Colony Collapse Disorder (CCD) in Canada: Do we have a problem?

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Colony Collapse Disorder (also known by several other names) has become a plague in throughout the United States. Major losses in colonies have been reported from all states that have reported (http://maarec.cas.psu.edu) as of 26 February, 2007. In Canada, where winter losses are commonly problematic, no instances of CCD have been confirmed, at least so far. But, very recent reports are of suspicious losses having been experienced in Ontario and Saskatchewan. Should Canadian beekeepers be concerned? Does Canadian beekeeping provide insights into CCD?

Let's first look at the information that the CCD Working Group in the USA has provided (http://maarec.cas.psu.edu).

The symptoms of a CCD collapsed colony are no adult bees and no corpses, presence of capped brood, presence of both honey and pollen (bee-bread) stores. A collapsing colony shows too small a workforce for colony maintenance and that workforce is made up of young bees, and the bee cluster seems reluctant to feed on either stored honey or pollen. One of the most peculiar of symptoms is the lack of robbing behaviour of surviving colonies of colonies that have died out. What is going on? Strange symptoms indeed!

The CCD Working Group concludes that "stress" is a major contributor to the condition, and they itemize a number of stresses that are likely involved. In particular, they mention that migratory beekeeping practices are stressful to the bees. The reasons suggested are confinement and temperature fluctuations during transport. Certainly, added to those reasons are the mechanical vibrations and shocks that colonies on trucks experience, which, when protracted over several days' duration would be upsetting to the bees. Confinement itself would cause the air within the hives to become stale, with higher than usual levels of Carbon dioxide (CO_2) and moisture. Even moving colonies short distances for pollination or honey production is well known to cause the bees to become upset, so moves taking days and over thousands of kilometres would be expected to be stressful on the bees, as well as on the beekeepers.

Rapid movement of colonies of bees across the USA may cause "jet-lag". Yes, bees to sleep and do have regular daily rhythms of activity (just as do people) (Kaiser 1988; Sauer et al.

2003, 2004; Zhang et al. 2006), so one can suggest that a colony of bees being whipped across two or three time zones in a quick move would be subject to some stress.

Migratory beekeeping involves the packing of large numbers of colonies onto the backs of trucks. There, the colonies are un-naturally close together. The CCD Working Group acknowledges that when the bees cluster on the outsides of hives packed as truckloads, mingling of bees between the hives would occur. The bees' defecation on the outside of the hives would increase rates of transmission of pathogens.

That transport in and of itself causes colony death and the CCD Working Group reports that 10% to 30% losses are "not uncommon" as a result of moving colonies for pollination. With such losses, migratory beekeepers make splits to compensate for the losses. The Working Group notes that the reuse of equipment from hives that have died out is part of the transfer of diseases and chemical contaminants and may contribute to the problem. They also point out that making splits changes the age structure of the colonies being split, and results in an un-natural age structure of bees in the split itself. Thus, the ratio of young, nurse workers to older foragers becomes imbalanced, further stressing the colonies.

Although migratory beekeepers seem to have suffered badly, reports of CCD are not confined to their operations.

Other stresses noted by the CCD Working Group are overcrowded apiaries, nutritional stress, drought and contaminated water, use of antibiotics and chemical pesticides (within and outside the hive) and, of course, mite parasitosis.

Overcrowded apiaries are commonly part of migratory beekeeping, especially for pollination services. The "staging apiaries" where hundreds of hives are placed cheek-by-jowl are not healthy for the bees. Often there is not enough food within the flight ranges of the foragers, robbing is commonplace (and would lead to disease transmission), and hives weaken despite the efforts of the beekeepers to provide food (pollen or pollen substitute and syrup).

Nutritional stress is not really addressed by the Working Group, but several points are worth mentioning. Honeybee colonies used for pollination services on large monocultures, such as almonds, blueberries, alfalfa are placed in environments where little or no food choice is available to them. It is known that a diverse diet of a mixture of pollens from different plant sources is beneficial to bees, and the same would be true for nectar (Schmidt *et al.* 1987, 1995). Thus, nutritional imbalance could explain, in part, some of the observed symptoms. Moreover, the situation for almonds is complicated by the potential toxicity of pollen and nectar from almond flowers (Kevan and Ebert 2005), especially perhaps in large quantity and for prolonged durations.

Pollen or pollen substitutes fed to the colonies, although not generally used by the beekeepers surveyed by the CCD Working Group, may offer some relief to migratory beekeeping and the potential problems that could result from prolonged use of colonies on a single crop, but care must be taken. Pollen can be a route for transmission of diseases, so only properly treated and sterilized pollen should be used. Pollen substitutes that use soy flour as the main source of protein are not as well accepted, nor as nutritious, as pollen substitutes that avoid the use of soy flour (Saffari *et al.* 2004). Some soy flours seem to contain anti-feedant compounds that detract from their palatability to honeybees.

The problems that mite parasitosis pose to beekeeping are the same in Canada as in the USA. Varroa infestations have lethal consequences, and must be kept in check. Although varroa is recognized as the major problem, tracheal mites are still very much around. Their presence in the breathing tubes of honeybees has been proven to cause respiratory distress (Harrison *et al.* 2001; Skinner 2000). Associated with varroa infestations is a complex of viral infections (Kevan *et al.* 2006). The report of the CCD Working Group includes information on the incidences of various diseases in samples that they examined, but it is too early to conclude cause and effect.

The Working Group also considered pesticide contamination, notably the neonicotinoids (which includes imidacloprid, notorious for its implications in “mad bee disease” (also a colony decline condition), clothianiden, and thiamethoxam). In general, these insecticides are well known to be highly toxic to honeybees, to be highly persistent in the environment, and translocatable in plants and into pollen and nectar. These compounds are becoming increasingly widely used, sometimes on crops for which honeybees are used for pollination. They are inadequately tested for their hazards to pollinators, even honeybees. Sub-lethal effects of imidacloprid include impairment of memory, and inability to remember (Decourtye *et al.* 2004); both important to bees that need to forage far from home and find their way back!

