Natural Suppression of Honey Bee Tracheal Mites In North Dakota: A Five Year Study

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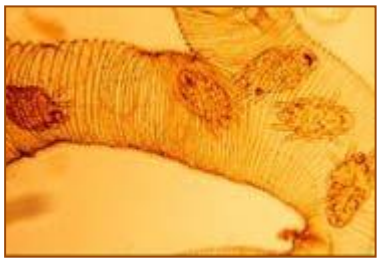
ABSTRACT

The honey bee tracheal mite (HBTM), Acarapis woodi is a parasite that infests the tracheae of adult bees. It has been suggested that abnormally large brood comb cell diameter may stress the honey bee colony, thereby rendering its population more susceptible to infestation by parasitic mites. This five-year study of 80 colonies was undertaken to determine the effect of cell diameter on the incidence and population dynamics of HBTM in commercially managed colonies in North Dakota. We expected that HBTM infestations would develop naturally and advance to severe levels over time. This did not happen. Thus, the data presented document natural HBTM suppression. The data clearly demonstrate that low-level chronic infestations of HBTM may persist in honey bee colonies without apparent impact on colony vigor or productivity. The data do not explain why HBTM populations in these colonies remained suppressed. There was no significant effect of cell diameter on tracheal mite populations or on honey production.

INTRODUCTION



The tracheal mite, *Acarapis woodi* (Rennie) , is a parasite of adult honey bees (*Apis mellifera L.*) . Honey bee tracheal mites (HBTM) feed and reproduce in the tracheae of their host causing respiratory distress, loss of hemolymph and possible secondary infection, all of which can impact colony vigor. Levels of infestation above 30 percent (of the bees within a colony) contribute to a loss in colony productivity and are likely to lead to the demise of the colony over winter (Henderson and Morse, 1990: Shimanuki *et al.*, 1992) . Erickson, 1990; Erickson, et al., 1990 suggested that brood comb cell diameters greater (or smaller) than normal may alter colony behavior or otherwise stress the colony, thereby rendering it more susceptible to infestation by parasitic mites and disease.

The diameter of cells naturally constructed in wax comb (that is in the absence of manufactured foundation) by most races of honey bees, is ~5.1 mm/cell (or 888 cells/dm2) , but may range from 5.0-5.3 mm/cell (Erickson, *et al.*, 1990) . The diameter of cells constructed by managed honey bee colonies in Langstroth type hives is predetermined by the diameter of cell impressions on the foundation selected for use. This diameter may vary from 4.8-5.6 mm/cell, depending on the source and specifications of the manufacturer (Erickson, *et al.*, 1990) . Cell diameter for most commercially available foundation is between 5.07 mm (~900 cells/dm2) and 5.4 mm (~780 cells/dm2) .

This study was undertaken to determine the long-term effect of small vs. large brood comb cell diameter on the incidence and population dynamics of HBTM in commercially managed colonies in North Dakota. HBTM was known to occur in the study area since 1989. However, significant HBTM populations did not develop in any of the test colonies. The data presented provide a five-year case study of chronic, but very low-level HBTM infestations in two apiaries of 40 colonies each. A further purpose of the study was to determine whether comb cell diameter influences colony level honey production.

METHODS AND MATERIALS

Eighty colonies of honey bees were established in single story standard 24.5 cm (9.625 in) deep Langstroth hives on pallets near Marion, in southeastern North Dakota. There were two treatment groups split equally between two dedicated apiaries. Frames for forty hives were fitted with “small cell” diameter foundation. This foundation was made using a circa 1929 A. I. Root foundation mill producing a cell diameter of 5.12 mm/cell (~880 cells/dm2) . The remaining forty hives were fitted with “large cell” foundation having a cell diameter of 5.44 mm/cell (~780 cells/dm2) obtained from Dadant and Sons, Hamilton, IL. All brood chambers in each treatment held nine frames with one type of foundation and one starter comb previously drawn from the same foundation. In the spring, one division board feeder was temporarily inserted in each brood chamber.

