Greater Than the Sum of Its Parts:
The American Beekeeping Federation and The American Honey Producers Association Joint 2008 Conference

by M.E.A. McNeil

The 2008 National Beekeeping Conference, held in Sacramento, California in January, met and surpassed the hopes of planners to have the largest American bee conference ever. More significant was the extraordinary display of alliances, some the strangest of bedfellows, from the US Army to Haagen-Dazs ice cream.

The seriousness of the decline in honey bees was a theme throughout the four days, with beekeepers airing frustrations and researchers asking which finds are causes and which are the results of causes. The Apiary Inspectors of America (AIA), who met at the conference, found that 51% of beekeepers reported abnormally high losses – up to 70% of hives. Only half of those losses were related to colony collapse disorder (CCD). The rest of the beekeepers averaged 17% loss, which has become acceptable. Native pollinators are in decline as well, as are European pollinators and forage plants.

Canadian researcher Steve Pernal summed it up: "Beekeeping is in great peril." Mark Brady, a commercial beekeeper, recalled lying on the ground under a broken truck on the side of the road, far from home, wondering about the future: "we live in next year country."

CCD has catalyzed an unprecedented cooperative effort. Many coalitions predate that crisis though, as honey bee losses have grown. The American Beekeeping Federation (ABF) and the American Honey Producers Association (AHPA), the two national organizations that have been split for three decades, began planning this joint conference over two years ago.

The need for convergence was the theme of the opening remarks by Secretary A.G. Kawamura of the California Department of Food and Agriculture, himself once a beekeeper. California, the fifth largest agricultural producer in the world, has no small stake in the welfare of bees. ABF president Danny Weaver asked beekeepers to "find the common ground," and AHPA president Mark Brady called for "working together."

Mapping the honey bee genome, completed in 2005, involved researchers at some 90 facilities worldwide -- establishing new networks of labs. DNA evidence that the bee has few genes for immunity, leaving it particularly vulnerable to pathogens, was referenced in much of the work presented at the conference. The puzzle of CCD was presented in the larger context of honey bee health.

"We have not found one smoking gun," said Dennis VanEgelsdorp, Apiary Inspector, Pennsylvania Department of Agriculture, who has been investigating CCD since the first losses were found. Now "it is a multi-factorial analysis."

A current working theory is that CCD may be a confluence of problems that can come in shifting combinations, according to Jeff Pettis of the USDA/ARS (United States Department of Agriculture/Agricultural Research Service) Beltsville, Maryland. He cites possible interacting elements: nutrition, viruses, nosema, mites, pesticides, as well as management – concerns for all beekeepers.

A clichéd but useful metaphor for the various USDA labs is that they work like a beehive, an organization dividing tasks by adjusting to the overall need – with all of the tasks interdependent. (Including, by the way, research on the use of native pollinators.) The CCD Action Plan is at www.ars.usda.gov/is/br/ccd_actionplan.pdf .

So when a beekeeper asked a USDA Tucson researcher why she was not addressing his CCD losses, it seems that the lab was working on the nutritional piece of the overall goal of honey bee health. Natural pollen is sometimes scarce, particularly during times of the year when thousands of colonies are congregated to be moved for agricultural pollination. In addition, Diana Summataro of the Tucson lab, in describing bee plants, said that honey bees have not evolved with such native plants as squash, blueberries and cranberries, which have pollens that are not adequately nutritious. Gloria DeGrandi-Hoffman said that research at Tucson has developed a nutritional bee supplement, licensed for commercial distribution as Mega-Bee. In this case, the government lab allied with a private lab that contributed money and expertise for the research.

De-Grandi-Hoffman reported that high fructose corn syrup at high temperatures can form hydroxymethylfurfural (HMF), which is toxic to bees. Slightly dark syrup, often found at a cheap price, is a

sign of HMF. The project is funded in part by Project Apis m (www.projectapism.org). The Tucson lab requests samples for a study from beekeepers (e-mail Diana.Sammataro@ars.usda.gov).

The remarkable goal of sequencing all organisms present in CCD bees has been taken on by the USDA Beltsville in cooperation with other labs. From 428 sequences, Jay Evans identified eight species of bacteria associated with a "stable bacterial community" in the intestines of bees all over the world. In a separate study, Swedish researchers Alejandra Vasquez and Tobias Olofson reported that the regular use of antibiotics in the hive destroys these probiotics, degrading the nutritional quality of the bee bread. Among these benign symbiotic bacteria is lacto-bacillis, which produces lactic acid; the resulting acidic environment inhibits the growth of some harmful bacteria. (pH in the larval gut is 4.0 – 4.6.)

