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Honey Bee Diseases and Pests

A COMPANION TO

Beekeeping in Northern Climates

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2016

Honey Bee Diseases and Pests

2016

By

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To the Reader:

This booklet contains up-to-date information on controlling diseases, parasitic mites and other pests of honey bees. It is extremely important for beekeepers to keep abreast of all the latest information on new bee diseases and pests and how best to control them. It is the responsibility of every beekeeper to maintain healthy bees and to keep hive products free of chemical residues. Please follow these pages carefully.

If you are reading a PDF version of this manual. Please help support our effort to make this information available by contributing at;

www.beelab.umn.edu/giving

10-20-15

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Our Philosophy

In this manual, we advocate using as few chemical treatments as possible in bee colonies to control diseases and parasitic mites for the following reasons:

- Bees should not be dependent on our treatments for their survival. Bees can develop natural resistance to disease and mites through careful selection and breeding.
- Antibiotics and pesticides can contaminate honey, beeswax and other hive products.
- Diseases and mites can develop resistance to antibiotics and some pesticides through prolonged use, rendering treatments ineffective.
- Combinations of chemical compounds can lead to potentially toxic effects on bees, in the same way that combinations of drugs used for human health can have synergistic and negative side effects.

Knowledge, Prevention, Control

Our strategy for keeping bees healthy and reducing chemical treatments follows three deliberate steps: Knowledge, Prevention and Control. We want all beekeepers to be educated about the diseases and pests that bees face, and to use the best beekeeping management practices to control them.

1. Knowledge:

Learn about bee diseases and mite pests.

Be able to recognize **clinical symptoms** of diseases and understand the **life cycle** of mites.

2. Prevention:

Implement **sound** beekeeping **practices** to avoid getting and spreading diseases and mites.

Sample your colonies for diseases and mites to know the degree of infection or infestation.

Bee self-defense! Use stocks of bees that demonstrate some resistance to diseases and mites.

3. Control:

Use cultural **/** mechanical / non-chemical control techniques to reduce transmission if your bees have diseases or mites.

Last resort: Use chemical treatments only when absolutely necessary and according to the label.

For more information on controlling diseases and pests, we encourage you to visit the national **Bee Health website:**

www.extension.org/bee_health

Resistant Bees

Currently, bees are being bred in the U.S. that are resistant to American foulbrood (AFB) and chalkbrood diseases, and demonstrate some resistance to the parasitic mite, *Varroa destructor* (the varroa mite). We encourage you to try these different lines of bees.

Bees bred for **hygienic behavior** demonstrate good resistance to AFB and chalkbrood and partial resistance to varroa mites. We bred the **MN Hygienic line** at the University of Minnesota. Now, other **Hygienic** stocks are available through commercial beekeepers and queen bee producers. These bees will require periodic treatments for varroa, but may not require treatments for AFB or chalkbrood.

Bees bred by Drs. John Harbo and Jeff Harris at the USDA Bee Research lab in Baton Rouge for **Varroa Sensitive Hygiene (VSH)** have very good resistance to varroa, but they have not been tested for disease resistance. They are best used as hybrids, when VSH queens are mated to local drones.

Russian bees, imported from Russia by the USDA Bee Research Lab in Baton Rouge, have demonstrated resistance to varroa mites.

Resistance Management

For many years beekeepers have applied treatments of oxytetracycline (an antibiotic, trade name Terramycin® or TM) to prevent and treat the highly infectious and devastating disease, American Foulbrood (AFB). In most cases, TM is no longer effective in treating AFB because the bacterium that causes AFB has developed resistance to the antibiotic. This problem has forced us to think of resistance management strategies that do not involve the use of antibiotics. Please read and follow the section in this booklet on prevention and control of AFB carefully.

Also, in recent years, varroa mites have developed resistance to two pesticides used inside colonies to control varroa mites: fluvalinate (a synthetic pyrethroid, trade name Apistan®) and coumaphos (an organophosphate, trade name CheckMite+®). Apistan® was used very successfully for 10 years to control varroa. When it became ineffective, CheckMite+® was given Section 18 (temporary-emergency) registration for use in many states. Coumaphos has a different mode of action than fluvalinate, so it kills mites that are resistant to fluvalinate. However, the mites very quickly developed resistance to coumaphos rendering it ineffective. Colonies throughout the U.S. still contain high amounts of both fluvalinate and coumaphos residues in the wax, even though most beekeepers no longer use these treatments. It is uncertain as to the health risk this chemical contaminant poses to bees. **Do not use Apistan® or CheckMite® in bee colonies any longer.**

It is very important to employ resistance management strategies in our treatment of bees to avoid allowing the mites to develop resistance to the treatments, and to avoid contaminating beeswax!

To control varroa mites, the best resistant strategy is to use **Integrated Pest Management**. The idea of IPM is that beekeepers sample their colonies regularly for varroa mites (spring through fall). When the number of mites exceeds a threshold range, the beekeeper must decide what kind of treatment is appropriate and rotate among treatments so that mites don't develop resistance to them. It is very important that beekeepers do not just assume their colonies have or do not have mites!

All beekeepers must learn to sample their colonies to know how serious the mite infestation is in each colony, and then must learn to make the best treatment decision.

At times, mite levels may not appear to be high enough to initiate treatment, but the colonies should be monitored closely because varroa mite levels can increase dramatically in just a few weeks in late summer and fall. Beekeepers should opt

to use a treatment that the mites cannot develop resistance to, such as formic acid or formulations containing thymol (a botanical oil). In all situations, the beekeeper should sample the mite levels after treatment to ensure the treatment was effective. If mites are still found on adult bees at high levels, especially in October, a late-season treatment, such as oxalic acid, will have to be used. See page 16 for more information on varroa.

Final Note

It is the responsibility of every beekeeper to be able to recognize symptoms of disease and to know how to sample colonies for mites and other bee pests. It is very important to maintain healthy bee colonies for pollination and honey production. Please subscribe to one of the beekeeping trade journals, and/or join a beekeeping association to keep informed of the latest developments. When in doubt, ask national and state beekeeping extension, research and regulatory personnel a lot of questions. It is their job to help you find correct answers.

COMB REPLACEMENT

Beeswax and Pesticides

The properties of beeswax are such that it absorbs many chemicals, such as pesticides. Residues of over 170 different pesticide compounds have been detected in wax combs of colonies throughout the U.S. The pesticides include insecticides, fungicides and herbicides used in agricultural and urban environments. These residues come from pollen that bees collect on flowers wherever they forage, and are absorbed into the wax combs when bees store the pollen in the colony. Other residues in wax and pollen include some of the pesticides beekeepers use to control mites, in particular Apistan® and CheckMite+®. It is important to avoid using these treatments (for additional reasons, see page 3). Good beekeepers will avoid having pesticides in the colony when honey supers are placed on the colony, and will not extract honey from the brood chamber where pesticides were applied. In the brood nest, observant beekeepers may notice some cells that are sealed off with a layer of propolis (plant resins) by the bees. Under the propolis seal is pollen that is contaminated with pesticides, called entombed pollen. Brood combs with entombed pollen should be culled and replaced.

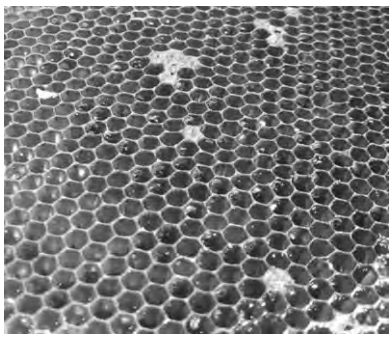

Figure 1.
Old comb with AFB "scale" hardened and stuck to lower edge of comb. Comb is upside down in photo to expose lower part of cells.

