Animal &
Plant Health
Agency

The Small Hive Beetle

A Serious Threat to European Apiculture

Pollination

Pollinating insects provide almost incalculable economic and ecological benefits to humans, flowering plants and wildlife. Pollination by bees and other insects is the first step in the flowering/ fruiting process resulting in the production of vegetables and fruits. This essential nutrition comprises approximately 35% of the human diet. The production of 84% of crop species cultivated in Europe depends directly on pollinators. 70% of the 124 main crops used directly for human consumption in the world are dependent on pollinators.

Honey bee on willow

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This document is also available on BeeBase (the National Bee Unit website), www.nationalbeeunit.com

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About this leaflet

The Small hive beetle

This leaflet describes the Small hive beetle (*Aethina tumida*), a potential threat to European and UK beekeeping. This beetle, indigenous to Africa, has spread to the USA, Canada, Mexico, Jamaica, Australia and Cuba where it has proved it can be a very serious pest of European honey bees. In 2014 Small hive beetle was confirmed in Italy and there is an increased risk of its accidental introduction into the UK. All beekeepers need to be aware of the fundamental details of the beetle's lifecycle and how it can be recognised and controlled.

Acronyms

APHA	Animal and Plant Health Agency
BBKA	British Beekeepers' Association
BDI	Bee Disease Insurance
BFA	Bee Farmers Association
BQCV	Black Queen Cell Virus
CBPV	Chronic Bee Paralysis Virus
CRD	Chemicals Regulation Directorate
DARDNI	Department of Agriculture and Rural Development Northern Ireland
Defra	Department for Environment, Food and Rural Affairs
DWV	Deformed Wing Virus
EBV	Egypt Bee Virus
EF	European Foulbrood
EPS	Exotic Pest Surveillance
GIS	Geographical Information Systems
ISO	International Standards Organisation
IPI	Insect Pollinators Initiative
IPM	Integrated Pest Management
NBI	National Bee Inspector
NBU	National Bee Unit
OIE	World Animal Health Organisation
RAS	Random Apiary Survey
RBI	Regional Bee Inspector
SA	Sentinel apiary
SASA	Science and Advice for Scottish Agriculture
SBI	Seasonal Bee Inspector
SIA	Statutory Infected Area
VMD	Veterinary Medicines
WBKA	Directorate Welsh Bee Keepers' Association
WG	Welsh Government

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Help and advice

The National Bee Unit

The National Bee Unit (NBU) provides an integrated statutory and advisory service to beekeepers in England and Wales. It provides diagnostic, consultancy and research services to Defra, Welsh Government, and the Scottish Government, commerce and beekeepers. The NBU is a recognised centre of excellence in the provision of advice and research in bee health. For laboratory diagnostics, methodology is based on the World Organisation for Animal Health (OIE) Manuals of Standard diagnostic tests for laboratory diagnosis. Most staff are trained practical beekeepers as well as scientists and are supported by teams of specialists across the rest of the Animal and Plant Health Agency (APHA) and Fera Science Limited.

The Unit has modern facilities, including laboratories with computer support through BeeBase (see next section), as well as 150 colonies and associated apiary facilities to support them.

The NBU offers a bee health inspection and advisory service operating in England and Wales, comprising a regional network of Inspectors. The head of field inspection services is the National Bee Inspector (NBI). Regional Bee Inspectors (RBIs) reporting to the NBI manage teams of Seasonal Bee Inspectors (SBIs) throughout England and Wales. As well as the statutory inspections and apiary surveillance programme, Bee Inspectors provide free advice and assistance to beekeepers on a range of bee health issues and run training courses for beekeepers on disease recognition, disease control and good husbandry, often in conjunction with local Beekeeping Associations. The NBU team delivers around 500 training events every year. Bee Inspectors also assist with field trials within the NBU's research and development programme.

For further information contact the NBU office, who will put you in touch with your local Bee Inspector or visit the NBU's BeeBase website key contacts pages (http://www.nationalbeeunit.com/public/Contacts/contacts.cfm).

The NBU has broad research and development interests (current list outlined on BeeBase (http://www.nationalbeeunit.com/index.cfm?sectio nid=48). Our portfolio covers varroacide development, EU- wide colony loss surveillance, risk assessment, novel control methods for exotic pest threats, and the economics and biology of pollination. The NBU was a contributor within the Insect Pollinators Initiative (IPI) (www.bbsrc.ac.uk/pollinators), researching systems that model the epidemiology of disease and facilitate improved management in the future. We are also using advanced molecular techniques to identify specific bacterial strain types, which will add to our understanding of the spread of serious brood diseases. The NBU works in partnership with many Universities and organisations both in the UK and overseas to achieve these shared research goals.

BeeBase is the NBU's award winning website. It contains all the apicultural information relating to the statutory bee health programme in England and Wales. In June 2010, the information for the Scottish inspections programme was also incorporated into BeeBase. The website contains a wide range of beekeeping information, such as the activities of the NBU, the bee related legislation, pests and diseases information, including their recognition and control, interactive maps, current and past research areas, publications, advisory leaflets (including this one) and key contacts. To access this information visit the NBU website (www.nationalbeeunit.com). Many beekeepers find this website to be a very useful source of information and advice. In addition to the public pages of the BeeBase website, registered users can view their own apiary records, and diagnostic histories.

Why is it so important to register on BeeBase?

As well as containing useful information on beekeeping, BeeBase is a vital tool in the control of bee disease and pests. Where statutory pests or diseases (for example, foulbrood) are confirmed, the NBU uses BeeBase to identify apiaries at risk in the local area and, as a result, target control measures effectively. By knowing where colonies are, we can help you manage disease risks in your apiaries. Such risks include the incursion of serious exotic pest threats (for example Small hive beetle). The more beekeepers who are registered, the more rigorous our bee health surveillance is and, crucially, the better our chances of eliminating pests and diseases.

How to sign up to BeeBase

If you are not yet registered please visit the public pages of BeeBase where you can sign up online at: www.nationalbeeunit.com. Otherwise you can get in touch with the NBU office team who will be happy to help. You can email us at: nbu@apha.gsi.gov.uk or contact us by telephone on: +44 0300 3030094. By telling us who you are, you will be playing a very important part in helping to maintain and sustain honey bees for the future.

How do I know that my details will be secure?

All of the information that you provide for the purposes of registration on BeeBase is covered by the Public Service Guarantee on Data Handling (see Confidentiality page of BeeBase). In addition, all data will be handled according to rules stated in the Data Protection Act, 1998. All levels of access to BeeBase are protected in much the same way as on- line banking. Your personal access is password protected. When you first register you are allocated a temporary password, which is valid for your first visit only. You will then be prompted to set your own password. You need to ensure that your own password remains confidential. You will also be allocated a personal ID Number, which relates solely to you.

As a personally registered beekeeper, once you have received an inspection visit, you can check and amend your own records on BeeBase.
If you wish, you can make use of the apiary records system to record your apiary visits. Your SBI, RBI, NBI and NBU staff at APHA will have access to your records, but no Inspector or NBU staff member will ever disclose to others that you have been inspected or any details about your bees or beekeeping without your consent. Although BeeBase includes public pages containing information such as disease, colony losses, leaflets, useful links and much more general information, the public has no access to your or other beekeepers' details.

Beekeeping Associations

In many areas, Beekeeping Associations operate disease training schemes and provide practical advice and advisory leaflets to members on bee disease recognition and management. Contact your local Beekeeping Association or bee health advisor for details (England – www.bbka.org.uk; Wales – www.wbka.com and the Bee Farmers Association – http://beefarmers.co.uk/).

