

## MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING

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## MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING

The Candidate shall be able to give:-

3.1 a detailed account of the field diagnosis of American foul brood (AFB) and European foul brood (EFB), including lateral flow devices and a detailed account of the signs of these two diseases;

- Wear full protective clothing and have a smoker well lit.
- Keep the colony subdued with smoke.
- Remove the hive roof and place it on the ground by the hive (to the side of the hive or behind away from the hive entrance).
- If there are supers on the hive, remove them and place them on the upturned roof, keeping them covered to prevent robbing.
- Remove any queen excluder and examine the underside for the queen. If she is present return her to the colony. Place the excluder on the ground next to the roof brood disease
- Where two boxes are used for the brood nest, examine the bottom one first.
- Remove the outside comb, which is unlikely to contain brood, and lean it against a front corner of the hive – you will then have room to work.
- Take each comb in turn, and holding it by the lugs within the brood chamber, give it a sharp shake. This will deposit the bees on the bottom of the hive without harming them, the queen or brood.
- Any bees on a comb may be concealing infected brood from the beekeeper's view. On combs free from bees, any abnormality is easily spotted.
- Examine the brood, both sealed and unsealed, quickly but carefully, for any signs of abnormality – such as discoloured larvae or perforated cappings.
- Look for AFB scales by holding the combs towards the light and scanning the bottom walls of any open cells.
- Look inside any sealed cells with abnormal looking cappings after opening the cell with a corner of the hive tool, matchstick or suitable implement.
- To establish the consistency of any dead remains present, probe these with a matchstick.
- Dispose of the used matchstick in the smoker.
- Continue until you have examined all the brood combs; then reassemble the hive.

American Foul Brood	European Foul Brood
AFB generally affects only sealed brood. When infected larvae die within the sealed cell, the appearance of the cell cappings changes. A good way of remembering is that AFB = A (after sealing of the cell).	EFB affects mainly unsealed brood, killing larvae before they are sealed in their cells. An easy way to remember is that EFB = <b>E</b> (early infection before sealing of the cell).
Wax cappings become sunken and perforated when adult bees nibble holes in them to try to remove the infected larva within. These perforations tend to be jagged and irregular in shape.	The EFB infected larva moves inside its cell instead of remaining in the normal coiled position characteristic of a healthy larva of the same age.
Some cappings may become moist or greasy looking and slightly darker in colour than other cells.	When it dies it lies in an unnatural attitude – twisted spirally around the walls, across the mouth of the cell or stretched out lengthways from the mouth to the base.
At first only very few cells may show signs of disease, and the colony will appear normal in other respects.	The dead larva often collapses as though it had been melted, turning yellowish-brown and eventually drying up to form a loosely attached brown scale.
Eventually much of the sealed brood will become affected by the disease, causing a patchy or 'pepper pot' brood pattern.	The gut of an infected larva may be visible through its translucent body wall. It has a creamy white colour caused by the mass of bacteria living within it.

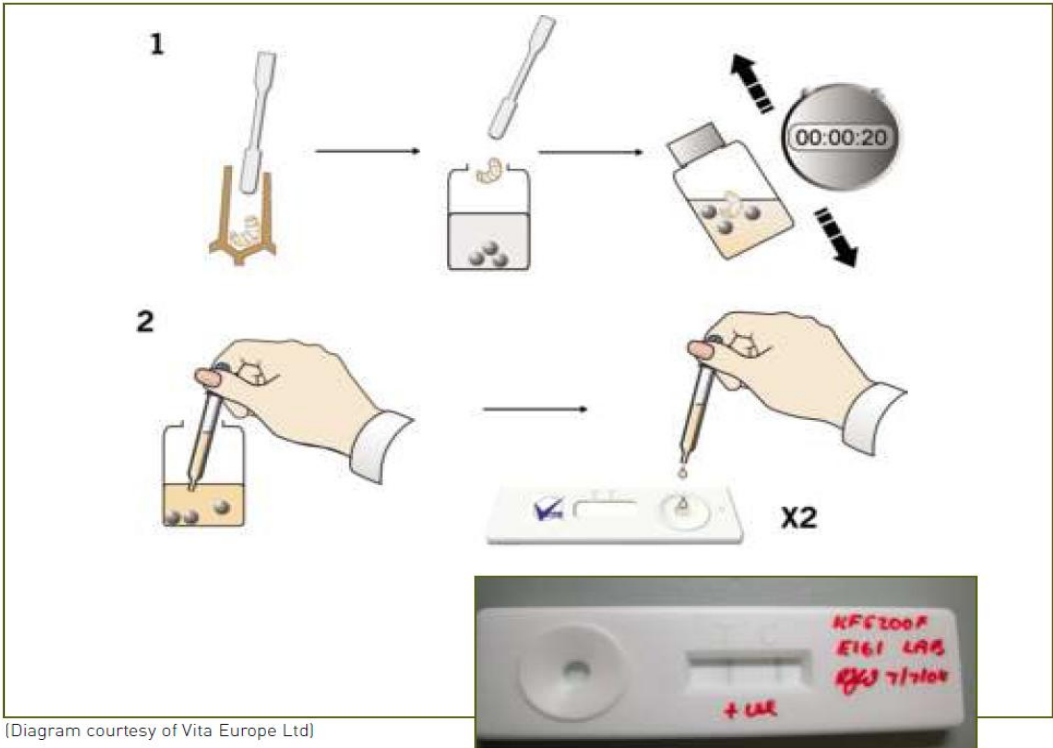
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There may then be an unpleasant smell associated with decomposition.	When a high proportion of the larvae are being killed by EFB, the brood pattern will often appear patchy and erratic as dead brood is removed by the bees and the queen lays in the vacant cells.
At the sunken capping stage the dead larval remains are light to dark brown in colour, and have a slimy consistency.	A very unpleasant odour may sometimes accompany severe EFB infection, depending on the presence of certain other species of bacteria in the remains of dead larvae.
Further drying leads to the final stage, which is a very dark brown, rather rough scale lying on the lower side of the cell and extending from just behind the mouth of the cell right back to the base.	
The scales can be detected if the comb is held facing the light: they reflect the light from their rough surfaces and can easily be seen, even when their colour is almost the same as the comb itself.	
If a matchstick is inserted and slowly withdrawn, the remains can be drawn out in a brown, mucus-like thread or 'rope' 10-30mm long. This is called the 'ropiness' test and is a reliable test for the presence of AFB.	
The ropy condition is followed by a tacky stage as the larval remains in the cell gradually dry up and the colour changes to dark brown.	
The proboscis of dead pupae may sometimes remain intact, protruding upwards from the bottom edge of the cell	

European foul brood cannot be reliably identified visually, as the disease signs can easily be confused with various other brood abnormalities. Suspect infections are confirmed in the field by Fera Bee Inspectors using Lateral Flow Devices. Occasionally sample brood combs (or suspect larvae in plastic tubes) are sent to the NBU laboratory where larval gut contents are examined for the presence of the causative bacteria using a Lateral Flow Device (LFD).

A sample of suspect infected larval material is placed in the buffer bottle and shaken for about 20 seconds. 2-3 drops of the resulting suspension are then placed on the lateral flow device. The blue lines at the C (Control) and T (Test) line indicate a positive result for foul brood infection.

# MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING



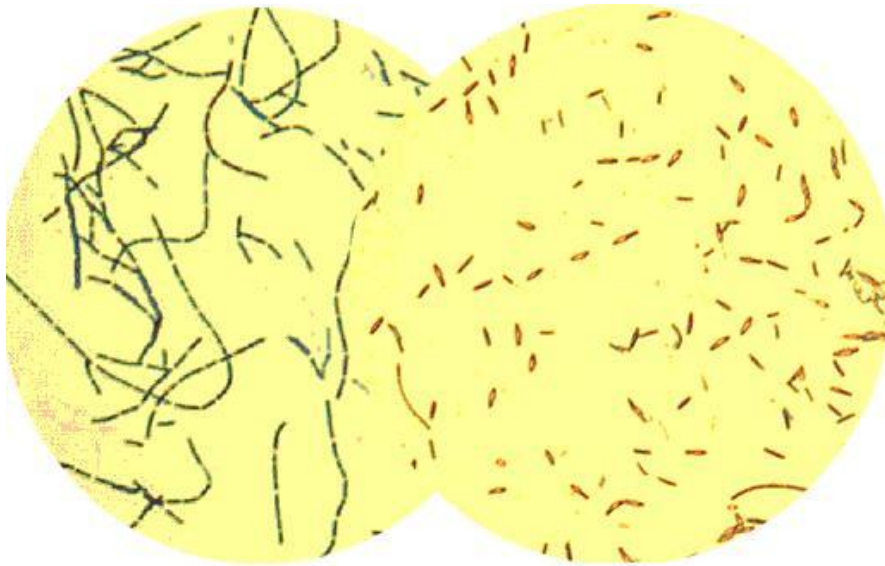
## MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING

3.2 an account of the life cycle of the causative organisms of AFB and EFB and their development within the larvae;

### AFB

Honeybees are plagued by the American foulbrood disease (AFB), which is considered to be the most fatal of honeybee brood diseases. The disease attacks only the very young larvae. Larvae older than 48 hours are not susceptible. Adult bees are not affected by the disease.

American foulbrood disease is caused by the spore-forming bacterium known as *Paenibacillus larvae*. The bacterium exists in two forms: the spore stage and the vegetative stage, which consists of slender rod-shaped bacterial cells. Only the spore stage is contagious to bees.



LEFT *Paenibacillus larvae* in the vegetative stage.  
RIGHT *Paenibacillus larvae* spores without appendages.  
Image credit: Baylor College of Medicine [www.hgsc.bcm.tmc.edu](http://www.hgsc.bcm.tmc.edu)

### Pathogenesis

Infection occurs when bee larvae ingest *P. larvae* spores in contaminated food given to them by nurse bees. The spores germinate in the larval midgut into the vegetative forms (rod stage) a day after ingestion by the larvae, becoming bacteria. The rods penetrate the gut wall entering the tissues where they proliferate rapidly and at an enormous rate, feeding at the expense of the tissues, and continuing to proliferate until larval death. New spores form after the larva dies. The infected larvae die after their cell is sealed over. When this occurs the nourishment supply of the bacteria is no longer maintained, and their growth and proliferation cease. Each bacterium then transforms itself into spore stage. After death, the white larvae become dark brown and decay into a glue-like mass, which will rope. The decaying mass has a foul smell, hence the name foulbrood. At the final stage, within a month or so, a dead larva or pupa dries to a dark brown scale that adheres tightly to the lower side of the cell and cannot be removed by the bees. Each scale contains millions of infective spores. These spores are a potential source of infection. Once inside the larval gut again, the cycle will repeat.