Beeswax and Disease

Old combs may also harbor disease spores, such as American foulbrood (AFB), chalkbrood, and *Nosema*. American foulbrood spores remain viable in combs indefinitely. Many beekeepers have had the unfortunate experience of purchasing used equipment from a beekeeper, or hiving a new package of bees in used equipment, and having the bees die from AFB. Experienced beekeepers will be able to spot combs containing AFB scales (Figure 1) and should burn contaminated combs and equipment.

Old Combs

Old combs accumulate cast off cocoons and larval feces causing the cells in the combs to become shallower and smaller in diameter. Larvae that develop in old combs with smaller cells emerge slightly smaller than they do in new combs with normal size cells. It is not necessarily true that bigger bees produce more honey and smaller bees less honey, so having smaller cells is not as damaging to a bee colony as the preceding two problems. Some people claim that smaller cells prevent varroa mites from reproducing successfully. This claim is **NOT** substantiated by research.

Replace Your Old Combs

- Traditionally, beekeepers do not replace combs because it is costly to replace the foundation, and it is energetically costly for the bees to draw out new comb. Some beekeepers have combs that are over 30 years old. It is now time to reconsider this old practice. It is essential for beekeepers to prevent pesticides from contaminating wax and honey. It is critical for the survival of the beekeeping industry to maintain pure, wholesome products.
- In Europe, many beekeepers insist on replacing up to 1/2 of the combs in each of their colonies every year. However, this practice may not be feasible for many beekeepers.
- **We recommend that every beekeeper replace all brood combs at least every 3 years.**
- If you follow the Horizontal 2-Queen method described in the companion manual, *Beekeeping in Northern Climates*, replacing combs will not be a problem, especially during the spring when divides are made. You can easily replace combs in empty equipment at your leisure during the winter.
- To help recognize old combs from new combs, consider using a system to track them. The date of first use can be put on the top bars by scratching, burning, paint, thumbtacks, magic marker, or other method.

DISEASES

A responsibility of every beekeeper, and one of the principles of productive beekeeping, is to keep all colonies in a "disease-free" condition.

American Foulbrood (AFB)

American foulbrood (AFB) is the most damaging brood disease. It is highly contagious among bee colonies (not to humans). Although it is not commonly observed in colonies, if left unchecked it will cause colony death. More over, AFB can spread to neighboring colonies within 3-5 miles, causing their demise. It is extremely important to be able to identify and control this disease if found.

American foulbrood is caused by the bacterium, *Paenibacillus larvae.* The bacteria infect young larvae, which die after the cells are capped. Infected pre-pupae turn brown, gooey and smelly, and sink to the bottom of the cell (Figure 2). The dead brood then dries into a characteristic hard scale on the bottom of the cell. The colony will eventually die from disease, but the infectious scales remain in combs and honey taken from diseased colonies.

Symptoms:

- Discolored sealed brood (pre-pupae), which when stirred with a toothpick, will "string-out" like glue when the toothpick is withdrawn slowly from the cell ("ropiness" test, Figure 3).
- Characteristic foul odor.
- In advanced cases, the cappings over the older brood are perforated with one or more small holes, are sunken, and have a greasy appearance. The brood pattern will be very scattered.

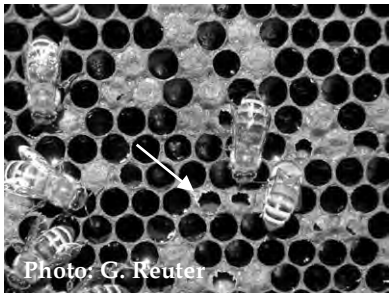

Figure 2.
AFB kills sealed brood. Symptoms include brood cells with perforated cappings and brown, gooey, smelly dead brood inside.

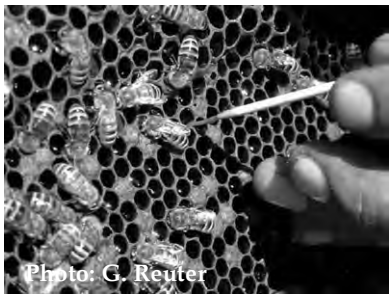

Figure 3.
The “ropiness” test to determine if brood has AFB

Prevention:

- Maintain strong colonies with young, prolific queens, and inspect brood regularly.
- Replace old combs regularly (see page 5). Old brood combs contain the disease spores, the source of AFB infection. The most effective way to eliminate AFB spores is to eliminate the infected combs by burning them.
- Use caution when buying used equipment, exchanging brood combs between colonies, and feeding bees honey from an unknown source. Do not move frames from a diseased colony to a healthy colony. Do not feed extracted honey from a diseased colony or from an unknown source to bees at any time.
- Some bees have a genetic predisposition for disease resistance. Colonies bred for **hygienic behavior** are able to detect, uncap and remove diseased brood from the nest before the disease reaches the infectious stage. Hygienic bees have a natural behavioral defense against AFB and may never show symptoms of the disease. It is important when purchasing queens bred for hygienic behavior to ask if the queens mated predominately with drones from surrounding hygienic colonies. This will ensure that the queen's colony (her worker bees) will have the genetic ability to quickly uncap and remove diseased brood.

Treatment:

- If symptoms of AFB are found, the following steps should be taken:
- **Shake, Requeen and Burn.**
  1. **Shake** all the bees off the infected comb and hive them into brand new equipment with frames containing only foundation (no drawn comb).
  2. Introduce a queen bred for hygienic behavior into the colony. The queen should remain caged for 3 days.

3. Isolate the colony well away from the infection source, and feed them light sugar syrup (1:1) to encourage them to draw out new comb. The bees will have no larvae to feed for at least 6 days; feeding them syrup during that time allows the disease spores to be passed out of the bees' digestive systems.
4. Burn all frames, combs, honey and brood from the original diseased colony. If you want to reuse the bottom boards, top boards and supers, they must be scorched with a torch. To do this, all interior surfaces must be heated until charred black.
5. If it is too late in the season to salvage the bees, you may need to burn them also. This seems drastic but it is the most responsible way to eliminate the spread of this infectious, highly devastating and antibiotic-resistant disease. **NEVER** leave diseased equipment out where other bees can rob from it.

- **We do not recommend that beekeepers use antibiotics in their** bee colonies **to** treat AFB**.** It is better to shake, requeen and burn.
- **Be aware that the antibiotics kill only the actively growing bacteria. They do not kill the spores. These spores remain in the comb and boxes, and are a source for re-infection when the antibiotic is stopped. Replace and burn all combs that had any signs of AFB.**
- If you do use an antibiotic you must use only antibiotics registered for use in bee colonies, and follow the labeled instructions precisely. Use the correct dosage, timing and method of application. Treat colonies only during non-honey flow periods to avoid contaminating honey. If you treat during a honey flow, remove all supers while treating and wait 30 days after stopping treatment to put supers back on the colony.

We strongly recommend AGAINST giving colonies routine, preventative (prophylactic) treatments of antibiotics!

IMPORTANT: All antibiotic treatments must be completed or removed at least 30 days before any honey supers are put on the colony to prevent the antibiotic from getting into the honey for human consumption.

European Foulbrood (EFB)

It used to be that European foulbrood (EFB) rarely killed a colony. Currently, a new type of EFB seems to be spreading through the U.S. that can severely weaken, if not kill, a colony. EFB is caused primarily by the bacterium, *Melissococcus pluton*, but it is usually associated with other, secondary bacteria. Symptoms appear during times of "stress," e.g. colony build-up, and poor weather and resource conditions. Unlike AFB, the larvae usually die **before** the cells are capped. Most of the time the symptoms of EFB will disappear without treatment when a good honey flow begins.

