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FURTHER INVESTIGATIONS INTO CONTROL OF THE PARASITE BEE MITE *TROPILAELAPS CLAREAE* WITHOUT MEDICATION

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Summary

Three methods for controlling *Tropilaelaps clareae* in honeybee (*Apis mellifera*) colonies without medication were tested: (1) caging the queen for more than 21 days, then releasing her a few days after all workers had emerged, (2) caging the queen for 9 days until all brood was sealed, then cutting off the cappings and shaking the brood out of the combs, and (3) removing all brood from the colony. The effectiveness of the treatments was assessed by determining percentage infestation of worker bees before, during and after treatment and recording numbers of mites falling daily on to the bottom board of the hive. With method (1) percentage infestation and numbers of mites falling on to the bottom board increased up to 10 times after 8 days, when no unsealed brood was left. Within 3 days after the last bees emerged the numbers of dying mites decreased considerably and a few days later none were found on adult bees. With method (2) the number of dying mites collected decreased considerably within 3 or 4 days after the brood had been shaken out, and a few days later no mites were found on the workers. With method (3) the number of mites collected declined considerably within 1 to 3 days after removal of the brood and a few days later no mites were found on the workers. It appeared that worker bees cleared the comb cells of dead mites within a few days. As *T. clareae* is unable to feed on blood of adult bees it can be controlled simply by depriving colonies of brood.

Introduction

The parasitic honeybee mite *Tropilaelaps clareae* causes severe problems to beekeeping in South-East Asia. The two mite species *T. clareae* and *Varroa jacobsoni* are considered to be the cause of continued destruction of *Apis mellifera* colonies in Asia (De Jong et al., 1982). In addition to *V. jacobsoni*, heavy infestation of *A. mellifera* by *T. clareae* has been reported from Burma (Nyein & Zmarlicki, 1982) and Thailand (Burgett et al., 1983). In Afghanistan only *T. clareae* has been found (Woyke 1984*a*). It has destroyed 90% of *A. mellifera* colonies, and can kill honeybee colonies within 1 year (Woyke, 1985). Thus it is more destructive of *A. mellifera* than *V. jacobsoni*.

According to the literature, the biology of *T. clareae* is similar to that of *V. jacobsoni* (De Jong et al., 1982; Burgett et al., 1983). It is known that *V. jacobsoni* reproduces on bee brood, but in the absence of brood it may survive up to 5–8 months on adult workers (Lange et al., 1976; Shabanov et al., 1978). Control methods similar to those used for *V. jacobsoni* were applied to combat *T. clareae*; however, 6 weekly treatments with Folbex in colonies containing brood were ineffective, whereas dusting combs with sulphur every month reduced the mite population (Atwal & Goyal, 1971) as did 2 weeks' continuous fumigation with formic acid (Rajesh et al., 1984). It has been recommended that broodless colonies be fumigated with acaricides to kill mites remaining on adult bees (Nyein & Zmarlicki, 1982; Akratanakul, 1984; Zmarlicki, 1984).

Akratanakul (1984) found that *T. clareae* can survive without food for 2 days only. Woyke (1984*b*, 1985) reported that *T. clareae* also can live on adult worker bees in the absence of brood for only 2 days, being unable to feed on blood of adult bees, and proposed to control it without any medicine by depriving bee colonies of all brood. This paper presents detailed results of investigations on three methods used to control *T. clareae* without medication.

Materials and Methods

This investigation was conducted in Kabul, Afghanistan in 1984, using a hybrid population derived from *A. m. ligustica* and *A. m. caucasica*. Three methods of mite control were investigated:

1. The queen was caged and released a few days after day 21 when all bees had emerged.
2. The queen was caged, and after 9 days when all the brood was sealed, the cappings were cut off with a knife and the brood was shaken out by striking the combs against a hard surface.

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3. All the brood was taken out of the colony. The queen was free in the first series of replications and caged in the second.

Degree of infestation of bee brood was determined by opening cappings on 50–100 brood cells and counting those with *T. clareae*. Adult worker bee infestation was determined before, during and after the treatment. About 200–400 workers were brushed out of brood combs into a container of petroleum. The bees were removed individually with the aid of forceps, and their mites counted.

