Varroa-Resistance: A Team Update

By Georgiana Webb, Isobel Grindrod and Stephen Martin, University of Salford

Catch up on the latest developments at Salford with news from Georgiana Webb (Georgi), a new MPhil student part-funded by the BBKA, and from Isobel Grindrod (Izzy) and Stephen Martin. Varroas' days could be numbered.

Georgi's news

During my time at the University of Salford, I completed a degree in Wildlife Conservation with Zoo Biology, gaining a 1st class. My final year dissertation topic revealed a passion I never knew I had: 'bee-research'. I was previously unaware of the many problems that honey bees encounter. My dissertation was entitled 'Selection for Hygienic Behaviour in Honey Bees (*Apis mellifera*): A Meta-Analysis', and I focused on honey bees' normal hygienic behaviour of removing dead brood. The conclusion from data I gathered from 21 scientific research papers was that selectively-bred hygienic colonies are superior to non-selected colonies when performing hygienic behaviour. This suggested that hygienic behaviour can be selected for and it was likely to be due to the earlier detection and removal of dead pupae by hygienic bees. I was hooked, and applied to do a two-year MPhil degree on honey bees that started February 2021.

This year, I have been very busy in the laboratory measuring the recapping rates of many colonies, both experimental and control, in our current 'queen-swap' experiment. Recapping is an important behaviour that appears to be linked to decreased mite reproduction and increased colony survival.[1] The queen-swap experiment is designed to understand if the recapping trait is genetic or a learnt behaviour; we hope to have an answer this winter. It is important, as it will help beekeepers to understand if mite-resistant colonies need to be split or if propagation of locally-mated queens will be sufficient to ensure that recapping and thus mite-resistant traits can be passed on.

I am also saving mite offspring and pupae that are both infested and non-infested for future chemical analysis. This analysis aims to identify where the signal for bees to perform hygienic behaviour emanates from; it could be the mites, the pupae or even an entirely different source. It will also allow us to see which key compounds we can detect in the UK honey bee population. To date, several compounds have been identified by groups in the USA, Italy and France, with the French team having the most compelling data. Finally, I am working with a new graduate, Alex Vatentine, who, last winter, conducted a survey into the treatment habits of British beekeepers. Together, we are writing a scientific publication as the data Alex collected is very interesting. We hope to publish the results this winter if all goes well.

I have been fortunate enough, despite COVID, to have already had several beekeeping experiences, finding queens and even witnessing a swarm; we subsequently collected the bees off a nearby branch and carefully transferred them to a hive. I believe if you question everything, you can often discover topics that may need more consideration and therefore further research and I think this is important because we do not know all of the answers. Therefore, I hope to contribute to the vital research on mite-resistant honey bees and helping beekeepers reduce or eventually stop mite treatments while completing my Master's degree.

Izzy and Georgi getting ready to collect their first swarm.

An important update from Izzy

I started my three-year PhD in October 2019 and am funded by Bee Diseases Insurance Ltd (BDI) with all my studies focused on trying to understand *Varroa*-resistant honey bees. I am pleased to say that after almost two years of hard work, Stephen and I have completed a major part of my research programme. This comprises three key parts of work that have resulted in:

- The *BBKA News Special Issue* on *Natural Varroa-Resistant Honey Bees: Biology, Testing and Propagation.*[2]
- An eight-minute instructional video showing beekeepers how to measure recapping and mite removal behaviours.[3]
- A major, high-impact scientific publication bringing together data from over sixty previous studies conducted over the past

forty years to propose a simple framework that explains how *Varroa*-resistance arises in the *A. mellifera* population across many continents.[4] This paper is free to download and print.

This mix of scientific and outreach work is designed to help both beekeepers and scientists understand, measure and propagate *Varroa*-resistant honey bees in the UK. For the first time we have a simple framework that indicates how mite-resistance may have evolved in honey bees. Over time, knowledge gaps will be filled and hypotheses will be tested. The framework should allow the beekeeper to see how the various traits, often long-associated with mite-resistant colonies, link together. Although, the basic mechanism is shown in the *BBKA News Special Issue*,[2] anyone interested in the full details should read the paper.[4] Originally the paper was concise and somewhat difficult to understand. However, after several rounds of reviewer comments it has become a much more detailed and involved piece of writing. I have had to develop a thick-skin dealing with some reviewer comments, but in the end, it was all worth it. My next task is to continue working with the queen-swap experiment for the rest of the year.

