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Honey Bee Diseases and Their Control

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Honey Bee Diseases and Their Control

by *Carl Johansen*, Dept. of Entomology, Washington State University, and *Michael Burgett*, Dept. of Entomology, Oregon State University.

Presence of a bee disease in an apiary can mean the difference between a good honey yield or none at all. It is imperative that all beekeepers be able to recognize the symptoms of the principal bee diseases soon after they appear so that adequate precautionary measures can be taken to prevent their further spread. Good disease control is best accomplished by preventive measures that do not allow the start of bee diseases in your colonies.

DISEASES OF ADULT HONEY BEES

The most threatening of all bee diseases are those which attack the brood (larvae and pupae). However, beekeepers must also guard against diseases which attack adult bees. Two of the most common diseases are *Nosema* and paralysis.

Nosema

Nosema is the most widespread of all adult bee diseases, especially under northern climatic conditions where bees are confined for long periods of time without flight during the winter and early spring. The disease varies with the season, worsening in the late winter and spring. *Nosema* symptoms normally disappear with the onset of warmer weather in the later spring and summer.

Nosema is caused by a protozoan called *Nosema apis*. This parasitic microorganism is transmitted among adult bees as a spore which enters the midgut of the adult where it attacks the cells which line the wall of the intestine. Spores can be transmitted in food and water. It is known that the spores can be passed out with the faeces of bees, and combs are often contaminated in this manner.

Symptoms. Worker bees can be seen wandering about the entrance of the hive or in the grass near the hive. The abdomen of an infected bee is often distended and shiny in appearance. Many of the affected bees will have their wings spread at an abnormal angle, and are unable to fly.

Control. Fumagillin, an antibiotic drug, is a control material for *Nosema* disease. It is the most practical

method for commercial beekeepers who must manipulate hundreds or even thousands of colonies. One level teaspoon of Fumidil-B (a commercial preparation of fumagillin) dissolved in 2 gallons of a 1-to-1 sugar syrup will treat two colonies. Fumidil-B can be obtained only through bee supply companies.

To prepare a medicated syrup, heat the water to about 160°F; remove from heat. Add the sugar and stir until the mixture becomes a clear syrup. Finally, dissolve the Fumidil-B in a small amount of warm water and mix it into the syrup. Feed the medicated syrup to the colonies in the fall or both in the fall and spring, *but never during or immediately before a honey flow*. Feeding during both spring and fall provides maximum effectiveness.

Fumidil-B can also be added to pollen supplements. The dosage in the syrup to be added to the supplement should be about double that given in the directions above. A basic recipe for pollen supplement is as follows:

- 3 pounds brewer's yeast
- 3 pounds sucrose
- 2½ pounds (approximately 2½ pints) hot water

If you wish to use pollen in the mixture, add 10% by weight of clean pollen. It may be necessary to add more water if pollen is used, but only use enough water to form a doughlike consistency. Less than the amount in the recipe may be sufficient in humid areas.

To prepare supplement cakes, first mix the pollen into the hot water. When the pollen has softened, add the sugar until dissolved or in smooth suspension. Finally, add the brewer's yeast and mix by hand, adding until the supplement has the texture of a doughlike paste (neither runny nor hard). Portion into 1½-pound cakes and flatten to ½ inch. Place these on the top bars of the frames directly over the brood cluster.

Paralysis

There are several conditions that cause symptoms similar to paralysis in adult bees. Paralysis is caused by

The manuscript was reviewed by P. F. Thurber, Kirkland, WA; James C. Bach, Chief Apiary Inspector, Div. of Plant Industry, WSDA, Yakima, WA; and Robert Saunders, State Entomologist, ISDA, Boise, ID.

a filterable virus. There are several forms of paralysis each differing only slightly in the observed symptoms.

Symptoms. The adult bees are often dark colored and shiny. The bees tremble and become weak and unable to fly. The affected bees usually crawl out of the hive to die or are carried out by healthy adults. Paralysis, like Nosema, usually is most severe in the late spring and disappears by early summer. It is what is often termed a "stress" disease and an infected colony is rarely destroyed by paralysis.

