Advances in Contingency Planning for Small Hive Beetle

Nigel Semmence, National Bee Unit (NBU), details the changes in contingency responses for small hive beetle (SHB) that have occurred in recent years

The small hive beetle (SHB) *Aethina tumida* (Coleoptera: Nitidulidae) is an invasive species of global concern as it can have significant impact on apiculture, as well as feral and wild bee populations. This is comprehensively reviewed in Cornelissen et al (2019); Neumann et al (2016) and Roth et al (2022). The life cycle and potential impact are well described in the references above and in the National Bee Unit's (NBU's) advisory leaflet, *The Small Hive Beetle*, available from BeeBase (www.nationalbeeunit.com).

SHB naturally occurs in sub–Saharan Africa and is a minor problem for endemic honey bees. However, it has spread to all continents, except Antarctica, and has established in many countries and islands, including North and Central America, and Australia (Cornelissen and Neumann, 2022). New introductions are often followed by national eradication policies which have impacts upon beekeepers, and where it has established, the control methods as well as adopting the required hygiene procedures come as an additional cost to beekeeping.

The main impact of SHB is due to its ability to reproduce rapidly, with females being able to lay 1000–2000 eggs which hatch into larvae and consume honey, pollen, and wax. This can lead to the collapse of the honey bee colony within a couple of weeks. When the larvae reach maturity, they enter the wandering stage and move into the surrounding soil where they pupate (Neumann et al, 2016).

In 2014, SHB was detected in the region of Calabria in southern Italy and appears to have been introduced from Africa (EFSA, 2015; Granato et al, 2017). An eradication policy was adopted and within the first two years, 6,000 hives were destroyed and €2 million paid as compensation. It has subsequently been detected there every year and eradication is not believed to be an achievable policy objective anymore (Salvioni and Champetier, 2022). The Italian authorities have established a zone of surveillance to the north of Calabria and the results can be seen on their website (https://www.izsvenezie.com/aethina-tumida-in-italy/).

Identification

SHB is a statutory notifiable pest in the UK and Europe, and beekeepers In England and Wales are required to report to the NBU any suspected SHB. Both the adults and larvae are quite characteristic and shown in figures 1 to 4.

The adults have light brown to black bodies, a shortened elytra (wing case) and clubbed antennae. However, the adult beetles when in a colony are often harassed by the bees and adopt a defence position with the legs and the antennae tucked underneath their body, as in Figure 2.

The larvae have a brown head and a double row of spines on their backs, as well as two large spines on the last segment of their body, as shown in Figure 3. From below, the three pairs of prolegs are clearly visible, as shown in Figure 4.

From a beekeeper's perspective, if you find any large beetle (around half the size of a bee or bigger) running on the combs, or any masses of larvae within a hive, I recommend collecting a sample and contacting your local bee inspector for advice.

Surveillance

Exotic pest surveillance for SHB and *Tropilaelaps* mites is part of our routine risk-based inspection programme in England and Wales. Annually, around 5,000–6,000 apiaries are inspected and some of those apiaries which are close to risk points are examined specifically for exotic pests. This involves examining the combs and hive for adult SHB as well as looking in the gaps and crevices for SHB eggs. Risk points include airports, ports, honey bee importers, honey packers, zoos, and plant importers.

We also have the sentinel apiary scheme and currently, in England and Wales, there are approximately 125 voluntary sentinel apiaries. This is where a beekeeper close to a risk point volunteers to examine their colonies and send in samples during the beekeeping season. They are given training and traps for SHB and shown how to collect debris samples, sending to the laboratory for analysis.

We also have around 50 enhanced sentinel apiaries, which are apiaries close to the highest risk points, such as freight ports and honey bee importers, where the beekeeper agrees to three inspections from the local inspector per year when a full exotic pest inspection is done and a debris sample collected.

In all the above surveillance, the debris sample is key as if SHB had been

Figure 1: adult side view, showing an adult SHB from the side; 1 mm scale

Figure 2: adult underside, showing an adult SHB from below; 1 mm scale

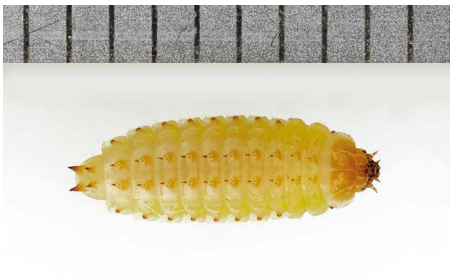


Figure 3: larva top, showing a SHB larva from above; 1 mm scale

Figure 4: larva underside, showing a SHB larva from below; 1 mm scale

present in the hive, there is likely to be dead beetles (or parts of them) amongst the debris that will be detected in the laboratory.

Imports

The most likely route for SHB entry into the UK is through movement with honey bees. There are export and import controls which aim to prevent the introduction and spread of bee pests and diseases through legislation. Safeguard measures are in place for the Calabria and Sicily regions of Italy and no exports of bees can occur. Additionally, all imports of honey bees must come with health certificates obtained from the relevant competent authority. A proportion of the imports are checked on arrival at destination on a risk basis. Currently, only queen honey bees can be imported into Great Britain (GB) from Europe and this has consequently reduced the risk of SHB being imported too, as there are more places for SHB to hide in a hive or nucleus colony than in a queen cage. The annual number of honey bee imports is shown in Figure 6.

Contingency Response

The response for exotic pests is outlined in our contingency plans and these are based on pest risk analysis and can be found on BeeBase. On confirmation of a positive SHB sample, we would investigate the back story and start inspecting apiaries within 16 km of any confirmed apiaries (Chauzet et al, 2016). This area is termed the statutory infected area (SIA) and restrictions will be placed on all apiaries within it, prohibiting the removal of colonies, queen bees, used beekeeping equipment, hive debris, all unprocessed hive products, including honey and raw beeswax, or any other thing which is liable to spread SHB.

