Natural Varroa resistance: the end of chemical control?

How resistance develops and increases colony survival

Stephen Martin and Isobel (Izzy) Grindrod

The dreaded varroa mite was first detected in the UK in 1992, and within a few years had spread across most of the country. That's now 30 years ago, its pearl anniversary, although we suspect no beekeepers are celebrating that. Today, a high proportion of beekeepers have never kept bees without varroa, and mite treatments are just another part of beekeeping – therein lies the problem. Why change what I do if it works? But should we really be exposing our bees to formic or oxalic acid the two most-used varroa controls in the UK? Do you want to be locked into treatments for decades to come or do you want the bees to solve the problem for you?

The infographic on the following pages was designed by Izzy and shown at the BBKA spring convention. This article aims to introduce the poster and get the treatment-free discussion started.

A brief history of varroa

In the early 1990s, the National Bee Unit and beekeepers were waiting for the possible arrival of the varroa mite as it spread westwards around the globe. Its journey started in the 1950s when the more prolific Western honey bee (*Apis mellifera*) colonies that were moved into regions native to the Eastern honey bee (*Apis cerana*) were invaded by varroa. Molecular data has since found that varroa split into two species – *Varroa jacobsoni* and *Varroa destructor* – around 2–3 million years ago and both lived on *A. cerana*. It is unclear why the two mite species existed. However, when *V. destructor* (the mite we have) encountered the imported *A. mellifera* colonies that lacked the traits to control its populations, a new beekeeping problem arose that went on to sweep around the entire world.

How varroa kills a colony

When pathogens or pests find themselves in or on a new host, just like varroa did, the past balanced relationship between host and pest is suddenly lost. Typically, the host is the one at a severe disadvantage; look no further than the recent covid pandemic. Coronaviruses are very common in bats and cause no damage, but when they enter the human population, well, you know the rest.

Initially, varroa was believed to kill a colony by 'sucking it to death' – it was though to feed on the bee's blood or, as we now know more correctly, the bee's fat body. This weakens the bees, causing deformed wings, and eventually killing the colony, typically overwinter. However, Dr Bill Bailey and Brenda Ball revealed that the real reason mite-infested colonies died was because varroa provided a new viral transmission route for a small group of naturally occurring honey bee viral pathogens. The pathogen best adapted to take advantage of this new situation was deformed wing virus (DWV). This virus reduces the lifespan of bees infected by the mites when they are pupae. A perfect storm occurs within your hives during autumn as varroa numbers peak, thus infesting an ever-decreasing number of worker brood cells as the colonies prepare for winter. If more than 2,000 overwintering bees become infested with DWV as pupae (from mite feeding), the colony is unlikely to survive. Realising that they must prevent this from happening, beekeepers have reduced the varroa population by treating them with a variety of miticides.

> A perfect storm occurs within your hives during autumn as varroa numbers peak

To treat or not to treat, that is the question

When varroa first arrived in the UK in the early 1990s, beekeepers were reluctant to treat their colonies, as it went against the ethos of beekeeping to place pesticides (miticides) in a beehive. These compounds will affect your bees if the incorrect dose is given. Many beekeepers refused to treat, or used homemade remedies. I was even told by a beekeeper that his bees didn't require any treatment since "I keep my bees under a cliff so the mites can't see them when they are flying over!"

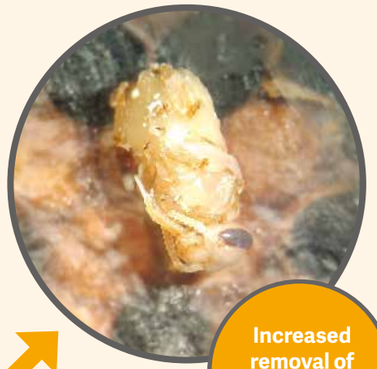
It took almost a decade before treatment became universally accepted, and sadly many beekeepers never returned to beekeeping after their colonies died from varroa. However, over the past two decades, varroa treatment has become the norm. The compounds used to treat the mite continue to change as various

How resistance develops and increases colony survival

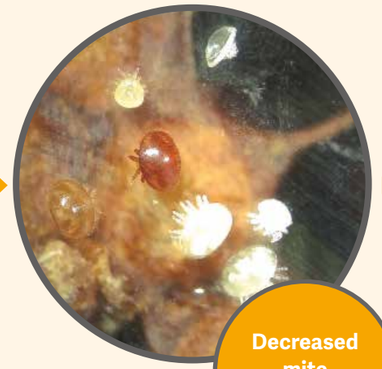
Honey bees seem to have developed a way of coping with varroa. Left to their own devices, the bees may uncap brood cells in which they detect mites, remove the mites and then recap the cells. Beekeepers may see uncapped or partially capped cells and think that it is baldbrood.

THE PROBLEM

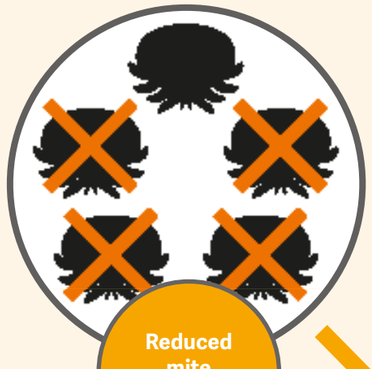
Varroa and deformed wing virus (DWV) cause the collapse of honey bee colonies worldwide and the chemicals (miticides) used to control them are becoming less effective



Increased removal of mite-infested brood



Decreased mite fertility



Reduced mite infestation

Natural resistance is increasing in prevalence but until now we have not had a unified understanding of how it develops

INCREASED COLONY SURVIVAL

Increased mite detection

Brood removal, and potentially recapping, interrupts female mite reproduction reducing the number of offspring she produces

Increased recapping

Lower DWV load

DWV reduces the lifespan of workers

Less DWV means more healthy workers and less chance of colony collapse

THE SOLUTION?

