# International Conference on Pollinator Biology, Health and Policy

## Nittany Lion Inn, University Park, PA
## August 14-17, 2013

by PETER LORING BORST

I had the good fortune to attend the Second International Conference on Pollinator Biology, Health and Policy, held this August in State College, PA. The conference was introduced by Christina Grozinger, who was named the Director of the Center for Pollinator Research in 2009. She is the inspiration for pollinator researchers, professionals, and aficionados throughout the world, many of whom were in attendance. I am not going to present an exhaustive article, but highlight the points I found most interesting. The incredible diversity and variety makes it difficult to leave things out, and I hope that no one will take offense if I didn't summarize their work. There really weren't any bad presentations, the overall quality was top-notch.

Dr. Grozinger began by saying that the problem with honey bees and pollinators in general cannot be just neonicotinoids, even as they would come up again and again throughout the week. The bigger picture is that we are introducing around one thousand agrochemicals into the environment and it is impossible to test all the combinations of these substances in all settings. Therefore, the question we must pose is: What sort of response can there be to such a complex situation?

The first speaker was Dave Goulson, Sussex University. He presented a list of the three main factors that are contributing to pollinator decline: habitat loss, pathogens, and pesticides. Goulson was emphatic that while he would focus on pesticides, we should not get the impression they are the main factor. One of the key points he made was that there needs to be a specific measure of colony quality that can be evaluated directly, in order to measure the impact of any new factor. (I would suggest that the supersedure rate of queens is just such a metric.) Dr. Goulson went on to point out that seed dressing is a very inefficient method of applying insecticide, as only 2% is absorbed into the growing plant, the rest being lost into the soil. He added that the very concept of Integrated Pest Management seems to have been forgotten with the preemptive applications of chemicals.

**Disruption**

Heather Patisaul, from the Department of Biology at NC State University spoke on the topic of endocrine disruption. She began by reminding us that the Swiss chemist Paul Müller was awarded a Nobel Prize for his work with DDT. This chemical saved millions of human lives, particularly during World War II, by killing the mosquitoes that spread typhus and malaria. When Rachel Carson brought its negative consequences to the world's attention, she did not advocate a ban, but judicious use. Again we were reminded of the concept of IPM, where pests are carefully targeted and collateral damage is minimized. Unfortunately, DDT and the chemically similar DES still permeate the environment. Both of these substances have a long latency, and can disrupt the endocrine systems of humans, animals and insects.

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The issue of endocrine disruption is brought closer to home when we realize that the onset of puberty in girls has gotten much earlier and that natural estrogens occur in common foods which contain soy products. To this is added the onslaught of estrogens into the environment from municipal water treatment. Estrogens, whether natural or synthetic, can cause all sorts of effects on the nervous system. Low doses appear to stimulate hyperactivity while high doses create crippling anxiety. The point being, these effects can occur in pollinators, as well, leading to disruption, failure to thrive, and reduced populations.

**Rapid Fire Talks**

The format from day two forward was one of very short presentations followed by one or two questions. The rapid succession of talks was dizzying but never dull! The presentations began with Robert Raguso, of Cornell University, who spoke eloquently on the topic of the coevolution of pollinators and flowers and the natural chemicals which enhance the process of attraction. Many of the same chemical attractants are used by various flowering plants all over the world to attract completely different species of pollinators.

Chris Mullin of Penn State updated us on his ongoing research into adjuvants. These are so-called inert substances that serve as vehicles for various pesticides. Most active ingredients are tested individually, and not in combination with the adjuvants, the purpose of which is to greatly enhance their effectiveness. In other words, the actual formulations are known to be much more toxic than the active ingredients. Further, the so-called inerts are not generally tested, either

