# Survivor Stock
## A Protocol for Small-Scale Beekeepers

*by M.E.A. McNeil*

*Advice from a cutting edge university bee breeder is combined with a hundred year old queen rearing method to create a local survivor stock breeding program for a bee club.*

They stood in the bee yard like rubes at the ballet – awed by the elegant movement of the beekeeper, Sue Cobey.[1] She was in her element, opening hives, pulling frames with grace, listening to the music of the bees. Her apiary at the University of California at Davis was host to a unique class, "Queen Rearing for Survivor Stock."

She lifted a lid and said, without looking further, "These are young. You can tell by the sound." They listened. Opening another, she pointed to a queen: "She's a virgin. See how nervously she moves." They looked.

The class was created for an odd lot of Marin County beekeepers who have kept two to a dozen hives over two to dozens of years. What has brought them here is a common desire to breed a local stock that will, for a start, survive without chemicals. Cobey would not be teaching this class if that were not a possibility, but she sees it as a difficult and uncertain undertaking. U. C. Davis Extension Apiarist Eric Mussen,[2] widely recognized for his expertise, showed his support for the project by volunteering his presence -- although he was not making book on its success.

Cobey said, "A rough guess is that it will take about five to ten years to develop mite resistant bees. You can select quickly for a single trait, but to select bees that are also productive is key, so this takes time, persistence and a long term commitment. There are many considerations."

The wager here is that the possibility of developing a local sustainable stock -- however difficult – trumps the current record of failure. The response to varroa, the invasive pest that vectors viral disease, has been a disaster; repeatedly knocking it down with increasingly stronger chemicals, has created more virulent mites and weakened bees.

Agricultural pesticides have been cited as contributing to the continuing problems of the honey bee. But bee expert Peter Borst points out "beekeeper's abuse of pesticides" as contributing, according to a study he cites.[3] Mussen reported USDA lab statistics[4] that show that of all pesticides (including herbicides, fungicides, and insecticides), 79% are miticides, placed there by beekeepers and found in wax, pollen, and adult bees. The proportion of all pesticides found in immature bees is 100% beekeeper miticides.

The study cited by Borst reports that these miticides, primarily coumaphos (Check mite) and tau-fluvalinate (Apistan) are lipophilic compounds — which is to say that they are absorbed by the wax in the hive and remain there as long as five years after treatment is stopped. Otherwise sublethal doses of these miticides can combine to cause be mortality.[5]

So, uncertain as it is, letting of the chemicals looked like the way to go for this group of Marin Beekeepers. And they are not alone. The response of queen breeders has been to focus less on maintaining racial lines than on selection of desirable traits. A few of these breeders do not use chemical treatment. And some diverse, mostly unconnected programs across the county have begun to do the same.[6]

In the classroom, Cobey pointed out some mechanisms for survival: hygienic behavior in bees that clean out pathogens and VSH (Varroa Senstive Hygiene)[7] in those that remove breeding mites. Out in the bee yard, she showed the beekeepers how to do a liquid nitrogen test

on brood. Borst cites a study at Cornell that suggests that this test (which shows how well the bees hygienically clean out the resultant dead brood) correlates with VSH behavior.[8]

Two days later, a class member returned to the Davis lab, and Coby pulled the test frame. It showed about 75% of the dead brood cleaned out – not good enough for a breeding colony.

Cobey points out that there are a number of ways to organize a program. Protocols vary, with some withdrawing chemical treatment and simply selecting stock from survivors. South African researcher Mike Allsopp writes that the mite resistance of two sub-species of African bees is not innate but the product of natural selection in the feral population: "Programmes and especially gene selection programmes can never adequately keep up with the changing environment, certainly not to the extent that a 'live-and-let-die' approach can. Allowing natural selection to determine who the winners are will always be the most sensible strategy."[9]

That is how Danny Weaver of BeeWeaver[10] developed 5000 untreated hives kept between Texas and North Dakota; but Weaver sacrificed thousands of colonies to that goal. Eliminating chemicals cold turkey in a small apiary can leave nothing, not even minimally resistant stock to start with. A second approach, such as that used by The Ohio State Beekeepers' Association in the Ohio Queen Program (OQP),[11] is to use the least and most benign treatment -- IPM (Integrated Pest Management).[12] One OQP regional coordinator, Brian Neuman, has used that method to wean his apiaries off hive chemicals, to now produce untreated queens.

Cobey says it is critical to monitor colony levels, use marginal controls when needed and re-queen susceptible colonies. The mites are allies in the process, since the bees need the exposure to develop resistance.

Although she would like to see a more thorough protocol worked out, she offered the following suggestions:

> Use screened bottom boards and monitor mite levels regularly; be aware of the fluctuations with emergence of brood (more falling mites). Ant-proof the hives, as the ants will eat fallen mites and skew the count.
>
> Use powdered sugar weekly all season. To be most effective, powdered sugar requires heating, which is not practical in the field -- but it can be used in management, such as shaking bees or setting up new colonies.
>
> Use drone comb, eliminating it every 28 days. If there is a mite load at the end of the season, use thymol, which is not residual.
>
> Learn how to raise queens. Alternatively, you can make splits in a nuc with nectar, pollen and crowded young, well fed bees – mimicking swarm conditions.
>
> Swap queens or queen cells.

