# Veterinary care of honey bees in the UK

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**In recent years, bee colonies worldwide have declined due to a combination of problems, including conditions such as varroosis, nosemosis and foulbrood diseases, and a number of viruses. As well as affecting both honey and wax production, this has also had a significant impact on crop pollination and the environment. Honey bees (*Apis mellifera*) are classified as food-producing animals but, to date, veterinary surgeons have played only a very modest role within the apiculture industry in the UK. However, the future of honey bee colonies will depend on practitioners working together with beekeepers to limit further losses. This article describes the most important pathogens affecting honey bees and outlines the options for treatment. In particular, it highlights how veterinary surgeons can help to promote and maintain bee health and food safety.**

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## Bees in the UK

The population of honey bees in the UK has fallen by almost 50 per cent since 1965, as has the number of beekeepers. There are currently an estimated 250,000 bee colonies in England and Wales, in addition to a number of feral colonies, but these are all continuing to experience a dramatic decline since the arrival of the parasitic mite *Varroa destructor* in 1992.

Honey bees have a poorly developed immune system and can be attacked by parasitic mites (eg, *V destructor*), fungi (eg, *Nosema* species), bacteria (eg, *Paenibacillus* species larvae), numerous viruses and scavengers (eg, beetles) during any stage of its life cycle. While strong colonies can fight off the effects of some of these pathogens, prolonged attack can cause stress and ultimately result in the collapse of a colony.

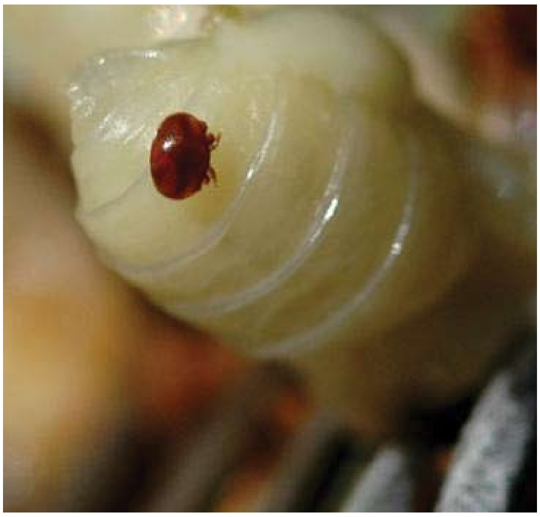

**Fig 1: Adult *Varroa destructor* mite on a pupa**

## Varroosis

*V destructor* is an ectoparasitic mite that attacks honey bees (Figs 1, 2). It can be seen with the naked eye on bees or on the bottom of hives (Fig 3). It is known to have affected bees for over 60 years, which is insufficient time for the host–parasite relationship to reach an equilibrium, thus resulting in very large losses of bee colonies.

*V destructor* reproduces in sealed brood cells and feeds on bees by consuming their haemolymph. The mite itself does not harm bees, but the parasite has

**Fig 2: Adult *Varroa destructor* mite on the thorax of a male bee (drone)**

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Fig 3: *Varroa* mites on the bottom of a hive

Fig 4: Plastic strips containing synthetic pyrethroids to control varroosis

Fig 5: Oxalic acid being administered to a hive of bees to treat varroosis

become an effective vector for a number of viruses affecting bees, and it is the resulting low levels of viral infection that eventually prove fatal for honey bee colonies. If left untreated, most colonies will die from *Varroa* infestation.

In the UK, *V destructor* was first successfully controlled using plastic strips containing the synthetic pyrethroids flumethrin (Bayvarol; Bayer) and tau-fluvalinate (Apistan; Vita Europe) (Fig 4). In recent years, however, populations of mites resistant to these chemicals have emerged and spread throughout the country. The only other licensed treatment, a thymol gel (Apiguard; Vita Europe), has variable efficacy and is not reliable in all parts of the UK. Protocols based on integrated pest management have therefore been developed to help overcome the lack of effective approved pharmaceutical agents, and the use of several unapproved substances has now grown to fill the therapeutic gap.

Oxalic acid is not licensed for use in bees in the UK and does not have a maximum residues limit (MRL)