Figure 1: The National Agri Food Innovation Campus. Sand Hutton, York

Introduction to the Small hive beetle problem

The Small hive beetle, *Aethina tumida* (Murray, A. 1867) (commonly abbreviated to SHB), is a major threat to the long-term sustainability and economic prosperity of UK beekeeping and, as a consequence, to agriculture and the environment through disruption to pollination services, the value of which is estimated at hundreds of millions of pounds annually.

It is called the 'Small' hive beetle to distinguish it from other beetle pests of bee hives in Africa, known as the Large hive beetle (Figures 2a and 2b). The SHB is indigenous to Africa, where it is considered a minor scavenger pest of honey bee colonies, causing comparatively little harm.

However, outside its native range within colonies which lack African bees' defences, adult beetles enter hives unchecked causing devastating infestations. Until the late 1990s, the Small hive beetle was thought to be restricted to Africa but in 1998 it was detected in Florida and it is now widespread throughout Australia and the United States including Hawaii, where it was first found in 2010. It is also present in Canada, Mexico, Jamaica, Cuba and Italy (see later section).

At the time of writing, the Small hive beetle is not thought to be present in the UK

The beetle can multiply to huge numbers within infested colonies, where it eats brood, honey and pollen, destroys combs and causes fermentation and spoiling of honey. If beetle infestations are uncontrolled they ultimately destroy the colony. Economic impact on the beekeeping industry in the USA has been severe. Within two years of its discovery at least 20,000 colonies were destroyed by the beetle, costing many millions of dollars.

The Small hive beetle has been found in Manitoba, Canada where it arrived with beeswax imported from the USA, and has also been reported in Quebec.

In October 2002, it was found in New South Wales and Queensland, Australia. The economic consequences to the beekeeping industry in Australia have been serious, jeopardising bee exports, pollination services and honey production.

Since 2002 the beetle has spread widely and is now considered endemic in New South Wales, Queensland and Victoria, and has also been found in the North East of Western Australia close to Northern Territory. This clearly shows the ability of the beetle to 'hitch a ride' right across the world.

Figure 2a: *Aethina tumida* (adult Small hive beetle), unusually on the outside of a brood box. Normally they move down into the hive to get away from the light

Figure 2b: One of the species of Large hive beetle, *Oplostomus fuligineus*

It is not known how the beetle reached either the USA or Australia, although in the USA shipping into the East Coast ports is considered the most likely route. By the time the beetle was detected in either country it was already well established, leaving little or no chance of eradication. The only remaining options are to attempt to control it and slow down its spread.

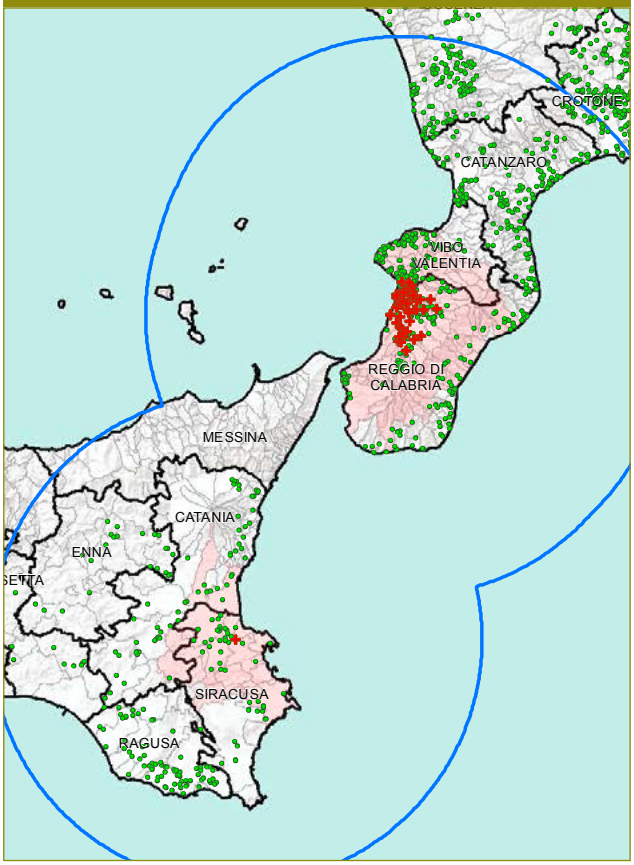
The potential implications for UK apiculture are enormous. We must now assume that the Small hive beetle could spread to the UK, and may initially prove as harmful here as in Australia and the USA.

The Small hive beetle situation in Europe

On 11th September 2014, the Italian National Reference Laboratory for Apiculture confirmed the first detection and presence of the Small hive beetle in Gioia Tauro municipality, Calabria region, in the South west of Italy. Italian authorities have opted for an eradication policy where infested hives are destroyed and the surrounding soil is treated.

Within the space of three months a further sixty apiaries were found to be infected across the region of Calabria, including an incursion into the region of Sicily. This demonstrates the beetle's ability to spread very quickly in a short space of time and highlights the importance that beekeepers should import bees responsibly. Inspections resumed in early spring 2015 and although for most of the year no positive cases were found, in late September 2015, further cases of Small hive beetle infested apiaries were detected. For more up to date information on the situation, please see the Istituto Zooprofilattico Sperimentale delle Venezie, Italian National Reference Laboratory for Apiculture (IZSVe) website: http://www.izsvenezie.com/

Figure 3A: The spread of SHB in the regions of Calabria and Sicily, December 2014. The blue line represents the 100km surveillance zone.



Apicultural trade within Europe

In those Member States where the Small hive beetle is not present, apicultural trade will continue as normal. Each country will have to comply with the Trade in Animal and Related Products (TARP) Regulations 2011, Commission Regulation (EU) N. 206/2010 and Commission Implementing Decision 2015/838/EU. Their purpose is to prevent the spread of harmful pests and diseases which could spread via trade in animals and animal by-products. They outline that:

- Bees or bee by products can only move between Member States if accompanied by a valid health certificate;
- Intensified checks for Small hive beetle, *Tropilaelaps spp*. and American foulbrood be carried out from the point of origin;
- Should the consignment be free from pests and diseases, a health certificate be issued which travels with the package until it reaches its point of destination.

Figure 3 B and C: Those apiaries in which colonies were found to be infested with SHB had the hives destroyed and surrounding soil treated

Potential impact on UK beekeeping

Figure 4: Black adult Small hive beetle clearly visible on hive frame. They can also be found hiding in empty cells at the margins of the brood nest, making them very difficult to spot at low infestation levels

Could the Small hive beetle reach the UK?

Yes it could. There is a significant risk that the Small hive beetle could be transported and introduced into the UK. The presence of SHB in Italy intensifies this risk. A pest risk analysis completed in March 2010 identified the following pathways through which the beetle could be carried:

- Movement of honey bees: queens and package bees (workers) for the purposes of trade;
- Movement of alternative hosts e.g. bumble bees for pollination purposes;
- Trade in hive products e.g. raw beeswax and honey in drums;
- Soil or compost associated with the plant trade;
- Fruit imports – in particular avocado, bananas, grapes, grapefruit, kei apples, mango, melons and pineapples – Small hive beetle may oviposit (lay eggs) on fruit;
- Movement on beekeeping clothing/ equipment;
- Movement in freight containers and transport vehicles themselves;
- Natural spread of the pest itself by flight, on its own or possibly in association with a host swarm.

The UK has not permitted the import of colonies of bees or package bees from Third Countries (outside the EU) for many years. EU legislation now prohibits (with the exception of New Zealand) imports of package bees or colonies from Third Countries.

Import regulations are our main defence against the introduction of the Small hive beetle (and other very serious bee pests and diseases) from overseas to the UK, and it is absolutely essential that all beekeepers abide by them.

