PennState Extension

Viruses in Honey Bees

Honey bees are infected with many different kinds of viruses. However, most virus infections are not problematic, if the honey bee colony is healthy and does not experience chronic stress.

Photo: Robyn Underwood, Penn State

Honey bees can be infected with many viruses. Sacbrood virus was the first bee-infecting virus to be described in the scientific literature in 1913, and approximately 20 more viruses were subsequently described based on their symptoms in bees. With new molecular biology tools, it is now possible to use DNA to identify viruses infecting bees, even if there are no symptoms. A recent screening of honey bees collected in Pennsylvania found that they were infected with several viruses including; Deformed wing virus (DWV), Black queen cell virus (BQCV), Sacbrood virus (SBV), two Paralysis viruses, and more.

Deformed wing virus

When a colony is heavily infected with Deformed wing virus (DWV), it shows the classic diagnostic symptom of bees with deformed wings. When this symptom is seen, the colony often also shows many other symptoms that make up Parasitic Mite Syndrome (PMS). PMS includes a spotty brood pattern, larvae sunken in cells, cappings removed from some cells containing pupae that have been chewed, and a dwindling adult population.

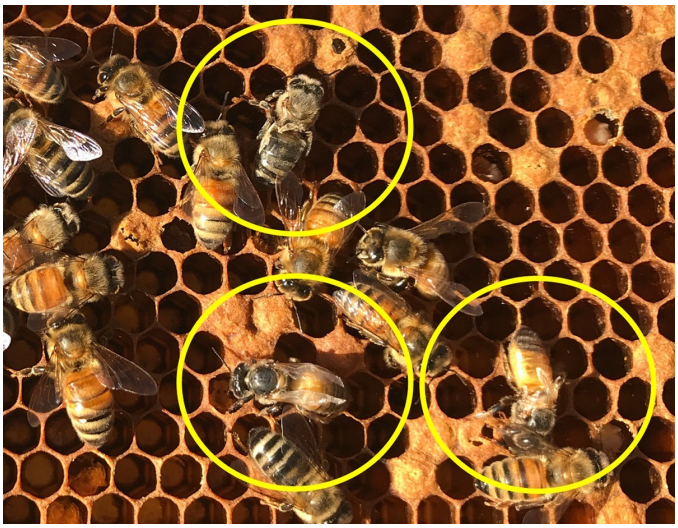

Figure 1. Bees with deformed wings. Photo: Robyn Underwood, Penn State

Figure 2. Uncapped cells with chewed pupae. Photo: Robyn Underwood, Penn State

An alcohol wash for Varroa mites may or may not show that there is a large mite population, depending on the stage of the infection. Varroa mites have been shown to transmit DWV from one bee to another and to cause the virus to reach damaging levels. So, even if the mite population is not high when deformed wings and PMS symptoms are seen, both mites and DWV were probably involved.

Sacbrood virus

Sacbrood (SBV) is characterized by the uncapping of brood in the stretched larva stage. If you remove the capping and the larva, it appears to be inside of a sack.

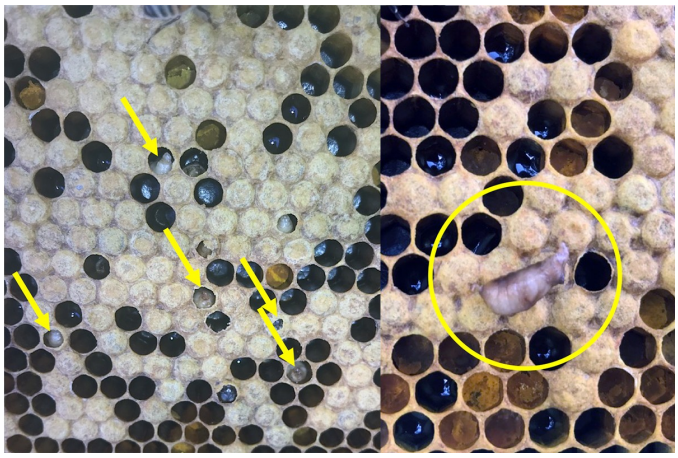

Figure 3. Uncapped cells with stretched larvae and a larva removed from a cell that appears to be in a sack. Photos: Robyn Underwood, Penn State

Paralysis Virus

There are two paralysis viruses, acute and chronic, that are not readily differentiated by beekeepers. Bees infected with a paralysis virus are seen shaking and with little or no hairs.