**Table 1: Control of varroosis in the UK**

| Product (manufacturer) | Licensed in the UK? | Active substance | Use | Application | Period of treatment | Comments |
|---|---|---|---|---|---|---|
| Bayvarol (Bayer) | Yes | Flumethrin (synthetic pyrethroid) | Plastic strips hung between brood frames | Contact | Autumn or early spring for six weeks | Highly effective (>95%). Can be used during honey flow. Is too similar to Apistan to be used with it as an alternative treatment |
| Apistan (Vita Europe) | Yes | Tau-fluvalinate (synthetic pyrethroid) | Plastic strips hung between brood frames | Contact | Autumn or early spring for six weeks | Highly effective (>95%). Can be used during honey flow. Is too similar to Bayvarol to be used with it as an alternative treatment |
| Apiguard (Vita Europe) | Yes | Thymol (terpene) | Slow release gel matrix (25% ai). Two 50 g pack treatments with a 10- to 15-day interval | Evaporation, contact, ingestion | Spring or late summer after honey harvest for four to six weeks | Good efficacy (90 to 95%) under optimal conditions, depending on the temperature and bee activity. When using, ensure *Varroa* mesh floors are closed and vents in crown boards are covered |
| ApilifeVAR (LAIF) | Yes | Thymol, eucalyptol, menthol, camphor (essential oils) | Vermiculite carrier matrix | Evaporation | Autumn for eight weeks | Variable efficacy (70 to 90%), depending on temperature. Easy to apply |
| Apivar (Biove) | No | Amitraz (organophosphate) | Plastic strips hung between brood frames | Contact, systemic | Autumn, spring or early summer for six weeks | Highly effective. Can be used during honey flow |
| Exomite Apis (Exocet) | No* | Thymol in electrostatically charged powder (essential oil) | Powder in application tray at hive entrance | Contact | Spring or autumn after honey harvest for 24 days | Efficacy has not been fully evaluated |
| Perizin (Bayer) | No | Coumaphos (organophosphate) | Solution trickled over bees | Contact, systemic | Late autumn, winter and broodless periods | Should ideally be used in broodless conditions |
| Formic acid (generic) | No† | Formic acid as a 60 or 80 per cent solution (organic acid) | Evaporator kits (commercially available) | Evaporation | Late summer or autumn | Variable efficacy (up to 80 to 90%) after two treatments. Kills mites in sealed brood cells. Is temperature dependent. Brood and queen may be lost if misused. Is highly corrosive |
| Lactic acid (generic) | No‡ | Lactic acid solution (organic acid) | Acid solution sprayed over bee combs | Contact | Winter and broodless periods | Should ideally be used in broodless conditions. Causes skin burns and is a respiratory irritant |
| Oxalic acid (generic) | No‡ | Oxalic acid solution (organic acid) | 3·2 to 4·2% acid solution in 60% sucrose trickled over bee combs. Use 2·5 ml per brood comb | Contact (not ingestion, despite sugar presence), sublimation | Winter and broodless periods | Should ideally be used in broodless conditions. Average efficacy (90%) is possible. Sugarless solutions have poor efficacy. There is a danger of significant colony weakening. More scientific trials are needed. Highly toxic by inhalation, ingestion or skin absorption |

*Not authorised as a medicine, but is used as a hive cleanser, †Not authorised in any EU state except in Germany with Illertisser plates or Nassenheider evaporators, ‡Not authorised in any EU state, but is tolerated in many countries but has been shown to be an effective treatment for *Varroa* infestation. It is best applied topically during the winter when there is no (or at least very little) brood present (Fig 5). The efficacy and safety of oxalic acid is supported by a large body of evidence in the literature, and this product is now becoming more widely used. A number of approved products based on oxalic acid are available in Germany, Italy and Spain, and Veterinary Medicines Directorate (VMD) is aware of this. Similar approval of such products, which would make them available on the general sales list (GSL) is required in the UK.

**Fig 6: Spores of *Nosema* species seen on light microscopy**

## Nosemosis

Two species of *Nosema,* a genus of microsporidian parasites, affect honey bees:

- *Nosema apis* has long been known to infect western honey bees. It invades the mid-gut of adult bees, shortening the lives of infected individuals and reducing the ability of nurse bees to feed larvae;
- *Nosema ceranae* is a newly recognised species and operates in a similar manner. It is able to cause a gradual depopulation of hives, resulting in decreased honey production and heavy autumn/winter colony deaths. Other than depopulation and death after a long incubation period, there are no specific outward signs of disease in infected bees. Diagnosis therefore requires light microscopy (Fig 6) or more sophisticated PCR-based molecular techniques.

Both species of *Nosema* have been found in the UK, and the National Bee Unit is currently attempting to establish their distribution throughout the honey bee population in the UK. Some studies have suggested that *N ceranae* played a part in the multifactorial colony losses experienced in the UK, USA and Europe (Higes and others 2009).

Treatment of nosemosis is possible with Fumidil B (Ceva), which is licensed for use in bees in the UK but its availability is at risk as it does not have a MRL, which is required for medicines used in food-producing animals. It is therefore important that treatment is optimised and other effective medication is identified to deal with this condition. Although Fumidil B has been used by UK beekeepers for nearly half a century to control *N apis*, there is no recent work that confirms its efficacy under current UK conditions.

