Brood diseases of bee

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Brood diseases of bees
American foul brood

American foul brood (AFB), also known as American brood disease (ABD) is an infectious disease of honey bees caused by the bacteria, *Bacillus larvae*. This bacteria forms spores which will survive for many years in the environment and the bee larvae become infected by swallowing the spores with their food. The spores then develop and multiply within the larvae.

Very young larvae are highly susceptible to infection; as few as 10 spores can infect a larva less than a day old. As the larva gets older it becomes more resistant and thousands of spores are needed to produce an infection. However, in one infected larva about 2,500 million spores are formed. The organism is introduced into the hive in the form of spores in honey, which may have been robbed from another bee colony that has been weakened by the disease or died out. It can also be introduced on combs or used beekeeping equipment from some previously established source of infection. Some of the spores get mixed with the brood food given to the larvae, and germinate in their bodies.

Some of the infected larvae may be removed by adult bees, but others remain in the cells and in due course the cells are sealed over. Soon after the cells containing the larvae are sealed, the larvae die and the bacteria turn into spores. The attempts by the hive bees to clean out the cells result in the spores being spread throughout the hive. More larvae become infected and eventually the colony may die out. The weakened or dead colony becomes a source of infection as bees from other colonies rob it of its honey that contains the spores. The spores are very resistant, retaining their powers of germination for many years in honey, old combs, or in derelict hives and hollow trees.

Signs

The first signs of AFB are sunken and perforated cappings on the sealed brood (Figure 1). The larva dies after the cell has been capped and the body turns chocolate brown. The capping becomes moist and darkens as the larva shrinks and is drawn down into the cell. The worker bees nibble holes in the sunken capping and eventually remove it. The dead larva is slimy at first. When a matchstick is poked into it and then withdrawn a slimy thread of mucus-like brown material is drawn out. Later, the larval remains become tacky, and gradually dry to a dark brown scale. In the final stage, the remains consist of a dark brown rough scale, lying on the lower side of the cell and extending from just behind the opening of the cell to the base.

The brood in infected combs often appears patchy, owing to the removal of some of the younger infected larvae and the presence of dead larvae in various stages of decay. The scales can be detected if the comb is held with light directed from behind and the observer looks down at an angle from the top of the comb (Figure 2).

The scales stick tightly to the lower sides of the cells and the bees have great difficulty in removing them. They persist in combs from colonies that have died out as a result of the disease. A foul smell comes from the brood while decaying by which time the disease is well established. Detection by smell cannot be relied on to identify the disease, since other organisms can produce a foul odour.

Whenever a colony dies out, or an irregular pattern of brood is observed, the combs should be examined for the signs of the disease, sunken and perforated cappings or scales. If anything resembling them is found, a sample of comb should be submitted immediately for laboratory examination at the Department of Agriculture, Midland or the Animal Health Laboratories, South Perth.

The remaining combs should be left in the hive, and the hive made absolutely bee tight pending the receipt of a report on the condition of the sample.

Beekeepers who use glasses for reading should wear their glasses under their bee veils when examining the brood combs in their hives.

Spread

When bees attempt to clean out the cells containing dead larvae they spread.
the spores throughout the hive. The honey contained in the brood combs and in the supers becomes contaminated with the spores and is a source of infection for any colony whose bees gain access to it. Interchange of infected equipment is of great significance in the spread of the disease from one hive to another and from one apiary to another - see Bulletin 4092 'Preventing the spread of American brood disease' (Agdex 481/653).

If the beekeeper fails to notice the disease, or neglects to take steps to deal with it, the colony becomes so weak that it is unable to defend itself against robber bees from strong nearby colonies. The robbers take all the honey they can find back to their hive, and some of it will be fed to their own larvae. These larvae, fed on food contaminated with spores, will become infected. It is usually the strong colonies, capable of robbing a weaker one, that are the first to bring AFB into an apiary.

Bees will travel up to 1 km to rob a hive which has died out. Sometimes they will go further, particularly when combs or honey are exposed.

Once in the apiary, the disease is spread rapidly by the beekeeper who does not notice its presence and transfers combs from one colony to another. The practice of extracting honey from brood combs and then putting them back into other hives is extremely dangerous and is the surest way of spreading the disease if the combs are infected.

The disease may also spread by the exposure of contaminated honey. When honey from infected hives is extracted, the appliances used in handling the honey become contaminated and bees that gain entry may carry the spores back to their hives. The combs in the supers are also a source of infection if stored where the bees can rob them or if placed into another colony.

