TREES FOR BEES CORNER

NUTRITION, NOSEMA AND NEONICS: WHAT'S FOOD GOT TO DO WITH IT?

Linda Newstrom-Lloyd

A good diet plays a crucial role in the prevention of colony failures in more ways than we realise. It is often possible to distinguish the different types of colony losses that are due to single causes like queen failure, excessive pesticide or plant poisoning (e.g., karaka), specific diseases (e.g., AFB), or starvation.

To illustrate, poisoning is suggested by a heap of dead bees at the hive entrance. Diseases can be tested for by submitting a sample of bees to the lab (e.g., John Mackay at dnature; john@dnature.co.nz) or by learning to recognise symptoms of *Nosema*, AFB, chalkbrood, etc. Starvation is indicated by insufficient food stores in the hive. But what if none of these are clear-cut symptoms?

For example, in spring 2014, no causes were obvious for the rapid depopulation and collapse of many colonies, a large-scale event in the Coromandel and other parts of the North Island. Oksana Borowik reports,

> "Over a short period, colonies of over 10,000 were reduced to just a few hundred bees and a queen. The remaining bees were unable to tend to the brood, leaving the hives too weak to produce a honey crop, or even to survive".

This is the first such incident to occur in New Zealand and it is estimated that thousands of hives were affected (Borowik, 2015a & b; Borowik and Goodwin 2015). These symptoms are characteristic of what has been termed Colony Collapse Disorder (CCD) syndrome.

The Toringo or Seibold Crab Apple (Malus sieboldii) is frequently used on Trees for Bees Demonstration farms as a good source of spring pollen. The fragrant white flowers open from pink buds in mid-spring. This deciduous small tree is covered with flowers at blossom time providing plentiful bee feed with protein-rich pollen. It produces a small crab apple early in the season and birds and ducks love the fruits.

What exactly is CCD?

Most scientists no longer refer to this syndrome as CCD, but rather "rapid depopulation" or other more general names to include variations on this type of syndrome, such as the historical 'dwindling' disease.

The main symptom of this syndrome is extremely rapid colony losses characterised by the sudden disappearance of the workers who were out foraging. They leave only the queen, the brood, some food and a few adult bees remaining in the hive.

A new, multi-causal model

Since 2006, enormous research effort has gone into the search for *'the'* cause of such rapid colony losses, only to find that this syndrome (whether it is called CCD or any other name) does not have a single cause. This type of colony loss is thought to result from multiple interacting causes.

Recently, an intriguing article published by Andrew Barron (Barron, 2015) proposed a conceptual model, similar to a population model, to show exactly how the symptoms of rapid depopulation could occur from a range of different multi-causal factors.

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The model focuses on the *social consequences* of the sublethal effects of multiple stressors on bees. Sublethal effects are symptoms that do not kill the bees, but do impair their normal behaviour such as learning, memory, ability to navigate or orient, or to communicate sources of food. These types of sublethal effects are known to result from diseases such as *Nosema ceranae*, sublethal doses of stressors such as neonicotinoid traces in pollen or nectar, or even mild starvation that shortens the life of a bee.

Barron says,

> … [D]iseases do not need to kill individual bees to kill a bee hive: if they sufficiently compromise colony function this can cause colony failure. From the perspective of a colony maintaining its resource base and population it makes no difference if a pathogen kills the worker bees out right, or simply prevents them successfully returning home from foraging … A honey bee society usually contains within it autoregulatory mechanisms that operate to maintain the functions of the society against external stressors: fully understanding colony failure will require understanding how these social systems have failed. (p. 46)

Barron goes on to say that multiple stressors can interact in complex ways to alter the physiology of worker bees or the functioning of the entire colony. For example, if field-realistic (i.e. fairly low sublethal) doses of a neonicotinoid are combined with an organophosphate miticide, the impact is greater than the addition of the two stressors. They potentiate each other to impact odour learning and odour discrimination which bees need to find their food. This leads to lost foragers.

Multiple stressors can interact in complex ways to alter the physiology of worker bees or the functioning of the entire colony.

The Fried Egg Plant (Gordonia yunnanensis) *is used on Trees for Bees Demonstration farms as an answer to pollen and nectar dearth from autumn into winter. The large evergreen tree (up to 4 m) has flowers that look like a camellia, with white petals and showy golden stamens providing protein-rich pollen. Gordonia axillaris (also called Fried Egg Plant) is a similar species. Photos: Linda Newstrom-Lloyd.*

Other interactions that show potentiation and synergism involve malnutrition or starvation which makes bees more susceptible to *Nosema*, and to sublethal doses of a neurotoxin such as neonicotinoids or fipronil. These neurotoxins also make bees more susceptible to *Nosema* and in turn, *Nosema* infections make bees more susceptible to neurotoxins. If we think about the way human malnutrition, disease and toxins interact, this all makes sense. The problem is that it is very subtle and complex to diagnose in bees.

For a beehive that is losing its foragers, Barron's model incorporates the process of young nurse bees that are no longer socially inhibited by workers, and therefore enter into foraging work prematurely. Precocious foraging by nurse bees can be caused by colony starvation, pollen deprivation, disease, and even wax deprivation, according to Barron. The precocious young bees are not as effective at foraging and can get lost or die too soon. This compromises caretaking and feeding of the queen and brood, resulting in disrupted ratios in the division of labour in bee society.

Oksana Borowik reports that Mark Goodwin's team at Ruakura have marked over 12,000 bees to track their ages and have already made significant observations regarding premature foraging behaviour (Borowik, 2015). This is a work in progress and we eagerly await the results.

You might want to read Barron's full paper (see reference below). But to make a long story short, if chronic sublethal stressors are causing too much precocious foraging and poor foraging performance, the whole functioning of the colony can be altered enough to cause rapid adult population decline. At a certain point, an extremely rapid terminal decline causes death of the colony (e.g., within 14 days). The symptoms can be just like CCD or rapid depopulation syndromes: many different causes, same symptoms and many similar syndromes all leading to the same result.

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What can be done?

How can you ensure that your bee colonies are protected from and resilient to the effects of chronic sublethal stressors? Basically, the answer is reducing exposure to sublethal stressors and preventing them from accumulating in your apiary. Plenty of evidence exists in the scientific literature that good nutrition can not only help to prevent diseases like *Nosema* taking hold, but also can make bees more resilient to low doses or short exposures to toxins (Di Pasquale et al., 2013). All three factors interact: disease, toxins, and poor nutrition.

The one factor that beekeepers have the most control over is food supply. Beekeepers can make sure to:

1. locate apiaries near a diversity of natural fresh pollen and nectar sources to cover their feed requirements
2. not overdo artificial feeding of pollen substitutes and sugar solutions, which provide inferior nutrition (Di Pasquale et al., 2013) and should only be used for short-term emergencies
3. not overstock colonies by placing excessive numbers of hives into one apiary site, or one apiary too close to others (both lead to starvation)
4. be alert to other beekeepers overstocking hives too close to your apiary sites, and engage farmers and landowners in cooperating to protect bee health by not allowing overstocking on their land.

Well-fed bees that have sufficient protein, lipids and carbohydrates with adequate vitamins, minerals and other phytochemicals will be able to withstand diseases like *Nosema* and even chronic low doses of toxins. Taking malnutrition and starvation out of the equation will go a long way to preventing colony losses due to multiple sub-lethal stressors.

References and further reading

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E-mail newstrom.lloyd@gmail.com if you would like to obtain PDFs of the references listed here.