Experimental & Applied Acarology, 16 (1992) 313–319
Elsevier Science Publishers B.V., Amsterdam

ACARI 648

Grooming behaviour of *Apis cerana*, *Apis mellifera* and *Apis dorsata* and its effect on the parasitic mites *Varroa jacobsoni* and *Tropilaelaps clareae*

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ABSTRACT

Büchler, R., Drescher, W. and Tornier, I., 1992. Grooming behaviour of *Apis cerana*, *Apis mellifera* and *Apis dorsata* and its effect on the parasitic mites *Varroa jacobsoni* and *Tropilaelaps clareae*. *Exp. Appl. Acarol.*, 16: 313–319.

One *Apis mellifera* and one *Apis cerana* observation hive were used to test the response to individually introduced *Varroa jacobsoni* mites. Within 60 s, 88.6% of the involved cerana worker bees ($n=44$) showed auto-grooming behaviour. Within 5 min, allo-grooming behaviour, involving up to four nestmates, was observed in 33.3% of the infested bees. Successful mite removal was observed in 75% of the not-prematurely discontinued observations ($n=36$); 32% of the mites removed were caught with the mandibles.

For mellifera auto-grooming behaviour was observed in most cases but delayed in comparison to cerana, and allo-grooming behaviour was rarely observed. Within 5 min, 48% of the mites in not-prematurely discontinued observations ($n=25$) were removed, but none of the mites was caught with the mandibles.

For *Apis dorsata* auto-grooming behaviour in response to the infestation with *Tropilaelaps clareae* and *Varroa* mites is reported for the first time. *Varroa* was removed at a higher rate than *Tropilaelaps*. The higher survival chance of *Tropilaelaps* seems to be due to differences in mite behaviour and the preference for certain parts of the bee-body.

INTRODUCTION

Peng et al. (1987) reported the intensive grooming behaviour of *Apis cerana* bees after artificial infestation with *Varroa jacobsoni* and suggested that

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0168-8162/93/$06.00

this might be the most important defence mechanism of cerana bees against the mite; within 2 h about 99.6% of the parasites had been removed. Rath and Drescher (1990) described the effective removal of *Varroa* mite-infested worker brood as an additional defence mechanism in *A. cerana* bees. After acaricide treatment of 64 *A. cerana* colonies in Thailand an average number of 70 *Varroa* mites was found with a maximum of 798 mites per colony. The conclusion was drawn that the grooming behaviour might not always be as effective as reported in the publication cited above.

To compare the grooming behaviour of *A. cerana* and *A. mellifera* bees different sources of *Varroa* mites were used in our experiments in spring 1991 in Thailand. Some additional observations could be made with *A. dorsata* bees concerning their response to *Varroa*, a parasite rarely found on bees and in the debris of *A. dorsata* colonies (Rath and Delfinado-Baker, 1991) and against *Tropilaelaps clareae*. *A. dorsata* is considered to be the original host of *Tropilaelaps* (Burgett et al., 1983; Delfinado-Baker et al., 1985). Nothing is known about the grooming abilities of *A. dorsata* under field conditions, but Koeniger and Muzaffar (1988) reported that 19.6% of the dead mites were damaged in cage experiments and Rath and Delfinado-Baker (1991) found 76% of the dead *Tropilaelaps* mites in the debris of a natural colony to be characteristically injured.

MATERIALS AND METHODS

Experiments with A. cerana and A. mellifera

The experiments were conducted in Chiang Mai (North Thailand) from 18 February–3 March 1991. Two observation hives with two combs each were filled with *A. cerana* and *A. mellifera* bees. Mites from three sources (not identical to the observation colonies) were taken for the tests: from adult cerana bees, from adult mellifera bees and from sealed mellifera brood cells.

Using a fine brush, the *Varroa* mites were carefully placed through a small window in the glass walls of the observation hive upon the thorax of unmarked bees. The behaviour of bees and mites was observed for up to 10 min.

The different types of grooming behaviour were classified according to Woolridge (1987):

- auto-grooming when the activity was limited to the infested bee (corresponding to "self cleaning" according to Peng et al. (1987));
- allo-grooming when one to several nest-mates joined the grooming effort of the parasitized bee (corresponding to "nestmate cleaning" according to Peng et al. (1987)).