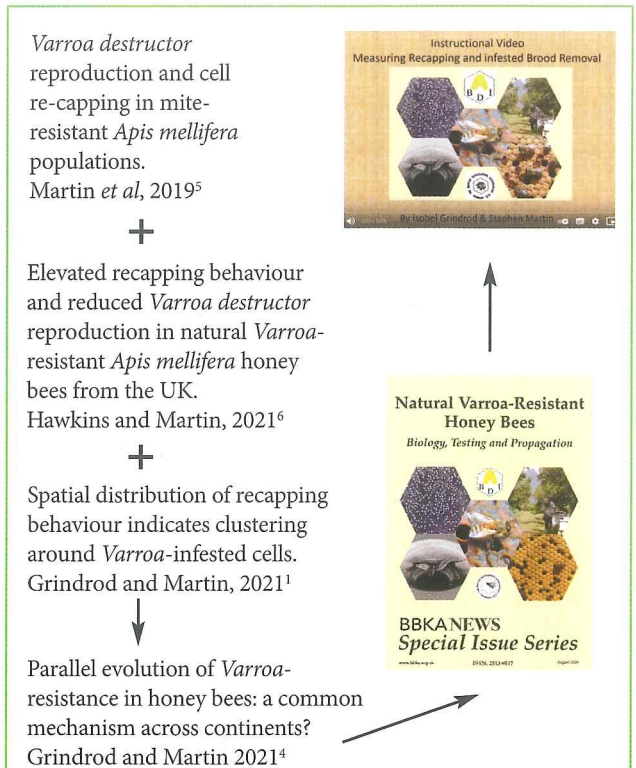
A brief overview from Stephen

I have been in *Varroa* research for many decades now and this is the first time I can see a path to the end of the *Varroa* problem for UK beekeepers. A small number of beekeepers have already had over a decade of mite-free treatment. Also, an increasing number are switching to reduced or even no treatments to control the mite populations and instead allowing their bees to adapt to the mite. This is possible in the UK since we do not typically move our colonies long-distances or keep large colony numbers.

I originally studied mite-resistance of Africanised honey bees in Mexico back in the 1990s. At that time, we understood that this trait was restricted to just Africanised bees. However, as time went by, other isolated populations started to appear in many countries. Despite these populations being studied, and lots of ideas being proposed, no clear evidence was forthcoming. The breakthrough came when a Scandinavian PhD student, Melissa Oddie, found that 'recapping behaviour' was elevated consistently in five mite-resistant populations throughout Europe, relative to five nearby non-resistant populations. This was my 'light-bulb moment' since this was the first consistent behavioural data I had seen linked with resistance. I quickly was able to confirm Melissa's original findings during trips to Brazil and South Africa,[4] (see Martin *et al.*, 2019 for the full story[5]). My BDI/BBKA-funded postgraduate student, George Hawkins, then confirmed the link between increased recapping and resistance in the UK.[6] Despite some initial scepticism by bee scientists, Izzy got to work, first explaining the potential reasons behind the increase in 'recapping of non-infested cells'[1] and then progressed to her '*magnum opus*', bringing together forty years of past *Varroa*-resistance research to provide the first comprehensive mechanism of mite-resistance in honey bees.[4] The bottom line is that any type of honey bee population e.g. strain, colour etc, kept in any environment, by whatever method the beekeeper choses, is capable of developing *Varroa*-resistance if given the chance.

Before we start to advise the best way to achieve this, our aim is to have a sound and detailed understanding of the mechanism of mite-resistance, as this allows all the advice we give to be evidence-based. The work my team is doing is going a long way to achieving that goal. For the first time in decades, I am confident that we will see *Varroa* treatments eventually phased out in the UK. Feral populations have a major role to play in this because they are typically the first colonies to become resistant since the selective forces are greatest in these colonies.

The team at Salford will continue to focus on helping beekeepers in their fight against the mite and, to that end, we will try to ensure



A diagram indicating how the key publications link together along with data from around the world to produce the evidenced-based *BBKA News Special Issue* on *Varroa*-resistance and then the instructional video. Unusually, we produced the *Special Issue* in parallel with the final research paper and, due to the importance of the topic for beekeepers, we published the *Special Issue* before the paper since academic publishing can be a long process.

the studies we publish are all open access publications, allowing any beekeeper, to download for free, read and make up their own mind. In the near future we aim to publish the treatment survey Alex conducted earlier this year, finish the queen-swap experiment and continue our work on mite-resistance both in the UK and elsewhere. Finally, I must thank all BDI/BBKA beekeepers, as it is their funding that helps this research to be conducted and the next generation of bee scientists to emerge.

References

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