

# American Foulbrood–Biology and Diagnosis

## Infosheet

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American foulbrood (AFB) is the most serious brood disease of honey bees. AFB is caused by a spore-forming bacteria, *Paenibacillus larvae*; that is specific to honey bees. This disease is highly contagious, will weaken and in most cases kill a honey bee colony. AFB will also contaminate beekeeping equipment which must then be destroyed to prevent the spread of AFB to additional colonies. There is **no cure for AFB**. Beekeepers can only take steps to prevent an infection from establishing itself in a beekeeping operation.



Figure 1.



Figure 2.



Figure 3.

Figure 1. Ropey test of AFB infected larvae. Figure 2. AFB infected larvae settling to the bottom of the cell. Figure 3. old dried AFB infected larvae or AFB scale.

Note: In the past AFB was known by the species name *Bacillus larvae*.

### PREVALENCE

AFB may be found at any time of the year in honey bee colonies or in used beekeeping equipment infected with bacterial spores. Used equipment infected with AFB can remain contaminated for decades.

There are strains of AFB present outside Ontario that may be resistant to currently registered drug treatments for AFB such as oxytetracycline. Although AFB is found throughout Ontario, there have been no instances of AFB resistant to oxytetracycline in Ontario. To maintain this status, beekeepers must adhere to requirements when importing bee stock from other provinces or countries. Beekeepers must also take care not to misuse antibiotics. See 2012 [Treatment Recommendations](http://www.omafra.gov.on.ca/english/food/inspection/bees/11-treatment-recomms.htm) (<http://www.omafra.gov.on.ca/english/food/inspection/bees/11-treatment-recomms.htm>)

### IMPACT

AFB has the potential to contaminate beekeeping equipment when it can no longer be safely used. In most situations AFB is highly virulent and once contracted will kill a colony. An AFB infection can spread to other honey bee colonies up to an 8 km radius (typically 3.2 km). AFB can spread anywhere infected colonies are located and

whenever contaminated equipment is exchanged, no matter what the distance. One beekeeper's AFB infection can quickly become another beekeeper's problem. This risk makes AFB an economic threat to commercial beekeepers.

### **LIFE CYCLE AND BIOLOGY**

AFB has two major life stages; the vegetative stage and the spore forming stage. AFB will only impact developing honey bee larvae. Adult honey bees are not affected.

#### **1. Spore stage**

AFB spores are picked up by worker bees from infected honey bee colonies or equipment contaminated with large numbers of spores. These spores are highly resistant to heat and other environmental factors and can remain viable in contaminated used honey bee equipment for up to 70 years.

#### **2. Vegetative stage**

Spores contaminate the mouthparts of worker bees and are fed to developing honey bee larvae via brood food (less than 2 days old). The spores undergo a transformation into the vegetative stage of the bacterium, rapidly multiplying in the tissues of the larvae, generating billions of new spores.

#### **3. Spore stage**

The honey bee brood dies after the brood cell is capped then decomposes into a gooey mass, referred to as "AFB scale". This scale settles to the bottom of the cell. Eventually the scale dries, becomes black in color, hardens and adheres firmly to the wall of the wax cell. Each scale may contain up to 2.5 billion spores. As only 35 spores will infect a day old bee larva and only one spore can infect an hour old larva the capacity for infection is enormous.

#### **4. Spore stage**

As the worker bees remove diseased scale from the wax comb they will contaminate their mouthparts and infect other developing brood. Many honey bee brood then become infected. The strength and health of the honey bee colony begins to break down as the colony's population dwindles.

#### **5. Spore stage**

As the colony becomes weakened and further contaminated by AFB it may be targeted by nearby honey bee colonies whose bees rob the honey stores of the weakened colony. This honey is brought back to healthy honey bee colonies along with large numbers of infective AFB spores. Spores infect honey bee brood in the new colonies.

### **SPREAD OF AFB THROUGH HONEY BEE ACTIVITY**

#### **Robbing**

Honey bees from one colony may collect the honey stores of another colony. When this occurs, AFB spores can be transferred with the honey. This can result in the spread of AFB within a beeyard or between different beeyards (up to 8 km). This is particularly a concern during a nectar dearth when combined with weakened colonies and exposed contaminated wax comb. Infected beekeeping equipment that is stored in locations accessible to honey bees is another source of infection.



