HONEY BEES

CORNELL COOPERATIVE EXTENSION

Identification and Control of American Foulbrood in Honey Bees

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American foulbrood (AFB) is an insidious, worldwide bacterial disease that infects honey bee larvae, which then die in the pupal stage. The chief problem with this disease is that the bacterium may remain alive in the spore or resting stage for 50 years or more.

AFB almost invariably results in the death of the colony, which in some ways is a strange way for a parasite to treat its host. Most parasites infect or infest but do not kill, because the death of the host denies them a place to live. Because of the long-lived spore, however, the bacterium has greater long-range success by arising from the dead, so to speak, to strike again. The long-lived spore, which is largely resistant to changes in the weather, poses a challenge to the beekeeper.

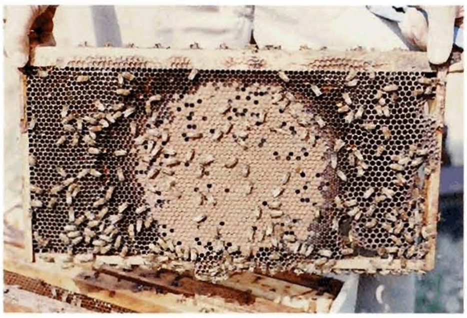
Know Healthy Brood

Brood is the composite name given to the three development stages—eggs, larvae, and pupae—in the brood nest of a honey bee colony. Complete development of a worker bee in the bee-controlled environment of a hive takes 21 days. Drones develop in 24 days and queens in 16. In a normal colony, brood of the same age is found next to brood of a like age, as the queen lays eggs in ever-expanding concentric circles.

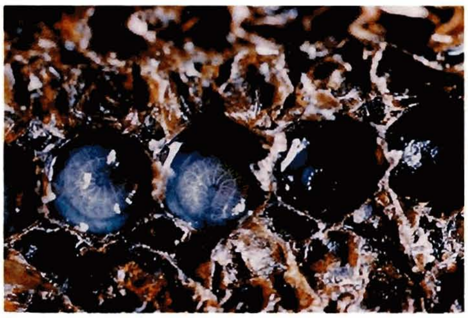
Healthy eggs and larvae have a pure, glistening white appearance. Of the three development stages, only the larvae feed, and it is during feeding that they may take in the AFB spores and become infected.

Sources of Infection

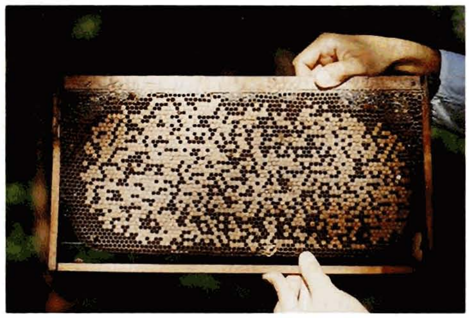
The most common source of an American foulbrood infection is healthy bees robbing honey from a mankept or feral colony that has died from the disease. Though most bees forage no farther than two miles from the hive, some bees may forage over an area five to six miles or more in diameter, so tracking down a source of infection is difficult. It is helpful to keep in touch with neighboring beekeepers to make certain they are watching their colonies for disease.



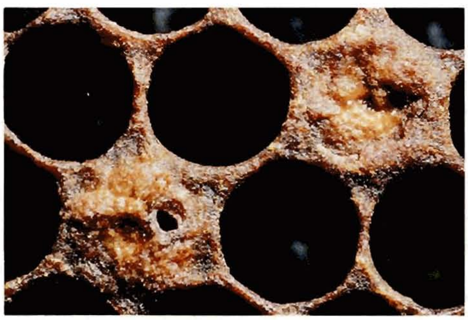
1. A healthy brood pattern. Pupae lie next to pupae and larvae are all around the outside, because the queen lays eggs in expanding concentric circles. Note the good color and convex shape of the cappings over the pupae.

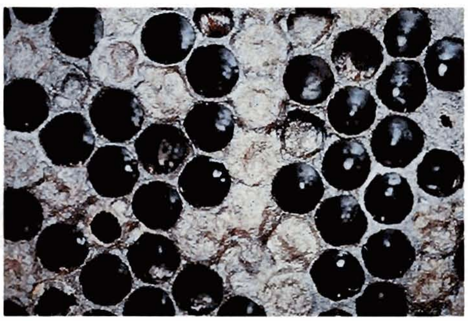


2. Healthy larvae are a glistening white. Those of a similar age are found close to each other.

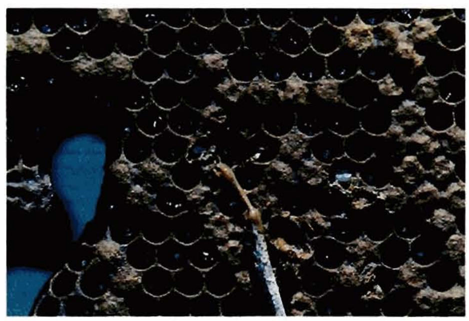


3. A spotty brood pattern indicating a weakness or disease. The queen has not laid eggs in a compact manner.





4–5. Brood dead from American foulbrood. The cell cappings are dark and sunken; some are perforated.



6. A larvae dead from American fouldbrood. The brown, ropy consistency of the dead larvae is typical of those that die from this disease.

Discarded honey, perhaps exposed in a dump, or old, stored equipment are other possible sources of disease spores. Beekeepers may accidentally spread spores from one colony to another with contaminated hive tools or unwashed hands. Some disease is probably spread by drifting bees that accidentally enter a hive not their own. Beekeepers should give their colonies at least three careful checks for AFB each year. Hive tools, smokers, and hands should be washed carefully after finding and handling frames from an infected colony.

Control

For many decades, our chief means of combating AFB has been to search out and destroy (burn) the brood combs in infected hives. Wood that is more than 3/4 inch thick can be scorched and reused. This method, in conjunction with the efforts of a strong force of state apiary inspectors, has kept disease levels low. Less money is available for apiary inspection today, however, as other government programs have taken precedent, and beekeepers are increasingly forced to identify and treat diseases with only limited assistance.

