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EFFECT OF JH_{III} ON THE REPRODUCTION OF *VARROA JACOBSONI*

Heinz HÄNEL

Institut für Bienenkunde, Universität Frankfurt
Karl-v-Frisch-Weg 2, D-6370 OBERURSEL (FRG.)

INTRODUCTION

There are some indications that JH_{III} might have a physiological role in the reproduction of ticks (vitellogenesis, ovarian development, and oviposition) (POUND and OLIVER, 1979). Further, a gonadotropic hormone has been found in Ixodoidea (Acari) (SHANBAKY and KHALIL 1975. KHALIL and SHANBAKY, 1976) proving that some acari do have an endocrine system similar to insects and some chelicerates.

It is well known that some plants interfere with the hormonal system of their pest insects by means of precocene-like substances (BOWERS, 1980) and there is one fascinating example of a host-parasite relationship where the parasite (Siphonaptera) triggers its own reproduction with host hormones (steroids from the female rabbit) (ROTHSCHILD and FORD, 1966).

The bee parasitic mite *V. jacobsoni* only lays eggs within the sealed brood cell where the development of the young mites up to copulation takes place. As this is only a twelve day period, the mite must synchronize its reproduction with the metamorphosis of the bee. SMIRNOW (1979) mentioned that the production of eggs and the oviposition of *Varroa* takes place in the time of reduced JH titer in bee larvae. The time of reduced JH titer in worker bee larvae is by far too short (HAGENGUTH, 1979; REMBOLD and HAGENGUTH, 1980) for the whole oviposition period of the mite; however, this is the first hint of some interaction of JH to *Varroa* reproduction. Thus it appears interesting to investigate, if in this relationship the parasite triggers its reproduction with the help of the endocrine system of the bee larvae.

METHODS

The toxicity to bees was determined by spraying three different concentrations of JH_{III} (300, 100, 10 µg dissolved in 1 ml acetone : H_2O [1:9]) on 50 worker bees in cages, each carrying 10 *Varroa* mites.

Three replicates were made at each concentration. The two control cages of bees received water or the solvent. Mortality was checked daily for 11 days.

Two different treatments with JH_{III} were conducted. In treatment (A), sealed cells with bee larvae and pupae of different age, and containing a mite were treated topically with 1 µg JH_{III} dissolved in 10µl H_2O:acetone (9:1) or with the solvent alone. In treatment (B) *Varroa* mites were collected from hives in August and September. The sealed cells containing worker larvae were treated with different amounts of JH_{III} (0.5, 1, 2, 2.5 µg) dissolved in H_2O:acetone and the controls received the solvent. After the first topical treatment of the larvae, one mite was introduced and the cell was sealed again. The combs were then incubated and examined before the bees emerged.

RESULTS

Toxicity : Mortality in the test groups (3 groups, 3 concentrations each) was not significantly different from the controls (chi^2 — test $p = 0.95$). No bees were killed by the treatments or the solvent. Thus the amounts of JH used in the assays were within « physiological limits ».

(A) In this treatment, I investigated the influence of the age of the bee larvae on the susceptibility of *Varroa* to JH_{III}. In table 1 the actual offspring numbers are given and in figure 1 the ratio of the number of offspring from treated mites to the number of offspring from control mites is shown. Any deviation of the ratio from one, indicates an influence of JH on oviposition. Figure 1 shows that there is a significant increase in the offspring ratio when sealed 5th instar larvae are treated with JH_{III}. The effect decreases in pupae with white eyes, where some of the mites had developed their first egg already. The treatment showed no effect in cells containing pink eyed pupae and *Varroa* with nymphs and eggs.

The treatments of series (B) show that mites collected from hive bees can be stimulated to produce offspring by topically applied JH_{III}. In 9 treatments containing 4 control groups. There was a significant increase of offspring in the JH_{III} groups ($chi^2 = 12.48$ $p = 0.95$).

Table 2 indicates the stimulus effect of JH_{III} on reproduction. The effect of the larval age was investigated with mites collected from hive bees. Mites and JH_{III} were added to sealed larvae of different ages. Figure 2 shows in a different way that only on young larvae oviposition is triggered in a high proportion of the mites. Table 3 indicates the actual number of mites used in this set of experiments.

