Nosemosis update: more on a most mysterious honey bee disease

by Peter Armitage

All of our honey bees probably have the microsporidian gut parasite known as *Nosema*, of which there are two species, *Nosema apis* and *Nosema ceranae*.[1] When a *Nosema* population booms in a colony, the disease is called "nosemosis," and it can be a serious if not fatal disease. I know two beeks in our province who lost colonies to the disease last spring. Samples of their infected colonies were tested by Dr. Barry Hicks and both had spore counts greater than 2 million. In general, spore counts greater than 1 million are considered serious, and that's the threshold at which treatment is recommended.

A bad Nosema infection, spring 2018 (photo courtesy Andy Ogden)

Two questions arose at the NLBKA's November 2018 conference concerning *Nosema* management that warrant responses. Both questions relate to apparent contradictions regarding the use of the fungicide fumagillan[2] in the treatment of *Nosema ceranae* infections, and whether or not this species of *Nosema* can be managed by freezing in a domestic refrigerator. Differences of opinion or differences in the results of scientific research are confusing for beekeepers seeking advice on management options. I address these questions in this article as well as some related matters concerning the disease.[3]

Treat or not to treat? That is the question

In the most recent issue of *Hivelights*, Rod Scarlett reported that the Canadian Honey Council (CHC) recognized the importance of maintaining the availability of the fungicide Fumagilin-B for the treatment of nosemosis, and "at a recent Board meeting passed a motion that the CHC, 'investigate and pursue information regarding the feasibility of obtaining the Canadian rights to the label and formulation of Fumagilin B as well as look for options for supply of both the active and a processing lab facility'. The whole process may take time, and it may include partnerships, but knowing how important nosema control is to many beekeepers, it would seem appropriate to ensure some amount of Canadian control in its production" (August 2018: 3).[4]

---

[1] Molecular testing of samples of our bees by the National Bee Diagnostic Centre at Beaverlodge strongly suggests that *Nosema ceranae* is the dominant species in our stocks. How this species got to be dominant is a complete mystery.

[2] Fumagilan-B is the brand name. Until recently it was manufactured by Medivet in Alberta.

[3] I last wrote about the disease in the September 2017 issue of this newsletter, and I invite you to review this article for a succinct overview, including symptoms and treatment options. Having read a lot more about nosemosis over the last year or so, I still consider the 2017 article to be accurate, with the exception of the reference to freezing as a treatment option for *Nosema ceranae*. The science on this is somewhat contradictory. See http://nlbeekeeping.ca/data/documents/2017-09-28-NLBKA-Newsletter-Fall.pdf

[4] Also listen to Andony Melathopolous' recent interview with Steve Pernal and Courtney MacInnis. http://blogs.oregonstate.edu/pollinationpodcast/

On the other hand, Daniel Borges of the Ontario Beekeepers' Association's Tech Transfer Team (TTT) in Guelph told me that they did not recommend the use of fumagillan because of the preponderance of *Nosema ceranae* and new unpublished research by the TTT showing that fumagillan promotes the proliferation of more virulent strains of the microsporidium. Apparently, fumagillan knocks back *Nosema ceranae* significantly in the spring, but does not completely eradicate it, and what survives is more virulent and problematic for the health of the colonies.

Evidently, these contrasting opinions from different parts of Canada are confusing for the average beekeeper who simply wants to make timely management decisions.

Following the NLBKA conference, I asked Dr. Julie Ferland for another opinion. She's the provincial apiarist in Quebec and is also a veterinarian.[5] In reply to my nosemosis questions she noted, for a start, that the effects of *Nosema* on winter survival appear to be different in western and eastern Canada. Ontario studies do not show any effect of *Nosema* on winter colony survival, and Quebec is currently doing its own study on the issue. Ferland went on to say that in Quebec, they no longer recommend fumagillan for the control and prevention of *Nosema* for the following reasons:

- the actual mechanism by which fumagillin acts on Nosema is not well enough understood;
- fumagillin degrades very quickly in sugar syrup, which means that many treatments may be completely ineffective;
- *Nosema* populations may rebound within weeks of treatment;
- it is possible that fumagillin contributed to the shift from *Nosema apis* to *Nosema ceranae*;
- the risk of residues in honey is not negligible. The fungicide is toxic to humans which is why its use is prohibited in Europe.[6]

She noted, furthermore, that they "have several beekeepers who have stopped using fumagillin completely and have not seen any real effect on their colonies in the following years. We see no difference between the health of treated colonies and the health of untreated colonies. There appear to be various factors that determine the impact of *Nosema* on honey bee colonies and these factors are poorly understood."

