Varroa destructor mite mortality rate according to the amount of worker broods in africanized honey bee (*Apis mellifera* L.) colonies

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ABSTRACT. The *Varroa destructor* mite has caused the death of hundreds of thousands of *Apis mellifera* colonies in several countries worldwide. However, the effects determined by the *Varroa* mite change according to the *A. mellifera s*ubspecies. In Africanized bee colonies from South and Central America, the parasite causes little damage, as the infestation levels are relatively stable and low, thus treatments against the pest are not required. Among several factors, the *grooming* behavior of Africanized worker bees plays an important role in the maintenance of the low infestation levels. This study determined the daily rate of live and dead mites found at the bottom of the hive in five Africanized honey bee colonies. During fifteen days of observations, a significant increase was verified in the number of live and dead mites at the bottom of the hive as the amount of worker broods from each honey bee colony decreased. This suggests a more intense *grooming* activity as the *Varroa* concentration in the adult honey bee population increases.

Key words: *Varroa* mortality, worker broods, *grooming* behavior, infestation level.

RESUMO. Taxa de mortalidade do ácaro *Varroa destructor* de acordo com a quantidade de crias em colônias de abelhas africanizadas (*Apis mellifera* L.). O ácaro *Varroa destructor* tem causado a mortalidade de centenas de milhares de colônias de abelhas *Apis mellifera* em várias partes do mundo. Os efeitos determinados pelo ácaro *Varroa* variam com a subespécie de *Apis mellifera*. Nas Américas do Sul e Central, o parasita causa poucos danos às colônias de abelhas africanizadas, a taxa de infestação é estável e baixa, não sendo necessário o tratamento químico contra a praga. Entre vários fatores que são responsáveis pela tolerância das abelhas africanizadas a esse parasita, o comportamento de *grooming* executado pelas operárias deve exercer importante papel na manutenção dos baixos níveis de infestação. Neste estudo, foram avaliadas as taxas diárias de ácaros vivos e mortos encontrados no fundo das colméias de cinco colônias de abelhas africanizadas. Durante 15 dias de observações, foi verificado significativo aumento de ácaros no fundo da colméia à medida que diminui a quantidade de crias de operárias das colônias de abelhas. Isso sugere que a atividade de *grooming* é incrementada à medida que aumenta a concentração de ácaros na população de abelhas adultas.

Palavras-chave: mortalidade de *Varroas*, crias de operárias, comportamento de *grooming*, nível de infestação.

Introduction

Varroa destructor (Anderson and Trueman, 2000) is an ectoparasite mite that causes serious damages to beekeeping worldwide. The effects determined by *Varroa destructor* infestation are uneven in the different parts of the world. In Europe, high mortality rates of honey bee colonies are common, while in the South and Central America the *varroosis* does not seem to be a serious *pest*. It is clear that the type of bee affects the development of this parasite. African bees and their hybrids are more tolerant to the mite than European honey bees (Moretto *et al.*, 1991a; Medina and Martin, 1999).

The reproductive potential of the *Varroa destructor* females was considered an important factor for different infestation levels of the *varroosis* pest among *Apis mellifera* subspecies. The *Varroa* fertility levels depend on the host *Apis mellifera* subspecies. In Brazil, where Africanized honey bee colonies have survived with *Varroa* without pesticide treatments, the reproductive success of female mites into worker brood cells is lower than in European honeybee colonies (Medina and Martin, 1999). However, according to Garrido *et al*. (2003), after *V. destructor* haplotype replacement (J haplotype by K haplotype), an increase on the reproductive ability of *Varroa* females in Africanized bee colonies was verified.

Other factors, such as hygienic and *grooming* behaviors, also influence the populational dynamics of the *V. destructor* mite (Mondragón *et al*., 2005; Ibrahim *et al*., 2007). Moretto (2002) verified that Africanized worker bees artificially infested with adult female mites were more able of getting rid of the parasites than hybrids when Italian and Africanized honeybees were compared. In broodless bee colonies, the daily mite mortality rate was three times higher in Africanized bee colonies than in Carnica honeybee colonies (Moretto, 2002). The present study evaluates the effect of the *grooming* behavior during a worker brood reduction period in Africanized honeybee colonies.

Material and methods

This study was conducted during the spring season of 2005, in the experimental apiary of the Department of Natural Sciences, Regional University of Blumenau, municipality of Blumenau, State of Santa Catarina, Brazil, at 26º 54'21" S, 49º 04'99" W and 17 m of altitude. The experiments were conducted on five nuclei containing four standard Langstroth-size brood combs covered with Africanized A*pis mellifera* honey bees.

In order to evaluate the number of live and dead *V. destructor* mites fallen on the bottom of the hive according to the amount of the worker broods of each honey colony, the queen was confined in a introduction cage until all worker bees had emerged. From the fourth day after queen confinement and until all worker broods had emerged, live and dead mites found at the bottom of the hive were counted daily. To prevent the contact of bees with mites at the bottom of the hive, a size-8 mesh was placed between the bottom and the nest.

As soon as the worker broods emerged, each bee colony was treated with Bayvarol acaricide in order to kill the entire mite population. Because each colony had only adult bees, only one stripe of the acaricide was placed between the combs. Mites (live and dead) found at the bottom of the hive were recorded from the first day after treatment until the third consecutive day, when mites were no longer detected (this occurred approximately 10 days after treatment with Bayvarol). The total mite population in each bee colony was estimated from *Varroa* found at the bottom of the hive from the day the queen was caged until the emergence of all worker bees plus varroas killed by the chemical action.

The mortality rate and live mites found at the bottom of the hive were obtained by dividing the number of dead and live varroa, respectively, daily collected from the bottom of the hive by the total number of varroa present in each honeybee colony.

