Chronic Bee Paralysis: Past, Present and Future

Dr Giles Budge, senior lecturer at Newcastle University and crop and bee health lead at Fera Science Ltd, with an update on research initiatives

Chronic bee paralysis has a long history with honey bees, going back millennia. Indeed, the first record of hairless black bees that may have described this disease has been attributed to Aristotle from 350 BC[1]. The disease became known by many different names, including: 'black robbers' and 'little blacks' in Britain; schwarzsucht (black addiction), maladie noire (black disease) and mal nero in continental Europe; and 'hairless black syndrome' in the United States of America. It took the efforts of a brilliant British bee scientist in the 1960's, Leslie Bailey, to relate these various maladies to a single causative organism – chronic bee paralysis virus (CBPV).

Chronic bee paralysis is found on every continent where honey bees are kept. In the UK, eight per cent of colonies were reported to be showing 'paralytic' symptoms in 1947, reducing to two per cent of colonies by 1966[2]. A large-scale survey completed by the National Bee Unit (NBU) between 2009 and 2011 suggested that the virus was not commonly detected when random apiaries were tested – only seven in 1000 apiaries tested positive. Interestingly, the prevalence was found to be far higher when apiaries showing poor health were targeted – in this case 160 in 1000 apiaries tested positive for the virus[3].

Recent Changes

The past few years have seen a dramatic increase in the incidence of chronic bee paralysis, especially for professional beekeepers. In 2016, a Bee Farmers' Association (BFA) survey reported 46 per cent of professional UK beekeepers had experienced problems with chronic bee paralysis in the past two years. Many reported reoccurring problems within apiaries and colony losses in over 40 per cent of those affected, which is uncharacteristically severe for this disease. The BFA estimated the cost of CBPV-caused disease to its membership was over £1.35 million per annum. A repeat of the survey of BFA members in 2017 awaits analysis, but early indications are that the problem persists.

In the United States of America, CBPV was detected at 0.7 per cent colony-level prevalence in 2010, but has more than doubled annually to reach 16 per cent in 2014[4]. Prevalence of CBPV is increasing in Italy, currently at eight per cent[5]. Apiarists in Germany are experiencing more frequent disease outbreaks (R Buchler, pers comm). Taken together, these observations demonstrate a clear recent change in disease incidence and consequent impact on apiculture.

Chronic bee paralysis has been a very difficult disease to study because the onset of symptoms can be sudden and the outbreak location unpredictable. As such, there are no scientific papers that provide robust evidence to demonstrate successful treatments.

Queen replacement has been suggested, but given that all races of bee appear to be susceptible, any success by this method may be attributed to a drop in adult bee population due to the brood break associated with queen replacement.

A recent promising management method appears to be a modification of the shook swarm, described by Chris Neel in a previous issue of *Bee Farmer*[6]. Nevertheless, our inability to explain or predict disease outbreaks means that bee farmers cannot implement evidence-based colony and apiary management strategies to prevent this damaging disease.

The Future

Over the past few years, I have been in discussions with bee farmers and NBU inspectors about the recent resurgence of chronic bee paralysis, listening to the many sad stories of colonies being devastated by this disease and what experienced beekeepers felt might be the causes.

In January 2016, I was asked to come and present what is known about chronic bee paralysis to Southern Region members of the BFA. I prepared by reading the literature on this disease going back over 100 years. What became clear was, with the exception of Leslie Bailey's 1960's research and some work done by the brilliant Magali Ribière in the noughties, most literature was the result of haphazard, opportunistic studies as a consequence of the unpredictable nature of the disease. Indeed, the research of the NBU was scuppered in 2009 when the disease all but vanished from the apiaries under study.

Research and Funding Availability

If there is a positive, the recent increases in chronic bee paralysis mean this disease is easier to study now than at any time in the past. I felt the time was right for greater research effort focusing on chronic bee paralysis and put together a consortium to bid into an open call from the Biotechnology and Biological Sciences Research Council (BBSRC).

Photographs supplied by Giles Budge

On 18 July this year, I received a letter confirming the consortium had won this funding.

The consortium includes:

- Newcastle University (Dr Giles Budge, principal investigator; Professor Steve Rushton, biological modeller)
- University of St Andrews (Professor David Evans, virologist)
- The Bee Farmers' Association (members opting to participate)
- National Bee Unit, Animal and Plant Health Agency (Mike Brown)
- ANSES (French agency for food, environmental and occupational health and safety), European Union Reference Laboratory for Honey Bee Health (Dr Magali Ribière)
- additional support from Dr Jay Evans, USDA (US Department of Agriculture), USA, and Dr Joachim de Miranda, SLU (Swedish university of agricultural sciences), Sweden.

Objectives

The chronic bee paralysis research project is divided into four objectives.

Objective 1: modelling the epidemiology and drivers of chronic bee paralysis
We will gather new information on what stressors are associated with colonies suffering from chronic bee paralysis and will consider pathogens in adult bees, pesticide exposure in adult bees, weather, local land use and apiary management practices. As such, we will be collecting samples from healthy and diseased colonies, along with husbandry information from bee farmers this year and next. Next year, we will set up field trials with bee farmers on apiaries that are suffering from reoccurring disease to monitor the dynamics of disease spread in individual colonies and apiaries. This will provide new information on where and when the virus becomes associated with the colony. This first objective will inform us about the pre-requisite colony stressors necessary for disease to develop, with the aim of writing new protocols for early disease detection.

Objective 2: CBPV evolution, transmission and virulence
We will assess whether the recent emergence of chronic bee paralysis is the result of shifts in the transmissibility or virulence of modern CBPV strains. We will describe temporal and spatial genetic variation, by sequencing representative historic and recent samples. We will recover infectious historic strains and use these to compare the risk posed by past and current strains. Finally, we will assess the risk posed by CBPV to other non-*Apis* pollinators, such as solitary bees and bumblebees.

Objective 3: quantifying the impact of co-stressors on disease development
We will investigate co-stressors of chronic bee paralysis using controlled *in vivo* challenge tests to include: lack of foraging due to poor weather, overcrowding and the presence of the gut parasite, *Nosema ceranae*. We will assess the impact of these factors on transmission and virulence for different virus strains.

Objective 4: developing a management toolkit to mitigate chronic bee paralysis
We will work closely with the BFA to translate research outcomes into improved professional practices when managing chronic bee paralysis. This will include a series of controlled field experiments using bee farmer apiaries where different management practices are employed. We expect this programme of work to provide a step-change in our understanding of chronic bee paralysis disease development, virus evolution and the role of co-stressors to develop informed, evidence-based management practices.

Final Comments

I would like to thank everyone who has discussed this difficult issue with me in recent years and all those BFA members who have already pledged their support for the project. As a team, we look forward to working together over the next four years to help mitigate the impact from this damaging disease. If you have any questions, please contact me by email at: giles.budge@ncl.ac.uk □

References

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Signs of Paralysis

Signs of chronic bee paralysis include a range of individual and colony-level symptoms. Individual signs include abnormal trembling motion with paralysis of the wings and body. Affected bees are unable to fly and sometimes crawl on the ground. They are often displaced in the hive, appearing on frame top-bars and lugs. Abdomens can be shiny, hairless and bloated, with the bees sometimes suffering from dysentery and dislocated wings. Affected individuals may suffer from nibbling attacks by healthy bees, giving them the appearance of 'robber' bees (below, left). Affected bees die after a few days of showing signs, leading to piles of dead bees inside the hive or just outside the entrance (below, right). Affected colonies can sometimes recover, but often the colony will lose so many adult bees that it will enter terminal decline.