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Resistance to *Acarapis woodi* by honey bees from far-eastern Russia

Lilia I. de GUZMAN^{a*}, Thomas E. RINDERER^a, Gary T. DELATTE^a,
J. Anthony STELZER^a, Lorraine BEAMAN^a, Victor KUZNETSOV^b

^a USDA Honey Bee Breeding, Genetics and Physiology Laboratory, 1157 Ben Hur Road,
Baton Rouge, LA 70820, USA

^b Institute of Biology and Pedology, Far-Eastern Branch of the Russian Academy of Sciences,
Vladivostok 690022, Russia

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Abstract – Honey bees from the Primorsky region of far-eastern Russia were evaluated for their resistance to *Acarapis woodi*. Results from a field test in Louisiana showed that Primorsky honey bees showed strong resistance to tracheal mites. The Primorsky honey bees maintained nearly mite-free colonies throughout the experiment while the domestic stocks were ultimately parasitized by high levels of tracheal mites.

Acarapis woodi / tracheal mite / resistance / *Varroa destructor* / far-eastern Russia / Primorsky region

1. INTRODUCTION

The honey bee tracheal mite, *Acarapis woodi* (Rennie), continues to be a significant threat to honey bees in the United States. Concerns about acaricides and their potential effects on honey bees (*Apis mellifera* L.) and their by-products have led researchers to seek non-chemical means of managing mite populations.

Several studies have identified stocks of honey bees that are resistant to *A. woodi*. Buckfast and ARS-Y-C-1, which were imported from the United Kingdom and Yugoslavia, respectively, have shown considerable degrees of resistance to tracheal mites (Gary et al., 1990; Milne et al., 1991; Rinderer et al., 1993; Williams et al., 1994; Danka et al., 1995; de Guzman et al., 1996; Lin et al., 1996; de Guzman et al., 1998). These stocks are now commercially available in the United States. However, neither of these stocks has notable resistance to the external parasitic mite, *Varroa destructor* (Anderson

and Trueman, 2000), formerly referred to as *V. jacobsoni* Oudemans.

In Russia, tracheal mites were first discovered in Tula province (a hundred miles south of Moscow) in 1922 (Perepelova, 1927). Honey bees in the Primorsky region have no known historical exposure to the parasite. However, a few attendant workers of queens imported into the United States from the region were infested with tracheal mites and thus showed the existence of this parasite in the Primorsky region.

Honey bees from the Primorsky region of far-eastern Russia were imported into the United States in 1997 (Rinderer et al., 1997) and have been released to the beekeeping industry because of their strong resistance to *V. destructor* (Rinderer et al., 1999, 2000, 2001). To more fully evaluate the commercial value of Primorsky honey bees, we conducted these studies to explore their comparative susceptibility to *A. woodi* infestations.

* Correspondence and reprints
E-mail: ldeguzman@ars.usda.gov

2. MATERIALS AND METHODS

Natural infestations of tracheal mites were monitored in experimental colonies used to evaluate Primorsky honey bees for their resistance to *V. destructor* (Rinderer et al., 2001). Twenty-two daughter queens of six selected Primorsky breeder colonies were established in standard hives with 1.35 kg of Primorsky bees as described by Rinderer et al. (2001). Similarly, 22 queens purchased from four United States queen breeders, were established with about 1.35 kg of domestic bees. Domestic and Primorsky colonies were divided equally in two apiaries near Baton Rouge, Louisiana, with random placement within apiaries. All colonies (except one domestic colony which was requeened in March 1999) were requeened in April 1999 as a standard management practice.

Due to their microscopic size, tracheal mites can only be inoculated by using infested adult bees, which may also harbor adult *V. destructor* mites. Hence, colonies were not inoculated with tracheal mite-infested adult bees to avoid the inadvertent addition of *V. destructor* into the colonies, because the *V. destructor* populations were also being measured. Thus, the difference in the initial infestations resulted from colonies being established from two different bulk packages and the impossibility of tracheal mite inoculation into the colonies. This technique allowed us to determine the ability of Primorsky colonies to maintain mite-free colonies while being exposed to tracheal mite infestations within the apiaries. Further, we were able to follow growth of tracheal mite populations in domestic colonies founded with very low (0–7%) levels of infestation in Louisiana where summer heat is thought to have a great influence on tracheal mite populations.

Infestation parameters were calculated by randomly selecting 30 worker bees from a sample of about 300–500 bees per colony and classifying each bee as to whether or not it was infested. The proportion of infested bees (prevalence) and mite abundance (number of mites per bee) were calculated for each colony at each sampling event. No inferential statistics were conducted due to the small number of infested Primorsky colonies at each sampling event.

