Colony Collapse Disorder

Over the fall, winter, and spring of 2006-07, many beekeepers across the U.S. were surprised to find that their honey bee colony populations had shrunken down to a queen and a very few, young worker bees. In many cases, brood (dying immature bees – eggs, larvae and pupae) still remained. That brood must be fed and incubated, continuously, to remain alive. Lack of stored food did not appear to be the problem, since most of the hives still contained generous amounts of stored honey and pollens.

University and USDA researchers, who first began collecting and analyzing samples from the affected colonies, named the condition "Colony Collapse Disorder" (CCD). Although 2006-07 was the time the problem generated so much media interest, similar losses were fairly common in 2004-05, but not so much in 2005-06. Data collected by the Apiary Inspectors of America suggest that CCD is holding pretty steady. About 25% of U.S. reporting beekeepers feel that they are having colony losses due to CCD. Once in an operation, it is extremely hard to dislodge. Losses in affected operations can range from 30 to 100%. Unexpected, periodic losses of honey bee colonies, very similar to this, have been noted in the bee journals since the late 1800's, but they tended to be very short term. In 1965, '66, and '67 a similar problem persisted for three years. Our current session is the longest, yet. The best place to find basic information about the disorder and what the scientists have determined so far is at a Web site named MAAREC. Put that acronym into a computer browser, then follow the links to the colony collapse disorder or CCD articles of interest to you.

Many suspected causes of CCD have been proposed. Observations reported by beekeepers suggest that the disorder seems to move through operations and geographic regions like a contagious disease, so the earliest research emphasis was placed on finding and identifying microbes that might be causing the problem. Analytical technology has advanced to the point that most microbes can by identified through specific portions of their genomes. Using that approach, many bacteria, fungi, and viruses were found associated with the distressed bees. But, most of them also were found in bees from apparently healthy colonies. The unexpected invasions with benign bacteria and fungi, found associated with diseased bees, were determined to be opportunistic infections of already extremely sick bees.

Two microbes, not previously demonstrated from U.S. colonies, *Nosema ceranae* (fungal invader of adult bee intestinal tract) and Israeli Acute Paralysis Virus (replicates in numerous bee tissues), fairly quickly moved to the top of the list of potential causes. However, analysis of sample bees collected years earlier around the country demonstrated that those microbes were in our bees previous to the collapse problem. Apparently, researchers have found a few more unidentified viruses to be analyzed and described, but whether or not they are important in CCD remains to be determined.

Recent laboratory research on exposure of developing honey bee brood to various types of pesticides demonstrated that all the chemicals were detrimental to bees. The chemicals caused some cells in a number of developing tissues to kill themselves (apoptosis). The fact that ovarian nurse cells were involved may help explain the problem beekeepers face with early queen failures. Perhaps those ovarian cells continue to eliminate themselves when adult queens are exposed to pesticide residues in contaminated combs.

Beekeepers have become suspicious of a newer class of insecticides that are being used on more and more commercial crops, ornamentals, and garden crops – the neonicotinoids. In particular, the active ingredient imidacloprid attracts attention. Imidacloprid is toxic to adult honey bees at field application rates, and labels on the products prohibit applications that will come into contact with adult bees. After application, imidacloprid moves into plant tissues and travels systemically throughout the plant. Eventually, various concentrations of the chemical can be found in nectar and pollen produced by treated plants. In most cases the amount of imidacloprid is very small. That information allowed the chemical to be registered for extensive commercial and home use. However, in the case of perennials, especially trees, the amount of chemical in nectar can become quite high.

As an insect poison, imidacloprid mimics nicotine. At extremely low doses, it stimulates the nervous system, and bees can learn more quickly than normal. At slightly higher doses, the bees return to normal levels of functioning. At a bit higher levels, the bees lose their ability to learn and to respond to stimuli they previously had learned. These sublethal, but physiologically demonstrable, effects are cited by beekeepers as the reason that their colonies fail to thrive. The intoxicated bees are thought to fail to return to the hive from their foraging trips and colonies dwindle. Additionally, beekeepers believe that very small amounts of imidacloprid, ingested over a prolonged period of time from stored honey or pollen, negatively affect honey bee physiology making the bees more susceptible to infections, etc. (compromised immune system). Such an effect of synergism involving imidacloprid and *Nosema ceranae* infections has been demonstrated in two laboratory tests. However, studies conducted in conjunction with researchers at The Pennsylvania State University determined that very little imidacloprid actually can be found in a hive, especially when compared to residues of other insecticides, fungicides, and herbicides. Also, in some areas of fairly intensive use of imidacloprid as a seed or foliar treatment, beekeepers are having no problems with their colonies.

Diagnoses always include examinations for tracheal mites (*Acarapis woodi*), that live in the respiratory system of adult honey bees, and varroa mites (*Varroa destructor*) that are ectoparasitic mites of adult bees and pupae. Varroa mites have been particularly difficult to keep at sub-economic levels in colony populations. But, not many samples have had high numbers of *Varroa*, suggesting that beekeepers have developed effective methods of dealing with that pest. Both mites have been around for decades, so they are not considered to be a leading cause of CCD. However, their presence does put stress on bee populations and varroa mites vector virus diseases among the bees.

Other possibilities for losses were determined to probably not be involved with the disorder. Electromagnetic waves from global communication systems are not likely to interfere with honey bee navigation, because honey bees use polarized light and landmarks to fly between home and foraging locations. Genetically modified crop plants received little attention, because changes made in the crops (an enzyme that denatures Roundup®; *B.t.* toxins that paralyze the intestinal tract of caterpillars but not honey bees; and protease inhibitors that target digestive enzymes of caterpillars but not of honey bees) did not appear to be problematic for honey bees.

The intensity of research on possible leads to causes of CCD is increasing around the world, as other countries are having similar losses in their honey bee colonies. The global nature of the problem suggests that some other, more fundamental aspect of the environment may be involved. Honey bees prosper best and are best able to resist diseases, parasites, exposures to toxins, etc. when they feed on a quality diet. For bees in general, and honey bees in particular, that means a constant supply of pollens that provide their required proteins, vitamins, lipids, sterols, minerals, antioxidants and carbohydrates. While global warming may not directly challenge a species of insect, like the honey bee, which can prosper from very cold climates to the equator, climate change may result in more stress on bees. Increased periods of dry, hot, cold, or rainy weather could limit availability and access to those important pollens. Bees would then have to rear their brood at the expense of their body nutrient reserves. The brood would be less well fed, and in turn would not be as good at rearing the next "round of brood." That sort of downward spiral will leave the bees very fragile and susceptible to all of the stresses detailed above.

I will remain in touch with researchers and try to bring you any breaking news as it develops.

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