

## **COLONY COLLAPSE DISORDER (CCD), FEDERAL FUNDING AND THE CHALLENGES OF BEE DECLINE RESEARCH: A BUREAUCRAT'S PERSPECTIVE**

**Mary F. Purcell-Miramontes, USDA-NIFA, Washington D. C.**

Some may think that the life of a National Program Leader is a piece of cake and 9 to 5. Before I came to Washington DC, I thought this was true, but I was quickly proven wrong. I am an entomologist with USDA's National Institute of Food and Agriculture, whose purpose is to provide extramural support to research, extension and educational programs for US agriculture. In the past 7 years, an increasing amount of my time has been spent responding to Colony Collapse Disorder, a seemingly new crisis which threatens the honeybee industry and crop growers who depend on honeybees for pollination services. In this article, I describe my experience as a public servant responding to this calamity, including an overview of USDA funding resources that were tapped to address the problem, and my perception of the challenges in conducting research to understand and mitigate colony losses.

In February of 2007, I received a phone call from our agency's congressional affairs liaison; Senator Max Baucus of Montana was asking how much money USDA was spending on a problem that was leading to the collapse of beekeeper's colonies. Soon after, I picked up a New York Times and saw on the Op Ed page an article by May Berenbaum on a mysterious malady called Colony Collapse Disorder (CCD [Berenbaum 2007]). She wrote:

“In more than 20 states, beekeepers have noticed that their honeybees have mysteriously vanished, leaving behind no clues as to their whereabouts. There are no tell-tale dead bodies either inside colonies or out in front of hives, where bees typically deposit corpses of dead nest mates.”

CCD is believed to be a condition in which bees incur multiple interacting stresses (e.g., parasitism by *Varroa* mites, exposure to harmful levels of pesticides, disease infection, poor nutrition, and the ravages of being transported across the US). Worker bees are absent, no dead bees are left in the hive; the brood, food stores and the queen are all that remain, and the hive soon collapses a few days or weeks later (vanEngelsdorp et al., 2009).

I was intrigued. I knew that since the 1980s honeybees were in serious decline because of the parasitic *Varroa* mite, an invasive species from Asia. I had also read the National Academy of Sciences study on the Status of Pollinators in North America (National Research Council 2007). But I had never heard about vanishing bees before. Soon after, I began receiving more calls and emails from congressional staffers and the media asking me what I knew about CCD (as if I was the expert), and more importantly what was NIFA doing to address the problem. My other counterparts in USDA were similarly besieged. Kevin Hackett at ARS, Colin Stewart at APHIS and Doug Holy at NRCS were called to briefing after briefing on Capitol Hill.

A multitude of meetings among and between scientists, apiary inspectors, beekeepers and industry representatives were abuzz in the winter and spring 2007. I team up with Hackett, who oversees bee and pollination programs at ARS, in Beltsville MD to bring together scientists,

beekeepers and inspectors that observed the collapsed colonies and other honey bee researchers and apiculturists. The group deliberated for 2 ½ days and provided several recommendations for what research was needed to better understand the problem.

At the Beltsville Meeting, the scientists hypothesized that there were at least 5 suspected factors interacting to cause these losses: pests, microbial bee diseases, pesticides, nutrient deficiencies, and other management stresses imposed on bees such as transporting hives across the US to pollinate crops. The USDA undersecretary, Gale Buchanan, advised USDA program leaders to coordinate a national response to CCD. Our first step was to write a National CCD Action Plan to prioritize a federal strategy for research needed to address CCD ([www.ars.usda.gov/is/br/ccd/ccd\\_actionplan.pdf](http://www.ars.usda.gov/is/br/ccd/ccd_actionplan.pdf)). Five USDA agencies (APHIS, ARS, NASS, NIFA and NRCS) along with EPA and administrators from Purdue and Pennsylvania State University co-authored the action plan. We formed a committee called the National CCD Steering Committee which was composed of program leaders from the above agencies and universities.