3. RESULTS

3.1. Prevalence

The Primorsky colonies started with uninfested bees while the domestic colonies had very low initial infestations of tracheal mites ranging from 0–7% (9 out of 22 colonies

were infested) (Tab. I). Infestations in the domestic colonies subsequently decreased to their lowest levels (mean = $0.30 \pm 1.4\%$, mean \pm SD) in September 1998 when only one domestic colony was infested with 7%. Mean infestations in the domestic colonies started to increase in October (mean = $0.91 \pm 1.8\%$, range = 0–7%) but remained low until November 1998 with the exception of one domestic colony having 27% infestation. In February 1999, tracheal mite infestations rose sharply (mean = $12 \pm 22.3\%$, range = 0–77%) and remained higher throughout the remainder of the experimental period. The highest mean infestation rate (mean = $18 \pm 29\%$, range = 0–93%) for domestic stock was recorded in March 1999. In the Primorsky honey bee colonies, *A. woodi* was unable to maintain a population and infestation rates remained at or near zero throughout the experiment. Only one Primorsky colony had an infestation of 3% each in April and May 1999.

There were 7 and 8 dead domestic colonies observed in May and June 1999, respectively, primarily due to *Varroa destructor* infestations (Tab. I). However, at least three of these 15 dead colonies were concurrently infested (40–87%) with tracheal mites. By June 1999, no Primorsky colonies died.

3.2. Abundance

For the first 6 months, both types had similar mite abundances. Thereafter, mean mite abundances in the domestic colonies were higher. The average number of mites per bee in the domestic colonies was two with the highest number (seven mites) observed in May 1999. The Primorsky bees were nearly mite-free during our one-year evaluation.

4. DISCUSSION

Honey bee colonies with tracheal mite infestation levels above 25% are most likely to die from the feeding activities of mites (Eischen, 1987). However, lower infestation levels (20%) were reported to have caused death of honey bee colonies in New York (Otis and Scott-Dupree, 1992). Although the domestic honey bee stocks had average infestations

Table I. Descriptive statistics for *A. woodi* prevalence in domestic and Primorsky colonies.

Type	Statistic	Month									
		1998					1999				
		Jul.	Aug.	Sept.	Oct.	Nov.	Feb.	Mar.	Apr.	May	Jun.
Domestic	Mean	1.7	0.45	0.3	0.91	1.5	11.5	17.5	13.6	15.7	13.3
	Minimum	0	0	0	0	0	0	0	0	0	0
	Maximum	6.7	3.3	6.7	6.7	26.7	76.7	93.1	73.3	86.7	63.3
	Std. deviation	2.2	1.2	1.4	1.8	5.8	22.3	29	21.6	27.3	20.7
	No. colonies examined	22	22	22	22	22	22	22	22	22*	14**
	No. colonies infested	9	3	1	5	2	7	9	10	12	9
Primorsky	Mean	0	0	0	0	0	0	0	0.15	0.15	0
	Minimum	0	0	0	0	0	0	0	0	0	0
	Maximum	0	0	0	0	0	0	0	3.3	3.3	0
	Std. deviation	0	0	0	0	0	0	0	0.7	0.7	0
	No. colonies examined	22	22	22	22	22	22	22	22	22	19
	No. colonies infested	0	0	0	0	0	0	0	1	1	0

All colonies were requeened in April 1999.

* 7 colonies died due to *Varroa destructor*. One colony had 87% tracheal mite infestation.

** 8 colonies died due to *Varroa destructor*. Two colonies had 40 and 47% tracheal mite infestations.

(18 ± 29%) below these two economically damaging levels, it is interesting to note that some domestic colonies developed high tracheal mite infestations (up to 93%) observed in March 1999. On the other hand, the Primorsky honey bees showed strong resistance to *A. woodi* by maintaining nearly mite-free colonies throughout the experimental period despite being exposed to such high infestations in the domestic colonies. This observation is consistent with our recent studies showing the same ability of Primorsky honey bees to maintain low levels of tracheal mite infestation in colonies located in Louisiana, Iowa and Mississippi (de Guzman et al., 2001a and b). In Louisiana, colonies established with tracheal mite infested domestic honey bees (range = 18–54%), sharply decreased their infestations to 0–3% 91 days after the introduction of Primorsky queens (de Guzman et al., 2001b). Clearly, the use of this stock should require few to no treatments to control tracheal mites.

A survey of tracheal mite resistance in colonies headed by several United States commer-

cial breeding stocks revealed great variations (Danka and Villa, 2000). Although a majority of the authors' test colonies displayed resistance to tracheal mites, some colonies showed a high degree of susceptibility to the parasite. Similar variation was evident in our study. While some domestic colonies maintained mite-free colonies also, several colonies showed a dramatic increase (up to 93%) in infestation observed from February to June 1999. In May and June 1999, a total of 15 domestic colonies died due to *V. destructor* parasitism. However, 3 of these dead colonies were also highly (40–87%) infested with tracheal mites. The occurrence of high levels of tracheal mites may have weakened the *V. destructor* resistance of these colonies. High susceptibility of different domestic stocks to tracheal mites was also observed experimentally in Louisiana where about 60% of the infested domestic colonies died from high tracheal mite infestations during 9 months of observations (de Guzman et al., 2001a). The authors also showed that about 91% of the Primorsky colonies survived

the winter with low levels (average of 4% in untreated colonies) of tracheal mite infestations at the end of the experiment.