Diana Cox-Foster of Pennsylvania State University is another member of the team doing this "metagenomic investigation". She described finding four variants of Israeli Acute Paralysis Virus (IAPV), closely related to the lethal Kashmir Bee Virus (KBV), as well as new pathogens. She cited Dr. Ilan Sela, the Israeli investigator who named IAPV, as having found that it can work its way into the honey bees' genes and can do the same with varroa. IAPV was found to be carried by the small hive beetle, which may have brought it in.

Another approach to the identification of viruses and bacteria comes from a U.S. Army biowarfare lab, which usually deals with human pathogens. Colin Henderson and Jerry Bromenshank of the University of Montana are working with the Edgewood Chemical Biological Center in Maryland, using the Integrated Virus Detection System (IVDS). The inventor of the machine, Charles Wick, said that it identifies viruses by sorting them by size, which is highly accurate. The method has found several new viruses, but it is not known if they are pathogenic. A strong connection between IAPV and CCD was not found by this lab.

Henderson said that advantages of IVDS technology are that it is much faster and less expensive to run than sequencing equipment. Of the half dozen IVDS machines, one will be installed in the bee lab at the University of Californian at Davis.

So can CCD be diagnosed early? Potential clues are three physical characteristics of affected bees described by VanEngelsdorp: unusual nodules; sting glands melanized (black scar tissue associated with yeast infection); pebbling of the Malpighian tubules.

Unusually high colony losses are reported in Canada, but not with the same CCD symptoms reported in the US, according to Canadian researcher Stephen Pernal. He has turned his attention to the new bully in the hive, *Nosema ceranae*, which has jumped from its Asian bee host to become more prevalent here than *Nosema apis.* Not only is *N. ceranae* much more virulent, but Pernal has found that it does not wane during summer, as *N. apis* does. He found it common in packages. The infested workers abandon the queen, becoming precocious foragers, eventually leaving behind a small cluster, similar to the pattern in CCD. Spores can be destroyed by irradiation; Pernal recommends renewing comb. He cited a New Zealand study that showed a relationship between longevity and resistance to nosema. Pernal's lab works closely with Beltsville, which found nosema in half of American CCD samples. Other work on *N. ceranae* is being done with a new fungal pathologist at the University of Montana, Robert Cramer, together with Jerry Bromenshank.

Pettis considers the biggest problem to be varroa mites, although he says they are not the immediate cause of CCD. A printed progress report on the USDA/ARS, distributed at the conference, listed work on varroa controls: The Weslaco lab is studying unexplained losses with the miticide fenpyroximate, Hivastan, which it is developing in cooperation with a private lab. Biopesticides such as beta plant acids and the bee pheromone 2-heptanone are both being developed at the Tucson lab with commercial partners. Two fungal treatments have been studied at Weslaco, with one, *Metarhizium anisopliae*, a feasible product. Application of another fungus, *Beauveria bassiana* which occurs naturally in beehives, has been patented at the ARS lab in Montpellier, France.

IPM methods (Integrated Pest Management) for trapping small hive beetle were suggested by Kate Aronstein, a research molecular biologist at USDA Weslaco.

"Numerous environmental chemicals, including insecticides and fungicides are found in pollen and wax. There are unprecedented amounts of both fluvalinate and coumophos at high frequency." These are findings of groups working with Maryann Frazier of Penn State University, working with Chris Mullen, an insect toxicologist, and other teams in "a very integrated effort." With samples of CCD related wax, larvae, pollen, and bees received from vanEngelsdorp, she found attempts by her lab to analyze them "antiquated". It took Roger Simonds, a chemist at the USDA Natural Science Laboratory, to test for well over a hundred pesticides measured in parts per billion. He analyzed them with a multi-residue screening, which he confirmed by mass spectrometry.

In 92 samples, he identified 43 different pesticides and broken down component chemicals -- some of which are more toxic than the pesticides they once comprised. Fungicides were found, which, Frazier explained, can synergize with pesticides to become as much a 1000 times more toxic when combined in lab studies. Both fluvalinate and coumaphos were found in every CCD wax sample as well as in healthy controls. Pesticides were found in 100% of adult bees. In the weak, dead and recovering CCD hives there were higher levels of fluvalinate and coumaphos, as well as more pesticides.

"We are putting a chemical in the hive to control mites that is highly toxic to honey bees today," said Frazier. She explained that when fluvalinate was registered, its LD50 (the level at which 50% of bees are killed) was relatively non-toxic (65.85 micrograms per bee) With a changed formula, the LD50 increased (.2), and with inert ingredients added, it is extremely toxic to bees (.00964 micrograms per bee). The half life of fluvalinate is five years.

Frazier said there is evidence that our wax is contaminated with both in-hive mitecides and agricultural pesticides that can migrate into the pollen – the protein source of the young brood. These chemicals are found in foundation as well in lower levels. She also said that there is increasing evidence that there may be interactions between some pesticides and some viral diseases. Even so, she concluded that the correlation of pesticides and CCD could not be said to be causal.

