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Honey bees, diseases in loss of social immunity by changing climate

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ABSTRACT

Insect social life is generally associated with increased exposure to pathogens and the risk of diseases transmission, due to factor such as high population density, frequent physical contact and reduced genetic variability. Honey bees are attacked by numerous parasite and pathogens towards which they present a variety of individual and group level defense behaviors that reduce colony level parasite and disease loads are termed social immunity. Large-scale losses of honey bee colonies represent a poorly understood problem of global importance. Both biotic and abiotic factors are involved in this phenomenon that is often associated with high loads of parasites and pathogens. A stronger impact of pathogens in honey bees exposed to neonicotinoid insecticides has been reported, but the causal link between insecticide exposure and the possible immune alteration of honey bees remains elusive. Here, we demonstrate that the neonicotinoid insecticide clothianidin negatively modulates NF-κB immune signaling in insects. Viruses and other pathogens can spread rapidly in social insect colonies from close contacts among nestmates, food sharing and periods of confinement. There is a relationship between the effectiveness of social and individual immunity and the nutritional state of the colony. Parasitic Varroa mites undermine the relationship because they reduce nutrient levels, suppress individual immune function and transmit viruses. The maintenance of the immune system can be costly, and a lack of dietary protein can increase the susceptibility of organisms to disease. All species of honey bees has shown great adaptive potential, as it is found almost everywhere in the world and in highly diverse climates. the precise impact of potential environmental changes on honey bees as a result of climate change, there is a large body of data at our disposal indicating that environmental changes have a direct influence on honey bee development.

Keywords- Honey bees, social immunity, diseases, climate, Parasites

INTRODUCTION

Honey bees and other social insects comprise more than half of the insect biomass in the world making them one of the most ecologically successful insect groups. Contributing to this success is the coordination of activities among members of a colony. Essential tasks such as thermoregulation, brood rearing and resource gathering are efficiently executed due to the architecture and organization of the nest and spatial proximity among individuals. However, crowded conditions, warm tem- peratures, high concentrations of resources and periods of confinement in the nest are ideal for pathogen invasion and transmission that can lead to epidemics. The risk of disease outbreaks is mitigated by specialized group behaviors (social immunity) and immune systems in individuals. Honey bees are important pollinators in undisturbed ecosystems but are essential for the production of numerous high-value crops. Over the past decades, the health of honey bees has been in steady decline especially with arrival of parasitic Varroa mites. There has been considerable effort to identify parasites and pathogens that threaten the health and survival of honey bee colonies. Viruses have received much attention due to the significant loss of colonies especially over winter from Varroa mite and virus associations Greater attention also has been given to nutritional needs of colonies and how improvements in this area might reduce colony losses. This review will focus on the role of nutrition in immune response to viral pathogens. We briefly describe the connections between nutrition and individual immunity and speculate on the possible changing nutritional requirements of colonies throughout the year.

These changes might revolve around trade-offs between colony growth and immune defense. Within this framework, we include the effects of parasitism by Varroa because when the mite is present, optimal nutrition alone might not be sufficient to keep virus levels low. Honey bee viruses More than 20 viruses have been identified to infect honey bees worldwide. The most common are: Deformed wing virus (DWV), Black queen cell virus (BQCV), and Israeli acute paralysis virus (IAPV). Viruses infect all developmental stages and castes. Though always present in colonies, viruses often persist as covert asymptomatic infections. However, if colonies are under stress, virus levels can increase causing reduced worker longevity and brood survival and colony loss in winter or early spring Viruses such BQCV also can cause colony death.

Bee diseases and parasites*:* Numerous predators, parasites (mites) and pathogens (protozoa, bacteria and viruses) prey upon the honey bee.

Mites: The honey bee tracheal mite, *Acarapis woodi*, is a parasite of *Apis mellifera* and *Apis cerana*. It lodges itself in the trachea of worker bees, where it breeds, and eventually suffocaotes them. Although it was a pest in the20th Century, the tracheal mite is now no longer a major problem for world apiculture. *Tropilaelaps* spp. is a parasitic mite of *Apis dorsata* honey bees in tropical Asia. The introduction of *Apis mellifera* into the distribution range of *Apis dorsata* has provided the *Tropilaelaps* mite with a new host. A recent study based on molecular markers has identified at least four *Tropilaelaps* species in Asia, although *T. clareae* is the only one that is parasitic to *Apis mellifera*. *Tropilaelaps* are brood parasites, feeding on the haemo lymph of the bee brood and breeding there. A proliferation of these parasites can kill honey bee colonies and encourage the emergence of other pathogens. The mite is so reliant on brood that it dies after more than seven days without it.

Protozoa: *Nosema apis* is a microsporidian that attacks the midgut wall of adult honey bees. The disease can develop with no visible symptoms or manifest itself as a weakening of the colony, possibly ending in death. Colony infestation is latent. The disease tends to emerge mainly in early spring following long, wet winters: during winter, honey bees are prevented from going outside and drop their excrement inside the hive, forming a source of contagion for other bees. After this, the disease spreads rapidly.

Bacteria: The bacteria pathogenic to honey bees attack the brood a disease that has been known since ancient times, is caused by *Bacillus larvae*. This serious highly contagious disease occurs across the globe. A supply of pollen from outside the nest is usually all colonies need to overcome the disease, although heavy losses have been reported in the past.

Viruses: Eighteen different viruses have been identified in honey bees of the *Apis* genus. Some of these viruses are highly anecdotal, while others are latent and can be extremely prolific among the bees in our hives without causing any noticeable signs. For reasons as yet unknown, these viruses can become highly pathogenic

Viruses commonly detected in honey bee colonies.