Drug Treatment

Oxytetracycline (trade name Terramycin=TM) is a common drug that is effective in preventing AFB infections. It is sold as a sugared powder that may be applied directly around the edges of a brood nest. Increasingly, however, beekeepers are mixing the unsugared TM powder with vegetable oil and sugar and feeding it to colonies in a form called antibiotic extender patties, which have the consistency of a thick paste. The proper mixture is one pound (450 grams) of vegetable oil (Crisco, for example), two pounds of granulated sugar (900 grams), and six tablespoons of TM-25 (37.5 grams). The ingredients must be thoroughly mixed. A half-pound patty placed on the top bars of the frames in the brood nest will last about six weeks and will serve as an effective preventative for AFB.

Equally important is that vegetable oil is effective in controlling tracheal mites, one of the two mite species that plague the beekeeping industry, especially in the northern states. Research has shown that colonies infected with varroa mites, the second of the two mite species, are healthier when treated with antibiotic extender patties. Even though vegetable oil kills few varroa mites, the colonies seem to benefit from the control of tracheal mites.

Terramycin is also effective in controlling European foulbrood (EFB), yet another bacterial disease that often poses problems for colonies, especially in the spring. Follow TM label instructions carefully when using this material.

Conclusions and Recommendations

AFB was once the most serious disease of honey bees in the United States. Varroa mites (found in 1987) and tracheal mites (found in 1984) are equally if not more destructive. Antibiotic extender patties have been proven as effective control agents for AFB, EFB, and tracheal mites. We recommend their use twice a year in the northern states—once in the early spring, about late April, and again in the fall, after the first killing frost. Yet another chemical is required to treat varroa mites.

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HONEY BEES

CORNELL COOPERATIVE EXTENSION

Biology and Control of Tracheal Mites of Honey Bees

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On July 3, 1984, mites that infest the tracheae, or breathing tubes, of honey bees were found in southernmost Texas. Tracheal mites *(Acarapis woodi)* had been collected in Mexico in 1980, so their coming into the United States should not have been a great surprise. These mites are widespread in the world. But their importance as pests of honey bees had been in question until their arrival here.

We estimate that from 1985 through 1991 at least half of the honey bee colonies in the United States have died as a result of tracheal mite infestations. Losses have been heaviest in the northern states and lighter in the South and California. There are several reasons why bees can better tolerate mites in warmer climates. One is that in the South bees live for a shorter period of time; those that are infested die earlier and cannot continue to produce mites to infest the rest of the population. Colony growth and the production of young bees in the spring are also greater in the South; consequently, the infested population is diluted. Our experience in the North is that most of the colonies that die from tracheal mite infestations do so in February, March, and April at a time when only a few replacement bees are being raised.

Northern, commercial, migratory beekeepers with operations in the South and California have been able to replace weak and lost colonies rapidly and keep their total colony numbers consistent. Some beekeepers in the North have been able to replace lost colonies by buying package bees and queens from the South. A small number of northern beekeepers have purchased replacement colonies, mostly from the South.

There is no question that the total number of colonies of honey bees in the United States is much less than a few years ago. Many existing colonies are in a weakened condition. Although there are no data, beekeepers and growers generally agree that colonies that have been rented for pollination during the past two years have, on average, contained fewer bees than in previous years.

At the same time, a large percentage of the feral colonies, those that live in hollow trees and buildings, have also been devastated by these mites. Feral colonies contribute bees for pollination under both commercial and noncommercial circumstances.

Hobby beekeepers throughout the country have also suffered severe losses, probably because of tracheal mites. Colonies owned by hobby beekeepers have played an important role in pollination. In many instances there have been some colonies in this category near orchards; growers should be advised that these bees may no longer exist and they will be increasingly dependent on rented colonies.

History and Distribution

Between about 1900 and 1920, 90 percent of the colonies of honey bees in Great Britain died from some unknown cause. After tracheal mites were discovered in 1919 and named in 1921, it was immediately assumed that they were the cause of the trouble. As a result and after a survey for tracheal mites in North America proved negative, the United States and Canada adopted legislation in 1923 that prohibited the importation of honey bees from abroad except by the U.S. Department of Agriculture. This legislation has given the North American beekeeping industry good protection until recently.

Proof that tracheal mites were the cause of the great losses of honey bees in the early part of the century in Great Britain has always been lacking. This, as might be expected, has led to much debate. Some beekeepers and researchers have suggested that the mites were not the culprits. During the 1920s and 1930s, tracheal mites were found in many countries in Europe, but they never caused the great problems they were apparently responsible for in Great Britain. Many in the United States believed therefore that they would be no problem here, which proved to be a serious error.

Fig. 1. Swarms of honey bees probably have some resistance to tracheal mites. For this reason, it may be worth capturing them in the early spring—May or early June in the Northeast. Bait hives, shown here, are one way to capture swarms. (See information bulletin 187, *Bait Hives for Honey Bees,* in the list of publications at the end of this fact sheet.)

Fig. 2. Colonies of bees on some kind of a hive stand will have dry bottomboards and are less stressed than colonies resting on damp ground.