"Entombed pollen," something not seen before, was found in a monitoring project, according to VanEngelsdorp. Migratory operations were sampled monthly as they moved along the east coast. In Maine hives that sealed some pollen cells were found. Feeding the pollen to bees in cages caused mortality.

Several beekeepers addressed concerns about agricultural chemicals: Dave Ellingson said that fungicides and pesticides are combined by farmers to save spray time, making them more lethal to bees. Gene Brandi reported that fertilizers and pesticides are mixed with irrigation water, which is the bees' water supply. Dave Mendes said that the EPA does not test pesticides; it is the manufacturers that submit testing to the EPA. A lethal dose is measured for a mature bee, "but we are worried about sublethal doses."

A paradigm shift away from the idea of chemicals as the cure was evident throughout the conference, including Larry Connor's symposium for sideliners. Sue Cobey of UC Davis said, "We need soft treatments; we need to get away from chemical control." Danny Weaver urged us to "embrace the environmental movement as part of a coalition." Kim Flottum, editor of Bee Culture, said "Chemicals have to go." His solutions include "know the guy who raises your queens."

One of the motivations for breeding hygienic bees is to move away from chemicals. Ironically, early research on selecting hygienic behavior by Rothenbeuler was not pursued because of the advent of antibiotics, according to Gary Reuter of the University of Minnesota. Hygienic bees have two recessive traits, to uncap and remove diseased larvae, so there can be "uncappers" and "removers". These bees won't have AFB or chalkbrood. At least half of the bees in the colony have to have these traits for the colony to function as hygienic.

Cobey has done long-term breeding projects that have led her to believe, "We can do this, we can produce resistant bees." She has found a declining number of breeder queens nationwide and sees that greater genetic diversity will strengthen the bees. She has been unable to import bee eggs and sperm, which can carry viruses (the irony of Australian bee importation has not escaped her). At UC Davis, she is working on methods to package and transport breeding materials safely. She and Eric Mussen hosted a tour of the newly refurbished Harry Laidlaw lab for conference visitors in celebration of its rebirth.

"A lot of bees are sick and hurting," said Marla Spivak of the University of Minnesota to an audience of beekeepers. "Despite this there are colonies out there that are healthy. Breed from them. Relax control of the ones you have to nurse." To a question about developing a new pedigree, she said, "I don't think we are going there – just a good line of bees." She and Cobey plan to map drone congregation areas around some California queen breeding yards.

The Russian bee breeding project will end at the USDA Baton Rouge Lab in 2009, according to Tom Rinderer. At that time an organization of beekeepers, The Russian Bee Breeding Association, will take over the certification program. The lab is now working on developing the trait for varroa-sensitive hygiene (VHS). Rinderer reported that VHS behavior is age dependent. The bees are not hygienic toward drone brood but, interestingly, will uncap and recap infested drone brood. He would like to identify the volatile chemicals that trigger hygienic behavior and wonders if mite feces are involved. The project is a collaborative effort that includes Tom Glenn, a California queen breeder.

The Southwest Survivor Queenbee Project (www.zizqueenbees.com) is one example of the proactive local networking seen at the conference. Mark Spitzig and Melanie Kirby, a young Peace Corps alumna, are collecting regionally hearty survivor breeder stock from a 400 mile range in New Mexico.

They have organized a coalition of beekeepers with government and other groups, with the state bee inspector as their technical advisor.

This pattern of networking reaches from grassroots through government and commercial enterprises. Analyzing a group of CCD samples, for example, was paid for by more than ten entities, including The National Honey Board and individual beekeepers: one young woman raised over $10,000. Haagen-Dazs Ice Cream has made substantial donations to UC Davis and Penn State bee research.; a website and print campaign will educate the public about bees. A new flavor, vanilla honey bee, was served at a dinner on the Davis campus.

In an emotional passing of the guard to an innovative young generation, Bill Wilson, retired USDA researcher, received the Founders' Award from the Foundation for the Preservation of Honey Bees. Marion Ellis of the University of Nebraska remembered that Wilson was so exacting that he wouldn't permit morning coffee for him as a young assistant dissecting bee trachea, lest his hands shake. Wilson was enthusiastic about technological advances for scientific precision, laughing: "I don't even know how to turn some of these new machines on."

His optimism was embodied in six young bee scientists in the audience who were awarded graduate scholarships by the foundation. Their work includes: researching the honey bee immune system on a molecular level, IPM practices for migratory beekeeping, volatile molecules emitted by brood and their role in communication with nurse bees, the reproductive quality of queen bees, chemical cues for hygienic behavior, and the effects of the two types of nosema. (For details see www.abfnet.org/node/35, click on Nov/Dec '07 newsletter.) The standing ovation at the luncheon was for Wilson and a life well lived -- as well as for the hope in these scholars for beekeepers and for the bees.

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