USDA has been the principal source of Federal funding for research and other programs designed to protect and conserve pollinators. The 2008 Farm Bill directed USDA to devote more resources to conduct research on CCD and to support conservation programs for pollinators. (Johnson 2010). Since the inception of the Cooperative State Research Service in 1981 (now known as the National Institute of Food and Agriculture [NIFA]), extramural grant programs have historically funded hundreds of pollinator health projects primarily to university and federal researchers, educators and extension specialists. Given the level of urgency of the problem, the Coordinated Agricultural Projects (CAP) competitive grant mechanism was used, which supports nationally important problems that require coordination of multiple researchers, extension specialists and educators. Between 2008 and 2012, the NRI and AFRI funded a \$4.1 M CAP grant to Keith Delaplane at the University of Georgia and 14 associated researchers and extension specialists at 20 universities and ARS (<http://www.beecdcap.uga.edu/>). This grant laid important ground work to understanding factors associated with colony losses. A second CAP grant for \$5 M went to Dennis vanEngelsdorp, now at the University of Maryland, and 10 other institutions, to build the infrastructure for an ongoing national database on honey bee health and to provide beekeepers region-specific data for making management decisions (<http://beeinformed.org/about/>). Another NIFA grant program, the Specialty Crops Research Initiative (SCRI) was instrumental in supporting pollinator research. One of its legislatively mandated focus areas was to “identify and address threats from pests and diseases, including threats to specialty crop pollinators ([http://www.nifa.usda.gov/funding/rfas/pdfs/12\\_scri.pdf](http://www.nifa.usda.gov/funding/rfas/pdfs/12_scri.pdf)). In 2011, SCRI awarded Dr. Anne Averill at the University of Massachusetts \$3.3 M to address declines in native bee pollinators in fruit and vegetable crops. In addition, smaller grants to single or smaller groups of investigators (up to \$500K) from several programs have provided another important source of funds to researchers, educators and extension (e.g., AFRI Foundational Programs, regional IPM, Sustainable Agriculture Research and Education program, Small Business Innovation Research and Hatch funds).

In addition, the farm bill authorized USDA to encourage “the development of habitat for native and managed pollinators” and “the use of conservation practices that encourage native and managed pollinators” during administration of any conservation program. Several programs administered by the Natural Resources Conservation Service (NRCS) were then used to carry out these goals (Vaughn and

Skinner 2008). In 2008, \$5 M from USDA-ARS was allocated to initiate the “USDA-ARS Areawide Project to Improve Honey Bee Health” led by Jeffrey Pettis ([http://www.ars.usda.gov/research/projects/projects.htm?accn\\_no=412674](http://www.ars.usda.gov/research/projects/projects.htm?accn_no=412674)). The overall goal was to conduct demonstration tests across the US with an emphasis on Varroa-mite resistant bees, improved nutritional supplements, and developing effective controls (Pettis and Delaplane 2010). In 2009, USDA-APHIS funded a national survey of beekeepers in 34 states to detect exotic pests and diseases of honey bees ([http://www.aphis.usda.gov/plant\\_health/plant\\_pest\\_info/honey\\_bees/downloads/SurveyProjectPlan.pdf](http://www.aphis.usda.gov/plant_health/plant_pest_info/honey_bees/downloads/SurveyProjectPlan.pdf)).

Much of the knowledge about bee declines and CCD was made possible by these sources of USDA funds. However, researchers were confronted with numerous challenges to studying a problem of this magnitude, and quick solutions were not easy to come by. So here was the first challenge: Because the foragers had vanished, researchers were left with sampling and measuring diseases, pesticides and pests from the bees that remained in the hive. Although researchers might argue this point, I wonder if it's valid to consider the bees that remain as comparable to the disappearing foragers. A further challenge would be to track foraging bees exposed to either diseases and/or pesticides after leaving the hives and to quantify their return rates. Several researchers are tackling this problem (e.g., Ciarlo et al., 2011; EAA et al. 2012; Yang et al., 2008). In the US, some bee kill incidents were believed to result from spray drift of Clothianidin, a neonicotinoid insecticide from cornfields (Krupke et al., 2012). So are pesticides and/or diseases the culprits? Although it may be tempting to say yes, we cannot make firm conclusions yet. Dosages were probably far higher than what a bee would encounter in the field. More studies are needed using doses that approximate what bees typically consume under field conditions. In addition, these studies tested individual bees, and did not study bees at the colony level, which would better reflect actual conditions.