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### EFB

The bacterium responsible for causing the symptoms of European Foulbrood is probably *Melissococcus plutonius*, probably because when a larva is affected with the Bacterium other bacteria move in causing secondary infections:

- *Bacillus alveri* and *laterosporus*
- *Bacterium eurydice*
- *Streptococcus faecalis*

The larvae are fed the bacteria with the brood food which multiplies in the ventriculus (stomach) using the larval food. The bacteria lodge between the peritrophic membrane and the food in the ventriculus. The bacteria act essentially as a parasite competing for food, and the larva dies of starvation about 3 or 4 days before the cell is due to be sealed. During this period the larva contorts itself into unusual positions in the cell and its colour changes from pearly white to cream and then to a yellowy green colour. Much of the early colour change is due to the bacterial mass in the larval stomach. The larva is twisted spirally or flattened out lengthways in the cell.

## MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING

### 3.3 a detailed account of the development of AFB and EFB within the colony;

#### AFB

Infection of the larva is by ingestion of the spores in contaminated brood food. Germination of the spores in the adult bee is prevented by the bactericidal effect of 10-hydroxydecenoic acid (10-HDA) from the worker bee's mandibular glands.

Once in the larval gut however the conditions are ideal for germination and the bacterial population doubles about every 8 hours. When the honeybee larva voids the contents of its gut prior to metamorphosis sporulation begins and the cell contents become a source of further infection. The bacteria continue to multiply in the haemolymph and this leads to the death of the larva. Once larval death has occurred the bacteria again sporulate within the body. Adult bees cleaning away dead remains in the hive become infected.

AFB bacteria gradually destroy larval tissue.

House-cleaning bees come along and try clean up both the messy (pre)pupae and the scales, so becoming contaminated with the spores. The spores can get into every part of the hive including the honey. House-cleaning bees soon become nurse bees, feeding young larvae, and the spores will be passed to the larvae in this way. The disease may be quite slow to get going in the beginning; the bees can keep the spread under control for a time by the removal of diseased larvae in early stages. As the number of young bees decline the disease will take control and quickly destroy the colony.

#### EFB

There are three important facts involved in the spread of *Melissococcus Plutonius* in a colony:

- The *M. plutonius* never forms spores. The normal vegetative cells are infective and produce in huge numbers in the infected larva.
- The contents of the ventriculus of a larva, and so the bacteria, are "sealed in" until the larva pupates and the connection between the ventriculus and hindgut opens. Then all the waste and bacteria, which have been stored in the gut during larval life, pass out into the cell
- Very young adults clean out the cells and later produce food to be fed to larvae.

If we take these together we can see how the disease spreads through the colony. Infected larvae which survive to pupate discharge the guts contents into the cell. This then is cleaned by House Bees which pick up the bacteria and, subsequently, feed them to the young larvae in brood food. When the larvae have spun an inadequate cocoon, the bacteria will be more accessible to the house bees.

## MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING

3.4 a detailed account of the ways in which AFB and EFB are spread from one colony to another;

Natural methods of spread:

- drifting, where a worker bee may go into the wrong hive, taking spores with it
- swarm from an infected hive
- robbing. This is probably the most important bee-based method of spread. Colonies weakened, or killed, by foulbrood have their stores looted by other colonies. Thus carrying back spores to their own colony

Beekeeper methods of spread:

- move infected combs from one colony to a healthy colony
- unite a weak (diseased) colony with a stronger colony
- feed honey from a dubious source to bees
- trap pollen from infected colony and feed to healthy colony
- inspect hives on remote site with dirty gloves and suit after inspecting own infected colony
- hive unknown swarms near healthy colonies
- buy old equipment without cleansing before use
- move bees to area with large numbers of colonies close by, e.g. pollinating sites
- purchase of infected stock of bees

## MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING

### 3.5 a detailed account of the authorised treatment of colonies infected with AFB and EFB including methods of destruction of colonies and the sterilisation of equipment;

AFB is a notifiable disease under the Bee Diseases and Pests Control Orders (for England and Wales) and is subject to official control by a programme of apiary inspections carried out by the NBU. Control of the disease is through compulsory destruction of infected colonies, which is a very effective measure.

Methods of control of AFB using antibiotics that are used in some overseas countries are not effective, as they only serve to suppress signs of the disease without eradicating it and through frequent use allow the development of resistant bacterial strains. **The use of antibiotics to control AFB is not permitted in the UK.**

By eradication of a colony, this is the destruction of the bees and combs by burning in an open pit.

Hive boxes must be scorched with a burner and clothes, gloves, tools etc. thoroughly cleaned in hot water and soda crystals.

EFB is a notifiable disease under the Bee Diseases and Pests Control Order (for England and Wales) and is subject to official control by the examination of colonies for signs of disease and compulsory treatment or destruction of diseased colonies. Weak colonies and colonies with a high proportion of diseased brood are destroyed, as with American foul brood, but lightly diseased colonies may be treated with an antibiotic. Treatment must be carried out only by an Appointed Officer under the Order, using drugs officially dispensed following confirmation of European foul brood in a disease sample submitted for diagnosis at an approved laboratory or by LFD. Treatment is prescribed by the designated Veterinary Laboratories Agency (VLA).

Control of the disease by a husbandry method known as the “*shook swarm*” has also been shown to be effective and is an option available to beekeepers.

## MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING

3.6 a detailed account of the statutory requirements relating to notifiable diseases and pests and the implementation of these requirements in the United Kingdom,

<https://secure.fera.defra.gov.uk/beebase/pdfs/Statutory%20procedures%20leaflet.pdf>

Relevant Statutory Order is The Bee diseases and Pest Control (England) order 2006: SI 2006 No. 342.

### Notification

If Beekeeper suspects the presence of a notifiable disease or pest they are legally obliged to either contact the NBU or submit a sample pest or disease to Fera lab for analysis.

### Notifiable Diseases and Pests

Foul brood

- American Foulbrood
- European Foulbrood

Pests

- Small Hive Beetle (SHB) *Aethina tumida*
- Tropilaelaps* spp mites

### Inspections

- NBU carryout regular inspections, prefer to involve beekeeper, however have powers to enter premises to inspect
- Beekeeper have responsibility colonies regularly for signs of notifiable diseases/pest

### If foulbrood or pest suspected:

- Bee inspector will issue a Standstill Notice
  - This prohibits Beekeeper from moving any bees, equipment or hive products from the apiary
  - Inspector will confirm diagnosis, foulbrood using LFD
- Apiary Inspection Report (B2) sent to Fera by Bee Inspector
- If Foulbrood may contain sample
- If pest sample always included
- Standstill remains in force until statutory control measures have been completed and apiary has been officially examined and cleared, this is a minimum of 6 weeks

### Lab examination

- Fera will aim to complete an examination and produce a diagnostic report within 1 working day
- Report is sent 1<sup>st</sup> class post to bee inspector, who will contact beekeeper and explain procedure

### If AFB confirmed

- Bee Inspector will issue Destruction Notice to Beekeeper
- Beekeeper must:
  - Destroy the infected colony by burning all bees, frames, combs, honey and quilts, usually in a pit dug for the purpose near the apiary
  - The hive bodies must be sterilised by using a blowlamp and may be reused
- All clothing, tools etc. must be thoroughly cleaned with Soda Crystal solution
- The Standstill Notice remains in force for minimum of 6 weeks after destruction
- Bee Inspector will re-inspect Apiary and withdraw Notice if no signs of disease are obvious
- Bee Inspector will usually carry out follow up inspection the following season

### If EFB confirmed

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- Bee Inspector will issue either a Treatment Notice or a Destruction Notice
  - Type of notice depends on time of year, level of infection and colony strength
  - Destruction Notice normal if infected Brood Comb  $\geq 50\%$  or colony previously infected
  - Treatment Notice will apply if infection light enough to respond to Antibiotics or Shook Swarm, Beekeeper can decide to destroy colony
- Shook Swarm Treatment
  - Conditional licences offered to remove ripe honey and supers and move colonies to hospital apiary
  - Beekeeper prepares clean hive with either fresh foundation or sterilised drawn comb
  - Old brood combs destroyed by fire
  - Shook swarm carried out by Bee Inspector
  - If no honey flow bees fed winter feed after 2 days, infected nectar used in comb building
  - Follow up inspection 6 weeks later or start of following season
- Antibiotic Treatment
  - As per above
  - Bee Inspector applies treatment
  - Honey removed after treatment under licence or after the withdrawal of the Standstill notice must be stored in sealed containers and is prohibited from sale or consumption for at least 6 months after the treatment date

If Small Hive Beetle or *Tropilaelaps* spp. Mites are suspected

- England and Wales Contingency plan for exotic pests and diseases of honey bees will be invoked
- NBU will contact Defra and Welsh Assembly Government
- Defra will notify European Commission
- NBU will set up a National Disease Control Centre at Fera Lab in York to:
  - Coordinate the emergency
  - Arrange surveys to assess extent of outbreak
  - Procure and deploy necessary resources
  - Liase with beekeeping associations and other interested parties, nationally and locally
  - Assess wider impact e.g. colony losses on pollination services to agriculture, horticulture and the environment
  - Provide up to date information to stakeholders and the media
  - A local disease control centre may also be established
- Statutory Infected Area
  - Minimum of 16 km radius around infected colony
    - Movement restrictions will apply into and out area of bee related items
  - If outbreak is isolated and eradication is viable all colonies in affected apiary and surrounding area will be destroyed. In case of infestation soil 10-20m from hive will be treated if licensed products exist
  - If outbreak is widespread appropriate control methods and veterinary medicines will be applied subject to the Veterinary Medicines Directorate

Beekeepers responsibilities

- Follow advice of Bee Inspector
- Learn to recognise diseases and pests
- Regularly examine colonies (at least Autumn and Spring)
- Report suspected foulbrood immediately to local Bee Inspector or NBU
- Plebes on new comb or foundation after EFB infection
- Follow hygiene guidelines
- Keep varroa and other diseases under control, healthy hives have best chance of surviving EFB
- Be insured

## MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING

3.7 an account of the statutory requirements relating to the importation of honeybees;

<https://secure.fera.defra.gov.uk/beebase/pdfs/importingbees.pdf>

Feature	EU	Third Country	New Zealand
Animals and Animal Products (Import and Export) (England) Regulations 2006 and the Bee Diseases and Pests Control (England) Order 2006			
Documentation	<ul style="list-style-type: none"> <li>• Health Certificate as per Annex E Part 2 Council Directive 92/65/EEC (as amended 2007/265/EC) issued by relevant member state authority</li> <li>• Valid for 10 days and must be held 12 months</li> <li>• Must give at least 24 hours notice to Animal Health Office for destination area of arrival</li> </ul>	<ul style="list-style-type: none"> <li>• Only from listed countries as per Annex II Part 1 Council Decision 79/542/EEC (Annex A) AND AFB, SHB and Tropilaelaps are confirmed notifiable</li> <li>• Must have certificate modelled on Annex 1 (queen bees) to Commission Decision 2003/881/EC signed by relevant Authority in third country</li> <li>• Valid 10 days, to be held by Border Inspection Post (Heathrow or Gatwick only)</li> <li>• Other countries contact Fera or NBU, else get source to confirm compliance</li> <li>• BIP creates CVED which accompanies package to destination</li> </ul>	<ul style="list-style-type: none"> <li>• As per third Country</li> </ul>
Packages	<ul style="list-style-type: none"> <li>• No restrictions</li> </ul>	<ul style="list-style-type: none"> <li>• Queen and up to 20 Attendants only</li> </ul>	<ul style="list-style-type: none"> <li>• Queens and bee packages</li> </ul>
Post Import Controls	<ul style="list-style-type: none"> <li>• Transfer queens to new queen cages before introduction to local colony</li> </ul>	<ul style="list-style-type: none"> <li>• Send queen cages, attendant worker bees and any other accompanying material to NBU within 5 days of receipt</li> <li>• Use breathable containers for packaging material e.g. matchbox</li> </ul>	<ul style="list-style-type: none"> <li>• As per Third Country</li> </ul>

