

Diagnosing and Treating Nosema Disease

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Causative Agent

Nosema disease is caused by a single-celled animal (protozoan) named *Nosema apis*. *Nosema* species are obligate, intra-cellular parasites (microsporidians) of specific animals. *Nosema apis* cannot be reared in laboratory culture, as is possible with most bacteria and fungi. It can multiply only in living honey bee midgut cells.

Life Cycle

When a bee ingests *Nosema* spores, the spores are filtered out of the honey sac by the proventricular valve and released into the midgut. The exact physical and chemical conditions of the honey bee midgut stimulate germination. The organism penetrates a midgut cell and grows by absorbing nutrients from that cell. The parasite increases in size until it is large enough to divide in half. Each new parasite continues this process until the nutrients in the cell are exhausted. That stimulus triggers sporulation. In about six to ten days, approximately 100 new spores are formed in a parasitized cell. The nutrient-depleted cell ruptures. The spores are released into the midgut lumen to start the process, again. Heavily infected worker honey bees can contain an excess of 50 million spores. Damaged intestinal tissue is subject to secondary infections and "dysentery" (brown diarrhea spots on the exterior of the hive) is a common sign of this disease. Diseased bees also defecate inside the hive, contaminating combs with millions of infectious spores.

Effects on Colony

Nosema infections have specific negative effects on honey bees. Worker bees that ingest spores when they are less than a week old normally do not produce royal jelly. Their life spans will be reduced up to 78%. Young queens that ingest *Nosema* spores normally are superseded within a month. In climates where winter prohibits supersedures for many months, colonies often go queenless and dwindle away in early spring. Experience in Minnesota suggests that an average of one million or more spores per bee can lead to increased winter losses. When high percentages of workers are infected and spore counts exceed ten million spores per bee, significant numbers of colonies will die or lose queens during the winter. All levels of infection lead to very slow spring build up, even when forage and temperatures are ideal. Frequently, reduced honey yields follow this poor population build up.

Diagnosis

Nosema disease is difficult to diagnose without using laboratory equipment. Decapitating a bee and pulling out the last abdominal segments usually will remove the intestinal tract intact. A healthy midgut is tan in color, with concentric constrictions. An infected midgut will become swollen, whitish and lose its visible constrictions. However, other causes of

dysentery, such as ingesting honeydew, fermented syrups; indigestible sugars in cola syrups, molasses and kitchen corn syrups; can result in similar intestinal changes.

Scientists use a specific methodology to determine levels of infestation. Known numbers of severed abdomens are homogenized, using a mortar and pestle. The homogenate is sieved through two layers of cheesecloth into calibrated centrifuge tubes. The tubes are spun in a clinical centrifuge at the next to the highest speed for six minutes to drive the spores to the bottom of the tubes. The liquid (supernatant) is poured off (decanted) and the plug (pellet) at the bottom is resuspended in a specific volume of water (one ml per bee). The plug is broken up well (resuspended) by sucking the water in and out many times through a small-tipped disposable pipette. Then a small droplet of the suspension is placed on a blood cell counting chamber (hemocytometer). The number of spores counted over certain areas of the chamber grid can be converted to millions of spores per bee. If infection levels are below 10,000 spores per bee, no spores will be seen and the diagnosis is determined to be "not detected." That does not mean that there is no infection.

Treating Infected Colonies

Medicating for *Nosema* is based on the most appropriate times to prevent comb contamination and development of disease in bees that clean up fecal deposits from combs while expanding the brood nest. Later in the summer, when bees are defecating outside the hive, *Nosema* usually cannot be detected. A few bees are infected all year, but only the diseased late season bees are of consequence. When they develop high levels of infection, they defecate on the combs in October, November and December, then die.

Brood rearing never ceases in many parts of California over the winter, but as the days begin to lengthen in late December, the bees are stimulated to pick up the pace. Availability of nectars and pollens, along with warming temperatures, accelerate brood rearing. It is at this time that many bees "cleaning and polishing" cells, in anticipation of egg laying, become infected. How severe the disease will get in the colony population depends upon the initial spore load (amount of contamination) and how much of the time the bees are confined to the hive by non-flight weather. So, *Nosema* levels can vary significantly from year to year.

In order to "cover the bases" in Minnesota, if a colony population had one million or more spores per bee in April, we fed it two gallons of fumagillin-medicated, heavy (two parts sugar : one part water) syrup in September. If we had to "feed for weight," that was done earlier, so that the early syrup could be "ripened" and stored before the medicated syrup was applied. If the medicated syrup is mixed with other, unripened syrup, it can be diluted to ineffective concentrations. We anticipated that the medicated syrup would be consumed throughout the winter. Spore deposition on combs in early winter would be reduced and the parasite could not reproduce in medicated bees that became inoculated in the spring. The syrup would be consumed, totally, long before the bees produced any honey.

Although we have not conducted the experiments, it is likely that two gallons of medicated syrup may not be required in most of California. *Nosema* levels are not as high in

California as they are in Minnesota. Combs should not be so badly contaminated during the winter months, since intermittent flight is possible. Therefore, first treatments with medicated syrup should coincide well with the normal practice of providing colonies with "stimulative" syrup and pollen substitute feeding in late December and January. A gallon, or so, of medicated syrup probably will provide protection until the bees are flying well in March and April. Heavy nectar flows from *Manzanita*, *Eucalyptus*, mustard and radish might dilute the medication significantly, as would later feeding with non-medicated syrup.

Expected Results of Treatment

Beekeepers who have fed fumagillin to field colonies in the past have noted significant differences in colony build up. In fact, many of them stopped using fumagillin. The colonies built up too quickly and swarm control became nearly impossible.

I am happy to discuss *Nosema*, its consequences in colonies, and treatments. I can be reached by telephone at: (530) 752-0472 or by email at: ecmussen@ucdavis.edu. Copies of this "Bee Brief" can be downloaded at:

<http://entomology.ucdavis.edu/facutly/mussen/beebriefs/index.cfm>.