A swarm from an infected colony will take contaminated honey with it which may infect the brood in the new hive. Bees drifting from one hive to another may also spread the disease. If pollen is trapped from an infected colony, this too will spread the disease if fed to other hives.

Another source of infection is a diseased colony in a hollow tree. Such a tree will continue to be a danger to beekeepers until it is destroyed by fire.

The disease is spread from one district to another by the transfer of hives from an infected source. The greatest care should be taken when buying bees, particularly if the hives appear to have been neglected. Always inspect every comb most carefully before buying. Purchasers should request that vendors have the honey from their hives tested for the presence of AFB spores before buying an apiary. This test is available through the Department of Agriculture, and the advice of an Apiary Inspector should be sought.

Diagnosis

Once a beekeeper is familiar with AFB, the characteristic signs of the disease are readily identifiable. However, the cause of the brood mortality, which results in decreased honey production, may not be apparent initially, and beekeepers are encouraged to seek advice to confirm the diagnosis of AFB. Where a brood abnormality is suspected, it is strongly recommended that one or more of the following actions be taken.

- Discuss the problem with an Apiary Inspector. The Inspector will either arrange to make a field visit to the apiary, or advise on the appropriate samples to submit for laboratory testing.
- A sample of an affected brood frame can be taken to an Apiary Inspector for examination, and the Inspector’s opinion sought on the cause of the brood abnormality.
- To confirm the presence of AFB, submit a sample of the affected brood frame, or a smear of infected larvae taken from the brood frame, to the Apiary Inspector, who will then arrange for the samples to be submitted to the Animal Health Laboratory.

The procedure for collecting and submitting smears for the diagnosis of AFB is outlined in the final section of this Bulletin.

- Samples of honey can be submitted for honey culture testing at the Animal Health Laboratory, South Perth. This is a screening test for the presence of AFB spores; the test is described in this Bulletin in the section on prevention.

Elimination of AFB infections

Brood disease, including AFB, is a notifiable disease and all beekeepers suspecting or confirming the presence of AFB must notify an Apiary Inspector, or the Senior Apiculturist at the Department of Agriculture.

Departmental staff will assist in the diagnosis of the disease, and will advise apiarists on how to manage any infected apiaries so that the disease is controlled and eliminated as quickly as practical. Apiaries infected with AFB are not normally placed in quarantine by Apiary Inspectors.

However, where beekeepers fail to control the disease, or if an Apiary Inspector considers that the apiaries represent a risk to the rest of the industry, they will be quarantined, and movement restrictions imposed.

For example, whenever a beekeeper neglects an infected apiary, or where infected hives die out, or where
infected apiaries are subject to robbing, the Apiary Inspector may quarantine the apiary and place a work order on the apiary. This course of action would be instituted where the site is not cleaned up adequately by an apiarist, and where other apiaries in the region are put at risk to the infection.

AFB can be controlled by either:
• destruction of the hives by burning;
• wax dipping contaminated equipment;
or by both of these procedures.

Where only a small number of hives are found to be infected, it is often more expedient to burn the infected hives rather than attempt to salvage the equipment by wax dipping.

**Destruction of the hive**

As soon as AFB is found in a hive, reduce the entrance and seal any holes or cracks. If bees are already dead, close the hive completely. In the evening, after all the bees have returned to the hive, completely close the entrance and pour about 500 mL of petrol into the hive. Replace the lid immediately to prevent bees and fumes from escaping. The fumes will kill all the bees within a few minutes.

The quickest, safest and surest way of dealing with AFB is to burn the complete hive and all its contents. However, this may not be practical in some situations, particularly where many hives are affected.

For each hive, dig a hole 1 m in diameter and 50 cm deep and lay a heap of dry leaves or paper in the centre of the hole. Bring up the hive with its contents to the edge of the hole, take out a few of the combs and arrange them around the leaves and paper. Set this pile alight and when it is burning well, add the remaining combs, the dead bees, the mats, boxes, bottom boards and lids, as well as any supers and their combs that are known to have been used on that colony. Add the lids last, so as not to smother the fire.

Any hives in which bees have died out previously in the apiary should also be burnt.

It is important not to drop any honey, wax or dead bees on the ground when transferring the combs from the hive to the burning pit. Burning should be done when the bees are not flying, normally after dark. If the bees are active, they will be attracted by the smell of honey and wax, and may rob the pile of contaminated material.