Could the Small hive beetle survive in the UK?

Yes. The Small hive beetle is able to survive even in the colder climates of North America, such as Minnesota and Wisconsin. In Canada, however, there are reports that the SHB does not survive the winter. This is put down to adult beetles within the hive being too old to reproduce after the long winter and the larvae and pupa in the soil not surviving the freezing conditions in soil.

Limiting factors

Important factors that affect its survival are temperature and humidity, which are more important than, for example, type of soil available to pupal stages. For completion of the life cycle temperatures ranging from 17-25°C are ideal. Consequently we can predict that apiaries in milder parts of the UK would be more affected than those in colder areas.

Could we eradicate the Small hive beetle from the UK?

Unless the Small hive beetle is detected very soon after its arrival, it will rapidly spread into the surrounding honey bee population, making eradication very difficult. A major limiting factor to eradication would be the unknown distribution of managed bee hives and the potential for populations of the beetle to survive in wild hosts (e.g. feral bees and bumble bees).

Surveillance for the Small hive beetle

The range of chemical or biological controls available may be limited. Some of those used in other parts of the world are not licensed for use within the UK. Control methods used overseas so far have not been completely successful in eliminating the Small hive beetle, merely controlling it to below damaging population levels. If the Small hive beetle does become established in the UK, then beekeepers here will have to learn to control it along the same lines as beekeepers in countries where the beetle is already present.

National Bee Unit apiary surveillance for exotic threats including the Small hive beetle

The Small hive beetle is not thought to be present in the UK. Since 2003, the NBU and its Inspectors have increased statutory surveillance programmes to monitor for exotic pests including Small hive beetle (and Tropilaelaps mites).

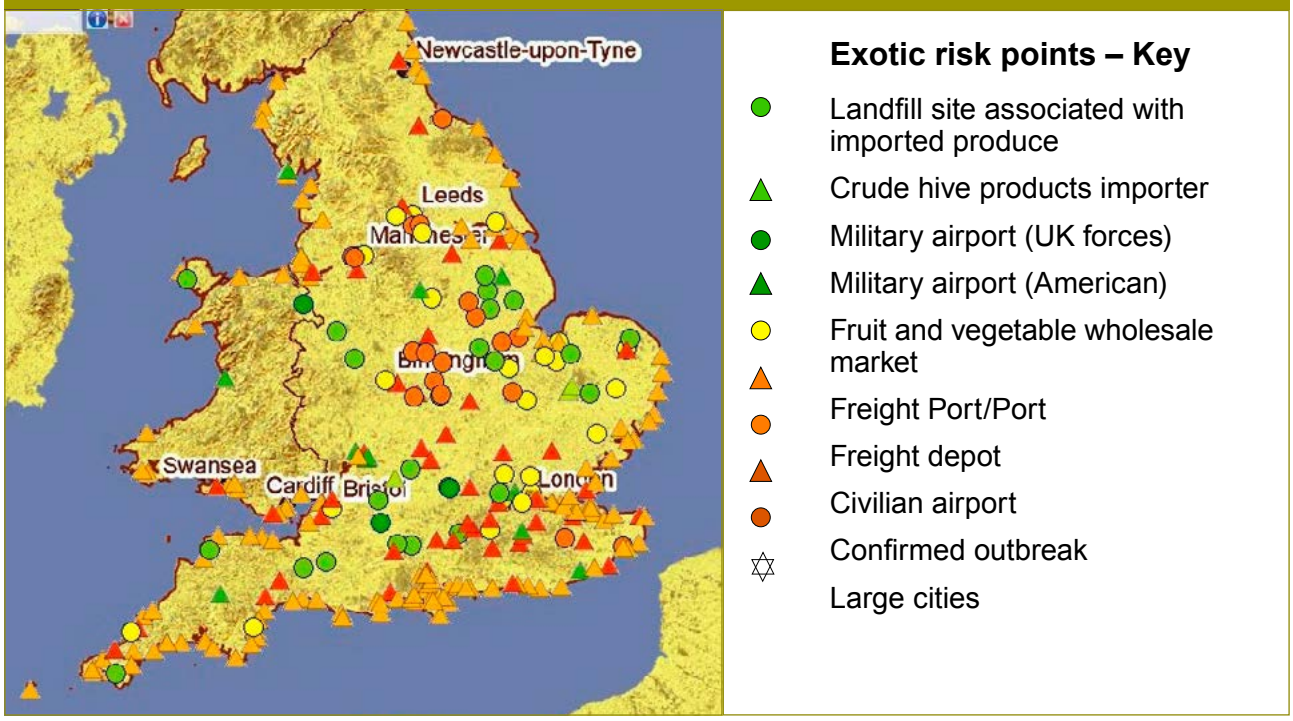
These exotic pest surveillance (EPS) inspections represents an important percentage of the annual statutory programme (please see the Tropilaelaps advisory leaflet for more details, or the NBU's BeeBase website www.nationalbeeunit.com).

The NBU uses Geographical Information Systems (GIS) to prioritise this programme and target apiaries identified as 'at risk'. For instance, apiaries situated close to (<10km) civilian and military airports; freight depots and ports of entry – for fruit and other foodstuffs; apiaries belonging to bee importers and surrounding apiaries, and if the Small hive beetle is found here, apiaries containing bees moved from declared infested areas. A map of these risk points is available to view on BeeBase (Figure 5).

The only chance for eradication will be early interception of exotic pests, so by targeting inspections to these areas we have a better chance of succeeding.

It is recognised that selection of and inspection of these 'at risk' apiaries, is based on the current understanding of the most likely routes for entry, and may mean that the surveillance programme could inadvertently miss unexpected introductions. However, the inspection programme is regularly updated to take account of improved knowledge of the means of spread and dispersal of pests like the Small hive beetle.

Figure 5: BeeBase map showing 'at risk' apiary locations in England and Wales



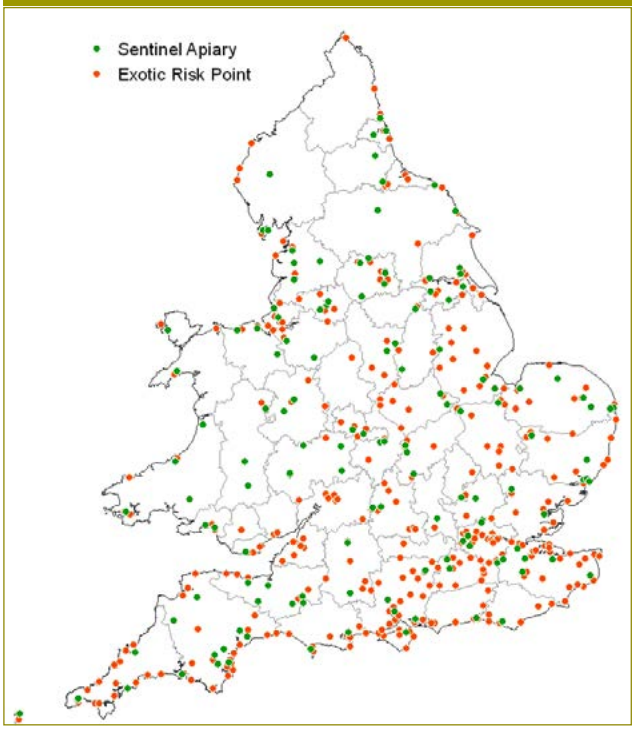
Sentinel apiaries

EPS is an important first line defence, but we do not work alone in our ongoing campaign to keep exotic pests at bay. Since 2010, a voluntary group of beekeepers in England and Wales have been specifically monitoring their colonies for exotic pest species on behalf of the NBU. These 'sentinel apiary' (SA) holders represent a valuable additional front-line defence against exotic pest incursion. There are approximately fifteen SAs in each of the eight beekeeping regions (i.e. 120 in total across England and Wales), which are in both 'at risk' and random areas to maximise the likelihood of detection (Figure 6). Hives within the SAs are regularly examined by the beekeepers, according to specific monitoring protocols. Twice in each season samples of hive debris are submitted to the NBU where they are tested for the presence of Small hive beetle (and *Tropilaelaps*). The establishment of SAs marks an increase in the level of surveillance for exotic pests, improving the chances for early interception and successful eradication.

