



TECH TRANSFER PROGRAM CORNER

Honey Bee Diseases, Pests, Identification, Diagnosis and Treatment

By Dr. Renata Borba, ABC Tech Transfer Lead

The clustered and warm environment of the honey bee colony provides a favorable condition for growth of many pathogens. As a result, honey bees act as a host for a multitude of pathogens and parasites. Protecting bees from pathogens and disease is an integral component of the hive management, which requires dedication to learning about disease identification, diagnosis and treatment. For the next few months we will discuss the most common bacterial, fungal and viral diseases, as well as the widely spread parasitic mite *Varroa destructor*.

While being able to identify signs of a disease may be crucial for the survival of the colony, it is as important for a beekeeper to understand about the nature and healthy/normal behavior of bees. In some situations, a perfectly healthy colony can show signs that are very similar to a disease infection but instead, it may be due to queen problems or management practice.

AMERICAN FOULBROOD (Part one of a two part series) (By Dr. Meghan Milbrath)

Honey bee colonies can be infected with two bacterial diseases: **American Foulbrood (AFB)** and **European Foulbrood (EFB)**. They are called 'Foulbrood' because both diseases affect the brood (the term for bee larvae and pupae) and these diseases cause the hive to have a particular foul odor. In this article, we will discuss how to identify and safely manage American Foulbrood, the more severe bacterial disease. Infection with AFB is serious, needs immediate attention, and may require the involvement of a veterinarian. Early diagnosis and prompt response is essential for preventing the spread of AFB.

Inspection for disease

Take care when inspecting hives to prevent the transmission of bacteria or spores to healthy colonies. While unlikely, be aware that bacterial spores can be transmitted by hands, hive tools, smokers, and any beekeeping equipment. Wear nitrile or latex gloves when working in hives that may have foulbrood, remembering to remove and safely dispose of them before handling another hive. Do not wear leather beekeeping gloves

when inspecting someone else's colonies, or when working with sick hives, as they cannot be cleaned. Wash beekeeping jackets and other equipment often.

Keep your hands clean. Wash your hands often and well. If water is not available at your site, use rubbing alcohol or hand sanitizer and rub vigorously. Remove all the wax and propolis from your hands, as spores can remain in these materials. Best practice is to use nitrile gloves - being careful to remove and dispose of them after handling an infected hive.

Make sure that your hive tools are completely clean. After working suspect or sick hives, switch to a clean tool. If water is available soak your tools in bleach solution, and use a chlorinated scrubbing cleaner like comet as well as rubbing alcohol to remove all of the propolis that can accumulate on the tool. Clean tools can be autoclaved if facilities are available. If no water is available, you can flame the tool, but some spores may still remain in any attached propolis and wax.

American Foulbrood is an infectious and highly contagious disease caused by a gram-positive spore-forming bacterium, *Paenibacillus larvae*. AFB has been known to affect honey bees for hundreds of years. It is found all around the world, though different genotypes predominate in different areas. AFB is considered by many to be the worst disease of honey bees. There are three reasons why this disease is so serious:

1. AFB has a highly persistent spore form that can remain infectious for decades and spread easily to other colonies.
2. AFB can devastate an otherwise healthy hive. It does not require another stressor, and colonies do not spontaneously recover – AFB generally leads to death.
3. It is highly infectious – only a few spores are needed to cause infection in an otherwise healthy colony.

The infectious spore form is incredibly stable in the environment. It can persist for decades on equipment, honey, wax, pollen, etc., and can remain infectious years later, even after freezing, droughts, and humidity. No other honey bee disease is known to be as persistent, and great care must be

taken with the equipment of colonies known or suspected to be infected with AFB. If a beekeeper does not notice or appropriately deal with an infected colony, they can easily spread the spores throughout their entire operation through actions taken in routine apiary management.

AFB spores infect the bee early in the larval stage (12 - 48 hours old), generally through infected food. Infection spreads quickly among the larvae, as nurse bees move from cell to cell during feeding. Only a few spores (<10) are required to cause disease in larvae. Adult bees can carry the spores, but are not affected. The spores germinate into the active vegetative form when they reach the larval intestine. They begin to reproduce, and the bacteria massively colonize the midgut. In the midgut, the bacteria release toxins and enzymes that digest the larval tissues. As the disease worsens, the gut epithelium (lining) is breached, and the infection spreads to all tissues, causing sepsis and death. In the strain of AFB found in the US, death occurs just as the larvae are capped (in a cocoon to commence pupation). The larvae completely breakdown into a glue-like biofilm. As conditions become unfavorable for the vegetative form, the bacteria form spores. A single dead larva may contain millions of infectious spores.