The tracheal mite resistance mechanisms in Primorsky colonies were not established directly in this study. However, our field study suggests that colony defense against foreign honey bees or mite grooming behavior, a mechanism of resistance observed in the Buckfast bees (Danka and Villa, 1998), may be contributory factors to Primorsky honey bee resistance to tracheal mites. Colonies of both Primorsky and domestic stocks were located in the same apiary and were often next to one another. Drifting and robbing between colonies occurred often during colony manipulations. Presumably, intercolonial movement of honey bees plays a major role in mite invasion. Although every opportunity seems to have presented itself for tracheal mites to move from infested domestic colonies to uninfested Primorsky colonies, the Primorsky colonies remained relatively mite-free. Perhaps the Primorsky honey bees resisted mite invasion by resisting the invasion of foreign honey bees or by auto- or allo-grooming of invading mites.

Further studies should be done to identify the mechanisms of resistance to tracheal mites by the Primorsky honey bees. Some features of their tracheal mite resistance may be shown to result from mechanisms that support resistance to *V. destructor*.

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Résumé – Résistance à *Acarapis woodi* chez les abeilles domestiques de l'extrémité orientale de la Russie. Plusieurs études ont identifié des lignées d'abeilles domestiques (*Apis mellifera*) résistant à l'acarien des trachées, *Acarapis woodi*, mais aucune d'elles ne présente de résistance notable au parasite externe *Varroa destructor*. Des abeilles de la région de Primorsky (extrémité orientale de la Russie) ont été importées aux États-Unis en 1997 en raison de leur forte résistance à *V. destructor*. Afin d'évaluer

plus complètement la valeur commerciale des abeilles Primorsky (P), nous avons étudié leur sensibilité à *A. woodi*. Les infestations naturelles par *A. woodi* ont été suivies chez 22 reines sœurs de six colonies sélectionnées d'éleveurs de Primorsky. Les colonies Primorsky (P) ont été comparées à 22 colonies domestiques (D) ayant chacune à leur tête une reine achetée aux États-Unis chez quatre éleveurs. Les colonies tests ont été créées avec des paquets d'abeilles de 1,35 kg en juin 1998.

Nos résultats montrent que les colonies P comme les colonies D avaient des infestations moyennes situées en-dessous du seuil économique. Bien que les lignées d'abeilles D aient eu des infestations moyennes ($18 \pm 29\%$) en-dessous du seuil de dégât économique, il est intéressant de noter que certaines colonies D ont présenté des niveaux d'infestation élevés (jusqu'à 93%) en mars 1999. Par contre les abeilles P ont maintenu des colonies pratiquement indemnes d'*A. woodi* durant toute la durée de l'expérience. Cette observation est en accord avec nos études récentes qui montrent la même capacité qu'ont les abeilles P à maintenir bas les niveaux d'infestation par *A. woodi* dans des colonies situées dans les états de Louisiane, d'Iowa et du Mississippi (de Guzman et al., 2001a and b). L'utilisation de cette lignée devrait donc nécessiter peu ou pas de traitements contre l'acarien des trachées. Il faudrait mener d'autres études pour découvrir les mécanismes de résistance à *A. woodi* utilisés par les abeilles Primorsky.

***Acarapis woodi* / résistance / *Varroa destructor* / Russie d'Extrême-Orient / région de Primorsky**

Zusammenfassung – Resistenz gegen *Acarapis woodi* bei Honigbienen aus dem fernöstlichen Russland. Honigbienen aus der Primorski Region des fernöstlichen Russlands wurden auf ihre Resistenz gegen die Tracheenmilbe *Acarapis woodi* überprüft. In Völkern mit 22 Tochterköniginnen wurde ein natürlicher Befall mit der Tracheenmilbe beobachtet. Die Primorski Völker wurden mit 22 heimischen Völkern mit Königinnen von 4 Züchtern aus den USA verglichen. Die Testvölker wurden im Juni 1998 aus 1,35 kg Paketbienen gebildet. Nach unseren Ergebnissen blieben beide, die Primorski und die USA Völker unterhalb der ökonomischen Schadensschwelle. Obwohl die Bienen aus den USA Beständen mit einem durchschnittlichen Befall von $18 \pm 29\%$ unter der ökonomischen Schadensgrenze lagen, ist der Hinweis auf einen hohen Befallsgrad, mit bis zu 93% bei einigen Völkern im März 1999 wichtig. Die Primorski Honigbienen blieben dagegen über die gesamte Versuchszeit nahezu befallsfrei. Diese Beobachtung stimmt mit

unseren jetzigen Untersuchungen überein, die ebenfalls die Fähigkeit der Primorski Bienen aufzeigen, in Völkern in Louisiana, Iowa und Mississippi den Befallsgrad mit Tracheenmilben auf einer niedrigen Stufe zu erhalten (de Guzman et al., 2001a und b). Deshalb ist bei der Nutzung dieser Zuchtvölker nur wenig oder gar keine Behandlung zur Kontrolle der Tracheenmilben nötig. In weiteren Untersuchungen müsste der Resistenzmechanismus der Primorski Bienen gegen die Tracheenmilbe untersucht werden.

***Acarapis woodi* / Tracheenmilbe / Resistenz / *Varroa destructor* / fernöstliches Russland / Primorski Region**

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