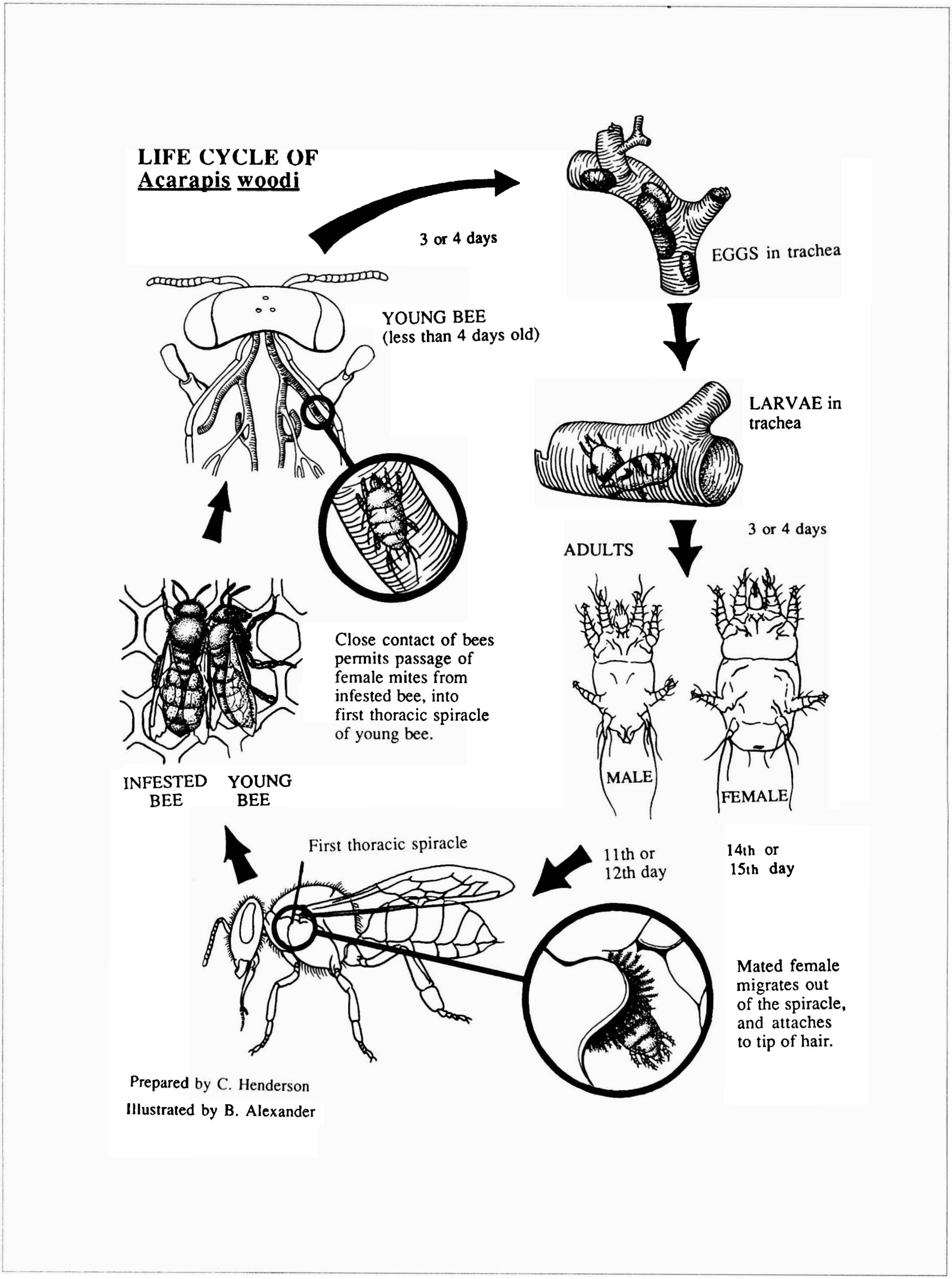

Fig. 3. Life cycle of *Acarapis woodi*

Life Cycle and Biology of Mites

Most tracheal mites are found in the largest, paired tracheae in the first segment of the bee's thorax. Sometimes mites are found on only one side of the body, because the tracheae from one side do not connect with those on the other side. Under normal circumstances, the whole life cycle takes place in the tracheae (see fig. 3). A mated female mite lays five to seven eggs over a period of several days. These hatch, and the young puncture the tracheal wall and feed on the bee's blood. The sex ratio is not equal; usually there are more females than males. The mites mate in the tracheae and the young females then migrate out of the breathing tube, attach themselves to one of the bee's body hairs, and transfer to a young, passing bee. Apparently, only very young bees can become infested.

Tracheal mites have been found laying eggs outside of the tracheae, indicating that they are closely related to externally living species of mites. Externally living species of mites, however, cause no apparent losses. The two external species have been found throughout the United States wherever and whenever they have been searched for. Their populations are never very high. Grooming by honey bees may keep their numbers low.

Research has been done on how tracheal mites kill bees. Heavily infested, foraging bees are just as active as their uninfested sisters up until the day they die; however, they do die at an earlier age. A virus or bacteria may be spread by the mites that feed on the bee's blood. One research report from Europe in 1956 found that the blood of tracheal mite–infested bees contained more bacteria than that of uninfested bees. We presume externally feeding mites could transmit the same microorganisms though we have no data in this regard.

Spread in the United States

The spread of tracheal mites across the United States has been rapid. Efforts by governmental agencies to limit the spread were too little and too late. But it is doubtful from a practical point of view if anything could have been done to stop their spread.

In the United States today more than 1,000,000 colonies of honey bees are rented to growers of fruits, vegetables, seeds, and nuts each year for pollination. Each year the number of colonies needed by growers has increased as U.S. agriculture has become more concentrated and fields and farms have grown larger. In 1991, for example, more than 30,000 colonies of honey bees were moved into Maine, mostly from Florida, for fruit pollination, mostly blueberries; in 1981 the number so moved was just under 10,000. These colonies were subsequently taken to Massachusetts for cranberry pollination or to northern Maine, New York, or North Dakota for honey production. Colonies of bees from fourteen states are carried into California each year for the pollination of almonds; they may subsequently be moved to other states for pollination or honey production before being taken back to their home base.

There are no official records concerning the number of queen honey bees and packages of bees that are grown in the southern states and California and sold to northern beekeepers each year. In the country as a whole, we can reasonably estimate that as many as 1,000,000 queens and 250,000 packages may have been moved in this manner each year in the mid-1980s. The number is smaller today. The finding of tracheal mites and other problems have slowed this movement of queens and package bees as beekeepers in the North have become cautious about buying southern bees. In the springs of 1990 and 1991, however, the demand for these bees almost exceeded the supply.

