

HONEY BEE
DISEASES AND
PESTS

Honeybee bacterial
diseases

- Bacterial diseases of the honeybee mainly affect the brood, and are referred to collectively as **foulbrood** diseases:
 - **American foulbrood and**
 - **European foulbrood disease**
 - are well known and may be harmful to both brood and colonies.
- The name “**foulbrood**” comes from the foul smell emitted by an affected brood.

American fowlbrood
disease (AFB)

- AFB is an infectious and contagious disease of the capped brood of the honeybee *A. mellifera* and other *Apis spp.*
- It is caused by a Gram-positive spore-forming bacterium, *Paenibacillus larvae*.
- AFB is a cosmopolitan disease occurring throughout the world where honeybees of the genus *Apis* are reared.

- AFB is a major threat to apiculture, since it is contagious and may be lethal for infected colonies.
- Therefore, AFB has the potential to cause beekeepers significant economical loss.
- Early detection is crucial because routine apiary management and practices, e.g. handling small hive tools, interchange of hive material, or even migratory beekeeping, can easily spread *P. larvae* to healthy honeybee colonies.
- AFB is a notifiable disease to sanitary authorities in many countries including Turkey.
- AFB is a notifiable disease to the OIE.

- The spores are the only infectious and contagious form of *P. larvae*.
- The spores may be found in wax, honey, pollen, on the hairs and cuticle of honeybees, but also on the wood of the frames and the hive.
- They are very stable and resistant to chemical agents and to desiccation, heat, cold, freezing, droughts, and humidity.
- *Paenibacillus larvae* produces an antibacterial substance preventing the development of other bacterial pathogens.
- However, American and European foulbrood diseases have been described as occurring simultaneously in some colonies.

Clinical signs at the colony level

- A colony affected by AFB is weakened through a decrease in honeybee population as well as impairment of population renewal of the infected brood.
- In severe cases, colonies may die following *P. larvae* infection.
- At the beginning of the disease outbreak, the colony appears normal.
- When the disease develops, the colony becomes more or less depopulated according to the infection level, *A. mellifera* strain, and the bacillus strain involved.

Clinical signs at the colony level

- When the infection level is higher, the colony may become irritable and aggressive.
- When approaching and/or opening the hive, a slight to pronounced foul odour can be smelled if several larvae are affected.
- When present, this odour is one clinical sign of AFB.
- When only few cells are affected, this odour is not present.
- In some cases, in particular in managed colonies without regular inspections, when the brood is severely infected, the colony may die.

Clinical signs at the brood level

- The brood frame appears mottled and the mappings of affected cells become concave and punctured.
- Inside the affected cells, immature forms are dead and present the following main clinical signs:
 - Larval color turns progressively from creamy to dark brown.
 - The larval remains become glutinous in consistency.

Clinical signs at the brood level

- On account of this viscosity, the larva can be drawn out as threads when a probe is inserted into the larval remains and removed from the cell (matchstick test).
- Performing this test to evaluate the viscosity of the dead larvae represents the threads drawn out are usually >2 cm.

Clinical signs at the brood level

- As the infection progresses, inside cells with concave and punctured mappings, the dead brood specimens appear greasy and darkened.
- The remains of diseased larvae typically form dry, hard, and dark brittle scales sticking to the lower side of the cell.
- When death occurs at the pupal stage, a characteristic pupal tongue protrudes from the pupal head, although this clinical sign is rarely observed.

Pathogenesis

- AFB can affect the larvae of the three castes of honeybee (workers, drones, and queens).
- The spores are infectious only for larvae, and adult bees do not develop clinical signs after ingestion of *P. larvae* spores in the brood-food or honey.
- Contamination usually occurs when the larvae are 12-48 hours old. Indeed, at this age in the early larval stages, they are especially sensitive to *P. larvae* infection.

Pathogenesis

- The vegetative forms of *P. larvae* massively colonise the midgut.
- The infection thus into a septic stage and extends to all tissues, causing the death of the infected larvae.
- The larvae die when the cell is capped.
- The dead larvae become viscous and the developing infection results in gas release within the capped cell.

Contributing factors

- Several contributing factors may influence outbreaks of AFB.
 - Virulence of *Paenibacillus larvae* strains
 - Robbing and drifting behaviors of bees
 - Insufficient hygienic behavior by the bees
 - Inappropriate beekeeping practices
 - feeding colonies with unknown honey and beebread
 - artificial swarm forming
 - trading colonies
 - seasonal migrations (migratory beekeeping)
 - lack of routine inspection of the colonies
 - exchanges of material between hives and apiaries

Diagnosis

- Diagnosis must be performed as early as possible in order to limit or avoid the spread of the disease within the hive, between colonies within the apiary, and to neighboring apiaries.
- The diagnosis of AFB is based the presence of clinical signs and on identification of the pathogenic agent.

The following are the principal clinical signs of AFB

- The colony may appear weakened, due to depopulation. Unusual aggressive behavior of the bees can be observed.
- A mottled appearance of the brood combs.
- The presence of concave and punctured cell cappings.
- A foul smell from the brood combs may be detected.
- The presence of uncapped cells with larval remains.
- The larval remains are glutinous and can be drawn out like threads (usually >2cm) with a probe (matchstick test). This is one of the main features of the clinical examination for AFB.
- The presence of protruding tongues in pupae remains one of the most characteristic but also one of the rarer clinical signs of AFB.

Differential diagnosis

- Differential diagnosis must take into account all the diseases of the brood, in particular European foulbrood disease (which in its most severe form affects capped brood) and sacbrood disease (which at a late stage may occasionally present black viscous larvae which can be drawn out like threads (<1 cm)).
- Differential diagnosis must also take into account a number of other possible problems:
 - Chalkbrood disease
 - Balbrood due to the small wax moth.
 - Problems due to the laying activity of the queen or the presence of laying workers with multiple eggs oviposited aspect of the brood.
 - Varroosis causing a mottled aspect of the brood.

Laboratory diagnosis

- Identification of *P. larvae* is necessary to confirm the diagnosis in particular in the countries where AFB is a notifiable disease and sanitary measures must be taken by authorities.
- Sampling has to be done carefully, and shipping must be done according to regulations and to laboratory advice.
- Laboratory analyses
 - Microscopic examination can reveal the presence of spores but also of the vegetative form in infected larvae.
 - Culture is possible on several media.
 - ELISA
 - PCR

Prognosis

- The prognosis for a colony infected by AFB must be considered from guarded to poor:
 - The prognosis may be guarded if few larvae are affected and if control measures are quickly implemented after an early diagnosis.
 - The prognosis is poor if a colony is highly infected.

AFB control

- AFB is a notifiable disease in many countries, and is on the list of the diseases notifiable to the OIE.
- Thus, sanitary measures must be implemented in many countries according to the relevant legislation;
 - destruction of colonies,
 - shaking bees (or shock swarm),
 - regulation of local transportation,
 - exchange and trade, etc.
- When one or more colonies within an apiary is affected by AFB,
 - the beekeeper and all professionals operating there have an obligation to take sanitary measures with their equipment:
 - hive tools, gloves, smokers, etc., have to be soaked in or scrubbed with a strong solution of washing soda between each hive inspection and of course between apiaries.

Prophylaxis

- Prophylactic measures are the best way to control AFB, as well as other infectious diseases, within an apiary.
- These measures concern beekeepers, bees, and apiaries, as well as management of beekeeping equipment.
 - Beekeeper training
 - Prophylaxis by honey and adult bee sampling and testing
 - Honeybees exhibiting hygienic behaviour
 - Apiary management
 - Material management