This immediately raises the question of what the current known apiary density is, and this can be seen in Figure 7.

In the highest density areas, we could have 250 known apiaries per 10 square kilometres (100 km^2), meaning we may have to inspect around 2,000 apiaries in a 16 km radius (804 km^2) zone.

This would be done on a risk-based approach, with the arrival route being considered and highest risk apiaries being inspected first. On confirmation of SHB in an apiary, all the colonies would be destroyed, and the surrounding ground treated to prevent SHB pupae from developing.

Another area that has moved forward is the development of modelling that is currently underway to help analyse the likely spread of SHB under a range of different scenarios and how much resource the required inspections would take.

Improvements

Vast improvements have occurred over the past ten years in how the NBU records inspection data. Simply put, we have moved from a paper-based system to a paperless one with infield data input. This doesn't do justice to the vast amount of work that has occurred in the background which includes the creation of a BeeBase app that the inspectors use on iPads in the field, along with recent improvements in mapping. All of this is crucial for contingency responses as having worked on many responses, both real and exercises, it is the paperwork and map generation that takes time, and this has now been streamlined dramatically.

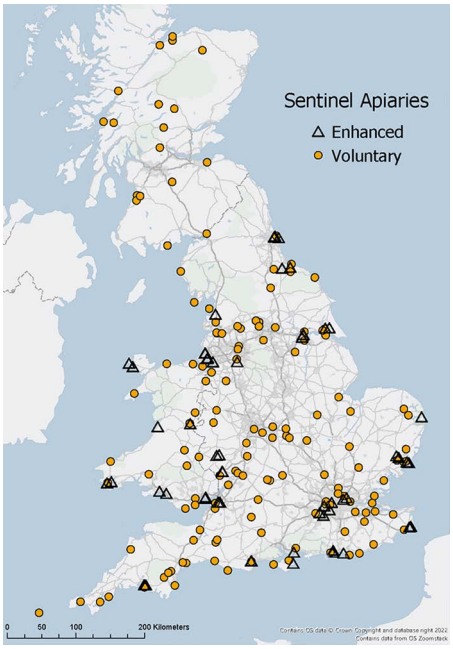
We have a culture of continuous improvement and lessons identified are gathered during all responses and exercises and put into an action plan which is then implemented over the following winter. Asian hornet outbreak lessons identified have had an impact on all our contingency response planning and we now have contingency boxes distributed in four sites with equipment needed in the first week or so of a response which, for example, includes SHB traps and stationery.

Another example of where the SHB response has benefited from our experience during Asian hornet responses is that in the early stages of a response to SHB, we can utilise mobile welfare units to act as forward operating bases. These can be placed close to the centre of a response and moved if required.

Scaling Up

As well as learning from the vast experience of contingency events held in other Animal and Plant Health Agency (APHA) departments such as Animal Health, Plant Health, and Wildlife, the NBU can utilise them during contingency events. To access resource and support from the wider APHA, we hold a planning call at the start of a response which alerts the wider agency as to our possible requirements. This has been evident

Figure 5: sentinel apiary map 2022



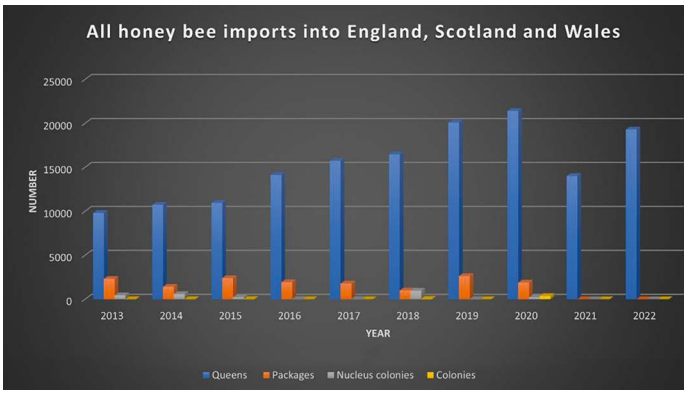


Figure 6: honey bee imports

throughout the Asian hornet response where, for example, plant inspectors have helped with trap monitoring, and with our utilisation of the contracts team to hire tree climbers and associated equipment when required.

Another area that can be scaled up is the processing and confirmation of SHB samples in the laboratory. Much work has been undertaken on utilising molecular techniques and this will enable the laboratory to process the huge number of samples that may be required (Franco et al, 2022; Ponting et al, 2021).

The chemicals that are used currently to control SHB pupae in the ground in Italy are not licensed for use in the UK, so it is likely that we would utilise commercially available nematodes for this purpose and research continues in this area (Benuszak et al, 2019; Cuthbertson et al, 2013; Sabella et al, 2022; Sanchez et al, 2021).

Exercises

Although the regular ingresses of Asian hornet and resultant contingency responses means we are well practised, and familiar with how to run them, we still practise the early stages of a SHB contingency event. These are unannounced and the inspectors are only aware that one is likely to occur that year and not where or when. For example, there will be one this year and it will be started by several floor debris samples being given to the laboratory. One of them will be spiked with SHB adults and/or larvae and, on confirmation, this will start the exercise at a predetermined area. A forward operating base will be set up and inspections will be undertaken, usually over a two-day period with all the standard record keeping and reporting being practised.

Summary

I hope the above has given a good insight into the ongoing improvements into the NBU's response to SHB if it ever arrives. Looking to the future, if it became established in the UK, we are learning much from the United States of America (USA) and other countries on control methods that beekeepers could apply, and a future update of our SHB advisory leaflet will contain information on these (Steif et al, 2020). □

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Figure 7: apiary density