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J.M. Kulinčević, T.E. Rinderer, D.J. Urošević. SEASONALITY AND COLONY VARIATION OF REPRODUCING AND NON-REPRODUCING (1) VARROA JACOBSONI FEMALES IN WESTERN HONEY BEE (APIS MELLIFERA) WORKER BROOD. *Apidologie*, 1988, 19 (2), pp.173-180.
hal-00890739

HAL Id: hal-00890739

<https://hal.science/hal-00890739>

Submitted on 11 May 2020

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SEASONALITY AND COLONY VARIATION OF REPRODUCING AND NON-REPRODUCING ⁽¹⁾ *VARROA JACOBSONI* FEMALES IN WESTERN HONEY BEE (*APIS MELLIFERA*) WORKER BROOD

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SUMMARY

From June 19 to September 26, 1985, the worker brood of 14 honey bee colonies was periodically examined. Observations of numbers of reproducing female mites and numbers of non-reproducing females were recorded. Similar observations were recorded during 1986 from June 28 to October 1. Data for 1985 and 1986 were analyzed independently. Numbers of reproducing females and numbers of non-reproducing females were analyzed using a randomized block design in an analysis of variance in which colonies were considered as blocks and dates were considered as treatments.

The analyses indicated significant differences among dates in 1985 for numbers of reproducing females ($p < 0.0001$) and numbers of non-reproducing females ($p < 0.1$). Analyses of the data from 1986 failed to uncover the differences found for 1985.

The number of non reproductive female mites remained low for both years. In 1985 the average number of non-reproductive females per 100 cells per colony ranged from 0.29 (6/19/85) to 2.36 (9/14/85). In 1986 the average number ranged from 0.31 (10/01/86) to 1.06 (7/16/86).

The number of reproductive females varied tremendously in 1985. The average number of reproductive females per 100 cells per colony ranged from 0.29 (6/19/85) to 32.50 (9/14/85). In 1986 the average number varied from 3.13 (10/01/86) to 20.38 (7/16/86).

INTRODUCTION

KOENIGER *et al.* (1981) reported that *Varroa jacobsoni* does not normally reproduce when it occasionally infests worker brood of the Eastern honey bee,

(1) This research was partly financed by the International Cooperation and Development Special Foreign Currency Program of the United States Department of Agriculture.

Apis cerana. This phenomenon constitutes a chief characteristic of the interaction between this parasite and its natural Asian host. Extensive mite reproduction occurs only on drone brood of *A. cerana* (KOENIGER *et al.*, 1981). This caste-specific parasitism enhances the potential for the survival of *A. cerana* worker brood and hence parasitized *A. cerana* colonies.

A tendency for a portion of the infesting *Varroa jacobsoni* to not reproduce on the worker brood of *A. mellifera* has been reported for West Germany, Turkey and Brazil (RITTER and DE JONG, 1983), Greece (IFANTIDIS, 1984) and Yugoslavia (SULIMANOVIĆ *et al.*, 1982). An unusually consistent high level of non-reproducing female mites in *A. mellifera* worker brood (70-90 %) was reported for mite populations in Uruguay (RUTTNER and MARX, 1984). Similar levels of non-reproducing mites were reported for European bees in Paraguay (RUTTNER and MARX, 1984) and Africanized bees in Brazil (ROZENKRANZ, 1986). Variation may exist among *A. mellifera* colonies for this characteristic. If such variation in part results from honey-bee characteristics of a genetical nature, selective breeding for these characteristics might lead to the development of mitetolerant stocks. Alternately, variation in the numbers of reproducing mites might be so strong that reduced numbers of infesting mites would be the more profitable characteristic for selection. The purpose of this experiment was to compare variation of these two characteristics in honey bee populations in order to determine which could be more successfully selected in a breeding program.

MATERIALS AND METHODS

Langstroth hives were used for 14 colonies of *A. mellifera carnica* in 1985, and 16 colonies of the same subspecies in 1986. These colonies were maintained as though they were part of a commercial apiary. No attempts were made to precisely equalize brood nest sizes or adult population. However, the colonies were maintained as strong units and subjected to reasonably uniform procedures of colony management.

Worker brood was removed on each colony and 8 occasions in 1985 and 6 occasions in 1986. Cells were opened on those containing worker pupae with dark eyes and light-brown abdominal chitin (16-17 days old) were examined. Examinations and mite classifications were made according to the procedures of IFANTIDIS (1984), except that samples were not frozen prior to inspection. Based on mite morphology and progeny counts, all mites observed were classified as reproducing or non-reproducing. Numbers of infesting mites in these two categories were submitted to analysis of variance for the main factors of colony and date of inspection for both years of the experiment.

RESULTS AND ANALYSES

In 1985, large variation in the numbers of reproducing mites was observed both among colonies and dates. Significant differences also were observed among colonies and dates for numbers of non-reproducing mites (Table 1).

