

## Managing Maladies

### Diseases, Parasites, and Pests and Their Control

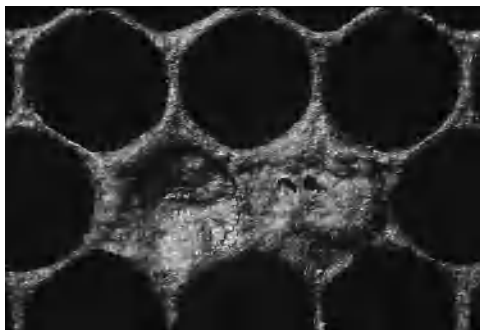
The first line of defense in protecting your colonies from diseases, mites, and other maladies lies in your ability to detect and recognize early symptoms of these problems. Failure to recognize problems early can lead to decreased productivity and weak and even dead colonies.

### Brood Diseases

#### AMERICAN FOULBROOD

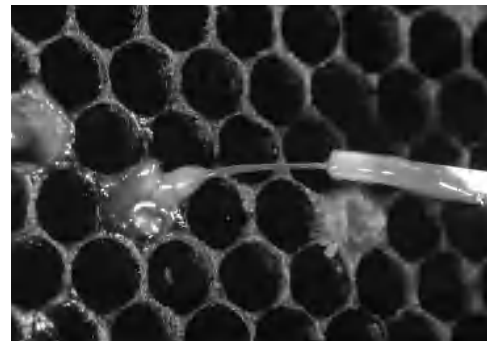
American foulbrood (AFB) is an infectious brood disease caused by the spore-forming bacterium *Paenibacillus larvae*. It is the most widespread and destructive of the brood diseases. Adult bees are not affected by AFB. *Paenibacillus larvae* occurs in two forms: vegetative (rod-shaped bacterial cells) and spores. Only the spore stage is infectious to honey bees. Larvae less than 53 hours old become infected by swallowing spores present in their food. Older larvae are not susceptible. The spores germinate into the vegetative stage soon after they enter the larval gut and continue to multiply until larval death. New spores form after the larva dies. Death typically occurs after the cell is capped, during the last 2 days of the larval stage or first 2 days of the pupal stage.

Brood combs in an infected colony have a scattered and irregular pattern of capped and uncapped cells. Infected cells are discolored, sunken, and have punctured cappings (Figure 36). This “pepperbox” appearance contrasts with the yellowish-brown, convex, and continuity of sealed cells of a healthy brood comb (Figure 8, page 6). Dead larvae

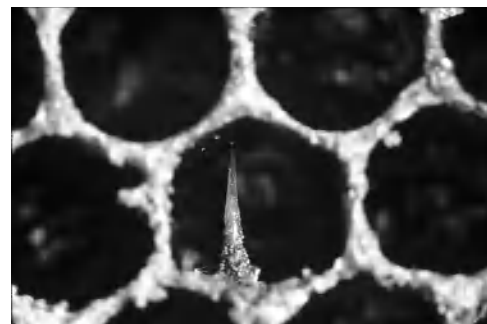


**Figure 36.** Brood cells from a colony with American foulbrood, showing sunken, punctured cappings. (Courtesy Scott Camazine)

change gradually from a healthy pearly white to light brown and then to a dark coffee-brown. With American foulbrood, this color change is uniform over the entire body. Within a month or so, these dead larvae dry down into brittle scales that are almost black. Each scale contains as many as 100 million spores. The scales lie flat along the lower walls of the cells with the rear portion curving partway up the bottom of the cell. House bees cannot completely remove the scales from the cells. During the early stages of decay—up until about 3 weeks after death—the dead larvae have a glue-like consistency. The cell mass may string out for an inch or more when a toothpick is inserted and withdrawn; this is known as the “ropy stage” (Figure 37). When death does not occur until the pupal stage, pupae undergo the same changes in color and consistency as larvae. In addition, a pupal tongue sticks up from the remains toward the top wall of the cell; this is one of the most characteristic symptoms of American foulbrood but may not always be present. (Figure 38).



