European Honey Bees in Cuba are Calm, Productive and *Varroa*-Resistant

By Prof Stephen Martin, Salford University

Figure 1. Izzy (left) and Gerogi (right) enjoy some local produce while visiting a rural beekeeper.

In November 2021, I finally arrived in Cuba after several failed attempts earlier in the year due to issues around COVID and constantly changing travel rules. Although I have travelled extensively doing honey bee research, I was excited to visit Cuba since recent studies showed that both *Varroa* and deformed wing virus (DWV) were present in the Cuban honey bees. Despite this, they apparently survived without any form of treatment for *Varroa*. This was very important since the Cuban honey bees had not become Africanised and were still European. However, nobody was apparently aware of *Varroa* -resistant honey bees in Cuba despite the many scientific papers and people studying and discussing *Varroa* -resistance mechanisms. What was really going on?

Cuba is the largest Caribbean island and has a long and complex history of invaders, with the last military dictatorship being overthrown in the 1950s in a revolution led by Fidel Castro. A once close relationship with the USA became strained after the revolution and led to the country becoming embargoed by the USA and its allies; this is still in force having lasted for over sixty years. This has caused no end of hardship for the people of Cuba as the country is not wealthy and struggles under the weight of the embargo. Despite this, they have free education up to university level and free healthcare for all. Tourism is one of Cuba's main industries and provides foreign currency. However, the recent COVID pandemic led to the collapse of this industry over the past two years. Therefore, when we arrived fuel, food, and energy shortages were commonplace but despite all the hardships Cubans still love their music, rum and dancing.

It was like stepping back in time when 'Izzy' my PhD student, now Dr Isobel Grindrod, Georgi Webb, my MPhil student (Figure 1) and I arrived at Cuba's main airport. Izzy and I spent over an hour trying to report our missing luggage before our private taxi driver drove an old beat-up car, without seat belts, at high-speed down dark streets to our accommodation, a private house (casa particular) in central Habana. Think of a four-star hostel, considering the décor, hidden behind a small door on a busy backstreet (Figure 2). It had wonderfully high ceilings decorated with facades and pictures of old Cuba in the 1950s when Habana was in its heyday. The owners spoke English and were very helpful in explaining their country's complex two currency system. To get to the honey bee research institute on the outskirts of Habana we rented a car. I had to use all my driving skills to avoid the other cars, trucks, buses, mopeds, bikes, horse and carts, pedestrians and potholes, some of which were really big! Also, since there are no road signs in Cuba, my students had to navigate, which is not easy when most of the road markings have worn off and potholes were not marked on maps Luckily the little Korean hire car had more power than the smoky Russian cars or 1950s American cars (Figure 3) used as taxis packed with people. Still, the daily 45 minutes commute to and from work was always eventful.

Figure 2. Above, our middle-floor accommodation in old Habana, looks much more impressive on the inside (right).

Figure 3. A well-maintained 1950's car in Habana.

Figure 4. CIAPI the home of the Cuban honey bee research.

Due to COVID, masks were being worn by everyone all the time. Interestingly, COVID levels had been suppressed by a combination of high rates of vaccine uptake and the Cubans' lack of movement. During our visit only one case of COVID was discovered in Habana, so their measures were working.

We were invited to work with the Cuban Honey Bee Research Institute, Centro de Investigaciones Apícolas (CIAPI) on the outskirts of Habana. Over the years, this has grown from a single wooden building to a large complex of laboratories (Figure 4) under the expert guidance of its head Adolfo Pérez Piñeiro, the Director of the Institute. Now the various offices and administration buildings support jobs for well over fifty people. CIAPI is involved with all aspects of honey bees in Cuba, from honey testing, pest and parasite studies, pollen studies and promoting honey bees and beekeeping. Right next door to CIAPI is one of the biggest honey packer plants in Cuba, which is currently being expanded. There are almost 2,000 Cuban beekeepers, who are all classed as professionals and registered centrally. They manage around 220,000 colonies. Within each region, beekeepers are part of close-knit cooperatives. Hence there is no need for long-distance movements of bees and all queens are produced locally and bred for calmness and productivity.