TABLE 1. — Analysis of variance, numbers, means, and standard deviations for reproducing and non-reproducing females of *Varroa jacobsoni* parasitizing 100 cells of worker brood of *Apis mellifera* from 6/19/85 to 9/26/85

Date	Total number of mites	Reproducing female mites				Non-reproducing female mites			
		Number	X ± SD per colony	Range	Percentage of total	Number	X ± SD per colony	Range	Percentage of total
		6/19/85	8	0.3 ± 0.6	0-2	50.0	4	0.3 ± 0.5	0-1
6/28/85	28	1.0 ± 1.8	0-6	50.0	14	1.0 ± 1.1	0-3	50.0	
7/18/85	34	1.7 ± 2.7	0-7	70.6	10	0.7 ± 1.1	0-3	29.4	
8/01/85	75	4.1 ± 4.2	0-12	76.0	18	1.3 ± 1.4	0-4	24.0	
8/15/85	155	10.1 ± 9.8	1-33	92.8	11	0.8 ± 0.9	0-3	7.2	
8/29/85	191	12.6 ± 2.2	1-39	92.7	14	1.0 ± 1.0	0-3	7.3	
9/14/85	488	32.5 ± 18.6	5-83	93.2	33	2.4 ± 1.6	0-5	6.8	
9/26/85	118	7.5 ± 19.1	0-64	89.0	13	0.9 ± 2.0	0-6	11.0	

Analyses

Source	df	MS	F	P	Source	df	MS	F	P
Colony	13	296.5	3.04	0.0009	Colony	13	2.9	2.03	0.026
Date	7	1 571.2	16.09	0.0001	Date	7	5.1	3.63	0.002
Sampling	91	97.6			Sampling	91	1.4		

TABLE 2. — Analysis of variance, numbers, means, and standard deviations for reproducing and non-reproducing females of *Varroa jacobsoni* parasitizing 100 cells of worker brood of 16 colonies of *Apis mellifera* from 6/28/85 to 10/01/86

Date	Total number of mites	Reproducing female mites				Non-reproducing female mites			
		Number	X ± SD per colony	Range	Percentage of total	Number	X ± SD per colony	Range	Percentage of total
6/28/86	237	222	13.9 ± 24.0	0-90	93.7	15	0.9 ± 1.3	0-4	6.3
7/16/86	343	326	20.4 ± 23.7	0-70	95.0	17	1.1 ± 1.3	0-16	5.0
8/01/86	253	238	14.8 ± 23.0	0-94	94.1	15	0.9 ± 1.0	0-3	5.9
8/13/86	167	152	9.5 ± 14.1	0-52	91.0	15	0.9 ± 1.5	0-4	9.0
8/29/86	197	182	11.4 ± 8.4	0-25	92.4	15	0.9 ± 1.2	0-3	7.6
10/01/86	55	50	3.3 ± 3.5	0-11	90.9	5	0.3 ± 0.6	0-2	9.1

Analyses									
Source	df	MS	F	P	Source	df	MS	F	P
Colony	15	537.2	1.88	0.04	Colony	15	2.63	2.25	0.01
Date	5	506.8	1.77	0.13	Date	5	1.04	0.89	0.49
Sampling	74	285.6			Sampling	74	1.17		

Seasonal fluctuations in the ranges of numbers of reproducing mites were wide ; early (6/19) the range was 0-2 and later (9/14) it was 5-83. This contrasted with weak seasonal fluctuations in ranges of numbers of non-reproductive mites ; early (6/19) this range was 0-1 and later (9/26) it was 0-6.

Similar, but less intense trends occurred in the data from 1986 (Table 2). Again, large variation occurred among colonies for numbers of reproducing mites, and some differences were observed among colonies for non-reproducing female mites. At its largest, (8/1) the range of reproducing mites was from 0-94 and for non-reproducing mites (7/16) was from 2-16. However, analysis of variance showed that date-related differences were insignificant during 1986 for numbers of both classes of mites.

DISCUSSION

Variation exists in the occurrence of non-reproducing *Varroa jacobsoni* between colonies. The variance we describe is similar to that reported by ROZENKRANZ (1986) for Carniolan and Africanized bees. However, the occurrence of non-reproducing mites is a minor theme in the population dynamics of *Varroa jacobsoni*, even when examined across a full seasonal range. At least, this is true of the mites in our two-year study. Selection for increased proportions of non-reproducing mites may yield some success. However, the large variation observed in the numbers of reproducing mites shows much greater promise for such numbers to be used as a measure in selection programs to improve honey-bee tolerance to *Varroa* mites. Seasonal variation in the levels of reproducing and non-reproducing mites suggests that selections can profitably be made during more than half of the active season.

Received for publication in March 1987.

Accepted for publication in April 1988.

ACKNOWLEDGEMENTS

In cooperation with the Louisiana Agricultural Experiment Station. We thank Steve M. Buco for statistical guidance.

