Healthy Colony Growth and Sub-Lethal Chemical Exposure

Larry Connor

Nearly 30 years ago certain beekeepers experienced Disappearing Disease in different parts of the United States, a condition where the bees in colonies were no longer found inside the hive or out – often after good buildup or at the end of a good season – leaving behind the queen, newly emerged workers, normal brood and food supplies. Disappearing Disease was also called Fall Dwindling and Colony Collapse, in addition to other names. Considerable investigation was made into the nature of the disease, and after several years of study, the scientific "blame" for the disease was attributed to poor colony nutrition. These results were published in 1982 in the *American Bee Journal* by Professor Walter Rothenbuhler and his research team at The Ohio State University.

Disappearing Disease took place years before tracheal or *Varroa* mites were introduced into the country. Cell phones were not yet in use, and a class of new insecticides called neonicotinoids did not exist. A few blamed African honey-bee genes as the cause of the problems, one reason perhaps why bee geneticist Rothenbuhler was selected to investigate the cause.

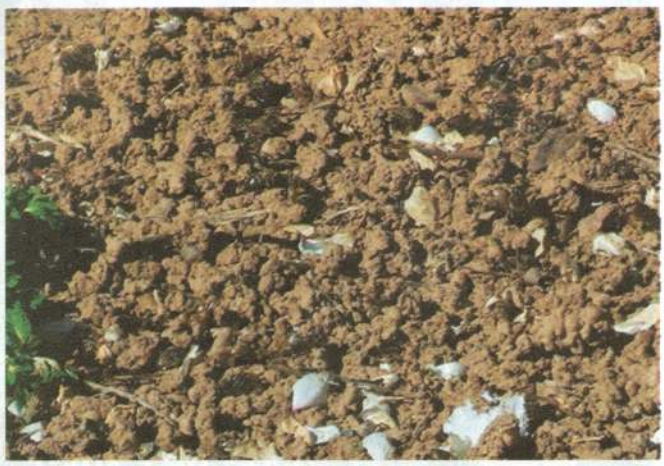
It has been about six months since most of us first heard about the Colony Collapse Disorder (CCD), and so far the collaborative research effort has eliminated a number of potential causes of the "disorder," including a shared queen/genetic source, *Nosema cerana*, high fructose corn syrup and several other potential explanations. Some causes were eliminated as a result of the survey of affected beekeepers combined with preliminary laboratory results. It is still too early to make an educated guess as to the cause, but history – our industry experience with Disappearing Disease – gives us two high-level candidates: pesticide exposure and/or nutritional deficiencies. If either of these factors is involved, it will undoubtedly be related to complications related to changes in beekeeping practices and/or agricultural methods applied on a widespread basis.

Pesticides – lethal and sub-lethal

Let's discuss pesticide use in and around the beehive. Beekeepers position bees in active agricultural areas when they provide bees for pollination. In these areas, the presence of a few hundred bees – dead and dying – in front of the hive has little impression on a commercial beekeeper who measures a pesticide kill in mounds of dead bees that can be scooped up with a shovel. But wait a minute! If you have worked around strong, healthy bee colonies for a long time you know that they very rarely leave dead bees in front of a hive in pesticide-free conditions. In agricultural areas, the treatment with so-called non-lethal materials, including herbicides, fungicides and other compounds, may result in so-called "minor" bee mortality, but not enough to cause concern for commercial beekeepers. Many commercial beekeepers undoubtedly think that a strong colony will raise enough bees to overcome such a small loss.

Of course, this is often true, but it puts some type of pesticide into the bees and probably the bee colony as well. It seems very likely that this material has both lethal and sub-lethal effects on the colony, as well as the few bees scattered about the front of the hive. Perhaps the bees that died are only the ones that were foraging in a field of target or non-target flowers, and directly blasted as a fungicide (or some other pesticide) that was being applied in an orchard or field. While the colony continues on, those bees are dead via chemical exposure. Some may return to the hive and are carried out of it, but not in a normal manner.