Clinical signs of American Foulbrood

The clinical signs of AFB are variable, and what you see will depend on the stage of the disease and the time elapsed since infection. At the beginning of an outbreak in a colony, only a few larvae may be infected. As the disease progresses, the population in the colony dwindles, as very few young bees survive.

Foul odor: As the infection continues, a particular foul odor will develop. In a severely infected colony, the odor may be detectible without opening the hive. Some beekeepers can smell the odor easily, and can tell there is an infected hive as they enter the yard. Other beekeepers can never smell the odor, and may not recognize it, so an absence of smell does not mean AFB is absent. The presence of a bad smell does not necessarily mean that AFB is present, as larval decay for any reason will smell unpleasant.

In addition to the foul smell, AFB causes a characteristic set of visual signs in the brood nest of a hive:

1. **Spotted brood pattern**
2. **Sunken cappings**
3. **Off center holes in cappings**
4. **Larval scale**
5. **Caramel color of dead larvae***
6. **Pupal tongue***

* These two signs (caramel color and pupal tongue) are unique to AFB.

Remember: a few gaps in the brood are considered normal, but capped cells are generally touching other capped cells, and the cappings look dry, even, and uniform.

Signs of AFB

1. Spotted or "shotgun" brood pattern

In a healthy colony, the cappings over the pupae should look uniform in shape and consistently colored. The larvae are generally raised in groups of the same age, so a healthy brood pattern would appear to be largely unbroken. In a heavily infected colony, few larvae live to emerge as adults, and the pattern becomes broken as they die and are replaced in a non-regular order.



A spotty brood pattern: This pattern is often referred to as "Shotgun" because it looks like shot sprayed on the frame

Photo by Sarah B. Scott

Not all spotty brood patterns are caused by AFB. Many other factors can cause spotty brood: other diseases, a poor queen, or environmental factors such as chilling or poor nutrition.

2. Sunken cappings

Larvae that are infected with AFB die just after the cell is capped. The death of the larvae can cause the cap to shrink down, and appear deflated. Other diseases, including non-typical EFB can kill the larvae at this stage, so sunken cappings are usually present, but not unique to AFB.



A typical frame of a colony in the early stages of AFB infection. Note the sunken, discolored cappings beginning to form holes, as well as the spotty, irregular pattern. As infection progresses, it is common for these cappings to develop a wet or greasy appearance. Note also that the adult bees that are present will appear to be completely healthy

Photo by Sarah B. Scott

3. Holes in cappings

As the larvae continue to die, many of the cappings will darken, and develop a hole. The holes are generally jagged and off-center.

Don't be mistaken by healthy holes!

Holes in the cappings are not always indicative of AFB; there are situations where you can witness holes in the cappings in a healthy hive: during the capping process, when the bees are emerging from the cells, and due to hygienic behavior.

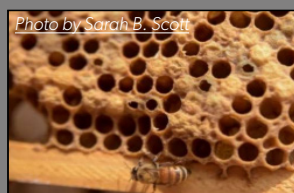


Photo by Sarah B. Scott

Holes in cappings of AFB-infected drone larvae (the caste is indicated by the larger size of the cell). AFB can infect workers, drones, and queens in the larval state

4. Larval scale

The larvae succumb to AFB just as they are capped. This means that signs of disease are visible in capped cells, as shown above, as well as in the open cells of older larvae. Healthy larvae are always a brilliant, glistening, pearly white. As the larvae die, they darken and flatten against the lower cell wall, almost looking like they have melted into a goo. Newly dead larvae appear wet, and are light tan or caramel colored. They will continue to desiccate, eventually drying into a scale at the lower cell wall (the side that is parallel to the ground when the frame is in the normal position). The scale of AFB will be hard, and stuck to the cell wall.

