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Editorial

A current perspective on honey bee health

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For the past two decades, as major colony losses were repeatedly reported worldwide, honey bee health has been an issue of growing concern for beekeepers, scientists, and the general public.

In 2010, a first special issue on bee health was published in Apidologie (Spivak and Le Conte 2010), providing reports on the status of honey bee colonies in different parts of the world (Moritz *et al*. 2010; Vandame and Palacio 2010; Pettis and Delaplane 2010). It also included a survey of bee health in Germany (Genersch *et al*. 2010) and highlighted the role of different stressors including environmental impacts, pathogens, and parasites (Brodschneider and Crailsheim 2010; Decourtye *et al*. 2010; Simone-Finstrom and Spivak 2010; Johnson *et al*. 2010; Le Conte *et al*. 2010; Chen and Huang 2010; Higes *et al*. 2010). Finally, two articles were presented on natural selection and breeding efforts against *Varroa destructor*, the major pest of the honey bee *Apis mellifera* worldwide (Büchler *et al*. 2010; Rinderer *et al*. 2010).

Since 2010, a continuously growing number of scientists and research units have invested considerable resources in bee health research, and their results continue to contribute to a significantly increasing state of knowledge. In this new special issue, it was our aim to provide a broad and integrative view of the current state of knowledge by presenting scientific review articles highlighting different aspects of honey be health research.

We continue the format of the 2010 special issue on bee health, by including in this special issue inventories of honey bee health in different parts of the world, focusing on areas that have attracted less scientific attention in the past. Pirk *et al*. review the state of bee health in Africa, from where no large scale colony losses have been reported so far. The authors discuss the presence of pathogens, parasites, pests, and predators of African honey bees, the threats they face in relation to habitat changes, and the current efforts aimed at protecting the health of African honey bees.

In their article "Pests, pathogens, and parasites of honey bees in Asia", Chantawannakul *et al*. describe interspecific transmission of pests and parasites between the different honey bee species of Asia and their spread to other parts of the world. Importantly, the focus of this review is not restricted solely to the non-native, but commercially important *A. mellifera*, but also discusses pests, pathogens, and parasites in the honey bee species native to Asia. Thus, for the first time, an overall picture of honey bee health and bee decline in the region is provided.

To complete the picture, a review on honey bee health in South America by M. Maggi *et al*. will be published in a forthcoming issue.

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Two articles on the topic of epidemiological surveillance provide an overview of honey bee disease incidence in the USA and risk indicators affecting honey bee colony survival in Europe.

In the USA, Traynor *et al*. describe a large multi-year survey where they quantified endemic health threats. They found that *Varroa* mite loads varied across years, while *Nosema* spp. infection rates peaked annually from January to April. Migratory beekeepers had significantly lower mite prevalence and loads than stationary operations, while *Nosema* spp. was more prevalent in migratory colonies. Since 2010, chronic bee paralysis virus prevalence doubled annually. Strong positive relationships were observed between *V. destructor* and Varroa-transmitted viruses, between *Nosema* spp. and Lake Sinai virus 2, and between several viral pathogens of bees. The authors also note the absence of *Tropilaelaps* spp. and slow bee paralysis virus in the USA.

Chauzat *et al*. describe the first active pan-European surveillance program on honey bee colony mortality (EPILOBEE). The program was set up across 17 European Member States and used harmonized epidemiological methods to estimate honey bee colony mortality over winter and during the beekeeping season. In nine Member States, winter losses were higher than the 10 % level that is empirically perceived as acceptable, whereas in four countries, winter losses were lower. Among the risk factors for winter losses, the authors identified the size of the operation and clinical signs of varroosis, AFB, and nosemosis in autumn. As risk factors for seasonal losses, any clinically detected diseases appeared relevant, together with the size of the operation and the beekeeper's non-participation to common veterinary treatments.

Three manuscripts are related to the mechanisms involved in bee health.

The review by Negri *et al*. focuses on cellular immunity and hemocytes in *Apis mellifera*. The article combines results obtained on cellular defences of *A. mellifera* to show the importance of the cellular components of the immune system in the development of new strategies to enhance bees' fitness.

In their article, Erler and Moritz review the mechanisms of self-medication and disease prevention in the honey bee colony, with particular emphasis on the impact of self-produced gland secretions and foraged hive products on colony health. Specific health-enhancing activities of bee products should be distinguished from the effects of an intact nutrition ensuring the basic immune competence of bees. They conclude that foraged plant-derived compounds vary in antibiotic activity, depending on the floral and regional origin, and secondary plant metabolites in honey, pollen, and propolis are important for the antibiotic activity against pathogens and parasites.

Poquet *et al*. review the modulation of pesticide response in honey bees. While it is widely accepted that honey bees are frequently exposed to pesticides, the role they play in impacting bee health remains controversial. Honey bees are exposed to fluctuating environmental conditions and can go through important physiological changes within a few days. Those factors can strongly affect the bee response to pesticides. Integrating the range of variability in conditions experienced by bees is relevant to honey bee toxicology and will contribute to a better assessment of their susceptibility to pesticides. The development of risk assessment procedures is a difficult task, due to the variability of responses observed for a single pesticide at a specific dose. The aim of this review is therefore to provide empirical evidence of how co-exposure to stressors, environmental and endogenous factors modulates the honey bee response to pesticides.

An extensive review, a "Quo Vadis," is given by Neumann *et al*. on biology and control of the Small Hive Beetle *Aethina tumida*. The Small Hive Beetle (SHB) is a generalist parasite native to sub-Saharan Africa and has recently become an invasive species with introductions recorded since 1996 from America, Australia, Europe, and Asia. While SHB are considered a minor pest in Africa, they can cause significant damage to honey bee colonies in their new range. The authors provide a comprehensive overview on the biology, distribution, pest status, diagnosis, control, and prevention of this parasite to foster adequate mitigation and to stimulate future research.

Finally, two articles provide a real glimmer of hope for apiarists and bee scientists as well:

Varroa-surviving honey bees and selection efforts for Varroa-sensitive hygienic behavior.

In her review, Locke discusses naturally occurring Varroa mite-surviving *A. mellifera* populations that have been reported around the world. The author synthesizes the current state of knowledge on naturally occurring survival of Varroa mite infestation together with the explanations for long-term survival and discusses the significance of these populations for apiculture.

In their research article, Danka *et al*. demonstrate the importance of selecting bees using the character of Varroa-sensitive hygiene (VSH). By outcrossing VSH queens to U.S. commercial stocks and subsequently selecting colonies with low mite infestations from 2008 to 2014, they demonstrated that introgressing the VSH trait into commercial honey bee stocks can create bees that have useful mite resistance but retain desirable beekeeping characteristics.

This second special issue on honey bee health involves prominent scientists in the field and synthesizes part of the tremendous scientific information published since 2010. We are proud of our collaboration with the authors to compile this issue and gratefully thank all authors for their contributions. We hope the articles in this special issue will prove useful for the scientific and beekeeping community and will contribute to improving honey bee colony health worldwide.

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