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SHORT COMMUNICATION

REPRODUCTIVE STRATEGIES OF THE MITE *Varroa jacobsoni* (MESOSTIGMATA, VARROIDAE): INFLUENCE OF LARVA TYPE AND COMB CELL SIZE ON HONEY BEE BROOD INFESTATION RATES

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ABSTRACT

The effect of differences in brood comb cell size on the cell invasion rates of the ectoparasitic bee mite *Varroa jacobsoni*, was tested in five colonies of Africanized honey bees. Drone cells were designated as large cells and worker brood cells as small cells. Combs with both types of cells were introduced into a colony with a drone laying queen or one with laying workers, so that only drone larvae were produced. These combs were then introduced into broodless colonies, so that the experimental comb had the only brood available for the mites to infest. The infestation rates were determined soon after the cells were sealed. Drone larvae in drone-size cells became infested by a mean of 0.38 adult female mites, which was significantly more than the 0.188 mites found per drone larva in worker cells.

A second test was made to determine whether the type of larva could override the effect of cell size. Drone larvae (less than three days of age) were transferred into worker-size cells and worker larvae into drone cells. After the cells were sealed the infestation rate of the drone larvae in worker-size cells was 1.86 mites/larva, while on worker larvae in drone cells it was 0.379, which was significantly lower.

Though cell size was important, characteristics inherent to the drone larvae make them more attractive to the varroa mites, even when the drone larvae are in worker-size cells.

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INTRODUCTION

Varroa jacobsoni is an important ectoparasite of the honey bee *Apis mellifera*. The adult female mites feed on the hemolymph of adult workers and drones. However in order to reproduce they must enter into brood cells (De Jong, 1990). In this bee species drone brood is preferred, though worker brood is also infested in both European honey bees (Grobov, 1977) and Africanized bees (Issa, 1985). This preference is reflected in the reproductive success of this mite, as drone cells remain sealed for 15 days and worker cells only about 11, so that in the former more of the few, serially produced progeny have time to reach the adult stage (Ifantidis, 1983; De Jong, 1984).

As a result of the high infestation rates in worker brood, *Varroa jacobsoni* has become the most important problem on a world wide basis for beekeeping with *Apis mellifera* (De Jong *et al.*, 1982). However, though it is nearly 100% lethal for untreated colonies in Europe and in temperate areas of South America, Africanized bees in tropical and subtropical regions of South America are little affected (De Jong *et al.*, 1984; Moretto *et al.*, 1991b). Apparently there already has been some adaptation by the Africanized bees to this new parasite, implying a relatively rapid evolutionary process, as *Varroa jacobsoni* was introduced into Brazil about 1971 (De Jong *et al.*, 1982). Part of this adaptation involves an active defense, as africanized bees are more efficient at removing the mites from their bodies Moretto *et al.* (1991a). However other factors are probably also involved.

On it's original host, *Apis cerana*, which normally is only very slightly affected, as one would expect in a normal host-parasite relationship, *Varroa jacobsoni* practically only is found and reproduces in drone cells (Koeniger *et al.*, 1981), though it has also been found to reproduce occasionally in worker brood (De Jong, 1988). This preference has been carried over to the new host, *Apis mellifera*, though the worker brood in the latter bee species is much more affected than in the original host (De Jong, 1984).

In order to study the mechanisms of this behavior, and as a basis for possible control mechanisms, several researchers have made observations on the preference of *Varroa jacobsoni* for various types of brood cells. Message (1986) found that *Varroa jacobsoni* prefers worker larvae in European size worker cells (larger) over larvae from the same queen in Africanized size worker cells. De Jong and Morse (1988) studied worker brood in irregularly built combs and determined that worker larvae reared in protruding cells were much more heavily infested than those in cells of normal height.

We have examined the effect of drone and worker-size comb cells on the preference of *Varroa jacobsoni* for drone and worker larvae.

MATERIAL AND METHODS

In the first trial we placed empty combs with worker and drone cells in a colony with an old queen which could only lay unfertilized (drone) eggs. These combs were then

transferred into broodless colonies and examined soon after the cells were sealed. In subsequent trials the drone eggs were obtained from queenless, laying worker colonies. The experiment was repeated two to three times for each of the colonies. The sealed cells were opened with a forceps, the larva removed and the larva and the interior of the cells examined carefully with a fiber optic lamp in order to determine the number of adult female mites which had invaded the cell.