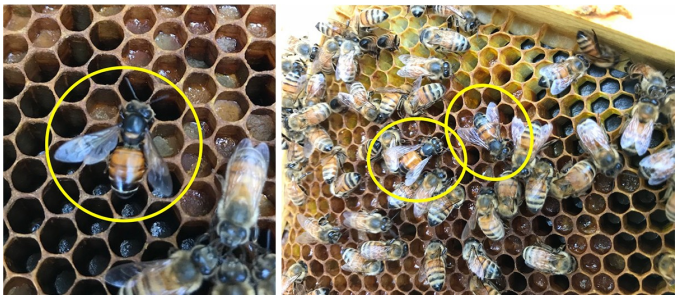

Figure 4. Bald, shiny, shaking bees. Photos: Robyn Underwood, Penn State

Virus infections can have a range of effects on honey bees, from no obvious symptoms to death within hours. Obvious symptoms—deformed wings from DWV infection, hairless or greasy appearance due to chronic bee paralysis virus infection, poor locomotion or paralysis from a paralysis virus, or brood deformities from SBV and BQCV, usually indicate a severe infection.

Virus infections have been associated with a higher risk for colony death in the winter. Colonies exhibiting traits of Colony Collapse Disorder (CCD) have been found to be infected with several viruses, suggesting that it is a combination of viruses that undermines bee health in these cases.

Routes of transmission

Viruses can be readily transmitted within and between honey bee colonies, and can also be transmitted among other bee and insect species in the area. Transmission can occur from drone to queen during mating, from queen to egg, from nurses to larvae during feeding, and between workers during trophallaxis, or through the environment, particularly when bees feed on contaminated food, such as contaminated honey stores in the colony or contaminated flowers in the field.

DWV infections are closely associated with Varroa destructor mite parasitization. DWV is transmitted by varroa mites, and this transmission generates very high prevalence (many workers in the colony are infected), high virulence (individual workers have high levels of the virus), and high pathogenicity (severe symptoms in infected workers). It is thought that varroa mites impair the immune function of honey bees by removing hemolymph, and mite transmission may also select for more virulent strains of DWV. Intriguingly, the number of offspring a varroa mite female can produce is higher on pupae infected with DWV. DWV reduces wound-healing in honey bees, and this may allow for their offspring to obtain more food from the infected pupae through the slit the mother mite cuts into the cuticle.

Stress can reduce the bees' ability to manage viral infections. Pesticide exposure can reduce immune responses. For example, exposure to neonicotinoids, organosilicones, and KATP channel agonists can all result in increased viral titers. Additionally, treatment with a chemical miticide to control varroa mite populations, such as amitraz, can cause bees to be less tolerant of virus infections. However, providing bees with high-quality diets with pollen from diverse plant species can help bees have lower viral levels.

Diagnosing and managing viral infections

Options for diagnosing viral infections are limited. As discussed above, some viruses have clear symptoms that can be used to diagnose their presence. Identification of infections in colonies that do not show symptoms, confirmation of the presence of a particular virus, or evaluation of prevalence or levels of viruses, requires molecular approaches, such as polymerase chain reaction (PCR). This service is not available to the general public.

Options for dealing with viral infections are also limited since there is no specific treatment for viral infections in honey bees. However, beekeepers can take steps to minimize viral transmission and reduce exposure to other stressors, such as parasites, pesticides, and nutritional deficiencies. Below we outline these steps. It is also important to note that uncontrolled varroa mite populations are the main driver of DWV infections. Thus, beekeepers are encouraged to follow the practices outlined in the Penn State Extension article, *Methods to Control Varroa Mites: An Integrated Pest Management Approach*.

