The Food & Environment Research Agency

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Common Pests, Diseases and Disorders of the Adult Honey Bee

Pollination

Pollinating insects provide almost incalculable economic and ecological benefits to people, flowering plants and wildlife. Pollination by honey bees, which are the main managed pollinator species throughout the world, and other insects are key steps in the production of many important food crops that together comprise approximately one third of our diet. More than three quarters of crops cultivated in Europe and, worldwide, 70% of the 124 main crops used directly for human consumption, are dependent on pollinators. The UK's crop pollination industry has an estimated value greater than £400 million every year. Pollinating insects are also vitally important for the pollination of wild flora. With this in mind, it is easy to see why honey bee health is so important and why beekeepers should remain vigilant to pests and diseases that damage these essential pollination providers.

Honey bee on willow

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Common Pests, Diseases and Disorders of the Adult Honey Bee

Honey bee colonies are subject to a number of pests, infections, diseases and disorders that affect adult bees. This leaflet describes the recognition and management of some of the more common of these: Tracheal mites (Acarapisosis), Nosemosis, Dysentery and certain viruses. Symptoms seen in a colony vary according to the type of organism causing the disease. Many of these symptoms are non-specific and their severity largely depends upon the vigour of the affected colony. The common pests and diseases of adult bees are generally less serious than the brood conditions of American foulbrood (AFB) or European foulbrood (EFB). However, it is still very important that beekeepers are aware of the causes and symptoms of adult bee disorders and the best practices that will help to minimise their effects.

Acronyms

AFB	American foulbrood
BBKA	British Beekeepers' Association
BDI	Bee Disease Insurance
BFA	Bee Farmers' Association
BQCV	Black queen cell virus
CBPV	Chronic bee paralysis virus
CCD	Colony Collapse Disorder
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
EFB	European foulbrood
Fera	Food and Environment Research Agency
GLP	Good Laboratory Practice
ISO	International Standards Organisation
IPI	Insect Pollinators Initiative
IPM	Integrated Pest Management
NBI	National Bee Inspector
NBU	National Bee Unit
OIE	Office International des Epizooties
RAS	Random Apiary Survey
RBI	Regional Bee Inspector
SASA	Science and Advice for Scottish Agriculture
SBI	Seasonal Bee Inspector
VMD	Veterinary Medicines Directorate
WBKA	Welsh Beekeepers' Association
WG	Welsh Government

Contents

The National Bee Unit

The Food and Environment Research Agency's (Fera's) 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, the Scottish Government, commerce and beekeepers. The NBU is a recognised centre of excellence in the provision of advice and research in bee health. The Unit's laboratories are fully compliant with the international Good Laboratory Practice (GLP) and ISO 9001 quality schemes to ensure a high professional standard, and use as a base, the Office International des Epizooties (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 Fera (www.defra.gov.uk/fera).

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

The NBU has 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 programmes.

For further information contact the NBU, who will put you in touch with the appropriate Bee Inspector for your area, or visit the NBU's BeeBase website key contacts pages (https://secure.fera.defra.gov.uk/beebase/public/Contacts/contacts.cfm).

The NBU has broad research and development interests (current list outlined on BeeBase https://secure.fera.defra .gov.uk/beebase/index.cfm?sectionid=48). Our portfolio covers varroacide development, EU-wide colony loss surveillance, risk assessment and novel control methods for exotic pest threats and the economics and biology of pollination. The NBU is a contributor within the Insect Pollinators Initiative (IPI) (www.bbsrc.ac.uk/pollinators), leading research into systems that model the epidemiology of disease to enable 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. BeeBase 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. BeeBase 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 research areas, publications, advisory leaflets 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 (see below) can view their own apiary records, diagnostic histories and details.

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 can use BeeBase to identify apiaries at

risk in the local area and, as a result, target control measures effectively. By knowing where bees 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 can be 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@fera.gsi.gov.uk or contact us by telephone on: 01904 462510. 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 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 able 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 your own record on BeeBase. If you wish, you can make use of the apiary records system if you want to record your apiary visits. Your SBI, RBI, NBI and NBU staff at Fera 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 control 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).

Figure 1. Fera laboratory, Sand Hutton, York

Pests, diseases and disorders of adult bees

Adult honey bees are susceptible to a variety of pests, disorders and infections. This leaflet describes a selection of the most common ones: Tracheal mites (Acarapisosis), Nosemosis, Dysentery and certain viruses (*Varroa* and exotic pest species are covered in separate leaflets that can be downloaded from the NBU's BeeBase website www.nationalbeeunit.com). Symptoms seen in a colony vary according to the type of organism causing the disease. Many of these symptoms are non-specific and so the only way of confirming the presence of a pathogen is through appropriate laboratory diagnostics. Their severity largely depends upon the vigour of the affected colony. The common diseases of adult bees are generally less serious than the brood conditions of American foulbrood (AFB) or European foulbrood (EFB). However, it is still very important that beekeepers are aware of the causes and symptoms of adult bee diseases and the best practices that will help to minimise their effects.

It is also important to note that the pests and diseases described in this leaflet are often only apparent when colonies are in poor condition — their effects being suppressed in large, thriving colonies. Good beekeeping is therefore the best way to ensure that honey bee colonies remain healthy. In many cases, spread of disease can be reduced by good husbandry practices. Thriving colonies need to be:

- strong and vigorous with plenty of brood

- routinely monitored and treated for *Varroa* infestations

- well fed (honey and pollen)

- headed by fertile queens, preferably not more than two years old, and of good stock