Control. There are no known chemical control materials available for the treatment of paralysis. If the disorder persists, the colony should be requeened.

One method of relieving paralysis is to move an infected colony 50 to 100 feet from its original location. All the worker bees should be shaken on the ground and the brood, queen, and remaining frames placed back into the hive at its original location. This should be done on a warm, sunny day. Most of the foragers will return to the original location, but most of the adult house bees with paralysis will be too weak to do so. The diseased bees should be killed within a few days. This treatment is not recommended unless the colony is fairly strong and populous because it sacrifices most of the healthy, young house bees.

Dysentery

While this is not a disease in the pathological sense, it too is often encountered in the spring.

Symptoms. Dysentery is the accumulation and release of faeces inside the hive. Dysentery is usually a sign of poor-quality winter stores, of moisture leakage into the hive, or inadequate protection.

Control. Bees wintered out-of-doors with supplies of good quality will normally take flight on warm, sunny winter days. In such hives dysentery does not appear.

DISEASES OF THE BROOD

American foulbrood (AFB) is by far the most serious of the diseases that attack the immature stages of honey bees (brood). Next in importance is European foulbrood (EFB); then chalkbrood, and finally, sacbrood. Occasionally a condition known as "chilled brood" appears in a colony. It occurs when the temperature in the brood nest lowers enough to kill a quantity of brood. In chilled brood it is usually the brood along the outer margins of the brood comb that is killed, while the brood area near the center remains healthy. Diseased larvae and pupae, by contrast, are found scattered

among healthy larvae throughout the brood area. See brood disease identification chart on page 4.

American foulbrood

American foulbrood is considered the most serious and destructive of all bee diseases in the United States. A colony can very quickly succumb to this disease. It is caused by a spore-forming bacterium, *Bacillus larvae*. Adult bees are not affected by this disease, but they can carry the infectious spores on their bodies or in their honey stomachs.

AFB is spread through the interchange of infected combs, or by bees robbing the honey stores of colonies weakened by the disease. Spores can live in honey and infected equipment for years. Once it begins AFB is extremely difficult to combat.

Symptoms. American foulbrood kills the infected brood while they are older larvae or pupae, but primarily in the sealed stage. The larvae dry down to the bottom of the cell and turn a coffee color. The decaying larvae have a ropy consistency and can often be pulled out of the cell $\frac{5}{8}$ inch or more with the head of a match (see fig. 1). They usually have a foul, rotten odor. Scales formed by the dead larvae or pupae stick tightly to the bottoms of the brood cells. It is very difficult for house bees to remove these scales. This is one reason why AFB is so difficult to completely eradicate from hives.

AFB characteristically kills the pupa, the intermediate stage between the larva and the adult bee. The pupa decays in the same manner as the larva, finally drying down to a black scale. The tongue of the pupa, like a fine thread, sometimes points toward the top of the cell. This characteristic is unique to AFB. See figures 2 and 3, page 4.

Once the spores of AFB are ingested by a larval honey bee they enter the digestive tract where the spore changes to a vegetative rod form, multiplies rapidly, and attacks the wall of the alimentary canal. This will eventually kill the infected larva.

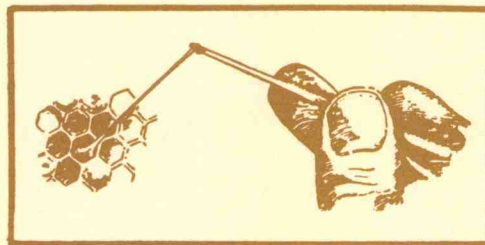


Figure 1. Diagram of a match test for the American foulbrood.

