Bee diseases are a worldwide problem

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During recent years, bees have increasingly become a focus of attention. They have always been recognised not only as honey producers but also as essential pollinators of plant crops and wild plants. However, bees are becoming more and more affected by disease. Changed environmental conditions, the increasing use of pesticides and, above all, more profit-oriented hive management systems have all contributed to this situation. In addition, the worldwide trade of bees and bee products has confronted bees with the constant challenge of new diseases and parasites.

Protection against diseases in the bee colony

Honey bees are socially organised insects. Their colony consists of 10,000 to 50,000 infertile worker bees, a number of males (drones) and one egg-laying female, the queen. However, a bee colony is far more than the sum of its individual bees. Like cells in higher organisms, bees are able to cooperate via neuronal stimuli and hormones.

The individual bee has an immune system. However, their social defence system, is of major importance. Old and ill bees die on forage flights or are prevented from entering the hive again on their return. Furthermore, bee hygiene consists of removing ill brood from the nest. This hygiene behaviour is genetically fixed and more or less pronounced within the various breeding lines and bee species.

The pathogenicity of bee pathogens and parasites is illustrated by a shortened lifespan, and modified morphology, physiology or behaviour of the individual bee. In terms of the colony, the consequences are a reduction of the colony's strength until it reaches a stage of disorder, implying the risk of a colony collapse.

Diseases are spread within the bee colony and between bee colonies. A horizontal transfer of diseases means the transfer of pathogens or parasites within the colony from bee to bee, and from colony to colony. A vertical transfer means that the pathogen is transferred from the brood to the adult bee or from the queen, the drones or the worker bees to the brood. Between apiaries, diseases are spread by swarms or by the beekeeper's interventions.
**Bee diseases have different causes**

Like other animals, honey bees can be infected or infested by a variety of pathogens or parasites. In addition to fungi and bacteria, viruses have recently become more important, because they can be transferred by such parasites. Most of the parasites found in bee colonies are mites and other insects.

In the following paragraphs, I would like specifically to address those bee diseases described in the OIE Manual of Diagnostic Tests and Vaccines for Terrestrial Animals, which are important for beekeeping.

**Foulbrood has spread worldwide**

American foulbrood (AFB) and European foulbrood (EFB) have been spread nearly all over the world. However, EFB does not represent a serious problem for bee colonies everywhere. Colonies are often able to heal themselves. In contrast, AFB is controlled by destroying the infected colonies or by forming artificial swarms. In many countries antibiotics are used for control. However, this only masks the infectious disease with the effect that, after the end of the treatment, a relapse occurs. Moreover, there is the risk of antibiotic residues in the honey.

**Nosemosis pathogens**

Nosemosis is a diarrheal disease of the bee caused by a microsporidium; specifically, a fungus. The pathogen destroys the bee’s mid-gut epithelium when it multiplies in the bee’s cells. As long as the infested bees are able to defecate outside the hive or die there, the bee colony is in a position to heal itself. With increasing infestation, the bees defecate more and more, within the nest as well as outside. When other bees pick up the faeces to remove them, mass infestation takes place. Finally, the bee colony dies.

Originally, the only parasite of Apis mellifera was Nosema apis, and Apis cerana was exclusively infested by Nosema ceranae. In 1973, N. ceranae was found for the first time in A. mellifera in the People’s Republic of China. Since 2003, this new parasite has rapidly spread all over the world. Today, it has replaced the original parasite, N. apis, nearly everywhere. The transfer of this parasite is nearly impossible to avoid. This is why restrictions on moving and transporting bees are not efficient methods of control.

**Varroa mites transfer viruses**

The situation of varroosis is very similar. Originally, the mite Varroa destructor exclusively infested A. cerana. The introduction of A. mellifera into Asia initiated its shift to the new host. In the meantime, this mite has spread throughout virtually the whole world. Only Australia and parts of Oceania still seem to be free from the Varroa mite.

The Varroa mite multiplies only in the brood of honey bees, damaging the developing bees as it sucks their haemolymph.
The bee colony becomes weaker and weaker, growing more susceptible to other diseases. Without treatment, most of the colonies die within a short time.

Because of the structure of their epidermis, honey bees are well protected against many kinds of viruses. The Varroa mite overcomes this natural defence mechanism when sucking, but also infects the brood with viruses via the adult bee, especially with ‘deformed wing virus’ but also with ‘acute bee paralysis virus’, both of which accelerate the collapse of the colony.