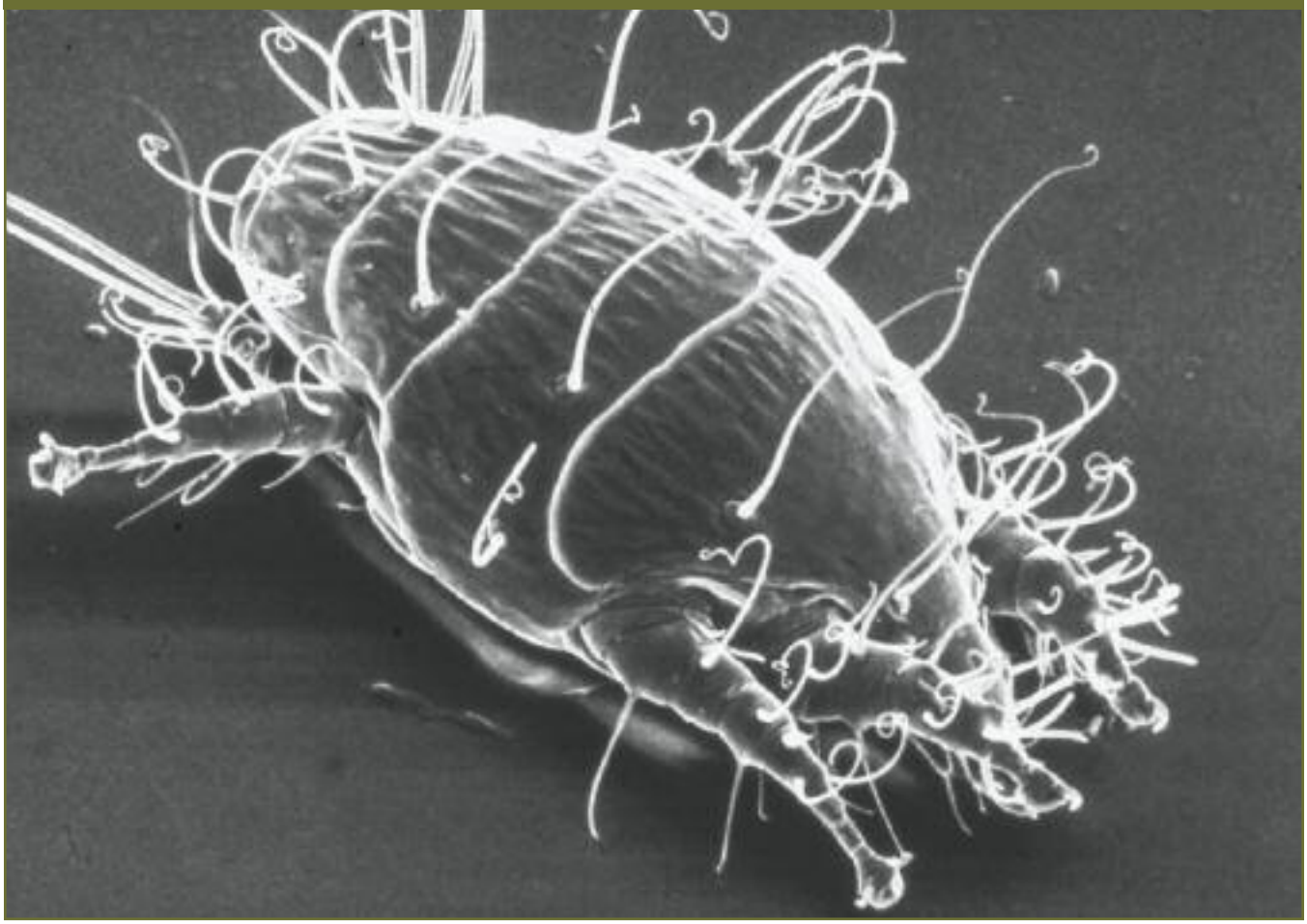
- free from foulbrood diseases - brood must be examined at least every spring and autumn for signs of AFB and EFB (see the NBU's Foulbrood leaflet)

- colonies must have adequate comb space to allow expansion and food storage

- the swarming impulse must be controlled

Tracheal mites (Acarapisosis)

Figure 2. Female tracheal mite seen under a high magnification Scanning Electron Microscope



Description of tracheal mite disease (Acarapisosis)

Tracheal mite infection (known as Acarapisosis or Acarine) is an infestation of the respiratory system of adult bees by the parasitic tracheal mite *Acarapis woodi*. This system consists of a complex arrangement of breathing tubes (trachea) and air sacs. These carry air to all organs of the body, from ten pairs of openings (spiracles) situated along each side of the thorax and abdomen. Tracheal mites can infest all castes - queen, workers and especially drones. Mites usually infest adult bees when they are less than 3 days old, but older (up to 10 days) bees are also susceptible, particularly within the winter cluster. The mite reproduces inside the trachea leading into the thorax from the first pair of spiracles. A honey bee becomes infested when a female mite (Figure 2) crawls through the spiracles and enters these tubes, attracted by the vibration of the wing roots, and by puffs of air coming out during respiration. She quickly lays eggs inside the tracheae, usually no later than one or two days after initial infestation (Figure 3). Female mites lay on average just one egg per day. These hatch into young mites (nymphs), which moult several times before reaching the adult stage a few days later. Both nymphs and adults obtain their food by using their pointed mouthparts (stylets) to pierce the wall of the trachea and suck on the host's blood (haemolymph). Typically, a single female mite will produce 20 offspring during her lifespan. Development time for female mites is about two weeks and slightly shorter for males (11 to 12 days). Usually only one generation of mites is produced with a single host, but two generations are possible in longer-lived autumn or winter bees. Multiple infestations, where a single bee hosts several adult mites, are common.

Methods of transmission of tracheal mites

Mated adult female mites must leave their honey bee host before it dies, and infest a fresh adult bee. This is the only time that mites may be found externally on the bees. Tracheal mites cannot survive for more than a few hours outside their host, so this transfer has to take place as quickly as possible, inside a colony. The female mite exits the trachea through the spiracle and uses her hind legs to anchor herself to one of the bee's body hairs. She then reaches out with her forelegs to grasp the hair of another passing bee. Only young bees in the first 10 days of adult life are susceptible, due to the fact that the hairs in the trachea are not fully hardened and thus allow mites to enter. The spread of the mite therefore depends on the presence of young bees in the hive and their close contact with older, infested bees. Approximately 85% of all bee-to-bee mite transfers take place at night, when the honey bees are relatively inactive. Dispersal of tracheal mites between colonies occurs by robbing, beekeepers transferring bees from infested to un-infested colonies, swarming or, more often, through drifting of individual workers or drones.