Keeping an eye out for the Small hive beetle

Beekeeper vigilance must now be heightened following the recent confirmed spread into Italy.

Figure 6: Distribution of sentinel apiaries in England and Wales in relation to risk points



Keeping an eye out for the beetle must be a routine part of colony management in the UK. In addition to apiary inspections for statutory bee diseases, the NBU provides advice and assistance to beekeepers on a range of bee health topics and good husbandry, and runs training courses for beekeepers on disease recognition and control, usually in conjunction with local Beekeeping Associations. These include how to look for and recognise the Small hive beetle.

Contingency planning

The NBU has developed a Contingency Plan (updated in 2014). This is an operational document that details the government response to an exotic pest and disease outbreak in the UK. Although the Contingency Plan is generic, it currently focuses on the two notifiable honey bee pest in the UK, the Small hive beetle and Tropilaelaps spp. mites. If SHB is suspected, a Statutory Infected Area (SIA) will be declared, which would extend to an area with a radius of at least 16 km around the suspect apiary or premises where the beetle (adult, pupa, larva or eggs) has been found. Emergency searches of apiaries around the first find will be completed very quickly to decide whether the pest can be eradicated or whether the beetle is already established. Further details of proposed actions are available in the Contingency Plan available on BeeBase. (http://www.nationalbeeunit.com/index.cfm?pagei d=206).

Why is it important to know about apiaries?

It is extremely important that all beekeepers register on BeeBase. If we don't know where 'at risk' colonies are located, then our chances of effectively monitoring for the arrival of the Small hive beetle, or achieving control in the event of an invasion are seriously jeopardised.

It is your responsibility to make sure your details are recorded on BeeBase. To register, please visit www.nationalbeeunit.com.

Small hive beetle facts

Latin name	*Aethina tumida.*
Common name	The Small hive beetle (often abbreviated to 'SHB').
Host	Mainly lives and breeds on the immature stages of its primary host the honey bee – in colonies, but it can also survive and reproduce on stored comb and beekeeping equipment, and on certain types of fruit, particularly melons (see later section: Small hive beetle and other hosts.).
Small hive beetle lifecycle	It can have several generations per year (1-6) depending on environmental conditions. Adult beetles can survive for up to 9 days without food or water. Females can lay one to two thousand eggs in the hive during their lifetime. Beetle larvae eat brood, pollen and honey. Mature larvae crawl out of the hive to pupate. Pupation usually occurs in soil outside the hive, usually at a depth of 10 cm and within 20 m of the hive. In rare instances larvae will crawl 200 m to find suitable soil. Soil humidity is an important limiting factor together with temperature. Temperatures above 17–25ºC are required for completion of the life cycle. Pupation rates vary from 92–98% in a range of soil types provided the soil is moist. Soil moisture appears to be a major limiting factor in beetle reproduction and thus population build-up. Adult beetles usually emerge after 3-4 weeks but can emerge anytime between 8 and 84 days depending on temperature. Adults can fly around 16 km to infest new colonies.
Current	Indigenous to Africa. First found in United States (Florida) in 1998. Now very widespread in the USA, including Hawaii (as of 2010). First found in Australia (Queensland, New South Wales) in 2002. Well established. Also present in Victoria and considered endemic in those States. Also detected in Western Australia (on the north east border with Northern Territory). Detected in Canada (Manitoba) in 2002. Also confirmed in Quebec (2008). Not yet well established. Confirmed in Jamaica (2005) and Mexico (2007). Reported present in Egypt (2000) but not substantiated. Intercepted and eradicated in Portugal (2004) in a consignment of queen bees from Texas. Confirmed in Cuba (2012). Presence confirmed in the region of Calabria and Sicily in Southern Italy (2014). Measures are in place to try and eradicate the pest.
UK Status	Exotic pest not currently considered present in the UK. Notifiable pest status with statutory surveillance programmes in place.
Methods of spread	Spread by movement of package bees, honey bee colonies, honey bee swarms, honeycomb, beeswax, beekeeping equipment, soil and fruit, or movement of alternative hosts (e.g. bumble bees).

Damage caused to beekeeping	In Africa it is a minor pest to beekeeping, as indigenous African bees have natural defences. For European honey bees in America and Australia the Small hive beetle can be a serious problem given certain conditions (and would therefore almost certainly cause similar damage in the UK). The beetles multiply to huge numbers, their larvae tunnel through comb to eat brood, ruin stored honey, and ultimately destroy infested colonies or cause them to abscond.
Control methods used overseas	The Small hive beetle cannot be eradicated once well established. In the USA and Australia, beekeepers control the beetle by using Integrated Pest Management, pesticides within the hive and in the surrounding soil, together with improved bee husbandry and changes to honey handling procedures in equipment storage and extraction rooms.

Figure 7: View of beetle's head and club shaped antenna

Figure 8: View of beetle's abdomen showing distinctive shortened wing case (elytra)

Small hive beetle biology

The Small hive beetle belongs in the order Coleoptera to a family of scavenger or sap beetles known as the Nitidulidae. Many of them are pests of fruit and stored food and some, like the Small hive beetle, have a close association with social Hymenoptera (bees, wasps and ants).

Adult beetle anatomy

Adult beetles are oval in shape, 5-7 mm long and 3-4.5 mm wide. Immediately after emergence they are coloured reddish- brown, but darken to dark brown or black when fully mature. There is some variation in size but they are about one-third the size of a worker bee. They have distinctive club shaped antennae, their bodies are broad and flattened dorsoventrally, their wing cases (elytra) are covered with fine hairs. The wing cases are short so that a few segments of the abdomen are visible (see Figure 8).

Egg laying

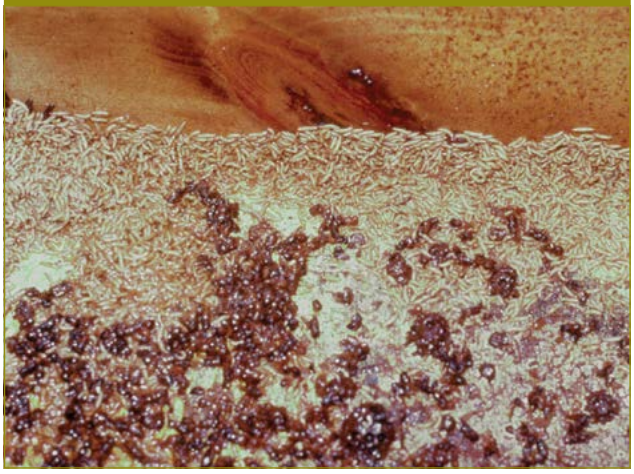
Adult beetles are attracted to bee colonies to reproduce. Once inside, adult beetles lay eggs in irregular masses in hive crevices or brood combs containing pollen or brood. The eggs are pearly white and about 1.5 x 0.25 mm, two-thirds the size of honey bee eggs. Each female beetle is capable of laying an enormous number of eggs during her lifetime (1000-2000), and so it takes relatively few beetles to produce a severe infestation.

