

Final Report

**An Integrated Pest Management Program for Mite Pests
of Honey Bees**

Project No. 97-MS3

**Marla Spivak
Brian Smith and Susan Cobey**

**University of Minnesota
The Ohio State University**

I. Breeding Programs for Mite Resistance

Spivak (1996, and unpublished data) has shown that colonies bred for hygienic behavior are able to detect and remove from the nest a significant portion of brood infested with the parasitic mite, *Varroa jacobsoni*. An Italian line of bees selected for hygienic behavior at the University of Minnesota detected, uncapped, and removed an average of 61% of the experimentally infested pupae over four summers (1994-1997); significantly more than the 13% removed by non-hygienic colonies (Figure 1). The results from 1994, 1996, and 1997 were comparable: the hygienic colonies detected and removed 60-70% of the experimentally infested pupae within 10 days, whereas the non-hygienic colonies removed under 20%. In 1995, the hygienic colonies removed only 25% of the infested pupae when one mite per cell was introduced, and 50% when two mites were introduced. It is now clear that these results were anomalous, and were probably due to extremely high mite loads in the colonies which increased the response threshold of the bees (decreased their sensitivity to the stimuli that elicit hygienic behavior).

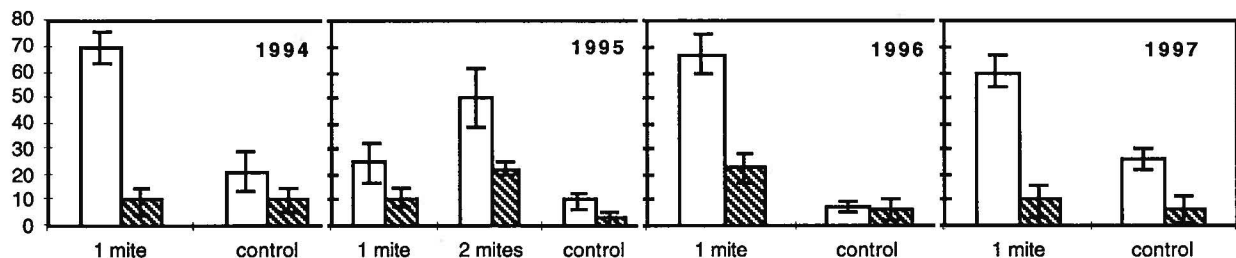


Figure 1. Percent removal (mean ± s.e.) of mite-infested and control (sham-operated) pupae by hygienic colonies (open bars) and non-hygienic colonies (hatched bars) from 1994-1997.

Carniolan honey bee stock, maintained in a cooperative effort between the California Bee Breeders Association and Ohio State University, was also screened for hygienic behavior in 1995. Second generation hygienic breeder queens from Ohio tested at the University of Minnesota in 1997 removed 25% of the mite-infested brood. Continued selection for hygienic behavior within the Carniolan stock should increase the tendency of these colonies to remove infested brood.

The Carniolan stock also has been selected for reduced incidence of tracheal mites, another highly destructive mite pest of honey bees. Initial infestation levels of nearly 50% in 1991 have decreased annually to almost undetectable levels (1%) by 1997. The colonies are showing good winter survivability without treatment.

II. Commercial Productivity and Profitability of Hygienic Colonies

For beekeepers to benefit from stock selected for specific traits such as hygienic behavior, naturally mated daughter queens of selected breeders must produce as much honey, have lower incidences of diseases, and have lower levels of *Varroa* mites than colonies from other commercial stocks. Large-scale field tests were conducted in collaboration with a commercial beekeepers in 1996 and 1997 (Spivak and Reuter, 1997; and Spivak, unpublished data). The hygienic Italian line at the University of Minnesota was compared to two different commercial stocks of Italian bees. The results indicated that the hygienic colonies had significantly lower levels of chalkbrood (a fungal disease of brood), had no American foulbrood (a bacterial disease of brood), and produced more honey. Importantly, the hygienic colonies had significantly lower levels of mites.