Symptoms of Acarapisosis

Adult bees that are infested with tracheal mites will cluster in front of the hive, appearing confused and disorientated, unable to return to the colony. Large numbers of bees may also be seen crawling up stems of grass in front of the hive (Figure 4). Such behaviours are not, however, clear indications of Acarapisosis: not only are they associated with other pests and diseases; even bees that are severely infested with mites can behave in a normal way, in spite of the fact that their tracheal wall has been damaged. Detection under a low power microscope after simple dissection of the bees is the only reliable method of diagnosis (see next section).

Figure 3. Eggs of the tracheal mite blocking the trachea of a honey bee (high magnification Scanning Electron Microscope)

Figure 4. Crawling up a grass stems - a sign of disease in adult honey bees

Effects of Acarapisosis on infested colonies

In some countries, tracheal mites have caused considerable damage and loss of colonies, particularly when mites first arrive in a country and bees are initially exposed to infestation. However, although honey yield may be reduced in colonies with tracheal mites, in the UK Acarapisosis is not usually a serious disease, with low numbers of colonies being affected. Mite levels in individual colonies vary and are lowest in the late spring and early summer, generally increase in the late summer and autumn, and are not easily detected in winter. The springtime declines in mite prevalence are often associated with nectar flows and rapid honey bee population growth. During the bees' active season infestation has little effect on workers' performance, but lifespans of over-wintering bees are shortened, leading to 'spring dwindling': the winter bees die early in the spring. If a colony goes into winter with an infestation level of >30% then it is unlikely to survive.

Figure 5. Diagnosis of tracheal mites by dissection and light microscopy

Diagnosis of Tracheal mites

Acarapisosis can only be reliably diagnosed by carrying out dissection and microscopic examination of honey bees' primary trachea. The following tools are required for dissection and microscopic examination (Figure 5):

- a binocular dissecting microscope with a magnification up to x40, and a cool, concentrated light source
- a double dissecting needle
- a pair of fine-pointed steel forceps
- a small sheet of cork

To determine the level of infestation in a colony it is best to dissect and examine 30 freshly dead bees. Each recently-killed adult bee is laid on its back and pinned firmly to the cork by pushing the double needle at an angle through the thorax between the coxal joints of the second and third pairs of legs (Figure 6a). The head and forelegs of the bees are firmly gripped between the forceps' blades (Figure 6b) and together detached cleanly from the body by a sharp pull of the forceps away from the bee and slightly upwards (Figure 6c). The aperture now left in the thorax is focused under the microscope. The chitinous collar surrounding the aperture must now be removed to expose the thoracic breathing tubes. The collar (Figure 6d and 7a) is gripped with the points of the forceps where it is narrowest, and peeled off with a rotary motion of the closed forceps. The clean removal of the collar requires practice.

Figure 6a. Pinning out the bee for dissection

Figure 6b. Grip the head and forelegs with forceps as indicated by the dotted line (magnification x40)

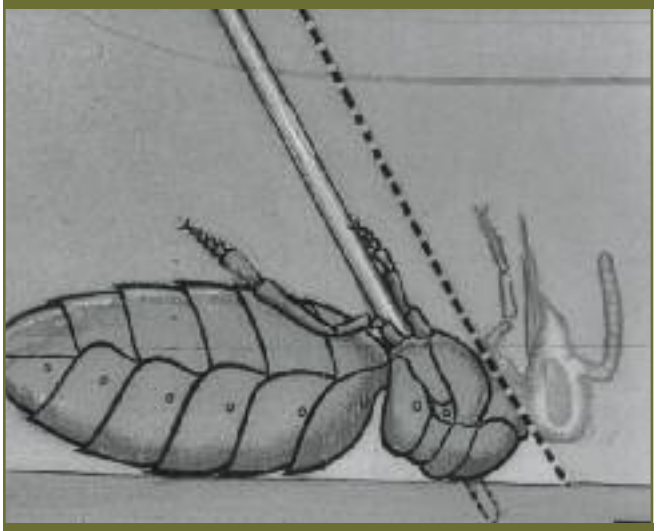


Figure 6c. Exposing thoracic collar after removal of head (magnification x40)

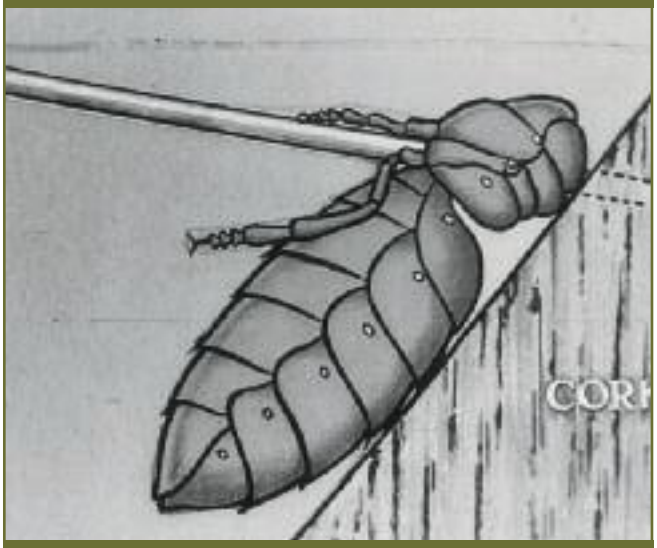
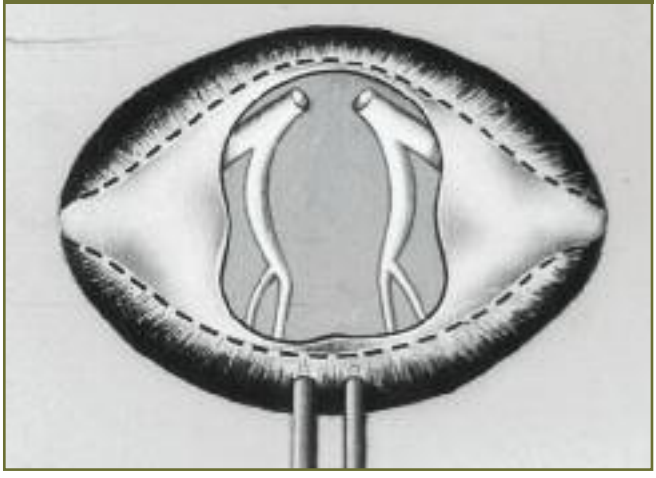