Other treatments have been trialled against *Nosema* species in various countries, including plant extracts (Protofil; manufacturer?), a formic acid and iodine formulation (Nosestat; manufacturer?), a preparation of vegetable oil and vitamins (Apiherb; manufacturer?), an extract containing beet extracts and molasses (Vita Feed Gold; Vita Europe), salicylic acid, garlic

### Box 1: Role of the veterinary practitioner in the beekeeping sector

Most medication for honey bees is currently sold on the general sales list (GSL) (Table 2). So, traditionally, veterinary surgeons have had very little to do with bees, while beekeepers have been responsible for:

- Controlling the health status of their bee colonies;
- Identifying proper treatment options for various pathogens (possibly involving laboratory analysis);
- Ensuring that bee health and honey safety assurance systems are adhered to;
- Keeping records as stipulated by European legislation.

Veterinary surgeons usually only get involved in honey bee health when the available medication appears ineffective or POM-V (prescription-only medicines – veterinarian) products such as antibiotics are required, or if non-licensed medication has to be given via the prescribing cascade to deal with emergencies.

However, legislation relating to medication for honey bees is likely to change in the future and this will require suitably qualified persons (SQPs) to store and supply medication. This move, driven by European rules, will in all probability change GSL medicines to POM-VPS (prescription-only medicines – veterinarian, pharmacist or SQP) products.

Veterinary practitioners will therefore have to become more involved with:

- Diagnosis and treatment of notifiable diseases in bees;
- Prescription of veterinary drugs, and any associated administration;
- Sampling of hive products to check for the presence of residues;
- Planning and implementation of good farming practices and hygiene measures based on hazard analysis and critical control point (HACCP) principles.

In order to fulfil this role, clinicians must have a good understanding of bee health and disease prevention.

Veterinary surgeons working in an official capacity (eg, for government departments) need to have a solid knowledge of beekeeping practices and any associated animal and public health issues to ensure responsible inspection and auditing. In its Terrestrial Animal Health Code 2009, the World Organisation for Animal Health (OIE) indicated that 'the permanent official sanitary surveillance of apiaries should be under the authority of the Veterinary Authority' and should be performed by either representatives of this Authority or by those of approved organisations, possibly assisted by specially trained 'health inspectors or advisers' such as experienced beekeepers.

**Table 2: Veterinary medicinal products authorised by the Veterinary Medicines Directorate for use in bees in the UK***

| Product | Authorisation holder | Active substance | Indications |
|---|---|---|---|
| Apiguard gel | Vita (Europe) | Thymol | Treatment of varroosis in honey bees |
| Apistan | Vita (Europe) | Tau-fluvalinate | Control of varroosis in honey bees |
| Bayvarol Strips (3·6 mg) | Bayer | Flumethrin | Diagnosis and control of varroosis in honey bees |
| Fumidil B | Ceva | Fumagillin<br>Fumagillin<br>Biocyclohexylamine salt | Control of nosemosis in honey bees |

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and thymol. While these products have been shown to be effective to varying degrees against *N apis*, they appear to have little effect against *N ceranae*, and this requires further research.

## Foulbrood diseases

### American foulbrood

American foulbrood (AFB) is an infectious notifiable disease affecting honey bee broods. It is caused by the larvae of *Paenibacillus* species, a spore-forming bacterium. AFB is widely distributed and destroys broods but the bacterium does not affect adult bees.

Young bee larvae become infected with *Paenibacillus* larvae spores via contaminated brood food. The spores germinate into the vegetative stage as soon as they enter the larval gut and continue to multiply until larvae die as a result of septicaemia (usually after the cell has been capped). Brood combs in an infected colony have a scattered and irregular pattern of capped and uncapped cells and show punctured and discoloured cappings (Fig 7).

AFB can usually be diagnosed in the field by carrying out a simple 'ropiness test'. This involves stirring the contents of a cell with a match or similar probe and gradually pulling them out. If *Paenibacillus* larvae are present, their remains will form a fine elastic thread or 'rope' between 10 and 30 mm long (Fig 8).

After infected larvae die, they form spores (known as the sporulation process) that can remain viable for up to 40 years in hives. AFB spores can be easily transported and transferred by bees. As the infection weakens the affected colony, it can no longer defend itself against invasion from stronger colonies in the area. Spore-contaminated products (eg, honey, nectar and pollen) can be spread quickly from hive to hive. Contaminated beekeeping equipment can also transfer the disease between hives.

Current methods for the control of AFB involve destroying heavily infected colonies by burning. Tetracyclines, tylosin or sulphathiazole may be efficacious at the vegetative stage but are not suitable for killing off spores. No antibiotics are registered for use in bees within the EU, as there is concern about antibiotic residues in honey and the emergence of antimicrobial-resistant strains of the bacterium. For this reason, antibiotic treatments must not be used. Infection of the colonies can be prevented by good beekeeping practices such as not feeding colonies with honey and renewing brood combs every other year.

