

## HERITABILITY OF AFRICANIZED AND EUROPEAN HONEY BEE DEFENSIVE BEHAVIOR AGAINST THE MITE

### *Varroa jacobsoni*

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#### ABSTRACT

This study was undertaken to determine whether Italian and Africanized *Apis mellifera* workers can rid themselves of the mite *Varroa jacobsoni* after artificial infestation with adult females of this parasite.

Ten colonies of Italian honey bees and twenty colonies of Africanized honey bees were used. Workers of both racial types artificially infested with varroa reacted to the presence of the parasite. Africanized bees proved to be more efficient than Italian bees in ridding themselves of the parasite, with 38.20% of them being able to do so, as opposed to only 5.40% of the Italian workers.

The heritability of this trait, calculated for the 20 colonies of Africanized bees, was  $h^2 = 0.71 \pm 0.41$ .

#### INTRODUCTION

The effect of *Varroa jacobsoni* on *Apis mellifera* varies according to the region where this pest has taken hold. In Europe and in other parts of the world with a predominantly temperate climate, a high degree of varroa infestation is reached within only a few years after the initial infestation (Ritter and De Jong, 1984). In contrast, in regions with a tropical climate such as Brazil, Uruguay and Paraguay, varroa has been present for more than 15 years and has stabilized at low levels of infestation, apparently causing no serious damage to apiculture (De Jong *et al.*, 1984; Ruttner and Marx, 1984;

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Engels *et al.*, 1986; Gonçalves, 1987; Mendoza *et al.*, 1987; Moretto *et al.*, 1991). Bee race is also known to influence the population dynamics of this parasite, with European races being less resistant to the pest than African races (Camazine, 1986; Rosenkranz, 1986; Moritz and Mautz, 1990; Moretto *et al.*, 1991; Shimanuki *et al.*, 1991).

Ron and Rosenthal (1989) noted that, under the climatic conditions of Israel in the Middle East, the rate of varroa infestation in European races of *Apis mellifera* and their hybrids is a genetically transmitted trait. Thus, bee colonies with greater resistance to varroa infestation can be obtained by selection programs.

Peng *et al.* (1987) noted that 99.6% of workers of *Apis cerana* bees, when artificially parasitized with adult varroa females, identify and remove the parasite from their body.

The objectives of the present study were: 1) to determine whether there is a difference between Africanized Italian worker bees in the ability to get rid of *Varroa jacobsoni* when artificially parasitized, and 2) to determine whether this is controlled genetically.

## MATERIALS AND METHODS

This study was carried out in Ribeirão Preto, State of São Paulo, Brazil, (21°11'25", latitude South). The climate is considered to be humid tropical with a mean yearly temperature of 21°C (Andrade, 1964).

We analyzed the reaction to varroa of workers from 10 colonies of Italian bees and 20 colonies of Africanized bees. The methodology employed was that of Peng *et al.* (1987), with some modifications. Three days before the beginning of the analysis of worker behavior an observation hive was prepared for each bee colony to be tested. Each observation hive consisted of a comb covered with adult bees and contained recently sealed worker brood, honey and pollen. 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 who identified the presence of the varroa on this bee. For each colony, fifty workers were observed, 10 per day over a period of 5 to 10 days.

To determine whether Africanized and pure Italian workers bees differed in their ability to get rid of the mite, we used the Student *t*-test for statistical analysis of the data. To estimate the heritability of the trait under study in female progeny, we used the method of Brandeburgo *et al.* (1989). The equation used was:

$$h^2 = 4 \sigma^2: \sigma^2q + \sigma^2\varepsilon,$$

where,  $\sigma^2q$  is the between colonies effect and  $\sigma^2\varepsilon$  the effect of the error for each observation. The expected mean squares were estimated by analysis of variance.

We used the linear model

$$Y_{ij} = \mu + q_i + \varepsilon_{ij},$$

where  $Y_{ij}$  = each observation of the trait under study,  $\mu$  = overall mean,  $q_i$  = queen effect, and  $\varepsilon_{ij}$  = error for each observation. For analysis of variance, data were transformed to arc-sine.

## RESULTS

Immediately after infestation, many bees reacted to the parasites. Among these reactions were the execution of body movements by the bees in attempts to get rid of the parasite. These included rapid abdominal movements and the use of the second and third pair of legs which moved laterally and dorsally in relation to the thorax and above the head. When the bee executed these types of movements it was often able to shake the mite off its body, frequently inducing its dislocation to another bee. When the mite moved to the ventral part of the thorax, the bee would often bite it with its mandibles, at times succeeding in removing it from its own body and at others causing the mite to move to another part of the body, from where it was later removed with the legs. When the parasite attached itself to the abdominal sternites, to the posterior part of the thorax or to the propodeum, the bee could not remove it from its body despite strong body and leg movements. Under these circumstances, the bee continued to execute movements with its legs and abdomen, which often attracted nestmates which would examine it with their tongues and antennae. While being inspected, the parasitized bee would generally stop moving its body and legs, thus permitting nestmates to locate the mite. When the inspecting workers noted the presence of the varroa on the body of the artificially infested bee, they would touch it with tongue and mandibles, dislodging it from the site to which it was attached. The inspecting bees would sometimes remove the mite from the body of the parasitized bee. In most cases, the parasite was forced to move on the bee's body and the bee, in turn, removed the mite by executing continuous movements.