The colonies are typically maintained in two deep boxes with additional supers placed on top, queen excluders are not used (Figure 5). The colonies were some of the largest I have seen in sub/tropical climates. With the climate, there is almost constant brood rearing; they re-queen colonies annually as they also do in Hawaii. There is also a large feral honey bee population, since around a quarter of Cuba consists of forests. These are palm forests like the ones I visited in the Sierra del Rosario mountains (Figure 6). These forests consist predominantly of royal palms, which, when they flower, are a copious source of nectar and pollen for the bees. There are many other species of flowering plants that produce an abundance of nectar and pollen in the wet season, although during the dry season their abundance is much reduced. It is not surprising that the annual average honey production is between 40kg and 70kg with up to 100kg per year being achieved by beekeepers in particularly good regions. The bees are, on the whole, calm. We worked the bees and collected samples of sealed brood, sometimes without a veil, although we had them at the ready, and we did not need gloves. We always worked the bees in the morning when the bees were working to bring in pollen and nectar. We did get stung at one particularly grumpy apiary, but that is bees for you.

Our main aim was to study the behaviours of the Cuban honey bees and see if we could explain why their beekeepers did not need to treat their colonies for the *Varroa* mite. Previous research had found that the detection and removal of *Varroa* -infested brood was the main mechanism of natural *Varroa* resistance found in South Africa and Brazil (Africanised honey bees) as well as in mite-resistant European honey bee populations. This works, because the removal/cannibalisation of the infested pupae prevents the mother mite from reproducing and depletes the mites, limiting the supply to 20–25 offspring, which they can produce during their lifetime. Currently, the easiest way to detect mite resistance in a population is to measure the number of recapped cells. This is the behaviour where a hole is made in the cap of the sealed worker brood and then resealed. If the cell is *Varroa*-infested, it can be removed, but the cell can also be recapped as the system is imperfect. The opening and recapping of cells happens many times during pupal development.[1]

We worked alongside Anais Luis who is in charge of the honey bee pests and diseases laboratory, and Adolfo to sample apiaries from several locations in western Cuba to get a better idea of what was going on. When we collected our first set of mature, sealed worker brood samples from several colonies in the CIAPI's apiary, it was obvious that cells were being opened (Figure 7). This 'bald brood' is commonly seen in *Varroa*-resistant colonies. We had already set up the laboratory with several binocular microscopes and good lights with Dr Isobel Grindrod solving the problem of attaching the ring light to the microscope using a mask (Figure 8). Within minutes it became clear to all of us that the recapping rates were indeed high in all the colonies we were investigating. However, as scientists, we pressed on to uncap up to 300 cells from colonies sampled from seven apiaries across western Cuba to get a more accurate data set.

We also taught Anais how to conduct mite introductions that allow mite removal rates to be calculated. This is a much more tedious and time-consuming experiment but, after we left Cuba, Anais conducted the experiment, so we ended up with both recapping and mite removal data for the Cuban honey bees. During the trip, we opened almost 7,000 worker and 2,000 drone cells from thirty-two colonies located in six locations that were hundreds of kilometres apart. The recapping rates in workers were the highest ever seen in *Varroa*-resistant European bees i.e. around 70% of all infested cells were recapped. This is on a par with African and Africanised bees. Likewise, the mite removal rate measured by Anais was also around 80%, indicating that the Cuban honey bees had learnt to detect and remove infested worker cells, reducing the infestation rate to around 13% in the worker brood. Although it was 40% in the drone brood since these cells do not undergo targeted recapping or removal. We also found decreased reproductive abilities of the mother mites were below one mated female offspring per reproductive cycle, again a figure in line with other studies on *Varroa*-resistant honey bee populations.

Figure 5. A typical Cuban apiary.

