UPDATE on CCD
6-20-2008

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Background
As most of you are aware, the almond growers in California have put strong demand on the US bee industry for pollination, and this has resulted in supply problems. Free markets seem to have provided some respite from the problem. Rising fees for pollination contracts attracted a number of beekeepers who formerly were only honey producers; however, any surplus capacity in the industry may soon be tapped out as demand for colonies for almonds alone is expected to top 2 million by 2012. In addition to market responses, federal regulations covering the importation of honey bees into the contiguous United States were revised; and the new regulations went into effect 22 November 2004 (7 CFR 322). These changes allowed queens and attendant worker bees and packages of bees to be imported from Australia, Canada, and New Zealand. Subsequently, many thousands of package bees have been imported from Australia, the first importations of bees into the US since The Federal Honey Bee Act of 1922 banned all such imports to protect US bees from exotic pests, parasites, pathogens and predators. There have been limited exceptions to that law, one being the importation of queens from England by Roger Morse in 1989. The new regulations come with a number of stipulations. You can read all the details at: http://www.aphis.usda.gov/plant_health/permits/organism/bees/bee_transit.shtml.

In the fall of 2006, several large beekeepers in Florida began reporting significant losses of bees in Florida. These losses escalated over the winter of 2006/2007; and by the spring of 2007, the problem had affected 24 states (although it is not clear if it was actually present in all 24 states or if it affected beekeepers claiming residence from 24 states). Many of these losses could not be attributed to any known cause; and the name Colony Collapse Disorder, or CCD, was given to bees with this condition. The ever increasing demand for bees by almond growers, the growing inability of the US bee industry to meet that demand, and the potential effects on the nation's food supply have all helped to bring this situation to the attention of the public.

Large losses are not new to US beekeepers. At least 18 reports of spring-dwindle, fall-dwindle and fall-collapse date as far back as 1869, although the cause or causes of those events were never determined. Such occurrences have become increasingly commonplace since the tracheal mite *Acarapis woodi* and *Varroa destructor* were first detected in the US in 1984 and 1987, respectively. For example, mite-related losses reached catastrophic proportions during the winters of 1995/1996 and 2000/2001 when colony deaths in northern states ranged between 50 and 100% in most beekeeping operations. Despite considerable efforts at both state and federal levels, effective and sustainable controls have not yet been developed for these mites, Pesticide resistance is a major problem that contributes to periodic catastrophic losses on the scale currently being seen. The lack of a comprehensive, industry wide stock improvement program also plays a major role.

Scope of problem

In order to assess the scope of the current problem, a survey was commissioned by the Apiary Inspectors of America (see Am. Bee Journal, July 2007). Surveys from 384 beekeepers from 13 states were evaluated. Based on those surveys, total losses over the 2006/2007 winter were estimated at 31.8%, with an average loss of 37.8%. Extrapolating those results to the entire US, the authors estimated a total loss of 651,000 – 875,000 of the nation's 2.4 million colonies. This survey provided some good information on overall losses; however, as there is no way at present to accurately establish a cause of death, it is not possible to determine what proportion of the losses were from some known problem, like parasitic mites, and how many were from some new problem – call it CCD. It is likely that parasitic mites played a major role in the current losses; however, the relative importance of mites versus 'something new' is not known. Anecdotally, it appears that 'something new' is playing a major role in the current losses. Reports from several beekeepers during the winter of 2007/2008 indicate that the problem has not abated and that a similar pattern of losses occurred again this past winter.

Symptoms

The reason behind our inability to fully grasp the scope of the problem is complex. First, there is no clearly established set of symptoms that distinguish CCD from other honey bee maladies. Second, no one has been tracking large numbers of colonies over long periods of time to determine the relationship between colony health and the presence or absence of various problems and management practices. Third, infection with parasitic mites can result in a wide range in the rates at which colonies die-off, making the use of this symptom problematic. Fourth, when bees are lost over the winter, there is often no evidence to examine in the form of samples of bees and brood from the previous fall. Attempts to establish a cause of death are necessarily speculative. Systematic efforts to fill these information gaps are now underway.

So far, a tentative list of symptoms of CCD include: 1) a rapid loss of the adult worker bee population (although the actual rate of loss is not given, and rapid losses are also seen with parasitic mites); 2) large amounts of apparently healthy brood remaining in the hives; 3) an absence of significant levels of mites or disease in the remaining brood and bees (this seems to be the most robust symptom that distinguishes CCD from parasitic mite syndrome which leaves few bees but varying amounts of brood exhibiting a number of serious pathologies); and 4) few dead bees around the hive (although this does not distinguish it all that well from mite damage). Other symptoms, such as bees not robbing out colonies after the collapse, have not proven to be reliable indicators of CCD and could be the result of a secondary infestation with small hive beetle or variation in local nectar flow patterns. For now, a diagnosis of CCD is essentially one of exclusion of other possible causes.