Symptoms:

- Discolored, boat-shaped larvae (first yellow then brown). Larvae die before they are sealed (Figure 4). A toothpick inserted into dead larvae will not be “ropy” like AFB.
- Characteristic sour odor (which is different from foul odor of American foulbrood).

Prevention:

- Make sure bees are well fed. Provide sugar syrup in early spring before the honey flow begins.
- Bees bred for hygienic behavior do not demonstrate resistance to EFB. The reasons are still unclear.

Treatment: Last Resort

- Feed bees light sugar syrup (1:1) for 2-3 weeks to simulate a honey flow. If symptoms do not disappear, you may try one to three rounds of treatment with antibiotic, Terramycin® (oxytetracycline), mixed and administered according to the following information. Read and follow the instructions on the label.
- Formulation for powdered sugar application: Mix one 6.4-ounce package of TM25 with 2 pounds powdered sugar. If the mixture is fed at a rate of 3 rounded tablespoons per colony, each colony will receive 250-335 milligrams of oxytetracycline per dose.

There is no evidence that EFB is resistant to Terramycin® at this time. Tylosin® is not registered for the treatment of EFB**.**

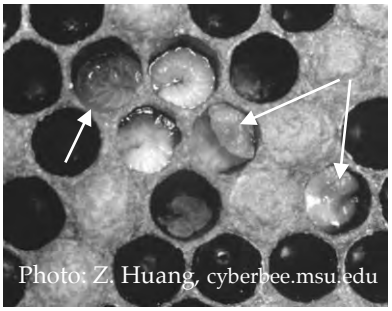

Figure 4.
An EFB infection kills larvae before they are sealed. The dead larvae do not become ropy.

We strongly recommend AGAINST giving colonies routine, preventative (prophylactic) treatments of antibiotics!

IMPORTANT: All antibiotic treatments must be completed or removed at least 30 days before any honey supers are put on the colony to prevent the antibiotic from getting into the honey for human consumption.

Chalkbrood

Chalkbrood rarely kills a colony, but a severe infection can significantly weaken a colony. Chalkbrood is caused by the fungus, *Ascosphaera apis.* Symptoms appear during times of "stress." Infected larvae become "mummified" by the fungus and die under a capped cell. If this disease appears, it is usually only temporary, and will clear up after a good honey flow.

Symptoms:

- Infected pre-pupae turn into white or black mummies under sealed cells (Figures 5 and 6).
- Mummies may be found in the cells, or if the bees have removed them, they may be found on the bottom board or outside the entrance of the colony.

Prevention:

- Maintain strong colonies with young, prolific queens and inspect brood regularly.
- Replace old combs regularly (see page 5). Old brood combs contain the source of infection, the disease spores. The most effective way to eliminate the spores is to eliminate the infected combs.
- Use caution when buying used equipment, exchanging brood combs between colonies and when feeding bees honey from an unknown source. Do not move frames from a diseased colony to a healthy colony. Do not feed bees honey that may have come from a diseased colony.
- Bees bred for **hygienic behavior** demonstrate good resistance to chalkbrood. These bees detect and remove chalkbrood from the nest before it reaches the infectious stage, preventing the spread of the disease.

Treatment:

- **No registered chemical treatment is available. Antibiotics will not be effective against chalkbrood.**

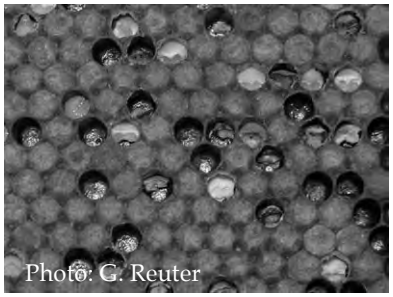

Figure 5.
Chalkbrood kills sealed brood. Symptoms include brood cells with perforated or opened capping with hard white or black "mummies" inside.

Figure 6.
Close-up of chalkbrood mummies.

Nosema

Nosema is a fungal disease affecting the adult bees. *Nosema* is a single-celled microsporidian (fungal microorganisms) that lives in the gut of bees. The spore stage of this disease is passed in the bees' feces. Infected bees may defecate within the hive, and the nest cleaning behavior of the bees spreads the disease. *Nosema* can cause problems during winter months when bees are confined within the hive for long periods.

In the past 10 years, a new species of *Nosema* was detected in bees around the world. This new species, called *Nosema* ceranae, has almost entirely displaced the old species, *Nosema* apis, throughout the U.S. Researchers are currently trying to understand the symptoms and problems associated with *Nosema ceranae*.

We know that *Nosema ceranae* infection levels naturally rise and fall in a beehive over the year. Levels are highest from April through June, then drop naturally until late fall when they begin to rise again through winter.

Symptoms:

- No readily observed symptoms.
- Severe infection may lead to problems with the queen, colony dwindling, increased winter loss and reduced honey production.

Prevention:

- Maintain strong colonies with young, prolific queens.
- Replace old combs regularly (see page 5). Old brood combs contain the source of infection, the disease spores. The most effective way to eliminate the spores is to eliminate the infected combs.
- Learn how to diagnose your own bees. Diagnosis will require a compound microscope with magnification up to 400X and a hemacytometer (blood cell counter). See the poster on our website: www.BeeLab.umn.edu on the free-bees page..

Treatment:

- **WE DO NOT RECOMMEND TREATING COLONIES FOR NOSEMA DISEASE.** Research is showing that Fumagilin, the medication sold to treat *Nosema*, can exacerbate the disease, especially if used improperly. We are strongly opposed to the unnecessary use of Fumagilin in bee colonies.
- We urge beekeepers to stay informed about this, and all diseases, through beekeeping associations and beekeeping trade journals.

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For instructional posters on testing for diseases and pests, see the Free-bees section on our website.

BeeLab.umn.edu

Viruses

Bees have a number of viruses that can range from benign to highly detrimental. These viruses are present in most bees at low levels. Some common viruses include:

- Deformed Wing Virus
- Black Queen Cell Virus
- Acute Bee Paralysis Virus
- Israeli Acute Paralysis Virus
- Sacbrood Virus

When the varroa mite (see section on Mites) feeds on the blood of an adult bee or developing pupa, it can pick up a bee virus and transfer the virus to another bee upon the mite's next feeding. In this way, viruses are spread among bees in the colony, and viral levels can increase to levels that affect bee health.

Figure 7.
Close up of bee with deformed wing virus (DWV)

Symptoms

- Only one virus, Deformed Wing Virus (DWV) has symptoms observable in adult bees. A newly emerged bee that is infected with DWV will have shriveled, deformed and unusable wings. The bee will die within 3 days after emergence (Figure 7).
- Other viruses, such as Sacbrood and Black Queen Cell virus have observable symptoms in brood.

Prevention

- The best strategy is to keep varroa mite levels low so there are fewer mites to spread the viruses.

Treatment

- Currently there are no treatments for viruses.
- For good information on viruses, visit the Bee Health eXtension website, and click the link on viruses: **www.extension.org**

10-20-15

Sampling Colonies for *Varroa destructor*

An extremely important tool for gaining control of Varroa mites!

University of Minnesota Instructional Poster #174, Katie Lee, Gary S. Reuter, and Marla Spivak Department of Entomology
www.BeeLab.umn.edu

WHY SAMPLE in a standard way?

- •Be informed: know thy enemy
- •Decrease use of miticides
- •Reduce chemical residues in hive
- •Save time and money
- •Develop regional treatment thresholds
- •Breed queens from colonies with low mites

1. **Sampling a Colony:** Sample 300 adult bees from one frame containing brood (eggs, larvae or pupae).