As soon as everything is reduced to ashes, fill in the hole with soil.

Alternatively, the hives can be burnt in a large incinerator or sawmill furnace. This is usually essential in summer when there is a fire hazard. Beekeepers are advised to consult with local fire control officers before burning diseased hives.

**Wax dipping**

After the colonies have been killed, and all the dead bees, honey, scrapings, and brood frames have been destroyed by burning, the boxes, lids, bottoms, pallets and queen excluders can be prepared for decontamination using wax dipping.

The principle of wax dipping involves decontaminating equipment by placing it in a vat of molten wax at 140 to 150°C for a minimum of five minutes to kill all AFB spores.

Wax dipping services are commercially available in Western Australia. Alternatively, the equipment needed to undertake wax dipping can be bought or hired. For further information on the implementation of a wax dipping protocol for the treatment and prevention of AFB, contact an Apiary Inspector. Miscellaneous Publication 4/92 'Preservation of wood hive equipment' (Agdex 481/721) gives details of the wax dipping protocol on page 15.

**Prevention**

Beekeepers can use several management strategies to lessen the likelihood of AFB infecting an apiary.

• Regularly inspect the brood.
• Check for the presence of other apiaries in the vicinity and promptly report any cases of neglect.
• Seek the advice of an Apiary Inspector whenever there is a brood abnormality, or if the strength of a colony decreases for an unknown reason.

• Apply the barrier management technique to all apiaries. This management technique will limit the spread of any AFB infection that starts in a colony in the apiary. Details of how to set up barrier management within an apiary, are set out in Bulletin 4092 'Preventing the spread of American brood disease'.

• Do not borrow or use other apiarists' equipment. Whenever new equipment is introduced to an apiary, ensure that it has been properly decontaminated before it is used.

Consult with an Apiary Inspector for advice on how to apply these management principles to your own particular method of management.

• Take advantage of the Department's Honey Culture Test service. Submit honey samples from each of your apiaries for testing for the presence of AFB spores. Do this on a regular basis. Where a honey sample is found to contain a large number of spores, AFB infection is probably present in the apiary.

The honey culture test

The honey culture test is a screening test that can also be used to monitor the presence of AFB in an apiary from which the disease is being eradicated, and can be used subsequently to check that an apiary remains free from the disease.

Commercial apiarists should submit honey samples to the Department for honey culture tests twice yearly, while amateur apiarists are advised to forward a sample annually or as the need arises.

For full details of how and when to submit honey samples for the honey culture test, and how to interpret the results of the test, contact the Apiary Inspector at the Midland District Office, by telephoning (09) 274 5334 during office hours.
Healthy brood

*Healthy brood* is characterised by its pearly white and even appearance, which is a result of a young vigorous queen. Discoloration of the larvae and or cappings indicate either a brood disorder or disease.

![Healthy comb. Note uniformity of brood](image)

Pearly white healthy larvae

Capped brood showing two cells partially capped

American brood disease

*American brood disease* is the most serious honey bee disease in Western Australia. Early recognition of the disease and prompt reporting to the Department of Agriculture will result in effective control.

![Frame showing uneven brood pattern](image)

Dark, sunken perforated cappings covering infected larvae

Diseased pupa showing ropiness. Note coffee brown colour

Dried scales of infected pupae (not easily seen in dark comb)
European brood disease

*European brood disease* is a serious disease of honey bees in the south-eastern States of Australia which has not yet been detected in W.A. Beekeepers should watch for signs of the disease, particularly at the first expansion of brood in the spring.

Chalk brood

*Chalk brood* takes its name from the chalky-white appearance of dead brood. Chalk brood must be regarded as a contagious disease and was found in Queensland in 1993 for the first time.

Sac brood

*Sac brood*. Similarities in appearance of Sac brood, European and American brood disease make it necessary for beekeepers to recognise the signs of these diseases.
European brood disease

Cause
European brood disease (EBD) is caused by another bacterial infection of young larvae, differing from AFB in that the larvae die when about four days old, before the cells are sealed.

The organism causing this disease is *Melissococcus pluton*, formerly called *Bacillus pluton*. It is a conspicuous ovoid coccus with pointed ends, readily identified under a microscope. It may be accompanied by other organisms such as *Bacillus alvei*. This was originally believed to cause EBD, but as long ago as 1906 it was recognised to be a saprophyte, living on the dead remains of larvae and not always present.

Since the identification of *Melissococcus pluton* in South Australia in early 1977, European brood disease is now widespread throughout the eastern States.