Within the first five minutes after artificial infestation,  $3 \pm 2.71\%$  of the Italian bees and  $19.70 \pm 10.76\%$  of the Africanized bees were able to get rid of the parasite: the difference between races being statistically significant ( $t = 6.50$ ;  $P < 0.01$ ). Within the period of five to 30 minutes after artificial infestation, the respective rates of removal were  $0.60 \pm 0.97\%$  and  $7.20 \pm 6.23\%$ . Again, Africanized bees showed a significantly greater ability to get rid of the parasites ( $t = 4.00$ ;  $P < 0.01$ ).

The percentage of artificially parasitized bees which got rid of the mite due to the activity of nestmates, within 5 min after infestation was significantly higher in Africanized bees ( $7.30 \pm 7.14\%$ ) than in Italian bees ( $1.60 \pm 2.07\%$ ) ( $t = 3.21$ ;  $P < 0.01$ ). From five to 30 minutes after infestation, the rates of removal by nestmates were again higher in Africanized bees ( $4.60 \pm 5.73\%$ ) than Italian bees ( $0.20 \pm 0.63\%$ ) ( $t = 3.12$ ;  $P < 0.01$ ).

When all artificially infested workers which got rid of the varroa by their own movements or by the action of fellow bees over a period of 30 minutes after infestation were analyzed as a whole, the rate was  $5.40 \pm 3.66\%$  for Italian bees and  $38.20 \pm 19.60\%$  for Africanized bees, i.e., Africanized bees showed a greater ability to get rid of the mite ( $t = 7.03$ ;  $P < 0.01$ ).

To estimate the heritability of the trait under study, we compared the number of parasitized bees which got rid of the parasite after artificial infestation. Table I presents the mean squares and expected mean square obtained by analysis of variance of the five replications. The heritability of the trait "ability of artificially infested workers to get rid of varroa" was  $0.71 \pm 0.41$ .

Table I - Analysis of variance applied to the data from 20 colonies of Africanized bees analyzed for the ability of their workers to rid themselves of the acarid *Varroa jacobsoni* after artificial infestation.

Source of variation	d.f.	MS	E(MS)
Among colonies	19	16.53	0.67
Error	80	3.11	3.11
Total	99	-	-

## DISCUSSION

The observations of the behavior of Italian and Africanized bees after artificial infestation showed that workers of both races responded to the presence of the mite by body movements of the parasitized bee itself or by reactions of nestmates. Italian workers made fewer attempts to remove the mite when compared to Africanized worker bees.

Peng *et al.* (1987) reported that all *Apis cerana* workers immediately responded to the varroa parasite after artificial infestation by executing movements in an attempt to get rid of it, whereas *Apis mellifera* bees of European races had a limited ability to identify the varroa as a parasite.

Africanized bees are known to be generally more resistant to varroosis than bees of European races (Ruttner and Marx, 1984; Engels *et al.*, 1986; Moretto *et al.*, 1991). The duration of the sealed - cell stage of worker brood cells plays an important role in the reproductive ability of the varroa. In colonies of bees of African races a smaller number of descendants are produced by adult varroa females in each reproductive cycle when compared to the number produced in colonies of European bee races (Moritz and Mautz, 1990).

We detected an additional defense mechanism against varroosis among Africanized bees, compared to pure Italian bees. Africanized bees were about seven times more efficient than Italian bees in getting rid of the parasite after artificial infestation. In comparing our results with those obtained by Peng *et al.* (1987), we note that Africanized bees are not as efficient as *Apis cerana* in ridding themselves of *V. jacobsoni* after artificial infestation. However, Africanized worker bees proved to be much more efficient than the European bees used by Peng *et al.* (1987), only 0.2% of which were able to rid themselves of varroa. Polremi (1989, cited by Moritz and Mautz, 1990) also reported that *Apis mellifera meda*, from Iran, has a greater ability to rid itself of varroa when compared to bees of European races. In *Apis cerana*, in addition to the fact that artificially infested bees almost always rid themselves of the mites, many are killed directly by the parasitized bee itself or by fellow bees (Peng *et al.*, 1987a). In our experiment, in which we tested 1000 Africanized worker bees, we only observed two varroa deaths resulting from attacks by the parasitized bee itself.

We noted that the ability of artificially infested workers to rid themselves of varroa was different in the two bee races, with a range of variation of 0-12% for Italian bees and of 10-70% for Africanized bees. The high variability of this trait detected in Africanized bees and the difference in the range of variation between the two races suggest the existence of genetic mechanisms which control the ability of artificially infested bees to rid themselves of varroa. The high heritability ( $h^2 = 0.71$ ) detected in the progeny of Africanized bees indicates that selection for resistance to varroosis is possible.

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## RESUMO

O presente trabalho procurou verificar se entre as abelhas *Apis mellifera*, italianas puras e africanizadas, existem mecanismos que permitem as operárias livrarem-se do ácaro *Varroa jacobsoni* quando infestadas artificialmente com fêmeas adultas desse parasita.

De 10 colônias de abelhas italianas puras e 20 colônias de abelhas africanizadas analisadas nesse trabalho, constatamos que em ambas as raças de abelhas, as operárias infestadas artificialmente com a *Varroa* reagem à presença do parasita. As abelhas africanizadas mostraram-se mais eficientes em se livrar do parasita do que as italianas. Nas abelhas africanizadas 38,20% das operárias infestadas artificialmente conseguiram se livrar do ácaro, enquanto que nas abelhas italianas puras apenas 5,40% das operárias infestadas se livraram do parasita.

A herdabilidade para o caráter em estudo foi determinada nas 20 colônias de abelhas africanizadas como sendo,  $h^2 = 0,71 \pm 0,41$ .

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