Then, what about the chemical and antibiotic cocktails that beekeepers themselves are using in their hives? A chemical pesticide is a poison and the trick in the use of poisons is to differentially kill the pest while not killing the host. That is the basis for pharmacology and administering the right dose. Too much, and the host becomes debilitated, at the least, and may even die, along with the pest. ‘The operation was successful, but the patient died!’

The autopsies made by members of the CCD Working Group revealed a number of anomalies and infections, but the data are too preliminary to allow for conclusions about symptoms, effects, and causes.

All in all, it seems that a broad suite of stresses is taking its toll on US honeybees. Are various combinations of stresses resulting in a set of similar symptoms across the country? Stress in general increases human susceptibility to illness, and the same idea applies to honeybees. Stressed, their capacity to ward of primary infections of the well-known suite of larval and adult diseases (Morse and Nowogrodski (editors) 2000) is reduced. Moreover, stressed, their capacity to fight secondary infections, such as of viruses associated with varroa (Kevan *et al.* 2006) is lessened. Stress, immunocompromization, and unusually serious infections by common pathogens and/or otherwise and usually benign organisms, seem to have combined to produce this devastating condition, CCD.

Although there is no presently confirmed evidence for the same condition’s occurrence in Canada, complacency is not recommended. In Canada, we can be proud that Canadian beekeeping seems to be a gentler practice than in the USA, especially when it comes to the major commercial operations there. Canadian beekeepers, by and large, seem to use fewer chemical and antibiotic control agents against pests and diseases than do their US counter parts, and those that are used are applied more conservatively. Migratory beekeeping for pollination services is not so much a part of commercial beekeeping in Canada as it is in the USA, and where it is practised in Canada, the moves are shorter and fewer. Nevertheless, vigilance is required. Beekeeping in Canada and the USA share too many similarities for Canadians to dismiss the problem out of hand. Some reports of higher than expected winter losses are now coming to the attention of the industry, and CCD can not be eliminated as being involved.

In Canada, we may be lucky. We may not. Whatever happens this spring as Canadian beekeepers open their hives, an international effort can work to the benefit of beekeeping continentally. It seems that the industry in the USA will require a major influx of support and funding to rebuild. If Canadian beekeepers do not encounter CCD, the differences between the two countries may provide insights that could help understand, solve, and prevent repetition of the problem. If Canadian beekeepers do encounter CCD, then there is advanced warning from neighbours to the south, and collaboration will be the order of the day.

References

Decourtye A., Devillers J., Cluzeau S., Charreton M., Pham-Delegue M. H. 2004. Effects of imidacloprid and deltamethrin on associative learning in honeybees under semi-field and laboratory conditions. *Ecotoxicology and Environmental Safety* 57: 410 - 419.

Harrison J.F., Camazine S., Marden J.H., Kirkton, S. D., Rozo A., Yang X. 2001. Mite not make it home: Tracheal mites reduce the safety margin for oxygen delivery of flying honeybees. *Journal of Experimental Biology* 204: 805 - 814.

Kaiser, W. 1988. Busy bees need rest, too – Behavioral and electromyographical sleep signs in honeybees. *Journal of Comparative Physiology A* 163: 565-584.

Kevan P.G., Ebert T. 2005. Can almond nectar & pollen poison honey bees? *American Bee Journal* 145: 507-509.

Kevan P. G., Hannan M. A., Ostiguy N., Guzman, E. 2006. A summary of the Varroa-virus disease complex in honeybees. *American Bee Journal* 146: 694 - 697.

Morse R. A., Nowogrodzki R. (editors). 2000. Honey bee pests, predators, and diseases. Comstock Pub., Cornell University Press, 2nd ed. 474 p.

Saffari, A. M., Kevan, P. G., Atkinson, J. L. 2004. A promising pollen substitute for honey bees. *American Bee Journal*144: 230 - 231. Also see: www.honeybeeworld.com/diary/articles/A%20promising%20pollen%20substitute.htm

Saffari, A. M., Kevan, P. G., Atkinson, J. L. 2006. Feedbee® Balances Growth. *Bee Culture* 134 (8): 30

Sauer S., Herrmann E., Kaiser W. 2004. Sleep deprivation in honey bees. *Journal of Sleep Research* 13: 145 - 152.

Sauer S., Kinkelin M.., Herrmann E., Kaiser W. 2003. The dynamics of sleep-like behaviour in honey bees. *Journal of Comparative Physiology A* 189: 599-607.

Schmidt, L. S., Schmidt, J. O., Rao, H., Wang, W., and Xu, L. 1995. Feeding preferences and survival of young worker honey bees (Hymenoptera: Apidae) fed rape, sesame, and sunflower pollen. *Journal of Economic Entomology* 88: 1591 - 1595.

Schmidt, J. O., Thoenes, S. C., and Levin, M. D. 1987. Survival of honey bees, *Apis mellifera* (Hymenoptera: Apidae), fed various pollen sources. *Annals of the Entomological Society of America* 80: 176 - 183.

Skinner, A. J. 2000. Impacts of tracheal mites (*Acarapis woodi* (Rennie)) on the respiration and thermoregulation of overwintering honey bees in a temperate climate. M. Sc. Dissertation, University of Guelph. Department of Environmental Biology. 186 pp.

Zhang S.W., Schwarz S., Pahl M., Zhu H., Tautz J. 2006. Honeybee memory: a honeybee knows what to do and when. *Journal of Experimental of Biology* 209: 4420-4428.

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