We do not know if the mites that infested bees in Mexico came from bees imported from Europe or South America or from swarms migrating naturally from a more southern country. Migratory beekeeping is also practiced in Mexico. It is assumed that mites were spread in Mexico both by beekeepers and through natural swarming. Southern Texas probably became infested as a result of a feral swarm flying across the Mexican-U.S. border. There may be small areas in the United States where tracheal mites are not yet found. From a practical point of view, however, it is logical to assume that they are everywhere and that all beekeepers should take steps to protect against damage by them.

Diagnosis

We have no good or easy way of determining if tracheal mites are present other than to dissect the bees and examine their tracheae. A large number of bees must be examined to obtain an accurate percentage of honey bees infested. Most investigators examine a minimum of thirty bees from one colony. This is a slow, laborious task. Although it is true that tracheal mite–infested bees may be seen crawling in front of colonies and that their wings may be disjointed, these actions are symptomatic of all sick bees dying from many causes, such as a virus infection, nosema, and old age.

It is perhaps useful to compare the diagnosis of American foulbrood and that of tracheal mites. On a good day, an apiary inspector can expect to examine a hundred or more colonies of bees and perhaps scan 2,000,000 brood cells for American foulbrood. Having done so, he or she can say with reasonable certainty whether the disease is present. In the case of tracheal mites, the same inspector might take a sample of bees in alcohol from the same number of, or probably even more, colonies; however, these must be sent to a laboratory for diagnosis. In the laboratory the most skillful person might be able to prepare and dissect only 2,000 to 3,000 adult worker bees in a day. Since a colony of honey bees may contain 10,000 to 50,000 bees, the percentage of bees that can be examined is obviously low.

Methods of Control

Menthol is the only chemical approved and registered to control tracheal mites. It is effective if used properly. We now have several years of experience, in many parts of the country, using this chemical. Menthol is available both as a natural and a synthetic product; these forms appear to be equally effective. Menthol has a low toxicity to mammals and is safe to use. One should avoid excessive inhalation of the fumes, however, and gloves should be worn to protect against possible skin irritation.

Menthol is effective only when the temperature is warm or when there are a sufficient number of bees in the hive to raise the temperature so that the menthol will evaporate. The use of menthol in the fall (in late September, October, and November in the northern states) is not effective; the outside temperature is too cool to make the menthol evaporate. Bees rear the least amount of brood in the fall, and although bees may be present in large numbers at this time, the temperature within the hive is too low to cause menthol evaporation.

In the North, menthol is most effective in controlling tracheal mites when placed in colonies in the spring; label directions concerning its use should be followed carefully.

We expect that the Environmental Protection Agency will soon approve a second chemical for the control of tracheal mites. This chemical will kill both tracheal mites and varroa mites, which are also a serious problem in many beekeeping areas.

Disease-Resistant Honey Bees

Many researchers and beekeepers across the United States are working to find bees that are resistant to or tolerant of tracheal mites. We believe such bees exist because many beekeepers in other temperate parts of the world do not report serious problems with tracheal mites. Two pathways are being explored: importing queens from European stock that is thought to be resistant, and searching among our own bees for resistant stock. In many parts of the country the USDA, state colleges, and private beekeepers are making such searches. Through this collective effort we are already having a small degree of success, and we can reasonably expect to have resistant or tolerant bees available for sale to beekeepers through commercial channels within a few years.

Obtaining Clean Stock

Purchasers of bees should expect that tracheal mites are almost everywhere in the United States except Hawaii and Alaska. Mature colonies, queens, and package bees should all be suspected of carrying tracheal mites. No one expects that any bees will be totally free of them. Sellers of package bees and queens are very much aware that their reputations are at stake; if they are to have continuing sales, they must have relatively clean bees. Although states where package bees and queens are produced have bee inspection services and the bees are shipped with inspection certificates, the reputation of the breeder is still the most important criterion. Beekeepers should purchase package bees and queens from well-known and experienced growers.

Complications with Other Diseases

Research on plant and animal diseases shows that when any living organism suffering from one disease is weakened it becomes more susceptible to attack by another organism. Many beekeepers have reported finding tracheal mite–infested colonies that were also suffering from other diseases. Beekeepers should take all the precautions possible to protect their colonies against attack by multiple organisms at one time.

Conclusions and Recommendations

We may logically assume that tracheal mites infest all colonies of honey bees in the northeastern states. For the next several years colonies that are weak and unthrifty in the spring should be treated with menthol at that time. Combining weak colonies in April and early May may also be helpful. Combining colonies increases the number of bees available to protect the brood nest and to participate in grooming, housecleaning, and other in-hive practices that may build strong colonies.

Weak colonies should be combined in the following way: A dry bottomboard is placed on a hivestand or stones to keep it dry. The super with brood and bees is placed on the bottomboard. A sheet of newspaper with three or four slits cut in it for ventilation is placed over the super and the top bars of the frames. A second super, from another weak hive, is placed on top. A cover is put into place. The newspaper will soon be chewed away by the bees, but it will cause them to mingle slowly, and there will be little or no fighting among them.

As in the case of any bee disease, the apiary site is especially important. Good locations for bee colonies should be fully exposed to the sun, slope to the east or south, and have good air and water drainage and a nearby source of clean water. All of these factors are necessary for a colony to keep dry and improve its ability to keep the brood nest warm. The local environment must also allow bees to take cleansing flights every few weeks during the winter months. Bees must be able to void fecal matter outside of the hive so that any disease microorganisms in the feces will not be available to infect other bees in the hive. Old bees may harbor many diseases. If these sick and diseased bees have an opportunity to fly they may do so and die outside of the hive where they cannot cause further infection of others.