Virus	Transmission	Lifestage infected	Symptoms
Acute bee paralysis virus (ABPV)	Horizontal primarily through feeding, Varroa parasitism	Brood and adults	Paralysis, trembling, inability to fly, darkening and loss of hair on thorax and abdomen
Black queen cell virus (BQCV)	Horizontal primarily through feeding, Varroa parasitism, possible vertical transmission through eggs	Brood and adults	Dead queen larvae or prepupae sealed in queen cells with dark brown to black walls
Chronic bee paralysis virus	Horizontal primarily through feeding and contact, possible transovarial	Adults	Trembling inability to fly, bloated abdomens, black hairless bees
Deformed wing virus	Horizontal primarily through feeding, venereal, transovarial, transspermal, Varroa parasitism	Brood and adults	Deformed wings in emergent bees, premature aging of adults
Israeli acute paralysis virus (IAPV)	Horizontal primarily through feeding, transovarial, venereal, transpermal, Varroa parasitism	Brood and adults	Similar to ABPV. Also, reduced mitochondrial function, and possible disturbance in energy-related host processes.
Kashmir bee virus (KBV)	Horizontal primarily through feeding, transovarial, Varroa parasitism	Brood and adults	Weakening of colonies but no clear field symptoms

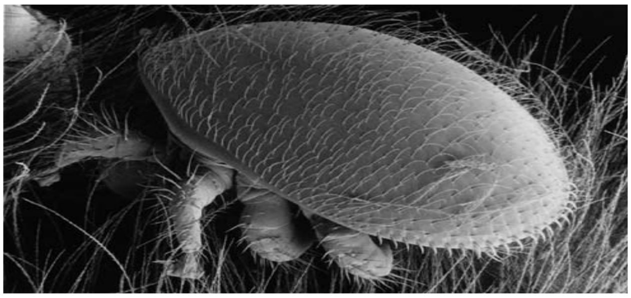

Fig- ***Varroa destructor* mite**

to honey bees causing trembling and paralysis that are observable at the colony entrance. This is the case with chronic paralysis virus (CPV) and acute paralysis virus (APV). It is not yet known how these viruses act to kill bees. No treatment exists to control such viruses, which can weaken or kill the colony.

Honey bee immune system:

The risk of disease outbreaks is reduced in colonies of honey bees and other social insects by group-level behaviors ('social immunity') and individual immunity. Together these provide multiple levels of disease prevention and responses to challenges from pathogens and parasites.

Social immunity: The collective defense against parasites and pathogens that emerges from the behavioral cooperation among individuals in colonies is 'social immunity'. With social immunity, many individuals do small tasks that collectively have a colony-wide impact on reducing the spread of parasites and pathogens. For example, workers remove adults that die in the colony and brood that are diseased or parasitized (hygienic behavior). Adults that die outside the nest also contribute to social immunity if they have high pathogen loads. Thermoregulatory behaviors also are a type of social immunity particularly when worker bees generate a behavioral 'social fever' against heat-sensitive pathogens such as chalkbrood fungus

Impact of climate change on honey bees:

Climate change can impact on honey bees at different levels. It can have a direct influence on honey bee behavior and physiology. It can alter the quality of the floral environment and increase or reduce colony harvesting capacity and development. It can define new honey bee distribution ranges and give rise to new competitive relationships among species and races, as well as among their parasites and pathogens.

Beekeepers will also be obliged to change their apiculture methods. They will favour moving their hives to new foraging areas and importing foreign races to test their value in the new environments. Bees adjust their behavior to weather conditions. They do not go out when it rains and, in extremely hot weather, they gather water to keep the colony cool. In contrast, the Asian species have remained in Asia, which might indicate lesser adaptability to different environments and fragility in the face of climate change. *Apis mellifera* seems to have more adaptive potential than its Asian cousins, which have low yields and have been subject to little transhumance. Humans, with whom *Apis mellifera* has co-evolved for several centuries, will certainly be decisive in helping honey bees to survive in hostile environments and in preserving the biodiversity of these species. Beekeeping is an essential pollination and production support tool in this respect. Other pathogens or haplotypes have more limited distribution ranges, such as *Tropilaelaps*, which to date has been found only in Asia. Climate change will lead to movements of honey bees of different species and races, bringing them into contact with pathogens with which they have never co-evolved, as has occurred with *Varroa destructor* and *Apis mellifera.* However, researchers agree that the bees' environment and stress, both of which are influenced by climate change, have been decisive factors in this heavy mortality. There appear to be strong interactions between diseases, pesticides, environment and climate. Climate change has an action on each of these factors. To understand the effect of climate change on the evolution of honey bee populations, each of these factors will need to be taken into account.

CONCLUSION

Phenomenon include pesticide use, new diseases, stress and a combination of these factors. As a result, climate change will shift the balance between the honey bee, its plant environment and its diseases. The honey bee has shown a great capacity to colonies widely diverse environments and its genetic variability should enable it to adapt to such climate change. However, the fear is that climate-induced stress will in future compound the various factors already endangering the species in certain regions of the world.

If humans modify the honey bee's environment, they also have a duty to take conservation measures to prevent the loss of this rich genetic diversity of bees. The composition of nutrients obtained from food influences microbial communities in the gut. The communities could affect immune function by providing essential nutrients, inducing host immune responses or reducing the growth of pathogens. While there is evidence for these benefits in other organisms, the role of microbial communities as extensions of social and individual immune systems has only begun to be explored in honey bees. Though improved nutrition can optimize colony growth and immune responses to virus, Varroa parasitism might undermine any benefits that nutrition might offer.

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