Figure 6d. The thoracic collar of the honey bee (magnification x40)



In a healthy, uninfested bee the trachea have a uniform, creamy-white appearance (Figure 7a). In infested bees the trachea show patchy discolouration or dark staining, (melanisation, caused by mites feeding (Figure 7b)), although early infestation may be marked only by translucent areas that indicate the position of individual mites or eggs. In extreme cases of very heavy infestation a bee's trachea may appear entirely blackened with dark bands. At higher magnifications (Figure 8), the eggs, nymphs and adult stages of the mite may also be seen in the trachea.

Figure 7a. Breathing tubes of a healthy bee – note their 'r'-shape and uniform, creamy-white appearance (magnification x40)

Figure 7b. Breathing tubes of an infested bee – note patchy discolouration (magnification x40)

Figure 8. Adult tracheal mite together with eggs and nymphs, teased out from the trachea of an infested honey bee (high magnification Scanning Electron Microscope)

Treatment and control of Tracheal mites

At the time of writing (Autumn 2013) there is no proprietary treatment registered under the Medicines Act, available for Acarapisosis. However, this situation may change. The NBU regularly updates its BeeBase website with the latest disease control advice for beekeepers. See https://secure.fera.defra.gov.uk/beebase/index.cfm?pageid=192 or contact the NBU for advice. The best method of control available to the beekeeper is to re-queen colonies that are susceptible to the disease. As with other adult bee diseases, it is important that colonies are kept large, thriving and able to suppress infestation without chemical treatment.

Description of *Nosema* disease (Nosemosis)

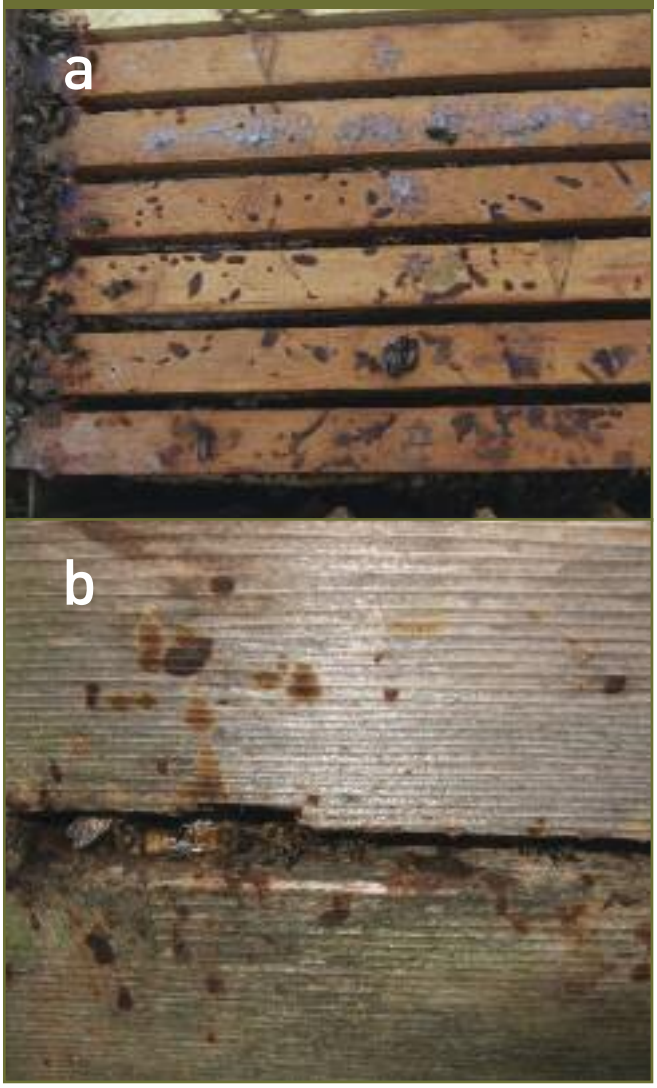
Nosema disease, or Nosemosis, is caused by either of the two species of *Nosema* identified in adult honey bees. These are *N. apis* and an Asian variant, *N. ceranae*, which was first detected in the UK more recently (2008). Both *Nosema* species are highly specialised 'microsporidial' parasites that multiply within living cells of the gut and both are widely distributed in the UK. Adult workers, drones and queens are all susceptible. *Nosema spp*. germinate to invade the digestive cells lining the mid-gut (epithelium) of adult bees where they multiply rapidly. The reproductive cycle of the pathogen progresses, eventually producing new mature spores (endospores), which germinate to infect neighbouring host cells. *Nosema* spores are shed into the gut when the host cell ruptures, where they either infect more epithelial cells or are later excreted by the bees. Under optimal conditions *Nosema* completes its development in 48 - 60 hours.