Figure 6. Royal palm forest.

Therefore, the key three traits found in *Varroa*-resistant populations, i.e., high recapping rates, particularly of infested cells; high removal of infested cells and low reproductive ability, were all present in Cuba. This confirms what the beekeepers had long known: their bees were resistant to *Varroa*.

So how was *Varroa*-resistance achieved in Cuba? The answer was the centralised decision of 'not to treat' when *Varroa* first arrived in the country, or use any biological control such as drone trapping during the initial high mite levels. This decision was greatly helped by Cuban beekeepers being registered and being within a strong locally-based beekeeping community. Initial high losses of many thousands were encountered, and the overall colony numbers fell, being at the lowest, six or seven years after the mite arrived. However, in 2021, colony numbers rebounded to their highest level, aided by a very efficient local queen rearing industry (Figure 9). The pattern of loss and recovery was also seen in South Africa, another country that chose not to treat but to allow their honey bees to adapt to the mite.

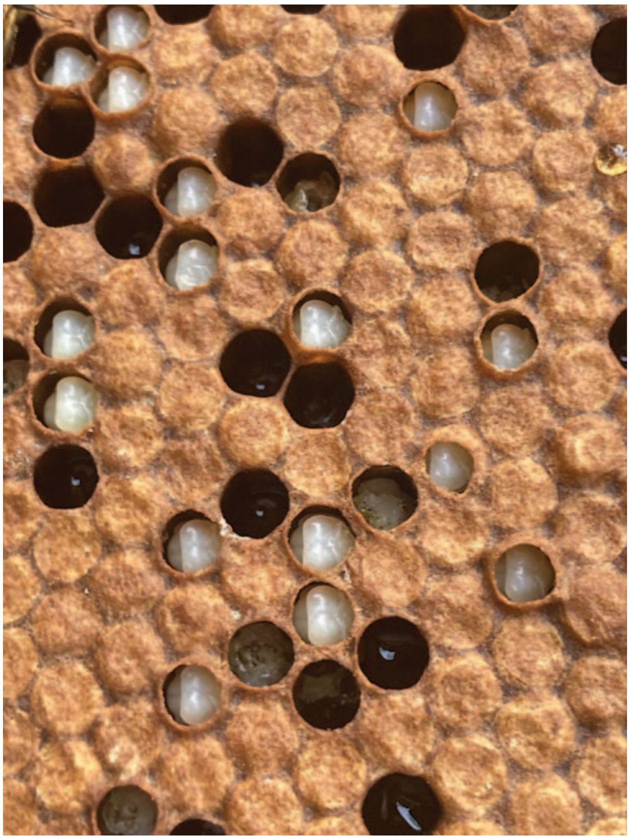

Figure 7. Typical 'bald brood' frequently seen in Cuban colonies.

Figure 8. Izzy working hard in Cuba. Note the clever use of a mask to secure the ring light to the microscope.

Figure 9. A Cuban queen rearing apiary.

As Cuba has around 221,000 managed colonies of European honey bees that are not treated for *Varroa*, this means it is by far the biggest population of *Varroa*-resistant European honey bees in the world. Work done in Cuba and elsewhere provides a strong foundation for ideas on how honey bees develop *Varroa*-resistance, since all resistant populations so far studied demonstrate the same key traits irrespective of where in the world the bees are.

I hope this article will give hope to more people that a 'new normal' of living with treatment-free honey bees is a real possibility, as an increasing number of UK beekeepers are discovering.

Further reading

Luis AR, Grindrod I, Webb G, Piñeiro AP, Martin SJ. Recapping behaviour in Cuba: home to the world's largest population of *Varroa*-resistant European honey bees. *Scientific Reports* 2022; 12(1):15597; DOI: 10.1038/s41598-022-19871-5
Free to download.

Reference

1. Martin S, Grindrod I. *BBKA News Special Issue, Natural Varroa-Resistant Honey Bees.* August, 2020.