DISCUSSION

From the results we might conclude that there is a sensitive phase at the beginning of the sealed brood phase where mites can be stimulated to lay eggs. They may incorporate large amounts of vitellogenin into the largest egg (HÄNEL, *in* prep.).

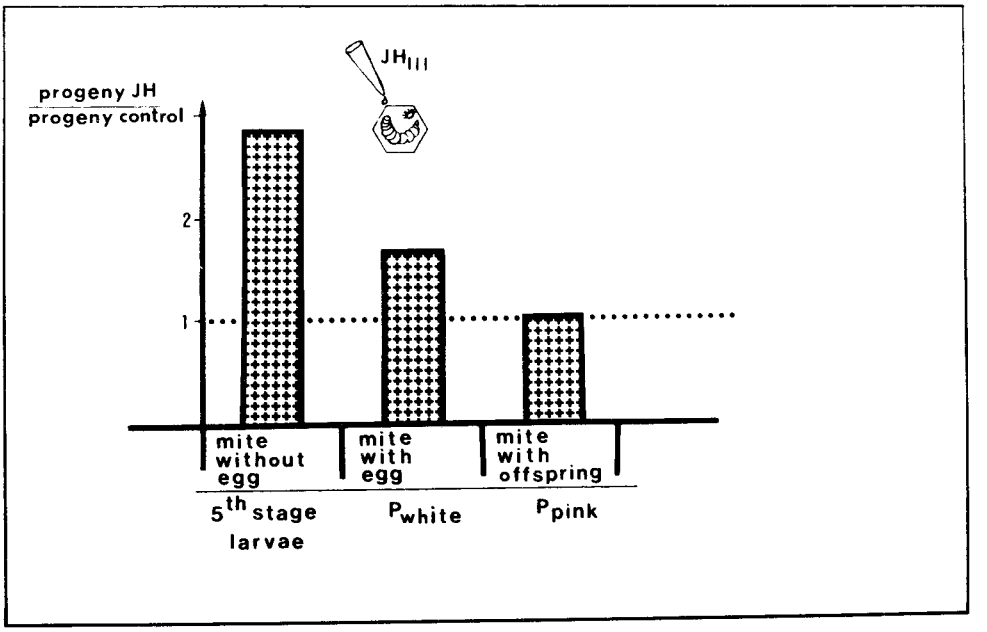

FIG. 1. — *Offspring ratio (JH treated / control mites) in three different blocks of bees*

ABB. 1. — *Nachkommenverhältnis (JH behandelte/Kontrollmilben) in drei verschiedenen Bienenaltersgruppen*

TABL. 1. — *Effect of tropically applied* JH_{III} (0.1 µg in 10 µl H_2O : acetone [9 : 1]) *on mites in sealed brood cells of* Apis mellifera (offspring numbers).

TAB. 1. — *Einfluß von* JH_{III} (1 µg in 10 µl H_2O:Aceton [9:1]) *auf Milben in verdeckelten Brutzellen von* Apis mellifera (Anzahl der Nachkommen).

	Bee age at the time of treatment					
	5th instar larvae		pupae white eyes		pupae pink eyes	
	JH	contr.	JH	contr.	JH	contr.
Varroa mothers	44	21	11	15	86	70
Offspring	62	11	36	31	138	107

We are investigating the influence of adult bee age on mite reproduction. Preliminary experiments by DE RUIJTER (pers. comm.) seem to indicate that mites from old bees lay eggs more often that those from young bees. This is interesting in comparison to the JH_{III} titer measurements by RUTZ *et al.* (1977), who found a strong hormone increase in the life of the adult worker bee.