IDENTIFICATION OF BROOD DISEASES

	American foulbrood	European foulbrood	Sacbrood	Atypical European foulbrood
Causative organism	Bacillus larvae	Streptococcus pluton	Filterable virus	Bacillus alvei
Odor	Usually strong and foul	Slightly acid-sour	None to slightly sour	Slightly acid-sour
Amount of brood affected	Usually much	Usually much	Usually little	Usually much
Cappings	Often sunken and perforated	Affected brood mostly unsealed	Sunken caps less prominent than AFB, some with two holes	After sunken and perforated
Age of larvae	Usually die after capping	Usually die before capping	Usually die after capping	Many die after capping
Color of larvae	Become dark brown	Yellow, gray, brown	Become dark brown, head end darker	Become dark brown
Consistency of the larvae	Sticky, "roping" out $\frac{5}{8}$ " or more	Soft, breakable, sometimes slimy	Watery, granular, tough skin forms a sac	Slightly sticky rope. If any, less than $\frac{1}{2}$ "
Position of dead larvae in cells	Usually lengthwise. Soon become shapeless	Usually curled at bottom or on side-walls	Lengthwise, become mummified	Usually lengthwise soon become shapeless
Pupae	Sometimes affected. Tongue usually sticks up	Not affected	Rarely affected	Sometimes affected
Scales	Dark brown, stuck to floor of cell, brittle; fluoresce in ultraviolet light	Yellow to brown. Usually small, free, and at bottom of cell, tough and rubbery	Blackish, free, lengthwise along floor, brittle	Sometimes found but not stuck to floor of cell. Very hard. Can generally be removed

Control. Sulfathiazole, which was previously used as a preventive treatment for AFB, has been removed from this use by the Environmental Protection Agency. USDA researchers at Beltsville, Maryland are currently trying to obtain the data required for reinstatement of this medication. Directions for use of terramycin for prevention of both AFB and EFB are listed under the control section of the European foulbrood discussion.

Disposal. Bee inspectors try to examine all registered hives for the presence of diseases at least once a year. State laws usually require that colonies infected with American foulbrood be fumigated, rendered, or destroyed.

Diseased equipment can be fumigated with ethylene oxide, if it is done with the consent and supervision of the Chief Apiary Inspector. There is one fumigation

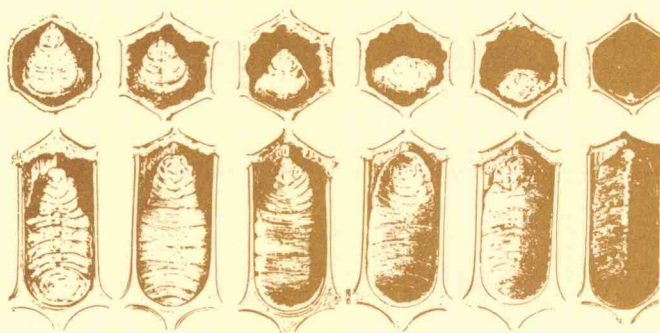


Figure 2. American foulbrood: end and top views of larvae showing progress of decay from the normal condition to the scale.

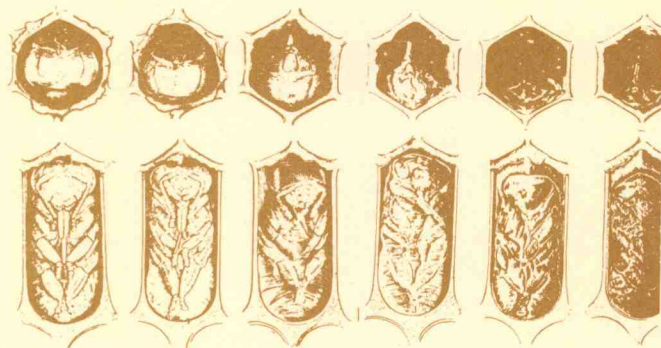


Figure 3. American foulbrood: end and top views of pupae showing progressive stages from the normal condition to the scale.

chamber in Oregon and one in Washington. Contact the Commodities Inspections Divisions, Oregon Department of Agriculture, Agriculture Buildings, Salem, OR 97321 or the Division of Plant Industry, Washington State Department of Agriculture, 2015 South First Street, Yakima, WA 98903. It may be permissible to save the bees in your state. Such colonies *must* be given the gorging treatment with medicated syrup and provided with antibiotic extender patties. Bees placed in fumigated equipment should also be medicated.