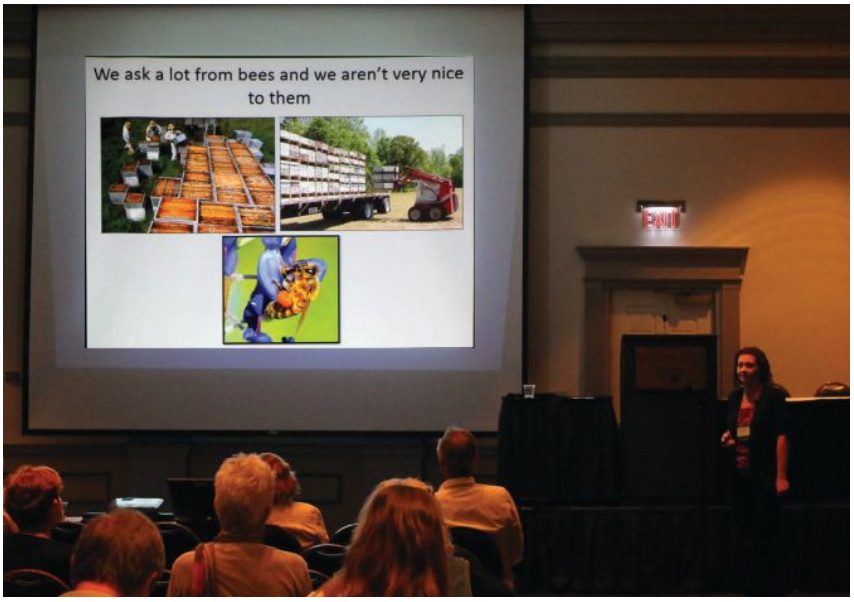
**Inside the main presentation hall**

alone or in combination. Adjuvants include surfactants which not only help to disperse toxic chemicals, but can penetrate the cuticles of insects, rendering them highly damaging to insects. The actual substances are not required to be listed, so often the farmer or applicator has no idea what he is putting into the environment.

Geraldine Wright, of Newcastle University, changed the subject from man-made chemicals to natural toxins, in her talk "Sipping from a Poisoned Chalice" which was about the stuff plants put in nectar themselves. She explores the question of why these poisons are in nectar, which is supposed to be an attraction and reward for pollinators. Plants make toxins to kill off sucking insects, and it is possible these end up in nectar by "mistake." On the other hand, some of these chemicals in nectar can manipulate the behavior of pollinators, rewarding sippers but penalizing guzzlers. For example, orange blossom nectar evidently contains caffeine. Consumption of caffeine by pollinators has been shown to enhance the formations of memories. Works in humans, too!

**Wild Bees**

Another researcher from Cornell University, Mia Park spoke about her work on wild pollinators in apples. She, like many of the presenters, emphasized the benefit of natural areas adjacent to crop lands. For example, while fungicides applied to apple trees may be more harmful to pollinators than insecticides, these effects can be moderated by abundant floral resources provided by diverse landscapes as opposed to "agriculturally simplified" ones (monoculture). Of course, the farmland in the eastern part of the US tends to be far more diverse than further west where very large farms are the rule.




**Vanessa Corby-Harris presenting her work on honey bee nutrition**

One of the best things about these gatherings is you get a chance to see people that you haven't seen in a while. I was glad to see Jamie Strange again. He and I worked together at the Dyce Lab for Honey Bee Research in 2006. Jamie subsequently went on to the USDA Pollinating Insects Research Unit, in Logan, Utah. (I left to work for NYS Ag & Markets as an apiary inspector.) The focus there is bumble bees, and he has been working on non-destructive methods of identification using DNA from small samples. It has been a great concern of researchers to be able to study and identify scarce or endangered pollinators, without contributing to their further decline by killing them. So, they use ways such as snipping small portions of wings or legs to provide DNA for identification purposes, while allowing them to reproduce normally.

Another person I met working at the Dyce Lab was Mace Vaughan. Mace is known nationally as an important member of the staff at Xerces; he is the Director of the Pollinator Program. Xerces is on the front line of pollinator protection and conservation. Mace produced a "Habitat Assessment Guide" as well as many other publications such as "Farming for Bees: Guidelines for Providing Native Bee Habitat on Farms." His presentation covered the barriers to conservation adoption, including costs to growers, but emphasized the many benefits including aesthetics and enrichment of ecosystems. Pollinator protection doesn't have to be an either/or decision; it's good for all of us.

**The Beekeeper Connection**

There weren't a lot of beekeepers at the International Conference on Pollinator Biology, but there were some important ones. I talked with New York State beekeeper Jim Doan, who was there with his wife. Dave Mendes gave an eloquent presentation, outlining the concerns of the beekeeping industry. He began by saying that he had attended the first conference three years ago, and assessed the progress we have made since then. Overall, he said, the bee research community deserves a D minus grade. Which means, if it were one of his kids, they'd be put on notice.