Figure 4. Spotty brood pattern with noticeable AFB scale.



Figure 5. Sunken perforated cell cuppings.



Figure 6. Infected larvae settled to the bottom of the brood cell.

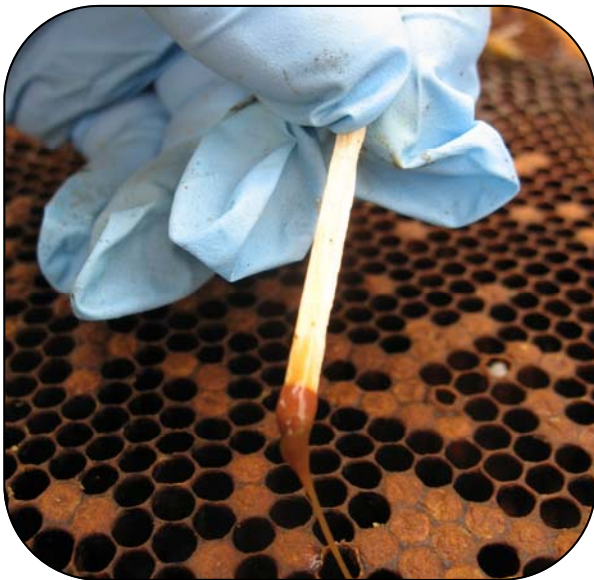


Figure 7. Ropey test. Larva has a mucus-like consistency and will draw out of the cell.

### Drifting

Honey bees from adjacent colonies mistakenly enter another colony after returning from foraging. This can spread AFB within a beeyard.

### SPREAD OF AFB THROUGH BEEKEEPER ACTIVITY

#### Feeding contaminated honey or pollen

Honey and pollen obtained from outside sources may contain AFB spores. Honey from outside sources should **not** be fed to honey bee colonies. If purchasing pollen for the purpose of feeding to honey bees, ensure that the pollen has been irradiated.

#### Exchanging equipment between colonies

Moving frames of brood between different colonies in a beeyard to equalize colonies or to boost weak colonies is a common beekeeper practice among beekeepers. AFB may be spread from an infected colony to an uninfected colony when this is done. Beekeepers must be mindful of this practice's risk and should be vigilant for any symptoms of disease.

#### Purchasing infected honey bee colonies or equipment

Beekeepers regularly sell and purchase honey bees or used equipment from other beekeepers. This may also introduce AFB to a clean operation. The selling or purchasing honey bees and of used beekeeping equipment between beekeepers falls under the legislation of the Ontario *Bees Act*. Under the Act a beekeeper selling any honey bees or used beekeeping equipment **must** hold a valid permit demonstrating that the material for sale or a proportion of the beekeeping outfit received an inspection by a provincial apiary inspector and has been demonstrated to be in good health.

#### Packages

Although not as likely to spread AFB, honey bee packages are a potential source of infection. Packages require federal and provincial import permits.

### Swarms

Swarms may be a source of AFB if the swarm originated from an infected colony. Swarms always have a chance of transferring pests and diseases since there is no way to be certain of the swarm's origin. However, since a swarm has no brood there is an opportunity to take management steps to minimize the risk.

### DETECTION—DIAGNOSIS

Physical symptoms of AFB are found in the brood nest of the honey bee colony and used brood comb. It is important for beekeepers to familiarize themselves with healthy brood conditions and types of brood disease. There

are a variety of symptoms that indicate an AFB infection. Not all symptoms are always present in each AFB infection, particularly with the different stages of an infection, and not all are specific to AFB. However, some symptoms are very specific to the disease.

### **Spotty brood pattern**

(not always specific to AFB)

A healthy, productive colony will produce a solid brood pattern, with few empty cells. Unhealthy or diseased colonies may have a brood pattern with many missed cells. This feature is common to many disorders in a hive including other brood diseases or may simply indicate the condition of a poor queen (figure 4).

### **Perforated brood cappings of the brood cell**

(not always specific to AFB)

It is more likely that the perforated capping of a brood cell is a brood disease if the perforations are irregular and located at the margin of the capping. This feature is seen in other brood diseases such as chalkbrood and brood damage caused by high levels of varroa mites (figure 5).

### **Wax cappings with a dark, greasy appearance**

(not always present in early stages of AFB).