In a second experiment, one to three day old drone larvae were transferred into worker sized cells and one to three day old worker larvae into drone sized cells. Six colonies were used, and as before the cells were examined soon after sealing.

Analyses were made with Chi-square for the comparison of percentages of infested cells and the Wilcoxon signed ranks test for the comparison of infestation rates (alpha = 5%).

RESULTS

Drone larvae reared in drone-sized cells were significantly more infested than drone larvae in worker cells, both in terms of percentage of cells infested and mean number of mites per cell (Table I). Drone larvae remained significantly more attractive to *Varroa jacobsoni* than worker larvae, even when the drone larvae were in (small) worker cells and worker larvae in (large) drone cells (Table II).

Table I - Percentages of infested cells and infestation rate by *Varroa jacobsoni* (mites per brood cell) for drone larvae reared in worker cells (w) and drone cells (d).

Colony #	# of cells analysed		Mean % of cells infested		Mean infestation rate	
	w	d	w	d	w	d
1	233	185	13.5	25.1	0.164	0.324
2	610	450	13.3	23.7	0.183	0.426
3	1353	352	20.8	28.1	0.257	0.412
4	366	241	17.3	30.2	0.214	0.377
5	177	129	8.89	26.0	0.125	0.355

Table II - Percentages of infested cells and infestation rate by *Varroa jacobsoni* (original female mites per brood cell) for drone larvae reared in worker cells (d) and worker larvae reared in drone cells (w).

Colony #	# of cells analysed		Mean % of cells infested		Mean infestation rate	
	d	w	d	w	d	w
6	9	32	55.5	6.25	1.67	0.94
7	10	36	90.0	19.4	3.8	0.277
8	6	4	83.3	0	1.5	0
9	134	68	65.8	45.6	1.8	0.691
10	269	126	65.7	49.2	1.78	0.746
11	13	11	15.4	9.1	0.15	0.091

DISCUSSION

Clearly, as demonstrated in other contexts by Message (1986) and De Jong and Morse (1988), cell size is important for the choice of a bee brood cell for *Varroa jacobsoni* females, which are in a reproductive phase. However it does not override the attraction factors inherent to the drone larva.

As a result of it's co-evolution with the original host *Apis cerana, Varroa jacobsoni* practically only attacks drone brood in this Asian bee species, while in *Apis mellifera*, the new host, worker brood is also heavily affected, so that colonies of european races of these bees are seriously weakened and killed (De Jong, 1990). The apparent adaptation of Africanized bees to this relatively recently introduced parasite is influenced by several factors, including bee grooming behavior (Moretto *et al.*, 1991a), climate (De Jong *et al.*, 1984; Moretto *et al.*, 1991b), reproductive success on worker larvae (Camazine, 1986) and may involve a difference in the degree of preference for drone brood (investigated in this paper). These mechanisms are possible candidates for a selection program for increased resistance.

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RESUMO

O efeito da diferença do tamanho das células de cria na taxa de invasão do ectoparasita de abelhas *Varroa jacobsoni* foi testado em cinco colônias de abelhas africanizadas. As células de zangões foram designadas como maiores e as de operárias como menores. Favos contendo ambos os tipos de células foram introduzidos em colônias com operárias poedeiras ou com rainha realizando postura de zangões. Assim foram obtidas apenas larvas de zangões. Esses favos foram introduzidos, então, em colônias sem cria, de modo que contivessem a única cria de abelha disponível para o ácaro infestar. A taxa de infestação foi determinada logo após a operculação das células. Larvas de zangões desenvolvidas em células de zangões foram infestadas por uma média de 0,38 ácaros-fêmeas adultos, que é significativamente maior do que a infestação em larvas de zangões desenvolvidas em células de operárias, que foi de 0,188 ácaros-fêmeas adultos.

Um segundo teste foi realizado para determinar se o tipo de larva pode ser mais importante que o efeito do tamanho da célula. Larvas de zangões (com menos de 3 dias de idade), foram transferidas para células de operárias e larvas de operárias para células de zangões. A taxa de infestação foi determinada logo após a operculação das células. Para larvas de zangões desenvolvidas em células de operárias a taxa de infestação foi de 1,86 ácaros/larva, enquanto que para larvas de operárias desenvolvidas em células de zangões foi de 0,379 ácaros/larva, sendo esta significativamente menor.

Embora o tamanho da célula seja importante, características inerentes às larvas de zangões as tornam mais atrativas ao ácaro Varroa, mesmo que se desenvolvam em células de operárias.

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