil and warm climates, the beetles have demonstrated that they can survive in just about any kind of soil. They can also survive extreme winter conditions.

The arrival of SHBs means that beekeepers must make some changes in the methods they use. When they first encountered the destructive potential of this honey bee pest, many beekeepers thought that the outlook for the whole industry was grim. But when beekeepers make a few adaptations to their beekeeping practices, the outlook for the industry does not appear as alarming.

Figure 2. Adult small hive beetles (circled) crawling on the surface of a comb inside a beehive.

Prevention

In the past, some of the more severe problems caused by SHB infestations occurred in the honey house where supers had been stacked and were waiting to be extracted. Beekeepers must take preventive measures to ensure healthy colonies and thus minimize hive infestations by SHBs. The following precautions should be taken to keep these beetles from infesting bee colonies:

- When colonies die for any reason, remove the equipment from the yard immediately and store it properly before beetles infest it.
- Extract honey from supers immediately after removing the supers from the colony.
- Keep the honey house clean.

These are some other recommendations that should be followed to help prevent invasions and infestations of the small hive beetle into your bee yard:

- Do not throw burr comb on the ground around the hives. It is better to collect all excess wax in a bucket and remove it from the yard.
- Minimize the amount of time inspecting colonies, as the beetles easily detect the bees' alarm pheromone. This makes the beetles scatter and hide.

- Remove excess supers from the colony, as frames with few or no adult bees make good hiding places for beetles.
- If larvae are found on the bottom board, do not brush them off onto the ground. Doing so will only lead to more adult beetles in a few weeks. Any larvae found should be removed from the colony and killed by either freezing them for 24 hours or placing them in a closed container with soapy water.

Treatment

Inside the hive

For controlling the SHB inside the beehive, coumophos is the only registered chemical pesticide available. This product (sold under the trade name of CheckMite+) is formulated as plastic strips impregnated with the pesticide. The strips are cut in half and attached to a small piece of cardboard placed on the bottom board of the hive. The beetles will hide beneath the cardboard and contact the pesticide, which kills them. In North Carolina, CheckMite+ is a restricted-use pesticide. Thus, you must have a pesticide applicator's license to purchase and use it. Coumophos is an organophosphate that can be very dangerous to humans and honey bees if misused. It is important to read the label and follow the directions carefully. These precautions are especially important:

- Honey supers must be removed prior to treatment.
- If honey is produced while a hive is being treated, the honey cannot be sold or used for human consumption.

A nonchemical means of inside-the-hive control is the West small hive beetle trap. This is a two-piece plastic trap that sits on the existing bottom board. The top piece has small holes, and the bottom is filled with vegetable oil. As the beetles enter and move throughout the hive, the bees tend to chase them, causing the beetles to look for a hiding spot. The beetles try to escape the harassment of the bees by exiting through the holes of the trap. Then they fall into the oil and drown.

Outside the hive

Another product, GuardStar, is available for control outside the hive if larvae are observed crawling out of a hive entrance. GuardStar is a liquid treatment that is mixed with water and applied to the ground around the hive to kill the beetles pupating in the soil. The active ingredient is permethrin, a synthetic pesticide that is highly toxic to honey bees. Therefore, this product should be applied with great caution.

At this writing in early 2006, there are still many unknowns about this beetle, such as their mating cues and the signals they use to locate a hive. Researchers are working to decipher these cues to SHB behavior, which may lead to better control measures in the future, such as lures and bait traps.

If you think you have small hive beetles in your hives, you should contact your regional NCDA&CS apiary inspector before you begin treatment. Once the presence of the beetles has been verified, treatments may be used as needed. But neither CheckMite+ nor GuardStar should be used as a preventive measure.

Figure 3. A comparison of an adult SHB and a SHB larva.

For More Information

For more information, contact the following:

Honey Bee Inspection Program Office (http://www.ncagr.gov/plantindustry/plant/apiary/index.htm)
NC Department of Agriculture & Consumer Services
Telephone: 919-233-8214

Honey Bee Program Research Facility (http://www.cals.ncsu.edu/entomology/apiculture/)
NC State University
Telephone: 919-513-7702

For more information on beekeeping, visit the Beekeeping Notes website (http://entomology.ces.ncsu.edu/apiculture/beekeeping-notes/).

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