

Reproduction of *Varroa destructor* in Africanized Honey Bees under the Tropical

Conditions of Costa Rica

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Abstract

Varroa destructor is a worldwide ectoparasite of serious economic importance for beekeeping. Severe colony mortality is routine in parasitized European honey bees (EHB) colonies in Europe, Asia and North America. This study was carried out in Heredia, Costa Rica. The reproductive ability of varroa mites was determined approximately 240 h after cell sealing in worker brood from four Africanized honey bee (AHB) colonies and four hybrid (HF1) colonies. Several variables were measured for foundress female mites: fertility, production of a mature female mite, production of only immature offspring, production of only female or only male offspring and no reproduction at all. No significant differences were found between AHB and HF1 in the percentage of fertile foundress mites ($\chi^2 = 3.66$, $P = 0.06$), the percentage of foundress mites that produced mature female offspring ($\chi^2 = 0.53$, $P = 0.47$), and the percentage of

foundress mites that produced only immature stages ($\chi^2 = 0.09$, $P = 0.75$). However, the percentage of foundress mites that did not reproduce at all tended to be greater in AHB (30.2%) than in HF1 colonies (23.5%) ($\chi^2 = 3.66$, $P = 0.06$). In both groups of bees, the number of fertile varroa mites was higher than what other studies have reported for AHB in Brazil. Nevertheless, a factor that limited varroa reproduction in AHB and HF1 colonies was the non-reproducing mites that we found in more than 23.0% of the worker brood cells.

Keywords: *Varroa destructor*, reproductive ability, Africanized honey bees, hybrids

Introduction

Varroa destructor (Mesostigmata:Varroidae) [1] is a dangerous ectoparasite of worldwide economic importance for beekeeping and a serious threat to honey bees (*Apis mellifera*). Most honey bee colonies do not survive infestation by the mite when left untreated [2].

Because varroa populations increase when brood is present, it would be expected that in tropical climates, where brood rearing occurs year-round, the effect of varroa would be even more devastating. However, that has not been the case in tropical regions of South America, specifically in Brazil, where varroa is not considered a problem [6]. Nevertheless, regional differences in season length, weather conditions and bee and mite genotypes make it difficult to characterize the mite reproduction on Africanized honey bee (AHB) over a widespread area.

In Costa Rica, most of the beekeepers re-queen the colonies every two years in order to obtain less defensive bees (hybrid colonies = AHB x European honey bee) and to improve honey production. The rest of the beekeepers do not change queens at all, they

work with highly defensive AHB. The mite was first detected in Costa Rica on September 1997 from brood and adult bee samples collected in Los Santos area, Central Valley of Costa Rica [10]. Beekeepers have reported loss of colonies and reduced production of honey as a consequence of *V. destructor* introduction. Furthermore, the occurrence of deformed wing virus and Kashmir bee virus associated with a high infestation of *V. destructor* (averaging up to 10.0% of mite infestation) in AHB colonies [4], indicate that varroa is a serious pest that has been added to beekeeping in this country. There are few reports concerning the reproductive ability of *V. destructor* in AHB colonies in tropical conditions [3]. The study of varroa reproduction contributes to our understanding of mite population growth on AHB. Therefore, the aim of the present study was to investigate the reproduction of *V. destructor* in worker brood of AHB colonies in Costa Rica.

Materials and Methods

The study was conducted at the Universidad Nacional located in Heredia, Central Valley of Costa Rica, from February to July 2004. The reproductive ability of varroa mites was determined approximately 240 h after cell sealing in worker brood from four AHB colonies and four hybrid (HF1) colonies (AHB x European honey bee). Previous to the study, the experimental colonies were treated with formic acid (65% vol./vol.) in a gel formulation for a treatment period of 15 days to minimize numbers of phoretic mites (avoid over-infestation of the worker cells). After the formic acid treatment, the mite infestation level of the colonies was determined in adult bees (mite infestation was less than 5.0%).

Several variables were measured for foundress female mites: fertility (production of

offspring), production of a mature female mite (viable female offspring), production of only immature offspring, production of only female or only male offspring and no reproduction at all. Data were obtained from 318 cells in AHB colonies and 307 cells in HF1 colonies.

Combs containing brood close to being capped were chosen. Open worker brood cells likely to be capped within few hours were marked on a sheet of transparent plastic, temporarily laid over each comb. The brood combs were put back into the colony. After four hours, one mite collected from capped worker brood was introduced into a recently capped cell by carefully making and then resealing a small hole in the side of the cell cap, through which the mite was transferred using a paint brush. Each infested cell was numbered. The frames containing the infested cells were re-introduced into the experimental colony. This infestation method is widely used, even though the manipulation of the brood cells may elicit higher removal rates compared to naturally invaded brood cells. The removal response to infested cells may be due to the artificial introduction of the mites. By artificial introduction the cell is damaged and the mites may have an alien odor. In this study most of the artificial infested cells became accepted; however, removal of capped infested brood did occur (brood completely removed).