Further complicating the story is the possibility that CCD is occurring with diminishing frequency. The CAP-funded longitudinal studies on stationary bee hives were the first to systematically track bee losses in experimental bee hives in 7 states (Spivak 2010). They identified and quantified diseases, pesticide and pest levels within these hives. However, in the 4 years that these hives were followed, CCD was rarely observed (Spivak, personal communication). Moreover, vanEngelsdorp and Pettis indicated that the number of reported cases of CCD by beekeepers was sharply decreasing. For example, in the 2010/2011 winter survey, starvation was cited as the most frequently reported cause of bee losses and CCD was the 7<sup>th</sup> most reported cause of colony loss on the list (vanEngelsdorp et al. 2012).

So, was CCD just a transient problem? It's quite possible. Was the problem gone? Unfortunately, the answer is no. Winter surveys 2012/2013 indicate that honeybee losses have resurged to levels approaching 30%; beekeepers – even large scale operators – are experiencing heavier losses than during last year's mild winter (Pettis, personal communication). Although fewer in number, beekeepers that reported losses from CCD incurred more than 60% losses (vanEngelsdorp et al. 2012).

Therefore, beekeepers are still confronted with a myriad of challenges to keeping bees (diseases, pesticides, Varroa mite, lack of forage, etc.) and for the most part lack effective ways to manage these problems. Almond growers, whose acreage has increased has doubled in the past decade (835,000 acres in 2011), depend on the services of honeybees supplied by

beekeepers who manage them. Still other specialty crop growers are seriously concerned about how to meet the demand for pollination.

The CCD Steering Committee regrouped and agreed another meeting was needed to review the state of knowledge gathered over the past 5 years with an emphasis on obtaining recommendations for developing best management practices. A stakeholder workshop was convened in Alexandria VA in late October for 2 ½ days. Research progress in the 4 areas (pests, diseases, nutrition and pesticides) was reviewed. An impressive plethora of information was presented and constructive discussions were held to help USDA and EPA program leaders to determine next steps for a renewed federal strategy. The second part of the workshop focused on developing solutions or Best Management Practices to manage the declines. Breakout sessions were held to identify concrete strategies. It was an excellent collaborative effort between researchers, beekeepers, apiary inspectors, pesticide company reps, commodity group reps and conservation organizations. Important lines of communication were established. Some solutions will not involve science but will require agreements with land managers for agricultural and recreational use and special interest groups like duck hunters and environmentalists. In addition, hurdles must be crossed to increase communication between beekeepers, farmers and crop advisors. Finding effective strategies to influence growers to change their practices to protect bees were identified as another big challenge. A published report is expected within the next few months and will serve as the basis of a new action plan to prioritize future research on management of bee declines.

The challenges that surround the management of honey bees are certainly vexing to beekeepers because their enterprises (both personal and professional) are at stake. The silver lining to this, however, is that a tremendous groundswell of concern arose from the public about the welfare of honeybees and other pollinators. The average person is more aware than ever that the health of honeybees and the reproduction of plants that depend on them are at risk and wants something to be done. Much progress is being made in providing practical solutions that beekeepers can use. For example, Bee CAP co-investigator, Marla Spivak, established a “Tech-Transfer Team” in California, the Midwest and the Northeastern US to help honeybee queen breeders to select for “hygienic behavior”, a trait which helps bees defend against *Varroa* mites, still believed to be the main reason for colony losses. In addition, the teams identify and assess infection levels of several bee diseases from samples provided by beekeepers. Other investigators, Judy Chen and Jay Evans, funded both by USDA-ARS and NIFA, found that the *Varroa* mite spreads the Israeli Acute Paralysis Virus (IAPV), a disease that was strongly correlated with CCD (Di Prisco et al., 2011). Still, other questions loom large and overall losses are unacceptably high. Despite the complexities, I am optimistic that with continued investment of funds for research and outreach in the not too distant future (maybe 5 or 10 years) that practical answers to these challenges will be at hand.

