The Traveling Beekeeper

From the North Central Queen Assembly–John Harbo on Developing Mite-tolerant Bee Stocks

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In October the Ohio State Beekeepers Association and my publishing company, Wicwas Press, co-sponsored the first North Central Queen Assembly in Troy, Ohio at the Buckner Nature Center. It was a remarkable day, as nearly 90 highly motivated beekeepers cooperated to support, present and absorb the information-packed presentations of some of the leading bee breeders on the continent. The focus of the day was on the development of locally-adapted honey bee stocks in the northern parts of the country that are hygienic/mite tolerant AND able to meet the needs of the beekeeper—providing high honey productivity, good over-wintering ability, and extreme gentleness.

This program is in part due to my car breaking down in Columbus, Ohio in October 2006, when Dana Stahlman took me in as his and wife Mary's houseguest for a *loooong* weekend. This was described in an *ABJ* article earlier this year. During the ongoing conversation, Dana lamented the fate of queens in the country, and had already started the wheels in motion to start the Ohio Queen Program. I told him that I thought that was a great idea, but why not think bigger? Why not develop a regional program that addressed queen production and bee breeding so local beekeepers could learn the skills of raising queens and producing their own stock and productive queens. If nothing else, Dana and I agreed, getting beekeepers out to a meeting to learn more about queens and bee breeding would be a very good thing. I've always thought that for beekeepers, learning queen rearing is like getting an advanced degree in beekeeping; learning instrumental insemination and breeding bee stock is like getting a doctorate. Unfortunately, the bees fail to mail the diplomas.

The pieces fell together. The Ohio State Beekeepers Association put some money and lots of support into the Ohio Queen Program AND the NCQA. The state was organized with nine regional coordinators, and during the summer of 2007 a series of queen rearing classes were offered throughout the state. Meanwhile, Dana and I pulled together the program and found a location for the NCQA. He approached the Miami Valley Beekeepers Association that meets at the Buckner Nature Center in Troy Ohio, and they agreed to host the event. Eventually eight of their members took over setup, registration, breaks, lunchs, and cleanup. They setup and monitored the sound equipment and let the program run smoothly.

Dr. John Harbo, retired, USDA, ARS Honey Bee Breeding, Genetics & Physiology Research Laboratory

Whenever I assemble a program, I use a pretty simple process. I ask myself who I would like to hear speak, and on what subjects. The exception to this rule is when I plan to speak to a group. Then, I try to determine what beekeepers need to hear that will both educate and challenge them; helping them grow in their beekeeping. So, for the program I extracted speaking acceptances from John Harbo, retired USDA researcher from the Baton Rouge; Gary Reuter from the University of Minnesota—who worked with Marla Spivak to develop the Minnesota Hygienic stock; Greg Hunt from Purdue, who has been working on a mite-resistant bee in Indiana; Joe Latshaw, who has developed strains of bees used by commercial beekeepers; and myself. Jim Tew of Ohio State University willingly accepted my request to help with the instruction and kept the program running on time.

The program went very well, and the written evaluations are pretty encouraging. All but three of the participants want to see a follow-up or repeat of the course (the declining 3 were all new beekeepers and I suspect the subject was ahead of their skill level). Folks drove and flew in from nine states to attend, and beekeepers from at least four of these states are talking about duplicating a variation of the program at their state level. This was something Dana and I had hoped might happen, but the level of enthusiasm has been almost overwhelming.

Several participants politely yelled at me that there was no printed summary of the presentations, or copy of the notes. I

could only agree. But I did take personal notes, so I've decided to review the high points and some of the important minor details of the talks in a few articles for this magazine. There is a risk I will misrepresent some of the ideas the speakers give, but I figure I need to take that risk and later will let you know if I have really messed up on high points and minor details. Let's start.

Why the Suppressed Mite Reproduction stock is now called Varroa Sensitive Hygienic

Dr. John Harbo earned his doctorate with Prof. Roger Morse at Cornell University in 1971, and was hired as an entomologist at the newly established Honey Bee Stock Center in Baton Rouge, Louisiana. Harbo's research, like himself, is often the quiet, reserved sort that many beekeepers miss at first exposure. But later it will probably hit them that this guy is doing some pretty interesting and sometimes amazing stuff. He is also very approachable by beekeepers, and as a former USDA staffer, is used to giving information away without hesitation.

