

Analysis of the F1 generation, descendants of Africanized bee colonies with differing defense abilities against the mite *Varroa jacobsoni*

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ABSTRACT

A test was made to determine whether the ability manifested by individual *Apis mellifera* worker bees to rid themselves of the mite *Varroa jacobsoni* is transmitted to subsequent generations. Eight Africanized bee colonies were selected, four of them were determined to have low ability and four had high ability to rid themselves of the mites. Sister x brother crosses were performed by instrumental insemination to generate the F1 generation. In the parental generation the mean percentage of artificially infested workers who rid themselves of the mite was 17.5% in the group of colonies with low ability and 57.5% in the group of colonies with high ability. In the F1 generation, 18% of the bees from low ability colonies rid themselves of the mite as opposed to 59.5% of the bees from high ability colonies. We conclude therefore that this behavior is inheritable.

INTRODUCTION

The population dynamics of the mite *Varroa jacobsoni*, an ectoparasite of the honey bees *Apis cerana* and *Apis mellifera*, has been found to differ among the various regions where the pest has established itself (De Jong *et al.*, 1984; Ruttner *et al.*, 1984).

In some regions, *Varroa* acts as a serious pest causing enormous damage to apiculture, whereas in others, such as Brazil, this mite occurs at low levels of infestation without causing apparent damage to bee colonies. Many acaricides have been utilized in the fight

against *Varroa*, but none of them has proved to be effective in eradicating this pest (Gonçalves, 1987).

Among the racial types of *Apis mellifera*, Africanized bees present greater resistance to this mite when compared to European races (Camazine, 1986; Moretto *et al.*, 1991). The shorter postcapping period of worker brood cells found in African bee races compared to European races may be an important factor of resistance to the pest (Moritz and Hanel, 1984). Thus, if bee colonies with a shorter postcapping period of worker brood cells could be obtained to reduce the rate of *Varroa* reproduction, the level of parasite infestation could be reduced (Moritz, 1985; Buschler and Drescher, 1989; Le Conte and Cornuet, 1989). However in Africanized bees in Brazil, this is not an important factor (Rosenkranz and Engels, 1994).

The resistance to *Varroa jacobsoni* observed in Africanized bees under the climatic conditions of Brazil has been attributed, in part, to the defensive ability of

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workers when infested with females of this parasite (Moretto *et al.*, 1993). This behavior was found to be variable in the workers, and thus represented a trait that could be selected. The objective of the present study was to determine whether the defensive behavior against *Varroa jacobsoni* manifested by Africanized bees is heritable.

MATERIAL AND METHODS

The ability of worker bees to resist *Varroa jacobsoni* was determined by the method of Peng *et al.* (1987), except that the walls of the hive were removed for the observations. We selected eight of 20 Africanized bee colonies analyzed for the ability of workers to remove *Varroa* mites (Moretto *et al.*, 1993). Four of them were those with the greatest resistance (HIGH ABILITY) and the other four were those with the lowest resistance (LOW ABILITY). Two daughter queens and drones were obtained from each queen of the selected hives and these daughter queens were introduced into mating nuclei containing combs with brood, honey and pollen.

Sister x brother crosses were performed by instrumental insemination. Each queen was inseminated with 5 μ l of semen collected from several brother drones. Genetic pairing terminology would designate these as mother (through the drone) x daughter matings.

Three months after the beginning of oviposition, when the entire population of adult bees consisted of descendants of the inseminated queen, two observation hives were prepared for each nucleus. Each observation hive, prepared three days before the beginning of the analysis of worker behavior, consisted of a comb covered with adult bees, and contained recently sealed worker brood, honey and pollen, and a young africanized queen. Twenty-four hours before the test, 70 to 80 workers (any age) in each observation hive were marked with numbered colored plastic labels of the "Opalithplättchen" type. The label was fixed to the thorax under carbon dioxide anesthesia.

