The Random Apiary Survey Findings

Background

To get an accurate estimate of the prevalence of honey bee brood diseases and to monitor pathogens, including up-and-coming species, in adult bees, in 2009 the Department for Environment, Food and Rural Affairs (Defra) and the Welsh Government (WG) commissioned a two-year survey of apiaries across England and Wales. Beekeepers may well have read progress reports about this two-year Random Apiary Survey (RAS) in recent beekeeping publications, heard about it at association meetings, or may even have provided samples if your apiary was one of those selected within the survey. Before looking at the RAS results in more detail and how they compare with the data routinely gathered by the National Bee Unit's (NBU's) inspectors, it is helpful to understand a little more about how NBU inspectors currently operate.

Existing risk-based surveillance

The aim of the NBU is to detect and control notifiable pests and diseases as quickly as possible, but it is unfeasible for us to inspect every colony in every apiary each year. The inspection programme undertaken by the NBU is thus 'risk-based', which means that we concentrate our inspection efforts on apiaries according to previous pest and disease incidence in a given area and the proximity of apiaries to sites where exotic honey bee pest incursions are most likely to occur. NBU inspectors do not, therefore, just wander around the landscape looking for honey bee diseases; they target areas known to be at risk as part of a priority inspection programme. Although by working in this way we typically achieve 7,000 apiary visits (about 38,000 colonies) each year, the problem is that certain areas may not be visited at all because they are deemed to be 'low risk'. Herein lies the beginning of a Catch 22 situation: NBU inspectors do not visit an area because it has no history of pests and diseases and is low risk; then the same area might never be visited and pests and diseases, even if they are present, are unlikely to be discovered unless beekeepers spot and report the disease to us (as they are legally required to do)! This exposes a gap in our knowledge when it comes to the prevalence of pests and diseases, which cannot be solved by our existing inspection programme. So, to answer detailed questions about the prevalence of foul broods and also the emergence of potentially damaging pathogens in adult bees, the NBU needed to do something different. Hence the RAS was born: the largest apiary survey undertaken anywhere in the world.

Figure 1. An NBU inspector at work. All photos are courtesy of The Food and Environment Research Agency (Fera), Crown Copyright; images supplied by the National Bee Unit at Fera.

The basis of the RAS

The idea of the RAS was to dispatch our NBU inspectors to apiaries from across England and Wales over a two year period to provide random coverage of all eight beekeeping regions; a geographical area totalling over 150,000km^2. While visiting the apiary, they would inspect colonies for the presence of the damaging brood diseases American and European foul brood (AFB and EFB), record colony condition and also collect a sample of adult bees with which to complete a pest and pathogen screen back in the Food and Environment Research Agency's (Fera's) high tech molecular diagnostic laboratories in North Yorkshire. Thankfully AFB is a rare disease in England and Wales, but this represented a challenge for the survey because we had to make sure that we sampled a very large number of apiaries to stand a chance of finding just one case. In fact the rarity of AFB was the main driver for the scale of the survey. The full list of fourteen pests and pathogens for which we screened is presented in Table 1. The incidence of high levels of varroa was also noted and reported as part of the survey.

Did the survey provide a clear picture of disease?

For the purposes of the RAS the NBU inspectors made slightly more visits in the first year than they did in the second, in total inspecting more than 19,000 colonies by the time the survey was complete. Figure 2 shows the geographical spread of visits, and it is important to note that, overall, these were evenly distributed across England and Wales and two beekeeping years, and not concentrated in areas of high disease risk. Have a look at Figure 3, which zooms in on a small part of the map.

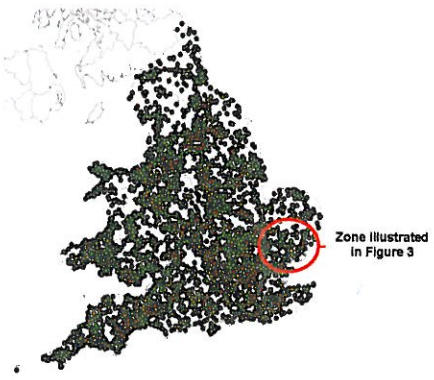

Figure 2. Distribution of the RAS visits 2009–2011. Red, Amber and Green colours indicate the disease risk status of apiaries prior to the visit (high, medium or low respectively).

This allows us to make a more detailed comparison between the distribution of inspections completed as part of the risk-based and RAS programmes respectively within a single beekeeping region. You should be able to see how the black (risk-based) dots are much more clumped together, whereas the grey (RAS) dots are well spread out. This shows us that during the RAS, inspectors made visits to apiaries that they would not normally go to during their routine

Table 1. The range of honey bee pests and pathogens screened within RAS

Pathogens

Nosema apis
Nosema ceranae
Melissococcus plutonius (EFB)
Paenibacillus larvae (AFB)

Pests

Acarapis spp (Tracheal mites)
Varroa

Viruses

Black queen cell virus (BQCV)
Kashmir bee virus (KBV)
Sacbrood virus (SBV)
Acute bee paralysis virus (ABPV)
Deformed wing virus (DWV)
Chronic bee paralysis virus (CBPV)
Israeli acute paralysis virus (IAPV)
Slow paralysis virus (SPV)