Beekeepers should become familiar with the symptoms of EBD and keep a close watch on their hives for any signs of the disease.

Signs
The sick larva moves about inside its cell instead of staying in a normal coiled position. When the larva dies, it is found in an unnatural position (Figure 3). The larva dies when it is about four to five days old, before the cell is sealed and before the pupal stage. The sick and recently dead larvae lack the pearly white appearance of a healthy brood. At first they are creamy white, they then collapse, turning yellowish brown and drying into brown, loose scales.

As with AFB, the brood pattern becomes irregular, with sick or dead larvae scattered among healthy larvae and sealed brood. Whereas AFB usually appears first in strong colonies that may have picked up the disease through robbing, EBD is often noticed first in small colonies, and particularly at the beginning of a honey flow.

The above are the basic signs of EBD, but variations do occur, owing to the activities of the other forms of bacteria that may flourish in brood weakened or killed by *Melissococcus pluton*. Figure 3 illustrates typical EBD. However, in the early stages of the infection of the colony, the larva may survive until the pupal stage, or, if the infection is very light, may eventually emerge as a stunted bee. There may be no smell from the infected combs, but the presence of some other organisms may result in a foul or sour odour.

Spread
The disease often spreads within a colony to such an extent that there is a serious decline in the population, followed by the death of the colony.

In other cases, after the first appearance of the disease, the signs may gradually disappear. The disease is likely to reappear later, and may have spread to other colonies in the apiary, either in an active form, or in a dormant form that may become active later.

European brood disease is an insidious disease, and an outbreak in an apiary may be even more disastrous than AFB.

*EBD* readily spreads through infected bees, equipment or apiary products brought into the apiary. To prevent the introduction of the disease into this State, a ban on the importation of queen bees, equipment or apiary products was implemented in November 1977.

Control
The Department's policy on the control of EBD will not be decided until there is an outbreak of the disease. The feasibility of an eradication program would be considered because it may be possible to eradicate EBD if it occurs in an isolated area. This may involve the total destruction of all colonies within the affected area.

Further information on EBD is contained in the Farmnote No. 39/91 'European brood disease of bees' (Agdex 481/653).

Other brood diseases
*Sac brood*

Sac brood disease, which is widespread in Western Australia, is caused by a virus. The disease kills larvae after the cells have been capped in the prepupal stage. Signs first noticed by the beekeeper are perforated cappings revealing the diseased larvae on the lower side of the cells, with darkened heads pointing upwards in a gondola shape.

Infected larvae change colour from pearly white to dull yellow or grey, and finally to black. The head of the larva is the first part to change colour. The larva dies in an upright position, with the head erect, and becomes

![Figure 3. European brood disease. Four to five day old larvae in unnatural positions in the cells and in various stages of collapse and decay.](image-url)
watery and granular with a tough skin that forms the sac. It eventually collapses to the lower side of the cell and forms a rough, brittle scale that does not adhere to the cell wall.

There is no prevention or control for sac brood. Re-queening offers some success, but a colony may recover from sac brood without the beekeeper’s intervention.

The disease is thought to be spread by nurse bees transmitting the virus from cell to cell and by robber bees when they carry contaminated honey from one hive to another. Sac brood occurs in most states of Australia.

**Addled brood**

Addled brood is less common than sac brood and may be mistaken for EBD. Addled brood is believed to be caused by some genetic defect. Death usually occurs in the prepupal or pupal stage. The saprophyte Bacillus alvei may be present in some of the decaying larvae, but if there is not Melissococcus pluton, the condition can be cleaned up by re-queening the colony with a vigorous queen of a new strain.

**Starvation or malnutrition**

Larvae may be weakened by starvation or malnutrition, particularly if the pollen available is lacking in some essential substance needed for the production of nourishing brood food. It may also occur if the colony does not reduce brood production sufficiently when there is a shortage of food, or when it is robbed of all its food reserves at the end of a honeyflow. The larvae may survive and result in small or short-lived bees. Usually some of the larvae and pupae are thrown out of the hive when a food shortage occurs.

**Bald brood**

Bald brood, the exposure of the heads of developing pupae, is the result of the activity of wax moth larvae. The bald brood occurs in patches or in lines, according to the route taken by the grubs. Some of the brood may die but most will develop normally.