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<p>Certification Requirements</p>	<ul style="list-style-type: none"> <li>• Not from prohibition area from AFB, 30 days since prohibition and all hives with 3km checked for AFB</li> <li>• At least 100km from SHB or Tropilaelaps infected area</li> <li>• Packaging and bees checked visually for SHB and Tropilaelaps</li> </ul>	<ul style="list-style-type: none"> <li>• From Supervised Breeding apiary</li> <li>• No restrictions due to AFB for previous 30 days</li> <li>• If outbreak previously a hives within 3km have been checked and all infected hives burned/treated to satisfaction of competent authority</li> <li>• Original hive tested for AFB within 30days</li> <li>• Come from area at least 100km away from Tropilaelaps or SHB infestations</li> <li>• Packaging checked for signs of SHB or Tropilaelaps incl. Eggs</li> <li>• Hive checked for disease immediately before packaging</li> <li>• All material packaging, food etc is new and not been in contact with diseased items</li> </ul>	<ul style="list-style-type: none"> <li>• Come from supervised breeding apiary</li> <li>• Not from AFB restricted area in last 30 days, third country 3km restriction</li> <li>• Inspected [prior to dispatch</li> <li>• Packaging etc. new and free from contamination</li> </ul>
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## MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING

3.8 a description of the life cycle and natural history of *Varroa destructor* including its development within the honeybee colony and its spread to other colonies;

### What is Varroa?

- The varroa mite, *Varroa destructor*, formerly known as *Varroa jacobsoni*, is an external parasite of honey bees. Originally confined to the Asian honey bee, *Apis cerana*, it has spread in recent decades to the Western honey bee, *Apis mellifera*.
- Unlike *Apis cerana*, our honey bee has few natural defences against varroa. The mites feed on both adult bees and brood, weakening them and spreading harmful pathogens such as bee viruses. Infested colonies eventually die out unless control measures are regularly applied.

### Development within the colony and spread between colonies

#### Life Span

- The life expectancy of varroa mites depends on the presence of brood and will vary from 27 days to about 5 months. During the summer varroa mites live for about 2-3 months during which time, providing brood is available, they can complete 3-4 breeding cycles. In winter, when brood rearing is restricted, mites over-winter solely on the bodies of the adult bees within the cluster, until brood rearing commences the following spring.

#### Reproduction

- The success rate of reproduction (new mature female mites) in worker brood is about 1.7 to 2 but increases to between 2 and 3 in drone brood due to the longer development period. The development and status of a colony affects mite population growth, and depending on circumstances mite numbers will increase between 12 and 800 fold.

#### How Varroa Spreads

- Varroa mites are mobile and can readily move between bees and within the hive. However, to travel between colonies they depend upon adult bees for transport – through the natural processes of drifting, robbing, and swarming. Varroa can spread slowly over long distances in this way. However, the movement of infested colonies by beekeepers is the principle means of spread over long distances.

## MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING



capping, where she  
d under the larva until  
prefer drone brood but  
worker brood.



ars after capping the  
white begins to feed off  
ishes a feeding site for  
ours after capping the  
of her eggs.



## MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING

3.9 a detailed account of the signs of Varroosis describing methods of detection and ways of monitoring the presence of the varroa mite in honeybee colonies;

<https://secure.fera.defra.gov.uk/beebase/pdfs/varroa.pdf>

<b>Signs and Detection</b>	
Mite Recognition	<ul style="list-style-type: none"> <li>• Mature females are reddish brown, flat bodies and six legs at the front</li> <li>• Immature females and males are pale and smaller (exist in cells only)</li> </ul>
On Frames	<ul style="list-style-type: none"> <li>• Low infestation – no visible signs</li> <li>• Poor brood build up</li> <li>• Poor brood pattern</li> <li>• Varroa found in drone brood on uncapping</li> </ul>
On bees	<ul style="list-style-type: none"> <li>• In severe infestation young emerge poorly developed with stunted growth and deformed wings</li> <li>• Mites may be seen on adults</li> </ul>
In hives	<ul style="list-style-type: none"> <li>• On solid floors – dead mites</li> <li>• Open mesh floors – dead mites found on varroa tray</li> </ul>
In cells	<ul style="list-style-type: none"> <li>• Mites may be seen on larvae, particularly drones, removed from sealed brood cells</li> <li>• Bald brood and poor brood pattern</li> <li>• Dead brood often discoloured brown and partly removed by bees</li> <li>• Drone uncapping – mites may be found in unsealed drone brood at pink eyed stage</li> </ul>

### Monitoring

Mite drop count using debris found on trays under varroa floor

- Mix debris from floor with methylated spirits. Varroa mites float to top, wax and other debris sink to bottom of container
- To calculate daily mite drop – count number of varroa mites and divide by the number of days since last count
  - Frequency – 4 times per year – early spring, after spring flow, at time of honey harvest, late autumn
  - All colonies if possible
  - Issues – Varroa trays may harbour wax moths if trays are not emptied

### Drone Uncapping

- Test about 100 drone larvae
- Count trapped mites
- 5% infestation is light, 25% infestation is severe
- May be carried out at every hive inspection

Production of drone brood may be encouraged by:

- Adding drone foundation to brood frames
- Leaving an empty frame for bees to produce comb
- Add super frame to brood chamber

## MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING

3.10 a detailed account of methods of treatment and control of Varroosis, including Integrated Pest Management (IPM) and an outline of the consequences of incorrect administration of chemical treatments, together with a way of determining the resistance of varroa to such treatments;

### Methods of Control

Current control methods used by beekeepers against varroa can be divided into two main categories:

- **'Varroacides'** – The use of chemicals to kill mites (or otherwise reduce their numbers). These are applied in feed, directly on adult bees, as fumigants, contact strips or by evaporation. These may include authorised proprietary veterinary medicines and unauthorised generic substances.
- **'Biotechnical Methods'** – The use of methods based on bee husbandry to reduce the mite population through physical means alone. Many of the most popular and effective methods involve trapping the mites in combs of brood which are then removed and destroyed.

	Advantages	Disadvantages
<b>Biotechnical methods</b>	<ul style="list-style-type: none"> <li>✓ Do not require the use of chemical varroacides</li> <li>✓ Can be combined with summer management</li> <li>✓ Inexpensive or free</li> </ul>	<ul style="list-style-type: none"> <li>✗ Can be time-consuming</li> <li>✗ Some need a high level of beekeeping skill</li> <li>✗ Generally not sufficient if used alone</li> <li>✗ Misuse can harm colonies</li> </ul>
<b>Authorised varroacides</b>	<ul style="list-style-type: none"> <li>✓ Proven efficacy</li> <li>✓ Proven safety</li> <li>✓ Convenient to use</li> </ul>	<ul style="list-style-type: none"> <li>✗ Mites likely to develop resistance</li> <li>✗ Residue problems in bee products if misused</li> <li>✗ Can be expensive</li> </ul>
<b>Unauthorised varroacides (generic substances)</b>	<ul style="list-style-type: none"> <li>✓ Some can be very effective</li> <li>✓ Usually relatively cheap</li> <li>✓ Usually natural substances</li> <li>✓ Many present low residue risk</li> <li>✓ Some offer control options not currently provided by biotechnical or authorised varroacides</li> </ul>	<ul style="list-style-type: none"> <li>✗ Use not approved by law in most situations</li> <li>✗ Efficacy may be low/variable</li> <li>✗ Safety typically not proven: some present serious risks to bees and beekeeper</li> <li>✗ Some present risk of residues in bee products</li> </ul>

# MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING

## Some commonly used biotechnical methods

Method	How to use	Main features
<b>Drone brood removal</b>	<ol style="list-style-type: none"> <li>Place two shallow combs in the brood chamber in spring, and allow the bees to build natural drone comb beneath them. A good time to put these in the colony is when the queen first begins to lay up drone brood. Place the combs in the colony one at a time and alternate at 9 day intervals (a run of alternating pair of frames). Another option is to use an empty deep frame fitted with a starter strip of foundation to avoid possible misshapen comb.</li> <li>When a drone comb is full of sealed drone brood (infested with varroa), cut it from the frame <b>before it emerges</b> and destroy it. Failure to do this will breed more mites. The frame can be re-used immediately.</li> <li>Repeat the process several times in the season for maximum effectiveness.</li> </ol>	<ul style="list-style-type: none"> <li>✓ easy to use</li> <li>✓ no special apparatus required</li> <li>✓ no varroacide used</li> <li>✓ well tolerated by colony</li> <li>✗ time-consuming</li> <li>✗ useful, but limited efficacy</li> </ul>
<b>Comb trapping</b>	<ol style="list-style-type: none"> <li>Confine the queen to a worker comb 'A' using a purpose-made comb-cage (available commercially).</li> <li>After 9 days confine her to a new, empty comb 'B' and leave comb 'A' in the brood chamber to become infested with mites.</li> <li>After a further 9 days remove comb 'A' (now sealed). Confine the queen to a new comb 'C', leaving comb 'B' in the brood chamber.</li> <li>After 9 more days remove comb 'B'. Release the queen (or re-queen by introducing another queen) leaving comb 'C' in the brood chamber.</li> <li>After 9 more days, remove comb 'C'.</li> </ol>	<ul style="list-style-type: none"> <li>✓ can be very effective</li> <li>✓ no varroacide used</li> <li>✓ more bees recruited to foraging</li> <li>✗ time-consuming</li> <li>✗ requires good beekeeping skill</li> <li>✗ can harm/weaken the colony if used without regard to time of season (e.g. late summer)</li> </ul>
<b>Artificial swarm</b>	<ol style="list-style-type: none"> <li>Move parent colony to one side of the original site, at least 4 metres away.</li> <li>Place a second hive containing newly drawn combs and the queen (alone) on the original site to house the artificial swarm. Foragers will return to this hive creating the artificial swarm.</li> <li>After 9 days remove all but one queen cell from the parent colony. The cell can be protected in a queen cell nursery cage which prevents the virgin queen from leaving the hive to mate, but allows worker bees access to care for her.</li> <li>After 3 weeks all brood in the parent colony will have hatched. Transfer two bait combs of unsealed brood from the artificial swarm to the parent colony, and when they are capped, remove and destroy them. At this stage, cull the virgin and introduce a new queen to the parent colony.</li> <li>The old queen in the swarm can later be removed and the two colonies reunited.</li> </ol>	<ul style="list-style-type: none"> <li>✓ combines swarm control with varroa control</li> <li>✓ removes a high proportion of varroa mites present</li> <li>✓ new queen introduced</li> <li>✗ only suitable for use in the swarming season</li> <li>✗ it may be necessary to take precautions to prevent absconding in the artificial swarm – such as placing a queen excluder below the brood chamber for a few days.</li> </ul>
<b>Open mesh Floors</b>	<ol style="list-style-type: none"> <li>Fit a mesh varroa-monitoring floor (without a collection tray) to the hive.</li> <li>Many of the mites falling from the colony are alive. The mesh floor allows these to drop out of the hive rather than returning to the colony.</li> <li>A lower proportion of mites is considered to enter the brood to reproduce.</li> <li>Used in conjunction with other control methods this method helps keep mite numbers down.</li> </ol>	<ul style="list-style-type: none"> <li>✓ open mesh floor removes some live varroa</li> <li>✓ no debris on floor to encourage wax moths</li> <li>✓ improves hive ventilation</li> <li>✓ can use collection tray to measure mite drop when required</li> <li>✗ not sufficient if used alone</li> </ul>

### Misuse of agrochemicals

The active ingredients of many proprietary varroacides were originally developed to control pests of crops or livestock. When marketed as varroacides, they are specifically formulated for safe and effective use with bees. Under the authorisation process the specific formulation, along with the container and packaging (which may affect chemical stability) and the labelling, is assessed for use in accordance with the manufacturer's instructions. Home-made concoctions made with the active ingredients of these (often available as agrochemicals) should never be used. These pose serious risks to the user and to bees, and can leave harmful residues in bee products. Furthermore, misuse of this sort has been attributed to rapid development of resistance in countries overseas.

## MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING

### Chemical residues in bee-products

Any chemical substance applied to bee colonies has the potential to leave residues in bee products. The risk of these being harmful can be minimised by the following rules.

- Use authorised products with a proven track record in preference to alternatives that may lack reliable residue data
- Always follow the label directions supplied with all authorised products
- Never treat immediately before or during a honey-flow, or while supers are on the hive, unless the label directions of an authorised product specifically permit this

### Some varroacides commonly used by beekeepers in the European Union

Name	Authorised	Active ingredient (a.i.)	How applied	How spread within the bee colony	When normally applied	Significant features
<b>Bayvarol®</b> (Bayer)	<b>UK</b>	flumethrin (synthetic pyrethroid)	Plastic strips hung between brood combs	Contact	Autumn or early Spring for 6 weeks	Highly effective >95%; can be used during honey flow; too similar to Apistan to use with it as alternating treatment
<b>Apistan®</b> (Vita Europe)	<b>UK</b>	tau-fluvalinate (synthetic pyrethroid)	Plastic strips hung between brood combs	Contact	Autumn or early Spring for 6-8 weeks	Highly effective >95%; can be used during honey flow; too similar to Bayvarol to use with it as alternating treatment
<b>Apiguard®</b> (Vita Europe)	<b>UK</b>	thymol (terpene)	Slow release gel matrix (25% a.i.); two 50g pack treatments with 10-15 day interval	Evaporation, contact, ingestion	Spring or late Summer after honey harvest for 4-6 weeks.	90-95% efficacy with optimum conditions; depends on temperature and bee activity. When using ensure varroa mesh floors are closed and vents in crownboards are covered
<b>Apilife-VAR®</b> (LAIF)	<b>UK</b>	thymol, eucalyptol, menthol, camphor	Vermiculite carrier matrix	Evaporation	Autumn for 8 weeks	Temperature dependent; high efficacy up to 70-90% but some variability; Easy to apply
<b>Apivar®</b> (Biové)	<b>Not UK</b>	amitraz	Plastic strips hung between brood combs	Contact/ systemic	Autumn or Spring/early Summer for 6 weeks	Highly effective; can be used during honey flow
<b>Exomite Apis®</b> (Exosect)	<b>Not UK</b>	thymol in electrostatically charged powder	Powder in application tray at hive entrance	Contact	Spring or Autumn after honey harvest for 24 days	Efficacy not fully evaluated
<b>Perizin®</b> (Bayer)	<b>Not UK</b>	coumaphos (organophosphate)	Solution trickled over bees	Contact/ systemic	Late Autumn/Winter and broodless periods	Ideally needs broodless conditions
<b>Formic acid</b> (generic)	<b>Not UK</b> [Note 1]	formic acid (60 or 80% solution)	Evaporator kits (commercially available)	Evaporation	Late Summer/Autumn	Kills mites in sealed brood cells; temperature dependent; efficacy up to 80 to 90% (2 treatments) but high variability; brood and queen loss if misused; highly corrosive
<b>Lactic acid</b> (generic)	<b>Not UK</b> [Note 2]	lactic acid solution	Acid solution sprayed over combs of bees	Contact	Winter and broodless periods	Ideally needs broodless conditions; Causes skin burns; respiratory irritant
<b>Oxalic acid</b> (generic)	<b>Not UK</b> [Note 2]	oxalic acid solution	3.2-4.2% acid solution in 60% sucrose trickled over combs of bees; 2.5ml per brood comb	Contact (not ingestion, despite sugar presence). Sublimation	Winter and broodless periods	Ideally needs broodless conditions; 90% average efficacy possible; sugarless solutions have poor efficacy; danger of significant colony weakening; more scientific trials needed; highly toxic by inhalation, ingestion or skin

Note 1 Not authorised in any EU Member State, except in Germany when used in conjunction with Illertisser mite plates or Nassenheider evaporators only.

Note 2 Not authorised in any EU Member State, but tolerated in many countries.

Contact the Defra Veterinary Medicines Directorate for up-to-date information on which varroacides are authorised for use in the UK. See address at end of leaflet.

## MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING

3.11 a detailed account of the cause, signs and treatment (if any) of adult bee diseases currently found in the United Kingdom these diseases to include Nosema, Dysentery, Acarine and Amoeba;

- **Acarine** is an infestation by the mite *Acarapis woodi*. The Isle of Wight disease in 1904 – 1920s was probably acarine. Despite the signs of acarine given in beekeeping books, there are no visible external signs – the signs usually given (crawling bees, dislocated wings, etc.) are those of **Chronic Bee Paralysis** associated with acarine (although not proved as a vector). The mites infest the trachea. Dissection and microscopic examination (20x) of the first thoracic trachea can confirm diagnosis. Send a sample to a microscopist (in a paper container not plastic). There is no approved medicament in the U.K since *Folbex VA* was withdrawn in early 1990 and *Frow Mixture* was banned. Oil of Wintergreen and menthol have been used as a treatment and creosote! The life of an infected bee is shortened. It usually has little effect in the active season. The mite is spread from old bees to very young bees. A severe winter may cause an infected colony to dwindle in the spring. Some strains of bees are more susceptible than others – the ‘tracheal mite’ is a huge problem in the U.S.A which uses Italian/NZ crosses. There are external acarine mites: *A. exturnus*, *A. dorsalis* & *A. vagans* – little is known about them.
- **Nosema** is caused by *Nosema apis*, a spore forming protozoa. The protozoa multiply in the ventriculus (30 – 50 million spores) and impair the digestion of pollen thereby shortening the life of the bee. The spores are later excreted. There are no obvious signs of nosema, although **Dysentery** (q.v.), excreta on combs and hive, frequently accompanies heavy infections. Bees normally defecate away from the hive – sometimes the bees defecate in and about the hive because of the excessive build up of waste matter in their guts. The excreta containing spores is cleaned up by the bees and they become infected. Infected colonies fail to build up normally in the spring. Dead bees may be seen outside the hive after cleansing flights. Confirmation of Nosema is by microscopic examination (400x): 30 bees are crushed in water and a droplet is examined for white, rice-shaped bodies. Send a sample to a microscopist in a paper container (not plastic). Nosema is the most common disease and is to be found in seemingly healthy colonies. In *Infectious Diseases of the Honey Bee* (Dr. Bailey & Brenda Ball), it is stated that of 80 apparently healthy colonies, 79 contained the spores of nosema. Avoid crushing bees which can release millions of spores. Replace and sterilize combs with 80% acetic acid (100 ml./brood box for one week – air before use). Treatment with the antibiotic *Fumidil B* (prepared from *Aspergillus fumigatus* the causative agent of *Stone Brood!*) inhibits the spores reproducing in the ventriculus, but does not kill the spores.
- **Amoeba** is caused by a protozoan amoeba-like parasite *Malpighamoeba mellifica*. Cysts are ingested with food and germinate in the rectum. They migrate to the malpighian tubules (the ‘kidneys’) to create more cysts that then accumulate in the rectum and are excreted. The infection seems to have no effect on the colony, there are no specific symptoms and no treatment. Often seen under a microscope when examining a sample for nosema - grainy circular cysts, larger than the rice shaped nosema spores. The spores are destroyed by acetic acid.
- Since colonies have been treated for varroa, you are unlikely to see a similar (and harmless) parasite **Braula coeca**, the bee louse, a wingless fly. *Braula* (which has 6 legs, varroa has 8) breeds under cell cappings. Adults feed on honey taken as queen or workers are feeding. Tunnels can spoil appearance of comb honey.
- **Viruses**. Nosema, acarine, varroa, etc. in themselves do not kill a colony – they weaken it and thereby allow viral infections to take over. It is for this reason that Dr. Bailey considers that it was viral infection (Chronic Bee Paralysis Virus?) and not acarine that killed so many colonies in the Isle of Wight Disease – the symptoms described such as crawling bees, trembling wings, etc. are those of CBPV. It is only in recent years that viruses have been identified using the electron microscope. There are no cures for viral infection, they are immune from any antibiotic treatment. Viruses only multiply in living cells of their hosts and any medicament which kills the virus would kill the host. In practice, most colonies terminally weakened with nosema or acarine exhibit signs of CBPV, particularly clustering on top bars and continual trembling.