**Figure 37.** American foulbrood; larval remains “roped out” when a match stick is inserted and withdrawn. (Courtesy Scott Camazine)



**Figure 38.** Scale of American foulbrood showing remains of pupal tongue. (Courtesy Scott Camazine)

Only a few dead larvae or pupae will be seen when the colony is first infected by the disease. Once established though, AFB spreads rapidly through the brood area. If left unchecked, AFB can be transmitted quickly to other healthy colonies at the same location and even to nearby apiaries.

Nurse bees within the hive inadvertently feed honey contaminated with spores to young larvae, which perpetuates the disease. As the number of brood cells increases with the scales of dead larvae, which are spore reservoirs, housecleaning bees also aid in spore dispersal. Honey supplies within the brood chamber soon become contaminated as honey is stored in these spore-laden cells. Bees also transfer honey from the brood chamber to the supers above, thus spreading disease throughout the entire hive.

As the infection weakens a colony, the colony can no longer defend itself against robbers from strong colonies in the area. Spore-contaminated honey is spread quickly from hive to hive.

American foulbrood is also transmitted through the interchange of combs between hives. When this disease is not recognized in an apiary, combs from a diseased hive inadvertently may be: (1) used in making splits or increases, (2) used in exchanging brood and food between hives, and (3) mixed with combs from other hives during honey extraction. In addition, the beekeeper's hive tool and gloves may spread AFB from hive to hive.

American foulbrood spores are highly resistant to desiccation, heat, and chemical disinfectants. These spores can remain virulent for more than 40 years in combs and honey. Therefore, honey should not be purchased from other sources to feed bees. Only feed combs of honey if you are absolutely sure they are disease free. An inexperienced beekeeper should not buy bees or equipment that have not been examined by an inspector or someone else familiar with the disease. Even a stray swarm from an infected colony may carry AFB. American foulbrood cannot be transmitted to humans and has no effect on honey for human consumption.

Because of the highly contagious and devastating action of the disease, every beekeeper should know the symptoms and be able to recognize AFB in its early stages. If you suspect disease and need help in diagnosis, contact your state apiary inspection service (see appendix or consult the MAAREC Web site: [maarec.cas.psu.edu](http://maarec.cas.psu.edu)).

Samples of diseased comb for laboratory diagnosis can be sent to:

BELTSVILLE BEE RESEARCH LABORATORY  
BUILDING 476 BARC-EAST  
BELTSVILLE, MD 20705

To send samples for diagnosis, select a sample of brood comb about 4 inches square that contains a large number of suspect cells. The section of comb can be wrapped in some type of breathable material such as tissue or paper towel and mailed in a strong cardboard box. Do not use aluminum foil or plastic bags. Samples that are crushed, wet from condensation, or moldy because of improper packaging make diagnosis impossible. Another alternative is to send a smear of the contents of the suspect cells in aluminum foil.

Colonies infected with American foulbrood should be destroyed by burning. Burning the bees and all of the equipment is the only sure way to be absolutely free of this disease. The bottom board, hive bodies, supers, and inner and outer covers can be disinfected and reused. However, there is no guarantee that the equipment can be completely sterilized, and the disease may reappear. Before burning, diseased colonies should be killed in the evening after all foraging activities have ceased. This can be done by drenching the bees in the colony with soapy water. Burning bees and equipment found to be infected with antibiotic-resistant AFB is highly recommended and even mandatory in some Mid-Atlantic States.

To burn diseased equipment, dig a pit 18 inches deep and wide enough to hold all combs and equipment to be burned. Build a fire in the pit. Set your unopened hive close to the pit and drop all combs and dead bees into the fire. After everything has been completely burned and the area cleaned of small pieces of comb or bees, cover the ashes with dirt.