Several southern queen breeders have already selected stock that shows some degree of resistance to tracheal mites. And stock that may have some resistance has been imported from Europe recently. Requeening weak colonies with this stock should be helpful. Colonies of bees that have survived mites in the past few years in the North no doubt have some degree of resistance. Queens from surviving feral and kept colonies are also somewhat resistant. Beekeepers in the Northeast should rear queens and grow new colonies from the strong, naturally surviving colonies. Too few northern beekeepers grow their own queens. Queen rearing is an art. It can be a valuable adjunct to honey production and growing colonies for pollination.

Although there are fewer swarms today than there were a few years ago, existing swarms are undoubtedly from populous colonies with some resistance to tracheal mites. It is important to remember that some races of bees swarm more than others. Although bees in swarms may have this undesirable trait, capturing them for use as breeding stock may nonetheless be worthwhile. At present our greatest need is for resistant bees.

The following publications on queen rearing, bait hives, disease control, and general beekeeping are available at nominal cost:

- *Small Scale Queen Rearing by Beekeepers in the Northeast*
- *Bait Hives for Honey Bees*
- *Identification and Prevention of American Foulbrood in Honey Bees*
- *Beekeeping: General Information*
- *Package Bees—Their Installation and Immediate Care*

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HONEY BEES

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Management of *Varroa jacobsoni* in the Northeast

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Contemporary beekeeping is a challenging enterprise. In addition to traditional bee diseases such as American and European foulbrood, chalkbrood, and nosema, today's beekeeper must contend with two parasitic mites: *Acarapis woodi*, the tracheal mite, and *Varroa jacobsoni*, the *Varroa* mite. Both mites have had devastating effects on managed and feral bee populations. You can still enjoy and profit from beekeeping, but you must incorporate an effective mite control program into your management scheme and you must always implement it on time.

This fact sheet focuses on *Varroa* in the Northeast. It will enable you to identify both the *Varroa* mite and the symptoms of infestation and it offers specific recommendations for safely and effectively managing the mite in your colonies. Remember! *Varroa* is unforgiving and it will kill your colonies if left unmanaged.

Origins and Distribution

Before the 1950s, *Varroa* was known only in Asia, where it is a parasite of the eastern honey bee, *Apis cerana*. *Varroa* has long coexisted with the eastern honey bee and causes it little or no damage. *Varroa* transferred to the western honey bee, *Apis mellifera*, during the 1950s. The western honey bee is the principal pollinator in many crop production systems and the major producer of honey worldwide, including the United States. *Varroa* was discovered in this country in 1987 in Wisconsin. Because both the honey bee and the U.S. beekeeping industry are highly mobile, *Varroa* quickly became endemic throughout the country and can now be found in every state in the continental United States. Unlike its seemingly benign relationship with the eastern honey bee, *Varroa* is exceptionally virulent on its new host.

Identification

Viewed from the top, the adult female *Varroa* mite is elliptical in shape, measuring 1.6 mm side to side and 1.1 mm front to rear (fig. 1). The adult has four pairs of legs. Typically, mites are light brown, dark brown, or reddish brown in color, although the immature stages are pale. *Varroa* superficially resembles another external parasite of the honey bee, the bee louse, *Braula coeca*. The bee louse is a wingless fly and has only three pairs of legs. It is extremely rare in New York, although it is common in parts of Pennsylvania and Maryland. The bee louse is not a serious pest of honey bees.

Figure 1

Symptoms

Figure 2

The three most obvious symptoms of *Varroa* are bees with deformed wings walking on combs (fig. 2), bees crawling at the colony entrance, and the presence of atypical brood diseases (fig. 3). These symptoms comprise the key features of parasitic mite syndrome. Bees with deformed wings are almost always associated with *Varroa*. Crawling bees at the entrance may indicate either *Varroa* or tracheal mites. If you observe this symptom, you should sample your bees for both mites. If you observe brood symptoms, you must also determine whether they are associated solely with *Varroa* or are a result of American foulbrood. Unfortunately, these symptoms are most apparent when mite levels have become dangerously high. If you observe any of these symptoms, immediately sample your colonies for mites.

Figure 3

Life History

Varroa is an external, obligate parasite of certain species of honey bees, which means that it requires a honey bee host to survive. It cannot survive on yellowjackets, wasps, or bumblebees. *Varroa* may be found on adult bees throughout the year, but it reproduces only on the immature stage of the bee. A mated female mite enters a brood cell containing a worker or drone larva shortly before it is capped and secures itself in the bottom of the cell. After the cell is capped, the mite opens a small hole in the cuticle of the developing bee and begins to feed. Approximately 60 hours after capping, the mite lays an egg that develops into a male. Then, at approximately 30-hour intervals, it lays additional eggs that develop into females. A brood cell may be infested by more than one mite.

Mites go through five developmental stages: egg, larva, 6-legged protonymph, 8-legged deutonymph, and 8-legged adult. The male develops in $5^{1}/_{2}$ to 6 days; the female, in $7^{1}/_{2}$ to 8 days. Shortly after a female matures, it mates with the male in the cell. Female mites emerge from the brood cell when the adult worker or drone emerges. Mites may leave the cell on their own or on the host bee. Outside the brood cell, mites are generally found on adult bees, most commonly in the brood nest. An individual female mite undergoes from one to seven reproductive cycles. Males do not survive outside the brood cell.

Mites are found 2 to 30 times as often on drone brood as on worker brood when the former is available. This is not unexpected. Drone brood is capped for about 15 days and worker brood for about 12.5 days. A mite can produce more offspring if it has entered a cell containing a drone larva because the longer capped stage of the developing male allows time for more daughter mites to mature. Mites reproducing on worker brood produce between 1.0 and 1.7 female offspring, whereas mites reproducing on drone brood produce about 2.4 females.