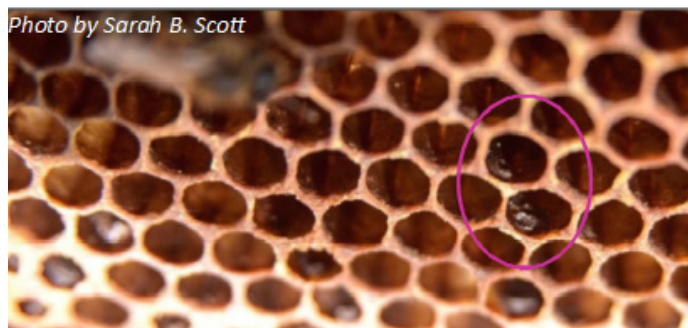


Photo by Sarah B. Scott

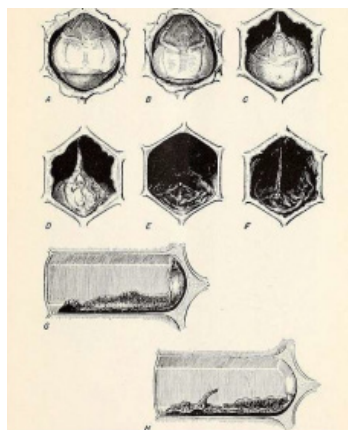
Larval scale. Note the dried, blacked larvae on the wall of the cells (this side would be towards the ground in the hive). Each of these scales can contain millions of AFB spores



How to inspect for larval scale. Hold the frame with the top bar facing towards you with the sun over your shoulder. Look at the cell wall that is directly facing towards you to inspect for a dried black scale. Photo courtesy of Randy Olive

5. Pupal tongue

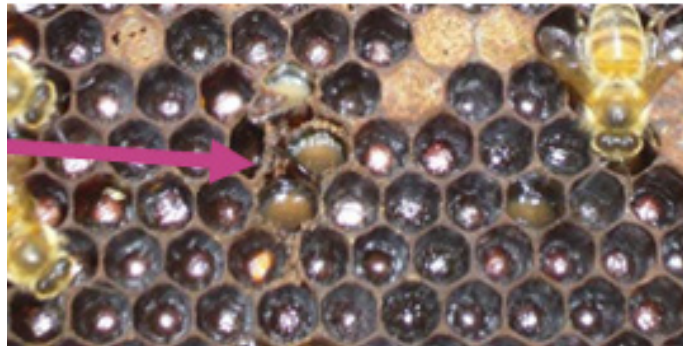
If the larvae live a bit after they are capped, then they can start to pupate. Larvae that die at this stage often leave what is called a 'pupal tongue' - the larvae melt, but the embryonic proboscis structure, which is more firm, does not melt, and can be retained as a visible point. This sign is less commonly seen, but is unique to AFB. If pupal tongue is not visible, you may still have AFB, but if you do see it, then you very likely are dealing with an AFB infection.



Decay of pupae infected with American Foulbrood. From 'Diagnosing bee diseases in the apiary' By C. E. Burnside. Panel A shows a healthy pupa, while panels B-F show the various stages of decay. The point visible in panel F is commonly referred to as the 'pupal tongue'. via Wikimedia Commons by Burnside, C. E.; Sturtevant, Arnold Parker [Public domain]

6. Caramel color

As the bacteria breakdown the larvae, they form a caramel color biofilm. This may not always be visible as this stage is only temporary. This color is characteristic of AFB. Other diseases cause larval discoloration, but they generally range from yellow to gray.



Frame with AFB with characteristic caramel coloring. Photo by Randy Oliver

A note on old equipment

Many new beekeepers are tempted to purchase used equipment or to use old equipment from a friend or family member. A common high-risk scenario is a beekeeper who wants to start beekeeping using their grandfather's equipment that they found out in the barn. If the grandfather stopped keeping bees in the 1930s - 1980s there is a real chance that they stopped beekeeping after they lost their bees to American Foulbrood, as the disease peaked during that era. It is highly likely that this equipment can still contain viable spores of AFB, and pose a threat to bees. It is impossible to use any of the field tests to determine if the old equipment is safe. If a beekeeper wants to use old equipment of unknown origin or uncertain history, the frames should all be burned, and the rest of the woodenware should be sterilized as explained later in this document. If the used equipment is from a new beekeeper who quit beekeeping after 1-2 years of failure (which is also common), there is still a risk of AFB spores, but it is not likely. The current main epidemic is varroa-associated viruses, which are not known to be as environmentally stable. When starting new hives, the best practice is to always use new equipment and to carefully inspect any incoming equipment, such as during the purchase of nucleus colonies.

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