Three pound packages from a single source in Moreauville, Louisiana were installed during the last week of April 1989. Following the installation of packages, all colonies were fed a mixture of high fructose corn syrup (HFCS) diluted with water (10% by volume) ad libitum for a period of ca seven weeks to facilitate comb construction and augment available bee forage. Similarly, pollen supplement was fed ad libitum for four weeks to stimulate brood rearing. Populations of bees and brood were equalized within treatments in June, 1989.

Thereafter, the colonies were maintained following the normal management practices of the beekeepers (A. & J. King) . These practices include maintaining one brood chamber below a queen excluder, disease control, requeening queenless colonies using daughter queens reared from superior stock selected by the beekeepers, supering and honey removal. In the fall, in preparation for the extended winters characteristic of the area, all honey above the queen excluder in each colony was removed. The colonies were reduced to one brood chamber and consolidated in apiaries of ca 80-100 colonies each. Normally, bees from weak colonies were shaken out into medium strength colonies, resulting in only strong colonies being wintered. For the purpose of this study only, weak colonies were simply united with medium strength colonies which led to the wintering of a few two-story colonies within the test groups. All colonies were weighed and fed an amount of undiluted HFCS equal to the difference between actual gross weight and a target gross weight of ~38 kg (85 lbs) , including migratory cover, for a single story colony (~63 kg or 140 lbs for a double) . The colonies were then placed wall to wall on pallets in two tiers of four per pallet. They were then covered with black plastic corrugated cartons and one ply of reflective insulation (foil covered bubble pack) on top only. Each of the eight colonies was provided an upper entrance. Colonies were packed for winter in late October early November, then unpacked in late March early April and fed diluted HFCS as needed along with Terramycin. Each spring, the winter survivors were split back to 40 colonies per treatment. All apiaries were maintained within a 42 km (25 miles) radius, but moved one to three times annually to optimize honey production. During the course of this study the only bees incorporated into the test group were replacement queens.

Cell Diameter

The actual diameter of the cells produced by colonies in both treatments was subsequently determined following the methods of Erickson and Edwards (1990) . In June 1993, live measurements of ten linear cells were taken at random from a single frame removed from the brood nest of each colony. Mean constructed cell diameters for the small and large cell treatments were 5.14 (S-x = 0.006) and 5.36 (Sx- = 0.006 mm/cell, respectively.

Tracheal Mites

Two composite samples of several hundred bees were taken from the packages in each treatment at the time they were installed. Thereafter, ca 100 adult bees were removed from the brood nest of each wintered unit beginning in 3/90 and continuing, both spring and fall until 4/95. (Note, all colonies were united in pairs in the fall of 1989, but only as needed thereafter) . The samples were taken each spring and fall immediately frozen and sent to the Carl Hayden Bee Research Center, Tucson, AZ where they were thawed and analyzed. For analysis, 30 bees were removed at random from each sample to determine the level of HBTM infestation for each colony/treatment/date.

HBTM infestations were estimated using the procedures of Delfinado-Baker (1984) : Prothoracic collars were removed from each of the 30 bees, clarified for 24-36 h in five percent potassium hydroxide at 39º C, and examined at 100x magnification with a stereo-microscope. Infestation was reported as the percent of overwintered units with mites and percent of each 30 bee sample with one or more mites.

Honey Production

Honey production was determined by weighing the honey removed from each colony. The mean weight of honey harvested per colony was determined annually for each treatment for comparison.

RESULTS AND DISCUSSION

Mites

This long-term study was undertaken with the expectation that HBTM infestations would develop naturally in all test colonies and advance to severe levels over time. Moreover, the management strategy of combining weak colonies in the fall and splitting them in the spring would be expected to spread infestations from colonies weakened by HBTM. Surprisingly, neither happened. Instead, the data presented document natural HBTM suppression. We were unable to determine the factor (s) contributing to this suppression.