Honey bee colonies infected with American foulbrood normally *cannot* legally be medicated. State inspectors will *only* give permission to treat diseased colonies if you have arranged for the colonies to be fumigated with ethylene oxide under inspector supervision.

If a beekeeper wants to reclaim some of his disease-contaminated equipment, the keeper should seek the advice of the State Bee Inspector in the area. *All* diseased equipment should be brought to the attention of the inspector *before* any attempt is made to salvage. Sometimes hive parts can be salvaged under prescribed conditions.

The technique used for killing colonies is to place 1 tablespoon of calcium cyanide on a piece of cardboard and shove it into the hive entrance after dark. Close all openings to the hive to prevent bees from escaping from the colony. Do *not* apply calcium cyanide or any other poison with a dust gun.

Calcium cyanide has not been readily available in recent years. Resmethrin, a synthetic pyrethyroid has been developed as a safer material for beekeeper use. Resmethrin is currently available from some bee supply outlets.

Clothes moth or paradichlorobenzene (PDB) crystals can also be used to kill colonies. The method is essentially the same as that for calcium cyanide.

Place the dead bees and hive contents in a pit and burn them. Cover the ashes with 2 feet of dirt. *Fumes from calcium cyanide are poisonous. Do not inhale.*

Honeycomb AFB test. Sunken and perforated cap-pings sometimes occur in old, dried-out combs even though American foulbrood was not involved in death of the brood. This is of particular concern when buying used bee equipment. P. F. Thurber, Kirkland, Washington has developed a simple test for AFB under such conditions.

First, lightly moisten the combs to be tested. Then, seal them in a plastic bag and warm to about 90°F for several hours. When the bag is opened again, you will get a strong whiff of American foulbrood odor, if diseased material is present.

EFB is largely caused by a bacterium known as

European foulbrood

Streptococcus pluton, although several secondary microorganisms contribute to its symptoms. Some of these speed the death of the infected bee larva, others its decomposition. EFB sometimes occurs east of the Cascade Mountains but is far more prevalent in the wetter climates west of the Cascades.

Symptoms. Infected larvae normally die in the cells while still curled at the bottom. This disease does not usually attack sealed brood. When the larvae die they take on a grayish-yellow color, and the affected brood may give off a slightly sour odor. Dead larvae flatten against the bottom or side walls of the brood cell. See figure 4. When dry, the scale does not stick to the walls of the brood cell and may be removed easily. When the head of a match is stuck into a dead EFB larva the contents do not form a "rope" as with AFB.

Recently an atypical form of EFB caused by the microorganism *Bacillus alvei* has become a problem to beekeepers in areas of northwestern Washington and parts of western Oregon. Capping on cells containing infected larvae are often sunken and perforated as in AFB, and the larvae become dark brown. Consistency of the larvae is sticky, and sometimes they will rope out with a match stick up to 1/2 inch. When a larva is killed by atypical EFB, the scale formed is very hard and can generally be removed from the cell. This is not so with AFB.

Control. Strong colonies are usually able to clean out EFB without difficulty, although occasionally even a populous colony may be reduced in numbers by this disease. Uniting two or more colonies weakened by EFB strengthens them, enabling them to clean the diseased larvae from the cells. If you cage the queen *in her colony* for a 10-day period, you will free the colony to put

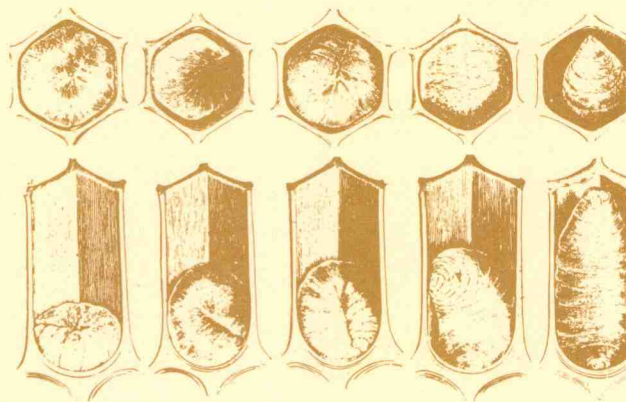


Figure 4. Dead larvae of various stages in the positions that result from European foulbrood.

its house in order; however, you have slowed down the normal growth rate. Requeening with vigorous, young stock is commonly recommended, since the bees will be better able to combat the disease.