Methods of transmission of *Nosema*

Heavily infected bees generate many millions of spores, which remain viable for at least a year on contaminated hive material, thus acting as a potential source of further infection. Honey bees normally defecate away from the hive, but during long periods of confinement they may soil the combs. They are also more likely to defecate within the cluster during late winter and so *Nosema* may spread most rapidly in the spring when the brood nest is expanding, particularly if normal comb cleaning behaviour coincides with confinement of foraging bees. Cell cleaning prior to storing autumn-fed sugar syrup (when little natural forage is available) may also result in the spread of *Nosema* infection. Infection is easily spread by beekeepers placing combs contaminated with *Nosema* spores into healthy colonies - it is very important not to transfer soiled combs between hives. A large survey conducted by the NBU in 2009-2011 (called the Random Apiary Survey (RAS)), demonstrated that 40% of apiaries in England and Wales were infected with *N. ceranae*, while 45% of apiaries were infected with *N. apis*. The results showed that many apiaries across England and Wales contained both species of *Nosema* but interestingly, very few colonies from the apiaries sampled showed symptoms of Nosemosis. These results suggest that a colony in good condition is generally able to cope with *Nosema* infection without it causing any noticeable problems. As always, good husbandry and apiary

management practices are vital in maintaining vigorous, healthy stocks, which are more able to withstand infection.

Figures 9a and 9b. Signs of *N. apis* infection showing dark brown coloured faeces on the top bars and at hive entrance



Infection with *N. apis* is often associated with symptoms of dysentery (see later section) - dark brown faecal matter splattered onto the hive entrance or across the frames (Figures 9a - 9c). Dysentery is not directly caused by these pathogens but by other factors such as fermented syrup. Dysentery then exacerbates the disease and helps to spread *Nosema* throughout the colony. These effects can be worsened during periods of prolonged confinement such as inclement weather, especially during the spring, when bees are forced to defecate in the hive, further contaminating the colony.

In Spain and other Mediterranean countries it has been reported that *N. ceranae* infections are characterised by a progressive reduction in the number of bees in a colony until the point of collapse. The beekeeper may also see a significant decline in colony productivity. Eventually the affected colonies contain insufficient bees to carry out basic colony tasks and they collapse. However, in northern European countries *N. ceranae* is not considered to be a significant pathogen. Unlike with *N. apis*, dysentery and mortality in front of hives are not commonly reported symptoms of *N. ceranae* infection.

Figure 9c. *Nosema* infection - faeces on comb

Effects of *Nosema* on the colony

The severity of Nosemosis is highly variable, but infected colonies are certainly less productive. *Nosema* infection shortens the life span of bees. Infected bees have under-developed fat bodies - i.e. the food storage cells that line the abdominal wall and provide the nutrients from which nurse bees produce brood-food and which also provide nutrients for bees in the winter. The brood-food glands of infected bees are also under-developed. Queens that contract the disease lay fewer eggs (because their ovaries degenerate more quickly than uninfected ones) and are likely to be superseded. A high level of infection therefore results in reduced brood rearing and a reduction in honey production. The effects of *Nosema* on a colony may be aggravated by the presence of certain viruses. Serious damage to colonies infected with *Nosema* is, however, uncommon. Only a small proportion of a colony normally becomes infected in a large, well-maintained colony.

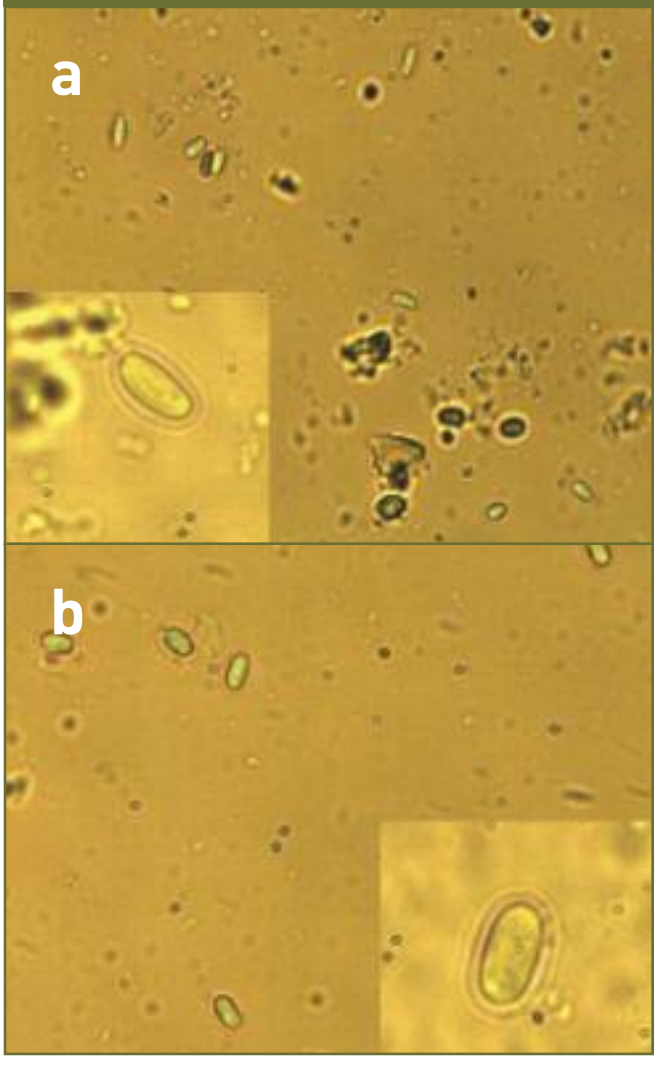
Diagnosis of *Nosema* infection

The clinical symptoms associated with *Nosema* infection can be seen with other types of colony conditions, so cannot be used to provide reliable diagnosis. A crude method to detect *Nosema* uses a light microscope to confirm presence of spores, as follows:

1. Using a pestle and mortar, crush the sample of bees (30 adults) in a little water.
2. Place a small drop of the resulting suspension onto a microscope slide and cover with a glass cover slip; the amount of liquid used should be just sufficient to fill the area under the cover slip.
3. Examine the suspension under the light microscope, magnification x400.
4. The spores of both *N. apis* and *N. ceranae* appear as translucent, greenish, rice shaped bodies (Figures 10a and 10b).
5. Spores of *N. ceranae* are more variable in shape and size than those of *N. apis*. They tend to be thinner, with a slight concave appearance.

