THE SPREAD AND CONTROL OF AMERICAN FOULBROOD

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American foulbrood (AFB) is a serious disease of honeybee brood. The disease is caused by the spore-forming bacterium *Paenibacillus larvae larvae*. The spores can survive for many years in scales (from diseased dead brood), hive products and equipment, and they are resistant to heat and chemicals. Normally, colonies with clinical symptoms of AFB in capped brood cells will die if treatment is not carried out (Hansen & Brødsgaard, 1997).

Spread

Recently AFB has been reported world-wide where *Apis mellifera* honeybees are kept, except in sub-Saharan Africa (Matheson, 1996). During the past decade there has been an increase in the number of AFB cases in Europe and the disease has given serious problems in many other parts of the world.

Only a few attempts have been made to find sub-clinical spore levels of the disease in sub-Saharan African bee colonies. We have examined honeys from Burundi collected in 1990 and 1991 and from The Gambia in 1999 but did not find contamination with *Paenibacillus larvae larvae* spores. Fries and Raina (2003) made a survey of honey samples from Kenya, Senegal, South Africa, Tanzania, Uganda, Zambia, and Zimbabwe. Neither contamination with foulbrood spores in the honey nor clinical symptoms of AFB in the bee colonies was found. The only report of the disease in South Africa is by Davison et al. (1999) who mentioned that Wolfgang Ritter identified one sample from South African bee colonies as AFB - following this, honeys were examined for *Paenibacillus larvae larvae*. No *Paenibacillus larvae larvae* were found in this survey and it was concluded that AFB was not present in South Africa.

In 2001, we sampled South African honeys and in 2002, we sampled honeys from The Gambia and Guinea Bissau. In two of the South African honeys and in one sample from Guinea Bissau we found contamination with *Paenibacillus larvae larvae* (Hansen et al., 2003).

Several studies by us and other authors report that colonies without clinical symptoms of AFB may contain honey contaminated with its spores. Our field experiments with inoculation of *Paenibacillus larvae larvae* spores have also shown that infected colonies may eliminate the infections and that no simple correlation exists between the number of spores in the honey and the first visible signs of AFB in capped brood cells. Therefore, our study (Hansen et al., 2003) only indicates the presence of *Paenibacillus larvae larvae* spores in sub-Saharan African bee colonies, and not that colonies with clinical symptoms of AFB are present.

The European honeybee is able to survive infection with AFB if the colonies are treated by the shaking method - see page 13 (Brødsgaard & Hansen, 1999). The African subspecies of the honeybee, *Apis mellifera scutellata*, is known to abscond from the hive more frequently when disturbed than other subspecies of *Apis mellifera*. This behavioural trait may act as a 'self-disinfection' by the colonies infected by *Paenibacillus larvae larvae*, resulting in a very low infection pressure in general, and extremely rare development of clinical symptoms.

In many areas of sub-Saharan Africa, wax moth *Galleria mellonella*, is a serious pest which destroys huge amounts of wax combs in store rooms and in hives from absconded colonies. This activity by wax moths will also result in a decrease in the general infection pressure.

Prevention

In general, it is very important to implement a management strategy which aims at preventing AFB. Clinical symptoms of the disease can be prevented by using the following management rules:

- Do not feed colonies contaminated honey or pollen
- Replace combs regularly
- Thoroughly clean used equipment
- Re-queen colonies with queens from tolerant colonies
- Feed colonies when there is no nectar flow
- Place colonies in a suitable environment
- Make an early and accurate disease diagnosis.

Control

The disease should be controlled in areas where honeybee colonies have clinical symptoms. On the basis of the spread and ecology of AFB it may be concluded that an eradication of the pathogen is only a realistic possibility in special cases, for example small,
isolated areas. Normally, the control should ensure that the pathogens are reduced to a level at which they do not provoke further clinical symptoms of the disease. The control can be carried out using antibiotics or management techniques.

**Antibiotics**

In many areas of the world, AFB is controlled by antibiotics. However, residues of oxytetracycline have been found in honey from the brood rest of colonies fed antibiotic extender patties. Furthermore, strains of *Paenibacillus larvae larvae* may develop resistance to sulfathiazole and oxytetracycline after continuous use of the drugs (Morse & Shimanuki, 1990). At the moment, resistance of *Paenibacillus larvae larvae* to antibiotics has been documented in Poland, South America, UK and the USA. Furthermore, there are indications of resistance in Iran and sub-Saharan Africa. These antibiotics are also used in treatment of human bacterial infections, and therefore this method of AFB control is not advisable.

**Management techniques**

A commonly used method is to burn diseased colonies and equipment. However, this method is unacceptable to many beekeepers because the destruction is costly. The shaking method is an effective method to control AFB. The method involves transferring the adult bees to a disease-free hive without drawn combs and destroying the brood combs of the infected colony. The contaminated honey in the honey stomach of the transferred bees is then consumed while the bees build new combs.

The bees from colonies with clinical symptoms of AFB can also be shaken into a screened box and kept there for several hours at outdoor temperature, or a few days in a cool cellar, to ensure the consumption of the contaminated honey. After 3-4 days, the bees are shaken on to frames with new foundation. If the nectar flow is poor the colonies can be fed sugar syrup immediately after they are shaken on to this new foundation. In Denmark we have used another variation of the method where the adult bees are shaken on to frames fitted with strips of wax.

The shaking method should be combined with decontamination of used equipment (Brødsgaard & Hansen, 1999) and comb melting from diseased colonies and store rooms. A certain tolerance of the honeybees against *Paenibacillus larvae larvae* is necessary. Therefore, if the colony has a poor tolerance against AFB it is very important to replace the colony with a queen from a tolerant strain. By using the shaking method in combination with decontamination, comb melting, and the use of queens from tolerant colonies, the pathogen is reduced to a level at which it does not provoke further clinical symptoms of the disease. The method is labour-intensive but saves the bee colonies (Hansen & Brødsgaard, 2002).

In recent years, essential oils (Albo et al, 2003) and biological control (inhibitory bacterium, Max Watkins, Vita Europe, pers. comm.) for AFB control have been tested in laboratory studies with success. These methods can be used provided that they do not leave residues or harm the bees. The efficacy is not yet fully documented in full-size colonies.

**Conclusion**

AFB is reported world-wide except for sub-Saharan Africa. Recently, we found sub-Saharan honeys contaminated with the foulbrood bacterium. However, this finding only indicates the presence of *Paenibacillus larvae larvae* in sub-Saharan African bee colonies. Until now, there is no indication that AFB is established in these bee colonies.

Many years' experience and research have shown that effective control of AFB without the use of veterinary drugs is possible. Therefore, to avoid residues in bee products and resistance of the pathogen, control measurements without veterinary drugs should be implemented in the management plans for all beekeepers. It is our experience that the same plans may be implemented for hobby, semi-commercial, and commercial beekeepers.

For sustainable beekeeping it is very important to educate beekeepers in control strategies for AFB and bee diseases in general, which prevent drug or pesticide residues. Honeybee tolerance should be included in the strategies. Therefore, breeding programmes should include a test for hygienic behaviour on promising bee strains.

**REFERENCES**