Losses of around thirty percent this past winter shows that honey bees are still in big trouble. He made the case that much time is spent in meetings, discussions, and policy groups, but little of this activity has translated to help for beekeepers. Beekeepers are left to wonder what is causing not only severe losses, but colonies that won't grow, don't make honey, and which lose queens at an alarming rate. At the same time he emphasized the need to concentrate on what makes a healthy hive rather than what caused "CCD".

Foremost among the needs are honey bee sanctuaries, areas where bees can be kept, away from agriculture but in regions of naturally abundant vegetation. He outlined the three P's: pathogens, pesticides, and poor nutrition; this latter could be remedied by

moving bees into natural areas with diverse pollen sources. Dave supports the concept of Bee Informed style data collection and evaluation (this refers to the Bee Informed Partnership's surveys on winter losses, etc.). Policy has to be based on real numbers, rather than anecdotes, he said. Furthermore, the channels of communication between beekeepers, researchers and regulators have to be enhanced. I believe that events such as this conference show how this can be done.

**Just the Facts**

At any conference like this, one is inundated with information. For example: Acres treated with pesticides is a far more accurate yardstick to evaluate with than the typical pounds per acre rule. Three-quarters of crop acreage in the US is actually approved to be treated with neonics, which includes corn, wheat, cotton and alfalfa. However, only 49% of the acreage is actually protected by neonicotinoid insecticides. It was shown that there was a spike in systemic fungicide treatments in 2005-2006, which is when the whole CCD issue hit the press.

Don Brady presented on behalf of the US EPA. He pointed to the honey bee as an excellent surrogate for the health of pollinators in general, which is supported by the fact that honey bee decline is often referred to when speaking of pollinator declines overall. The EPA is charged with the task of assessing risks, and uses multiple lines of evidence. The data is scrutinized for consistency, coherence, and biological plausibility. The ultimate goal is the formulation of "Best Management Practices." The week of the conference, EPA announced new labeling requirements which instituted restrictions on the use of neonics.

There can be no discussion of pollination in the US without including almond growers. Gabriele Ludwig of the Almond Board of California presented the grower's perspective. More facts: California produces 80% of the world's almonds; 70% of California's crop is exported. Colony numbers have been stable since 1994, despite serious winter losses. This point is lost on the general public. Beekeepers have a long tradition of increasing their numbers in the spring to compensate for winter loss. Unfortunately, bees are needed to pollinate almonds in February, which is a deadline that is hard for many northern beekeepers to make. Almond acreage has doubled in the past twenty years and the fee for pollination went from $40 in 2000, to $180 in 2010. It is crystal clear than the honey bee industry has benefited from the almond boom. Some would say that it is dependent on it.

**Crop Protection**

Two representatives from CropLife were slated to present. First was Dr. Paul Hoekstra, from Canada. He stated that colony numbers in Canada have actually increased by 25% in recent years, despite annual losses of 25% in winter. Worldwide, these losses have been concentrated in the US and


**Dr. Christina Grozinger talking about "what I have learned" from the week's presentations**

folks are downright suspicious of numbers in general, and regard them as a distraction. I mean, what is this difference between PPB and PPM anyway? (One is a thousand times as strong as the other. Imagine the difference between going 10 miles an hour and ten thousand miles an hour.)

**The Brains in the Family**

Not all of the presentations would appeal to the average beekeeper. Stuff like the honey bee brain may be of interest to a somewhat smaller group. All the same, very important work is being done by people like Susan Fahrbach, from the Department of Biology at Wake Forest University, in Winston-Salem, NC. She referred to the present as the Golden Age of Neurobiology. We now have the ability to culture brain cells (neurons) in glass dishes (in vitro). What this means is the effect of environmental contaminants on neurons can be studied directly, instead of using complicated things like bee hives in the field. Additionally, such techniques as RNA interference can be applied directly to the neurons.