To detect the numbers of mites dying and falling to the bottom of the hive, the bottom board was covered with white paper and a screen placed above it, 2 cm beneath the combs.

To ascertain how soon worker bees clear cells of dead mites, 100 dead mites were put in empty cells in each of two replications. In the first replication mites were put in brood comb in empty cells extending from the edge of the brood area to the corner of a frame. In the second replication mites were put in a comb adjacent to a brood comb, in cells extending from the centre to the corner of a frame.

Results

Method 1: queen caged for at least 21 days

Brood-cell infestation in 3 experimental colonies ranged from 6 to 40% (Table 1). Four brood

TABLE 1. Infestation of honeybee colonies in Afghanistan by *Tropilaelaps clareae* : numbers of mites found on adult workers and on hive bottom board with caging of the queen and brood left in the colony (Method 1). Tr/W = No. mites per 100 worker bees; FM = No. mites falling to bottom board. Figures in parentheses indicate percentage of brood cells infested at the beginning of the experiment.

	Colony					
	2 (*12*)		*3* (*6+27*)*		*4* (*40*)	
Day	*Tr/W*	*FM*	*Tr/W*	*FM*	*Tr/W*	*FM*
0	0·8		2·6		3·2	
1		24		13		30
2		23		19		25
3		16		77		31
4		16		116		42
5		18		120		29
6		17		153		28
7		32		158		62
8		52		112		103
9		58		147		182
10	9	88		148		217
11		168		213		346
12		186		232		242
13		184		231		244
14		244		215	7	220
15		194		287		202
16		173		302		163
17		194		272		146
18		126	3·9	218		137
19		166		196		101
20		194		95		106
21		195		104		100
22		150		85		68
23		101		44		24
24		32		41		12
25		11		7	0·4	1
26		0		7		4
27		0	0	4		2
28	0	2		0		4
29		0				2
30						1
31						1

*To 4 brood combs with 6% infestation were added 4 combs with 27% infestation.

combs with 27% infestation were added at the beginning of the test to colony 3 in which 4 brood combs had 6% infestation. This gave that colony an average of 16·5% brood infestation (assuming equal brood areas). Infestation of adult workers in the 3 colonies ranged from 0·8 to 3·2%.

The numbers of dead mites falling to the bottom of the hive were quite low in colony 2 in the first week, but in all colonies there was a several-fold increase by the 9th day, when no more open brood was present. A large increase was already evident in colony 3 by the 4th day, probably because the addition of more brood resulted in the workers eating some of the brood, thus leaving less open brood for *T. clareae*.

After all the brood was sealed, infestation of adult workers increased to levels of 3·9% (colony 3) to 9% (colony 2) or 1·5 to 11 times the initial level before the queens were caged. Thus, in the absence of open brood, emerging mites infested adult workers in higher numbers, but afterwards most of them died within a short time.

After 21 days, when all the workers had emerged, numbers of mites found on the bottom decreased rapidly within 3 days. Five days after the last bees had emerged, infestation of adult workers was only 0·4% in colony 4. In the other 2 colonies no more mites were found on adult bees 7 and 8 days respectively after the last bee emerged. Thus, thousands of mites which emerged from brood cells infested adult bees for a few days only, and afterwards all died.

Method 2: caging of queen and removal of brood after 9 days

Colonies with brood infestation as high as 54–86% were investigated (Table 2). On the 9th day after the queen was caged, 308–839 mites fell to the bottom and 3 days later, on the 11th day after caging of the queen, 386–957 mites fell. Infestation of adult workers increased up to 15–19% eleven days after the queen was caged. At this time cappings were cut off and all brood shaken out. Single cells with brood not removed and re-sealed by bees were found and brood destroyed during inspections on the following 2–3 days. The numbers of dead mites at the bottom of the hives decreased rapidly during the next 3–4 days. Examination of adult workers conducted 5–9 days after destruction of the brood did not reveal any mites on them (Table 2). The queens were released at the time adult workers were examined.

TABLE 2. Infestation of honeybee colonies in Afghanistan with *Tropilaelaps clareae* : numbers of mites found on adult workers and on hive bottom board with caging of queen and removal of sealed brood after 9 days (Method 2).

Abbreviations as for Table 1.

