Achieving Balance Between Bees and Varroa

By Gareth John

A fresh approach to bee management, by stopping varroa treatment methods, might, in contrast to popular belief, help reduce the varroa load on a colony and improve its varroa tolerance, as Gareth John has found.

Hives in a sunny spot in the apiary. Photo by David Wootton.

The natural development of tolerance

When a disease or pest first enters a new population, initial losses are high; they can exceed 90%. A dramatic example of this was the introduction of European diseases by Spanish Conquistadors to the natives of South America. Whole populations were literally decimated. Over time, however, a balance is restored and the disease or pest comes into equilibrium with its host. The less interference there is with the system, the sooner balance is achieved.

A major obstacle to the development of mite tolerance in the European honey bee is intensive beekeeping practices including mite control. Since the mite has been introduced to the western world, beekeepers have used methods to remove the mite from colonies, therefore eliminating the selective pressure of mite infestation that would be required for adaptations towards parasite tolerance or resistance in the bees, or towards lower virulence in the mites.[1]

When honey is regarded as a low-priced commodity, it is understandable if those whose livelihoods depend on selling cheap honey choose to interfere. This is especially true when agrochemical companies promise silver bullets and the prevailing paradigm is treat or perish. In reality, we know there is no silver bullet and what results is a constant arms race between the mite and the treatment. This makes money for the agrochemical companies, but delays the establishment of a sustainable equilibrium.

An attempt at minimal treatment

I started keeping bees many years before varroa arrived in the UK and had given up beekeeping when it did arrive. I recommenced beekeeping around fifteen years after varroa's arrival. By then, it seemed to me, enough time had elapsed for a degree of varroa tolerance to have emerged in our bee populations. By this I do not mean that varroa tolerance would have newly evolved in our bees. Rather, I mean that the pressure exerted on our bees by varroa might have led to pre-existing, but unexpressed, tolerance mechanisms becoming active. A great many potential capabilities are present in the genetic code beyond those that are expressed. For a detailed discussion of this, and how such traits can be unlocked by environmental stimuli see *Arrival of the Fittest: Solving Evolution's Greatest Puzzle* by Andreas Wagner, Oneworld Publications. Such tolerance, if it were there, would of course be masked by a routine treatment regime. Hence, when I recommenced beekeeping, I decided to count daily varroa falls. I would only treat if it became unavoidable, and then only to the minimum amount necessary. If the bees in my hives had any tolerance, hopefully, this regime would allow me to spot it.

I modeled my varroa counts on the methodology published by Stephen Martin, then at the NBU.[2] When the output from the model was presented graphically, it allowed me to see the shape of the population growth curve. I could thus determine the point when the mite growth rate was running away from the bees. I used this as my trigger for treatment instead of the generalised treatment guidelines given by the NBU. When this point arrived, I treated with essential oils to my own recipe, designed to minimise the dose. Effectiveness was around 90% and mite levels fell dramatically in treated hives. However, I found my colonies were continually superseding their queens. They often did this several times in a season and eventually, in the autumn, ended with unmated queens. In other words, my apiary was unable to maintain its colony numbers. So, although mite numbers were being controlled, I realised that the overall position was not sustainable.

Moving to treatment-free conditions

At about time this realisation dawned, I met Ron Hoskins at the Swindon Bee Project. I learnt that he gave up varroa treatments because of repeated queen failures! As these were rendering his apiary non-viable, he reasoned there was little downside in going treatment-free. The scientific literature also contained reports of harm to bees caused by varroacides, including essential oils such as thymol.[3] So I concluded that the only sustainable path was to follow Ron's advice. I ceased treatment and collected swarms from wild colonies; these having already been through a non-treatment regime.

At the same time I decided to stop all varroa monitoring. I did not trust my resolve to forego treatment if mite falls started to increase! Besides, my modeling showed a small amount of day-to-day mite control by the bees was potentially more effective than an occasional large mite control by the beekeeper.

As matters now stand, I have not treated, nor applied any biomechanical control such as drone culling, to any of my twenty or so colonies for four years. I lose far fewer colonies than previously to queen failure. I lose relatively few colonies to varroosis. My losses are generally less than those reported by treatment beekeepers. This pattern of losses is similar to that seen by other non-treatment beekeepers, at least where data is collected that compares treatment losses with non-treatment losses. By way of example, data collected in one Welsh beekeeping district shows that, over the four years to 2014, non-treatment winter losses averaged exactly 2/3rds of losses in treated colonies. The sample size was significant, representing over 1,000 colony winters. What is even more noticeable is that over the duration of the study the number of non-treatment hives rose steadily and, in the last year, represented four out of five of the hives monitored. This clearly suggests that non-treatment is catching on (data available at: http://ow.ly/LvhjS).

Since ceasing all treatment in my own hives, colony numbers have steadily grown and, in complete contradiction to the situation when I last treated, the current management question is not how to maintain colony numbers but how to prevent them increasing beyond manageable levels. It seems that the bees have sufficient varroa tolerance not just to survive, but to multiply. Many of the hives are extremely vibrant and capable of throwing large swarms: a robust ability to reproduce is, after all, a key marker of fitness. My hives produce sufficient honey not just for their own use during the winter but also by way of excess for the beekeeper without the need for any sugar feeding.