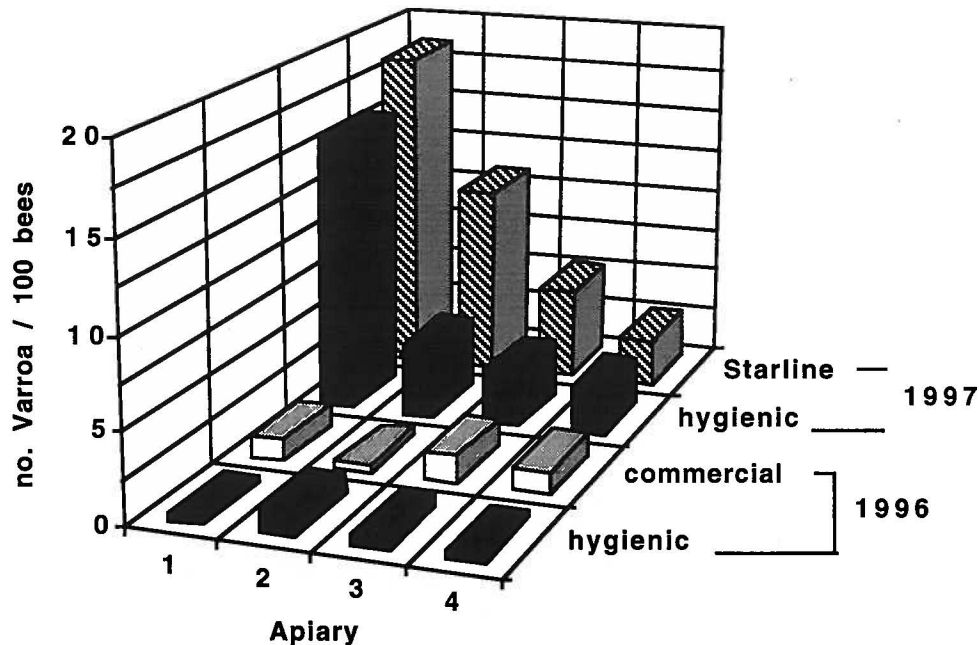


Figure 2. Comparison of the mite counts on adult bees in 1996 and 1997. The colonies in each experiment had not been treated for one year. Mite counts were derived by sampling adult bees, straining the mites off the bees, and calculating the number of mites per 100 bees. Comparison of the two bee lines across 4 apiaries (2-way ANOVA) indicated that in 1996, the hygienic colonies ($n = 49$) had significantly fewer mites than the commercial colonies ($n = 46$) in three of four apiaries, although the mite levels were low in all colonies (line effect: $F = 5.78$; $df = 1, 87$; $P = 0.013$). In 1997, the hygienic colonies ($n = 55$) had significantly fewer mites than the Starline colonies ($n=47$), even in highly infested apiaries (line effect: $F = 4.56$; $df = 1,94$; $P = 0.035$)

These promising results indicate that colonies headed by hygienic queens are healthier and more mite tolerant than unselected colonies. The results also show that it is possible to select for hygienic behavior without compromising honey production. Extension efforts are underway to encourage bee breeders to select for the behavior so that hygienic queens from various lines of bees may be available to beekeepers.

III. Maintenance of Breeder Stock - Instrumental Insemination

The ability to control mating using the technique of instrumental insemination is a critical component in developing and maintaining a honey bee breeding program. However, the beekeeping industry has been slow to adopt the technique because of the perception that inseminated queens are difficult to introduce into colonies and once introduced, do not perform well.

Sue Cobey and Brian Smith at the Ohio State University have completed a 25 minute training video, in English and Spanish, on Instrumental Insemination of Honey bee Queens. This is a teaching video that is suitable for self-learning or as an adjunct to lecture and for demonstration. The video makes it easy to visualize the process of insemination and should encourage beekeepers with a scientific bent to use instrumental insemination for maintaining or improving characteristics of their bees, including temper and resistance to disease and parasites. Instrumental insemination is integral to any carefully planned bee breeding program and is no longer the exclusive breeding tool of the scientist.

In addition, two studies were conducted at the Ohio State University to address perceived problems associated with the insemination process. The first explored the effect queen mandibular pheromone, QMP, on the introduction of instrumentally inseminated queens. The results indicated that the addition of a QMP lure, regardless of timing, appeared to decrease queen acceptance of inseminated queens in colonies. In 1998, the effect of lower QMP concentration levels on queen introduction will be tested.

In the second study, a comparison was made between the performance and commercial viability of instrumentally inseminated queens and their naturally mated sister queens. Comparisons of brood production, honey production, and supersedure rates over two years indicated there were no significant differences between the two sets of colonies containing the queens. These results should help establish confidence in the reliability of the insemination technique as an essential tool in the selection and breeding of honey bees.