Figure 10: Adult Small hive beetle on hive floor

Figure 11: A cluster of Small hive beetle eggs

Figure 9: Small hive beetle larvae in corners of a brood frame

Figure 12: Masses of larvae and adult beetles on hive floor



Larval development

After 2-6 days the beetle eggs hatch and the young beetle larvae begin to feed. Both larvae and adults prefer to eat bee eggs and brood but they will also eat pollen and honey. As the beetle larvae grow they burrow through brood combs, often in enormous numbers, causing great damage and ultimately consuming the colony's brood nest.

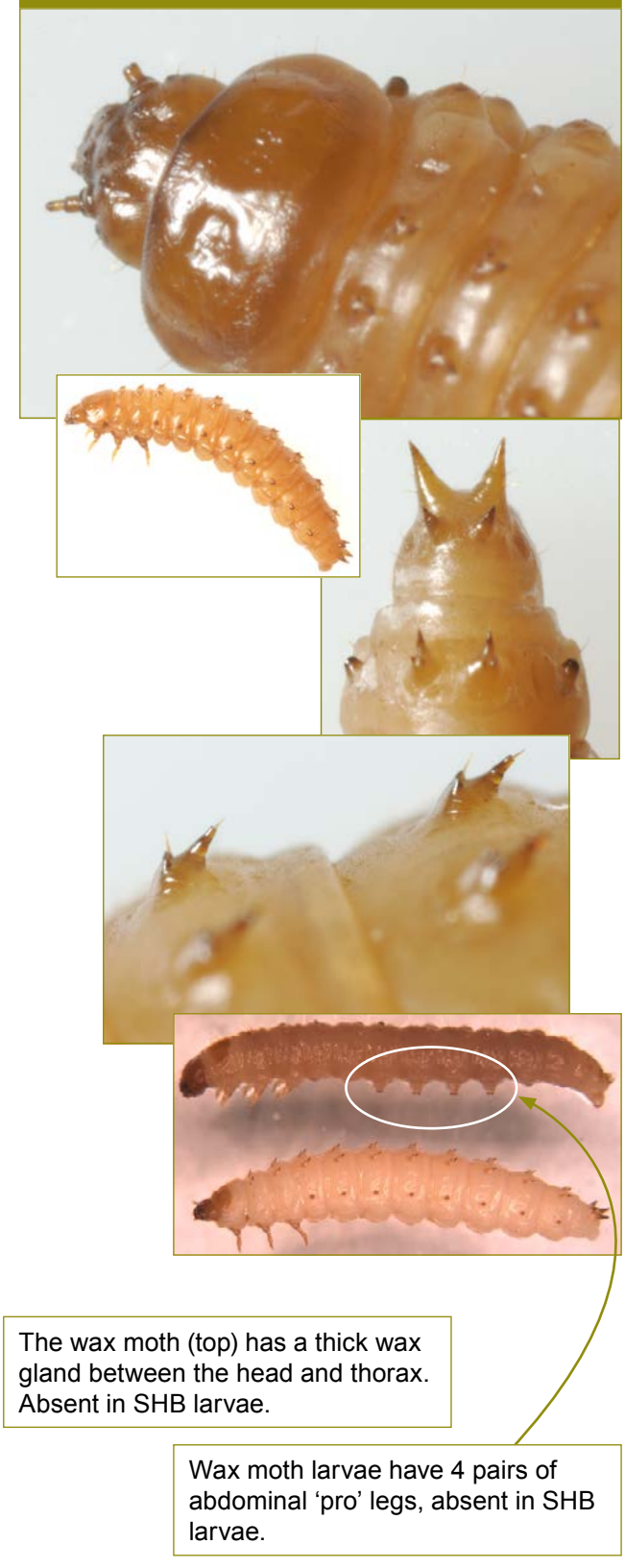
Small hive beetle larvae have characteristic rows of spines on the back and 3 pairs of legs near the head (true thoracic legs) but the 4 pairs of abdominal 'pro' legs present in wax moth larvae and most other caterpillars are absent. After 10- 14 days, the larvae have completed their growth and measure 10-11 mm in length. There is no webbing or 'frass' (particles of comb debris) as is found with wax moth infestation, but instead infested combs have a slimy appearance.

Pupation

The next phase of the Small hive beetle's lifecycle takes place in the soil. Mature larvae will enter what is known as the wandering phase, where the larvae group together in a procession, moving together en masse. Larvae can survive in this state for 48 days without food and water. Prior to leaving the hive the larvae often mass on the hive bottom board and in corners of frames, before moving outside the hive. They move towards the light at the hive entrance, and then exit the hive and burrow into the soil close to the hive entrance, constructing smooth-walled earthen cells in which they pupate. Pupae are white and then darken as metamorphosis takes place. They are able to pupate in all soil types, from sandy soils through to clay. The most important limiting factors are humidity and temperature; moist warm conditions are necessary for successful pupation.

Pupation is a vulnerable time for the Small hive beetle and there is probably high natural mortality. This is a point in their lifecycle where they could be eliminated by the beekeeper – for instance using a specific targeted pesticide or a biological control method once developed.

Figure 13: Views of Small hive beetle larvae showing three pairs of legs and distinctive rows of spines, with two large spines protruding from the rear



Emergence of adults

On average adult beetles first emerge after 3-4 weeks if the soil is warm and moist, but pupation can last from 8-84 days depending on environmental conditions. About one week after emergence, adult beetles search for colonies in which to lay eggs. They disperse rapidly over large distances (perhaps 8-16 km). The adult beetles are attracted by the odours from the hive, adult bees and brood. Beekeepers in the USA have observed that the day following an apiary inspection there is often a huge influx of beetles, suggesting that released colony odours serve as a stimulus for beetles to 'home-in' on the apiary.

Opening the hive triggers beetles already present in the hive to lay eggs. The beetle has been detected in honey bee swarms, and is thought to travel with or follow them.

The chemical (pheromone) signals the Small hive beetle uses to locate apiaries are currently being investigated, and could potentially form the basis of future control methods, such as pheromone lures and bait traps.

Reproductive potential

Small hive beetles have a huge reproductive potential. Individual female beetles are capable of producing between one and two thousand eggs during their 4-6 month life. In South Africa as many as five generations a year are possible, a new generation being produced every 5-12 weeks. Under ideal conditions, the Small hive beetle population is capable of very rapid growth. Warm temperatures (ideally above 10ºC) are however required for normal completion of the life cycle. Where the ground temperatures remain low for much of the year, the population will build up more slowly. This is likely to be the case under UK conditions.

Figure 14: Small hive beetle pupating in soil

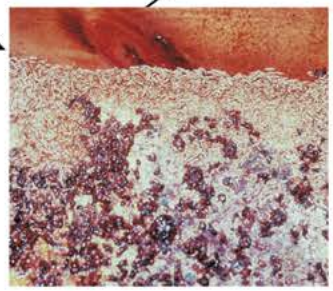
Figure 15: Adult Small hive beetle ready to emerge from the soil

Figure 16: Pre pupal larva, pupa and newly emerged adult Small hive beetle. The reddish colour of the adult is typical and will darken as the beetle emerges from the soil and flies off to find a honey bee colony.

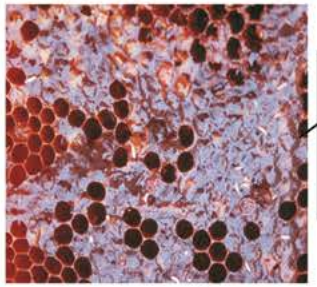
The life cycle of the small hive beetle *(Aethina tumida)*

Life cycle is completed in the soil. Larvae mature in 10-14 days and measure 10-11mm when fully grown. They crawl out of the hive at night to pupate in the soil. Adult beetles hatch out on average 3-4 weeks later. They measure 5-7mm (1/3 the size of a worker bee) and are dark reddish brown to black.