2. 300 bees occupy a volume of 0.42 cup or 100 ml. Be careful! Bees are small, so small changes in volume leads to large changes in the number of bees (i.e. 0.33 cup = 200 bees, and 0.5 cup = 400 bees).

3. To make your own cup, add 0.42 cups or 100 ml of water to a cup. Mark a line at the water. 0.42 cups = 1/3 cup + 1 tbsp +1 1/14 tsp .

4. Use one of 3 methods to collect bees: Method 1: Rap a brood frame into a wash-bin bucket. Use your cup to scoop out 300 bees. Rap cup on a hard surface to be sure the bees are at the marked line. Add or subtract bees as needed.

5. Method 2: If your cup is rectangular, run the cup gently down the backs of the bees, causing them to tumble into the cup. Rap the cup on a hard surface to be sure the volume of bees is at the marked line.

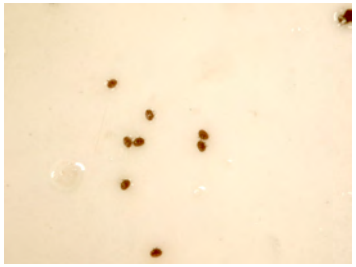
6. Method 3: Use the divice called "Gizmo" to sample. It is available from the Walter T Kelly Beekeeping Company or you can build it using the plans online (www.BeeLab.umn.edu).

7. Gizmo has a volume built in to measure 300 bees. Out of the three methods, Gizmo is most accurate, but the other two methods can work as well if the bees are consistantly at the marked line.

8. Once the bees are measured, you can use powdered sugar to dislodge the mites. First, dump the 300 bees into a jar with a size 8 hardware mesh cover.

9. Add about 2 Tbsp (one hive tool scoop) of powdered sugar. Add more sugar if the bees are not coated in white**. Let the bees set for at least one minute in the shade**. Don't hurry this!

10. Shake the jar into a white dish for one minute to dislodge mites from bees. Shake HARD. It is important to remove as many mites as possible. Replace the sugar-coated bees bees in the colony where they will be cleaned.



11. Add enough water to the dish to dissolve the sugar. Count the mites. This is **mites per 300 bees**. The mites will be regular-shaped reddish-brown ovals. You can sometimes see their legs kicking.

12. **Sampling an Apiary**: Sample a total of eight colonies using using one of the methods described above. Sample every fifth colony – loop back if need be.

- The standard number for mites in the colony is the number mites per 100 adult bees (# mites/100 adult bees).
- If you know how many bees were in your sample, you can calculate the number of mites per 100 bees.
- If you sample 300 bees, you just divide by 3. For example, if there are 12 mites in your sample, then there are 4 mites per 100 bees.
- For other amounts of bees in the sample use this formula.

$$\text{\# mites/100 adult bees} = \frac{\text{\# of mites in the sample}}{\text{\# of bees in the sample}} \times 100$$

- For treatment options go to **BeeLab.umn.edu**

Figure 1. AFB – American Foulbrood scale see page 5

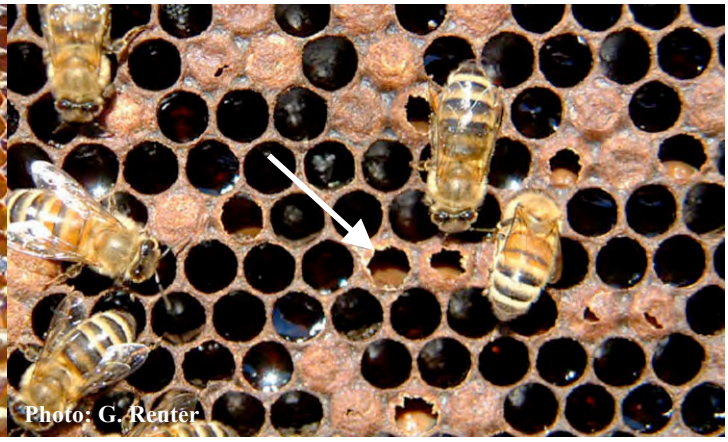


Figure 2. AFB – American Foulbrood active see page 7

Figure 3. AFB – American Foulbrood "ropy" see page 7

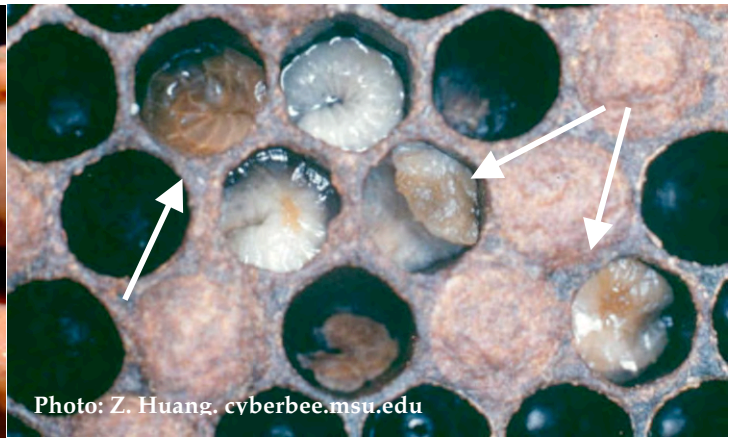


Figure 4. EFB – European Foulbrood see page 10

Figure 5. Chalkbrood see page 11

Figure 6. Chalkbrood see page 11

Figure 7. DWV deformed wing virus see page 14

Figure 8. Tracheal mites see page 15

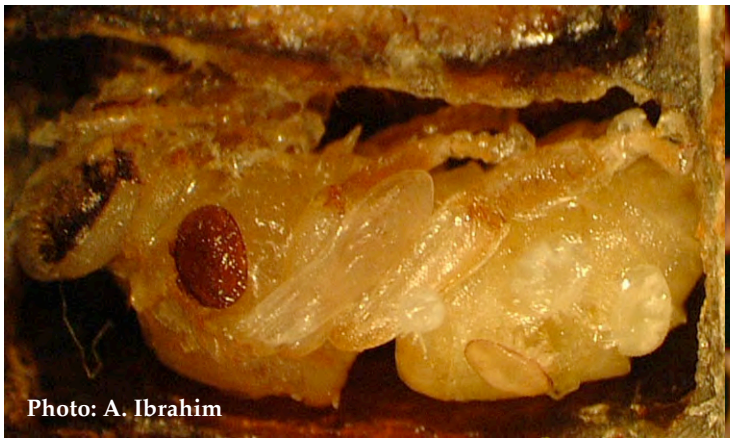


Figure 9. Varroa mite see page 16

Figure 10. Varroa mite see page 16

Figure 11. Varroa mite powder sugar test see page 20

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Figure 15. Wax moth see page 32

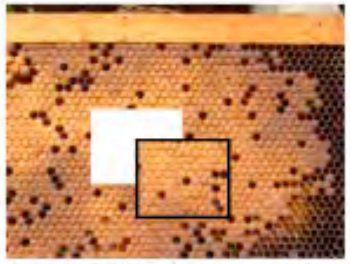
Figure 16. Bear Fence see page 34

Testing for Hygienic Behavior

University of Minnesota Instructional Poster #162, Gary S. Reuter and Marla Spivak, Department of Entomology
www.extension.umn.edu/honeybees

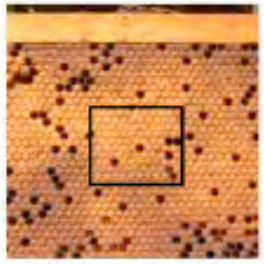
1. Hygienic behavior is a genetic trait of honey bees. It is the main defense against American foulbrood and chalkbrood, and is one defense against varroa mites.Testing for this trait is simple. It involves freezing a section of sealed pupae and recording how many dead pupae the bees remove within 24 hurs.

