Next Up, the Survivors

Part one of two parts

by M.E.A. McNeil

The first part of this article surveys research and small scale beekeepers involved with survival stock. The second part will discuss larger scale commercial breeders committed to untreated stock as well a protocol for beekeepers to begin breeding their own resistant bees.

"Who has the nerve to try what we did?"
– Billy Davis, Northern Virginia

A new bee grail, or perhaps the oldest one, is survivor honey bee stock. Everyone wants to get away from the chemicals. But how do we do it? "There are so many factors that need to be looked at," said Sue Cobey, University of California at Davis bee researcher.

How, of course, is the question. Our bees are punctured by parasites fore and aft and inoculated with disease. So it is fair to wonder if it's just another smoker dream, a return to the 19th century when the bees took care of their own pathogens, summer or winter, left in a box until it was time to collect the honey. Is it really possible that Mother Nature alone can save the bees? Well, the answer, from those working with survivor stocks, is: yes and no.

"There is a huge silent group of beekeepers who do minimal treatment, and often minimal management, and have bees that survive pretty well," said writer and beekeeper Randy Oliver. "The commercial breeders have not done better: shorter queen survival, poorer overwintering, about the same honey crops -- and they have bred better mites." On the other hand, he cautions, survivor stock can be plagued with multiple swarming, poor drone production, small clusters, and not much honey. In addition, what works at a small scale may not work at a larger scale, he says: "Be careful what you ask for, you might get it."

After *Varroa destructor* invaded France in 1982, the feral population was decimated. Over ten years later, researcher Yves Le Conte discovered populations in the wild and in neglected apiaries showing resilience. He collected some 40 such colonies near Avignon and compared them to controls. They proved to have significant resistance to mites and showed less viral infection. Tests showed them to be more responsive to some compounds found on the cuticle of the mite. Interestingly, they swarmed more. The brood cell size tended to be smaller, because accumulated larval cocoons reduced the size -- and thus, opines Le Conte, possibly restricting the area for mites to live. Some of these colonies have survived for a decade untreated. Le Conte hypothesizes that the success of these bees may come from a combination of factors, as well as the possibility that the mite has evolved to less virulence.

Photo: Klaus Spitzl

John Kefuss and Maria Bolt at a mating yard at Le Rucher D'Oc, Toulouse France. Dr. Kefuss calls his mite resistance selection process "The 007 Bond Method." Some of their bee lines have been untreated for as long as 15 years.

American researcher John Kefuss works in France, overseeing an aggressive program that selects for mite resistant bees. "I helped test a lot of chemicals with German and French bee research

laboratories that are presently being used all over the world including the USA. From this experience I realized that chemical treatments were only a poor short term solution. It is for this reason that I started selecting for varroa resistance. Sometimes you just have to bite the bullet" – a sentiment that may have inspired him to name his protocol, "Live and let die," the 007 Bond test.

He finds, though, that evolution is a slow waltz for an action hero; he ups the pace with his "Bond Accelerated Treatment," in which varroa-infested brood is directly introduced into colonies to heighten selective pressure. He has experienced the loss of 90% of colonies in six months with this technique. Survivor breeder queens are instrumentally inseminated, and their daughters are naturally mated in outyards.

Photo: John Kefuss

Maria Bolt, left, and Klaus Spitzl of Le Rucher D'Oc are opening a grafting colony with a cloake board modified from the more common ten frame super to a five frame super. The change was inspired by Brazilian research that showed heavier queens with this configuration. This "hybrid cloake board," they report, works very well.

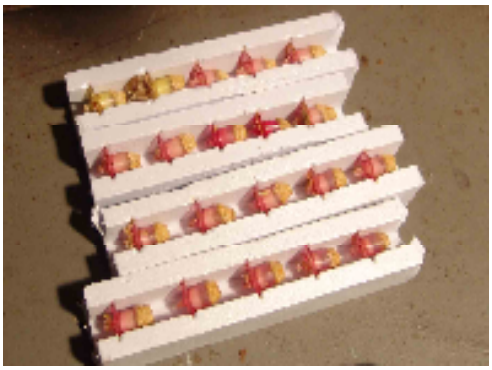

Photo: John Kefuss

James Bond's girls: queens bred by John Kefuss by aggressive selection for mite resistance.