Adults can locate colonies long distance, lay eggs (2/3 size of bee eggs) in masses in hive crevices and on combs. Eggs hatch 2-6 days later. Laying adult females often lay masses of eggs at the same time.

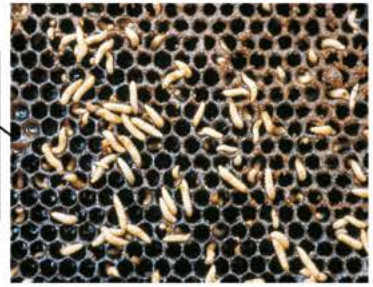


Larvae often clump together in combs cells and in the corners of frames.



Feeding activities of the larvae causes fermentation and spoilage of honey Severe damage can occur in honey houses. It has a slimy appearance and smells of “rotten oranges”.

Larvae and adults preferentially consume bee eggs and brood, as well as honey and pollen. Tens of thousands of larvae can be produced in each hive.



There can be up to 30 larvae per cell. There is no webbing or frass like wax moth infestation.

Close up of “Maggot-like” SHB larva: Note spines on the dorsum and 3 pro legs near the hear. Larvae reach maturity in 10-14 days and measures around 10-11mm.

Harmful effects of the Small hive beetle

Small hive beetle and African bees

In Africa, the Small hive beetle is considered to be a very minor economic pest of weak honey bee colonies and stored honey supers. Within its native range it is a scavenger beetle, consuming dead colonies, in much the same way as wax moth in the UK. African bees have strong house-cleaning and defensive traits, which include: preventing the beetles access to the colony by aggressively harassing them, filling cavities where the beetle could hide with propolis, removing beetle larvae from the hive, and by confining beetles to 'propolis prisons'. These behaviours limit Small hive beetle reproduction in African colonies, and so keep the beetle population down to manageable levels and below damaging thresholds.

Small hive beetle and European bees

Unlike African bees, European honey bees – as are present in the UK, Europe, USA and Australia – generally have fewer natural defences against the Small hive beetle. Consequently, the beetle reproduces very successfully; their populations increase to much higher levels than observed in African colonies, with far more harmful consequences. Weak colonies are at the greatest risk of infestation. Strong colonies will actively remove beetle larvae (much as they do with wax moth caterpillars), but they are not able to expel adult beetles due to their hard exoskeleton and their defensive behaviour. They are able to scurry around the hive avoiding bees trying to grab hold of them and remove them. Strong colonies are better able to resist and keep the beetles at bay.

Scientists and bee breeders are hopeful that any bees displaying these defensive traits, and/or the ability to incarcerate beetles in propolis prisons, could be selected for in the future to aid resistance.

Damage to the colony

Small hive beetle larvae do the most damage in the colony, burrowing through brood combs and consuming the brood and stores. The level of harm to the colony depends on the number of beetle larvae present. Once present in large numbers, the very survival of the colony is at great risk. Queens stop laying and colonies can quickly collapse. In heavy infestations, tens of thousands of Small hive beetle larvae may be present in a single hive. In such cases there can often be up to 30 larvae per cell. Such large numbers can generate enough heat inside the hive to cause combs to collapse and, subsequently, for the colony to abscond.

Figure 17: Small hive beetle larvae burrowing through comb. All the pollen and brood has been consumed

Figure 18: A severely infested colony

Honey spoilage

Defaecation of adult beetles and larvae in honeycomb causes the honey to ferment and drip out of cells. Affected combs become slimy and are reported to have a characteristic odour reminiscent of 'rotten oranges'. These combs are repellent to bees and can also cause absconding.

Figure 19: Honey spoilage. Damaged and spoiled honeycomb, with a 'slimy' appearance caused by Small hive beetle larval feeding and defaecation

Small hive beetle and bumble bees

Recent evidence suggests that Small hive beetles parasitise colonies of other social bees. In North America they have been found naturally infesting commercial bumble bee colonies (*Bombus impatiens*), in glasshouses and also in the field.

Although this species is not used for commercial pollination in the UK, the fact that beetles can successfully use bumble bees as hosts demonstrates that imports of other infected bumble bee colonies could represent a potential risk. This could have important ecological consequences if the beetles became established in the UK. However, it is not known if the beetles can find and infest bumble bee species indigenous to the UK.

Figure 20: Fermented honey ('slime') that has leaked out of frames onto the hive floor

Small hive beetle and feral bees

There is strong growing evidence that unmanaged and feral colonies of honey bees exist across the UK. A recent Pest Risk Analysis identified feral bees as a potential significant repository for Small hive beetles. Studies are currently underway to assess the status and distribution of feral bees which will help to evaluate this risk. Information from the study will inform the Contingency Plan. The presence of feral bee colonies needs to be taken into account and management options for these, in the event of detection of the Small hive beetle, will need to be considered.

Figure 21: Bumble bees may also be affected by the Small hive beetle

Small hive beetle and other hosts

In West Africa natural infestations of Small hive beetle have been found in colonies of the stingless bee *Dactylurina staudingerii*. In Australia it has been shown that Small hive beetle can also invade colonies of the stingless species *Trigona carbonaria* and *Austroplebeia australis*. However, these bees appear able to deal with invading beetles effectively.

Your responsibilities as a beekeeper

What should we be doing now?

The experiences of the USA, Australia, Mexico, Canada, Jamaica, Hawaii, Cuba and Italy show just how quickly the Small hive beetle is able to spread. It is important that beekeepers prepare for its potential arrival into the UK.

- Make sure your details are recorded on BeeBase. If we don't know where 'at risk' colonies are located, then our chances of effectively monitoring for the arrival of the Small hive beetle, or achieving control in the event of an invasion are seriously jeopardised. This is the responsibility of the beekeeper. To register as a beekeeper, please visit (www.nationalbeeunit.com).
- Make sure you only import bees through the proper channels and with appropriate health certification. Do NOT import bees illegally.
- Make sure you understand the essential details of the Small hive beetle's lifecycle, and how to recognise larvae and adult beetles.
- Be vigilant you should keep a look out for the Small hive beetle when you examine your bees – this should be part of routine colony management. If the beetle does enter the UK, early detection will allow control action to be targeted promptly where it is most needed and help reduce the spread of this pest throughout the country.
- Aim to stay informed and up to date on the spread and emerging biology of the Small hive beetle and the methods used to control it overseas. If it does enter the UK, you will need to be ready to deal with it. There is a great deal of new information on the Small hive beetle. The NBU provides regular updates to beekeepers as part of its bee health advisory work.

Small hive beetle and the law

The Small hive beetle is a statutory notifiable pest under both EU and UK legislation.

Beekeepers are permitted to import honey bees from a very limited number of countries outside the EU. Import regulations are our main defence against the introduction of the Small hive beetle (and other very serious bee pests and diseases) from overseas to the UK, and it is absolutely essential that all beekeepers abide by them.

Contact the NBU, or your appropriate government agriculture department for details of the import regulations. This information is also available on the NBU website (www.nationalbeeunit.com).

Sending suspect beetle samples to the NBU

Suspect SHB adults or larvae should immediately be sent to the NBU for examination. Use a sealed container, such as a stiff cardboard box all contained within outer packaging (e.g. jiffy bag). Please provide as many details as possible – your name, the date, the apiary name and location (including, where possible, the Ordnance Survey map reference). Do not send live beetles in the post. Kill them first by keeping them in a freezer for 24 hours. A simple to use sampling form is available to download directly from the honey bee pests and diseases pages on BeeBase at http://www.nationalbeeunit.com/index.cfm?pageid=117.