"Group cleaning", as described by Peng et al. (1987), was not observed in our experiments.

Auto-grooming or allo-grooming responses were registered. The observation was discontinued when the bee escaped from the observation area or when the mite left its host before any grooming response occurred. When the mite was lost after the bee had shown grooming behaviour, the event was generally recorded as successfully removed, because in many cases it was impossible to observe whether the mite had been directly removed by the bee or the mite had actively escaped from the bee.

The χ^2 test was used to study the significance of differences between the bee species and the three sources of mites.

Experiments with A. dorsata

Our experiments were carried out with a colony in Mae Joe (North Thailand) which had settled under the lower surface of a watertank about 20 m above the ground. The comb measured 1×0.55 m and contained brood of all stages. From a specially constructed platform, located about 3 m below the nest, it was possible to get nearer to the colony after several days of conditioning by using a ladder.

On 27 February 1991, *Varroa* and *Tropilaelaps* mites were placed upon the thorax of unmarked dorsata worker bees hanging in the curtain of the colony. All the mites used for the experiments were collected from mellifera brood cells. The behaviour of bees and mites was registered with a camcorder from about 30 cm distance. The evaluation and classification were made later on. The quality of the video pictures permitted the tracing of the mites on the bees in a section of about 7×10 cm.

RESULTS

A. cerana and A. mellifera

Fortynine tests were evaluated for both bee species. Table 1 shows the results concerning the fate of the mites within different observation periods (0–15 s, 0–60 s and 0–300 s). Cerana workers responded more vigorously than mellifera workers after the mites had been placed upon their thorax. The frequency of auto-grooming behaviour was significantly higher for all periods (χ^2, $P<0.01$).

In mellifera bees the response was restricted to auto-grooming behaviour, except when mites from mellifera brood were used. In cerana bees allo-grooming was observed during every observation period, except in the first period when mites from mellifera brood were introduced. In most cases this behaviour was stimulated by a shaking dance (Haydak, 1945) of the infested bee. One to four neighbouring bees combed the hairs of the artificially infested bee thoroughly with their mandibles, especially near the wing bases and in the petiolus region. Often the infested bee assisted by presenting its petiolus.

The grooming success differed greatly between the two species. Cerana bees were significantly more effective in removing mites over the entire observation period than mellifera bees (χ^2, $P<0.05$). In 32% of the mites removed

TABLE 1

Frequency (in %) of the auto- and allo-grooming reactions and removal success within different observation periods after artificial infestation with *Varroa* mites of *A. mellifera* and *A. cerana* worker-bees

Species	Source of mites	within 15 s				within 60 s				within 300 s			
		n	AUG[a]	ALG[b]	SUC[c]	*n*	AUG	ALG	SUC	*n*	AUG	ALG	SUC
A. cerana	cerana bees	23	65.2	8.7	13.0	20	85.0	30.0	40.0	17	94.1	35.3	64.7
	mell. bees	15	93.3	6.7	33.3	14	100.0	35.7	71.4	13	100.0	38.5	92.3
	mell. brood	11	36.4	0.0	18.2	10	80.0	20.0	30.0	6	100.0	16.7	66.7
	Total	49	67.3	6.1	20.4	44	88.6	29.5	47.7	36	97.2	33.3	75.0
A. mell.	cerana bees	17	11.8	0.0	0.0	13	30.8	0.0	0.0	6	66.7	0.0	50.0
	mell. bees	19	15.8	0.0	0.0	17	64.7	0.0	17.6	11	81.8	0.0	36.4
	mell. brood	13	38.5	7.7	15.4	10	50.0	20.0	40.0	8	62.5	25.0	62.5
	Total	49	20.4	2.0	4.1	40	50.0	5.0	17.5	25	72.0	8.0	48.0

[a]AUG = Auto-grooming.
[b]ALG = Allo-grooming.
[c]SUC = Success, host-bee lost the mite after grooming.

from cerana bees the bee caught the mite with its mandibles. This behaviour was never observed in mellifera bees. Five to 10 min after the artificial infestation in both groups the grooming actions had mostly ceased.

