The winter of 2021-22: What happened to Ontario bees?

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Last winter was tough on bees. Really tough. It's extremely likely that some of your colonies died. There is a good chance you that you lost many colonies. What happened? How can you prevent high losses of colonies again this coming winter?

You may not recognize my name. I worked as a professor at the University of Guelph from 1982 to 2017, but left the OMAFRA-funded honey bee program 20 years ago. During my career I taught nearly 4000 students about honey bees! For almost 50 years I have conducted research on many aspects of honey bees—the ecology of African honey bees in South America, honey-bee mating, the effects of tracheal mites on colonies, breeding bees resistant to tracheal mites, and the influence of pollen amounts on bees and their colonies. In recent years I have focused on the behaviour of Asian hive bees when attacked by "murder hornets" and the diversity of honey bees in Asia. And yes, I have studied Varroa mites and resistance of honey bees to them. I have seen and learned a lot during my half century of involvement with honey bees! I'd like to share some of what I have learned with you.

Why did so many colonies die last winter? We honestly don't know because no one was doing research to determine why some survived and others died. In the absence of detailed data, we must make educated guesses. Some beekeepers have blamed unidentified agro-chemical(s) (insecticides, herbicides, fungicides) or a new disease. But we don't have any direct evidence of them being involved. I prefer to take a hard look at some of the factors we do know about, factors that we could possibly manage to improve our beekeeping and reduce winter losses.

Let's begin with Varroa mites. To feed, Varroa mites bite bees. It was long believed that they suck the hemolymph (aka the blood) of pupae and adult bees. A little over 3 years ago, Sammy Ramsey and his advisor, my former MSc student Dennis vanEngelsdorp, discovered that Varroa mites feed on the fat body of both pupae and adults. The fat body is involved in storing fat (energy) for later use, synthesizing proteins and lipids, fighting off disease, detoxifying pesticides, regulating the temperature within the nest, and regulating hormones. Damage to the fat body in long-lived wintering bees will reduce bee health and survival.

Moreover, as mites feed, they may inject virus particles into the hemolymph. Honey bees are susceptible to infection by many different viruses—22 have been identified so far. Several of those viruses, like Deformed Wing Virus (DWV) and Black Queen Cell Virus (BQCV), were rarely detected until Varroa mites arrived on the scene. Viral particles of those two viruses have little effect on bees when they are consumed. However, when injected into the hemolymph—as happens when a mite that has fed on an infected bee subsequently bites another bee—they usually prove to be lethal.

The last bit of background info I would like to share is the difference between "summer bees" and "winter bees". In summer, worker bees rapidly progress through a sequence of behavioural castes (cell cleaner, nurse bee, food processor, guard, forager) and die after 25-30 days, on average. A 50-day-old bee in summer is exceptionally old! However, if bees only lived a maximum of 50 days, all your colonies would be dead by Christmas! That doesn't happen. Instead, many bees emerging as adults in autumn become *potentially* long-lived "winter bees". *If healthy*, they live on average more than 100 days. The longest-lived worker bee ever documented lived 304 days—a full 10 months!

In the late 1990s, I wanted to know when winter bees were produced by colonies. I reasoned that for colonies to be relatively strong in spring when brood-rearing commences, winter bee survival would have to be excellent. Feeding by mites and infections of viruses transferred from bee to bee would reduce the longevity of individual bees, thereby weakening or even killing colonies during winter. Therefore, *beekeepers would want to treat their hives with miticides before winter bees are produced*.

I enticed an undergrad student, Heather Mattila, to investigate this question with me. Heather reanalyzed a data set shared with us by J. Lloyd Harris, a former grad student at the University of Manitoba. Lloyd had marked 100 newly emerged bees every 12 days in his study colonies, starting July 14th and continuing until there was no more brood in colonies. He then checked those colonies for surviving marked bees and measured the area of sealed brood at 12-day intervals until Oct. 30th, and again from March 11th until all the bees had died. Through our reanalysis, Heather and I discovered a gradual transition from summer bees to winter bees in bees emerging from the end of August onwards. For example, in the Aug. 31st cohort of bees, 40% of the bees became long-lived winter bees (see Figure 1 below). By Sept. 12th, nearly 70% of the young bees introduced to hives became winter bees[1] (Fig. 1).

Figure 1.

