Honey Bee Diseases

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More than a two dozen pests and pathogens are associated with honey bees. The easiest way to minimize the possibility of hive contamination is to maintain good apiary hygiene.

Beekeepers should:

1. Exercise caution with equipment of unknown health history or origin. Clean any used equipment by placing it in a deep freeze for 48 hours and then scraping any wax, propolis, and other debris from the boxes. Collect and dispose of this waste. After freezing, sterilize equipment by scorching with a propane torch. Discard old frames and comb with an unknown health history.
2. Never open-air feed honey or syrup. This includes letting bees have open access to frames after extracting honey.
3. Never leave burr comb and hive scrapings about the apiary. Carry a bucket with you to collect the waste in. Dispose of it at the end of the day.
4. Store unused equipment under "bee tight" conditions in to prevent robbing behavior and access to the stored equipment by rodents, wax moths and hive beetles.
5. Clean hive tools and smokers between hives while performing inspections. Scrape off any honey or wax from tools and scorch in a lit smoker.
6. Never combine sick or collapsing hives with healthy ones.
7. Replace old black comb regularly with new foundation.

During inspections a beekeeper should always inspect the brood in their hive. Brood in a healthy colony has a uniform appearance with few interruptions of the brood pattern. Healthy larvae are pearly white and the pupal cappings should appear convex, not perforated or greasy. Larvae should move and roll when prodded. There should not be an offensive odor. When one or more of these criteria is not met, the colony needs further inspection and evaluation.

American Foulbrood (AFB)

Organism: Bacterium, *Paenibacillus larvae*
Life Stage Affected: Brood

Biology: American foulbrood (AFB) is the most contagious and devastating of the brood diseases. It is caused by a spore-forming, rod-shaped bacterium. The AFB life cycle includes an active vegetative stage and the dormant spore stage. Honey bee larvae become infected with

AFB by ingesting spores present in larval food. The spore germinates in the insect gut, ultimately killing it. AFB spores are resistant to heat, cold and ultraviolet radiation and can remain dormant, yet viable, for up to 80 years. Disease can be spread by using infected equipment and tools, when spore-laden honey is robbed by neighboring hives/apiaries, or when bees drift from diseased hives to clean hives.

Symptoms: The brood pattern of hives infected with American foulbrood appears mottled and irregular. The pupal cappings are sunken, perforated, greasy, and wet. Larvae turn from white (healthy) to dark brown and die upright in their cells. Advanced cases of AFB have an offensive odor described as rotten meat, sulfur, or dirty socks. Field diagnosis of active AFB is usually accomplished by the "toothpick test". A toothpick or twig is inserted into the suspect pupal capping that contains the brown, collapsed pupal remains. The toothpick is then slowly removed from the cell. If the brown, sticky mass of dead tissue "ropes out" ½ inch or more, it is highly probable that AFB is present.

As pupal decay progresses, the mass of dead tissue will dry to a rigid "scale" at the base of the cell. Each scale can contain billions of spores. AFB scale adheres tightly to the cell wall, lays flat and appear to be black and shiny. Often remnants of a pupal tongue are visible from the scale and at times are attached to the upper cell wall. When viewing scale, hold the frame at a 45-degree angle with the light source behind you. The ability to recognize scale is a necessary skill for all beekeepers. AFB infected equipment that has been in storage for many years can be easily diagnosed by the presence of scale. Routine inspection of brood combs for the presence of scale and thorough post mortem comb inspections of colonies lost during winter is essential before equipment is restocked or dispersed to other hives.

Control: AFB is a very serious and contagious disease. If you suspect you have a hive with AFB call your state bee inspector. You state inspector can confirm diagnosis, can help with abatement, will attempt to locate the initial source of infection (another apiary, diseased equipment, etc.), and will inspect other hives in the area for AFB. Honey bee colonies found to be infected with AFB must be abated according to existing state regulations. In most states, including Maine, hives infected with AFB are depopulated and burned.

Before you burn the hive equipment you must kill the bees in the colony. Do this in the evening when most bees are in the hive. Use an aerosol insecticide containing an active ingredient that is labeled for the control of bees. Block the entrance and apply the insecticide into the top of the hive and replace the lid. Adult bees should die within 10 minutes. If an insecticide is not available, the hive can be killed with kerosene, a gas/diesel mix, alcohol or soapy water. Block the hive entrance and pour one quart to one gallon over the top bars of the diseased colony and replace the lid. Allow 15 minutes or more for the bees to die. Repeat if necessary.

In a remote area of the apiary or other suitable burn site, dig a hole approximately 18 inches deep and large enough to contain the diseased equipment. All comb, bees and honey must be burned and covered with soil so there is no access by foraging bees. Burn the combs of wax first and later add combs containing honey so the fire isn't smothered. If the hive bodies, bottom boards and covers are in good repair, they can be salvaged but must be sterilized before reuse.