Antibiotics have been developed for controlling EFB. With one remedy, you mix thoroughly 1 part of terramycin (Oxytetracycline) TM-25 to 7½ parts of powdered sugar. Other formulations of terramycin (TM-5, TM-10) can be mixed to provide an equivalent dose. Terramycin can be obtained from bee supply dealers. Dust 3 level tablespoons of this preparation over the ends of the top bars of the brood frames in the hive. Terramycin is toxic to larvae, *if* it is dusted directly onto them. Infected colonies should be dusted at weekly intervals until they are free of visible disease symptoms. Usually three dustings are enough. *Never medicate a colony immediately prior to or during a honey flow.* Soluble terramycin TM-25 is fed at the rate of 1 level teaspoon per 1⅔ quarts of a 1-to-1 sugar-water syrup (about 5 teaspoons per 2 gallons). *Terramycin loses its strength in syrup in about a week.*

Terramycin has the added advantage of helping to prevent AFB as well as EFB. Most commercial beekeepers use terramycin in annual *early spring* feedings as a disease preventative.

If medication is combined with fall feedings to build up stores for overwintering colonies, use 2-to-1 sugar-water syrup. Such fall feedings should be completed by September 15 in most areas of the Northwest.

Do *not* increase the dosage rate; too much terramycin can kill honey bee broods. Reduced dosages, on the other hand, may lead to the development of resistant disease organisms. Sulfathiazole is ineffective against EFB.

Chalkbrood

Brood diseases caused by fungi were not previously a major problem to beekeepers in the United States. Chalkbrood, a fungal disease of honey bee larvae and pupae has recently been reported from many states. This disease is caused by the fungus *Ascosphaera apis* which was not known to occur in this country until 1967. A very similar disease associated with other species of *Ascosphaera* is now causing severe problems for the commercially managed alfalfa leafcutting bee in certain areas.

Symptoms. Drone brood and recently sealed worker larvae are most susceptible to chalkbrood. The infected brood dries down to a mummified condition and often turns white. After the larvae die, they may turn dark brown or black. This coloration is caused by the appearance of the spore structures of the fungus just

under the outer surface of the dead larval bodies. Rarely is more than 5% to 10% of the brood affected. When greater amounts of brood are killed, the deaths are often associated with low temperature and moisture stress conditions. House bees are able to remove the dead larvae from their cells.

Control. There are no established chemical control agents for chalkbrood. Symptoms usually disappear during the summer as worker bees remove the infected brood from the colony. The disease may be combated through these general practices:

- Requeen with a young queen.
- Replace heavily infected combs with similar stage combs from a healthy colony.
- Get rid of larval mummies which are a source of fungus spore contamination.
- Don't use commercial pollen which is contaminated with chalkbrood fungus material.

Sacbrood

Sacbrood usually appears during the spring or early summer. It is rarely found after mid-season. While considered less serious than other brood diseases, sacbrood may so weaken a colony that the bees will produce little or no honey. The disease is caused by a filterable virus and is not accompanied by a characteristic odor.

Symptoms. Sacbrood attacks only the older larvae, most of which die in the 2-day period before pupation. Their color changes to brown and their skin toughens. Dead larvae form brown scales in the cells.

Control. Dead larvae may easily be removed with a match or a toothpick. A strong colony easily cleans out all the cells containing dead larvae. When a colony has become weakened, requeen it to produce a strong force of young bees to clean up the disease. Neither sulfathiazole nor terramycin has an effect on this disease.

ANTIBIOTIC TREATMENTS

Obviously, larvae should be fed a drug if they are to be protected from brood diseases. A direct transfer of the drug to the larvae is not possible. We rely on placing the drug at the disposal of the nurse bees which then pass it to the larvae.

Gorging bees with medicated syrup

One method which is more efficient than bulk feeding systems is to spray or sprinkle medicated syrup directly onto the bees. Bees are apt to store syrup from a feeder in combs.