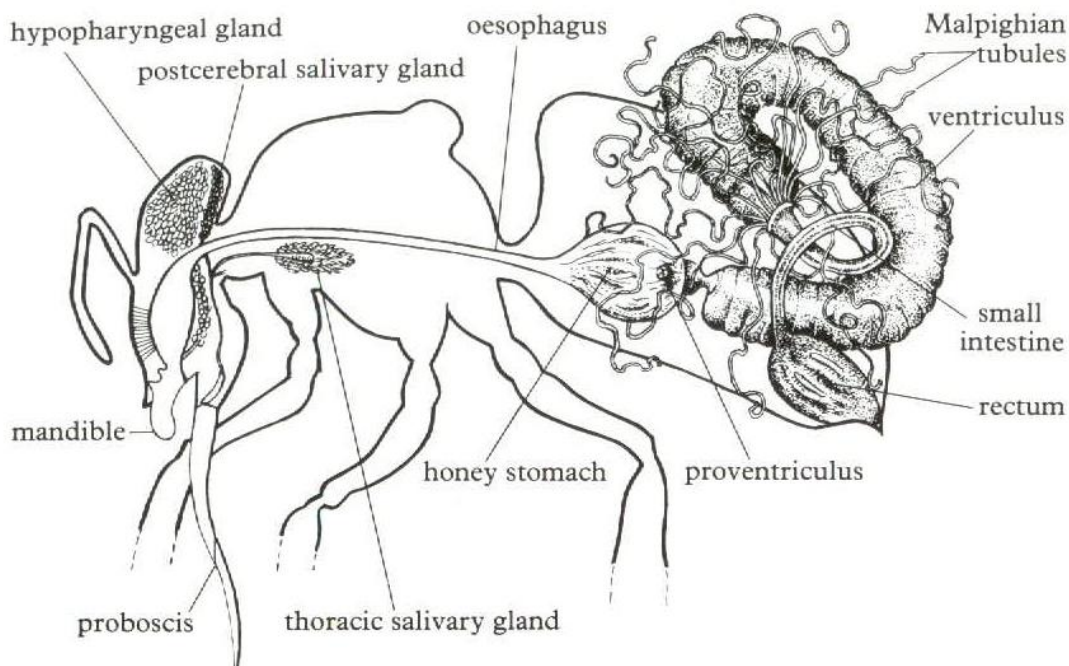
3.12 a simple account of the structure and function of the alimentary, excretory and

## MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING

**respiratory systems of the adult honeybee and of the life cycle of the causative organisms of adult honeybee diseases;**

### Alimentary System

Food is broken down by the process of digestion and these products are then circulated by the hemo-lymph (blood) and used to provide energy, bodybuilding substances, and the requirements for carrying out the chemical processes of life. The waste products of these processes have to be collected and eliminated from the insect's body. Digestion and excretion are the functions of the alimentary canal and its associated glands. These are shown in the figure. The mouth is between the base of the mandibles below the labrum and above the labium. Immediately inside the mouth the canal expands into a cavity which has muscular attachments to the front of the head which can expand and contract it, thus providing small amounts of suction to help pass the food from the proboscis and into the oesophagus. Muscles in the oesophagus provide waves of contractions which work the nectar back into the dilated crop or "honey stomach", where it is stored for a while. At the end of the honey stomach is the proventriculus, a valve that prevents the nectar from going any further unless it needs some for its own use.

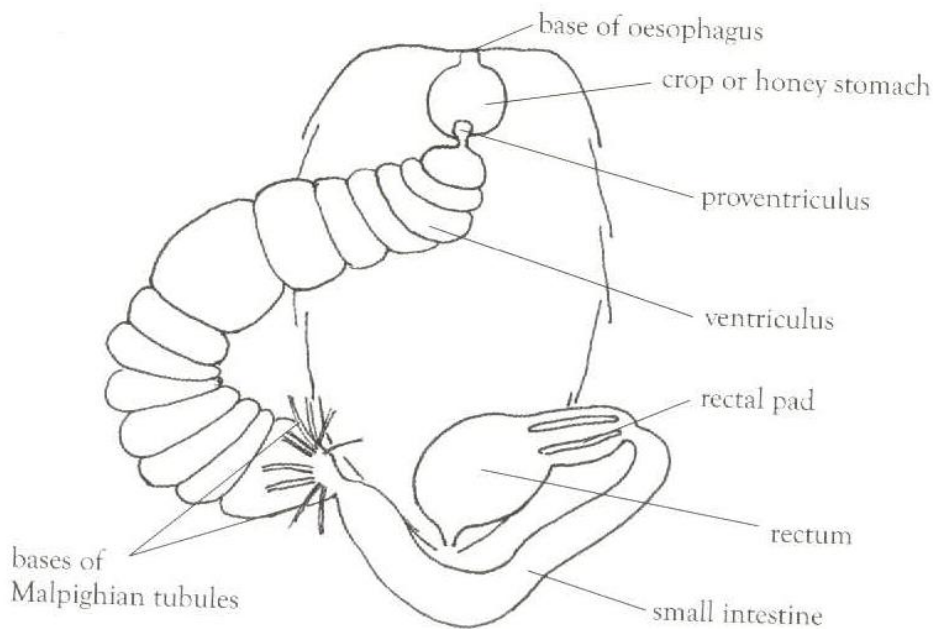


If the bee is a forager it is here that the nectar is carried back to the colony and regurgitated back to the mouth and fed to other bees. The proventriculus has four lips which are in continuous movement, sieving out solids from the nectar. The solids – pollen grains, spores, even bacteria – are removed from the nectar fairly quickly and passed back as a fairly dry lump, or bolus, into the ventriculus.

When the bee needs to have sugar the whole proventriculus gapes open and an amount of nectar is allowed through to the ventriculus, where the food is subjected to several enzymes which break it down into molecules small enough to be passed through the gut wall into the hemo-lymph. The bee appears to only digest two main food types, sugars and proteins. These are digested by enzymes produced in the walls of the ventriculus, assimilated and used to produce energy or to build up the bees own proteins.

The residue is passed into the small intestine and from there into the rectum where it is held, as faeces, until the bee is able to leave the hive and void the contents of the rectum in flight. During long spells of cold weather in winter the rectum can extend almost the whole length of the abdomen before the bee is able to get out for a cleansing flight. At the end of the ventriculus are about a hundred small thin walled tubes. These are the malpighian tubules which have a similar function to our kidneys in that they remove nitrogenous waste (the results of the breakdown of proteins during metabolism) from the hemo-lymph. The waste products mainly in the form of uric acid are passed into the gut to join the faeces in the rectum.

## MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING



### Excretory System

The excretory system is essentially a sophisticated filtration system which not only removes waste substances, which would slowly poison the cells, but also acts selectively, adjusting the amounts of particular substances in the haemolymph so that there is a balance between water and salts and the osmotic pressure and acidity remain within narrow limits.

There are two types of waste produced by active cells:

- Carbon Dioxide produced as a result of respiration and removed by the respiratory system
- Nitrogenous waste resulting from the chemical reactions which go on within the cells involving proteins and other nitrogen-containing compounds, this waste is removed by the excretory system.

There are four aspects of the excretory system;

- Filtration of the haemolymph by the Malpighian tubules
- Re-absorption from the excretory system of useful substances
- Active secretion of substances into the system
- Complete removal of the end product to the outside of the bees body

Substances in the haemolymph are filtered through the wall of the Malpighian tubule at its upper (distal) end. Muscle fibres cause the tubule to wave about and come in contact with the maximum amount of haemolymph. The substance passes through the single cell wall and travels down the centre (lumen) of the tubule.

As materials travel down the lumen some are re-absorbed, water retention is crucial part of re-absorption, depending on the Haemolymph state salts may or may not be re-absorbed.

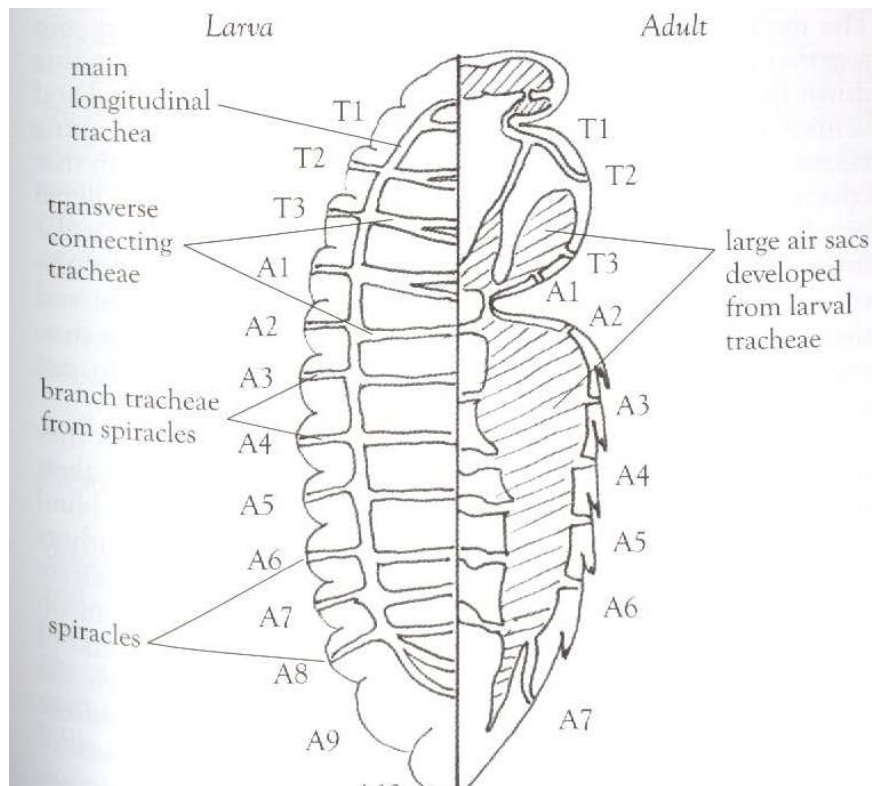
Finally, other substances are actively secreted by cells. They pull passing molecules in and push them through into the lumen. The Malpighian activity requires a lot of energy hence the proximity of tracheoles for sourcing Oxygen.

When the material in the lumen of the tubule reaches the intestinal connection, it passes into the digestive system and together with the waste from the digestive system is passed to the outside of the body through the small intestine, the rectum and finally the anus. During its final passage further water is re-absorbed.

### Respiratory System

## MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING

The bee breathes through tubes called trachea which convey oxygen to where it is required within the body of the insect. In all the higher animals oxygen is transported to the tissues by blood, but in insects the blood is not involved in the transport of oxygen through the body. The trachea is made of cuticle and is prevented from collapsing by spiral thickening. The trachea start quite large but very rapidly divide many times, getting smaller all the while, until finally they end up as single cells, or a loop. The trachea open to the air through holes in the cuticle called spiracles, and in many cases these are provided with a closing mechanism.

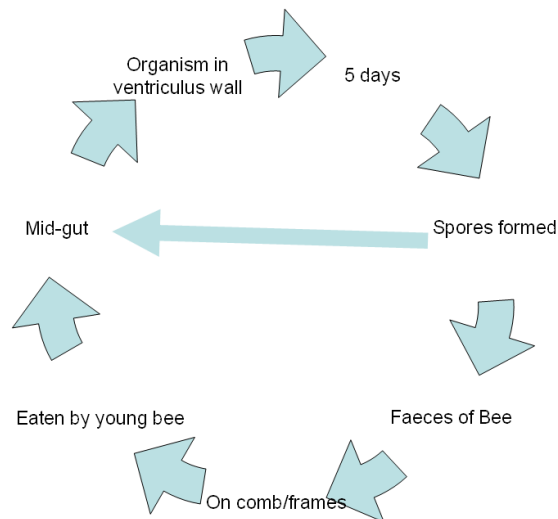


Air enters the tracheal system through spiracles and fills the tubes. When the cells in which the trachea end are using up oxygen, this reduces the pressure of oxygen at that point and molecules of oxygen migrate in to make up the deficiency. It is thus by diffusion that oxygen makes its way via the trachea into the body of the bee. Oxygen is used to oxidize substances such as sugar in the cells to release energy for their use, producing the residue substances carbon dioxide and water, this is cellular respiration. In the honeybee the main tracheal trunks become large sacs which are ventilated by breathing movements of the abdomen, whereby the abdomen is lengthened and contracted in a telescopic type movement.