Presently there are two sterilization techniques available:

1. Scorching: Empty hive bodies, covers, etc., may be sterilized by scorching the interior with a propane or butane torch. First, scrape the wax and propolis from the interior onto newspaper and burn it with the other diseased material. While scorching the interior of the beekeeping equipment, it is important to adequately scorch the corners and frame rest areas of the wood ware. Use caution and have a hose or fire extinguisher nearby.
2. Irradiation: Gamma radiation is an effective means to sterilize infected beekeeping equipment and commercial irradiation facilities are available in several states and provinces.

Some states (not Maine) allow the use of antibiotic treatment as a means of abating AFB. Treatment of AFB infected hives using antibiotics has limited success and several associated problems. First, the disease is likely to reappear once the treatment ceases after larvae ingest bacterial spores originating from dried scales and contaminated honey. In addition, overuse and improper dosing of antibiotic has resulted in strains of AFB with antibiotic resistance. Currently, strains of AFB with Terramycin resistance are found globally.

European Foulbrood (EFB)

Organism: Bacterium, *Melissococcus pluton*
Life Stage Affected: Brood

Biology: The organism causing EFB is non-spore forming. Larvae are susceptible to EFB for a longer period than they are to AFB. Larvae infected within the first two days of development die by the time they are four or five days old. Larvae infected after the age of two days may survive until maturity and become a source of re-infection. After the larvae ingest the bacteria it rapidly multiplies within the larval gut. Older infected larvae regurgitate the bacteria, spreading the infection to nurse bees as they clean cells or feed larvae.

Symptoms: The symptoms of EFB often appear in late spring but can show up any time of year when forage is scarce, and brood are not being properly fed. The brood pattern will appear irregular and diseased larvae turn yellowish to brown. Infected larvae die before cells are capped. The larvae appear to melt or deflate and look twisted because death occurs while in the

"C" shape. The remains of larvae killed by EFB are granular or watery and do not "rope out". As the dead larva dries out it forms a scale that is brown and rubbery. The odor of diseased larvae is sour and resembles that of dead fish.

Control: As nectar sources become more reliable and varied, light cases of EFB can clear up with no action necessary by the beekeeper. However, re-queening and medication (Terramycin) are sometimes necessary for more severe cases. Re-queening can accomplish two things. Firstly, it allows nurse bees to clean out infected larvae and cells while there is a break in the brood cycle. Secondly, you may replace a disease susceptible queen with a young queen that is potentially disease resistant. Unlike AFB, EFB may be treated with tetracycline (Terramycin) because the organism does not form spores. Current regulations require a visit from a licensed veterinarian to diagnose EFB and a prescription to acquire antibiotics. Equipment severely infected with EFB should be sterilized in the same manner as equipment infected with AFB or destroyed.

Chalkbrood

Organism: Fungus, *Ascosphaera apis*
Life Stage Affected: Brood

Biology: Chalkbrood disease was first documented in the United States in 1968. Nearly all beekeeping operations in the U.S. have chalkbrood disease at various levels and severity. Chalkbrood disease can become acute at times, resulting in low populations of worker bees and death of the hive. Larvae are most susceptible to chalkbrood when fungal spores are ingested at three or four days of age followed by a short period where the larvae get chilled. Factors thought to contribute to this disease and level of infection include: the strain of chalkbrood, a reduction in brood temperature, poor hive ventilation, poor apiary drainage, long periods of confinement, antibiotic use, contaminated pollen, drift between hives, and exchange of contaminated comb between colonies. Larvae die within two days after being capped.

Symptoms: Symptoms of chalkbrood usually appear in the spring. Initially, brood infected with chalkbrood appears white and fluffy as the fungal mycelium grows. Later, the pre-pupae dry out and become white hardened mummies. Sometimes mummies will be covered with black or gray spores that are viable for up to 15 years. Chalkbrood mummies are frequently found on bottom boards and at hive entrances in colonies with moderate to heavy infections. Perforated pupal cappings are often present and caused by nurse bees while cleaning the cells.

Treatment: Keeping colonies well ventilated and out of areas that are cool and damp is usually enough to reduce the severity of infection. Strains of bees selected for hygienic behavior have

demonstrated resistance to chalkbrood. Hygienic bees are efficient at uncapping and removing dead and diseased brood. Presently, there are no registered products for chalkbrood control.

The Nosemas

Organism: Fungus, *Nosema apis*
Life Stage Affected: Adult

Biology: Honey bees become infected by ingesting spores during hive cleaning activities. Once ingested, the spores germinate and enter the cells of the gut lining where they multiply. Infected cells rupture and release spores that either infect more gut cells or pass from the bee in their feces. Wintering in northern climates and package bee transport are most at risk for Nosema since bees are forced to defecate inside the hive or shipping cage during periods of confinement. Researchers have demonstrated that Nosema infection reduces the life span of bees by half and interferes with a nurse bee's ability to feed brood when their hypopharyngeal glands atrophy due to infection. Queens infected with Nosema are often superseded and the net result is a decline in population, reduced honey production, and lowered probability for wintering success. In addition, several viruses are known to only multiply in bees already infected with Nosema. This species of Nosema has become exceedingly rare as it has mostly been replaced by *N. ceranae.*

Symptoms: Diagnosis of Nosema infection requires microscopic examination. Possible indications of *Nosema apis* infection include: bees crawling in front of the hive that are unable to fly, trembling bees with disjointed wings, and fecal spotting on frames and on the outside of the hive. Workers may have swollen/full, greasy-looking abdomens. Nosema appears to aggravate dysentery but there is no evidence that it is the primary cause of dysentery.