Since both species are virtually identical in size and shape when viewed using conventional microscopy (Figure 10), the NBU uses more sensitive tests when it is necessary to discriminate accurately between species. Several other more sophisticated tests are available, which focus on the detection of species-specific genetic material, the most advanced of these molecular methods being sufficiently sensitive to detect and measure extremely low levels of infection in colonies and in individual bees.

Figure 10a. *Nosema ceranae* and Figure 10b. *Nosema apis* (x400 magnification)



Treatment and control of *Nosema*

In large, thriving colonies, *Nosema* infection is usually suppressed and rarely reaches levels that warrant control treatments. (Note that if *Nosema* is controlled, then this also effectively controls its associated viruses). In the past, beekeepers were able to treat *Nosema*-affected colonies with the antibiotic Fumidil B (active ingredient Fumagillin). However, this drug is no longer authorised in the UK for control of either *Nosema* species. In fact, research shows that it can have adverse effects when administered to a colony: treatment may successfully suppress infection without necessarily eradicating pathogens; at the same time, beneficial micro-organisms are killed; so control of the pathogen is only temporary and as a result, residual infection can rapidly resurge to even more damaging levels than seen pre-treatment.

For more information please visit the *Nosema* page of BeeBase (www.nationalbeeunit.com). For up-to-date advice on the availability of medicines please visit the Veterinary Medicines Directorate (VMD) website at: http://www.vmd.defra.gov.uk/ProductInformationDatabase

Given that *Nosema* is readily transmitted by soiled, infected combs, husbandry methods such as comb sterilisation and replacement are useful tools in managing disease and limiting spread. Make sure, therefore, that empty brood combs taken from colonies are sterilised before re-use. Sterilise combs by exposing them to the fumes of 80% acetic acid. This is made adding one part water to four parts glacial acetic acid. **The acid should be handled with great care**; take precautions to avoid contact with the skin or eyes. Splashes on the skin should be washed off immediately. Place the combs, with normal spacing, into hive boxes that are then stacked. In the bee spaces between each box in a stack, place a wad of cotton wool or other absorbent material, pre-soaked in 100 ml of acetic acid. Obvious gaps in the stack must be sealed to prevent the fumes escaping. Leave the stacks undisturbed for one week in a well-ventilated shed or a draught-free area outside. The fumes kill *Nosema* but do not harm honey or pollen stored in the combs. However, the acid fumes will corrode any exposed metal surfaces. Metal end spacers need to be removed before fumigation, and should be scalded in hot water containing washing soda. The combs must then be aired before use, making sure that any combs containing honey are aired under cover, as a precaution against robbing. For further details of this method see our 'Hive Cleaning and Sterilisation' factsheet on BeeBase.

Description of Dysentery

'Dysentery' describes heavy soiling of hives or combs by the faeces of adult bees (Figures 9a - 9c). It is not caused by an infection, but by other factors such as poor nutrition. This condition is not usually serious, but it can exacerbate the effects of any disease that is present in a hive and has been associated with the death of colonies.

Dysentery as a symptom of poor diet

Dysentery occurs when bees feed on 'unsuitable' stores, such as honey or sugar with unusually high moisture contents – bees are unable to retain the large accumulation of water in their bowels, resulting in diarrhoea. Fermented stores also stimulate dysentery, as will acid-inverted sucrose. Although the latter is often believed to be nutritionally suitable for bees because of its similarity to honey, in fact it contains toxins that aggravate water accumulation in the gut.

Dysentery and Amoebic disease

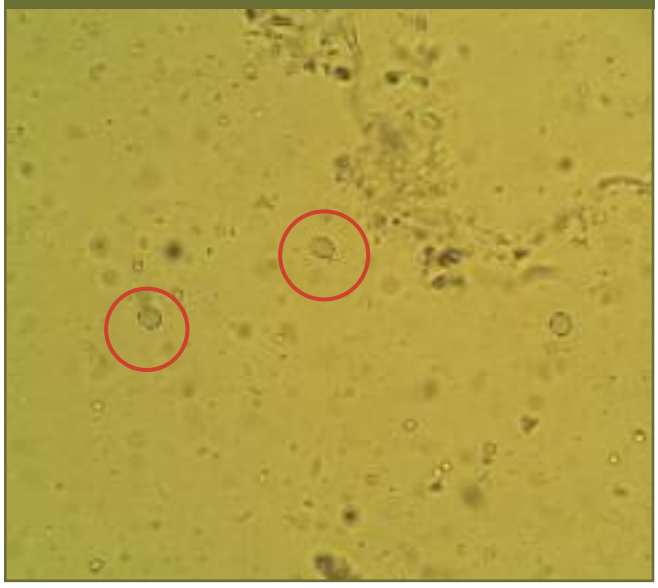
The previous section described the association of dysentery with *N. apis*, and it is likewise seen with/worsens cases of infection by *Malpighamoeba mellificae* - a single-celled parasite that affects the excretory organs (malpighian tubules) of adult bees. All castes are susceptible, but drones and queens are rarely infected. Infection occurs when cysts (Figure 11),

the dormant form of the parasite, are ingested from the faeces of infected bees. These germinate, invading the malpighian tubules, where they multiply at the expense of the excretory cells of the bee. Cysts pass into the rectum to be discharged with the faeces.

Methods of transmission of *Amoeba*

As the *Amoebae* replicate, they pack the lumen (tissue contained within large intestines, veins and arteries) of the tubules. There can be as many as half a million cysts/bee, which are shed in the faeces. *Amoebae* are spread when soiled beekeeping equipment is transferred into a healthy colony.