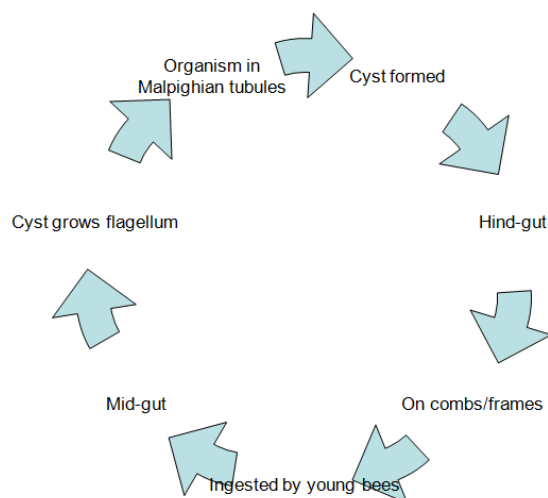
Three causative organisms:

- Microsporidian – *Nosema apis*
- Protozoan – *Amoeba* (*Malpighamoeba mellificae*)
- Non-Varroa Mite – Acarine (*Acarapis woodi*)
- *Nosema* (single cell organism from spores)
  - House bees tidy up faeces by eating it, within which are spores of *Nosema*
  - Spores pass through to mid-gut where they germinate and infect the epithelial cells lining the mid-gut
  - Feeding on the contents of the cell the *Nosema* multiplies, kills the cell and forms new spores, within 5 days in ideal conditions
  - Cells break down releasing 30-50 million spores, some invade new host cells and others pass out in faeces

## MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING

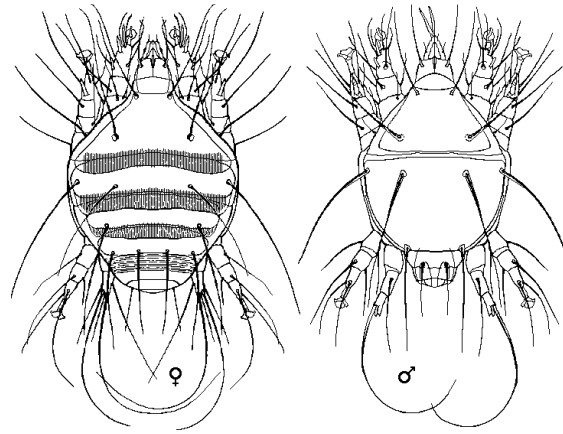


- Amoeba (microscopic single-celled animals)
  - Similar to Nosema resides in faeces, this time as a cyst
  - Mobile amoeba with flagellum emerges from cyst inside gut and moves to the Malpighian tubules, through opening that connect them to the gut
  - The amoeba attack the cells lining the tubules and after 3-4 weeks divide and form new cysts through producing a protective wall around themselves
  - Then on to the faeces



- Acarine (mite, similar cycle to Varroa)
  - Feeds by piercing the cuticle inside the tracheae and sucking the haemolymph (blood)
  - Each female lays 5-7 eggs
  - Eggs hatch to nymphs (6 legs and 8 when adults) between 3 and 6 days, adult females develop after 14 days and males a few days earlier
  - Female mites leaves the trachea, crawls up a hair and hangs on by one or two hind legs, and waves the remaining hairs until a suitable young bee less than 9 days comes along (the tracheae is protected by hairs which are not so dense on young bees). Grabs the hair of new host and is drawn to the first spiracle by vibrations of wings and puffs of air

## MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING



## MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING

3.13 a detailed account of the cause, signs and recommended treatment (if any) of the following brood diseases and conditions:- chalk brood, sacbrood, chilled brood, bald brood, neglected drone brood and stone brood drone brood and stone brood;

Disease	Symptoms	Cause	Occurrence	Treatment
Chalk Brood	<ul style="list-style-type: none"> <li>The larva appears as a white “plug” filling the cell. Sometimes a yellow shrunken “head” is visible on the top.</li> <li>At first it is soft and fluffy but hardens to a solid lump called a “chalk brood mummy”.</li> <li>The bees try to remove the mummies from the cells and they can be often seen on the hive floor or under hive if mesh floor</li> <li>Chalk brood mummies differ from stone brood mummies in that they are softer and crumble easily when handled</li> <li>Brood takes on a “pepperpot” appearance in heavy infestations</li> </ul>	<ul style="list-style-type: none"> <li>A fungus <b>Ascosphaera apis</b></li> <li>The spores are ingested by bees in the brood food and germinate in the gut</li> <li>Fungal hyphae penetrate through the gut wall and eventually grow out through the cuticle</li> <li>The young bee dies after the cell has been capped</li> </ul>	<ul style="list-style-type: none"> <li>Very common, Many hives have a few cells affected</li> <li>The disease is made worse if the brood is chilled slightly</li> <li>It has also been said that damp conditions favour the development of chalk brood</li> </ul>	<ul style="list-style-type: none"> <li>Mild infection does not harm the colony and no treatment is necessary</li> <li>Avoid chilling the brood if inspecting on a cold day</li> <li>Frames containing a lot of chalk brood should be destroyed and replaced with new foundation</li> <li>If the infestation is severe re-queening is sometimes recommended but not all authorities agree on this being effective</li> </ul>
Sacbrood	<ul style="list-style-type: none"> <li>Uncapped cells where the remains of the pupa have dried to a yellow/brown scale curled up at the top in the form of a “gondola” or “Chinese slipper”</li> <li>In the early stages, the capping is perforated and not fully removed and the cell contents may be fluid and sticky. The condition can be confused with AFB but not “ropey” if contents are drawn out with a matchstick</li> <li>Sacbrood can affect adult bees: <ul style="list-style-type: none"> <li>Shorten life</li> <li>Start foraging earlier</li> <li>Stop feeding larvae</li> <li>Collect very little pollen</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Virus infection</li> <li>Enters the larva through the food about 2 days after hatching</li> <li>Larva fails to perform the 5<sup>th</sup> moult properly; the moult between prepupa and pupa</li> <li>The old cuticle fails to separate from the epidermis and the space is filled with moulting fluid</li> <li>The larva dies in a sac of fluid</li> </ul>	<ul style="list-style-type: none"> <li>Low levels of infection are very common and do not appear to have a serious effect on the colony</li> <li>Can be found from May onwards</li> <li>Infections usually clear up by the end of the season</li> </ul>	<ul style="list-style-type: none"> <li>None</li> <li>If infection is severe and persistent the colony should be re-queened as some strains of bees appear to be more susceptible than others</li> </ul>
Chilled brood	<ul style="list-style-type: none"> <li>Blocks of brood at all stages are found dead or dying, normally towards the edge of the brood nest</li> <li>The dead brood turns yellow/brown then black</li> </ul>	<ul style="list-style-type: none"> <li>The temperature of the brood has dropped, usually because there are not sufficient bees to keep the brood warm</li> <li>Bees will abandon the frames on the outside of the nest to preserve the brood in the centre</li> </ul>	<ul style="list-style-type: none"> <li>Most common in Spring when a cold spell follows a period of warm weather. The queen starts to lay strongly but the cluster moves inwards as the temperature goes down leaving the outside frames exposed</li> <li>Can happen when the colony is split by swarm or artificial swarm</li> <li>Loss of bees by disease or poisoning</li> </ul>	<ul style="list-style-type: none"> <li>None. The colony needs more bees</li> <li>If the colony is otherwise healthy it can be united with a stronger colony</li> <li>The bees will clean up the affected brood</li> </ul>

## MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING

Bald brood	<ul style="list-style-type: none"> <li>Pupae appear to be developing normally but the cells are open with the cappings removed</li> <li>The open cells often appear in lines across the comb with tell-tale signs of wax moth debris alongside</li> </ul>	<ul style="list-style-type: none"> <li>Main cause is the lesser wax moth <i>Achroia grisella</i> burrowing through the cappings</li> <li>Less common is damage by the greater wax moth <i>Galleria mellonella</i></li> <li>Workers sometimes fail to cap the cells or uncap them thinking there is something wrong with the pupa</li> </ul>	<ul style="list-style-type: none"> <li>Associated with wax moth infestation</li> </ul>	<ul style="list-style-type: none"> <li>Not very harmful. Pupae in open cells appear to develop normally</li> <li>Wax moth can be removed from affected frames by tapping gently the side of the frame and killing the larvae as they emerge from the comb</li> <li>Treat frames for wax moth e.g. -15°C for 24 hours</li> <li>Replace old comb as wax moth feeds on old debris</li> </ul>
Neglected drone brood	<ul style="list-style-type: none"> <li>Many dead drone larvae</li> <li>Worker larvae, if present, appear normal</li> </ul>	<ul style="list-style-type: none"> <li>Worker bees stop feeding the drone larvae and they die in their cells before capping</li> </ul>	<ul style="list-style-type: none"> <li>Occurs when there is a drone laying queen or a laying worker. There are too many drones to feed and the workers appear to give up</li> <li>When there is an acute shortage of food, workers ignore drones and concentrate on worker brood</li> </ul>	<ul style="list-style-type: none"> <li>Drone laying queen should be replaced</li> <li>If laying worker bees should be shaken out away from hive and left to find own way home</li> <li>Shortage of food, feed sugar syrup</li> </ul>
Stone brood	<ul style="list-style-type: none"> <li>At first appears similar to chalk brood. Larvae become white and fluffy then die after cells are capped</li> <li>The remains become very hard and turn yellow/green as fruiting bodies appear</li> <li>Distinguished from chalk brood because mummies are much harder and not easily crushed</li> </ul>	<ul style="list-style-type: none"> <li>Fungus <i>Aspergillus flavus</i> is unjected by the larva in the brood food and develops in the gut in a similar way to chalk brood</li> <li>The hyphae penetrate the gut wall and grow through the cuticle killing the larva</li> </ul>	<ul style="list-style-type: none"> <li>Very rare</li> </ul>	<ul style="list-style-type: none"> <li>Infected combs should be removed from the hive and destroyed</li> <li>Care is necessary handling infected combs because the fungus is toxic to birds and can cause breathing difficulties in humans</li> </ul>

## MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING

3.14 a detailed account of the authorised treatments for adult bee diseases in the UK;

Product	Number	Authorisation Holder	Active Substance	Indication	VMP or Biocide
Apiguard Gel	17017/4002	Vita (Europe) Ltd	Thymol	For the treatment of varroosis due to <i>Varroa destructor</i> in honey bee.	VMP
Apistan	17017/4000	Vita (Europe) Ltd	Tau Fluvalinate	To control varroastosis in honey bee colonies.	VMP
Bayvarol Strips 3.6 mg	00010/4090	Bayer	Flumethrin	The product is indicated for the demonstration (diagnosis) and control (therapy) of <i>Varroa jacobsoni</i> in honey bees.	VMP
Fumidil B Powder for Syrup 20 mg/g	15052/4013	Ceva Animal Health Ltd.	Fumagillin Fumagillin Biclohexylamine Salt	For the control of Nosema in honey bees.	VMP

## MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING

3.15 a detailed account of the laboratory methods of diagnosis of Acarine, Nosema and Amoeba diseases in worker honeybees;

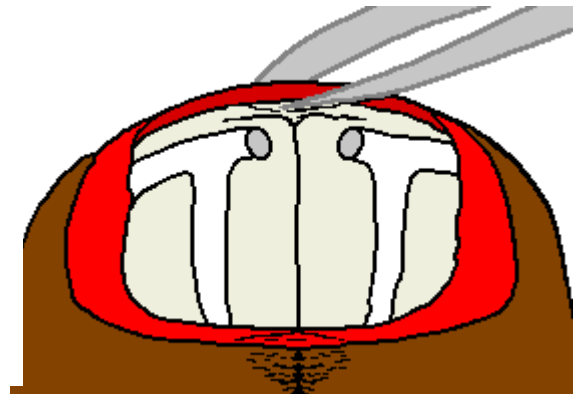
### Dissection to expose Acarine infestation

A random sample of 50 bees is collected from the suspect colony. These should be mainly bees crawling and unable to fly, found within about 3 metres of the front of the hive, rather than random collection from within the colony. The sample bees may be living, dying, or dead. Live bees must first be killed with ethyl alcohol or in a deep freeze at  $-20^{\circ}\text{C}$ .