RÉSUMÉ

VARIATION, EN FONCTION DE LA SAISON ET ENTRE COLONIES, DU NOMBRE DE FEMELLES REPRODUCTRICES ET DE FEMELLES NON REPRODUCTRICES DE *VARROA JACOBSONI* PRÉSENTES SUR LE COUVAIN DE L'ABEILLE *APIS MELLIFICA*

On a examiné régulièrement le couvain d'ouvrières de 14 colonies du 17 juin au 26 septembre 1985 et dénombré les femelles de *Varroa* reproductrices et les non reproductrices. Les observations ont été répétées en 1986 du 28 juin au 1^{er} octobre. On a traité séparément les données de 1985 et 1986. On a analysé le nombre de femelles reproductrices et de femelles non reproductrices par une analyse de variance en blocs aléatoires pour les deux facteurs : colonie et date.

Les analyses ont montré des différences significatives entre les dates en 1985 pour le nombre de femelles reproductrices ($p < 0,0001$) et le nombre de femelles non reproductrices ($p < 0,01$). Mais les analyses des données de 1986 n'ont pas confirmé les différences trouvées en 1985.

Le nombre de femelles non reproductrices est resté bas en cours des 2 années. En 1985 le nombre moyen de femelles non reproductrices par 100 cellules par colonie a varié de 0,29 (19/6/85) à 2,36 (14/9/85) et en 1986 de 0,31 (1/10/86) à 1,06 (16/7/86).

Le nombre de femelles reproductrices a considérablement varié en 1985. Le nombre moyen de femelles reproductrices par 100 cellules par colonie est allé de 0,29 (19/6/85) à 32,50 (14/9/85) et, en 1986, de 3,13 (1/10/86) à 20,38 (16/7/86).

La variation entre colonies du nombre d'acariens reproducteurs est le facteur le plus approprié comme critère de sélection pour obtenir des abeilles tolérant *Varroa*. La variation du nombre d'acariens non reproducteurs, bien que présente dans cette étude, est comparativement faible et prise seulement comme second choix en tant que critère de sélection. La variation saisonnière du niveau des acariens reproducteurs et des acariens non reproducteurs suggère que l'on peut effectuer avec succès une sélection durant plus de la moitié de la saison active.

ZUSAMMENFASSUNG

SCHWANKUNGEN DER ZAHL DER WEIBCHEN VON *VARROA JACOBSONI* MIT UND OHNE NACHKOMMEN AUF DER BRUT DER WESTLICHEN HONIGBIENE (*APIS MELLIFERA*) WÄHREND DER SAISON UND ZWISCHEN DEN VÖLKERN

In der Zeit zwischen 19. Juni und 26. September 1985 wurde die Arbeiterinnenbrut von 14 Völkern in regelmäßigen Abständen untersucht. Die Zahl der *Varroa*-Weibchen mit Fortpflanzung und die Zahl der Weibchen ohne Nachkommen wurden registriert. Ähnliche Beobachtungen wurden im Jahre 1986 zwischen 28. Juni und 1. Oktober durchgeführt. Die Daten von 1985 und von 1986 wurden unabhängig voneinander analysiert. Unter Verwendung eines zufallsverteilten Blockschemas in einer Varianzanalyse wurden die Zahlen der Weibchen mit Fortpflanzung und die Zahlen der Weibchen ohne Fortpflanzung analysiert, wobei die Völker als Blöcke und die Daten als der zu berücksichtigende Beobachtungsfall betrachtet wurden.

Die Analysen ergaben für die Daten von 1985 signifikante Unterschiede bei der Zahl der sich fortpflanzenden Weibchen ($p < 0,0001$) und der sich nicht fortpflanzenden Weibchen ($p < 0,01$). In den Analysen der Daten von 1986 wurden aber die für 1985 festgestellten Unterschiede nicht gefunden.

In beiden Jahren blieb die Zahl der sich nicht fortpflanzenden Weibchen gering. Im Jahre 1985 lag die mittlere Zahl von Weibchen ohne Nachkommen pro 100 Zellen je Volk zwischen 0.29 (19.6.1985) und 2.36 (14.9.1985). 1986 schwankte die mittlere Zahl zwischen 0.31 (1.10.1986) und 1.06 (16.7.1986).

Im Jahre 1985 schwankte die Zahl der Weibchen mit Nachkommen ganz außerordentlich. Die mittlere Zahl der Weibchen mit Nachkommen pro 100 Zellen schwankte zwischen 0.29 am 19.6. und 32.50 am 14.9.1985. Im Jahre 1986 lagen dieselben Werte zwischen 3.13 (1.10.1986) und 20.38 (16.7.1986).

Die Variation zwischen den Völkern in der Zahl der Milben mit Nachkommen erwies sich als geeignetster Kandidat für ein Selektionsmaß zur Zucht einer *Varroa*-toleranten Biene. Eine Variation in der Zahl der Milben ohne Nachkommen war zwar in dieser Untersuchung ebenfalls vorhanden, aber nur verhältnismäßig schwach ausgeprägt und deutlich nur eine zweite Wahl als Selektionsmerkmal. Die jahreszeitliche Schwankung in dem Grad der sich fortpflanzenden und nicht fortpflanzenden Milben deutet darauf hin, daß eine erfolgreiche Selektion während mehr als der Hälfte der aktiven Saison möglich ist.

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