Organism: Fungus, *Nosema ceranae*
Life Stage Affected: Adult

Biology: Previously, *Nosema ceranae* had been associated with the Asian honey bee (*Apis ceranae)*. The lifecycle of *N. ceranae* is similar to *N. apis* but is more virulent. *Nosema ceranae* has contributed to colony losses throughout Europe but the full effect of this parasite in North America has not been determined. *Nosema ceranae* can kill bees eight days after inoculation and results in a depopulation of the hive. Hives can be infected with both *Nosem*a species.

Symptoms: Unlike *N. apis*, *N. ceranae* causes both cold season and warm season colony issues. Clinical outbreaks have four phases: 1) asymptomatic; 2) replacement of reduced bee population; 3) false recovery; and 4) collapse.

Prevention/Treatment: Make sure colonies are well provisioned with clean food for winter. Regularly replace brood frames minimizes the build-up of Nosema and other types of spores in the colony. Discard any frames with excrement spotting/streaking. Re-queening can replace a disease susceptible queen with a young queen that is potentially disease resistant. Finally, there is some evidence that the use of bee specific probiotics can increase spring buildup and reduce Nosema infections.

Nosema infected equipment can be effectively fumigated with 80% acetic acid. Pour 150ml of the solution onto an absorbent material placed on the top bars of the frames in each box. The boxes are stacked outdoors or in an open shed and sealed with duct tape for one week. After fumigation the equipment is aired for one week. Acetic acid is highly corrosive and requires the use of personal protective equipment (goggles, coveralls, and gloves). Bee equipment can normally withstand only a few fumigations before the nails and frame wires corrode. Heat can also decontaminate Nosema infected equipment. Dry equipment should be heated to 120 degrees and held for 24 hours.

Viruses

There are over 30 different viruses that affect honey bee colonies. Viruses typically infect the larval or pupal stage, but symptoms are most often seen in adult bees. Many viruses are consumed by larva when they eat the royal jelly or bee bread produced by infected nurse bees. Several of the more common viruses are transmitted by the varroa mite.

Most of the time viruses persist naturally in colonies at low levels without presenting symptoms. When infection levels get high, some viruses produce easily recognizable symptoms. Unfortunately, many of the symptoms of virus infection are generic (e.g. trembling, hair loss, reduced longevity, smaller size, dark bodies, etc.). As a result, symptom based diagnosing of viruses can be tricky. There are currently no treatments for viral diseases but maintaining strong/ healthy colonies and most importantly controlling varroa mite are strategies beekeepers use to reduce the impact of viruses on their hives. Re-queening with virus resistant stock can also help. Below are a few common viruses to keep an eye out for:

Sacbrood: Larvae infected with sacbrood virus express symptoms in the prepupal stage of development. The color of the larvae changes from pearly white to gray and finally to black. The cells are partially or totally uncapped with a black shriveled larval head prominent. Because the larvae die in the stretched (prepupal) position, the shriveled head may be mistaken for a pupal tongue, which is an indicator of AFB. Infected larvae appear bloated due to the accumulation of virus laden fluid between the body and unshed larval skin. When the diseased larvae are removed, the soupy tissue remains are contained in the larval skin. The infected larvae do not "rope out" and the contents within the larval skin are watery. Sacbrood disease is of minor importance and rarely results in death to the colony.

Deformed Wing Virus (DWV): Deformed wing virus is a very common and widely distributed disease. It is closely associated with varroa mites and is transmitted through mite feeding, food and feces. It can be transmitted from queen to egg and from drone to queen. Adult symptoms include shortened adult life, deformed (thin and twisted) wings, shortened abdomen, and cuticle discoloration in adult bees.

Acute Bee Paralysis Virus (ABPV): This is transmitted in larval jelly from asymptomatic infected adult bees to developing larva or when vectored by varroa mites to larvae and pupae. Pupae infected with ABPV die before emerging. The decline in emerging bees causes a colony to dwindle towards collapse. Adult symptoms include the inability to fly, hair loss, trembling, and a reduced lifespan.

Israeli Acute Paralysis Virus (IAPV): IAPV is found in all life stages and vectored by varroa mite. Symptoms include trembling, darkened hairless bodies, paralysis and decreased longevity.

Kashmir Bee Virus (KBV): When KBV is fed to immature bees it does not cause infection, but when it is injected in to the insect hemolymph (by varroa mite feeding) it becomes deadly. Adult symptoms include the inability to fly, hair loss, trembling, and reduced lifespan of infected bees.

Black Queen Cell Virus (BQCV): BQCV virus primarily attacks developing queens and is most problematic in queen rearing facilities. This virus has been associated with high Nosema and varroa mite infestations. Once infected, a queen larva will die and turn pale yellow. Over the next couple of days, the larva will turn from brown to black. Infected workers and drones show no outward symptoms.