All of his 700 hives are untreated – some lines for 15 years, others for 10 years. "Our big varroa problem is that we do not have enough, so we have to buy combs of brood infected with varroa from beekeepers to keep up the pressure of selection," said Kefuss.

While the Starline bee program existed, Kefuss was the breeder in France. "So basically I just kept on selecting that material," crossing in genetics from his apiaries in Chile and other tested stocks. With Maria Bolt and Cyril Kefuss he runs Le Rucher D'Oc (Apiary of Oc, the area around Toulouse), which sells honey and bees, including Caucasians and, intriguingly, Chinese Italians for royal jelly production.

The Chinese government sent researcher Li Jianke to France to learn Kefuss' breeding program. Now Li has replicated it in China (the Bruce Lee protocol, perhaps). One of his goals is to eliminate all chemical treatments in Chinese hives. Yes.

In another Bond-type project, bees from isolated areas were selected by the German Carnica Association and exposed to varroa mites without treatment. Resistant bees are crossed into lineages that are documented back to the 1950s.

A variation of this survival approach was used by Ingmar Fries on Gotland Island, off the coast of Sweden. An isolated apiary was established there, with the colonies purposefully infested with *Varroa destructor* mites. Over six years they were monitored for mite levels and loss, although they were unmanaged and allowed to swarm.

As the mite infestation on adult bees diminished, winter mortality decreased from 76% in the third year to 19% in the sixth year. Swarming rates increased considerably, however. Fries speculates that both the bees and the mites may have adapted, ensuring survival of both the host and the parasite.

Cobey notes that the broodless period over a cold winter without the exposure to pathogens in a migratory setting lessens the impact of the mites considerably.

Photo: John Kefuss

Maria Bolt of Le Rucher D'Oc teaching instrumental insemination to Jean Francois Mallein. The breeding program there for untreated stock relies on both II and survival drone saturated open mating.

Two contrasting programs to monitor the varroa impact on feral bees were instituted by Adrian Wenner, of the University of California at Santa Barbara – who became expert in bee lining in the process. Colonies of genetically uniform bees on Santa Catalina Island perished from infestation; whereas, feral colonies with mixed genetic traits in isolated wilderness areas rebounded after the invasion of the mites in the 80's. Two small scale beekeepers have kept bees without treatment of any kind for 15 years, under Wenner's tutelage. Because of their proximity to the wilderness area, he surmises that their queens mate with feral survivor drones there. Wenner wonders if this renewal is the result of selection for mite resistant bees, a weaker strain of varroa mites, or both.

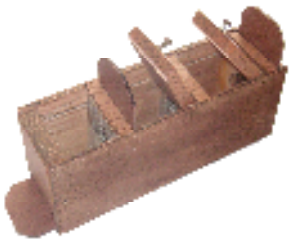

Photo: Jim Fischer

Box for catching feral bees for the purpose of bee lining, or following them to find their colony. To catch more than one bee for the purpose, which is necessary, the box has a chamber for catching a bee. Each of three chambers has a window and shutter to control light, which will draw the bee into that chamber. Once a bee crawls in toward the light in the first chamber, it is darkened and the bee is then attracted to the exposed light in the center holding chamber, allowing for the capture of more bees. In the same manner, a bee is brought into the release chamber on the other end, allowing her to fly out so her flight trajectory can be observed.

These questions were studied by Tom Seeley at Cornell University, who discovered a population of feral colonies of honey bees that co-exist with varroa mites. From 2002 to 2005 he worked with bees of the Arnot Forest, a research preserve in New York State. When he began, the number of colonies was close to the number recorded there in 1978, although *Varroa destructor* had ravaged American honey bees in the intervening years.

Although the bees were infested with varroa, the mite populations in the forest colonies did not rise in late summer. To see if the bees were suppressing mite reproduction, Seeley hived feral colonies and inoculated them with mites from a managed apiary. Control hives, New World Carniolans, were treated the same way. The Arnot bees did not prove to have superior resistance.

Seeley speculates that the forest environment provided selective pressure on the mites to become less virulent. In an apiary, mites reproduce horizontally, moving from hive to hive with no evolutionary penalty for killing a host. With feral bee nests more distant from others in the forest, mites reproduce vertically, generationally, in the same colony. Mites that co-exist with bees are the survivors, while mites that kill their host eliminate themselves and thus their DNA.