Figure 11. *Amoeba* cysts (circled)



Symptoms and diagnosis of *Amoeba*

There are no specific symptoms associated with Amoebic disease and precise effects of infection on colonies are unknown. Infection with *M. mellificae* has not only been associated with dysentery, but also spring dwindling and shortened lifespan of infected bees. The similar transmission mechanisms for *Nosema* and *M. mellificae* (oral-faecal route) mean that they are often found together (although neither is dependent on the other), and it is likely that a dual infection will be more damaging to the health of the honey bee. The incidence of *M. mellificae* is low in England and Wales. Diagnosis depends on examination of adult bees under a microscope for the presence of *Amoebic* cysts, using the same method as previously described for *Nosema* (Figures 10a and 10b).

Treatment and control of Dysentery

Irrespective of its cause, there is no effective treatment for dysentery, and cleansing flights that may alleviate the problem are entirely dependent on the weather (more common on warm, dry, windless days). However, there are steps that can be taken to reduce the risk of occurrence:

- As always, good husbandry and apiary management practices are vital in maintaining vigorous, healthy stocks that are more able to withstand infection.
- Autumn feeding should be completed by the first week of October – allowing time for the colony to take down the sugar syrup, reducing its water content to a safe level before the onset of cold weather. See our 'Best practice guidance notes Number 7 feeding bees – sugar' on BeeBase.
- Avoid feeding bees with fermented honey or sugars of uncertain origin.
- Use only refined sucrose, table sugar or ready made syrup mixtures (such as Ambrosia, Apisuc or equivalent).
- There are currently no approved proprietary products registered for the control of Amoebic disease in the UK, but combs from infected colonies can be sterilised for re-use with acetic acid (see 'Hive Cleaning and Sterilisation' factsheet on BeeBase).

The significance of honey bee viral diseases

Adult honey bees are subject to infection by a range of different viruses, which vary in their incidence and the severity of symptoms they can cause. All of them have at least the potential to cause harm, but outbreaks of most viral diseases are infrequent in the UK. Sub-clinical viral infections are, however, very common. These impact on the overall health of affected colonies, shortening bees' lives and making them more susceptible to other types of pests and pathogens that they might otherwise have been able to resist. For example, the presence or absence of viruses linked with *Nosema* or *Varroa* could account for the considerable variations reported in the apparent effects of these parasites. Few honey bee viruses elicit well-defined signs of disease and most are therefore not easy to diagnose. In following sections we provide information about just two of the more common viruses of adult honey bees, which can on occasion exhibit recognisable symptoms.

Beekeepers will be aware that certain viruses have been associated with the condition 'Colony Collapse Disorder' (CCD). This phenomenon, characterised by specific symptoms (sudden absence of the majority of the adult worker bee population, although the queen and plenty of stores remain) has been reported in the USA but has never been confirmed in the UK. The viruses (and other pathogens) that have been linked to its presence in America are extremely rare in the UK. On those very rare occasions that they have been detected in bee samples, (collected for the purposes of research carried out by the NBU), they have not been associated with symptoms of CCD. To date, CCD is believed to be absent in UK honey bee stocks.

Control of honey bee viruses – a general message

Chemotherapeutic treatments now available against *Varroa* should, if correctly used and applied at the correct time, indirectly suppress those viruses associated with this parasite. They will not, however, help you manage viruses that are introduced or spread independently of the mites. As yet, there are no known direct methods of controlling any honey bee viruses. The message for any viral disease, irrespective of the causative species, is the same - ***As a beekeeper, you can minimise the incidence and impact of viral diseases in your colonies by doing the following:***

- Keeping strong, healthy colonies.
- Monitoring regularly and treating for *Varroa* infestations.
- Treating colonies for disease when *Varroa* populations are low (i.e. before the mites reach damaging levels).
- Adhering to good apiary hygiene practices.
- Cleaning your equipment between each hive examination.
- Good beekeeping management.

For more information on these topics see our advisory leaflets at: https://secure.fera.defra.gov.uk/beebase/index.cfm?pageid=167 Alternatively, if you do not have the internet, then you can contact the NBU directly and request relevant material to be sent out to you (see details at the beginning of this leaflet).

Symptoms and diagnosis of deformed wing virus (DWV)

In the absence of *Varroa*, deformed wing virus (DWV) persists at low levels in infected colonies without causing any signs of infection. However, in the presence of the mite, DWV causes clinical symptoms in developing pupae, including pupal death. Newly emerged bees from affected colonies show deformed or poorly developed wings. The appearance/extent of deformity depends upon the stage at which individual bees become infected (Figure 12). Additional symptoms include a bloated, shortened abdomen. The virus multiplies slowly, and pupae infected at the 'white-eyed' stage of development survive to emergence but

are malformed and soon die. Brood may die earlier in development, and bees infected as adults appear normal until death. (Recent research into honey bee colony health in England and Wales has found that colonies with DWV infecting adult bees or brood are likely to be half the size of virus free colonies). It is important to understand that although you may not see any signs of DWV in your apiary, it does not mean that it is not there. Factors such as a healthy bee immune system and low *Varroa* populations could be keeping the virus suppressed until mite populations increase and the immune system cannot cope, resulting in overt signs of infection.

Figure 12. Symptoms of DWV

Methods of transmission of DWV

Transmission of DWV occurs via several routes, not all of which can be controlled by the beekeeper. These include:

- Through the bees' feeding activities; an infected nurse bee offering food to uninfected healthy brood, bees or the queen.
- Through bees' mating activities between a healthy virgin queen and an infected drone.
- An infected queen laying an infected egg.
- *Varroa* mite feeding activities can greatly increase levels of infection in a host, being a vector to many viruses.
- Infection can occur at a colony level through swarming and division.

Remember that viruses such as DWV are manageable by the colony itself if the bees are strong and placed under little stress. Also remember that a healthy host/pathogen relationship is essential for both to survive. A virus can often exist in a honey bee at such low levels that the individual bee's fitness is not affected and so a balance between the two is created. It is when one factor gets out of control that other symptoms, which may have been lying dormant, will start to flare up and become visible to the beekeeper.