End Stage Mite Infestation

The development of atypical brood diseases generally indicates the end phase of a mite infestation. The brood pattern usually deteriorates when mite infestation is moderate to high. The deterioration in the brood is believed to be a result of infection by several pathogens, presumably viruses and bacteria, although other factors, such as inadequate brood care, may be involved. The exact role *Varroa* plays in this process is not clear. Although the symptoms superficially resemble sacbrood, American foulbrood, and European foulbrood, the causative organisms of those diseases have not been identified from infected larvae or pupae with this condition, and treatment with antibiotics such as oxytetracycline-HCl does not completely resolve the condition. As little as two weeks can elapse from the time a colony first exhibits symptoms of brood deterioration until its total collapse. If you catch the infestation early, however, you can save your colony.

Transmission and Reinfestation

Varroa infests new colonies in several ways. Beekeepers commonly move brood among colonies so as to strengthen or equalize them. This practice can be a major source of transmission of both mites and disease. Robbing is also a significant source of transmission. Colonies weakened by mites or disease are unable to defend themselves and are usually robbed by stronger colonies. In the process, the robber bees take home more than just a free load of honey. Swarms from infested colonies establish new nests with mites already present and are not likely to survive more than a year or two. This makes feral colonies prime sources of reinfestation for managed colonies. Captured swarms are also likely to be infested with mites. Drifting bees, which are more common in apiaries where colonies are kept close together, can also spread mites among colonies.

Detection

Sample your colonies regularly. If you detect *Varroa*, begin a treatment program at the first available treatment window—spring or late summer to early fall. *Varroa* can be detected using the ether roll and cappings scratcher methods. For the ether roll you will need a quart glass jar, a pair of latex gloves, a can of automotive starting fluid, and either a bee brush, a plastic scoop, or a vacuum collection device (fig. 4). Collect approximately 300 bees from a comb and place them in the quart glass jar. Spray a 1- to 2-second burst of the starting fluid into the jar. Shake the jar vigorously for 10 seconds, then gently roll it two to three times along its long axis. Mites, if present, will adhere to the sides of the jar (fig. 5). Because mite levels are about twice as high on combs with brood as on those with only honey, you will maximize the chance of detecting mites in your colonies by sampling bees from brood combs. A portable vacuum collection device greatly speeds up the sampling process and provides a uniform sample size that allows for comparisons between colonies.

Figure 4

Figure 5

The second method involves removing some capped pupae, preferably drone pupae, with a cappings scratcher (fig. 6) and examining them for mites. This method is highly effective for detecting low levels of mites. Although mites can sometimes be seen on the adult bees or walking on the comb, this is more common when infestation rates are high and is not a reliable detection method.

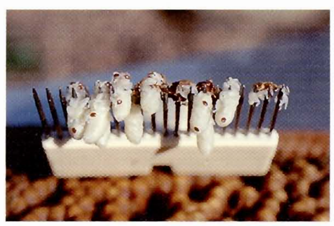

Figure 6

Rationale for Current Control Measures

A successful pest management program requires a good knowledge of the pest's population cycle so that treatments are applied at the most effective time. Because *Varroa* is so virulent, however, it has no natural population cycle. Instead, once a colony is infested, the mite population simply builds up until the colony dies. Population cycles in managed colonies are a result of the constant battle between beekeepers applying treatments to control the mites and the resurgence of mite populations after treatments have been applied. Because beekeepers treat at different times and colonies become infested and reinfested at different times and rates, a typical cycle is hard to define.

Given the high virulence of *Varroa*, the goal of an effective mite control program is to impose a population cycle on the mite such that the infestation rate is always below the economic injury level. A single spring, late summer, or early fall treatment might provide adequate control if each beekeeper were concerned only with his or her own bees. Unfortunately, infested feral colonies are constantly dying, and other beekeepers may not pay adequate attention to their bees. Thus you must assume that your bees are robbing nearby infested colonies, thereby augmenting the mite populations in your colonies, especially in the spring, late summer, and early fall or whenever there is a dearth of nectar.

To protect your colonies, you need to treat them twice each year. A **spring treatment** is essential to ensure that mite levels remain low throughout the summer. The goal in the spring is to begin treatment 6 to 8 weeks before you add supers to your colonies for honey production. A **late summer or early fall treatment** is required to ensure that your colonies enter the winter with healthy bees and mite levels low enough to allow them to survive until the following spring. At this time, the goal is to treat your colonies while a few weeks of brood rearing remain, but **after** the honey crop is harvested. This will ensure that your colonies have many healthy bees for the winter.

Your colonies can also pick up mites during a dearth of nectar in the summer. Monitoring your colonies for mites and mite damage in August and September will provide an added level of safety by detecting a buildup in mite populations during that period.

Economic Thresholds

If your colonies have low levels of mites during the spring, late summer, or early fall, you may not need to treat at those times. At present, however, there are no reliable data that indicate what constitutes a "safe" level of mites at those times. Similarly, if you keep your bees in an area where reinfestation is not a significant source of mites, you may not need to treat as often. But because you cannot prevent other bees from entering your area, you cannot be sure that your bees will always be safe from reinfestation. Therefore, once you have detected mites in your colonies, you should assume that they are present at dangerous levels and adhere to a regular spring and late summer or early fall treatment program.

Recommendations for the Proper Use of Apistan

The following steps are recommended for managing *Varroa* in the Northeast using Apistan™ (tau-fluvalinate), the only pesticide registered by EPA for control of this mite:

1. Read and follow the instructions on the pesticide label. **THE LABEL IS THE LAW** and always precedes any other recommendations.

2. Always wear gloves (latex, or for better protection, nitrile rubber) when handling Apistan or any other pesticide. Use gloves whether you are applying or removing the strips.

3. Apistan is available in three approved formulations: a 10 percent strip used to treat full-sized colonies; a 1.0 percent tab approved for queen mailing cages; and a 2.5 percent strip used in package shipments. All are sold under the name Apistan. Be sure to use the proper formulation for your specific application.