Publications

- Spivak, M., Gilliam, M. Hygienic Behavior. 1998 (Invited review paper) for *Bee World*. Submitted.
- Spivak, M., Boecking, O. 1998. Tolerance to *Varroa jacobsoni* by *Apis mellifera*: A Perspective for the Beekeeping Industry. In: *Proc. Int. Symp: Apiculture for the 21st Century*. Wicwas Press, Cheshire, CT. In Press.
- Reuter, G. S., Spivak, M. 1998. A simple assay for honey bee hygienic behavior. *Bee Cult.* In Press.
- Spivak, M., Reuter, G.S. 1998. Performance of hygienic colonies in a commercial apiary. *Apidologie* 29: 285-296.
- Spivak, M., Downey, D. 1998. Field assays for hygienic behavior in honey bees (Apidae: Hymenoptera). *J. Econ. Entomol.* 91(1): 64-70.
- Spivak, M., Reuter, G. S. 1998. Honey bee hygienic behavior. *Am. Bee J.* 138(4): 283-286.
- Cobey, S. 1997. Honey Bee Tracheal Mite Resistance: Are resistant stocks developing and can they be maintained? *Amer. Bee Jour.* 137:738-740
- Spivak, M. 1997. Honey bee hygienic behavior as a defense against *Varroa* mites. *Resist. Pest Mgmt. Newsletter* November issue.
- Spivak, M. 1996. Response of hygienic honey bees to *Varroa jacobsoni* mites. *Resist. Pest Mgmt. Newsletter* 8(1): 42-44.
- Calderone, N.W., Wilson, W.T., Spivak, M. 1997. Evaluation of plant extracts for control of the parasitic mites *Varroa jacobsoni* (Acari: Varroidae) and *Acarapis woodi* (Acari: Tarsonemidae) in colonies of the Western honey bee, *Apis mellifera* (Hymenoptera: Apidae) *J. Econ. Entomol.* 90(5): 1080-1086.
- Spivak, M. 1996. Honey bee hygienic behavior and defense against *Varroa jacobsoni*. *Apidologie* 27: 245-260.
- Calderone, N.W., Spivak, M. 1995. Plant extracts for control of the parasitic mite, *Varroa jacobsoni* (Acari: Varroidae), in colonies of the Western honey bee, *Apis mellifera* (Hymenoptera: Apidae). *J. Econ. Entomol.* 88(5): 1211-1215.

News Articles:

- Science News. 1997. "Bees and keepers tackle mite-y problem" Feb 8. vol. 151, pg. 92.
- AURI Ag Innovation News. 1997. "Mite-y Intolerant" January. p. A7.
- Farming Extra: Minnesota Extension Service. 1997. "Area bee population is struggling" MN-039 pg. 11
- Minnesota: The Magazine of the University of Minnesota Alumni Assoc. 1997. Campus Digest: "Cleanliness is this bee's business" May-June. pg. 14.

Research Presentations 1997-98: M. Spivak

- 1998 Colorado State University, Ft. Collins, CO. "Neuroethology of Honey Bee Hygienic Behavior" and "Honey Bee Hygienic Behavior and Resistance to Varroa Mites" April 34-24.
- 1998 Indiana and Kentucky State Beekeepers Associations (Joint meeting). Kentucky State Univ., Frankfort, KY. "Beekeeping in the Tropics" and "Hygienic Bee Research" April 3-4.
- 1997 Apiculture for the 21st Century symposium, Michigan State University. "Biological Tolerance Against Mites in *Apis mellifera*" June 27-28.
- 1998 Bee Master's Short Course. Simon Fraser University, British Columbia. 3 talks: "Africanized Bees," "Wintering Bee Colonies," and "Hygienic Behavior." Feb. 16-19.
- 1997 California State Beekeeping Assoc. "Breeding Bees for Tolerance to *Varroa* mites." Ventura, CA Nov. 18-20.
- 1997 New Mexico Beekeepers Assoc "Breeding Bees for Tolerance to *Varroa* mites." Albuquerque, NM Nov. 15

- 1997 Iowa State Beekeeping Assoc. "Breeding Bees for tolerance to *Varroa* mites" Ames, IA Oct 31.
- 1997 Minnesota Honey Producers Assoc. "Research Update" Willmar, MN July 18-19.
- 1997 South Dakota Beekeeping Association, "Are Hygienic Honey Bees Commercially Profitable?" Pierre, SD. July 11-12.

Reserach Presentations: S. Cobey

- 1997 American Honey Producers Assoc. Memphis, TN Jan 97 "The Stumbling Blocks of Bee Breeding" and "Maintaining A Bee Breeding Program"
- 1997 Central Ohio Beekeepers Assoc. Columbus, OH. Jan. 15, "Update On Bee Research At OSU"
- 1997 Ohio Apiary Inspectors Meeting Columbus, OH Apr. 5, "Selection For "Mite Resistance"
- 1997 Wisc. Beekeeprs Assoc. Meeting July 19, "New World Carniolan Program" and "Selection For Mite Resistance"
- 1997 Almond Industry Conference , Modesto, Ca. Dec. 1-2,=20 97 "Integrated pest management project for control of parasitic mites"
- 1998 American Beekeeping Federation Colorado Springs, CO. Jan. 19- 24, 1998 "Complexities of bee breeding at the commercial level." and "Using Instrumental Insemination In Commercial Bee breeding"
- 1998 American Bee Research Conference. Colorado Springs, CO Jan. 22-24 , "Field Preformance of Instrumentally Inseminated and Natrually Mated Queens"
- 1998 Facultad De Medicina Veterinaria & Zootecnia, Universidad Nacional Autonoma De Mexico. Mexico Citye, Mexico Feb. Honey Bee Selection Methods
- 1998 Beekeepers Association Of Veracruz. Coatepec, Mexico Feb. Instrumental Insemination & Bee Breeding