**Tropilaelaps mites not yet everywhere**

Different types of the *Tropilaelaps* mite infest the giant honey bees *A. dorsata* and *A. laboriosa*. Some switched to *A. mellifera* when it was newly introduced into their original habitat in Asia. Only a few types damage European bee species; among them, *T. clarae* and *T. mercedesae*.

Though *Tropilaelaps* mites and Varroa mites differ considerably in their outward appearances, their parasitic life cycles are quite similar. Both mites preferentially infest the bee brood and multiply within it. When the brood is infested by both kinds of mite, the *Tropilaelaps* mite dominates, because its offspring develop faster. However, *Tropilaelaps* mites cannot live on adult bees, but can only use them as carriers for spreading.

Generally, the *Tropilaelaps* mite has similar attributes to the Varroa mite to ensure rapid spread. We still do not know why *Tropilaelaps* mites have not yet left or have only partly left their original area of distribution on their new host, *A. mellifera*. The difficult method of transfer via adult bees, as well as the mites’ susceptibility to brood-free phases in a bee colony, could be the reason.

**The small hive beetle only damages weak colonies**

Another pest is not so easy to classify in the general scheme of diseases. The ‘small hive beetle’ is often classed as a pest but it can undoubtedly also be regarded as a predator.

Originally, this beetle was exclusively found in Africa, south of the Sahara, and African bees have developed defence mechanisms against it. Since the year 2000, global trade has carried the small hive beetle to new continents. There, it has spread naturally, both via bees, as bee colonies migrate or are transported during bee-keeping, and independently, through its own flight.

It is difficult to diagnose small hive beetle in the bee colony. As the hive is opened, the beetle immediately escapes into the dark. Special traps have been developed, in which the beetle hides, making it easier to recognise even the beginnings of an infestation. In most cases, however, the beetle is only detected when its larvae appear in large numbers and cause fermentation in the food, making the honey leak out of the cells. However, this only happens in very weak colonies or in honeycomb storage. As a result, this beetle causes only limited damage in colonies but is a real problem in honey storage.

The small hive beetle finds much the same conditions in bee colonies all over the world. Only its pupation period in the soil outside the nest depends on climate. That is why, in North America, this beetle only represents a serious problem in states with a tropical climate, such as Florida and California. The same is more or less true for the coastal regions of Australia. Only in these areas with tropical climates is it necessary to actively try to control the beetle.
Local bee species and subspecies and hive management systems must be strengthened

An important contribution towards keeping honey bees in good health is to protect native species. In Asia, the native \textit{A. cerana} is less susceptible to most parasites and diseases than the European bee, \textit{A. mellifera}. As their natural host, it has no problems with \textit{Varroa destructor} and \textit{Tropilaelaps} mites.

It is thus very important that countries such as Laos are encouraged to support their native bees and peasant beekeeping. The same is true for the native bee, \textit{A. mellifera}, in Central Africa and local bee-keeping practices. Although American foulbrood and varroosis were imported into Central Africa a long time ago, they have not been able to do lasting damage to the local bee colonies. Problems only appear with the introduction of the bee management methods practised in Europe and America, or with the importation of European bee species. We should have learned our lessons from the mistakes made in the past.

The spreading of bee diseases must be prevented

Bee health problems have increased principally because of the constant importation of new diseases. The introduction of diseases via bees can only be controlled through strict import controls based on the OIE standards. Since quarantine, even for a short time, is impracticable, special attention must be paid to disease control in the country of origin (see, in particular, Chapter 1.1.4. of the \textit{Terrestrial Animal Health Code} on the official health control of bee diseases). If the control system in the country of origin is not reliable, the import should be rejected.

Despite this, there is still a risk of importing diseases over land, through the drifting of bees and swarms, and by sea, as a result of wild swarms, e.g. those often found in shipping containers. The biggest problem worldwide, however, is caused by the fact that, in veterinary medicine, the honey bee is not universally regarded as livestock and so less attention is paid to bee disease controls at the frontier. Both illegal and uncontrolled imports can be the sources of disease. This is not only a local or regional problem, it’s a worldwide one.

Conclusion

To sum up, bee disease control must include not only management methods but environmental conditions as well. If we are to maintain healthy bees in the future, we must act to stop the global spread of bee diseases now.