During his career with USDA Harbo worked on stock maintenance, artificial insemination, and storage of spermatozoa in liquid nitrogen. He conducted groundwork research for designing selective breeding programs (precise measurements of bee longevity, honey production, honey consumption, brood production, egg-laying rates, and bee populations). In 1992 he began to select bees for resistance to varroa mites. This work resulted in a mite-resistance trait in which adult bees disrupt mite reproduction (uncap and remove worker bee pupae) in cells that contain an egg-laying mite, while ignoring infested cells when the mite does not lay eggs. This genetic trait was named Suppressed Mite Reproduction (SMR) and was later renamed Varroa Sensitive Hygiene (VSH).

Harbo explained that in any breeding program the overall objective of that program must have a measurable aspect. In his work selecting for low levels of mite populations, he needed to measure the mite levels at the beginning and at the end of the experiment, putting great emphasis on keeping the test period as short as possible to hopefully avoid any external complications. To provide uniform mite infestation, he devised a scheme of using very large bulk bee cages, providing a mechanism of mixing bee populations from many colonies to provide a single mite level at the start of the experiment. The bulk cages had to be modified to provide ventilation and cooling against the Louisiana heat and humidity.

Using a ten week test, and uniform mite populations in mixed bees, he subdivided the bees into 25 colonies in same weight packages. This way he knew the number of bees and the number of mites in the experiment. Colonies were established in a pattern designed to minimize drifting,

John Harbo has determined the best method to use to measure the size of a queen is by the width of her thorax. He has modified a plastic queen excluder and enlarged the opening—very precisely—to determine if a queen can pass through increasingly larger openings. The larger the queen, Harbo states, the greater the success with overall production and longevity. Lke most who have studied queen performance, Harbo finds smaller queens experience lower introduction success, earlier supersedure, and shorter lifespan in the hive.

keeping the colony screened and the queen in a cage until the next night to allow the queen and the bees to form a more cohesive unit.

At the end of the ten-week test, Harbo counted the number of mites in both the brood and on the adults. He found that a few of the colonies had very low mite levels, with no net mite growth of the population in the colony. He was both surprised and happy with the results.

The queens used in the experiment were inseminated with the semen of a single drone, thereby minimizing the variability caused by multiple males mated to the same queen.

To explain the outcome, Harbo had to consider several possibilities. There was a possibility that the mites failed to enter the brood cells, or that the bees had hygienic or strong grooming behaviors. There was also the chance the bees had a shorter developmental time. Finally, it was possible that the mites that entered the cells were unable or did not to reproduce, and this is what they had found—a group of colonies that prevented or suppressed the mite's ability to reproduce. This became known as the SMR, or Suppressed Mite Reproduction strain of bees.

Harbo conducted selective breeding and found that the SMR trait was heritable, that is, passed from one generation to the next. After six generations he obtained stock wherein only 8% of the mites in worker brood had progeny. The rest had not laid eggs. To Harbo, these results as well as backcrossing data suggested that there were relatively few genes involved, since the lower the number of genes, the easier it is to incorporate a trait into a population. He found that by the worker bee's 15th day of development—the purple eye stage—the bees in a colony had enough time to remove the reproductive mites.

This condition was studied further by Abduliah Ibrahim and Dr. Marla Spivak of the University of Minnesota. They reported that the SMR trait is essentially a hygienic behavior, where adult worker bees were removing bee pupae that were infected with mites that laid eggs; these same worker bees ignored bee pupae containing mites that had not laid eggs. It is not known if the mites in cells cleaned by the bees become disabled in some way or are free to infect another cell. The eggs and immature mite stages die without the pupae to feed upon. In the cells where the mite does not reproduce, the mite frequently deposits fecal material on the body of the bee, rather than on the cell wall.