> "Nosema is a mystery disease for me, and the many contradictions in the literature demonstrate very well that there is something else in the pathogenesis of this disease that we are still missing" — Dr. Julie Ferland, Quebec provincial apiarist

Is freezing an effective management tool?

In my 2017 article about nosemosis, published in this newsletter, I recommended freezing comb from infected hives in a deep-freezer (~-18 deg. C) for at least one week "given that *Nosema ceranae* is vulnerable to freezing." This was based on two credible scientific sources, Ritter (2015) and Fries (2009). However, I also cited Oliver's observation that freezing comb does not kill 100% of the *Nosema ceranae*

[5] She is responsible for putting together the annual wintering loss survey for Canada, which is based on a survey of commercial operators.

[6] This is why it should not be used when honey supers are on the hive.

spores (Randy Oliver, BEE-L post, 26 Sept. 2017). Nonetheless, I said, "freezing appears to terminate significant numbers of the spores, and therefore, appears to be a useful management tool to control the pathogen."

Not long after I published that article, additional information surfaced that contradicts Ritter and Fries. One of my beek buddies from B.C., Heather Clay,[7] brought research by Fenoy and colleagues to my attention (Fenoy, et al. 2009). These researchers showed that under controlled laboratory conditions freezing is ineffective for *Nosema ceranae.* Even after three weeks, 84% of the spores were still viable. BUT THEN, Dr. Stephen Pernal pointed me to a recently completed MSc thesis by his student, Courtney MacInnis, which appears to support the earlier research that found that *Nosema ceranae* is susceptible to freezing. Her research indicates that freezing empty drawn comb may be a useful management technique for this pathogen. "To ensure >50% mortality for *N. ceranae*-contaminated honeycomb, beekeepers should maintain comb at -12° C or colder for 7 days to reduce the viability of any spores present on wax" (2017: 87).

Finally, I asked Dr. Julie Ferland for an opinion. She replied as follows: "Regarding your question about freezing, there is again contradiction. I see freezing equipment as one more tool in the beekeepers' toolbox against various diseases (including viruses), so in my opinion, it can't hurt to freeze equipment for a few days. Without killing 100% of the spores, freezing will certainly have an effect by reducing the load of infectious pathogens. One thing is certain, it doesn't hurt. It is possible that freezing may be less effective when frames are fully loaded with honey. But there will certainly be a decrease in the number of infectious spores. The aim is to reduce the pathogenic load that bees will have to manage in the hive."

Acetic acid fumigation

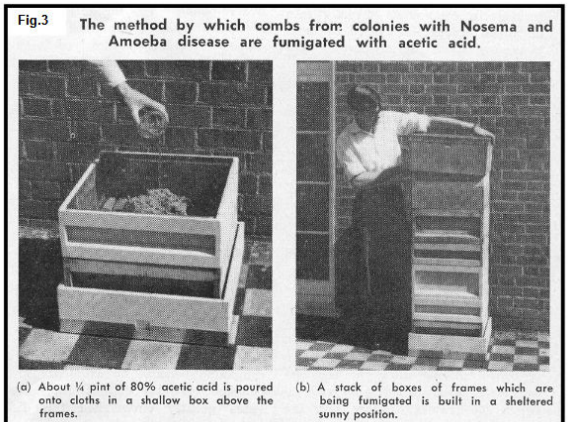


Fig.3 The method by which combs from colonies with Nosema and Amoeba disease are fumigated with acetic acid.

(a) About ¼ pint of 80% acetic acid is poured onto cloths in a shallow box above the frames.

(b) A stack of boxes of frames which are being fumigated is built in a sheltered sunny position.

Bailey's method of fumigating comb with acetic acid (1957)

The above back-and-forth on the question of whether freezing comb is a useful management tool for *Nosema ceranae* may leave you as confused as ever. There is one tool, however, regarding which there appears to be consensus in the scientific and apicultural communities. This is the use of acetic acid fumigation to kill *Nosema* spores in comb. It involves stacking deeps of infected comb/frames, and placing a pad of absorbent material soaked with about 140 ml of 80% acetic acid on top of the bars in the top deep. The deeps must be wrapped in plastic and left in warm conditions for one week.