	Colony					
	7 (*54*)		*10* (*86*)		*17* (*72*)	
Day	*Tr/W*	*FM*	*Tr/W*	*FM*	*Tr/W*	*FM*
9		367		308		839
10		319		672		936
11*	19·3	386	15·0	957	19·3	668
12		157		341		290
13		100		382		222
14		26		378		68
15		12		144		80
16		3		42	0	22
17		6		34		26
18	0	10		13		22
19		7		7		9
20			0	2		
21				6		
22				6		
23				4		

*Cappings of sealed brood cells were cut off and brood removed.

Method 3: removal of brood

All brood combs were removed from colonies A, B and D, and the queens were not caged (Table 3). The numbers of mites falling to the bottom board decreased rapidly within 3 days, but some dead mites were found as many as 14–15 days after removal of brood. It is possible that some mites survived for several days and fed on the new brood produced by the queens after being freed. Accordingly, the test was repeated using caged queens. Up to 556–1242 mites were found daily on the bottom board the days before the brood was removed (Table 3), but the numbers decreased drastically within 2–3 days after brood removal. Examination of adult worker infestation conducted 10, 11 and 14 days after brood removal did not reveal any mites, but dead mites were still found on the bottom board 15 days after brood removal. These mites could not feed on brood, nor were they feeding on adult bees. Presumably they were mites that had died inside comb cells, and were removed from there several days later. To test this presumption another experiment was carried out.

TABLE 3. Infestation of honeybee colonies in Afghanistan by *Tropilaelaps clareae* : numbers of mites found on adult workers and on hive bottom board with brood removed from colony and queen free or caged (Method 3). Abbreviations as for Table 1.

	Queen free			*Queen caged*					
	Colony			*Colony*					
Day	*A* (8) *FM*	*B* (8) *FM*	*D* (43) *FM*	*27* (47) *Tr/W*	*FM*	*12* (46) *Tr/W*	*FM*	*13* (74) *Tr/W*	*FM*
−3							404		1182
−2							556		1242
0*						3·9	392	2·0	550
1	3	37	10		12		22		222
2	0	12	24		4		7		108
3	1	9	15		2		2		38
4	1	3	1		3		7		13
5	2	2	3		4		4		9
6	1	3	3		1		0		16
7	0	0	2		1		1		4
8	1	0	1		1		5		1
9	0	0	1		2		1		5
10	0	0	2		0	0	3		1
11	0	0	0		2		2	0	2
12	1	0	0		0		0		4
13	0	0	0		3		0		6
14	0	0	2	0	2		2		6
15	1	0	0		2		0		3

*Brood removed.

Removal of dead mites from comb cells by worker bees

Colonies A, B and D from the previous test were used again, 16 days after the brood was removed and the queen produced new brood. Only single mites were found in the control colony A up to 5 days later (Table 4), but 60 *T. clareae* were found on the bottom board the next day, after 100 mites were put into empty cells in a brood comb of colony D. The remaining mites were found on the bottom board up to the 17th day of the investigation. When dead mites were put into cells of a comb next to the brood (colony B), single mites were found on the bottom until the last (14th) day of observation. This shows that the workers did not clear the cells immediately after the mites died but within several days. Single mites found on the bottom board of hives containing colonies that had been broodless for several days (Table 1–Table 3) were probably those that had died earlier in comb cells.

TABLE 4. Infestation of honeybee colonies in Afghanistan with *Tropilaelaps clareae* : numbers of dead mites found on bottom board after introduction into colony of 100 dead mites.
Co = control (no mites); *Mb* : mites placed in cells of brood comb; *Ma* : mites placed in cells of comb adjacent to brood comb.

	Colony		
Day	*A* (*Co*)	*D* (*Mb*)	*B* (*Ma*)
1	1	60	2
2	0	1	9
3	0	1	11
4	3	1	4
5	1	3	8
6	0	1	1
7	0	4	0
8	0	0	17
9	0	1	3
10	0	0	1
11	0	2	0
12	0	1	2
13	0	1	1
14	0	2	2
15	0	1	
16	0	0	
17	0	4	

Conclusions

The results of the present investigation indicate that, contrary to earlier reports, *T. clareae* cannot feed on blood of adult honeybees and the use of chemicals to combat it in broodless colonies is not necessary. *T. clareae* can be controlled simply by depriving colonies of all brood for a few days.

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