Equipment that was saved (bottom boards, hive bodies, and covers) should be scraped to remove all propolis and wax, then scrubbed with a stiff brush and hot, soapy water. Dispose of the wash water and burn the scrapings so they are not accessible to the bees. After scraping and scrubbing, all equipment should be either fire scorched or completely immersed in a boiling lye solution. Prepare your lye solution (sodium hydroxide) by mixing 1 pound of lye with 10 gallons of water. Boil the equipment for

20 minutes; wooden parts can be damaged by longer exposure. Weaker solutions may not remove all of the wax and propolis from the equipment. Remember that lye solutions are caustic and can cause severe burns. Before using, read the label carefully and observe all precautions.

A blowtorch is suitable for scorching small quantities of equipment. Burn the surface until it is light brown, making sure to include the corners. For large quantities of hive bodies, brush the inside surfaces with kerosene. Stack the hive bodies with the metal rabbets facing downward on top of each other, five to eight supers high, and then ignite the stacks, allowing them to burn long enough to lightly char the wood. Another approach is to fill the stack with wadded sheets of newspaper sprinkled with kerosene. Place an outer cover on top of the stack to smother the fire when you are finished.

Antibiotics such as Terramycin® (oxytetracycline HCL) have been used as a preventive measure as well as a treatment against American foulbrood. These antibiotics do not kill *Paenibacillus larvae* spores but prevent or delay their growth when present in low concentrations in the food fed by workers to susceptible larvae. While this treatment allows individual larvae to survive, it does absolutely nothing about the virulent spores in the contaminated equipment. Thus, the disease usually reappears once drug feeding stops. In addition, increasing numbers of colonies and whole beekeeping operations are being found infected with AFB that is resistant to the antibiotic Terramycin. New antibiotics are being investigated for treating foulbrood. However, inevitably over time these too will have reduced effectiveness due to the inherent ability of diseases to develop resistance to drugs.

For detailed information on approved chemicals for treating American foulbrood and their use, see the appendix or visit the MAAREC Web site: [maarec.cas.psu.edu](http://maarec.cas.psu.edu). If you do not have Internet access, contact your local cooperative extension office.

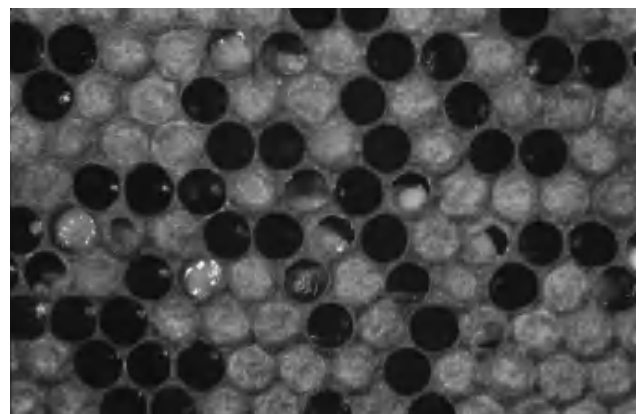
**CAUTION:** Do not feed antibiotics to your colonies when there is any danger of contaminating the honey crop. All drug feeding must stop at least 6 weeks before any surplus honey flow. Every precaution should be taken to ensure that no antibiotic will ever be present in honey taken from the hive.

## EUROPEAN FOULBROOD

European foulbrood (EFB), another bacterial brood disease, is caused by *Melissococcus pluton*. This disease is considered a stress disease and is most prevalent in spring and early summer—the period when brood rearing is at its height, although the earliest brood is rarely affected. European foulbrood frequently begins to disappear with a nectar flow and may disappear entirely for the balance of the year; or it may reappear during nectar dearths in the summer or fall. Occasionally, the disease remains active throughout the entire foraging season. All castes of bees are susceptible; commercial strains differ in susceptibility.

The disease and its symptoms are highly variable, probably because several other types of bacteria are often present in dead and dying larvae. EFB usually does not kill the colony, but a heavy infection will seriously reduce population development. European foulbrood generally kills larvae 2 to 4 days old while they are still coiled in the bottom of the cells (Figure 39). Unlike American foulbrood, most of the larvae die before their cells are capped. A spotty pattern of capped and uncapped cells develops only when EFB reaches serious proportions. Occasionally, pupae die from the disease.