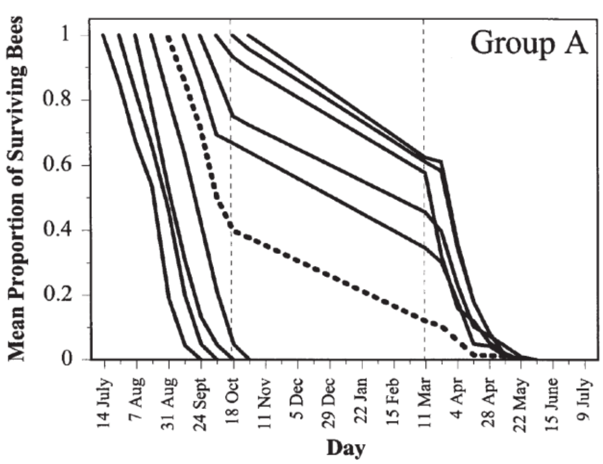
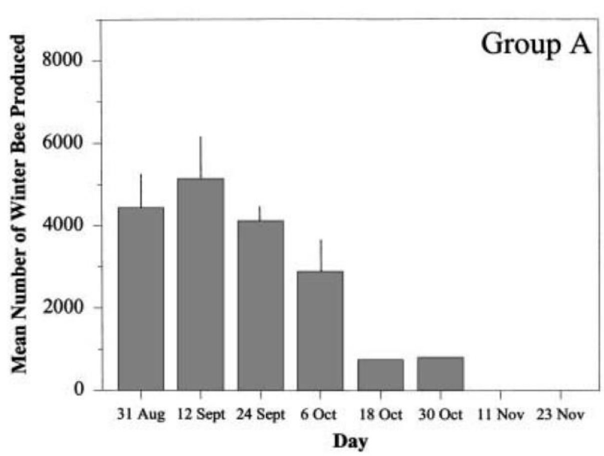


Figure 2.



Keep in mind that the number of bees emerging each day declines greatly over time during autumn. In our study, it declined from ~900 bees/day at the end of August to zero by November. By combining data on the numbers of bees emerging (estimated from the area of sealed worker brood) and the proportion of bees becoming winter bees in the different groups of bees introduced to hives, we determined that more than half the wintering bee population of bees was present by Sept. 12th, even though only about 50% of the bees emerging in early September had become winter bees (refer to Fig. 2)[1].

Keep in mind that Lloyd Harris obtained his data in Winnipeg. Being much further north than Guelph, Winnipeg is cooler and the nectar flow ends earlier there. In southern Ontario, the transitions depicted Figure 1 would typically occur a bit later in September. During her PhD studies under my supervision, Heather later showed that **the first winter bees in Guelph begin to emerge on about 10 September**[2].

Let's briefly summarize. Varroa mites feed on the fat body of bees, causing them to be more susceptible to diseases such as DWV and BQCV, less able to detoxify pesticides, and less efficient at regulating their cluster temperature during winter. As they feed, Varroa mites transfer viruses from bee to bee, and some of them, when introduced into bees' hemolymph by mites, are extremely lethal. Finally, a majority of the winter bees in your colonies have emerged before October. Every day after Sept. 10th that Varroa mites are allowed to feed on bees in your hives, your wintering bee population is being progressively damaged!

I know what you are going to say: "I can't treat my colonies with miticides until the honey flow has ended." Those indeed are the guidelines, designed to result in pure honey untainted with miticides. I see two possible solutions to that dilemma. You could treat your hives in August before the goldenrod flow begins. With our drought this summer, you could likely squeeze a miticide treatment in before Aug. 20th, then complete your mite control in October after the goldenrod and aster nectar flow has ended. Alternatively, you could choose to remove your honey before the fall nectar flow commences, then forgo fall honey extraction. That would entail applying your miticide treatments in late August and early September so that mite levels are low by the time your winter bees begin to be produced in numbers around mid-September. I encourage you to compare the average value of the fall honey crop against the costs associated with dead and weak colonies in spring. I suspect weak/dead colonies cost you much more than you make from your fall honey crop.

I return to the question I posed at the beginning of this article: What did cause the high colony mortality last winter? I echo the explanation my colleagues, Ernesto Guzman and Paul Kelly, have offered. The early (warm) spring in 2021 allowed the mites in your hives to rear an extra generation. That would have translated into about 2 times as many mites by October as would be present in typical years. In hives left untreated with miticides until October, the colonies were already doomed. Damage to wintering bees caused by feeding mites (i.e., damage to their fat body plus virus infections) would have already been so extensive that many colonies had no chance to survive the winter.

I have never been one to tell beekeepers how to manage their bees! I'll readily share my knowledge, however, and seek workable solutions with you. I'm a firm believer that the better you understand the inner workings of your bee colonies, the better you will be able to manage them. I hope that I have clarified the interconnections between Varroa mites, "winter bees", and colony mortality. If that will help reduce colony losses, my essay will have benefitted the beekeeping community of Ontario.

Note: I regularly give talks to beekeeper associations. If interested in having me speak on a particular topic, please contact me.

References

[1] Mattila, H. R., J. L. Harris, and G. W. Otis (2001). Timing and of production of winter bees in honey bee (*Apis mellifera*) colonies. *Insectes Sociaux* 48: 88-93.

[2] Mattila, H. R. and G. W. Otis (2007). Manipulating pollen supply in honey bee colonies during the fall does not affect the performance of winter bees. *Canadian Entomologist* 139: 554–563.