Causes of CCD

A number of possible causes for CCD have been suggested: 1) pesticides, especially the neo-nicotinoids, a relatively new class of pesticides gaining widespread use throughout the country; 2) an exotic species of nosema (*Nosema ceranae*, originally a parasite on the eastern honey bee *Apis cerana*); 3) pollen from GM plants; 4) nutritional deficits resulting from too much time spent in large monocultures; 5) beekeeper management practices; and 6) some combination of the aforementioned. Please note that cell phones are not on the list. To date, there are no definitive results that convincingly implicate any one of these possible causes. Interestingly, large losses have been experienced in several places around the world over the past few years.

Two studies have been published that address CCD. The first was an article in *Science* in which an association of CCD with the Israeli Acute Paralysis Virus (IAPV) was reported. IAPV was found in about 84% of the colonies classified as CCD colonies, but in under 5% of colonies classified as non-CCD colonies. Initially, this led to speculation that IAPV was introduced with package bees recently imported from Australia; and that led to calls to close the borders. Subsequently, research conducted at the USDA-ARS Bee Research Lab in Beltsville, MD on archived bee samples found that IAPV has actually been in the US since at least 2002, well before Australian packages were imported. To complicate matters further, there may be more than one strain of IAPV; and virulence may vary among strains. However, as the actual distribution of IAPV throughout the country prior to 2006 is not known, it is still not possible to exclude IAPV as a cause or contributor to CCD.

The association of CCD with *N. ceranae* was not as strong. *N. ceranae* was found in 100% of CCD colonies, but also in 80.9% of non-CCD colonies. A recent study by the ARS Bee Research Lab has found *N. ceranae* present in archived samples from each of the 12 states for which samples were available, some dating as far back to 1996. The *Science* study found that the best predictor of CCD was the simultaneous presence of IAPV, *N. ceranae*, *N. apis* and Kashmir bee virus (100% predictive). Again, while it does not appear that *N. ceranae* is a sole cause of CCD, a possible role in the disorder is not completely eliminated. Even though a definitive answer was not forthcoming, the study demonstrated a powerful new method for identifying unknown pathogens, whether they are affecting honey bees, livestock, crop plants or people.

Meanwhile, Spanish researchers reported that they have been able to duplicate the symptoms they were observing in Europe by infecting colonies with *N. ceranae*. The evidence was pretty convincing; however, the symptoms they reported being associated with their losses (initially called Bee Depopulation Syndrome or BDS) include a lack of brood in colonies after the worker population has disappeared, which stands in contrast to what is reported in the US with CCD (although this difference could be a seasonal phenomenon). Therefore, it is not clear if the condition affecting the bees in Europe is the same as that affecting the bees in North America. The Spanish group did report that they were able to control the problem with antibiotics. *N. ceranae* is showing up in increasing frequency here in the US, with large numbers of colonies exhibiting extremely high spore counts. As of August 2008, a clear association between levels of nosema in US colonies and colony mortality has not been shown, although some correlation would not be surprising.

Finally, there are a few studies demonstrating that some neo-nicotinoids and a protein found in pollen from certain GM plants can affect the honey bee's ability to navigate. However, it has not been demonstrated that this is a widespread problem in the field or that it is associated with CCD. Additional studies are required to better understand the impact these substance have on honey bees.

Summary

So, as of August 2008, no definitive cause for CCD has been established. My take on this is as follows. CCD seems to be a real and serious problem, although the exact extent and distribution throughout the industry is not yet known. At present, the cause remains unknown, and that makes it impossible to develop a cure. Clearly, both the extent and cause of the problem need to be determined. To determine the cause of CCD will require researchers to track a large number of colonies for one or two years (with frequent sampling and assessments of colony health). With a little luck, they will be tracking some colonies that stay healthy and some that eventually come down with CCD. The USDA-ARS Bee Research Lab in Beltsville, MD is conducting such a study at this time. As for the supply of colonies available for pollination, the increase in pollination rental fees has attracted beekeepers who had formerly limited their activities to producing honey. These beekeepers, along with imported Australian package bees, have provided a buffering capacity that has allowed most growers to obtain the hives they need for pollination. However, this capacity is limited, and as these beekeepers enter the migratory arena, they may soon find their bees suffering from the same phenomenon afflicting the many colonies that have been lost over the past two winters.

As serious as CCD appears to be, it needs to be kept in perspective. If CCD were cured tomorrow, the bee industry would still be facing the same serious problems that it had with parasitic mites before CCD came on the scene. We are long way from being out of the woods.