The most significant symptom of EFB is the color change of the larvae. They change from a normal pearly white to yellow, then brown, and finally grayish black. Larvae also lose their plump appearance and look undernourished. In such cases, larval remains appear twisted or coiled in the bottom of the cell (Figure 40, next page). They form a thin brown or blackish-brown scale and show distinct lines where their breathing tubes are located.



**Figure 39.** Larvae infected with European foulbrood. (Courtesy Maryann Frazier)

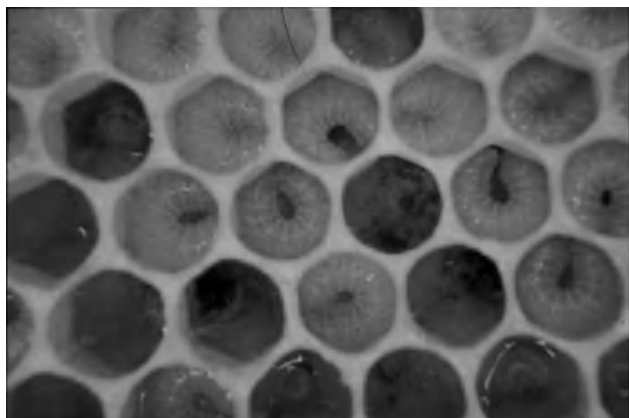
Recently dead larvae are rarely ropy. Scales can be removed easily from the cells because they do not adhere tightly to the cell as in American foulbrood. Bees remove the scales under the stimulus of a nectar flow or feeding.

*Melissococcus pluton* does not form spores, but the organism often overwinters on combs. It gains entry into the larva in contaminated brood food and multiplies rapidly within the gut of the larva. Not all infected larvae die from the disease. Some develop normally and void the germ or regurgitate the bacteria onto the underside of the cappings, which then become sources of the disease.

In some cases, European foulbrood can be eliminated by requeening colonies with a young queen. Requeening accomplishes two things: it gives the colony a more prolific queen and it permits a time lag between brood cycles that allows the house bees to remove diseased larvae from their cells. Antibiotics such as Terramycin have been used to treat this disease.

For detailed information on approved chemicals for treating European foulbrood and their use, see the appendix or visit the MAAREC Web site: [maarec.cas.psu.edu](http://maarec.cas.psu.edu). If you do not have Internet access, contact your local cooperative extension office.

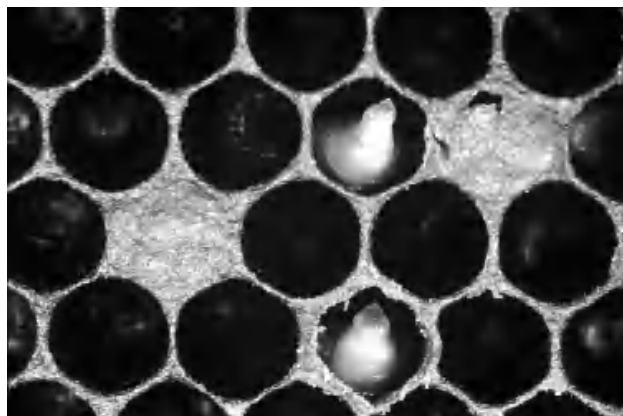
**CAUTION:** *Do not feed antibiotics to your colonies when there is any danger of contaminating the honey crop. All drug feeding must stop at least 6 weeks before any surplus honey flow. Every precaution should be taken to ensure that no antibiotic will ever be present in honey taken from the hive.*



**Figure 40.** European foulbrood advanced; larva twisted in cell. (Courtesy Dewey Caron)

## SACBROOD

This disease, caused by a virus, does not usually cause severe losses. It is most common during the first half of the brood-rearing season and often goes unnoticed since it usually affects only a small percentage of the brood. Both worker and drone larvae are affected. Pupae may be killed occasionally, whereas adult bees are immune to it. Death usually occurs after the cell is sealed and the larva has spun its cocoon. Dead brood is often scattered among healthy brood. The cappings over dead brood are first punctured and later removed by the bees. The larvae gradually change from pearly white to dull yellow or gray and finally to black. The head of the larva, the first part of the body to change color, becomes black. Larvae die in an upright position with raised heads (Figure 41). Diseased



