Modern Beekeeping Challenges in Hawaii
& Volcano Island Honey Co. vs. Varroa

In its pure form, beekeeping is a joyful activity that can be peaceful and rewarding for beekeepers. Unfortunately, it is not *quite* as simple as it used to be because of the confluence of diseases now threatening bee populations worldwide.

Hawaii‘'s geographic remoteness kept it isolated from the spread of new diseases for a long time. But in just the past few years, several new pathogens have arrived, with serious consequences for bees and beekeepers around the State.

The three main pests affecting Hawai‘i Island include: 1) Varroa mite, 2) Small Hive Beetle, and 3) Nosema cerenae, a parasitic fungus. These pathogens are not related by cause and effect, but their impact does seem to 'pile up' — such that their combined effect is more serious (and complicated) than each one individually.

Figure 1: In this picture you can see the varroa mite, a 1/4-inch pink, round mite, on several of the bees' backs.

Arguably the most dangerous of these pests is the *Varroa mite*, an 'ecto-parasite' that feeds on the blood of adult and developing bees (like a tick). While Varroa likes to feed on both worker (female) and drone (male) bees, it prefers the drones because of their larger size — allowing the mite to reproduce more quickly.

Like other pests, Varroa can spread quickly throughout a beehive because of honeybees' *social* nature. Bees interact constantly: passing honey, nectar, and pollen back and forth, cleaning each other and honeycomb cells, and feeding brood (babies) and the queen. Controlling bee diseases, therefore, requires a deep understanding of bee behavior and colony life.

Varroa's debilitating effect is not only in its ability to shorten bees' lifespan, but also its potential to serve as a vector for viruses. Certain viruses have always existed in bees' guts at a baseline level, but when those viruses get injected into the bees hemolymph (blood) by the mite, they multiply rapidly and kill the host bee. Since we cannot treat the viruses directly, many beekeepers have turned to focus on controlling Varroa.

Varroa was first identified in 1904 in Java. Since then, it has spread around the world. It first arrived in the U.S. in Maryland in 1979, and reached ‘Oahu in 2007 and Hawai‘i Island in 2008. While mainland beekeepers have learned how to cope with Varroa over the last three decades, Hawai‘i's beekeepers only have experience from the past three years! Thus, learning from beekeepers in other places can be extremely valuable, as they share what methods have and have not worked to combat the mites. On the other hand, Hawai‘i's diverse environment makes it more challenging to identify effective treatment options, since bees, pathogens and treatments work differently in different microclimates.

Figure 2: Participants at our beginning beekeeping course this summer examine a honeycomb frame, while Danielle Downey, the state beekeeping extension specialist, answers questions (far right).

What does *not* change from place to place, is the immense impact that bees have on humans and the environment. When bee populations decline, it affects the broader agricultural industry because of the crucial pollination services that bees provide. In Hawai‘i, some of the crops dependent on honeybees include coffee, macadamia nuts, melons, tomatoes, cucumbers, citrus, avocado and guava.

There are many different perspectives on how to deal with bee diseases. Some people believe that bees should not be treated at all, and allowed to develop their own resistance over time through the process of natural selection. In Italy, honeybee colonies have been found to build a resistance to Varroa over 10-15 years, but with a population decline of about 95%! Relying on natural selection therefore implies a long 'return' time for pre-Varroa population levels to come back.

For this reason, many beekeepers and farmers believe that we cannot wait for natural selection to take effect, since a sharp decline in bee populations would have immediate economic and food security repercussions. At Volcano Island Honey Co., we chose to respond proactively, by experimenting with different organic treatment options even before Varroa reached Hawaiʻi Island; more recently, we've also tried 'breeding techniques' to introduce Varroa Sensitive Hygiene genetics into our bee strains.

When Varroa hit Oahu in 2007, we applied for a Western Sustainable Agriculture Research and Education grant to do preliminary tests on organic treatment options. Little did we know that shortly thereafter, the mites would arrive on Hawaiʻi Island, and our precautionary research efforts would transform into a survival strategy.