A few colonies do not thrive, but one must expect this in any population. In the past, if such colonies were otherwise disease free, I have united them with a second weak colony. However, I have found that rarely does the combined colony survive the winter and, henceforth, I shall no longer be doing this; propping up weak colonies cannot form part of a robust regime.

Swarming versus splits

All of my queens are naturally reared through the swarming or the supersedure impulse and open-mated. I do not use splits as these do not give brood breaks, which are part of the mechanism of varroa tolerance. In addition, splits are a form of horizontal propagation (like taking cuttings from plants) rather than vertical propagation (true reproduction). This has potentially important effects on the virulence of both varroa and the viruses it carries.

For honey bees, horizontal transmission can occur either between honey bee colonies or between individuals within the colony. Vertical transmission occurs through reproduction … at the colony level from mother colonies to swarms … If vertical transmission is the main route for infections to spread, then it can be predicted that less virulent relationships between the host and parasite evolve because the pathogens depend on the success of host reproduction.[4]

In other words, if varroa or its viruses kill the bees before they swarm, they perish along with the bees. By contrast, if the beekeeper constantly makes splits, it does not matter if the mother colony perishes. Varroa and the viruses will have moved on in the combs of the split. It is worth noting that, in the active season, approximately two thirds of the varroa mites are in brood cells. These are left behind if the bees swarm, but not if the beekeeper splits the colony.

The importance of drones and wild colonies

Initially I was worried that local drones from non-tolerant stock would dilute the tolerance of my own bees. However, that has proven not to be the concern that I thought it would be. Either tolerant queens are capable of selecting tolerant drones, perhaps by smell, or there are sufficient tolerant drones in the vicinity to maintain an acceptable level of tolerance in my hives. The fact that my current colonies all started as swarms collected locally suggests that there are plenty of tolerant drones around, although this does not preclude a degree of selection by queens of their mates.

Tolerant drones may originate in wild colonies or from managed hives. The latter may, in fact, be treated, but this does not preclude them from having at least some helpful characteristics when it comes to varroa tolerance, albeit masked in their home hive by a treatment regime. Needless to say, drone culling removes potentially tolerant drones along with the rest.

Despite what we are told about there not being any wild bees left in the UK, where I live it is difficult to find a village that does not have bees living under roofs, in hollows in walls and in old trees. Many have been *in situ* for years. We are told that such colonies regularly die out and are replaced by swarms. The same is said of colonies kept treatment-free by beekeepers. With regard to the latter, the non-treatment beekeepers I know would certainly be aware if a colony died out; they keep their bees under constant observation.

Possible tolerance mechanisms

We often read that so-called hygienic behaviour is key to varroa tolerance. This is the uncapping and removal of varroa-infected pupae by the bees. I have no doubt that this is an important attribute of tolerant colonies. Moreover, it is not unusual to see the season's first batch of drone pupae thrown out of untreated hives. The pupae show signs of infection with both varroa and deformed wing virus. The second batch of drones are often pristine, so one wonders if a complex behaviour of drone trapping and hygienic behaviour is at play.

Apart from grooming and pupae removal, some of the other factors involved in varroa tolerance are physiological at the level of individual pupae and still others probably occur at the level of the whole colony.[4] Apart from swarming, whole hive factors might well include such things as temperature and humidity control, levels of carbon dioxide, organic volatiles and stress levels.

There are those who are convinced that small cells, i.e. brood cells of less than 5mm in diameter, are key to varroa tolerance. If one reads the scientific literature, however, the effect of small cells on their own is unclear. Indeed, for many of the factors mentioned here, and others besides, when tested in isolation, the evidence is often equivocal. I conclude from this that varroa tolerance is not a one-factor mechanism, but a complex set of behavioural and physiological interactions that occur at the level of the individual bees, at the level of the hive, in the interaction between the bees and varroa and, importantly, also between the bees and the viruses that varroa carries. An example of this interaction has been mentioned above in terms of horizontal versus vertical transmission, with the former potentially encouraging greater pathogen virulence. In this context, we know that there are different strains of deformed wing virus. At least one multiplies many times more rapidly than the others. Could horizontal

Swarming bees. Photo by David Wootton.

transmission of the virus, via constant colony splits, encourage the more virulent strain to develop? Conversely, could infection with a slower growing, more benign, strain be encouraged by swarming? This, combined with the swarming brood break, might help to save the bees from being overrun by the virus.

Conclusion

We do not have full answers to these and many other questions that surround varroa. Nevertheless, the message I take from this is that whenever I interfere with a hive I am potentially disturbing a highly complex and finely balanced system. For example, to allow the bees freedom to accurately control the internal hive environment, I do not use open mesh floors. Mindful of the comment by a commercial beekeeper and one-time bee inspector that 'varroa is a problem of forced bees', I do not stimulate bees to rear brood but allow matters to progress according to the rhythm of the seasons. The bees reproduce through swarms that I then collect, rather than by the use of splits.

As a hobbyist, I have the freedom to experiment. Surely, those of us who have this freedom should use it, and allow the bees to show us a way of coming to terms with varroa using their natural defences. The evidence suggests that the equilibrium I discussed at the beginning of this article may not be that far away.

References

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