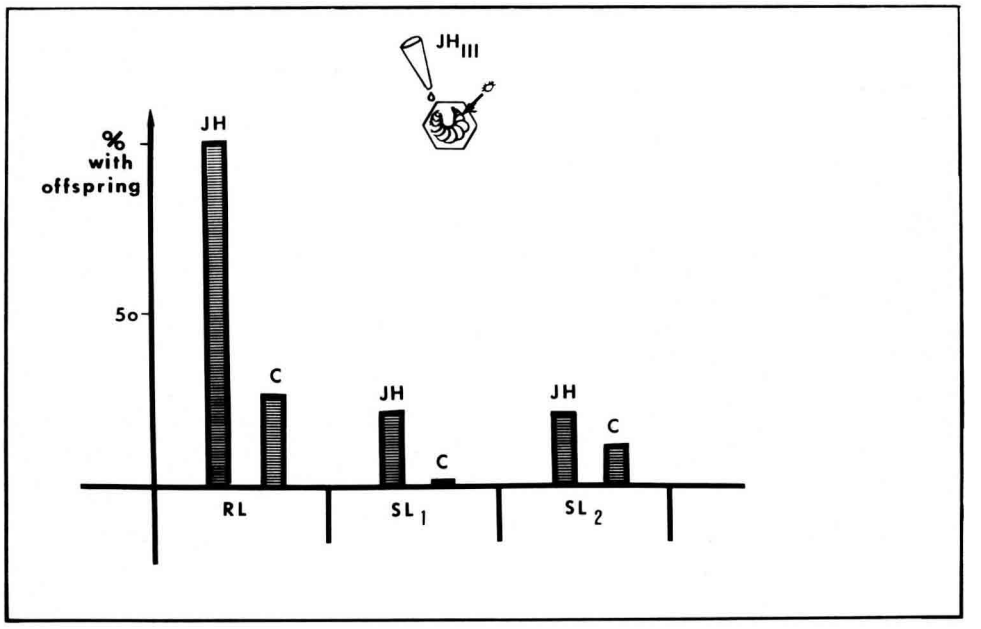

FIG. 2. — *Influence of JH_{III} on the offspring ratio of mites, added to bee larvae of different age.*
C = control; RL = 5th instar larvae; SL_1 = early spinning larvae; SL_2 = late spinning larvae.

ABB. 2. — *Einfluß von JH_{III} auf die Nachkommensrate von Milben, die zu Bienenlarven verschiedenen Alters* (verdeckelt) *hinzugesetzt wurden.*
C = Kontrollmilben; RL = Rund/Streckmade; SL_1 = frühe Streckmade; SL_2 = späte Streckmade.

TABL. 2. — *Number of mites following application of JH_{III} and* Varroa *mites to sealed brood cells with bees of different ages* (5th instar and prepupae)

TABL. 2. — *Nachkommenproduktion von Milben, die in verdeckelte Brutzellen zu verschieden alten Bienenlarven gesetzt wurden. Einfluß einer JH_{III}-Behandlung.*

	treatment	
	JH	control
Mites without offspring	62	85
Mites with offspring	22	6

There is also a peak of JH_{III} in the 5th instar drone larvae (HÄNEL, *in* prep.) which might trigger vitellogenin incorporation into the eggs of *Varroa*. There may be some other factors which trigger this process as well.

TABL. 3. — *Influence of JH on the offspring of mites added to bee larvae of different age.* Symbols as in fig. 2.

TAB. 3. — *Einfluß von JH auf die Nachkommensrate von Milben, die zu Bienenlarven verschiedenen Alters gesetzt wurden.* Abkürzungen wie in Abb. 2.

Bee group	Treatment	Mites with offspring	Mites without
RL	JH	6	0
	control	6	18
SL_1	JH	3	10
	control	0	13
SL_2	JH	3	14
	control	1	8

From our present findings we conclude that the mite can synchronize its reproduction with the metamorphosis of the bee larvae with the help of JH_{III}.

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ZUSAMMENFASSUNG

WIRKUNG VON JH_{III} AUF DIE FORTPFLANZUNG VON *VARROA JACOBSONI*

Behandelt man frisch verdeckelte Bienenmaden mit 1 µg Juvenilhormon (III), so löst man bei zuvor in die Brutzelle eingedrungenen oder auch bei künstlich zugesetzten Milben *(Varroa jacobsoni)* zu einem höheren Prozentsatz die Eilegeaktivität aus, als bei sonst gleich behandelten Kontrollmilben.

RÉSUMÉ

ACTION DE L'HORMONE JUVÉNILE III SUR LA REPRODUCTION DE *VARROA JACOBSONI*

Si l'on traite des nymphes d'abeilles récemment operculées avec 1 µg d'hormone junévile (III), on déclenche, chez les acariens *(Varroa jacobsoni)* qui avaient pénétré auparavant dans les cellules de couvain ou chez ceux qui avaient été introduits artificiellement, une activité de ponte supérieure à celle des acariens témoins traités de la même façon.

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