To spray bees, tip the hive over backwards to a horizontal position. Return the bottom board and the first

brood chamber to their original positions. Direct a 1-to-2 sugar-water syrup containing medication down into the interspaces until all bees are wet. Use lukewarm (about 100°F) syrup and do *not* apply gorging treatments on cool days. Do *not* use honey syrup which may lead to robbing. Repeat the spray application for each set of combs as you reassemble the hive. Use as much syrup as will coat the combs without running out the entrance, from 1 pint to 2 quarts, depending upon the size of the colony. Use a small, high-pressure hand sprayer equipped with a coarse nozzle that will deliver about 1 pint of liquid per minute. Do *not* use a sprayer which has previously been used for pesticides.

In the "double treatment," a second spraying or sprinkling is applied to the bees soon after they have cleaned themselves and the combs of the first syrup, usually in about 20 to 30 minutes. To clean up the second application, bees in a populous two-story colony late in the spring will be forced to regurgitate the medicated syrup into cells throughout the brood-rearing area. This second spraying is called "gorging." It greatly increases the chances of the medicated syrup being fed to all the young larvae. As can be seen, this method of administering an antibiotic is quite laborious and not practical if many colonies are to be treated at one time.

Treatments should be repeated at least three times at 3- to 7-day intervals. This gives the colony time to

clean out the diseased larvae that would be a source of reinfection. With brood diseases, the gorging treatment should be used primarily as a preventive measure, but it may also cure infestations of European foulbrood. This method is also valuable for *Nosema* disease, since all the adult bees ingest the Fumidil-B. Gorging is best accomplished late in the day to minimize the chances of bees from other colonies robbing infected honey.

Medicated extender patties

Another excellent method for getting an antibiotic to the larvae is the medicated extender patty. Patties are longer lasting than syrup or dusting for continuous treatment. They are used very early in the spring and should be completely consumed well before the first nectar flows. They can be prepared as follows:

1. Mix $\frac{1}{4}$ pound powdered sugar with 1 tablespoon TM-25.
2. Cut in $\frac{1}{4}$ pound of shortening and blend well.
3. Divide into two parts and drop each into a waxed paper sandwich bag (or between two sheets of waxed paper).
4. Roll out to $\frac{1}{4}$ inch thick.

Feed the prepared patties in the early spring by placing one over the brood nest area of each hive body.

APIARY REGISTRATION

Responsibilities

State Departments of Agriculture are responsible for inspecting bees to determine the presence of foulbrood. They are also responsible for information on moving live bees from one state to another. To assist in these duties it is state law in Oregon, Washington, and Idaho that beekeepers register their hives with their respective Department of Agriculture. Requests for information on these matters should be made to the Chief Apiary Inspector, Department of Agriculture, Agriculture Bldg., Salem, Oregon 97310 or 2015 South First St., Yakima, Washington 98903 or to the State Entomologist, P.O. Box 790, Boise, Idaho 83705.

Registration should be made on or before April 1 of each year. Oregon and Idaho charge a registration fee. Cooperation in registering colonies is to your benefit. Apiary inspectors have the responsibility of carrying out and enforcing provisions of Washington, Idaho, and Oregon Agricultural Codes.

Shipping samples for diagnosis

If you suspect the presence of a disease, send samples of brood or adult bees for examination to Honey Bee Pesticides/Diseases Research Unit, USDA-SEA, University Station, Box 3168, Laramie, Wyoming 82077.

For brood disease diagnosis, cut about a 4-inch square comb sample containing the affected brood or brood remains. Make certain that no honey is present and that the comb is not crushed. For adult disease diagnosis, send approximately 100 sick or dead bees. Mail all samples in a wooden or sturdy cardboard box. Do not use tin, glass, plastic, aluminum foil, or waxed paper. These materials promote mold growth that increases the difficulty of making a satisfactory diagnosis. Write your name, address, and ZIP code clearly on the box. If your State Inspector forwards the sample, his name, address, and ZIP code should also appear on the box or in an accompanying letter.

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