2. There are two methods to perform this test. One is the freezer-killed brood test (FKB). The other is the liquid nitrogen-killed brood test (LNKB). With either method use 3 - 10 day old pupae (just pupating to light tan color).



3. **For the FKB test:** Cut out a section of sealed brood containing about 100 cells on each side that contain the correct age pupae.

4. **FKB** - Freeze the section of brood in a freezer at least -10° F for 24-48 hours.



5. **FKB** - Count and record the nu sealed cells in the section. Put section back in frame and retur to the colony. Hold the section edges; do not damage the cell Skip to step 10.

6. **For the LNKB test:** Make a 3"diameter tube to pour the liquid nitrogen directly on the comb. You can use metal vent pipe or PVC plumbing pipe. If you use PVC it helps to route a "v" into the bottom edge. Obtain a supply of liquid nitrogen from a gas supply (welding or medical) or a veterinarian.

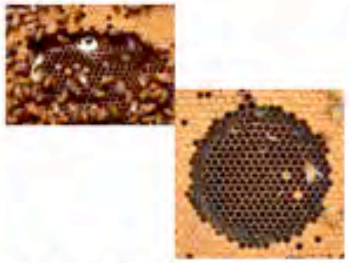
7. **LNKB** - Find a section of sealed brood of the proper age pupae and place the tube over it. Press the tube down to the midrib of the comb with a twisting motion until it seals.

8. **LNKB** - Start with a 10 oz.(400ml) cup of liquid nitrogen. Pour about 1/4" of the liquid nitrogen in the tube. When it evaporates pour the rest of the liquid nitrogen in the tube.

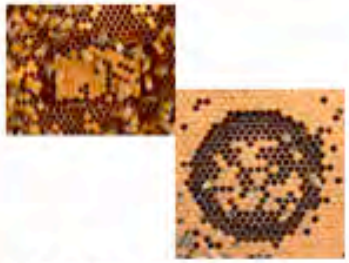
9. **LNKB** - Wait for the liquid nitrogen to evaporate and the tube to thaw before trying to remove it. Count and record the number of sealed cells in the tube.

10. **Both Tests:** Put a tack or sor mark on the top of the frame easier to find when you return frame to the colony within the and wait 24 hours to check th

11. **Both Tests:** After 24 hours return to the colony and remove the frame with the frozen brood and evaluate the results.



12. **Both Tests:** Count the cells with dead pupae that are still not cleaned out. The colony is hygienic if it completely removed at least 95% of the frozen pupae within 24 hours.



13. **Both Tests:** These are examples of tests where the bees are not hygienic. They did not remove the dead pupae from very many cells.

14. If you want to breed bees for hygienic behavior, it is very important to first select colonies with desirable traits, such as high honey production, gentleness, good wintering ability and queen longevity. Test only the best of these colonies for hygienic behavior.

15. A good hygienic queen will not with >50% drones from other h colonies for her colony to be hy That is, over 50% of the worke colony need to have hygienic both the queen and drones for colony to be hygienic!

MITES

Tracheal Mites

Tracheal mites (*Acarapis woodi*) are microscopic mites that live and reproduce inside the tracheal (breathing) tubes of adult honey bees and feed on bee blood. High infestation levels of mites in bees used to cause serious damage to bee colonies, especially during the winter months, but honey bees in most of the U.S. have developed natural resistance to these mites. We have not had serious infestations of tracheal mites in colonies in Minnesota for many years, so we encourage beekeepers not to worry about them.

Symptoms and Diagnosis:

- No readily observed physical symptoms.
- The bees from colonies that die in fall or winter from tracheal mites are found in piles in front of the entrance. Ample honey remains in the colony after the colony dies. Currently in Minnesota, most colony deaths with these symptoms are due to varroa mites, not tracheal mites.
- For accurate diagnosis, collect a sample of 25-50 bees from each colony or 100-200 bees from each apiary for laboratory examination. Collect bees of foraging age from frames at the outer ends. Dissect Individual bees and observe the tracheal tubes for mite infestation. You can learn how to dissect your own bees, or contact your local beekeeping association for help.

Figure 8.
Tracheal mites in breathing tubes (trachea) of a bee, viewed through a microscope (100-200X).

Prevention:

- Maintain strong colonies with young, prolific queens.

Bees have developed natural resistance to tracheal mites and survive well with low tracheal mite infestations. We recommend that beekeepers in northern climates do not treat, as most colonies will not require treatment.

Varroa Mites

Varroa mites (*Varroa destructor*) are the most serious problem for honey bees, and are the leading cause of colony death over the winter. It is very important that you keep track of, and control, mite levels in your colony to keep your colony alive.

Varroa mites are visible with the unaided eye. These mites infest and feed on the blood of both adult and immature stages of bees. An adult mite enters the cell containing an older larva and is sealed within the cell when the workers cap it over with wax. The mite then lays eggs (the first egg will be a male, the rest will be females), which mature and mate within the sealed cell. Usually 1-2 mated daughter mites, along with the mother mite, leave the cell when the bee emerges as an adult. When infestation levels are high, the mites cause extreme damage and death to honey bee colonies.

When a colony is dying from mites, symptoms may include being able to see mites on adult bees, spotty brood patterns, numerous uncapped cells and pupae being removed from cells. At advanced stages of infestation, the adult population dwindles and larvae are abandoned and die and decompose. Some call this larval death parasitic mite syndrome.

The mites may transmit bee viruses from pupa to pupa during feeding, which may be the main reason for colony death. Some bees may tolerate continued low infestation levels, and some stocks may have mechanisms of defense against mites, which gives them a level of resistance to this pest.

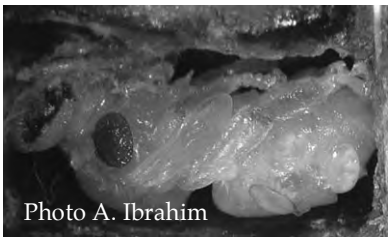


Figure 9.
Varroa mites on a bee pupa (cell wall was removed for the photo).

Figure 10.
Varroa mites on thorax of adult bees.

Symptoms and Diagnosis:

- Mature varroa mites are reddish brown and can be readily observed on white drone and worker pupae. With a trained eye, they also can be observed on the thorax or between the abdominal segments on adult bees and on the bottom board of the colony.
- Emerging bees that were parasitized may be deformed, weakened and have suppressed immune systems and shorter life spans.

- It is easy to sample a colony to determine the level of varroa mites. See the instructions on the following pages and color poster.

Prevention:

- Purchase or rear queens from lines of bees bred for resistance to the mites. We define "resistance" as the ability of a colony to live with mite infestation without treatment for a longer period of time than unselected lines of bees. In other words, it will take more time for resistant bees to require treatment compared to unselected lines. The lines bred for resistance may still require treatments but at less frequent intervals.
- Currently, the Russian line of bees and bees bred for VSH and hygienic behavior demonstrate resistance to the varroa mite.

Sample your colonies for mites in early spring through fall. If large numbers are found, consider using one of the treatments below (page 22).

Economic Thresholds of Varroa Mites

An economic threshold (or action threshold) is defined as the number of mites that should trigger management action to prevent damage to the colony and economic loss for the beekeeper. This threshold is relatively easy to determine for insect pests in a crop, but very difficult to determine for mites in a bee colony.

When there are many colonies within 3-5 miles of each other, such as in many cities, or a commercial beekeeping operation, the threshold is lower due to movement of mites on robbing and drifting bees among colonies (horizontal transmission). When colonies are relatively isolated (i.e., there are no other colonies within 3-5 miles), the threshold may be higher. Highly infested colonies often produce large honey crops before they collapse from mite infestation in the fall.