Understanding resistance will:

- **educate future research into promoting resistance in susceptible colonies**
- **help the global industry achieve widespread miticide-free beekeeping**
- **provide a sustainable and long-term solution to varroa.**

FURTHER READING

Data from 60 scientific studies was extracted, analysed and supported with computer modelling

treatments have become ineffective and advice changes. This long-term treatment solution to varroa has been adopted almost universally across the Northern Hemisphere. But is this the only long-term solution to the varroa problem?

Some countries, including South Africa, South America and Cuba, took a very different approach to the varroa problem. When varroa first arrived, it was decided centrally not to treat and to allow natural resistance to arise. Initially thousands of managed colonies died, although this was never recorded in South America, and several hard years had to be endured before the numbers started to recover.

Cuba's managed honeybee population recovered quickly to its previous 180,000 managed colonies and have now not received any treatment for over two decades. They are calm and productive colonies often producing 40–70kg of honey per year.

Likewise in South Africa, South and Central America beekeepers have never treated for varroa. This situation will have occurred throughout Sub-Saharan Africa but was never recorded, although reports of varroa-resistant honey bees are starting to appear there.

In Hawaii, where we have a long-term study site, we have seen the initial effects of varroa after its arrival on the island of Oahu. Within three years almost all the hundreds of feral colonies on Oahu had disappeared. However, within ten years feral colonies reappeared and beekeepers found they could keep treatment-free colonies by collecting swarms from the forests as the feral population had become resistant.

Is treatment the only long-term solution to the varroa problem?

The open secret

Attend any large group of UK beekeepers today, and you are likely to find up to a quarter of them are currently not treating for varroa; a smaller proportion may not have treated for more than six years, the minimum period for bees to be classed as mite-resistant. However, as government advice is to treat, treatment-free beekeepers have kept quiet for fear of being branded 'bad' beekeepers.

Our recent beekeeper survey, based on over 2,500 responses, suggested that around 300 UK beekeepers have been treatment-free for over six years. Most of them maintained 16–30 colonies, whereas the average number of colonies

managed by a UK beekeeper is between three and five. Both our survey and the BBKA annual overwintering survey have found that around 25% of UK beekeepers are currently not treating, although many will be forced to treat in the first few years if mite numbers increase to dangerous levels.

What's going on in treatment-free colonies?

The bees in resistant colonies have learned which cells are infested with varroa and prevent the mite reproducing by removing the infested pupae.

A French team has shown that the bees can detect chemical signals coming from the mite offspring. This ability to detect infested cells leads to increased recapping and infested pupae-removal behaviour. Initially, bees that can detect the mite offspring odour remove part of the cell cap and often the surrounding un-infested cells. Beekeepers may recognise this stage as bald brood. These opened cells are then either recapped or removed.

Recapping is part of the bee's hygienic behaviour, in which any healthy cells opened in error are resealed. Recapping can only be seen if the cell cap is removed carefully, enabling the underside of the cell cap to be viewed.

High levels of recapping (above 50% of infested cells) are currently the best indicator of mite resistance.

The opening and recapping of sealed worker cells happens many times during pupal development and is quite error prone. The aim is for infested cells to be opened and the infested pupae removed. Since the pupae are not dead, worker bees cannibalise them. During this process the mother varroa mite escapes but loses all her offspring, thus causing a decrease in her fertility as a varroa mite can only reproduce two or three times in its life. The removal behaviour leads to fewer mites, lower amounts of DWV and increased colony survival. Although bees cannibalising the infested pupae will ingest DWV, this is a long-standing viral transmission route and so any impact of DWV is negligible compared to transmission by varroa.

Studies show that colony losses of treated and treatment-free colonies are similar. Both reduce the mite population to a level that doesn't impact the colony.

Professor Stephen Martin of Salford University trained as a biolgist in the UK and Japan, where he once studied Asian hornets. On his return to the UK, he worked for the National Bee Unit for seven years researching the pests and pathogens of honey bees especially the varroa mite. At the universities of Sheffield and now Salford, he has studied chemical recognition systems in social insects and honey bee pathogens

Isobel Grindrod obtained a biology degtree at the University of Salford and went on to work with Stephen Martin there as a PhD student focusing on the natural resistance of honey bees to the varroa parasite.

What can you do?

Firstly, choose your long-term plan for managing varroa. Going treatment-free is not for everyone, particularly if you have only a couple of colonies.

Secondly, if you are interested in reducing treatment with an eventual aim of going treatment free, then understand what the bees are doing and how you can help.

Importantly don't be afraid of change. Throughout this article, you can see how our understanding of varroa has changed. Change is progression. Learn from treatment-free beekeepers, read articles and books, both scientific and beekeeper written.

Half and double

Our current advice to beekeepers is to reduce current treatments by half and double the monitoring. The aim is to allow your bees to learn the smells produced by mite offspring and remove the infested cells. A quicker way for people with fewer colonies is to collect wild swarms from locations where the bees have been surviving for many years.

We believe that there is sufficient evidence from resistant populations around the world that this honey bee-led approach is correct, since our bees always know best. It is therefore now time for researchers and treatment-free beekeepers to develop best practice to help willing beekeepers to stop treatment. This will take time, but every journey starts with the first step. We hope the infographic and links to material below will help.

FOR REFERENCES AND FURTHER READING, SEE WWW.BEE-CRAFT.COM/...

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Instructional video on how to measure recapping and mite removal. https://www.youtube.com/watch?v=Hfa9C1xvtec