As organic beekeepers, we are committed to not using toxic chemicals in our operation. Instead, we established a four step IPM (Integrated Pest Management) method, involving the following steps:
1. Establish a *threshold* to identify when pest control action must be taken (i.e. 50 mites per hive per day).
2. Use *prevention* methods as a long-term strategy to combat diseases.
3. *Monitor* pest levels to *identify* when an infestation threshold is reached and control methods are required.
4. Implement *control* methods when prevention is no longer effective or available.

Figure 3: Downey shows students how to diagnose some of the different bee diseases affecting the Big Island and explains how State programs and extension agents can help.

Control methods must be evaluated for their effectiveness and risk, starting with the least risky, most effective option first. As mentioned, because of Hawai‘i's extreme environmental variation, treatments successful in one microclimate may not work in others — making it more challenging to find an appropriate option for different local conditions. According to Ethel Villalobos of the University of Hawai‘i's Honeybee Project, the best approach to finding an effective treatment in Hawai‘i is looking at the big picture first, and then narrowing the options down to see what is appropriate for your local circumstances.

At VIHC, we tried different treatment methods, including drone removal (a biomechanical technique of removing drone brood, Varroa's favorite food, thereby killing mites feeding on the brood), formic acid, sugar spray and powder, and alcohol.

Formic acid was by far the most effective treatment, applied using Mite Away Quick Strips (MAQS). This method works by lowering the pH level in the hive — which the bees can tolerate but the mites cannot. MAQS effectively fumigate the hive and, while temporarily uncomfortable for the bees, there appear to be no long term negative side effects. After studying formic acid treatments over two years, Villalobos reported that the bees' reaction subsided significantly while mite mortality levels remained constant.

Figure 4: Even with the recent onset of bee pathogens, beekeeping can be a fun and fascinating activity! These beginning beekeeping students were delighted to open their first beehive!

The single biggest lesson we at VIHC have learned over the past few years, is to keep our bees *strong* and *clean*. Thus, treating the bees with sugar yielded surprisingly positive results, presumably because it incentivized grooming and cleaning behavior.

A final treatment approach recently tried at VIHC is 'stock improvement' — or selecting for bees with particular hygienic behavior effective against varroa, attributed to a set of Varroa Sensitive Hygiene genetics. Known as 'VSH', the desired hygienic behavior is a specific trait, allowing the bees to recognize that a mite has crawled into the honeycomb cell where a bee pupa is developing, then open up the cell and clean it out by cannibalizing the pupa, thereby destroying the mite.

VSH behavior was first documented in the 1960s at Ohio State University, where researchers discovered that one gene is responsible for uncapping the cell, and a second for removing the larva. The VSH genes are present in the honeybees genome, but tend to be expressed at a low frequency. Rather than being dominant or recessive, the genes are expressed *proportionally* as a percent of VSH in the parent bees; with 100% VSH, one can hardly find any mites in the hive.

The theory behind this phenomenon is that varroa probably existed millions of years ago, and was effectively combated through natural selection. Over time, Varroa disappeared, and bees no longer needed to express their Varroa resistant genes. But the genetic diversity providing the potential to combat Varroa remained hidden in the honeybee genome.

This summer, Tom and Suki Glenn of Glenn Apiaries in California visited several Hawai'i Island beekeepers, including VIHC, to artificially inseminate queens with semen from VSH drone bees. The Glenns explained that artificial insemination is essentially an acceleration of natural selection.

This summer was the Glenns fourth visit to Hawai'i Island in two years. Their idea is to continuously inseminate with VSH semen, to reach VHS levels of nearly 100%. VSH bees also seem to be able to fight other diseases in addition to Varroa, including foulbrood, chalkbrood, and the small hive beetle. From the Glenns experience, artificial insemination has been very successful: with VSH bees, they have not had to treat their hives since 2001.Their work is helping to diversify the gene stock now present in Hawai'i, by introducing and selecting for new genes.

Beekeeping is still a joyful, if a more complex, activity. At our Beginning Organic Beekeeping course this summer — which we co-taught with Bee Love Apiaries — we mirrored the complexity of modern beekeeping with an amazing array and interplay of different perspectives and viewpoints about if, and how, to treat for bee diseases.

Organic Varroa Management & Beekeeper Education in Hawai'i project sponsored by:

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