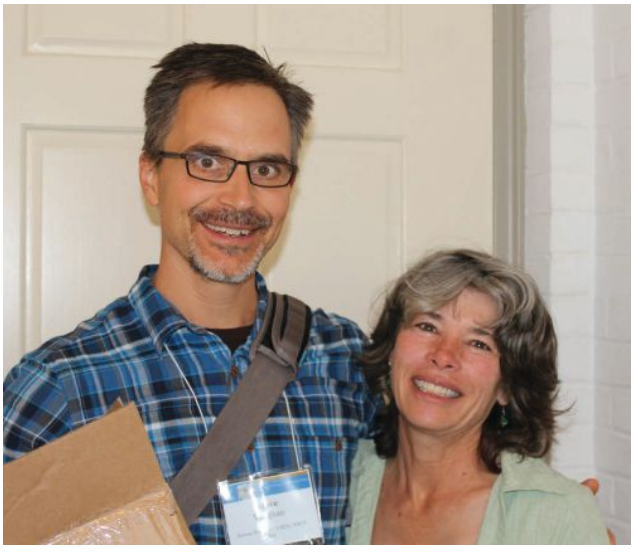
Some of the most interesting discoveries have to do with pattern formation in the brains. We know that foraging experience causes connections to be made among neurons, which leads to more efficient foraging behavior. Also, the ovaries produce important regulatory signals which affect learning and behavior, and these could be affected by endocrine disrupters. Hormones control how bees think, the same as with people!

Dr. Fahrbach's work led neatly to Olav Rueppell's talk on the "Genetic Architecture of Complex Traits." He has worked with the high and low pollen foraging lines developed by Rob Page. The high pollen foraging bees are more sensitive to sucrose and are better learners. So, these traits have genetic correlates which can be teased out by studying the DNA of the different lines.

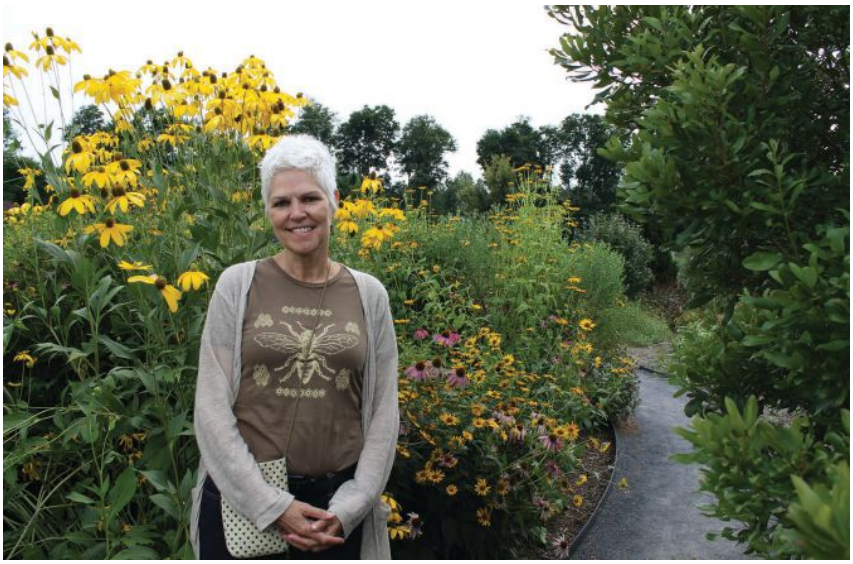
The work of geneticists has produced a lot of surprising results. We now know that many so-called genes do not function alone, but work as parts of complex networks. Inheritance, especially in honey bees, is full of twists and turns. Direct selection of traits in bees can produce results which are the opposite of those predicted. Much of these discoveries have been made by comparing African and European honey bee crosses. The offspring may not resemble their parents, indicating non-linear effects. Most importantly, the role of selection on drones has been largely ignored.

**The Big Question**

For me, the big question has been for some time: Why is the rate of queen supersedure so high? In the literature you can read about queens living for five or six years. Many of us have seen three or four year old queens. And yet, the average life expectancy of a purchased queen appears to be about six months! What is going on here? Jeff Pettis, of the USDA, focused on this issue. He described the extent of the problem: 50% queen loss in six months; queen replacement failure; high rate of drone laying queens. When examined, it



**Mace Vaughan of Xerces and Kathy Kellison of Partners for Sustainable Pollination**



**Attendee Phyllis Stiles of Bee City USA in the Pollinator Garden**

was discovered that drone laying queens had 62% dead sperm, despite the fact that the queens were well-mated (sufficient numbers of sperm). It was found that poor laying queens also showed a very poor rate of sperm viability: 50%. Meanwhile, good colonies with queens rated as "good layers" showed a 90% sperm viability. So, what could be causing drones to have sperm with such poor quality? The answer may surprise you: the chief suspect is beekeeper applied miticides. Applying miticides to drone producing colonies could result in drones with damaged sperm, leading to supersedure in colonies all over the country.