How to check your hives for the Small hive beetle

The following method is useful for the detection of all life stages.

Method: Scanning combs and boxes

It is important to **use a torch** when examining your colony(ies) for Small hive beetles – particularly in any apiary with tree cover, which can make the site dark even on a sunny day.

Carefully remove the hive roof and check for adult beetles running around under the lid. Then place the roof upside down next to the hive. Remove the supers and upper brood chamber (in double brood chamber colonies), and place them on the upturned roof for a few minutes. Place the crown board on top. A few minutes later, lift the boxes out of the way and scan for beetles on the inner surface of the upturned roof. When hives are opened adult beetles quickly scuttle away from the light, so look for adult beetles moving inside the hive, running across the combs, crown boards and the hive floor.

In warm weather, adult beetles will mostly be on the hive floor; in colder weather they hide themselves in the bee cluster for warmth. Look for clusters of eggs (two-thirds the size of bee eggs) in irregular masses usually in cracks and crevices in the hive. Look for larvae in the combs or on the bottom board.

Remove the combs one at a time from each box, and carefully examine each of them for evidence of adult beetles and damage caused by the larvae. Although they may at first glance look like wax moth, beetle larvae can easily be distinguished after close examination. Note that it is very difficult to detect low numbers of Small hive beetles in hives, so regular inspection of colonies in apiaries is essential for early detection.

Figure 22: Small hive beetle larvae are maggot like, with 3 pairs of legs near the head and no abdominal pro legs.

Figure 23: Wax moth larvae have 4 pairs of pro legs on the abdominal segments, adaptations for being on plant leaves (like other caterpillars).

Figure 24: Wax moth larvae move away from the light and spin silken galleries, whereas Small hive beetle larvae are active in the light and do not spin webbing

Figure 25: Homemade corrugated card insert to detect Small hive beetle

Method: Using corrugated hive floor inserts

A simple detection method, using either cardboard or corrugated plastic hive-floor inserts, has been used successfully for detecting the Small hive beetle. This exploits the beetle's tendency to seek dark crevices in which to hide. Corrugated plastic is longer lasting and can be obtained directly from appliance manufacturers or made up by the beekeeper. If making your own cardboard insert (Figure 25), remove the paper from one side to expose the corrugations. The upper side of the trap then needs to be 'faced' with plastic tape to prevent the bees from chewing it up and throwing it out of their hive. Place your trap, corrugated side down, on the bottom board towards the rear of the hive. Regularly examine the debris under your insert(s) for evidence of adult beetles or eggs in crevices on the hive floor. Whatever type of corrugated insert you use, it is important that immediately upon removal, you put the trap into a clear plastic bag when examining it – otherwise any beetles will escape (Figure 26).

Figure 26: Contain trap in clear plastic bag during examination

Figure 27: Using a corrugated plastic hive floor insert to detect Small hive beetles

Method: Using beetle traps

Another effective and simple detection method is the use of traps inserted between frames such as the Better Beetle Blaster and the Beetle Jail.

The Better Beetle Blaster is a disposable plastic trap which is designed to be placed between two top bars in the bottom brood chamber or supers. It should be half-filled with vegetable oil and checked at every inspection (figure 28).

The second beetle trap, the Beetle Jail, has three compartments. The trap has two plastic hooks which attach to a brood or super frame. As with the Better Beetle Blaster, it should be placed in the bottom brood chamber and/or supers. The outer two compartments should be filled a third to half full with vegetable oil while the middle section can be filled with cider vinegar in order to attract the beetles and larvae.

Bees have a tendency to propolise up the access holes at the top of the trap where the beetles or larvae access the oil. Therefore, on inspection, they will likely need cleaning.

Figure 28: Commercial SHB traps can be used as part of bee husbandry to control populations of SHB

Figure 29: A beetle jail in use, with dead adult beetles at the bottom of the trap

Traps

There are a number of traps used to control population levels of Small hive beetle. Many of them work by drowning larvae and beetles in vegetable oil when the beetles enter them to escape from the bees or to investigate the bait.

- The West Trap cannot be used with open mesh floors and is placed on top of the solid floorboard, and requires a wooden spacer to maintain a proper bee space beneath the frames. The trap contains a shallow pool of oil, and is covered by a slatted screen that excludes bees. Adult beetles enter the trap from above, to escape from bees, and fall into the oil and drown. Hives utilising this trap must be kept level to be effective;
- The Hood Trap attaches onto the top or bottom bar of a standard deep or shallow frame. It has a middle compartment used for bait such as cider vinegar and two outer compartments filled with vegetable oil, in which the beetles drown as they enter. In addition, the empty space around the trap is often filled with drone comb, which can be regularly removed and disposed of when about 50% of the drone cells are capped. This will effectively trap and remove a portion of reproducing Varroa mites before they can emerge.

Have I found a Small hive beetle?

Many types of beetle, insect eggs and larvae may sometimes be found in bee hives. Check to see if those you have found match the key identification points below.

Adult beetles

- size: 5-7mm
- colour: black
- clubbed antennae
- behaviour: hides from the light
- short wing cases

Larvae

- size: 10-11mm
- colour: beige
- spines on dorsum
- 3 pairs of legs at the head end and no pro legs on the abdomen
- absence of frass and webbing

Eggs

- size: 1.5 x 0.25mm (two-thirds size of honey bee eggs)
- colour: white
- location: masses of eggs, e.g. in hive crevices or hive floor

Small hive beetle management methods

Small hive beetle control overseas

This section provides information on the current treatment and husbandry methods used overseas, to combat the Small hive beetle and reduce its impact.

At present there is no product registered in the UK which is readily available for beekeepers to personally use against any life stage of the Small hive beetle. However, emergency treatments are available to the NBU under Special License from the Veterinary Medicines Directorate (VMD). Products used abroad are included here for information only. No mention should be taken as an endorsement of safety, efficacy or a recommendation for use.

Experience from countries where the beetle is present has shown that the best line of defence is good management or Integrated Pest Management (IPM), which begin with maintaining strong colonies. As with many pests, strong healthy colonies can exert considerable control over this beetle. Weak colonies, or empty supers are all prime targets for rapid infestation. There are a number of techniques that can reduce the impact of the beetle, that could be adopted and applied here in the event of it's arrival into the UK.

These include:

- Good bee husbandry, good hygiene practices and apiary management;
- Changes to extraction and honey handling procedures;
- Use of pesticides to kill beetles in the hive and surrounding soil.

Using bee husbandry to control the Small hive beetle

- If beetles become a severe problem, it would be advisable to avoid the use of open crownboards as well as plastic and metal frame ends. They provide ideal crevices for beetles to lay eggs in and avoid bee contact and imprisonment;

Figure 30: Should SHB arrive in the UK, avoid placing colonies in the shade.

- Maintain strong colonies with young and productive queens who are better able to regulate colony population – weak colonies are more vulnerable, because there are not enough bees to protect comb and defend the broodnest (just as with infestation by waxmoths);
- Avoid static sites where possible, as these may allow the beetle population to increase steadily. It may be preferable to move colonies to new sites periodically;
- Avoid placing hives in shady and damp locations where soils are likely to be moist. Such conditions allow for higher success of beetle pupation. Instead place colonies in full sun so that drier soil conditions will reduce pupation success;
- Upon arrival look for and select bees that seem to have lower beetle populations. There is likely to be genetic variation in the ability of colonies to resist beetle infestation, so by selecting for colonies with this characteristic, fewer alternative controls may be required;

Control of Small hive beetle using pesticides

Beekeepers overseas have used pesticides to kill the beetles. One of the main in-hive control methods uses treatment strips originally approved for use against Varroa mites. Strips are fixed to the underside of cardboard floor inserts to kill adult and larval beetles that are attracted there.