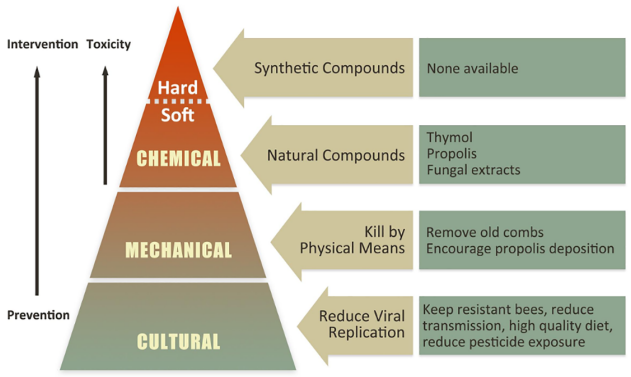

Figure 5. The IPM pyramid for virus control. Image: Nick Sloff, Penn State

Cultural Approaches

Use stocks of honey bees that are resistant to Varroa mites. These include Russian, Varroa sensitive hygiene, and ankle-biter/leg-chewer stocks. Russian and Varroa sensitive hygiene stocks have also been shown to be able to suppress viral populations.

Reduce between-colony transmission

Viral infections tend to be higher in areas with a higher density of honey bee colonies. Beekeepers can reduce transmission between colonies by:

- Limiting the number of colonies in an apiary
- Orienting the colonies to reduce drift of infected bees. Colonies can be spaced farther apart, face in different directions, or have different markings.
- Not moving frames from a colony that is exhibiting symptoms of virus infection to another colony.
- Cleaning hives tools or other equipment with alcohol after inspecting a colony showing symptoms of viral infection.
- Provide bees with high-quality diets

You can determine if the area surrounding your apiary provides high-quality forage for your bees during spring, summer, and fall using the Beescape.org tool. If your forage quality is predicted to be low, and/or you notice your bees have not been collecting honey or pollen for a long period of time, you should consider providing supplemental feed. Several studies have found that bee-collected pollen is usually better at supporting bee health than supplemental diets. Thus, if possible, consider using a pollen trap to collect pollen from strong colonies and store it in a freezer until needed.

Reduce exposure to pesticides

You can determine if the area surrounding your apiary is predicted to have high pesticide use using the Beescape.org tool. Beekeepers can also register with PA Plants or Driftwatch to be notified if a pesticide spray is planned in their area. It can also be helpful to have conversations with growers in your area. The PA Pollinator Protection Plan provides guidelines for discussing pesticide applications with growers that you are working with or adjacent to. Note also that exposure to acaracides used to control Varroa mites (such as amitraz) may exacerbate viral infections.

Mechanical approaches

Remove old combs

To remove viruses and other hive contaminants that build up as wax comb ages, you should rotate out old combs regularly. It is generally advised to replace about ⅓ of the frames in each colony each year. The old combs should be destroyed.

Encourage propolis deposition

Hive equipment can be made with a rough inner surface that encourages the bees to cover it with propolis. This can be accomplished by building equipment with wood that is rough on one side, or by scratching up the inner wooden surface. In addition, the use of cotton duck cloth as an inner cover compels the bees to gather and deposit propolis. Propolis has been shown to increase the expression of immune genes in honey bees and reduces the levels of virus.

Figure 6. A rough inner surface and a cotton duck cloth inner cover both encourage bees to collect and deposit propolis. Photos by Robyn Underwood

Chemical approaches

There are no chemical treatments commercially available for treating viral infections in honey bee colonies. Several studies have identified naturally-derived (soft) chemicals that may reduce viral loads, but these are not yet commercially available. These include:

Thymol treatment

Treatment with 0.16 ppm thymol was shown to reduce levels of DWV when emerged bees were fed thymol and returned to colonies. However, the effect of thymol was not consistent across other treatment approaches, and thus this requires further study.

Propolis

Coating the interior of honey bee hives with a propolis solution.

Fungal extracts

Research has shown that feeding extracts of two fungal species (*Ganoderma resinaceum*, *Fomes fomentarius*) can reduce levels of DWV and Lake Sinai virus.

Summary

Most virus infections in honey bee colonies are not problematic if the honey bee colony is healthy and does not experience chronic stress. However, high levels of varroa mites can lead to hive levels of DWV, which can lead to severe symptoms and colony death. In an IPM approach, beekeepers should rely heavily on cultural and mechanical practices to reduce the transmission of viruses and levels of viruses in colonies, as well as for managing varroa mite populations. Understanding the biology of bee-virus interactions and considering all the available options for managing viral infections will help improve honey bee colony well-being.

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Penn State News Articles on Honey Bee Viruses

Common crop chemical leaves bees susceptible to deadly viruses

Scientists find evidence of 27 new viruses in bees

Honey bees use multiple genetic pathways to fight infections

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