Each bee should be impaled, using a double needle placed at an angle away from the head through the thorax between the second and third pairs of legs (as shown below). The bee should ventral side up on an angled cork base, the angle is not critical, but is usually between  $45^{\circ}$  and  $60^{\circ}$ . Using a single edged razor blade, cut off the head and first pair of legs, the cut should be made from behind the first pair of legs to the back of the bee's head, indicated by the red line on the drawing, the severed head and front pair of legs can then be removed using tweezers.



Fine tipped tweezers can be used to peel away the collar (shown red at right) in order to expose the tracheae more fully. Pull upwards with a circular motion, following the ring of the collar. It will peel off easily, usually in one piece. The collar itself can be saved for later preparation as a microscope slide specimen, if required, by immersing in 70% isopropyl alcohol.



As mites enter through the spiracle check the outer end of the trachea first. Light infestations may be difficult to see, heavy infestations are easily visible as shadows or lumpy dark objects in trachea that can be clear to dark brown. Old and/or heavy infestations will render the trachea orange, brown or black.

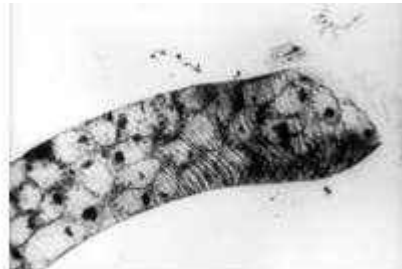
## MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING

### Diagnosis

The disease can only easily be diagnosed by carrying out a dissection and microscopic examination (using a dissecting microscope with up to x40 magnification) of the primary trachea. In a healthy or uninfested bee the trachea will have a uniform, creamy-white appearance. In infested bees the trachea will show patchy discolouration or dark staining, (melanisation, caused by mites feeding). In addition the eggs, nymphs and adult stages of the mite may also be seen in the trachea.



**Acarine infested trachea**



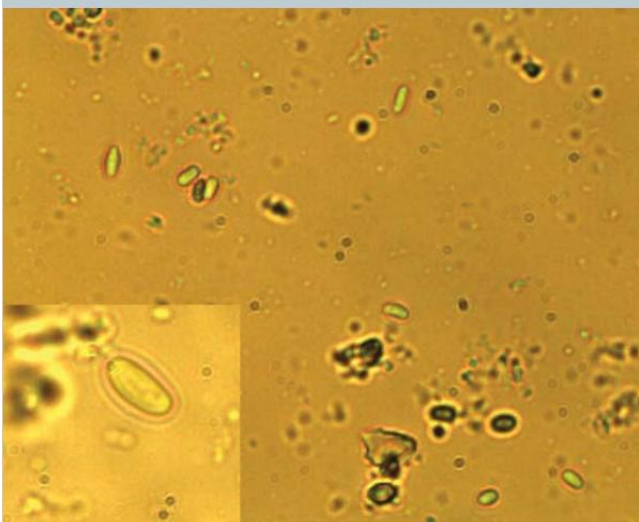
**Acarine infested trachea X40**

### Nosema

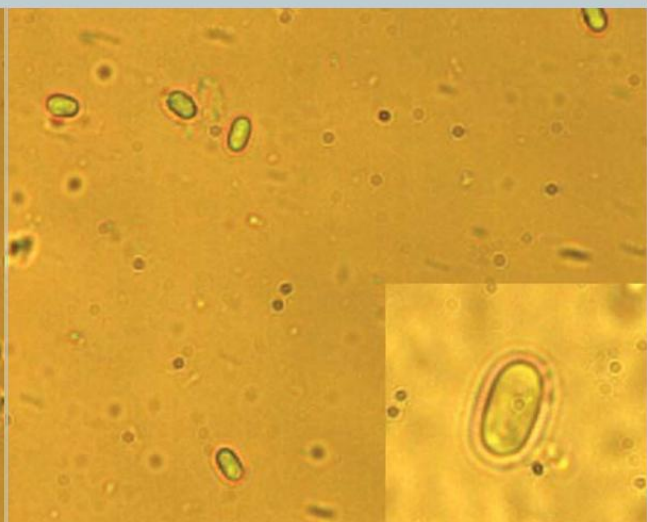
Abdomens of worker bees are ground up in a mortar with a little water and a drop of liquid spread onto a microscope slide. The tell-tale rice grain shapes can be seen using a light microscope with a magnification of 400x. If you take a large enough sample of bees, you could probably detect minute levels of Nosema in many colonies. For a realistic result, it is recommended that you use around 30 bees.

Nosema diagnosis can be carried out using a microscope with X 400 magnification. Collect about 30 bees and mash the abdomens in a pestle and mortar with a few drops of water. Deliver a single drop of the resulting soup onto a microscope slide and put on a cover. Under the microscope look for little pale rice shaped grains that are Nosema spores. There is little difference to be seen between *N. apis* and *N. ceranae* spores.

**Nosema ceranae with a single spore in close-up**



**Nosema apis with a single spore in close-up**



## MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING

3.16 a detailed description of the fumigation of comb using ethanoic acid (acetic acid), including safety precautions to be taken;

### Cautions

Gloves, eye protection and breathing mask/respirator should be worn. Overalls also recommended. Acid vapour will burn skin, ruin clothing and will cause internal damage if inhaled

### Material

- 80% v/v Acetic Acid + Absorbent pads
- 100% (Glacial) Acetic Acid can be diluted 1 part acid to 4 parts water for 80% concentration. Note 100% Acetic is frequently solid at low room temperatures which makes dilution difficult

### Method

- Start with a solid floor or board and place Brood Box/Super + comb to be sterilised on top. Place and absorbent pad on top and soak with  $\frac{1}{4}$  pint (140ml) of Acetic Acid, repeat with additional boxes and pads as required. Cover the top with crown board.
- The floor entrance must be blocked and sealed and all gaps and joins should be sealed with packing tape or similar. If possible, the stack is best sealed with plastic sheeting or in a large plastic sack to minimise escape of fumes.
- Fumigate for at least a week and then ventilate the combs for a further week before use.

**Note:** the acid vapour will attack any metal parts such as frame runners or metal ends, surrounding metal and also attacks concrete.

## MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING

3.17 a description of the effects of chronic bee paralysis (both syndromes), **acute bee paralysis virus, black queen cell virus**, sacbrood and deformed wing viruses together with an elementary account of the effects of other viruses affecting honeybees including their association with other bee diseases **and pests** where applicable;

### Chronic Bee Paralysis

**Associated: Varroa and Probably Acarine**

#### Type 1

- Trembling wings and body
- Not flying – crawling on ground and up plant stems
- Bloated abdomen (full honey sac)
- Huddle on top bars – does not react to smoke
- Dysentery
- Dislocated wings (K-wing)
- Deaths

#### Type 2

- Black shiny hairless bees (appear smaller)
- Broad abdomen
- Affected Bees nibbled by other Bees – refused entry to hive
- Trembling, not flying
- Deaths

### Acute Bee Virus

**Associated: Varroa**

- Weakening of the colony without signs of brood diseases and mites
- Increasing numbers of dead or dying bees on the inner cover or front of the hive. Dying bees may be trembling and display uncoordinated movement.
- Affected Bees are partly or completely hairless where the upper surface of the Thorax is especially dark
- Older Adult Bees have a greasy or oily appearance while recently emerged Bees may appear opaque as if pigmentation of the tissue had not been completed prior to emergence
- Rapid decline within a few days

### Black queen cell virus

**Associated: Nosema**

- Turns queen cell black
- Prepupa or pupa is yellow
- Tough skin slightly resembles sacbrood

### Sac Brood

**Associated: Varroa**

- The moult at prepupa to pupa goes wrong and the space fills with ectodysial (fluid)
- Moult skin resembles Chinese Slipper
- Changes from yellow to dark brown
- Pupa dies. Can give a short rope – can be confused with AFB

## **MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING**

- Adult Bees can be infected when cleaning cell
- Life shortened
- Become foragers earlier
- Stop feeding larvae
- Rarely collect pollen
- Behaviour of adult Bees can cause the disease to die out in a colony

### **Deformed Wing Virus**

#### **Associated: Varroa and Tropilaelaps**

- Damaged appendages, particularly stubby, useless wings
- Shortened, rounded abdomens
- Miscalouring
- Paralysis
- Severely reduced life-span (less than 48 hours)
- Typically expelled from the hive

### **Other Viruses**

#### **Slow paralysis virus**

##### **Associated: Varroa**

- Collapse late in the year

#### **Filamentous virus**

##### **Associated: nosema**

- Causes haemolymph to go milky

#### **Virus Y**

##### **Associated: nosema**

- No reported symptoms

#### **Virus X**

##### **Associated: amoeba**

- Shortens life
- Colonies die in spring

#### **Cloudy wing virus**

- Wings go cloudy
- Bee dies

## MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING

3.18 the scientific names of the causative organisms associated with diseases of honeybees;

### Brood disease

- AFB - Paenibacillus Larvae Larvae
- EFB - Melissococcus Plutonius
- Sac brood - Sac brood Virus
- Black Queen cell - Virus
- Chalk brood - Fungus Ascospaera apis
- Stone brood - Fungus – Aspergillus Flavus

### Adult disease

- Nosema - Protozoan Nosema apis/ceranae
- Amoeba - Protozoan Malpighamoeba Mellificae
- Gregarine - Protozoan Gregarinidae\_
- Melanosis - Fungus Torulopsis

### Viral adult disease

- Chronic bee paralysis - Virus
- Cloudy wing - Virus associate
- Slow paralysis - Virus
- Kashmir bee virus - Virus

### Parasites – mites

- Acarine - Acarapis woodi
- Varroa - Varroa Jacobsoni/Destructor
- Tropilaelaps

### Insects

- Braula - bee louse
- Senotainia - fly larva

## MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING

3.19 an outline account of the life cycle of *Braula coeca*, its effect on the colony and a description of the differences between adult *Braula* and *Varroa*;

### Life Cycle

- Egg laid in cells containing honey just under the cappings in cells
- After hatching larvae tunnel through the cappings feeding on honey and pollen
- Pupate inside tunnels
- Adult fly emerges 21 days after egg is laid and climbs onto body of a bee
- Feeds from the mouthparts of the bee, does not harm bee

### Effects on colony

- It is an inquiline in bee nests – lives with bees without harm to either self or bees
- Eats food from mouthparts of bees, particularly the queen
- May act as irritant to queen if she is overloaded with *Braula* mites thus rendering her less effective
- Tunnels in cappings containing larvae make cut comb unattractive. Mites are killed by freezing
- Varroacides have reduced numbers

### Differences between *Braula* and *Varroa*

Braula	Varroa
Harmless to colony	Harmful to adult bees in colony
Does not pierce bees	Pierce bees to feed on haemolymph
Does not vector other diseases	Vector for viruses and disease
Feeds on mouthparts of bee	Feeds on larval food and larvae in cells and haemolymph in adults
Coexists in colony	Can overwhelm colony causing collapse
Six legs	Eight legs



*Braula* is a six legged insect or more precisely a wingless fly . It is remarkably similar to the *Varroa* mite (an arachnid with eight legs) at first glance due to its colouration, size and form, but on closer inspection the similarities disappear.