HBTM were not detected in the two composite samples taken initially. The data in Table 1 are based on overwintered units, some of which were single colonies, while others consisted of two united colonies. These data show, by treatment, the percent of overwintered units infested on each sampling date, and the levels of infestation as a mean for infested (only) units. Although the average number of colonies infested with HBTM ranged from zero to 59 percent, the mean number of HBTM-infested units with small and large cells was 18.4 (Sx- = 5.9) and 16.5 (Sx- = 6.6) , respectively over all sampling dates. Similarly, the overall mean number of bees with HBTM in both treatments was 1.26 (Sx- = 0.15) and 1.46 (Sx- = 0.15) , respectively. The maximum number of bees with mites within any single infested colony was less than 12 percent. These data are similar to those obtained from a six year study of over 200 colonies conducted at Harpenden, Herts., England by Bailey (1961) . In this study, Bailey reported that the average number of colonies infested with HBTM ranged from six to 65 percent, with only 10.7 percent of the colonies having more than ten percent of the population infested.

Table 1. Honey bee tracheal mite infestation levels among overwintered units: 1989-1994.

Treatment	3/90	10/90	4/91	10/91	3/92 (1)	4/93 (1)	4/94 (2)	4/95
Small Cell - % units w/mites	30	18	8	11	7	0	14	59
N =	20	33	26	28	28	31	28	22
Mean # Bees w/mites for infested samples (2)	1.3	1.2	1.0	1.0	1.0	-	1.2	2.1
Large Cell - % units w/mites	29	23	12	0	3	0	10	55
N =	17	30	25	30	29	33	29	27
Mean # Bees w/mites for infested samples (2)	1.4	1.6	1.3	-	2.0	-	1.0	3.7

(1) Samples for 10/92 and 10/93 damaged during shipment.
(2) Sample size = 30.

Honey Production

Mean honey production per colony by year is presented in Table 2 for each treatment group. Mean honey production over all years was: small cell, 66.7 kg Sx- = 11 (147 lbs, Sx- = 24.2) ; large cell, 66.2 kg Sx- = 11.9 (146 lbs, Sx- = 26.3) ; and other apiaries, 67.1 kg, Sx- = 10.2 (148 lbs, Sx- = 22.5) . There were no significant differences in honey production between treatments and no appearance of any trends. Yields were low (down about 18%) in 1989, due in part to the need for the colonies to draw comb. Thereafter, honey production by treatment colonies was not significantly different from the mean yield for all other colonies managed by the beekeepers in their other apiaries.

Table 2. Average weight of honey produced per colony: 1989-1994

Treatment	**1989**	**1990**	**1991**	**1992**	**1993**
Small Cell	26.8 kg (59 lbs)	83.5 kg (184 lbs)	88.1 kg (194 lbs)	74.9 kg (165 lbs)	62.2 kg (137 lbs)
Large Cell	29.5 kg (65 lbs)	90.3 kg (199 lbs)	91.7 kg (202 lbs)	69.9 kg (154 lbs)	49.9 kg (110 lbs)
Other Apiaries	34.5 kg (75 lbs)	84.9 kg (187 lbs)	87.6 kg (193 lbs)	75.4 kg (166 lbs)	53.6 kg (118 lbs)

Conclusions

The absence of significant differences in HBTM infestations between cell diameter treatments may have been due in part to the suppression of HBTM populations. The data presented do not explain why HBTM populations in the test colonies remained suppressed. It could be argued that the bees used in the study were resistant to HBTM (Loper *et al.*, 1992) . However, it may also be that other factors, perhaps environmental, were responsible. The data clearly demonstrate that, in the upper Midwestern United States (and probably elsewhere) low-level chronic infestations of HBTM may persist in honey bee colonies without apparent impact on colony vigor and productivity.

Finally, it is interesting to note that while approximately 20 percent of the colonies in nontest apiaries maintained by the beekeepers are replaced each year due to colony loss of vigor and mortality, we were able to hold constant the number of colonies in both test apiaries without colony replacement over the five-year study period. This may have been the result of the modified strategy for uniting colonies in the fall and splitting them in the spring. However, some measure of this greater colony survival may result from increased vigor brought about by the presence of new wax combs in the test colonies.

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