**Figure 41.** Dead larva infected by sacbrood with typical darkened, raised head. (Courtesy Scott Camazine)



**Figure 42.** Larva infected with sacbrood that has been removed from the cell. Note the sac-like appearance of the larva when removed. (Courtesy Scott Camazine)

larvae are easily removed intact from the cells, unlike those afflicted with American foulbrood. The contents of the larvae are watery, and the tough outer skin appears as a sack or bag of fluid when suspended (Figure 42). The dried scale lies flat on the lower side of the cell, with the head end raised and the tail flat on the bottom of the cell. The scales are rough and brittle and do not adhere tightly to the cell wall.

Nurse bees are suspected of transmitting the disease by carrying the virus from cell to cell. It is also believed that robber bees spread the disease by carrying contaminated honey from colony to colony.

Sacbrood usually disappears in the late spring when the nectar flow has started. Strong colonies and regular requeening seem most effective in combating this disease. No antibiotic is effective in preventing or controlling sacbrood.

### CHALKBROOD

Chalkbrood is a fungal brood disease of honey bees caused by the spore-forming fungus *Ascosphaera apis*. Worker, drone, and queen larvae are all susceptible. Dead larvae are chalky white and usually covered with filaments (mycelia) that have a fluffy, cotton-like appearance (Figure 43). These mummified larvae may be mottled with brown or black spots, especially on the ventral sides, due to the presence of spore cysts or fruiting bodies of the fungus.

Diseased larvae can be found throughout the brood-rearing season but are most prevalent in late spring when the brood nest is rapidly expanding. Chalkbrood usually disappears or declines as the air temperature rises in the summer. Affected larvae are found on the outer fringes of the brood nest where there are too few nurse bees to maintain brood nest temperature. Brood cells can be either sealed or unsealed. Young pupae or recently sealed larvae are most susceptible. Infected larvae, stretched out in their cells, are removed by nurse bees 2 to 3 days after symptoms first appear. Dead larvae (mummies) are often found in front of the hive, on the bottom board, or in the pollen trap (Figure 44). In strong colonies, most of these mummies will be discarded by worker bees outside of the hive, thus reducing the possibility of reinfection from those that have died from the disease.

Spores of the fungus are ingested with the larval food. The spores germinate in the hind gut of the bee larva, but mycelial (vegetative) growth is arrested

until the larva is sealed in its cell. At this stage, the larva is about 6 or 7 days old.

The mycelial elements break through the gut wall and invade the larval tissues until the entire larva is overcome; this process generally takes from 2 to 3 days.

Spores remain virulent for years. Therefore, infected pieces of equipment, especially brood combs, are a reservoir for further infection. Chalkbrood usually does not destroy a colony. When the disease is serious, however, it can prevent normal population buildup and surplus honey production. Research has shown that the spores are easily passed from bee to bee. Therefore, drifting and robbing bees are potential vectors of the disease. Both workers and queens taken from infected colonies can transmit infection to healthy colonies. Colonies fed pollen collected from infected colonies will also contract the disease.

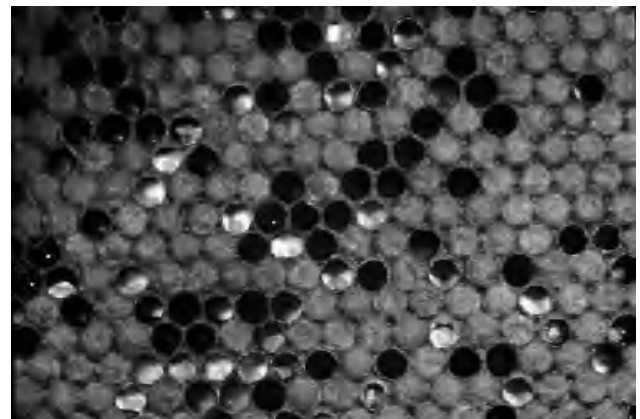


Figure 43. Worker larvae infected with chalkbrood. (Courtesy Scott Camazine)



Figure 44. Chalkbrood "mummies" removed by workers and dropped at hive entrance. (Courtesy Maryann Frazier)

Chalkbrood infections are not always visible in the brood nest. Therefore, beekeepers who collect pollen to sell or to feed to their bees should check the pollen and pollen traps from each colony for whole mummies or mummy parts. No treatment is presently available for control. However, colonies with persistent cases may benefit from requeening, particularly with hygienic stock.