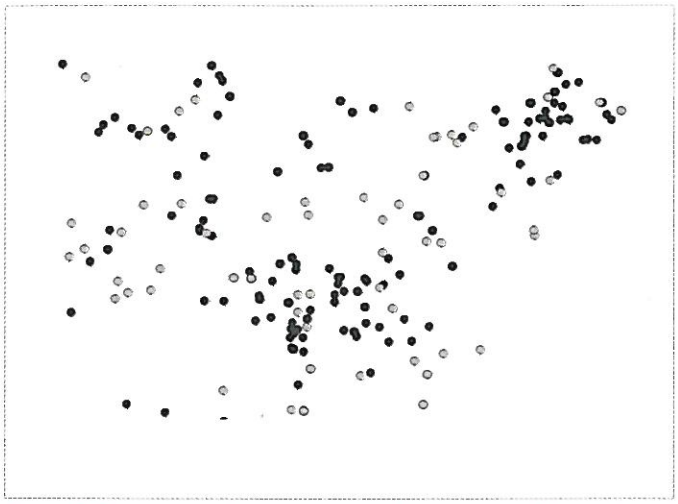

Figure 3. Distribution of inspections completed as part of the risk-based (black dots) and random (grey dots) programmes within a single geographical region.

surveillance activities, providing reassurance that the RAS achieved a sufficient number of random inspections to provide reliable disease estimates.

The results

What was the incidence of foul brood disease?

Brood disease prevalence across England and Wales, was 1 in 400 apiaries (0.25%) for American foul brood and 1 in 80 apiaries (1.25%) for European foul brood.

How did RAS and NBU risk-based inspections for foul brood compare?

Reassuringly it is good to note that, the NBU risk-based inspections detected far more foul brood disease compared to the RAS inspections. The data suggest that risk-based inspections are 1.5 to 3 times more efficient at finding AFB and 3 to 4 times more efficient at finding EFB compared to random inspections.

Was foul brood disease found in unexpected places?

Not only was less foul brood disease found in the RAS inspections, but most was located in areas that the NBU had already identified as high risk. Very little disease was found in apiaries that were thought to be at low risk of having foul brood. These results demonstrate that the NBU's current understanding of which apiaries in England and Wales are at risk from foul brood is sound.

At this point it is important to remember that this knowledge of risk is based on the quality of information that we have within BeeBase, the database of beekeeping statistics for England, Wales and Scotland. We rely on the great cooperation we get from beekeepers signing up to BeeBase and on beekeepers reporting suspect symptoms of foul brood diseases to us so that we can work together to tackle outbreaks quickly and effectively.

If you have not already done so, you can sign up online at: www.nationalbeeunit.com. Alternatively you can sign up by email at: nbu@fera.gsi.gov.uk, or by telephoning our offices on 01904 462510. You will be joining 26,000 other registered beekeepers (over 7,000 of whom signed up since the start of the RAS) and you will be making a really positive contribution to the collective health of our national honey bee stocks.

Are apiary risk ratings useful for finding foul brood disease?

The risk-based inspection programme currently allocates high (red), medium (amber) and low (green) risk classes to every known apiary, even before a visit takes place. NBU inspectors prioritise visits to the highest risk sites before visiting other lower risk sites. It was possible to look at all disease 'hits' found during the risk-based apiary visits, to see whether more disease was being found in higher risk apiaries. Interestingly, AFB was found at 1 in 100 high risk, 1 in 300 at medium risk, and 1 in 600 at low risk apiaries. Similarly, EFB was found at 1 in 16 high risk, 1 in 70 medium risk and 1 in 200 low risk apiaries. It is reassuring to know that these results suggest that the apiary risk classes used by the NBU are useful for targeting disease.

What about the prevalence of emerging pathogens in adult bees?

There has been much worry among beekeepers concerning emerging pathogens in recent years. These include Kashmir bee and Israeli acute paralysis viruses (KBV and IAPV), which have been suggested as risk indicators of Colony Collapse Disorder (CCD) in the United States. Also, *Nosema ceranae*, an Asian variant of the resident *Nosema apis*, has been linked to large scale colony losses in Spain and Portugal. The good news is that KBV and IAPV were very seldom found in the adult bee samples collected from each apiary visit within the RAS. To give you an idea of proportion, the size of each word presented in Figure 4 represents the relative prevalence of any particular pest or pathogen as detected in the RAS. KBV and IAPV were in fact so rare that they can hardly be seen in this Word Cloud. These are circled in red in Figure 4 below. It is a different

Figure 4. Word Cloud to illustrate the relative prevalence of pathogens (excluding varroa) screened within the RAS.

story, however, when it comes to the prevalence of *N. ceranae*: this was found to be very well distributed across England and Wales, with more than one third of apiaries testing positive (see Figure 5).

Do we know how pathogen prevalence may link to outbreak of disease?