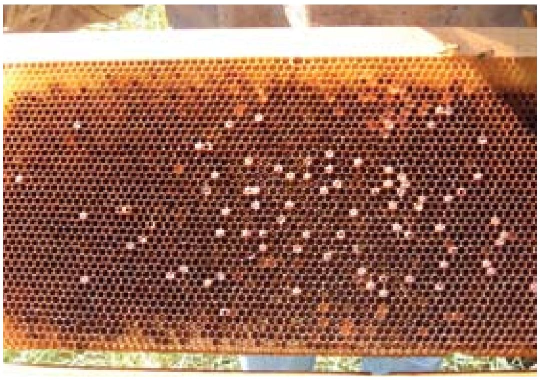

**Fig 7: Brood combs showing a scattered pattern of capped and uncapped cells, as well as punctured cappings, which is suggestive of American foulbrood**

**Fig 8: 'Ropiness test' for the diagnosis of American foulbrood. Dead *Paenibacillus* larvae tend to 'melt' and, when probed, a fine elastic thread or 'rope' can be seen to extrude from the cell**

### European foulbrood

European foulbrood (EFB) is also a serious notifiable bacterial disease of honey bee broods, and has been seen internationally. Several bacterial organisms are associated with EFB infection, but the main cause is *Melissococcus plutonius*. The disease is thought to be linked to stress, but queen genetics, weather and geography may also be involved. In the UK, in severe cases, treatment involves destroying EFB-infected colonies. Low level infections may be treated by an appointed bee inspector using oxytetracycline or by completely replacing a comb (called shook swarm).

## Viruses

Since 1963, when the first honey bee virus was isolated, 18 viruses affecting bees have been identified and characterised. These are mainly picornavirus-like in nature and appear as icosahedral particles, about 30 nm in diameter, and are morphologically similar when viewed under an electron microscope (Fig 9).

The most common viruses affecting honey bees are: deformed wing virus (DWV) (Fig 10a,b,c), black queen cell virus (BQCV), sacbrood virus (SBV), Kashmir bee virus (KBV), acute bee paralysis virus (ABPV) and chronic bee paralysis virus (CBPV). They can be dif-

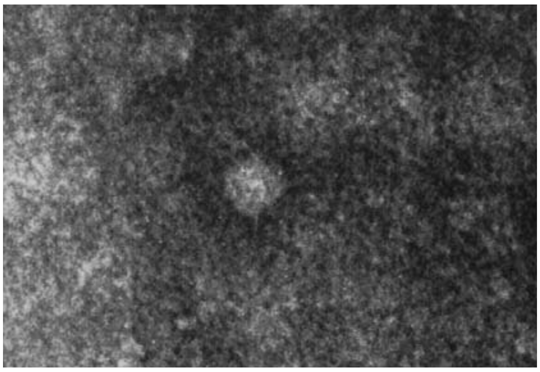

**Fig 9: Electron micrograph showing a picornavirus-like particle**

**Fig 10a,b,c (above, right and far right): Bee with deformed wings due to a viral infection**

ferentiated using PCR-based molecular techniques. Another virus – Israel acute paralysis virus (IAPV) – has been suggested as a marker for colony collapse disorder (Cox-Foster and others 2007).

Viruses are transmitted in honey bees via both horizontal and vertical transmission pathways. *V destructor* is thought to be a carrier and reservoir for viruses affecting bees (Shen 2005) and may be responsible for higher infectivity rates. *Nosema* species may also be potential vectors for viruses (eg, *N apis* is known to be associated with BQCV, filamentous virus and bee virus Y) as may EFB.

Although virus particles are frequently present in a latent or asymptomatic form in bees, they are able to reduce the life span of honey bees and dramatically affect honey bee health under stress conditions (eg, in cases of high levels of *Varroa* infestation or in the face of other diseases, or due to poor weather conditions or management practices).

Viral infections cannot be treated. Instead, their impact may be minimised by:

- Reducing stress to bees by implementing good beekeeping practices;
- Providing stores, especially pollen, to the bees;
- Keeping mite levels low by frequent monitoring and applying mite control treatments, when necessary;
- Replacing the queen with a queen from another source;
- Replacing combs.

**Fig 11: Regular inspection of hives is important to ensure problems are picked up early**

**Fig 12: Good beekeeping practices will ensure the production of healthy honey combs**

## Summary

With the continued worldwide decline in honey bee populations, veterinary surgeons are likely to have to play a greater role in the health and welfare of these animals (Fig 11) and to ensure the safety of the honey produced (Fig 12). In particular, practitioners will need to work with experienced beekeepers to ensure that bees are appropriately medicated and that the impact of diseases such as varoosis is limited.

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