Appropriate precautions need to be taken to prevent possible contamination of honey and other hive products with treatment residues. Other traps combined with pesticide treatments are also in use.

To kill Small hive beetle pupae a soil-drench could be applied to the ground around the hives in the apiary. In the UK permission would be required from VMD or the Chemicals Regulations Directorate (CRD) to use equivalent products to tackle the Small hive beetle.

Overseas, soil is mainly treated with permethrin in order to kill pupating larvae as they exit the hive to pupate in the soil. However, this substance is highly toxic to bees and great care is always taken to avoid spraying on or close to the hive entrance.

Figure 31: Cardboard trap combined with treatment

Figure 32: A commercial trap containing an insecticide, used to control Small hive beetle adults in colonies

Future research into Small hive beetle biology and control

Studies on the Small hive beetle have only recently been intensified, and so there are still significant gaps in our understanding of many aspects of its biology. These include, for instance, mating behaviour, natural enemies, methods of host location, and flying range. As more research is carried out, our understanding of the beetle's habits will undoubtedly increase, and this could identify new methods that might in the future be used to control it. So far, chemical measures to control the beetle have not been fully effective and are considered short-term measures.

Figure 33: Thousands of larvae from a dead colony being poured into soapy water to kill them. Infestation levels can reach 30,000 larvae per colony, 6,000 per brood frame

Research is being carried out to find alternative methods – such as beetle traps for use within or outside the hive (West, Hood and 'Fly Swat' traps), soil treatments targeted at the pupal stage (lime, diatomaceous earths), chemical lures and biological controls using natural enemies (entomopathogenic nematodes or fungi) – that may in the future provide more effective and preferably more environmentally friendly means of control. These have met with variable success, but may find a place in an IPM system when fully developed and evaluated.

Precautions in the extraction room

The Small hive beetle can very quickly become a serious problem in honey extraction facilities where hygiene is poor. This gives the opportunity for beetle infestations to increase very rapidly, e.g. inside wet supers containing honey prior to extraction, or combs in storage, kept in the protected environment of the extraction room. The following precautions will greatly reduce the beetle's impact:

- Beekeepers should always use queen excluders in hives, to prevent queens from laying in supers. Otherwise, if brood is brought into the extraction room with the honey crop any Small hive beetle larvae hatched from eggs laid in supers will rapidly cause spoilage of the honey and destruction of comb;
- Maintain efficient practices in the extraction room. Supers should be extracted rapidly after harvesting from hives to give Small hive beetles minimum opportunity to cause damage;
- Freezing of honeycomb kills all Small hive beetle life stages (-12°C for 12 hours). It is common practice for many beekeepers (usually small producers) to put super frames through the freezer prior to extraction or storage, to control wax moth;
- Stored comb should be regularly checked for signs of infestation;
- It is important to employ good hygiene around the extraction room – clear up thoroughly after extraction;
- Do not leave comb or wax cappings lying around for beetles to lay eggs in;
- Where honey is stored prior to extraction keep relative humidity down to below 50%. This inhibits Small hive beetle egg-hatching, and eliminates larval damage to honey. This can be done by circulating air down through stacks of supers raised up off the ground on pallets (using a fan or dehumidifier);
- Fluorescent light sources placed on the floor of the extraction room at night attracts larvae looking for soil in which to pupate. These can be swept up and destroyed by pouring into soapy water.

Useful addresses

National Bee Unit (NBU)
Sand Hutton, York,
North Yorkshire, YO41 1LZ
Tel: 01904 462510
Fax: 01904 462240
Email: nbu@apha.gsi.gov.uk
Web: www.nationalbeeunit.com

Office of the Chief Veterinary Officer
Department for Environment and Sustainable Development
Hill House, Picton Terrace
Carmarthen SA31 3BS
Tel: 01267 245007
Web: www.wales.gov.uk

Scottish Government
Pentland House, 47 Robb's Loan
Edinburgh,
Scotland EH14 1TY
Tel: 01312 446178
Web: www.scotland.gov.uk

Science and Advice for Scottish Agriculture
SASA, Roddinglaw Road
Edinburgh, Scotland EH12 9FJ
Tel: 01312 448890
Fax: 01312 448940
Email: info@sasa.gsi.gov.uk
Web: www.sasa.gov.uk

European Union
(website for details of European Community legislation in force)
Web: http://eur-lex.europa.eu/browse/directories/legislation.html?locale=en

Animal and Plant Health Agency
New Haw, Addlestone, Surrey,
KT15 3NB
Email:
corporatecorrespondence@apha.gsi.gov.uk
Web: www.gov.uk/apha

Development, Northern Ireland (DARDNI)
Dundonald House,
Belfast BT4 3SB,
Northern Ireland
Tel: 02890 24488
Web: www.dardni.gov.uk

Agri-Food and Biosciences Institute (AFBI)
Newforge Lane,
Belfast, BT9 5PX
Web: http://www.afbini.gov.uk

Veterinary Medicines Directorate (VMD)
Woodham Lane,
New Haw, Addlestone,
Surrey KT15 3LS
Tel: 01932 336911
Web: https://www.gov.uk/government/organisations/veterinary-medicines-directorate

Office of Public Sector Information
(European Community and UK Legislation)
Web: www.opsi.gov.uk

British Beekeepers' Association
(county and local beekeeping associations)
National Agricultural Centre,
Stoneleigh,
Warwickshire, CV8 2LG
Tel: 08718 112282
Web: www.bbka.org.uk

Welsh Beekeepers' Association
Web: www.wbka.com

Scottish Beekeepers' Association
Email: secretary@scottishbeekeepers.org.uk
Web: www.scottishbeekeepers.org.uk

Bee Farmers' Association of the United Kingdom
Web: www.beefarmers.co.uk

International Bee Research Association
(library and beekeeping information services)
Unit 6, Centre Court,
Main Avenue, Treforest, CF3 5YR
Tel: 02920 372409
Web: www.ibrabee.org.uk

Ulster Beekeepers' Association
Web: www.ubka.org

World Organisation for Animal Health, Office International des Epizooties (OIE)
Web: www.oie.int

Bee Diseases Insurance Ltd (BDI)
Registered Office
National Beekeeping Centre,
NAC Stoneleigh Park,
Warwickshire, CV8 2LG
Tel: 08718 112337
Web: www.beediseasesinsurance.co.uk

Overseas information

NSW Department of Agriculture, Australia
Web: http://www.dpi.nsw.gov.au/agriculture/livestock/honey-bees/pests-diseases#Small-hive-beetle-in-honey-bees

Department of Entomology, University of Georgia, USA
Web: http://www.ent.uga.edu/bees/disorders/small-hive-beetle.html

University of Florida
Small hive beetle fact sheet
Web: http://www.invasive.org/species/subject.cfm?sub=9335

USDA Bee Research Laboratory
Beltsville, Maryland, USA
Web: http://www.ars.usda.gov/News/docs.htm?docid=15572

Honey bee and pollinator extension website: Bee Health extension
Web: http://www.extension.org/bee_health

Plant Health Australia,
Canberra, Australia.
Level 1, 1 Phipps Close
DEAKIN ACT 2600
Web:
http://www.planthealthaustralia.com.au/
Web: http://beeaware.org.au/

ANSES
14 rue Pierre et Marie Curie,
94701 Maisons-Alfort Cedex,
FRANCE
tel: +33 (0) 1 49 77 13 50
Web: https://www.anses.fr/en

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