Our data indicate that there is a notable influence of the source of mites upon the response of the bees. Auto-grooming response of cerana bees within 15 s was significantly stronger against mites collected from mellifera workers than to those from cerana workers and mellifera brood. The allo-grooming response and the removal success of mellifera bees within 60 s were higher against mites collected from mellifera brood than to those from cerana and mellifera workers (χ^2, $P<0.05$).

Apis dorsata

Fourteen tests with *Tropilaelaps* and eight with *Varroa* mites were evaluated. Infestation with *Varroa* mites provoked intensive and long-lasting auto-grooming in nearly all cases immediately after placing the mite on the bee's thorax, whereas with *Tropilaelaps* mites this response was less frequent. The involved bees detached themselves with one or two pairs of their legs or even with all three pairs from their entanglement in the bee curtain and started removal movements with their legs directed towards the thorax and head. In several cases the mite could be pushed to the mouth parts. Afterwards movements of the head could be observed, suggesting chewing activity of the mandibles. Auto-grooming with the legs was accompanied frequently by intensive shaking of the body and excited movements over the surface of the curtain. Nearly all observed auto-grooming responses, both with *Tropilaelaps* and *Varroa* mites, were triggered when these mites moved to the lateral part of the

Fig. 1. Direct observation of the grooming behaviour in an *A. dorsata* colony.

thorax or to the ventral side of the bees. Shortly after placing of *Tropilaelaps* mites on the thorax of the dorsata bee, the mite escaped in about 50% of the observations to the petiolus region where it remained quiet, apparently undetected by the host bee.

Allo-grooming as shown by cerana has not been observed with dorsata bees. Only in a few cases up to two nest-mates shortly paid attention to the infested bee.

DISCUSSION

Our observations confirm the reports first given by Peng et al. (1987) that *A. cerana* bees show a more intensive and effective grooming response towards phoretic *Varroa* mites than *A. mellifera* workers. Also the reported time scheme is in close agreement with our observations. The stimulated allo-grooming could not be observed as frequently as Peng et al. (1987) described, and up to maximally four nest-mates joined the infested bee. Often this combined effort ceased before the mite had been removed and independently from the still lasting auto-grooming of the host bee. One reason for these differences might be the shorter observation period in our experiments. When we could no longer observe the mite on the bee, this bee was caught to see whether the mite had disappeared or not and the observation had to be discontinued.

Another explanation for differences in grooming behaviour, especially for the lack of group cleaning as described by Peng et al. (1987), might be that we observed *A. cerana* from Thailand while they used *A. cerana* from China. Possible racial differences should be considered.

The observation of Koeniger et al. (1981) and Rath and Drescher (1990) that reproduction of *Varroa* is almost restricted to drone brood implies that mites must have a chance to survive by phoresy on adult bees or by repeated invasions of worker brood, since drone brood is only available during 1–2 short periods. *Varroa* mites prefer certain positions on the body of cerana bees, for instance the lateral sections of the abdominal tergites (W. Rath, pers. commun., 1991). This may indicate that there are places on the bee body where they do not stimulate auto- and allo-grooming responses of their host and its nest-mates.

The effect of the observed grooming responses in *A. mellifera* is questionable, since only removal but no direct catching of mites could be stated. However, reports given by Wallner (1990), Boecking and Drescher (1991) and Ruttner (1991) for *A. mellifera carnica* bees indicate that they are able to kill *Varroa* mites.

Here for the first time experimentally induced grooming in *Apis dorsata* under field conditions is described. The response is similar to the auto-grooming behaviour as described in cerana and mellifera. Differences in the sensitiveness of different body parts, such as the lateral thorax (highly sensitive) and the petiolus region (less sensitive), can be recognized. The different response of dorsata bees against *Varroa* and *Tropilaelaps* mites suggests that the latter one is better adapted. Allo-grooming seems to be of minor or no importance *A. dorsata*.

ACKNOWLEDGEMENTS

We thank the project-partners in Thailand from the Beekeeping Section of the Plant Protection Service Department, specially Mr. Udom Yjrasavetakul and Mr. Sirisak Tiewtrakul, and our colleagues S. Nengel, O. Boecking and W. Rath from the Institut für Landwirtschaftliche Zoologie und Bienenkunde, Bonn for their assistance and their stimulating discussions.

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