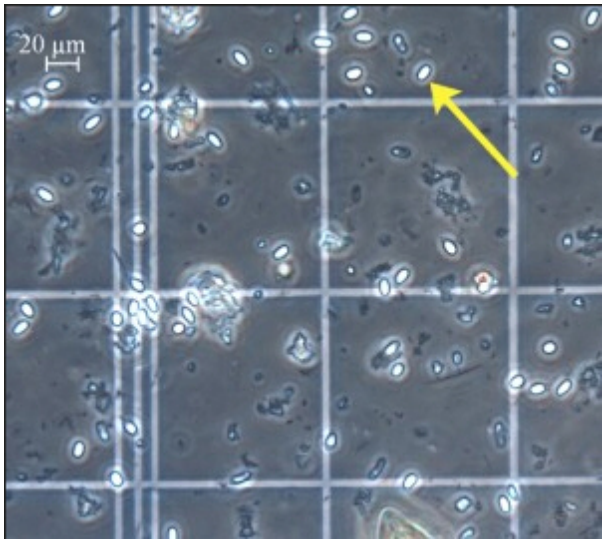
The foundational method description for acetic acid fumigation is Bailey (1957). Veteran Nova Scotia beekeeper, Tony Phillips, uses it, and strongly encourages others to do the same. The Honey Bee Research Centre at the University of Guelph is advocating its use as well, and Paul Kelly, the Research and Apiary Manager there, tells me they'll be posting a how-to video on YouTube in the new year.

[7] Clay is a former chief bee inspector/apiarist for New Brunswick and CEO of the Canadian Honey Council. She co-edited the 2013 CAPA document, *Honey Bee Diseases and Pests*, with Dr. Stephen Pernal.

This will my preferred method of decontaminating infected or possibly infected comb, and I hope to be ready to use it by next spring. We'll have more to say about this topic in the next newsletter.

Developing our own diagnostic capacity

Beekeepers get their bees tested to confirm that dysentery or a colony's failure to build in the spring is due to nosemosis, not some other reason. Knowing you have a bad *Nosema* infection in a colony can help you with important management decisions such as whether to replace a queen and/or remove and decontaminate badly infected comb. The primary method of diagnosing a *Nosema* infection is the "spore count" which involves macerating a sample of worker bee abdomens, and examining a slurry of mashed bee guts under a microscope. A counting chamber (haemocytometer) is used to estimate the number of *Nosema* spores and thereby determine the seriousness of the infection.



Using a haemocytometer and microscope to count *Nosema* spp spores. Yellow arrow points to one spore (photo beeinformed.org)

Until recently, testing of our colonies for nosemosis has been conducted by laboratories on the Mainland, the National Bee Diagnostic Centre at Beaverlodge, Alberta, in particular. However, in the past, testing was conducted on bees sampled from commercial apiaries only, and no diagnostic service is available for the apicultural community as a whole. Diagnostic service for nosemosis is available in some other provinces. For example, Ontario Honey Bee Diagnostic Labs and the Quebec government's Animal Health Laboratory provide spore counts on a fee-for-service basis.

I'm happy to report that the diagnostic situation in NL is changing for the better. Dr. Barry Hicks is equipped to test for nosemosis, and he provided spore counts to some beekeepers last season. Also, a couple of NL beekeepers now have microscopes and haemocytometers, and are in a position to do their own spore counts. All of this means that we may be able to do our own diagnostics for nosemosis in the very near future. Stay tuned for more information on this topic in upcoming newsletters.

References

Bailey, L. 1957. "Comb Fumigation for Nosema Diseases." *American Bee Journal*. January. pp.24-26.

Fenoy, S., C. Rueda, M. Higes, R. Martín-Hernández, and C. del Aguila. 2009. "High-level Resistance of *Nosema ceranae*, a Parasite of the Honeybee, to Temperature and Desiccation." *Applied and Environmental Microbiology*. Nov. pp.6886-6889. doi:10.1128/AEM.01025-09

Fries, Ingemar. 2009. "*Nosema ceranae* in European honey bees (*Apis mellifera*)." *Journal of Invertebrate Pathology*. September. 103. doi: 10.1016/j.jip.2009.06.017.

MacInnis, Courtney I. 2017. *Nosema ceranae*: A Sweet Surprise? Investigating the Viability and Infectivity of the Honey Bee (*Apis mellifera* L.) Parasite *N. ceranae*. Master of Science thesis. Department of Biological Sciences, University of Alberta.

Ritter, Wolfgang. 2015. “Practical Beekeeping: Beekeeping with the ‘New’ Parasite.” *Bee Culture*. 25 May.