"A lot of people want to rush headlong into taking anything not in a box as survivors," said Dave Tarpy, a researcher at North Carolina State University. "We need first to know if the bees in the trees are survivor stock. We don't know if they have resistant alleles. What is the mechanism, the bees or the mites? It could be the same bees in a different environment."

At work on these questions is a post-doc in his lab, Debbie Delaney, who has a two-year USDA grant to compare the genetics of feral bees to managed bees. She has begun setting swarm traps and bee lining for feral colonies in North Carolina's Umstead and Duke Forests. She is putting up a website to locate feral bees, and she hopes eventually to expand the project in stages across the country. In her doctoral work with Steve Shepherd at Washington State University, she examined the genetics of 700 pre-varroa and post-varroa colonies, comparing feral and managed bees from the Southeast and West. Significantly, she found the feral bees in her study genetically different not only from managed bees, but from feral bee samples from the 1990's. "We are in the preliminary stages of this exciting work," she said. "A national protocol will hopefully be one of the great boons that comes out of this work."

Photo: Save the Hives

Debbie Delaney, then a post-doc at North Carolina State University, is comparing the genetics of managed bees to feral bees in two forests in North Carolina.

The Tarpy lab will also do a project comparing bees in three climate regions in North Carolina. Delaney's experience is that bees shipped from one geographic region to another can have problems acclimatizing. "People need to select for their area," she said.

Photo: Debbie Delaney

Mite resistant feral Amazons or a bunch of susceptible girls that ran away from home? Debbie Delaney's research hopes to map the genetic evolution of feral bees in two North Carolina forests to see how it relates to managed stock.

"Varroa-tolerance likely includes a combination of factors pertaining to the biologies of both bees and mites," according to entomologist Eric H. Erickson, who headed the USDA ARS Carl Hayden Research Center in Tucson, Arizona. He established experimental apiaries of stock selected from survivors that had not been treated with miticides. Erickson's stock took two years to establish, improved over six years, and has survived his retirement. The measure of success was about seven mites per 100 bees (with 15/100 a marker for varroa-tolerance) – adaptation rather than eradication. He found it relatively easy to produce varroa-tolerant honey bee populations using locally adapted stock. "The only requirements," he wrote, "Are fundamental beekeeping skills, the ability to rear queens, and the few varroa-tolerant colonies that are present in nearly every apiary."

Cobey notes that what could have been done just a few years ago may be more difficult today, "with exposure to so many compounding and contributing factors."

When miticides were no longer effective in his Vermont apiaries, Kirk Webster decided to "make the jump." It was not an easy decision; bees and honey are his livelihood. He gradually removed treatment over five years, and he has not used chemicals on his 900 colonies since 2000. "I'm a farmer. I just want a practical way of making a living," he said.

Photo: Jennifer Keller

These feral bees, being sampled toward Fuquay Varina by North Carolina State Universtiy researcher Debbie Delancy, will be part of her research to compare feral DNA managed samples.

"When I started there were no good examples. What gave me the courage was my experience with the tracheal mites: I lost half my colonies, but as I propagated survivors the bees became better four to five years later -- as though the mites had weeded out the weak bees."

So Webster took a gamble for varroa resistance as well. "When I started experimenting, I had four stocks: my surviving untreated stock, other beekeepers' survivor stock, SMR stock, and Russian from the USDA imported stock. Most died out except for the Russians, which I was able to wean off all treatments in just one generation…Now all the new queens are forced to sink or swim." He doesn't count mites but selects by performance, which has gotten more stable year by year. "Mites are now more valuable to me alive than dead," he says, explaining that they cull the bees, "doing a much better job than a beekeeper would."

It is fair to point out that his success can in no small part be attributed to his location. Overwintering colonies in northern climes are broodless, with the accompanying loss of mites. His bees are kept in apiaries of about two dozen hives among the dairy farms in the Champlain Valley, where there is a variety of nectar and pollen and few pesticides. (It was there that he once kept bees for Charles Mraz.) Also, the hives are not moved, with the exception of mating nucs, which he takes to an isolated area in the Green Mountains nearby to mate with his selected drone stock. "Breeding can't be just a casual occupation," he said.

He's learned to deal with what he describes as a fierce swarming instinct in the Russian bees, which overwinter in small clusters. (Swarming coincides with varroa clean up, and less brood means fewer mites.) He finds that the bees are exceptionally good nectar gatherers, bringing him an average, over ten years of honey harvests from boom to bust, 80 pounds per colony.

