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Effect of host brood type on the number of offspring laid by the honeybee parasite *Varroa jacobsoni*

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ABSTRACT

The number of offspring laid by individual mites, varies depending on the type (drone or worker) of honeybee brood cell invaded. The number of offspring laid by individual mites increases when artificially transferred from worker to drone brood and vice versa when moved in the opposite direction.

Key words: *Varroa jacobsoni*, *Apis mellifera*, reproduction.

INTRODUCTION

On its natural host, *Apis cerana* F., *Varroa jacobsoni* Oud. is only able to reproduce successfully in sealed drone brood cells, because of effective detection and removal from infested worker cells (Rath and Drescher, 1990). However, when this species infested its 'new' host, *Apis mellifera* L., it was able to breed successfully in both drone and worker sealed brood cells. Studies have shown that a mite will lay fewer eggs in worker than in drone brood cells (Martin, 1995). Although mites show a strong preference towards invading drone brood (Boot *et al.*, 1992), they still invade worker cells. When mites invade worker cells, they lay eggs which are likely to perish because there is insufficient time to mature before the host bee emerges.

This study investigated whether the different numbers of offspring laid by mites in worker and drone cells is determined by the type of mite (genetic) or type of bee (environment).

METHOD

Mother mites and their offspring were carefully extracted from naturally infested honeybee brood cells which had been sealed for 10–11 days. They were

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then classified according to their developmental stage and sex. Only cells containing a single mother mite accompanied by normally developing offspring (Martin, 1995) were selected. The mothers were then segregated into six groups: those from worker cells which had laid three, four, or five offspring and those from drone cells which had laid four, five or six offspring. The mites were then kept for a maximum of 48 h in sealed Petri dishes containing bee pupae (various ages) at 23°C and high relative humidity (60%+) until they were needed.

Frames of brood comb from two uninfested colonies in which cells were beginning to be sealed were removed from the hive and an acetate sheet was temporarily placed over the frame and the position of any sealed cells marked. Six hours later the frame was again removed and mites from the Petri dishes individually transferred into the newly (within 6 h) sealed cells and their positions recorded on the acetate sheet. Each mite was inserted into the sealed cell by making a small hole in the cap with a hot needle and after the mite had been inserted with a fine brush the cell was resealed with the hot needle. The frames were returned to the hive and left for 10–12 days before the artificially infested cells were opened for inspection. Four combinations of transfers, two controls (drone to drone and worker to worker) and two experimental (drone to worker and worker to drone), were conducted.

RESULTS

Of the 119 mother mites artificially transferred, 16 (13%) disappeared; they were either removed by the bees or escaped when the bees resealed the cells. Of the remaining 103 mites, five died within the cell, 19 produced no offspring and four produced a single male offspring. All the cases of non-reproduction occurred in worker cells. Table 1 summarizes the data and shows that the number of offspring produced was related to the sex of the host brood. Table 2 provides details of the results for each transfer category and shows that the number of offspring remaining stable in the control groups increased in the worker to drone group and decreased in the drone to worker group. The decrease in the mean values of all groups except the worker to drone group is due to the mites which became non-reproductive after the transfer.

TABLE 1

Percentage of mites which laid more, less or the same number of offspring before and after the transfer

	Percentage of offspring laid before and after transfer		
	% same	% increasing	% decreasing
Worker to worker and drone to drone	**56** (30)	11 (6)	33 (18)
Worker to drone	26 (5)	**53** (10)	21 (4)
Drone to worker	4 (1)	0 (0)	**96 (24)**

The number of mites is given in parentheses.

TABLE 2

Comparison of the number of offspring laid before and after transfer in the four different groups

Number of offspring prior to transfer	Number of offspring after transfer Mode	Median	Mean (SD)
Control: worker to worker (alive = 45, dead = 1, missing = 7)			
3	3	3.0	2.0 (1.5)
4	4	4.0	2.8 (1.8)
5	5	5.0	3.6 (2.2)
Experimental: worker to drone (alive = 19, dead = 0, missing = 3)			
3	4	4.5	4.7 (0.7)
4	5	5.5	4.6 (0.9)
5	–	5.5	5.5 (0.5)
Control: drone to drone (alive = 9, dead = 1, missing = 1)			
4	–	4.0	3.7 (1.2)
5	5	5.0	4.3 (1.9)
6	6	6.0	6.0 (—)
Experimental: drone to worker (alive = 25, dead = 3, missing = 5)			
4	3	2.5	2.1 (1.4)
5	4	2.5	2.3 (1.5)
6	0	3.0	2.4 (2.0)

The numbers in parentheses indicate the condition of the mites at the end of the study.