Adult varroa females collected from worker and drone brood cells and from adult bees were immediately used for artificial worker infestation. For this procedure, the walls of the observation hive were removed and a fine brush was used to pick up a varroa and to transfer it to the body of a marked bee. Each artificially infested bee was then observed for up to 30 minutes, if the mite remained on the bee's body for this length of time. During the observation period, we recorded the number

of mites that were removed or that left the bee's body due to the movements of the parasitized bee and to the action of other workers which identified the presence of the varroa on this bee. For each colony, 50 workers were observed, 10 per day over a period of five to 10 days (Moretto *et al.*, 1993). The observer was aware of the history of each colony tested.

Data concerning worker defensive ability against *Varroa* were analyzed statistically by the Student t-test for the following comparisons: high versus low-ability parental groups, parental generation versus F1 for both groups, and high versus low-ability origin F1 groups.

RESULTS AND DISCUSSION

For the parental generation of the four colonies with low defense ability against *Varroa*, we obtained a mean percentage of about 18% of infested workers which rid themselves of the parasite, whereas for the four colonies with high ability, the mean percentage was about 58% (Table I). The difference between the two groups was statistically significant ($t = 12.67$; $P < 0.001$).

Among the low-ability colonies, there was no statistical difference between the parental generation and F1 ($t = 0.21$; $P > 0.50$). In the F1 generation of high-ability bees we obtained a mean percentage of 60% of workers which rid themselves of the parasite. Again, no statistical difference was detected between the parental generation and F1 in this group of bees ($t = 0.67$; $P > 0.50$).

When the mean percentage of workers which rid themselves of the parasite was compared between the F1 generations of groups with high and low ability, we continued to obtain statistical differences between the two groups ($t = 13.97$; $P < 0.001$). Although we did not obtain an increment in the ability of workers to rid themselves of *Varroa* between the parental and F1 generations in either group of bees, there was a strong relationship between the performance of the parental generation and F1. In other words, F1 colonies manifested essentially the same performance as the parental generation, implying the existence of some genetic mechanism for the control of this trait. Our observations corroborate preliminary evidence reported by Kulinčević and Rinderer (1987). After performing crosses between bees resistant and susceptible to varroasis, they did not obtain progress between the parental generation and F1, but noted that the descendants of resistant colonies were more resistant to the pest than the descendants of susceptible bees.

Table I - Percentage of artificially infested workers who rid themselves of the mite *Varroa jacobsoni* in colonies of Africanized bees of the parental and F1 generations of colony groups with high and low ability to rid themselves of the parasite.

Low ability				High ability			
Parental generation		F1 generation		Parental generation		F1 generation	
Colony	% workers free of the mite	Colony	% workers free of the mite	Colony	% workers free of the mite	Colony	% workers free of the mite
44	22	1	16	139	64	1	70
		2	18			2	64
80	13	1	14	128	52	1	50
		2	14			2	60
07	19	1	22	134	56	1	48
		2	24			2	58
110	16	1	16	120	58	1	60
		2	20			2	66
Mean	17.5		18		57.5		59.5

ACKNOWLEDGMENTS

Publication supported by FAPESP.

RESUMO

O presente trabalho teve como objetivo, verificar se a capacidade de se livrarem do ácaro *Varroa jacobsoni*, manifestada por operárias de abelhas *Apis mellifera*, é transmitida para as gerações seguintes de abelhas. Para isso, oito colônias de abelhas africanizadas foram selecionadas, sendo quatro consideradas de baixa capacidade e quatro de alta capacidade para a característica em estudo. Para gerar a geração F1, utilizamos a inseminação instrumental, e realizamos cruzamentos do tipo irmã x irmão. Nas colônias de abelhas que constituíam a geração parental, obtivemos em média 17,5% e 57,5% das operárias infestadas artificialmente que se livraram da *varroa*, no grupo das colônias de baixa e alta capacidade, respectivamente. Na geração F1, 18% das operárias infestadas se livraram do parasita nas colônias de baixa capacidade, enquanto que no grupo de alta capacidade 59,5% das operárias infestadas artificialmente manifestaram a característica.

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(Received November 10, 1994)