"I speculate from being around the colonies all the time, and I'm convinced that both the mites and the bees are changing." Although his losses are higher than they were before the mites invaded, he has no regrets about his move to resistant stock: "I'm really happy I went that way."

"I'd like to make it easier for others. I'd like to increase the gene pool for untreated bees. It's the only way for the future. Every time someone does what I did, we have another strain of untreated bees. We can trade stock so we don't have trouble with inbreeding."

Tess Arnold sells survivor stock queens, packages, and nucs as well as instrumentally inseminated Russian stock. He simply found it "too expensive to stay on the chemical treadmill" for his 100 colonies near Knoxville, Tennessee. Even with medication, the bees weren't doing well, with the arrival of tracheal mites and then varroa.

"I decided to let Mother Nature do her thing," he said, and he quickly lost most of his hives. He made splits and prized the survivors. To them he added feral bees, some New World Carniolans, Buckfasts, and, then the Russian stock. Now he has 200 hives and hopes to double the number. His losses are under 20% and, he expects, still going down.

Photo: Knoxville News Sentinal

Tess Arnold has kept survivor stock in Tennessee for fourteen years.

He uses screened bottom boards and a lot of drone comb – used both to flood the area with survival drones and to monitor mites. He rotates all the frames out every three years. Then, "the bees and the mites work it out."

Arnold selects stock for his next round of increases by checking the drone brood of the survivors, rejecting any with more than a few mites. He continues to add to the gene pool when he finds good stock. "I am not very isolated, and my bees are sometimes closer than I would like to people that use chemicals. But it helps their stock become more resistant also, so in the long run everybody wins."

Joe Waggle, a small scale beekeeper near Pittsburgh in Western Pennsylvania, works for a pest control company removing swarms. "I'm a good gauge for how the ferals are doing," he said, citing one call in 1995 and 35 swarms last year. He hives them or just as often gives them away to get people started, considering himself "too generous to be in business."

His motivation to work with untreated local bees came with that one call in '95, when mites and a severe winter contributed to losses of over 50% in the state: he found a thriving nest in a wallboard. The queen bore a dark end to her abdomen, which he named "leather tipped" queen after he began to encounter the marking in other survival stock. He also found the cells to be small, 4.9mm at the center. "I used to go for small cell, but not now," he said. "Now I am finding the cell size is larger, 5.1 mm. I theorize that resistant traits may have developed, or the mites might have evolved, so that the bees didn't need the small cell size any more."

He is setting out swarm traps in remote woodland areas with feral populations that he has found to have good productivity and survival. He finds that this particular stock has to fly

long distances to forage after the tree bloom ends in late June – a trait he calls "wing power," from Brother Adam, the famed breeder of the English Buckfast bee. Waggle relates this trait to enhanced brood rearing throughout the summer months, a trait useful for storing the fall surplus necessary in his northern climate. As carefully as he has been selecting, he reports that his 20 or so hives have not done as well as he hoped the last few years.

Waggle runs a Yahoo discussion Group, The Feral Bee Project, for beekeepers who have an interest in keeping unmedicated stock.

The Sustainable Honeybee Program breeds bees with the purpose of creating regional genetic selection of survivor stock for northern Virginia. A group of beekeepers work part time on a seven day cycle to breed queens; they produce 60 queens per week over 15 weeks. All 135 nucs for the 2009 season and most of the queens were booked by last December. The project is run as a registered non-profit organization.

Billy Davis, the group's mentor, started keeping bees in 1947. "When the mites came, we looked for the silver bullet like everybody else. I lost 90% of 40 colonies. I got into nucs and saw that we could get acclimated bees.

"Fifteen years ago our club was down to seven members, the bees were dying. I sold honey at a local farmers' market and asked every customer, 'Wouldn't you like to be a beekeeper?' and I started teaching classes.

"I was very fortunate to sit down with Sue Cobey at an EAS meeting some years ago and had a conversation about the need for local sustainable stock. I'd been a cattle breeder all my life and it made sense to look at the genetics."

Photo Dennis Murrell

Joe Waggle's first survivor stock, found in a Western Pennsylvania house wall, had thrived through the devastating losses of 1995-96. His question was, how did this colony survive the incursion of mites and a devastating winter?