DISCUSSION

The study shows that individual mites can alter the number of offspring they lay, depending of the type of brood cell they invade. The mites cease to lay eggs $\approx$170 h (Martin, 1994) and $\approx$200 h (Martin, 1995) after the cell is sealed in the worker and drone cells, respectively. However, because the sealed brood stage of a worker is shorter (282–290 h) than that of a drone (340–360 h), egg laying ceases when the developmental ages of both the worker and drone brood are similar (purple eyed). In the natural host, *A. cerana*, the sealed brood stage of the drone (324–348 h; Tan *et al.*, 1993; F. A. Shah, personal communication) lies closer to that of *A. mellifera* drones than the *A. mellifera* workers and correspondingly the mites laid five or six offspring (Sasaki, 1989).

The rate of development of the mites on drone and worker brood is similar (Martin, 1994, 1995); the mother mite continues to feed on the developing bee pupa after the cessation of egg laying (Donzé and Guerin, 1994) and any oocytes which have completed cytoplasmic development do not move on to vitellogenesis (Akimov *et al.*, 1990). These observations suggest that it is the developmental age of the bee pupa, possibly through a biochemical substance, that triggers the cessation of egg laying. This would also explain why the mites

entering *A. mellifera* worker brood cells often lay a fifth egg which has insufficient time to mature because of the short development time of the host worker bee, but rarely lays a sixth egg although it is capable of doing so.

Mites may have different threshold values when the cessation of egg laying trigger is activated. This would help explain why the majority of mites in the control group laid a similar number of offspring before and after the transfer (Table 2). Thus, a mite laying a relatively low or high number of offspring will normally continue to produce a relatively low or high number of offspring in any subsequent breeding attempts in brood cells of the same sex.

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REFERENCES

Akimov, I.A., Pilyetskaya, I.P. and Yastrebtsov, A.V. 1990. [The reproductive cycle of the mite *Varroa jacobsoni* and its relationship to the host.] Vest. Zool. 2: 41–46. (In Russian.)

Boot, W.J., Calis, J.N.M. and Beetsma, J. 1992. Differential periods of *Varroa* mite invasion into worker and drone cells of honey bees. Exp. Appl. Acarol. 16: 295–301.

Donzé, G. and Guerin, M. 1994. Behavioural attributes and parental care of *Varroa* mites parasitizing honeybee brood. Behav. Ecol. Sociobiol. 34: 305–319.

Martin, S.J. 1994. Ontogenesis of the mite *Varroa jacobsoni* Oud. in worker brood of the honeybee *Apis mellifera* L. under natural conditions. Exp. Appl. Acarol.18: 87–100.

Martin, S.J. 1995. Ontogenesis of the mite *Varroa jacobsoni* Oud. in drone brood of the honeybee *Apis mellifera* L. under natural conditions. Exp. Appl. Acarol. 19: 199–210.

Rath, W. and Drescher, W. 1990. Response of *Apis cerana* Fabr. towards brood infested with *Varroa jacobsoni* Oud and infestation rate of colonies in Thailand. Apidologie 21: 311–321.

Sasaki, M. 1989. [The reason why *Apis cerana japonica* is resistant to *Varroa* mite]. Honeybee Sci. 10: 28–36. (In Japanese.)

Shah, F.A. 1988. (pers. comm.) In Bees and Beekeeping by Eva Crane, 1990, Heinemann Newnes, 614 pp.

Tan, N.Q., Huan, L.V. and Dung, N.V. 1993. Development time of eggs, open brood and capped brood of *Apis cerana* and *Apis mellifera* in southern Vietnam. In Asian apiculture, L.J. Conner, T. Rinderer, H.A. Sylvester and S. Wongsiri (eds). Wicwas Press, USA.