## References

- Berenbaum, May R. Losing their buzz, New York Times, March 2, 2007  
(<http://www.nytimes.com/2007/03/02/opinion/02berenbaum.html>)
- CCD Steering Committee, USDA-ARS. CCD Action Plan 2007  
[http://www.ars.usda.gov/is/br/ccd/ccd\\_actionplan.pdf](http://www.ars.usda.gov/is/br/ccd/ccd_actionplan.pdf)
- Di Prisco, G., Pennacchio, F., Emilio, C., Boncristiani, H., Evans, J.D., and Chen, Y.P. (2011)  
*Varroa destructor*, an effective vector of Israeli Acute Paralysis Virus in the honey bee *Apis mellifera*. J. Gen. Virol. 92: 151 – 155. e29268. doi:10.1371/journal.pone.0029268
- Environment Agency Austria (EAA); Margrit Grimm, M., Sedy, K., SuBenbacher, E. and Riss, A. Existing Scientific evidence of the effects of neonicotinoid pesticides on bees. European Parliament; Directorate General for Internal Policies, pp. 1-20; 2012;  
<http://www.europarl.europa.eu/committees/en/studiesdownload.html?file=79433&language=EN>
- Krupke, C.H.; Hunt, G.J.; Eitzer, B.D.; Andino, G. & Given, K. (2012): Multiple Routes of Pesticide Exposure for Honey Bees Living Near Agricultural Fields. PLoS ONE 7(1):
- Pettis, J.S. and K. S. Delaplane. 2010. Coordinated responses to honey bee decline in the USA. Apidologie Vol. 41 (3) : 256-263, 2010 DOI: 10.1051/apido/2010013
- Spivak, M. 2010. Honey bee “medical records”: the stationary apiary monitoring projects. Amer.Bee.J.149(3):271-274;  
<http://www.beecdcap.uga.edu/documents/DrummondCAPcolumnDec2012.pdf>
- vanEngelsdorp, D., Evans, J. D. ; Saegerman, C. ; Mullin, C. ; Haubruge, E. ; Nguyen, B. K.; Frazier, M.; Cox-Foster, D.; Chen, Y.; Underwood, R.; Tarpay, D. R.; Pettis, J. S. Colony Collapse Disorder: A descriptive study. PloS One 4: pp. 1-17; e6481. 2009. DOI: 10.1371/journal.pone 0006481
- vanEngelsdorp, D., D. Caron, J. Hayes, R. Underwood, M. Henson, K. Rennich, A. Spleen, M. Andree, R. Snyder, K. Lee, K. Roccasecca, M. Wilson, J. Wilkes, E. Lengerich, J. Pettis, A national survey of managed honey bee 2010-11 winter colony losses in the USA: results from the Bee Informed Partnership. Vol 51 (1) 115-124, 2012, 10.3896/IBRA.1.51.1.14
- Vaughn, M. and Skinner, M. Using farm bill programs for pollinator conservation. USDA-NRCS and the Xerces Society. Tech. Note 78. Pp 1-16. 2008
- Yang, E. C., Y. C. Chuang, Y. L. Chen<sup>1</sup>, and L. H. Chang. Abnormal foraging behavior induced by sublethal dosage of Imidacloprid in the honey bee (Hymenoptera: Apidae). J. Econ. Entomol. 1743-1748, 2008; doi: <http://dx.doi.org/10.1603/0022-0493-101.6.1743>