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With natural mating, Cobey suggests that "it is ideal for beekeepers to control mating areas using resistant drone saturation; it will make the process much faster. Every time a queen open mates (with unknown drones), the colony goes back into the random gene pool. But if you Cobey says, "The ideal is for an II (instrumental insemination) lab to inseminate the breeder stock; perhaps someone from the group can learn this skill to provide the service." Bee geneticist Joe Latshaw[13] oversees and does II for the nine regions of the OQP.

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Most successful survivor stock breeders have some or all of the following advantages: hard winters and/or swarming which produce a natural mite drop, pesticide free foraging areas, hygienic and VHS behavior, control of drone selection by II or isolated breeding areas, careful record keeping and dedication.

The Marin group was starting with little advantage, apart from not much spraying in their area and, in the abstract, dedication. Because their livelihoods do not depend on their apiaries, they can sustain loss as long as that dedication holds out. Like a lot of small clubs across the country, they are willing beekeepers in need of protocol.

Sue Cobey's ideal would be small-scale beekeepers organizing in geographically specific groups to increase genetic diversity, agreeing to stop treating while using IPM and requeening susceptible bees. In her optimal plan, they'd be connected with a research program that could help evaluate, select and even breed (such as the OQP).

No such research center or multi-regional organizer is available to Marin, or for that matter, to many of the groups that would like to start a survivor queen rearing program. The Marin beekeepers reported back to their club that, with Cobey's continued guidance, they are on their own to launch this adventure. In class, they'd made their own wax queen cells with a bottom bar and a metal mold. They'd learned the importance of fresh larvae in producing the 50 different morphological characteristics of a queen. (A developing queen larva receives 1600 feeding visits from nurse bees, compared to the 143 feeding visits received by a worker larva. With a late start, she will receive less nutrition and become an inter-caste.)

They'd learned to create both a queenless starter and a queen-right finisher from the same colony using a Cloake board[16] -- a strategy that minimizes disturbance to the queen cells. And they'd tried their hands at grafting. But for most, at an age requiring a squint to read fine print, new larvae were too small to see. One called the grafting tool "a spoon for an ant."

For them, there was more truth than jest in Cobey's suggestion to "Take the ones you can't see." They knew they needed to do just that, and to do it they chose a solution nearly one hundred years old that makes use of the eyes of the bees.

The eclectic Marin group is comprised of a software designer, a lawyer, a land use planner, a surgeon, an engineer, a journalist (although most have no idea of what the others do, beyond keep bees). Among them is an Environmental Protection Agency chemist named Dan Stralka, who has been keeping bees for decades. Familiar with the chemical components of the current crisis of the honeybee, he has dedicated his apiary for years to the goal of breeding untreated survivor stock. Stralka taught the group a simple queen rearing technique that does not require grafting that was published in 1911 by C.C. Miller.[17]

Although the method is less practical for commercial beekeepers (Miller could breed his own queens, but he gave up trying to supply the editor of The American Bee Journal), it is a tool that has the potential to bring amateurs who have neither a research facility nor a skilled grafter into a grassroots movement to rear local stock. Stralka is in his fifth year of using the method, which first failed, then just held, and is now productive.

Thanks to a Cornell University program to digitize classic beekeeping books, Miller's writings are available, and they seem prescient: "I am not particular to keep a popular breed of bees … I am anxious to have those that are industrious, good winterers, gentle, and not given to much swarming…for a good many years I preferred to rear from queens of my own whose workers had distinguished themselves as being the most desirable."

Miller uses a specially prepared frame of eggs. It is created with undrawn foundation cut away by half or so in several jagged points and put into a breeder queen's colony. The bees will draw out the comb, and the queen will lay eggs in it.

To start rearing queens, Cobey teaches that swarm conditions need to be created by removing the queen and crowding the bees. (This can be done in a top brood box isolated by the Cloake board, if that system is used.) Then, where grafted queen cups would be introduced, Miller's special frame of eggs can be inserted, after any drone cells are cut from the bottom of it. Queen cells will be drawn down all along the bottom edges. "The comb being new and tender makes it probably an easier job for the bees to build queen-cells upon it; at any rate they always show a preference for such comb, and start on it a larger number of cells than they would on older comb."

Miller wrote that on typical comb, the bees will continue to start cells with "larvae too old to make good queens. But on these combs prepared as I have described, they do not do so. Rarely, if ever, will a cell be found elsewhere than on the edge of the comb, and I have never known the bees to start a cell after the larvae were too old. I do not know why there is this difference. I only know the fact. But it is a very convenient fact."

The Cloake board method suits Miller's process in finishing the queen cells as well: "Until near the point of emergence it is much better that the cells shall be in the care of a strong colony." The cells can then be placed into mating nucs – although we may not have just the tea-knife recommended by Miller for cutting them.

He writes of a selection process like that used by some survival stock breeders today: "I may mention that a queen which has a fine record for two successive seasons is preferred to one with the same kind of a record for only one season. At any rate, the results obtained in the way of improvement of stock as a result of my practice have been such as to warrant me in its continuance..."