4. Colonies should be treated twice each year to be protected from *Varroa* damage. The **spring treatment** should begin around March 1 in the southern part of the region and around April 1 in the northern part of the region. Leave the strips in the colonies for 6 to 8 weeks, then remove them before you add supers to your colonies for honey production. This will prevent contamination of your honey crop. The **late summer or early fall treatment** should begin around August 30 in the northern part of the region and around October 15 in the southern part of the region, but only **after** you have removed your honey crop. The earlier you can harvest your crop and begin treatment during this period, the better. Leave this treatment in your colonies for 6 to 8 weeks, then remove the strips for the winter. When removing strips, collect them into a group and dispose of them according to the label instructions.

   Special case: If you observe the development of atypical brood diseases in your colonies, regardless of when you observe it, sample your colonies for mites. If *Varroa* is present, remove all marketable honey and treat with Apistan for 6 to 8 weeks. After removing the strips, you may resume using the colony for honey production.

5. Whenever treating, use one new Apistan strip for every five full-depth combs of bees in the brood nest. For most colonies, that means two strips in the spring and four strips in the late summer or early fall. If you place all of your brood and the queen in the bottom hive body in preparation for winter and use a queen excluder to restrict the queen to the bottom hive body until brood rearing is over, you can use two strips for the late summer or early fall treatment. Always place strips so that they will be in contact with the bees when they cluster (fig. 7). Treat all colonies in an apiary and do so at the same time.

Figure 7

6. DON'TS:

   - Do *not* leave strips in your colonies for more or less than the recommended time. Not only do you risk contamination of hive products, you also increase the chance that the mite population will develop resistance to the pesticide.

   - Do *not* use formulations of fluvalinate or other pesticides that are not registered for use against *Varroa*.

   - Do *not* leave strips in colonies when a marketable nectar flow is under way.

   - Do *not* reuse strips.

Always check with your appropriate state agency before purchasing or applying a pesticide to be sure that it is registered for use in your state.

Facts about Apistan

The active ingredient in Apistan is a contact insecticide, tau-fluvalinate, that paralyzes the mite. The active ingredient is slowly released from the strip. When the bees come in contact with the strip, they pick up a small dose of the active ingredient. The bees transfer the active ingredient around the hive through contact with other bees. The mites must come in contact with the active ingredient to receive a lethal dose. Because mites on immature bees in capped cells are not treated until they emerge with the adult bees, it takes 6 to 8 weeks to assure an effective treatment.

Store Apistan out of direct sunlight at less than 80°F. The manufacturer confirms three years of shelf life in the package whether it remains unopened or is opened and then resealed. Keep the strips in the original package once opened. This helps maintain shelf life, keeps the label with the product, and prevents cross contamination with other insecticides.

Mite Resistance to Apistan

Numerous cases of resistance to this chemical have been confirmed in Europe. Most of the problems stem from improper use. Overuse, underuse, use of old strips, use of unregistered formulations, and failure to follow label directions all encourage the development of resistance. Apistan is the only registered product for the control of *Varroa* in the United States. Therefore, it is in the best interest of all beekeepers to use it according to label instructions to ensure the longest possible effective life.

Personal Safety

Apistan works because it is a highly toxic poison. You must minimize any contact between yourself and the product by wearing gloves (latex, or for better protection, nitrile rubber) whenever you handle Apistan. When you finish handling Apistan, discard the gloves. If you are wearing nitrile rubber gloves of at least 14 mils thickness, you may reuse them. First, wash the gloves with soap and water while they are still on your hands, rinse well, then remove them and store them for future use—*but only for pesticides.*

Alternative Treatments

Several alternative treatments have been suggested for *Varroa* control. These include using drone comb as a mite trap and caging the queen to disrupt the brood cycle. Unfortunately, little evidence supports the use of these methods and they are very labor intensive. The potential for breeding mite-resistant bees is being explored, but commercial stock will not be available for many years. Certain essential oils have shown promise as mite control agents, but the data on most oils are sparse and none have been registered. Use of any of these compounds puts your bees at risk and may contaminate your hive products.

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Summary

Nectar flows, brood rearing patterns, and the degree of isolation from other beekeepers vary greatly throughout the Northeast. Each affects the growth of mite populations and available treatment windows. You will have to plan carefully to optimize the recommended treatments for your local conditions. Much remains to be learned about the management of *Varroa*, and recommendations may change in the future. For now, the above recommendations provide you with the best way to protect your bees from *Varroa* and the best way to guarantee pure and natural hive products. If further research establishes a reliable economic threshold or if new treatments receive EPA approval, that information will be communicated to you through your local county extension offices, beekeeping organizations, and state inspection programs.

Recommended Readings

1. Denholm, C. H. 1997. Viruses and *Varroa*. Bee Craft 79:113–116.
2. Allen, M. F., and B. V. Ball. 1996. The incidence and world distribution of honey bee viruses. Bee World 77:141–162.
3. Martin, S. J. 1994. Ontogenesis of the mite *Varroa jacobsoni* Oud. in worker brood of the honey bee *Apis mellifera* L. under natural conditions. Experimental and Applied Acarology 18:87–100.
4. Martin, S. J. 1995. Ontogenesis of the mite *Varroa jacobsoni* Oud. in drone brood of the honey bee *Apis mellifera* L. under natural conditions. Experimental and Applied Acarology 19:199–210.
5. Matheson, A. 1993. Living with *Varroa*. Cardiff, U.K.: IBRA.
6. De Jong, D. 1990. Mites: *Varroa* and other parasites of brood. In *Honey Bee Pests, Predators, and Diseases*, 2d ed. R. A. Morse and R. Nowogrodzki, eds. Ithaca, N.Y.: Cornell University Press.

The catalog also can be accessed at the following World Wide Web site: http://www.cce.cornell.edu/publications/catalog.html

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HONEY BEES

CORNELL COOPERATIVE EXTENSION

Sampling for Laboratory Diagnosis of Honey Bee Mites and Diseases

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Like all living organisms, honey bees are susceptible to a wide variety of parasites and pathogens, including mites, protozoans, fungi, viruses, and bacteria. Generally, these conditions are self-limiting, but certain diseases will kill your colonies and others will render your equipment unusable.