The following thresholds are guidelines based on our experience in Minnesota. If colonies have above 2-3 mites per 100 adult bees in May, mite levels usually become very high (e.g., over 10 mites per 100 bees) by late summer as the colony grows and mite populations increase. This increase in mites is especially evident in areas where there are many beekeepers such as in cities, or where there are many commercial beekeeping apiaries. It is wise to treat colonies with over 2-3 mites per 100 adult bees in May before the honey flow.

If colonies have over 4-5 mites per 100 adult bees in late August or early September, it is critical to treat them to reduce transmission of mites to other colonies and to help reduce colony death during late fall and winter. It is very important to do a final mite sample toward the end of October when there is no brood in the colony to determine if the treatment was effective, or to ensure mite levels did not rise due to horizontal transmission.

How do you determine if your colony has 4-5 mites per 100 bees?

Sampling for Mites

- We strongly urge all beekeepers to monitor mite levels in all colonies at a minimum in early May, in late August or early September, and again in October.
- Our research has found that you can obtain a reliable estimate of the number of mites in the colony by dislodging the mites from a sample of 300 adult bees collected from a frame of brood in the brood nest (not from a honey super). Sampling fewer than 300 bees does not give a good estimate of the mite level.
- There are various ways to collect 300 bees from a brood frame. Refer to the **Instructional Poster on Center Plate**.
- **We recommend the "Powdered Sugar Roll" method to dislodge mites from bees.**

- Collect 300 bees in a container with a screened lid, as shown in the Instructional Poster. Generously coat the bees with powdered sugar and let the coated bees sit for at least one minute. Then vigorously shake the mites through the screened lid into a white container for one minute. Add water to the white container to dissolve the sugar, which will allow you to better see the mites to count them.
- Divide the total number of mites by 3 to obtain number of mites per 100 bees.
- **If you find 12 mites on 300 adult bees, divide 12/3 = 4 mites per 100 adult bees. This will tell you that the colony level infestation is 4 mites per 100 adult bees.**
- Our Bee Squad program at the University of Minnesota Bee Lab has developed a Varroa Mite Testing Kit that has everything you need for the powdered sugar roll test method put together in an easy-to-carry bucket. These kits are available at bee suppliers. A list of suppliers can be found on the Bee Squad website (www.BeeSquad.umn.edu).
- We also developed a mite sampling "Gizmo" to help you collect 300 bees (sold by Walter T. Kelley Co.) or you can make your own Gizmo from instructions on our website. Alternatively, you can use a 100 ml measuring cup, which will hold approximately 300 bees. We recommend using a square scoop, such as one that is sold to hold juice boxes. Mark 100 ml on the inside with a permanent marker. Run the scoop down the comb so the bees fall into the cup (rather than trying to scoop them upward into the cup). Sharply rap the bees so they settle at the 100 ml mark. You can verify you are collecting about 300 bees by freezing a couple samples long enough so they are not moving, and counting the chilled bees.
- The following are the two best methods to dislodge mites from a sample of adult bees.

1. Powdered Sugar

This sampling method was developed at the University of Nebraska. It has the advantage of not killing the bees. A canning jar with a two-piece lid is used to collect the sample. Before the sample is collected, prepare the jar by making a screen from #8 mesh hardware cloth the size of the center of the lid. Retain the metal ring that comes with the two-piece lid, and discard the center portion. Put the ring with the 8-mesh screen over the jar containing the sample of bees. Add 2-3 Tablespoons of powdered sugar to the jar through the screen to thoroughly coat the bees (Figure 11). Roll the jar sideways to distribute the sugar on the bees. **Allow the jar to sit for a minimum of one minute – this is very important**. Do not put jar in the sun. Then invert the jar and shake **vigorously** over a white container to recover the mites. The bees will remain in the jar, and the mites and sugar will pass through the screen to the white container. With this method, you can dislodge from 90- 95% of the mites from the adults. See more details on the center poster.

Figure 11.
Powdered sugar method for sampling varroa showing the sugar being put into jar.

2. Alcohol Wash

This is the most accurate method, but it kills the sample of bees. Collect the sample of bees in a jar already filled with alcohol (rubbing alcohol or blue windshield washer fluid is fine for this). The following can be done immediately or brought home to do later. The alcohol from the sample jar can be strained through a 1/8" screen into a white bowl. Shake the screened bees in the alcohol to dislodge the mites into the alcohol (Figure 12). This method will recover 95-100% of the mites on the adult bees. If you count the number of bees in the sample, you can determine the percent infestation of mites on adult bees.

Figure 12.
Alcohol wash showing screen full of bees.

Sampling for Mites Using a Sticky Board

This method of sampling for mites involves placing a "sticky board" (for example, cardboard coated with Vaseline) on the bottom board of a colony under a screened bottom board. Monitoring the number of mites that naturally fall and adhere to the board over 3 days. The mites that adhere to the board may be alive or dead at the time they fall. The sticky boards are good for general monitoring, but not good for quantifying how many mites are in a colony. There is no accurate way to relate the number of mites on a sticky board to mite infestation in the colony (i.e., mites per 100 adult bees). **We strongly urge beekeepers to sample mites using powdered sugar or an alcohol wash so there is a common basis for comparison of mite levels.**

Treatment Decision Examples:

- If you sample for mites on adult bees in early May and find a colony level infestation of 2-3 mites per 100 adult bees it is wise to treat now, without treating at this time, mite levels will increase rapidly through the summer, causing colonies to die in late summer or early fall. Sample again in late summer to determine if you need to treat your colony immediately after honey is harvested (late August).
- If you sample for mites in late August or early September, when there is still a lot of sealed brood remaining in the colony, and find 4-5 mites per 100 adult bees, we strongly recommend you treat your colony. It is best to treat as early in September as possible.
- Sample your colony 2-3 weeks after treatment to ensure the treatment worked. Do not allow your colonies to become a source of mites for healthy colonies within 2-3 miles from you.
- If you keep records of mite levels in spring through fall every year, you will be able to determine your own treatment thresholds specific to your area and management style.

Treatment:

- **If you choose not to treat your colony for varroa mites when mite levels are over 4-5/100 adult bees in late summer, there is a very high probability your colony will die over the winter.**
- **There are effective organic treatments on the market that are based on natural, rather than synthetic compounds.**
- **It is very, very important to sample for mites 2-3 weeks AFTER treatment to ensure the treatment was effective. If it was not, you may need to use a different product. It is every beekeeper's responsibility** to not allow your **colonies to become a source of mites to healthy colonies located 2-3 miles from you.**

Following is a list of treatment options with varying efficacies and degrees of difficulty of application.

There are some management practices that will provide some control of varroa mites. These will not solve the mite problem but can help delay the need for chemical control.

- **Screened Bottom Board.** Mites drop naturally off of adult bees and from the combs during the course of the day. Normally, they can crawl back onto the bees and return to the brood nest. If you use a screened bottom board (commercially available), the mites drop through the screen and land on the bottom board beneath it. However, the mites cannot return to the brood nest because the space (at least ¾") between the bottom board and the screen is too great for them to cross. This method is not very effective alone, but you can eliminate 10-20% of the mites by using screened bottom boards.

- **Drone Brood Removal.** Varroa mites prefer to reproduce on drone pupae because the development time of drones is longer than workers allowing the mites to produce more offspring on drone pupae. This management practice relies on providing bees extra drone comb and removing the drone brood containing mites from the colony before it emerges.