This caused a name change. The SMR bees became known as the Varroa Sensitive Hygienic or VSH bees. The VSH trait controls mites, and appears to be common and in all stocks of honey bees worldwide. The genes involved appear to be additive, and this is clearly a heritable trait of the honey bee. Since this trait is expressed by the behavior of adult bees, the trait does not appear in a colony until about 6 weeks after a mite-resistant queen is introduced.

In a typical bee colony with no resistance to varroa, about 11% of the mites that enter the brood cells do not lay eggs. Perhaps these are old mites. If the egg-laying mites are removed, the only remaining mites are those that are not laying eggs. But when a colony carries 50% of the VSH trait (such as a colony with a mite-resistant queen mated to susceptible drones), the colony is able to remove 83% of the mites that lay eggs. At the 75% VSH level, the bees remove 95% of the ovipositing mites. When examining a colony that has removed 95% of the reproducing mites, one finds 70% of the infested cells contain mites with no eggs (11/16, the 11% that were not disturbed because they laid no eggs plus the 4% that were missed). Finally, in colonies with 100% of the bees carrying the VSH trait, 100% of the reproducing mites were removed. The good news here is that a partial VSH colony will still have a significant advantage in mite removal over a colony that does not carry any of the trait. For the beekeeper interested in using this trait in his or her bees, the

good news is that it is not necessary to maintain a 100% VSH level to obtain genetic help in the fight against varroa.

Bee breeding in retirement

John and wife Carol have both retired, but not from keeping bees. They have established the Harbo Bee Company in Sunshine, Louisiana. Here John Harbo continues to do some bee breeding, but without the support of USDA and the country's taxpayers. He has established double colonies for stock, but runs shorter cross frames rather than traditional frames. The double units have a queen excluder on the single chamber and the bees share a common feeding area (of frames of honey), and honey super, as necessary. Carol, with degrees in business and a background in marketing and advertising, is helping with the business parts of the Harbo Bee Co.

Queen Size—Other researchers have reported that larger queen size is highly correlated with greater success in beekeeping. In one of Harbo's research projects he opened sealed queen cells about 3 days before emergence and weighed the developing queen with highly accurate scales, returned the queen to the queen cell, and carefully closed the cell back onto the cell base. He explained that the queen is the only bee that does not spin a complete cocoon, so this cell opening is easier with a queen than with drone or worker pupae.

John Harbo likes larger queens, they are easier to find and work with. After looking at various ways of comparing emerged queens using weight, and finding it too variable to use as a comparison tool, he started measuring the size of the queen across her thorax, wingbase to wingbase, so to speak. To do this he carefully modified a plastic queen excluder to expand the opening to increasingly larger openings—4.5, 4.8 mm and larger. Using this technique he is able to measure any adult queen of any age to determine her relative size.

The final queen of an individual colony is the function of both nature and nurture—the genetics of the bee and the conditions under which she is produced. Larger queens have long been shown to be more productive, laying more eggs, producing larger colonies, and lasting longer in the hive.

Using VSH breeders—Harbo purchased breeder queens from Tom Glenn of California. These are instrumentally inseminated queens and VSH on both the queen and drone side. He made daughter queens from these queens and compared them to non-hygienic bees he found in his colonies or from swarms he had hived.

This year he monitored each colony for varroa by measuring the rate of infestation in 100 cells of worker brood (purple eyed state or older). Using only 31 colonies in 2007, he found that the swarm colonies averaged 13 mites per 100 cells. His unselected colonies averaged 6.5%, colonies with free-mated VSH daughter queens averaged 3%, and the two VSH breeder queens averaged 1%.

Harbo is highly encouraged by these results. By purchasing queens of a known genetic resistance, grafting from them, and allowing them to mate naturally, he obtained an acceptable level of varroa mites in his test colonies in his first year.

As a speaker in conversations, Harbo becomes quite excited about the work he is doing in retirement. The industry is wise to keep an eye on what this experienced and talented man does over the next few years.

Next month—We will continue with talks presented at the North Central Queen Assembly in Troy, Oct., 13, 2007. If you are interested about a possible 2008 NCQA program, send an email to ebeebooks @aol.com and request to be put on the notification list. Or write to the address at the top of this article.