### STONEBROOD

Stonebrood is also a fungal disease. Several fungi belonging to the genus *Aspergillus* are associated with the disease, the most common being *A. flavus* and *A. fumigatus*. However, *A. flavus* is considered, by far, the most important.

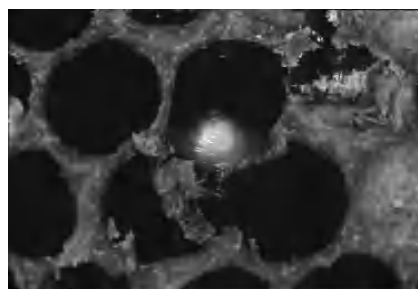
Both larvae and pupae are susceptible. The disease causes mummification of the infected brood. Mummies are hard and solid, not sponge-like as in the case of chalkbrood. Brood infected by *A. flavus* become covered with a powdery green growth of fungal spores. The spores are found most abundantly near the head of the affected brood.

This disease is considered of minor importance and is rarely encountered. No treatment is recommended. The bees remove the dead brood on their own and the colony normally recovers in a short period of time.

### PARASITIC MITE SYNDROME (PMS)

For the past several years, we have been seeing diseased bee larvae with symptoms resembling a cross between foulbrood and sacbrood. The USDA Beltsville Bee Lab has found these diseased larvae to be infected with one, or commonly several, viruses. This situation is associated with varroa mites. The complex of symptoms has been given the name "Parasitic Mite Syndrome" or PMS.

Affected larvae die in the late larval or prepupal stage, stretched out in their cells often with their heads slightly raised (Figure 45). In the early stage of infection, they are white but dull rather than glistening, and they look deflated. Later, the larva may have gray or brownish spots. Prepupae die after the cell has been capped, and the cappings may be perforated or completely removed by the bees. When the larval remains are stirred with a toothpick or small twig, they do not rope out but are globular (similar to European foulbrood).



**Figure 45. Virus-infected larva.**  
(Courtesy Maryann Frazier)

Since the virus complex is associated with varroa mites, controlling varroa is important in combating or at least controlling these viruses. Because many infected colonies seem to collapse in early fall, dealing with mite populations well before this time is necessary. Please see information under "Varroa Mite" for details on managing these mites in honey bee colonies.

Several years of survey data collected in the MAAREC region indicate that beekeepers treating varroa mite-infested colonies in autumn with fumagillin (Fumidil-B®) significantly improved colony winter survival. Fumagillin fed in sugar syrup is used to suppress nosema disease in overwintered colonies and newly established packages. Nosema disease weakens the digestive tracts of infected bees and may allow pathogens to enter the honey bees' guts where they can cause significant damage. Treating colonies in fall with fumagillin might help to protect bees from some of the pathogens associated with varroa mites, thus improving their chances of survival. Please see "Nosema" and the appendix at the back of this book for more information on treating colonies with fumagillin.

## Diseases of Adult Bees

### NOSEMA

Nosema disease, an obscure killer, is caused by a spore-forming protozoan (*Nosema apis*) that invades the digestive tracts of honey bee workers, queens, and drones. Spores of the disease are ingested with food or water by the adult bee. The spores germinate and multiply within the lining of the midgut. Millions of spores are shed into the digestive tract and eliminated in the feces. Damage to the digestive tract may produce dysentery and weaken the bees. As a result, the productive life of the worker is shortened and its ability to produce brood food decreases, thus retarding brood production and