In a large agricultural area, just how many of these sub-lethal chemicals are in a hive – materials that only affect a small percentage of the bees and do not kill thousands of bees and result in huge piles of dead bees that are noticed by the beekeepers? And even more importantly, how do these materials interact with each other and with the various mite-killing chemicals the beekeeper has been using to treat for *Varroa* mites? And how small an amount of these materials can interact with other chemicals to cause bee behavior changes, not to mention bee death? Are we dealing with just parts per billion, or nearly non-detectable parts per trillion that interact with miticides and other agricultural chemicals and negatively affect some behavior of the bees? If a scientist reports that a material has been looked for in a sample of bees, comb, honey, pollen or beeswax, and is not found, are we limited by the power of the chemical investigation tech-



Hundreds of dead bees covered the area immediately in front of the colonies in the apiary. In other apiary locations, where no spraying was underway, this bee mortality was not observed.

nology conducted on dead bee and hive samples where primary chemicals have often degraded naturally into less toxic compounds, or into compounds the scientist is not looking for? I am highly suspicious of any research effort that looks at samples from combs from dead hives, from bee bread, honey or beeswax, without a correlation with actively dying bees – it is a huge waste of time and research money to examine old samples.

In the early 1980s Penncap-M and Sevin killed many bees foraging in apple orchards after bloom, and on corn, especially sweet corn while the plants were in dehiscence. When samples of the dead bee piles found at the hive entrances were tested, they often had very low levels of insecticide because the bees has been exposed to the environment for too long, or the bees had metabolized the materials and this speeded their degradation. But when dying bees were collected and stored on ice and quickly delivered to the laboratory it become clear that the exposure to these materials was real, and the extent of the losses considerable. But what became even more amazing was the discovery that many samples of these dying bees contained not just one insecticide, but as many as five different pesticides including some that were not targeted for insect control, such as fungicides.

That was my big light-bulb moment. It was the interaction of two or more chemicals that was contributing to large-scale losses! It became clear that in these cases one plus one often equaled 1000, far from the expected result. Rare are the studies to show what and how these interactions work. And for the past 10 or 15 years, there have been few research programs that focused on this aspect of bee mortality. A quarter century ago there were several noted bee pesticide research labs that were helping the industry. These programs no longer exist. After all, there was more pressing work to be done with tracheal and *Varroa* mite control.

Drug interactions are common in humans. Your doctor will ask you what else you are taking before writing a prescription. Nowadays they even want to know what vitamins and over-the-counter medication you take, not just the prescription drugs. We know more about human drug interactions, and know that there are certain ones that may be deadly. But where is our research on drug interactions, synergisms, in honey bee colony treatments of miticides, foulbrood controls, and chemicals being applied outside of the colonies? For the most part, they do not exist. Few people are routinely looking for interactions.

That worries me. It worries me a great deal. Are we creating a chemical environment in the bee colony that combines mite controls with pesticides picked up in the fields and orchards that will combine, synergistically, to kill more bees? I certainly do not know the answer to this question, but until we have researchers actively working in the laboratory to screen these materials in various combinations of delivery and exposure techniques will we have definitive results that will tell us if this a concern or not.

Whenever I visit beekeepers – especially commercial businesses – I am usually a good guest and I do not take photos of chemical treatments that the beekeeper does not want me to record. It happens on many bee yard visits. Sometimes the beekeeper tries to do a slight of hand and remove the incriminating strip or pad or wooden stick before I can get the camera out and focused. Other times they tell me, point blank, don't make a photo of that. I can only speculate they want to hide the way they deliver a chemical to the colony because it does not necessarily comply with chemicals registered for mite control. I am pretty sure these items are not in the hive for decoration.

At meetings of commercially motivated beekeepers there are always at least two meetings going on, often at the same time. There is the one in the meeting room, where researchers are discussing their latest results. But for many beekeepers the really important meeting is the one conducted in the hallway or in a restaurant or bar where one experimental beekeeper tells about his or her latest mite-control concoction/delivery system/timing that they have been using. They often report on these techniques without being able to report how well the system worked. Sometimes, when the formal meeting is over, the researchers join in these conversations and keep the beekeepers from killing themselves by giving out

When the author toured almonds fields in California during the end of the blooming period, he observed a "light" sprinkling of dead bees at the entrance of many colonies. Ground-based sprays of fungicides were underway at the same time.

information that also will help them to keep from killing all of their hives. Some do anyway, but don't talk about it too much. We know this happens. These methods are posted on various Internet sites, sometimes before the meeting is over, and reprinted in local and state newsletters. Sometimes there is a comment that the particular treatment is not approved, or is dangerous to the beekeeper. Some of the recommendations even say it will kill some of the bees while doing their work.