While the RAS data presented in Figure 4 illustrates the relative prevalence of the different pests and diseases covered by the RAS, it does not provide the same insight into their respective relative impacts. If we were to draw a similar Word Cloud to illustrate the major players in terms of poor colony health the picture would probably be very different. For example, even though the RAS found that *N. ceranae* was very common (and hence appears in large letters in Figure 4) we also know, from subsequent analysis of our data, that the presence of this microsporidial parasite is not consistently linked to poor colony health.

Things were different for another major player, our old enemy varroa, which has long been cited as the public enemy number one when it comes to apiary health. Indeed, the RAS found, and again confirmed, that high levels of varroa mites were detrimental to the health of an apiary. Worse still, Deformed wing virus (DWV; Figure 6), which is associated with the mite (and also has a high

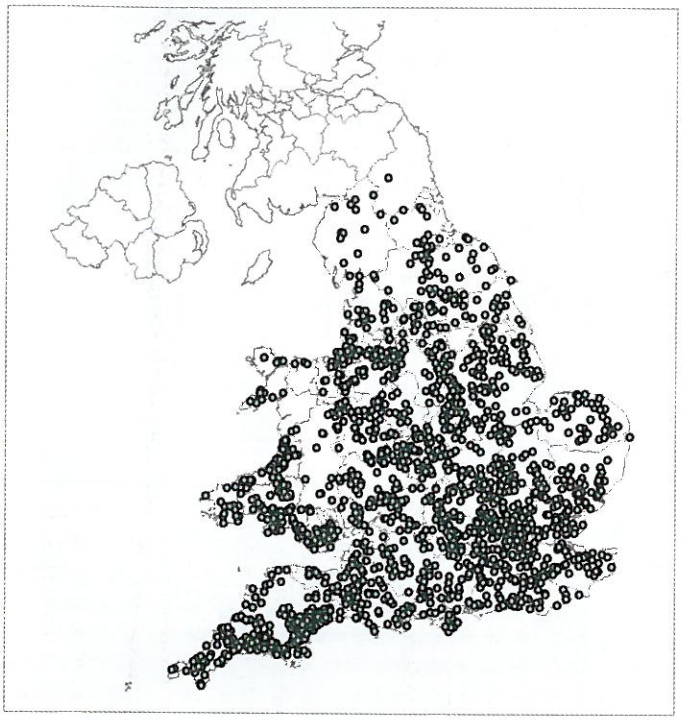

Figure 5. Distribution of RAS-samples aparies that were positive for N. ceranae pathogen across England and Wales.

prevalence), is associated with finding dead colonies in an apiary. Of the 19,000 colonies inspected during RAS, a significant proportion was found to have problems with these two organisms. This supports the findings in Defra funded project 'Investigating Abnormal Colony Losses in England and Wales' (https://secure.fera.defra.gov.uk/beebase/index.cfm?pageid=177), which showed DWV as the biggest risk factor associated with colony mortality (full project report available from Defra). So while there are some new kids on the block when it comes to pathogens, it is important not to lose sight of the ball but maintain the varroa vigil, and keep their levels low to maintain productive colonies (Figures 7 and 8).

Figure 6. Adult bee with deformed wings.

What do my personal results mean?

If your apiary was visited and sampled for this survey, then all your results are available on your personal pages of BeeBase. When you look at your results it is important to remember that the tests we use are incredibly sensitive, capable of detecting tiny amounts of any target pathogen. This means that the test can be positive, even in the absence of any disease symptoms. For example, molecular screens used at Fera can detect a single *Nosema* spore within an adult bee sample, so just because your bees tested positive, this does not mean that they will be on their knees with Nosemosis. Honey bees

Figure 7. Monitor for varroa in your colonies — uncapping fork for Varroa mite detection.

Figure 8. Varroa sticky board insert for monitoring mite drop on a varroa floor (top); low magnification (middle) and higher magnification (bottom) photos of varroa mites on the sticky board insert.

often cope with multiple infections without showing symptoms, and pathogen prevalence can vary seasonally. However, if your bees become stressed, perhaps due to lack of forage or high levels of varroa, then the pathogens we have tested for can cause problems to the health of your colonies. We are preparing an advisory note on what your results mean, which will help to guide those who have participated in this survey to interpret their results. For a copy, please visit BeeBase or email the NBU office (nbu@fera.gsi.gov.uk).

Summary thoughts

In the current economic climate the spending of public money is quite rightly in the spotlight. When compared with our risk-based inspections data, the results of the RAS demonstrate that the NBU programme of inspections is efficient in finding disease, and not missing unknown pockets of infection. That is not to say we cannot improve things. As always, the NBU is very grateful to all the beekeepers who help us and get involved in projects to improve our understanding of honey bee health. Without you, the RAS simply would not have been possible. Together, we have achieved a dataset unrivalled anywhere in the world, which will form the platform of future decisions regarding honey bee health and surveillance.

Acknowledgments

The National Bee Unit gratefully acknowledges the support of all the beekeepers in England and Wales who participated in this project, without whom we would not have been able to complete the work. The NBU also acknowledges the support of Defra and the Welsh Government who funded the survey.

Giles Budge, Mike Brown, Stephane Pietravalle, Gay Marris and the NBU inspectors