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Letters

Endosymbionts and honey bee colony losses?

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Honey bees, *Apis mellifera*, are essential pollinators for the maintenance of natural biodiversity and agriculture [1]. Colony losses witnessed throughout the Northern hemisphere are therefore worrying [2], especially because no single driver has yet emerged as the definitive cause [3]. Interactions between viruses, ectoparasitic mites and microsporidian endoparasites are most likely key factors [3–5], but the underlying mechanisms are not well understood. Although it is known that maternally-inherited, facultative bacterial endosymbionts such as *Wolbachia* or *Rickettsia* can significantly interfere with viral and fungal infections of arthropods [6], they have so far been neglected in this regard. Here we propose to evaluate the potential role of such endosymbionts for colony losses.

Endosymbionts are widespread [7] in arthropods and transmitted vertically [8], but can only spread in host populations when infected females have a higher fitness, e.g. via providing protection against viruses or fungi [6]. For example, *Wolbachia* can protect the host against several vectored RNA viruses [9] and can be regarded as part of host immunity [6]. However, endosymbionts such as *Spiroplasma* and *Hamiltonella* can also be beneficial for their host's vectorial capacity, e.g. in the whitefly *Bemisia tabaci*–Tomato yellow leaf curl virus system, *Hamiltonella* protects viral particles in the vector [6,10].

To shed light on the potential influence of endosymbionts on losses, we here suggest an investigation of symbiont-mediated host protection against viruses transmitted by parasitic mites and/or associated with microsporidians (e.g. *Nosema ceranae*) [5], which could contribute to the tolerance of honey bee populations, e.g. against the mite *Varroa destructor* [11]. Moreover, endosymbionts carried by parasitic mites might favour virus transmission to and virulence in honeybees, which could explain regional differences in the impact of mites [11]. A combination of metagenomics and laboratory experiments appears suitable to compare the bacterial and viral communities associated with honey bees and their parasites in host populations with or without elevated losses [2]. In conclusion, it seems as if endosymbionts play a role in honey bee pathology [12] and should therefore be investigated as a potential key to our understanding of major colony losses.

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