Figure 13a. Dead and dying honey bees in front of hive

Figure 13b. Honey bees showing signs of CBPV - a lack of hairs gives the bees a characteristic shiny appearance

Chronic bee paralysis virus (CBPV)

Chronic bee paralysis virus (CBPV) has a widespread distribution in Britain but is rarely found infecting honey bees. Colonies may carry CBPV without showing symptoms. Symptoms, when present (Figures 13a and 13b), may include bees crawling on the ground outside the hive entrance, vigorous trembling of bees and hairless or bloated abdomens caused by distension of the honey sac with liquid. (See video footage of CBPV affected bees at: https://secure.fera.defra.gov.uk/beebase/index.cfm?pageid=275). These visual symptoms are reasonably reliable in diagnosing the disease. Bristles on the bee's body are easily damaged in these conditions and the wounds allow entry of the virus. This hair loss gives affected bees a shiny, greasy appearance. Once CBPV has gained access to the bee's blood (haemolymph) it rapidly spreads to and multiplies within many tissues including the nervous system. Severe cases of CBPV are rare: there is no regular seasonal pattern to its occurrence. At the height of the summer season, severely affected colonies may suddenly decline, leaving the queen with few workers on neglected combs. (However, recovery is possible if conditions improve). Symptoms of paralysis occur when local events confine adult bees to their colonies at times of the year when they would normally be foraging. These events occur at irregular intervals during the usually active season of bees for a variety of reasons, both natural (e.g. a sudden failure of nectar flows) and artificial (e.g. when too many colonies are kept for the available forage).

Methods of transmission of CBPV

- This virus spreads most readily when bees are confined and have unusually prolonged bodily contact. This occurs in periods of inclement weather or due to overcrowding.
- The faeces of infected bees contain high levels of infective virus and oral-faecal transmission has been reported.

Treatment and control of CBPV

In crowded conditions, CBPV will spread more rapidly because bees will be in greater contact with each other – increasing the chances that bees will rub up against one another thereby pulling out hairs from their abdomens. This would leave an open wound on the bee where the virus is free to enter and worsen or cause infection in healthy bees. As a result we recommend that in strong colonies that show signs of CBPV, beekeepers should ensure that there is plenty of room by adding supers or an extra brood box. CBPV rarely causes severe problems and if a colony cannot combat the virus through its own means then the only method of control is to re-queen a colony with a queen from a less susceptible strain.

Diagnostic Services at the NBU

The diagnosis of any notifiable pests and diseases such as the detection of foulbroods, and suspected exotic pests is a statutory service, provided by the NBU at no charge to the beekeeper. However, we also offer a chargeable adult bee disease diagnosis service. This provides fast, reliable diagnostics to allow you to monitor your colonies for the causative organisms of those adult bee diseases discussed in this leaflet.

To detect the causes of adult diseases it is necessary to analyse samples of bees. We have developed methods and expertise that will detect even very low levels of disease and give you an idea of the extent of the infection so that you are better able to decide on the appropriate course of action. If you are interested in using this service, you will need to submit 30 adult bees to the NBU. A report, together with advisory notes as appropriate, is sent by return post. Full details and price lists are available from the BeeBase website (https://secure.fera.defra.gov.uk/beebase/index.cfm?pageid=158). Our standard test uses microscopic techniques for the presence of Acarine, *Nosema* spp. and *Amoeba*. Molecular pathogen screening (using TaqMan® PCR) can test for viruses and/or *N. apis* and *N. ceranae*. Please ask for more details.

Useful addresses

Fera National Bee Unit (NBU)
The Food and Environment Research Agency
National Bee Unit, Sand Hutton,
York, North Yorkshire, YO41 1LZ
Tel: 01904 462510
Fax: 01904 462240
Email: nbu@fera.gsi.gov.uk
Web: www.nationalbeeunit.com

Office of the Chief Veterinary Officer
Welsh Assembly Government Officer
Hill House Picton Terrace
Carmarthen SA31 3BS
Tel: 01267 245 007
Web: www.wales.gov.uk

Scottish Government
Pentland House
47 Robbs Loan
Edinburgh
EH14 1TY
Tel: 0131 244 6178
Web: www.scotland.gov.uk

Science and Advice for Scottish Agriculture
SASA, Roddinglaw Road
Edinburgh EH12 9FJ
Tel: 0131 244 8890
Fax: 0131 244 8940
Email: info@sasa.gsi.gov.uk
Web: www.sasa.gov.uk

Chemicals LAIF
Industria Bio-chimica
Via dell'artigianato,
1335010 Vigonza (PD)
Italy
Web: www.beekeeping.org/chemical-laif/index.htm

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

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

Defra Veterinary Medicines Directorate
Woodham Lane
New Haw
Addlestone
Surrey
KT15 3LS
Tel: +44 01932 336911
Web: www.vmd.gov.uk

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

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

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

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

Ulster Beekeepers' Association
Web: www.ubka.org

Bee Farmers' Association (BFA)
Web: www.beefarmers.co.uk

International Bee Research Association
(library and beekeeping information services)
Unit 6, Centre Court
Main Avenue Treforest
CF37 5YR
UK
Tel: 02920 372409
Web: www.ibra.org.uk

Welsh Beekeepers' Association
Web: www.wbka.com/

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Web: www.nodglobal.com

Bayer (UK and Ireland) Ltd
Web: www.bayer.co.uk

Biové
Laboratoires Biové
Rue de Lorraine
P.O.Box 45
62510 Arques
France
Web: www.beekeeping.com/biove

BioVet
Tel: +41 (0)62917 5110
Email: info@biovet.ch
Web: www.biovet.ch/ea/lmkerei/thymovar.html

European Community and UK Legislation
The Stationery Office
51 Nine Elms Lane
London
SW8 5DR
Tel: +44 0870 600 5522
Web: www.hmso.gov.uk/stat.htm

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

References and Acknowledgements

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Notes

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