After 10 days, the cells were opened to examine the contents. At this time, mature female offspring could be distinguished from their mothers by their light pigmentation. The numbers of mature female and male offspring, deutonymphs, protonymphs and eggs-larvae were recorded. To study reproduction of individual mites only data from cells invaded by one mite were analyzed, because otherwise offspring of different mother mites cannot be distinguished.

Results

As shown in Table 1, no significant differences were found between AHB and HF1 in the percentages of fertile foundress mites, foundress mites that produced mature female offspring and the mother mites that produced only immature stages. However, the percentage of foundress mites that did not reproduce at all tended to be greater in AHB than in HF1 colonies (Table 1).

In cells with both female and male offspring, the male or one female was found dead in 26.9% of AHB cells and 28.2% of HF1 cells.

TABLE 1. Percentages of varroa foundress mites reproduction in worker brood of Africanized (AHB) and hybrid (HF1) honey bees in Costa Rica.

Characteristic	AHB (%)	HF1 (%)	Statistical test
Non-reproductive	30.2	23.5	$\chi^2 = 3.66$, df = 1, $P = 0.06$
Fertile	69.8	76.5	$\chi^2 = 3.66$, df = 1, $P = 0.06$
Mature female offspring	28.0	25.4	$\chi^2 = 0.53$, df = 1, $P = 0.47$
Immature offspring only	17.3	18.2	$\chi^2 = 0.09$, df = 1, $P = 0.75$
Males only	16.4	25.1	$\chi^2 = 6.80$, df = 1, $P = 0.01$
Females only	8.2	7.8	$\chi^2 = 0.03$, df = 1, $P = 0.86$

Discussion

Mite fertility of varroa infesting AHB and hybrid bees was similar when brood cells were inspected 10 days (240 h) after capping. Both types of bees had greater percentages of fertile varroa than have been reported for AHB in Brazil [5]. Despite this fertility of varroa foundresses, the percentage of mites that produced mature female offspring was less

than 30% for both types of bees. Medina and Martin (1999) found in Mexico that the percentage of foundress mites that produced mature female offspring was about 40% in AHB versus 75% in EHB worker cells. In addition, they reported a considerable rate of mortality suffered by the first (males, 42%) and second (females, 30%) mite offspring in AHB worker cells. We also found significant mortality of mites in both types of bees.

Wide variation in the rate of non-reproduction of varroa has been reported. Rosenkranz (1999) found that in Brazil 43% of mites were non-reproductive in AHB compared with only 19% in EHB. The percentage of non-reproducing mites in our study was greater than the percentage reported for mites in EHB and lower than the percentage reported for mites in AHB of Brazil. The physiological reasons underlying a lack of reproduction by *V. destructor* in worker brood cells are not well known. In this study, most of the foundress mites that did not reproduce looked alive and healthy (locomotion and appendage movement: legs, chelicerae). Approximately 17% of foundress mites produced only immature offspring in both AHB and HF1 colonies. This factor affects the production of mature female mites because immature stages remain in the cell when a bee emerges, and are removed by nurse bees [7].

In conclusion, in both groups of bees, the number of fertile varroa mites was higher than what other studies have reported for AHB in Brazil. Nevertheless, factors that limited varroa reproduction in AHB and HF1 colonies in Costa Rica were the non-reproducing mites, foundresses that produced only immature stages, foundresses that produced one adult sex, and mortality of emerging mites we found in a considerable percentage of worker cells. The combined effects of these factors results in less than 30% of the foundress mites producing viable female offspring in both AHB and HF1 colonies.

Perspectives

The low mite reproductive ability found in worker brood cells of AHB and HF1 colonies, seems insufficient to explain the colony losses and reduced production of honey due to *V. destructor* reported by beekeepers in Costa Rica. However, infestation rates of 10.0% found in adult bees during a 170-day research study (unpublished data), indicates that infestation with varroa mites could increase through the year (although apparently not as high as in temperate climates). Because of mite infestation increase, most of the beekeepers in Costa Rica have been applying the acaricides Apistan® (Fluvalinate) and Bayvarol® (Flumethrin) yearly for the treatment of infested colonies. We hypothesized that, due to the preference of mites to infest drone brood to reproduce, a high proportion of the mite reproduction should occur in drone cells of AHB colonies.

Further studies are needed concerning the reproductive capacity of *V. destructor* in drone brood of AHB colonies, in order to get knowledge with respect to the mite population dynamic under the tropical conditions of Costa Rica.

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