Davis finds the concept of survivor stock "somewhat confusing to say the least, so we chose to go with what we understood about genetics" The breeding program started five years ago with instrumentally inseminated hygienic queens, which are still brought in from time to time. Daughter queens are selected for gentleness, productivity, longevity and hygienic behavior determined by a nitrogen test. A queen that qualifies is overwintered and used as a production queen to see if the pattern is repeated in her daughters, in which case she will become a breeder queen. The group works with up to six breeder queens, one of which is four years old.

Although the project aims not to use chemicals, exceptions from time to time have included the use of fumagilin and a one time request for mite treatment in the drone yard of a co-operating nearby beekeeper. "I use apple cider vinegar to acidify the bees' digestive tracts, we've done that for years, said Davis.

The group has worked out the breeding calendar to the hour. "There are so many fine things to tweak. You have to learn a lot of tricks," said Davis. "Needless to say the complete plan is still a work in progress."

With several contributors, Davis has developed a standardized beekeeping course that is taught in nine locations in Virginia. "I'm behind this regional thing, and there is a lot of benefit to structure as a group. Who has the nerve to try what we did?"

[1] Sue Cobey interview, 12-11-08.

[2] Spivak, Marla and Gary S. Reuter, "Varroa destructor Infestation in Untreated Honey Bee (Hymenoptera: Apidae) Colonies Selected for Hygienic Behavior" Journal of Economic Entomology, Volume 94, Issue 2, April 2001, 326–331.

[3] Le Conte, Yves, Laboratoire Biologie et Protection de l'abeille, "Honey Bees Surviving *Varroa desructor* Infestations in France." http://web.uniud.it/eurbee/Proceedings/FullPapers/EuroBeeYLCVarroa.pdf .

[4] Sue Coby writes: "We have no data to support small cell size advantages, plus it may give an edge to AHB."

[5] Kefuss, John, presentation at the American Beekeeping Federation Convention, Reno, Nevada, January 2005.

[6] Sue Cobey interview 12-11-08.

[7] Fries, I. et al, "Survival of mite infested (*Varroa destructor*) honey bee (*Apis mellifera*) colonies in a Nordic climate", Apidologie.37 (5), 2006 , 564-570
http://www.db-alp.admin.ch/en/publikationen/pub_detail.php?id=17174.

[8] Wenner, Adrian, "Colony Survival: A Better Bee or a Milder Mite?" American Bee Journal, Vol 139 No 9, September 1999, http://www.beesource.com/pov/wenner/abjsep1999.htm.
"The exciting potential of remote feral bee colonies for Varroa coexistence," Third European Congress on Social Insects, St Petersburg, Russia, August 2005 http://www.beesource.com/pov/wenner/varroaabstract.htm.

[9] For a simplified method of bee lining: http://www.savethehives.com/fbp/Beelining.html.
A detailed account of bee lining including timing the bees by Adrian Wenner: http://www.beesource.com/pov/wenner/bsjun1992.htm.
A detailed account of bee lining: http://www.bindaree.com.au/hints/hint12_beelining.htm.
The bee lining box pictured is $50 including shipping from Jim Fischer 12821 Smith Mountain Lake Parkway Huddleston, VA 2410, 540-297-0300.

[10] Seeley, Thomas, "Honey bees surviving with parasitic mites found in Cornell`s Arnot Forest," http://vivo.cornell.edu/individual/vivo/individual5562.

[11] Delaney, Deborah and Steve Shepard, poster presented at the Annual Meeting of the Entomological Society of America, 2008, posted by Peter Borst on BEE-L, archived at http://listserv.albany.edu:8080/cgi-bin/wa?S1=bee-l.

[12] Erickson, Eric H., L.H. Hines, and A.H. Atmowidjojo, "Producing Varroa-tolerant Honey Bees from Locally Adapted Stock: A Recipe" Carl Hayden Bee Research Center, http://gears.tucson.ars.ag.gov/publ/tolerant2.html.

[13] Webster, Kirk, Kirk Webster March 2005 *Bee Culture,* "Restoring Health". He can be reached at Champlain Valley Bees and Queens, (802) 758-2501.

[14] Arnold Honeybee Services, (865) 924-2405.

[15] Bees Gone Wild Apiaries, http://mysite.verizon.net/vzeod3nx/id1.html, naturebee@yahoo.com.

[16] http://tech.groups.yahoo.com/group/FeralBeeProject/

[17] Honeybees.flintlock@gmail.com.