### **Wax cappings that are sunken in**

(not always present)

Wax cappings will be slightly concave rather than slightly convex.

### **Discoloured larvae**

(not always specific to AFB)

Any time a larvae dies in the cell, it will darken and become discoloured. Healthy larvae are always pearl white. Infected AFB brood will turn from white, to beige, to light coffee brown, to dark coffee brown, then to black as it begins to dry out (figure 6).

### **Dead larvae exhibiting a gooey, mucus-like consistency that settles to the bottom of the brood cell**

(very specific to AFB, usually present other than very early or late stages of larvae decomposition)

This is a condition specific to AFB. Place a match stick or thin twig into the cell, rotate the stick 360° and slowly pull the stick out of the cell. If the material in the cell stretches out to a length of 2.5 cm or more, it is infected by AFB. No other brood disease displays this symptom. American foulbrood does not always display this symptom. If it is early in the infection, the dead larvae will not be gooey enough. In later stages the dead larvae will harden and dry. If this symptom is encountered it is most definitely AFB (figure 7).

### **Black hardened scale that adheres to the wall of the wax cell**

This is specific to AFB. After the diseased larvae settles to the bottom of the cell it will begin to dry and harden. This is an important symptom found in used brood comb. The best way to do this is to hold each frame with your



Figure 8. Note rotted, drying AFB scale and greasy, dark wax comb.



Figure 9. Inspection of a brood frame.

thumb and index finger supporting the ear of the frame and slowly rotate the frame back and forth so the bottom of the frame rotates along a 30° axis. Make sure that you have good lighting as you do this, and if possible, have the sun shine at your back. You are looking for is black, flat, charcoal-like pieces stuck to the bottom of the cell. This dried scale is hard, brittle and cannot be removed from the wax cell without damaging it (figure 8).

### **Foul smell**

(specific / not specific to AFB)

Although other diseases and disorders of honey bees may be associated with a foul odour, the odour of AFB is quite distinct. It has an odour described as “fishy” or “rotten”. It is a smell that once encountered is not easily forgotten.

Beekeepers should examine their colonies on a regular basis to ensure that they are healthy and disease free. While inspecting the health of brood, gently shake most of the bees off of the frame over the open hive so that the appearance of the brood can be observed. If AFB is suspected or confirmed report the incident to Provincial Apiary Inspectors (figure 9).

If you have any further questions on how to effectively manage an AFB outbreak, contact the Apiculture Program or the Technology Transfer Program (*see below*).

### **RESOURCES**

For more information on the treatment of AFB see: 2012 Treatment Recommendations:

<http://www.omafra.gov.on.ca/english/food/inspection/bees/11-treatment-recomms.htm>

For more images of AFB see:

<http://www.omafra.gov.on.ca/english/food/inspection/bees/americanfoulbrood.htm>

Regional Apiary Inspectors (Ontario Ministry of Agriculture, Food and Rural Affairs):

[http://www.omafra.gov.on.ca/english/food/inspection/bees/info\\_beeinspectors.htm](http://www.omafra.gov.on.ca/english/food/inspection/bees/info_beeinspectors.htm)

Apiculture Program (Ontario Ministry of Agriculture, Food and Rural Affairs):

<http://www.omafra.gov.on.ca/english/food/inspection/bees/apicultu.html>

Toll Free: 1-888-466-2372 ext 6-4230

Local: (519) 826-4230

E-mail: [foodinspection@ontario.ca](mailto:foodinspection@ontario.ca)

Technology Transfer Program (Ontario Beekeepers Association): <http://techtransfer.ontariobee.com/>

Phone: (519) 836-3609

[obatechtransfer@rogers.com](mailto:obatechtransfer@rogers.com)

<http://techtransfer.ontariobee.com/index.php?action=display&cat=52&v=76>

Integrated Pest Management Workshops

<http://techtransfer.ontariobee.com/index.php?action=display&cat=55&v=69>

For more information on AFB see American Foulbrood – Prevention and Management Infosheet on the [Apiculture Program's web page](#).

### **RECOMMENDED READING**

OMAFRA - 2012 Treatment Recommendations for Honey Bee Disease and Mite Control

Ontario Beekeepers Association, Technology-Transfer Program – Ontario Beekeeping Manual with an Emphasis on Integrated Pest Management

Canadian Association of Professional Apiculturists – Honey Bee Diseases and Pests

## Notes

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