This possibility was further emphasized in the subsequent presentation by Juliana Rangel, from the North Carolina University at Raleigh. Juliana presented statistics which indicate that beekeepers attribute their losses to CCD at 9%, varroa at 24%, but queen failure at 31%, making it their worst problem. She pointed directly at the connection between miticides and sperm viability. In fact, her studies indicated that queens mated by drones with low quality sperm may actually increase the number of drones with which they mate to compensate.

Further studies of in-hive effects showed that colonies treated with miticides thrived, building more comb and storing more honey. However, all the colonies superseded their queens in six months. In other words, the colony health may have been improved by the mite control measures, but the genetic makeup of the colony contributed by the queen would be lost due to replacement by the bees. This would be a serious problem for anyone attempting to create or maintain distinct honey bee stocks.

**Gut Microbes**

Nancy Moran, University of Texas at Austin, discussed her ongoing investigation into the role of gut microbes in bee biology. In the past, microbes were studied by culturing them in the lab, but far too many important ones cannot be studied this way at all. Since 2003, new methods have revealed the microbe's complexity. Bacteria in the gut convert food to amino acids, help in detoxification, assist digestion, and provide the host with protection against harmful bacteria and diseases. Honey bees and bumble bees have very similar microflora, which is quite different from those found in other insects. The young bees emerge without them and are inoculated by the nest environment.

The role of antibiotics was also discussed. Gut microbiota from domestic honey bee stocks have been found to be highly resistant to tetracycline. Foulbrood, which is a bacterial infection of honey bee larvae, could have become resistant through cross species transmission of resistance genes.

This discussion flowed neatly into the next presentation by Elke Genersch, of the Institute for Bee Research in Hohen Neuendorf, Germany. She described her work on American foulbrood which shows great variation in the mode of infection and toxicity of different strains. Some strains kill very rapidly, whereas other strains produce more extensive infections by reproducing more slowly. These attributes can be controlled by knocking down gene expression, a technique which could ultimately lead to treatments using specific proteins to alter the enzymes which control the appropriate genes.

**Natural Antibacterials**

As most beekeepers know, Marla Spivak has been studying propolis, that sticky stuff bees like to use to fill the cracks in the hive. These saps and resins seem to have little in common other than gumminess, until one realizes that plants use them to protect themselves from foreign invaders. When a tree is damaged, the sap flows out to help heal the wound, and this sap often contains potent antibacterial substances. Over millions of years honey bees have learned to collect and use it to paint the inside of the hive.

Dr. Spivak designed various techniques to encourage the collection of propolis and discovered that colonies with an abundance of it exhibited a "quiet immune response." In other words, they were protected by the bee glue, which in turn spared them having to activate their immune systems.

The conference ended as it had begun, with words from Christina Grozinger. She reiterated the need for diversity, which is the exact opposite of what so much of modern agriculture is based on. In order to have a healthy environment, there needs to be a variety of crops planted, a quilt-like mixture of habitats, less reliance on a single species for pollination. She pointed to the idea of IPPM -- Integrated Pest and Pollinator Management -- since these are connected in so many ways. Dr. Grozinger also emphasized the need to include ecologists in policy discussions, to help us see the interconnectedness.

Looking forward, it is clear that the process of introducing new compounds into the environment needs to be redesigned. Often chemicals fail Tier One tests, but are moved on to field tests anyway! Furthermore, better assays and policies need to be developed

**Floral sundial in the gardens outside the Nittany Lion Inn**

to prevent potentially harmful agents from prematurely entering the field. Dr. Grozinger spoke clearly of the concept of Biologically Rational Pre-Assessments which don't use the old metrics of lethal dose (LD-50), but which include testing on growth and development of all life stages of beneficial and co-existing organisms. The conference adjourned with hopes to meet again in three years. She said she hoped Dave Mendes would give a better grade than a D minus next time.