One danger of a small breeding program, such as the one the Marin beekeepers propose, is inbreeding. Cobey said, "Genetic variation is important. It's the group you work on." She gave an example of disease resistance; nosema can affect only some bees in a colony, with some badly infected and others uninfected. Dave Tarpy of North Carolina State University calls it the need for "enough stock to see variation in alleles." Miller wrote, in an era before genetics was understood: "The danger from inbreeding must not be lost sight of entirely… Should signs of degeneracy at any time appear, it will not be difficult to introduce fresh blood."

With this caveat in mind, the Marin project will use existing over-wintered stock, feral colonies, and a few queens purchased from survivor stock breeders who have fostered hygienic and VHS behaviors. Although a study found it "best to use an un-manipulated wild population, and for this population to be as large as possible,"[18] there is no guarantee that a swarm has survival characteristics. And there is no third party certification to guarantee that commercial stock has advertised attributes or is untreated survivor stock.

"If it seems like selecting in the dark," said Cobey, "Well, that's where we are." What we really need, she says, is a national support program to research these stocks and check the progress of regional studies because the variables are numerous and complex — climate, location, exposure, stress.

Meanwhile, the Marin beekeepers are starting with the Miller method: "I have been asked whether I would advise a beginner with only half a dozen colonies, one of them having a superior queen, to use the plans I have given to rear queens from his best queen. I certainly should, if he intends to give much attention to the business…The essential steps to be taken are simple enough; and even a beginner can easily follow them." Those words were written in an era before the mites arrived, trailing viruses, but it is worth a try.

"This may look overwhelming when you look at the whole picture," said Cobey. "Just start small. It's fine, just get started. Do outreach and swap queens. Improvement will be slow and painful. We have put chemical pressures on the mites and consequently bred super mites. Now we need to turn that around and put the pressure on the bees by putting these small efforts together."

The Marin Beekeepers hope to do Sue Cobey and the memory of C.C. Miller proud and hope that, as he would put it, the results obtained in the way of improvement of stock as a result of this practice will be such as to warrant them in its continuance.

FOOTNOTES

[1] Sue Cobey teaches queen rearing and instrumental insemination classes at The University of California at Davis each spring: http://entomology.ucdavis.edu/courses/beeclasses/

[2] Recognition for Eric Mussen has included awards from The Entomological Society of America, California State Beekeepers and Apiary Inspectors of America.

[3] Johnson, Reed M.; Henry Pollock; May Berenbaum, "Synergistic Interactions Between In-Hive Miticides in *Apis mellifera"* Journal of Economic Entomology, Volume 102, Number 2, April 2009 , pp. 474-479

[4] The USDA AMS Lab in Gastonia, North Carolina.

[5] Op cit: Johnson et al.

[6] McNeil, M.E.A. "Next Up the Survivors", The American Bee Journal, March, 2009, pp 251-255, April, 2009, pp 353-358.

[7] VSH, Varroa Sensitive Hygiene stock was developed at the USDA under John Harbo.

[8] Strange, James; Nicholas Calderone, Dyce Laboratory, Department of Entomology, Cornell University, "Evaluation of Apicultural Characteristics of First-Year Colonies Initiated From Packaged Honey Bees" Journal of Economic Entomology. 102(2): 485Ð492 (2009)

[9] "The development of mite tolerance took 3-5 years in the Cape honeybee (*Apis mellifera capensis*) and 6-7 years in the Savanna honeybee (*Apis mellifera scutellata*)."
Allsopp, Mike, "Analysis of Varroa destructor infestation of southern African honeybee populations", Degree Thesis, MSc (Entomology) Department Entomology, University of Pretoria, South Africa.

[10] Bee Weaver, http://www.beeweaver.com/home.php

[11] http//www.ohiostatebeekeepers.org

[12] "IPM strategies are designed to be the least disruptive of natural pest controls, human health and the general environment." Bio-Integral Resource Center, birc@igc.org

[13] http://www.LatshawApiaries.com

[14] Kirk Webster, Champlain Valley Bees, (802) 758 2509

[15] http://www.ziaqueenbees.com

[16] The Cloake board is an insert allowing a hive to be partially closed off as a queenless starter on then reopened to become a finisher. The system was originated in the 1970s by New Zealand beekeeper Harry Cloake.
Cobey, Susan "A Versitile Queen Rearing and Banking System" The American Bee Journal, April and May, 2005. Part 1 is available at: http://www.honeybee.breeding.com/HBIS/pdf/Cobey

[17] C.C. Miller, "Fifty Years Among the Bees" 1911 A. I. Root Company, Medina, Ohio,1911, Republished by Dover, 2006. Original text from the Cornell University Albert R. Mann Library Core Historical Literature of Agriculture (CHLA). Ithaca, NY can be found at:
http://chla.library.cornell.edu/cgi/t/text/text-idx?c=chla;idno=5017631 "In 1869…I came across a copy of The American Bee Journal. I subscribed for it and also obtained the first volumes. It has been more service to me than any other bee journal published."

[18] Op cit, Johnson et al.