Compare the two images on the left. The *Braula coeca* in the left image looks more spider-like than the flatter crab-like form of the *Varroa* mite on the right.

## **MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING**

3.20 an outline account of the signs of poisoning by natural substances, pesticides, herbicides and other chemicals to which honeybees may be exposed;

Signs of poisoning include:

- Number of dead bees at the hive entrance
- Bees returning to apiary spin round on ground before succumbing
- Affected bees will be repelled by guards
- Colony will become upset and nasty tempered

## **MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING**

### **3.21 an account of the ways in which honeybees can become exposed to agricultural and pest control chemicals;**

The bee can be caught by sprays:

- When the crop on which it is working is sprayed
- When spray is used on a crop not flowering but contains a lot of flowering weeds
- When a bee is flying over a crop which is being spray to reach forage
- When spray is wind borne to hive or bee forage

## **MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING**

3.22 a detailed description of the action to take, and practical measures possible, when prior notification of application of toxic chemicals to crops is given;

If possible move hives at least 3 miles away prior to spraying

Gather as much detail about the spraying as possible:

- What crops and where
- Type of spray
- Time of spraying
- Weather conditions (direction of wind)

Close up hives when spraying is in progress

- Ensure ventilation is maintained
- Provide water supply within hive (contact feeder, wet sponge)

Maintain a clean water supply near the hives after spraying

## **MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING**

3.23 an outline description of a spray liaison scheme operated by a beekeeping association;

The association will have appointed a Spray Liaison Officer

- This person is key contact within and externally for Spray matters
- Contact is advertised on Website and Association Literature along with similar roles such as Swarm Officer
- Officer promotes communication with local farmers and their associations

The Association will publish a process for communicating spray events to all members and key external contacts covering:

- If spraying is notified how information is distributed
- If poisoning suspected notification and distribution of information

Publish the and educate the members on the action to be taken if poisoning suspected

## **MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING**

### **3.24 an account of the action to be taken when spray damage is suspected;**

A sudden reduction in the number of foraging bees, a large number of dead or dying bees outside the hive, may indicate poisoning by bees alighting on sprayed crops. Legislation has reduced the number of incidents.

Apart from the evidence of dead bees, the colony may become bad tempered and shivering, staggering and crawling bees may be seen (similar to CBPV). Returning foragers spin around on the ground until they die. Dead bees usually have their proboscis ('tongue') extended. If you suspect poisoning, contact your association's Spray Liaison Officer. Note time and day and try to locate location and time of spraying and witnesses.

If possible take 3 samples of 200 dead bees – use a paper or cardboard container not plastic – bees carrying pollen loads are useful in identifying the source of the problem. Send one sample to the National Bee Unit, Sand Hutton, Yorkshire, YO4 1BF, including all known details. Keep the remaining two samples in the deep freezer for future use. Do not expect a speedy response.

If the colony is badly depleted reduce the entrance to guard against robbing.

## MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING

3.25 a description of the damage caused to colonies and equipment by mice, woodpeckers and other pests and ways of preventing this;

### Mice

- Enter hives in Autumn seeing somewhere warm and dry to hibernate
- Mice have oval skulls and can squeeze through a cm (3/8 inch) wide slot but cannot pass through the same diameter
- Feed on pollen, honey and bees
- Disturb cluster causing chilling and death of colony
- Damage comb, frames and hive equipment

### Prevention

- Mouse guards applied in September before ivy flow

### Woodpeckers

- Bores holes in side of hive in very cold weather when they cannot find forage on hard ground
- Can cause chilling and death
- Damages hive walls, frames and combs
- Loss of bees through eating, woodpecker has long barbed tongue to extract bee

### Prevention

- Cover the hive with wired netting, leaving space between netting and hive and block gaps preventing entrance by woodpecker
- Cover with plastic bags but ensure ventilation is not affected

### Other mammals and birds

- Shrews, rats, moles, squirrels, hedgehogs, badgers can disturb colonies during winter
- Cattle and horses lean on hives and can overturn them
- Swifts, tits, swallows and shrikes can take bees on the wing (including queens on mating flights). Sparrows and pheasants sit on the hive roofs and take the bees as they emerge

### Common Wasp/Honnets

- Invades nest and can wipe out colony in early August when wasp nests break up and wasps are looking for sugar

### Prevention

- Reduce hive entrance at time of threat
- Wasp traps – jars containing water and jam (not honey) outside the entrance, wasps will be attracted and drown in the jar

## MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING

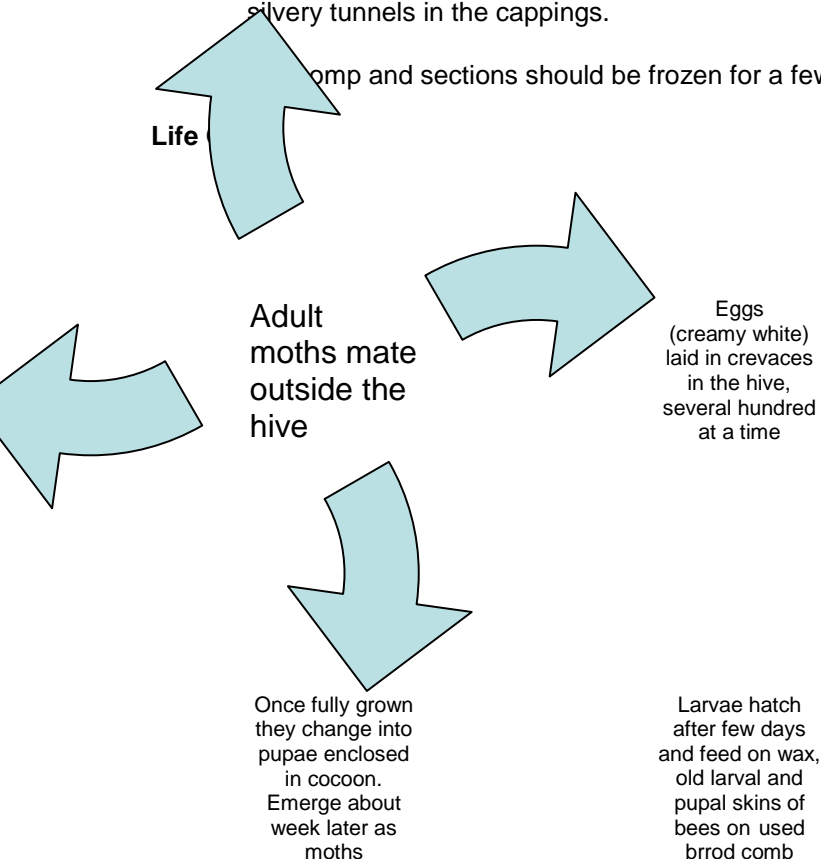
3.26 a detailed account of wax moth damage and the life cycle of both the Lesser and Greater wax moth (*Achroia grisella* and *Galleria mellonella*);

### Damage

- At the larvae stage both moths tunnel through the comb, as they do so they surround themselves with a silken tunnel to which their faeces and bits of wax become attached
- When the Greater Wax moth prepares to pupate it excavates hollows in the woodwork and can even make holes in frames where they spin their cocoons
- The lesser wax moth pupates on the comb causing less damage
- Wax moths prefer used brood comb, source of feed, so usually stored comb most at risk
- Colony weakened by Varroa or other diseases most at risk
- Sometimes larva tunnelling through brood will result in bald brood. The bees remove the capping damaged by the larva exposing the bee pupae beneath
- Comb honey is sometimes affected by young Greater Wax Moth larvae, damage appearing as silvery tunnels in the cappings.

Comb and sections should be frozen for a few days to destroy any larva.

Life



Notes: In good conditions 35 °C and food total cycle 4 weeks for greater moth and slightly shorter for lesser. Larva stage can last longer if cool and lack of food.

## MODULE 3 HONEYBEE DISEASES, PESTS AND POISONING

### 3.27 a detailed account of methods of treating or storing comb with particular reference to preventing wax moth damage;

In all cases, start with a stacking arrangement that is proof against the adult wax moth and mice. This means:

- floor or crown board as a base, raised on bricks off the ground and made moth-tight by use of entrance blocks and covers for holes
- supers/brood boxes and frames stacked on this. Use parcel tape to make the joins
- airtight over winter
  - metal grille or queen excluder and empty super if using sulphur (see below)
  - well-fitting roof.

There are a number of techniques:

- Freezing: if the stack is made outdoors and subject to a hard frost over several days, this will kill all stages of the moth. However, these sorts of frosts are becoming rarer, so placing in a deep-freeze for 48 hours is a good alternative.
- Stack as above after freezing.
- Sulphur: paper strips coated with yellow sulphur can be burnt at the top of the stack. The sulphur dioxide gas given off is heavier than air and sinks through the stack, killing every life form it encounters. Use a small tin can with holes or a smoker on its side with the top open as a burner, resting on the queen excluder.
- Make sure you don't set the whole thing alight! **DO NOT BREATHE IN THE FUMES**
  - light upwind and stand well away. Repeat in three to four weeks.
- Biological control: spray the face of each comb with a solution containing *Bacillus Thuringiensis* (Bt) (e.g. a product like 'Certan'). The bacterium will invade and kill the larvae. Different strains of Bt are prepared for different garden pests; all will have some effect, but use one selected for wax moths. The stack will need ventilation after application until the moisture evaporates, or else mildew will set in.
- Acetic acid: Use fumes from a pad soaked in strong (80%) at the top of the stack. **WEAR PROTECTIVE CLOTHING. THIS IS A DANGEROUS CHEMICAL.**

In all cases, ventilate the combs well before re-use in the hive.

As a final precaution, whenever you put used 'woodwork' back into the bee shed (floors, roofs, boxes, crown board), give them a quick but complete 'burn-over' with a flame torch. Concentrate on the cracks and joins in the woodwork. The eggs and larvae of the wax moth are tiny and can easily get into these gaps, where they will hide and grow.

Larvae also love rolls of corrugated cardboard etc., so do not allow these to accumulate near stored wax.