**Chilled brood and overheated brood**

Chilled brood and overheated brood occur when there are extreme temperature changes, and the colony is not strong enough to control the temperature throughout the brood nest. Young brood that have been chilled often turn black, and older brood turn grey. If overheated, the brood food dries up in cells of the very young and the larvae become shrivelled. The bees clear up the combs once they have control of the situation.

**Poisoned brood**

Poisoned brood is very unusual. It is likely to be accompanied by the death of adult bees.

**Chalk brood**

Chalk brood is caused by a fungus Ascophaera apis, which kills the larvae and covers them with a white fluffy mould. The larvae become swollen into the hexagonal shape to the cells. Later they dry into hard, shrunken chalk-like lumps, which may change in colour to grey or black.

The disease usually affects capped larvae and is easily recognised in affected cells that have been uncapped by nurse bees. In severe cases, the chalk-like mummies will rattle in the frame if shaken.

There is no successful control or treatment known for this disease.

The disease is spread by queen bees and when pollen contaminated with the fungus is fed to bees. Like many fungal diseases, spread of the disease is rapid. Chalk brood is found in the United States of America, Canada, Europe, New Zealand and was found in Australia in 1993.

**Stone brood**

Stone brood can be caused by more than one fungus. The primary cause is the fungus Aspergillus flowers. The larvae, which may be either sealed or unsealed, first turn white and fluffy; later they turn a pale greenish-yellow as the spores form, and become very hard.

The disease is uncommon in Western Australia. There is no known treatment for stone brood, although signs of the disease clear up with warm weather and relocation of the hive to a drier environment.

**Precautions against the spread of brood diseases**

- Learn the signs of brood diseases. The photographs illustrate them clearly. Every beekeeper must be able to recognise disease as soon as it occurs.
- Keep a sharp watch on the brood for any abnormality.
- Inspect all the combs of brood carefully at least twice a year. The most convenient times to do this are in the spring and again in the autumn.
- If a brood disease occurs, report it at once. Do not wait until you next come into Perth. Write, fax or phone. If you have any doubts, send in a piece of the suspect comb.
- If a colony dies, close up the hive to prevent the remaining stores from being robbed out pending examination of a sample comb to confirm the disease.
- Never leave combs where bees can rob from them. If you have spare boxes of comb, do not leave them standing on end in the apiary. Stack them with covers top and bottom, and seal any holes with plastic masking tape.
- Control wax moth (see Farmnote No. 41/91 ‘Wax moth and its control’, Agdex 481/612).
- Keep the honey supers covered, whether they be full of honey or are just stickies.
- Never buy or lease colonies of bees unless you have thoroughly examined all the combs first, and are quite sure that they are disease free.
- Treat stray swarms with suspicion until the development of a healthy brood nest shows that they are free from disease.
- If you feel that you cannot carry out these simple precautions, do not keep bees. If you keep bees and neglect these precautions, you are a menace to all other beekeepers in the State.
Apiary hygiene

Beekeepers are advised to maintain good apiary hygiene as outlined below.

- Avoid the introduction of bees and equipment from unknown sources.
- Avoid exposing honey combs or equipment to robbing. Spare equipment must be stored and fumigated away from robber bees.
- Disinfect extracting caravans and central extracting plants to reduce the risk of carrying infection.
- Watch for signs of disease.
- Report any brood abnormalities immediately to the Senior Apiculturist - Telephone (09) 368 3569.

Brood diseases are notifiable and beekeepers are legally required to report them.

- Submit slide smears and a sample of comb to the Department of Agriculture, South Perth (see below).

Procedure for submitting samples

- Obtain microscope slides from a Department of Agriculture District Office or the Apiculture Section at South Perth.
- Identify the hive that the samples are taken from.
- Select a piece of affected comb not less than 75 mm square.
- Write your name and hive identification number on a clean microscope slide using a felt pen.
- Select two larvae showing early signs of the suspected disease, place one at each end of the slide.
- Mash the larvae thoroughly, using a clean match for each larva.
- Remove the bulk of the larval remains from each mashed larva, leaving a separate patch of milky liquid (about the size of a five cent piece) at each end of the slide.
- Allow to dry, but protect from the sun at all times.
- Submit for diagnosis five slides each containing two larvae.
- Complete the details as set out in Farmnote No. 31/91 'European brood disease' (Agdex 431 /653).
- Pack the slides to protect from breakage and the comb in such a way as to prevent leakage. Post together with details to:

  Animal Health Laboratory, Department of Agriculture, 3 Baron-Hay Court, South Perth, WA 6151.

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