  1. To do drone brood removal, provide a colony with a comb of commercially-purchased drone foundation or an empty frame with no comb or foundation. The bees tend to build drone comb on empty frames. Watch your colony carefully, and when the bees have sealed the majority of drone brood on that frame, remove it and freeze it to kill the mites. After freezing for 36 hours, you can put the frame back in the colony and the bees will remove the dead drones and start again. **Be sure to remove the drone brood BEFORE the drones emerge or you will be propagating mites rather than controlling them.**
  2. This method is very labor intensive, but can remove a substantial number of mites during the summer. The efficacy will depend on how diligently you remove drone brood.

Thymol (Oil of Thyme) Apiguard®

- Thymol is a botanical oil. One thymol product registered for use is **Apiguard®**. This product contains thymol formulated in a slow release gel. The most effective range of ambient temperatures for proper vaporization of Apiguard® is 60-80°F (max 105°F).
- You will need to close any screened bottom boards and upper entrances during treatment. Peel back the cover of the Apiguard® container and place it upright on top of the frames in the top box (there should be no supers on the colony).* Put a ring (1.5" high) or an empty box on top, then replace the cover of the colony. The ring provides needed space above the container for effective delivery of the Apiguard®. After 2 weeks put a second treatment on the same way. If any gel remains in the first treatment, leave the container in the colony, otherwise remove the empty container. Leave the second container on for 4 weeks (total 6 week treatment time).
- **Label requirement:** Remove Apiguard® from the hive prior to putting on honey supers to prevent contamination of the honey.
- This treatment is not labor intensive, but efficacy will depend on ambient temperature and the continuous, complete volatilization of the product over the treatment period. It is important to sample colonies after treatment to determine how effective the treatment was.

* See label for instructions on use of bulk containers.

CAUTION:
When using these chemicals, caution must be taken to prevent harm to the beekeeper. At a minimum, wear pesticide resistant gloves and stay upwind to eliminate breathing in vapors. Wash gloves and then hands thoroughly with soap and water after application.

Thymol (Oil of Thyme) ApiLife VAR®

- Thymol is a botanical oil. This thymol product, registered for use, is **ApiLife VAR®**. This product contains thymol and minor proportions of menthol, eucalyptol and camphor. In our experience, it is not as effective as ApiGuard®. This product is formulated as an evaporating tablet. The most effective range of ambient temperatures for proper vaporization of ApiLife VAR® is 59-69°F.
- Take one tablet from a bag and break it into 4 pieces. Place pieces on the top bars of the top brood box, in the corners of the brood nest (not necessarily the corners of the box). Avoid placing pieces directly above the brood nest. After 7-10 days, replace with a fresh tablet broken into pieces as above. Repeat procedure again, 7-10 days later (3 treatments total). Leave the last tablet on for 12 days and then remove any residual product from the colony.
- **Label requirement:** Remove ApiLife VAR® tablets from the hive at least 30 days prior to harvesting honey to prevent contamination of the honey.
- This treatment is not labor intensive, but efficacy will depend on ambient temperature and the continuous, complete volatilization of the product over the 21-30 days of treatment. It is important to sample colonies after treatment to determine how effective the treatment was in controlling the mites.

CAUTION:
When using these chemicals, caution must be taken to prevent harm to the beekeeper. At a minimum, wear pesticide resistant gloves and stay upwind to eliminate breathing in vapors. Wash gloves and then hands thoroughly with soap and water after application.

Formic Acid

- A new formulation, called Mite-Away Quick Strips®, is now registered for use. Formic acid is an organic acid, and is considered an organic treatment. We are finding this to be a very effective treatment when used correctly.
- See **www.miteaway.com** and the label for complete instructions, and for storage and disposal instructions.
- *Formic acid is corrosive. Wear protective gear according to the instructions on the label.* You will notice that the bees react strongly to the formic acid for several days, and it may cause queen loss and some brood damage.
- Daytime ambient temperatures during the treatment period must be between 50-85 °F. Colonies will require adequate access to fresh air during treatment; so keep the bottom hive entrance, and any additional holes fully open. Remove the Quick Strips from the clear pouch, separate them, leaving paper wrap intact. Place two strips across the top bars of the frame over the bottom box so they lay flat and across the full width of the hive body, with approximately 2 inches between the strips and 4 inches between the ends of the brood chamber. Follow the instructions on the label for placement of the strips. Do not disturb the colony for 7 days. Check for mite levels 1-2 weeks after treatment, and allow one month between applications.

CAUTIONS:
When using these chemicals caution must be taken to prevent dangers to the beekeeper. As a minimum, wear pesticide resistant gloves and stay upwind to eliminate breathing in vapors. Wash gloves and then hands thoroughly with soap and water after application.

Oxalic Acid

- Although recently approved by the EPA, oxalic acid, an organic treatment, has been used to control mites in colonies since 2010 in Canada and for more than 20 years in Europe.
- Oxalic acid treatment has a low risk of hive product contamination and mite kill can be over 90%. Oxalic acid is applied in a liquid (trickle method described here) or by vaporization. Neither application method will kill mites in sealed brood.

- Oxalic acid should be used when the colonies have little or no brood in order to be most effective. It is most effective to use it when bees are loosely clustered and should be applied when temperatures are between 30-55 °F. Depending on weather conditions after treatment, it might be difficult to test mite levels after an oxalic acid treatment.
- Using a scale to measure the oxalic acid, prepare a solution by dissolving 35 grams of oxalic acid dihydrate (minimum 97% purity crystals) in 1 liter of lukewarm sugar syrup (light syrup which is 1:1 solution). Make sure the entire 35 grams is mixed it. It takes a lot of stirring for it to mix well. Mix only the amount you will use in one day. Dispose of any leftover at the end of the day. Mix new solution each day.
- Smoke the bees down prior to application. Use a syringe or other applicator to apply the solution directly to the bees in between the frames. Five milliliters (ml) should be trickled in between each frame on the bees for a total of 30 ml in a five frame nucleus, 40 ml in a single deep colony or 50 ml (maximum dose per colony) in a two or three deep colony. If you miss and place the solution on top of the frames, the bees will not remove it and your treatment will not be as effective.
- Only apply oxalic acid once a year if needed. It can be an effective part of a varroa management program, but overuse could harm bees. Do not treat weak or starving colonies. Do not treat when honey supers are in place.
- Protective gear should be worn per label guidelines.
- For instructions for the vaporization method, consult with the manufacturers of the devices.
- For instructions on treating colonies, read the Oxalic acid label.

Hopguard®

- Hopguard® (Potassium salt of Hop Beta Acids) is derived from hops. Please note that this product will NOT be effective if used while there is sealed brood in the nest, so it is best applied in late September or early October. More than one treatment may be necessary. We have not tried this treatment at the University of Minnesota and do not know how well it works in our 3-deep colonies.
- You must wear chemical-resistant gloves when handling the strips.
- Place two strips for every ten brood combs. For our 3-deep system, place two strips in the bottom brood box and two more in the second box, but NONE in the 3rd box, which is mostly honey. Folded strips must be opened and hung over a center brood frame, with one half of the strip on each side of the frame. Apply the second strip about 4 inches away from the first, keeping both toward the center of the box. Check mite levels and retreat if needed.

Apivar®

- Another new synthetic miticide was recently registered for use in bee hives: **Apivar® (Amitraz plus inert ingredients)** N'- (2,4-demethylphenyl), N- [[(2,4-dimethylphenyl) imino] methyl]- Nmethylmethanimidamide. It is not an organic product, and it is likely that mites will develop resistance to this product, as they did to Apistan® and CheckMite+®. We do not recommend this treatment for use by backyard beekeepers.
- You must wear chemical resistant gloves. It can be fatal if absorbed through the skin.
- Follow label and use 2 strips per brood chamber, hanging strips over the combs so that bees can walk on and contact the strips. After 14 days remove the strips. All strips must be removed at least 2 weeks before a honey flow.