The beekeeper is the first line of defense against parasites and pathogens. Adhering faithfully to sound disease management practices will reduce the chance of your bees contracting or disseminating American foulbrood (AFB) and other bee diseases. Occasionally, however, you will be confronted with diseased brood or symptoms of disease in adult bees. You must be able to identify these conditions so that you can take the proper steps. Missing, or misdiagnosing, a case of AFB can result in the rapid spread of this disease to your other colonies. You will then need to destroy much expensive equipment. If you are unsure of your diagnosis, you will need to seek help from a beekeeper with the necessary expertise or have a sample of the suspected disease analyzed at a laboratory. This fact sheet outlines procedures for obtaining samples of diseased brood and adult bees for laboratory analysis.

Diagnostic Services

The USDA-ARS Bee Research Lab in Beltsville, Maryland, provides mite and disease diagnostic services for beekeepers worldwide. The Bee Research Lab gives highest priority to brood and adult samples submitted in support of federal or state emergency operations. Second priority is given to brood samples associated with possible abatement action. Third priority is given to samples of adult bees required for the issuance of moving permits. Fourth priority goes to examination of adult bees for informational purposes.

Sample Collection Protocols

Brood Samples

Comb sample: The best sample for diagnosis of brood disease is a piece of comb that contains as much diseased brood as possible. Cut a 2" x 2" (minimum) square of comb from the suspected equipment. Include as much dead or discolored brood as possible. Wrap the sample in a paper towel or newsprint and package it loosely in a heavy cardboard box for shipment. **Do not** send samples with honey or nectar. **Do not** wrap the sample in foil, wax paper, or other material that will encourage decomposition and growth of molds. Assign a unique identifying number to the sample and include your name, address, and a brief description of the problem in a letter placed in the envelope.

Smear: If you are unable to cut out a section of comb, you may still be able to obtain a diagnosis if you can submit a sufficient quantity of diseased material. Using a flat wooden toothpick, remove as much material as possible from one suspected cell and place it on a 2" x 4" rectangle of paper. Include the toothpick because it may contain a considerable amount of diseased material. Carefully fold the paper to cover the sample. Place the sample in a coin envelope and then in a regular envelope. Assign a unique identifying number to the sample and include your name, address, and a brief description of the problem in a letter placed in the envelope.

Adult Samples

Samples of adult bees may be submitted for diagnosis of tracheal mites and viruses. You must specifically request which test you require when submitting adult bees.

Adult sample for mite diagnosis: Priority is given to pooled apiary samples. If many bees are crawling in front of your hives, collect between 100 and 150 of them. Otherwise, collect the same number of bees from combs. Collect an equal number of bees from each colony. **Do not collect dead bees.** Place the bees in a leakproof plastic bottle of 1 pint volume or less with a screw-cap lid (1½ turns or more). Add enough 70 percent isopropanol (rubbing alcohol), ethanol, or methanol to cover the bees completely. Seal the bottle tightly and tape around the cap-bottle junction to prevent the cap from coming loose and to prevent any alcohol from leaking. Place the bottle in a plastic bag with a zipper-like seal (e.g., Zip-loc), and package the sample in a sturdy cardboard box surrounded by enough absorbent material to soak up all of the alcohol in the event of a leak. Assign a unique identifying number to the sample and include your name, address, and a brief description of the problem in a letter placed in the envelope. Send only one sample per package. You must write one of the following on the outside top of the package, depending on which alcohol you used as a preservative:

FLAMMABLE LIQUID – 70% ISOPROPANOL
FLASH POINT 70.5°F/21.1°C
DOMESTIC SURFACE MAIL ONLY

FLAMMABLE LIQUID – 70% ETHANOL
FLASH POINT 55.6°F/13.1°C
DOMESTIC SURFACE MAIL ONLY

FLAMMABLE LIQUID – POISON – 70% METHANOL
FLASH POINT 50.0°F/10.0°C
DOMESTIC SURFACE MAIL ONLY

Note: *Commercial enterprises shipping samples in alcohol must follow strict U.S. DOT regulations and should contact their local U.S. DOT office for complete instructions. Generally, the easiest way to ensure compliance is to have samples shipped by a U.S. DOT–authorized packing and shipping agent.*

Adult sample for virus diagnosis: Adult bees crawling in front of the hive and unable to fly are often a sign of viral infection. Send at least 100 bees that are dying or crawling in front of the hives. **Dead and decayed bees are not satisfactory for examination.** Bees to be examined for viruses should be loosely wrapped in a paper bag, paper towel, or newspaper and sent in a mailing tube or heavy cardboard box. **Do not use alcohol, plastic bags, aluminum foil, waxed paper, tin, or glass.** Assign a unique identifying number to the sample and include your name, address, and a brief description of the problem in a letter sent with the sample.

Send all samples to:

U.S. Department of Agriculture
Bee Disease Diagnosis
Bee Research Laboratory
Building 476, BARC-E
Beltsville, MD 20705

Always inspect used equipment before purchasing: it is a major source of disease transmission. If there are no bees on the equipment, look for black scales on the lower surfaces of the cells and examine any dead brood. Submit samples of any questionable equipment for analysis.

Recommended Reading

Canadian Association of Professional Apiculturists. 1987. *Honey Bee Diseases and Pests*. 2d ed. Guelph, Ontario: University of Guelph.

Shimanuki, H., and D. A. Knox. 1997. Summary of control methods. In *Honey Bee Pests, Predators, and Diseases*, 3d ed. R. A. Morse and K. Flottum, eds. Ithaca, N.Y.: Cornell University Press.

Shimanuki, H., D. A. Knox, B. Furgala, D. M. Caron, and J. L. Williams. 1992. Diseases and pests of honey bees. In *The Hive and the Honey Bee*, J. Graham, ed. Hamilton, Ill.: Dadant and Sons.

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