In order to determine the differences in the rate of live and dead mites found in between and final periods in relation to the presence of the worker broods, the Student *t*-test was used.

Results

The mean mite population was of 874 (from 423 to 1199) *Varroas* among bee colonies tested. Table 1 shows the daily average percentages of live and dead mites found at the bottom of the hive obtained for each colony analyzed. The daily average percentages were 1.54 ± 0.60 and 2.67 ± 0.63 of live and dead mites, respectively.

Table 1. Daily mean percentage of live and dead *Varroa destructor* mites collected from the bottom of five Africanized bee colonies.

Colony	Live Mites	Dead Mites
1	1.12 ± 0.74	3.33 ± 1.69
2	1.05 ± 0.33	2.31 ± 1.21
3	2.53 ± 1.43	2.55 ± 1.03
4	1.70 ± 1.17	3.30 ± 1.28
5	1.32 ± 0.95	1.88 ± 0.75
Mean	1.54	2.67
Standart Deviation	0.61	0.63

Figure 1 shows the increase in the daily average percentages of dead and live mites collected from the bottom of the hive. From the tenth day on, an increase in the number of mites at the bottom of the hive was observed. Until the ninth day, the daily percentage of dead mites was of 2.31 ± 0.27, while in the last six days this rate increased to 3.37 ± 0.23 mites ($p < 0.001$). Among live mites found at the bottom of the hive, a significant difference between both periods was also verified ($p < 0.05$), and daily percentages of 1.49 ± 0.29 and 1.93 ± 0.43 for the first and second periods, respectively.

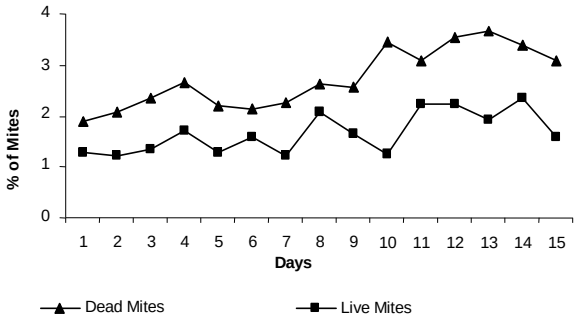

Figure 1. Daily mean percentage of live and dead mites collected in five Africanized bee colonies.

Discussion

Since the *V. destructor* mite was introduced in Brazil and in other countries in South and Central

America, the reproductive success reached by its females on worker brood cells was considered an important factor to the tolerance of Africanized bees. Several studies performed until the beginning of 2000 have shown that *Varroa* females that invaded worker brood cells produced fewer descendents in Africanized bee colonies when compared to European bee subspecies (Camazine, 1986; Rosenkranz and Engels, 1994; Medina and Martin, 1999; Calderón *et al*., 2003; Martin and Medina, 2004).

However, at the beginning of this decade, the analysis of the mitochondrial genome revealed a new type (K haplotype) of *V. destructor* in Brazilian Africanized bee colonies, and also a significant increase on the fertility rate of *Varroa* females in worker brood cells was verified (Garrido *et al.*, 2003). Recently, Moretto and colleagues (unpublished data) verified that in the climatic conditions of the Itajaí Valley, State of Santa Catarina, Brazil, the *Varroa* females currently present reproductive ability similar to that found for European bees from the United Kingdom, where the K haplotype is present (Martin and Medina 2004).

The daily mean percentage of *Varroas* (live and dead) found at the bottom of hives in this study was estimated at approximately 4%. Part of these fallen mites possibly fell due to natural death or an accidental drop, while others were possibly at the bottom of hives due to the *grooming* behavior of the worker bees.

The *grooming* behavior has been more intense among Africanized bees than among European bees when adult worker bees were artificially infested with *V. destructor* female mites (Moretto *et al*., 1991b). The mortality rate of *Varroa* recorded daily in broodless Africanized bee colonies was three times as high when compared to Carnica bee colonies (Moretto, 2002). The average number of live and dead mites recorded daily in the present study was of 4%, half the average percentage found for Africanized bee colonies in the study conducted by Moretto (2002). This discrepancy may be due to the fact that this study recorded mites at the bottom of the hive in bee colonies with worker broods, while the data presented by Moretto (2002), was obtained at the total absence of worker broods.

The highest presence of mites at the bottom of the hive, especially dead ones, occurred at the last six days of analysis (Figure 1), when the presence of worker broods was about near the end. The small amount or total absence of broods in Africanized bee colonies increases the concentration of mites in adult bees, favoring the attack of worker bees, which may explain the increase in the number of mites found at the bottom of the beehive at the final phase of the experiments.

Although during the winter in Brazil there are no prolonged periods with the absence of brood in bee colonies, as observed in regions with temperate climate, the great reduction in the brood area is possibly caused by reduction in the food flow during long dry periods and/or excessive rainfalls. Periods with small brood area in bee colonies and the majority of mites concentrated in adult bees must favor the parasite mortality due to the *grooming* behavior. The increase on the reproductive success of *V. destructor* female mites in Africanized bee colonies (Garrido *et al*., 2003) and the low infestation levels (about 2%) in southern Brazil (Carneiro *et al.,* 2007) suggest that the *grooming* behavior must play important role in the tolerance to the *Varroa* parasite verified in Africanized bees in Brazil.

Conclusion

This study showed that the occurrence of mites (live or dead) at the bottom of the bee colony increases as the concentration of worker broods decreases. In the absence of broods in the Africanized honey bee colonies, all populations of *Varroas* are concentrated upon adult bees, possibly influencing the *grooming* activity and consequently increasing the mite mortality.

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Received 14 May 2006.
Accepted 10 March, 2007.