DO NOT USE Apistan® or CheckMite+®

- These synthetic miticides are no longer effective in treating mites, and their long-term use from 1990-2005 has left residues in wax combs throughout the U.S and other countries. Avoid them.

Keep informed about the current research on mite control and current treatment decisions by reading the bee journals and attending beekeeping meetings!!

ALWAYS sample colonies after treatment to be sure the treatment was effective.

PESTS

Small Hive Beetles

The small hive beetle (*Aethina tumida* Murray, Coleoptera: Nitidulidae) is a relatively new pest to the Western Hemisphere. It was first identified in June of 1998 in Florida, but it was previously known only in sub-Saharan Africa. This is a new pest, so stay up to date on current information for detection and treatments.

Adult female beetles lay eggs near or on combs within colonies, and the larvae tunnel through wax combs eating mostly pollen, but also honey, bee eggs and larvae. They can cause considerable damage to new combs. The beetles defecate in the honey, causing it to ferment, froth and stink like rotten oranges. To complete their development, the larvae must crawl out of the colony and enter the soil to pupate. The larvae prefer to burrow in sandy soil. It is thought that the larvae have a difficult time entering denser or clay soils, which may be one saving grace in northern climates. The larvae look a bit like wax moth larvae, except that wax moth larva have legs (technically, prolegs) that run the length of the body and beetle larvae have only three sets of legs just behind the head. You may need to put your glasses on to see larval legs! If the larvae are successful in burrowing in the ground, they will pupate and emerge as adults in 3-4 weeks. The adult beetles are good flyers and can fly long distances to detect and infest bee colonies.

Figure 13.
Mug shot of small hive beetles next to a honey bee.

Symptoms and Diagnosis

- The adult beetles are about ¼“ long and reddish-dark brown to black in color. Unless you are good at detecting fine differences among beetles, it looks like many other small dark beetles, some of which have been found for years scavenging around in the debris on bottom boards without causing damage. With very close examination you will see the “clubbed” antennae.

- To find the adult beetles in your colonies, look for them scurrying across combs trying to hide when you first open the colony. They may be found in dark places under inner covers or on bottom boards. The beetles hide under corrugated cardboard, so you can find them by removing the paper side from a square of cardboard and stapling it, ridged side down, on the bottom board. The beetles walk over sticky materials without a problem, so don't expect to find them on sticky boards.

Prevention and Control

- Maintain strong colonies with young prolific, queens.
- Hive beetles are not a significant problem for bees in northern climates, such as Minnesota, despite the reintroduction of beetles every year from the South where the beetles do cause damage. Migratory beekeepers that move their bees into northern states, and that have been dealing with hive beetles for several years, say that the beetles can find and destroy weak colonies. However, the beetles do not seem to cause a problem in strong colonies.
- By using common sense and no chemicals, there are several things beekeepers can do to keep the small hive beetles in check. Do not bring honey supers that have brood, and therefore beetles, into the extracting facility. Use queen excluders to keep the brood separate from the honey. Keep the honey house and extracting equipment clean, and extract honey right away after harvesting it. Dr. Jeff Pettis at the USDA Bee Research Lab in Beltsville recommends circulating air across stored honey prior to extraction to lower the humidity under 50%, which prevents beetle eggs from hatching into larvae. The humidity in the extracting room can be lowered with a dehumidifier or air-conditioner. Beetle larvae are attracted to fluorescent lights and can be trapped there overnight in the honey house and then destroyed. If you are a migratory beekeeper moving colonies from locations where the beetles are prevalent, take precautions to not store equipment from those locations in northern climates, unless you fumigate the equipment.

Figure 14.
Close shot of small hive beetle. Note "clubbed" antennae.

- Mostly, do what you can to not let the beetles multiply and spread to new locations. This includes being vigilant in the honey house and maintaining strong colonies. A single colony that dies and has brood and pollen can produce thousands of small hive beetles, so collect dead colonies when they are found in the field. As much as possible, combine weak colonies and avoid apiaries with sandy or loosely compacted soil.

Wax Moths

The larvae of the greater wax moth (*Galleria mellonella*) and the lesser wax moth (*Achroia grisella*) ingest and form tunnels in wax comb, leaving loose layers of silk material and fecal pellets. If left unchecked, they will eventually destroy the comb, causing severe economic damage. To pupate, the larvae spin tough, white silk cocoons in wooden boxes and frames. The adult moths infest and lay eggs in cracks within weakened bee colonies and stored equipment.

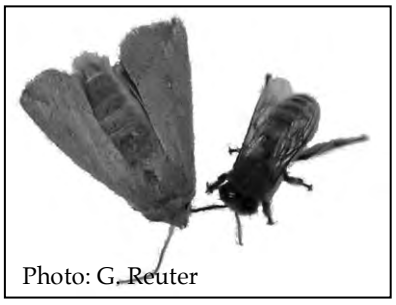


Figure 15.
Mug shot of greater wax moth next to a honey bee.

Prevention and Control

- Maintain strong, disease-free colonies with young, prolific queens. Clean wax and debris from bottom boards periodically.
- Every year, be sure to place all stored equipment onto colonies during the summer.
- Store unused combs in cold (unheated) buildings during the winter.
- Place 1-Tablespoon para-dichlorobenzene (PARA-MOTH®) crystals on a piece of paper every fourth or fifth stored super in a stack, beginning at floor level and on the top bars of the top box. Seal cracks and holes in the equipment to contain the PDB vapor. Air out combs at least 24 hours before placing the treated combs on bees.

Mice

Mice will readily move into stored hive equipment and outdoor wintered hives. They feed on pollen, honey and dead bees, and may destroy large numbers of frames and combs while building their nests.

Prevention and Control

- Reduce colony entrance to ⅜” - ½” in early fall and through winter so mice cannot enter. Do this with a ⅜” entrance reducer or ½" hardware cloth.
- Seal up cracks in stored equipment and store boxes on queen excluders, closed bottom boards, or pallets to prevent mice from entering.

Skunks

Skunks are very attracted to apiaries where they will scratch on the outside of the hive. When the guard bees come out to attack them, the skunks grab the bees with their paws and eat them. A single skunk can eat a large number of bees. A skunk can seriously weaken the colony's population. The colony tends to be mean when skunks have bothered them. Tell-tale signs are scratches on the front of the hive and bottom board, as well as grass that appears raked in front of the hive.

Prevention and Control

- Erect an electric fence around the apiary with the lower wire 3" from the ground. If possible run the electric wire directly in front of the bottom board.
- Nail a piece of carpet strip (piece of wood with a bunch of nails sticking up) onto the bottom board in front of the entrance. When the skunk scratches the strip it will get discouraged by the sharp pain.

Bears

Bears are very attracted to apiaries and will smash bee equipment to get at brood and honey. Bears return repeatedly to an apiary, often destroying the entire apiary. Once a bear begins feeding on the colonies, measures to get rid of them are ineffective. The only solution is to move the remaining colonies to avoid further damage.

Prevention and Control

- Erect an electric fence around the apiary **before** bear damage occurs. The fence should have three to four strands and be continuously charged with at least 7,000 volts. Fence maintenance is very important. Weeds and grass must be mowed or sprayed to prevent them from touching the fence and shorting it out. The voltage on the fence should be tested on each visit to the apiary. The fence line should be marked (with flags).
- In Minnesota, contact the Regional Department of Natural Resources in Brainerd (218) 828-2615 for more information on control measures. In other states, contact your state or county Department of Natural Resources.

Figure 16.
Electric fence around an apiary.