After listening awhile it is pretty easy to count up the treatment methods and chemicals used and realize that individual colonies are getting hit with three, four, five and often more compounds in a single season. Can anyone tell me what the synergistic effect might be from using five compounds in a beehive during a beekeeping season? Do any of these people ever collect data to see what impact their methods are having on mite loads? What happens with a sub-lethal herbicide or fungicide or so called safe insecticide is added to those hives? I really don't know. And I am pretty sure a lot of folks never want to know the real answer as long as there are bees alive in the hive.

So far the beekeepers affected by CCD report that they suspect *Varroa* and tracheal mites, viruses (that may or may not be associated with *Varroa* mites), small hive beetles, and other pathogens as key suspects as causative agents in the Disorder. But some suspect the increasing spread of certain insecticides, the neonicotinoids, especially imidacloprid (registered in 1992) and clothianidin, acetamiprid and thiamethoxam. The neonicotinoids are often applied to plants where they are systemic, moving through the plant tissue, making the entire plant toxic to pests (this would include pollen and nectar). The materials are also applied directly to crops for pest control.

The neonicotinoids are now the most widely applied insecticides used in the U.S., and are used on: *"seed treatments for corn, cotton, canola and sunflowers; foliar sprays for fruit, nut and coffee crops; granular and liquid drench applications in turf, ornamentals, fruit crops and in forests; and in California the number one use of imidacloprid is for the control of structural pests."* (From MAAREC.org, **Protecting Honey Bees from Chemical Pesticides**, Maryann Frazier, Senior Extension Associate, Penn State).

The report continues with the statement *"Additional research has found that imidacloprid impairs the memory and brain metabolism of bees, particularly the area of the brain that is used for making new memories. . . The chemical was present, by systemic uptake in corn and sunflowers in levels high enough to pose a threat to honey bees."* In a survey of corn pollen in France, imidacloprid was found in 49% of 81 samples.

Finally, when certain neonicotinoids were used with certain fungicides, they synergized to increase the toxicity of the neonicotinoid to honey bees over 1,000 fold in lab studies.

To me, this is where energy must be spent by research teams, especially labs set up for chemical analysis, emphasis on the plural, in order to involve as many minds and laboratories as possible to further discover these relationships and possible involvement with CCD.

There is another big area to discuss based on past history, and that is regarding bee nutrition. There is not enough space to discuss this in the rest of this article, so we will have to pick up on this in a future article. In the meanwhile, if you can, go on line and download a copy of *Fat Bee, Skinny Bee* from the Australian Department of Agriculture. **www.rirdc.gov.au/reports/HBE/05-054sum.html.** It is a real world discussion of how bee nutrition is monitored in Australia and how this affects beekeeping success.

Should scientists stop looking for Zebras in beehives?

The story has been around for a long time, but this is from an Internet piece I lifted from a Saab mechanic's website:

An example given *"for MD's in diagnosing illnesses is if you're walking down the street and hear hoof beats behind you, think horses not zebras. There's a noted tendency for ambitious young doctors to suspect rare illnesses rather than the common ones and a bias to making the symptoms fit a complex theory. It gratifies the ego, opens the door to career moves, and makes work interesting. Reality is usually banal and most of us find that boring."*

Lately I've heard bee researchers talk (in all the media attention bees have received) about looking for possible zebras – like cell phone interference with bee communications – when they should be looking for the old horses first. Pesticides and nutrition are two of the old horses we know, and should be researched thoroughly. BC

The boxes are unpacked, and the dust has started to settle on a new home for Dr. Connor and Wicwas Press in Kalamazoo, Michigan. The old email still works: ebeebooks@aol.com. So does a new phone number 269.344.8027.