Symposium Abstracts: The Rise and Fall of the Honeybee

Entomological Society of British Columbia Annual General Meeting, PacificForestry Centre, Victoria, B.C., Nov. 1-2, 2013

Note: There was a total of eight papers presented in this symposium. We were able to obtain abstracts from six of the authors.

SuperBoost

H. Borden, *Contech Enterprises Inc., Delta, B.C. www.contech-inc.com*

SuperBoost is a commercial product based on the 10-component fatty-acid ester honeybee brood pheromone. One hundred eighty milligrams of the non-volatile synthetic pheromone are deployed in a small plastic pouch held at the level of the brood comb in a rigid plastic holder. The pheromone exudes through a permeable plastic membrane at the rate of 0.5–2.0 mg/d. When SuperBoost was placed in colonies, the ratio of pollen to non-pollen foragers changed significantly in favour of the former for five weeks, and foragers returned to the hive with significantly heavier pollen loads than did bees returning to untreated control colonies. Compared to untreated control colonies, colonies treated for two consecutive five-week periods during spring build-up consumed more pollen-substitute diet, had more brood comb and more bees, and produced more splits.

In three studies in which colonies were treated with SuperBoost near the beginning of nectar flow, treated colonies produced 24–87% more honey than untreated control colonies. The effect is hypothesized to be caused by higher numbers of bees in treated colonies. In a fourth study, in which colonies were treated at the beginning of July, there was no significant increase in honey production. When colonies were treated during fall feeding, the results were similar to those obtained during spring build-up. Package bee colonies treated six times in the year starting on 30 April, when colonies were established, had 2.7-times greater survival than untreated colonies.

Although SuperBoost is sold elsewhere in the world, it is not available in Canada, where it has been declared an unregistered veterinary drug.

Re-opening Pandora's hive: The risks of importing honeybee packages from the U.S. to Canada

C. Culley, *Capital Region Beekeepers' Association, Victoria, B.C.*

In 1987, in response to the outbreak in the U.S. of two parasitic mites (honeybee tracheal mite, *Acarapis woodi*, and varroa mite, *Varroa destructor*), Agriculture and Agri-Food Canada closed the border to the importation of honeybees (*Apis mellifera*) from the continental U.S. Importations of honeybee queens were allowed from Hawaii in 1993. Following the Canadian Food Inspection Agency's (CFIA) 2003 risk assessment, the Agency maintained the import ban on honeybee packages, but in 2004 allowed the importation of honeybee queens from the U.S.

In 2013, because requests for import permits continue to be received, the Animal Health Risk Assessment (AHRA) unit of the CFIA conducted a risk assessment to provide scientific information and advice in support of the Canadian National Animal Health Program for the development of import policy. The CFIA's Animal Import/Export Division asked the AHRA to update and assess the likelihood of biological hazards spreading or becoming established in Canada, and their likely consequences as a result of the importation of honeybee packages from the U.S.

The Capital Region Beekeepers' Association (CRBA) sent a letter to the Minister of Agriculture and Agri-Food requesting that the border remain closed to honeybee packages due to many disease risks. Of the risks identified by the CRBA, only four were recognized by the CFIA: Africanized honeybee (AHB), antibiotic-resistant American foulbrood (AFB, resistant to oxytetracycline [rAFB]), small hive beetle (SHB), and amitraz-resistant *Varroa* mite (acaricide-resistant [rVAR]). The CFIA considered the following disease agents "not hazards": *Tropilaelaps* (not currently found in U.S., but could appear at any time and be spread with industrial movements of bees), *Apocephalus borealis* (insufficient research), and a wide variety of viruses, also thoroughly distributed by industrial movements. Several disease agents could also infect our native pollinators.

The CRBA does not accept the levels of risk established in the report, due to many uncertainties that were factored in. Lack of research is not a good reason for lower risk. This risk-assessment document was a literature review, which is useful; however, it makes it only more clear that more research needs to be done before risks can be properly assessed.

Trends in managed pollinators and resurgence of urban beekeeping

H. Clay, *Urban Bee Network, B.C.*

Honey has been a sought-after natural sweetener for centuries. Since the advent of the modern movable-frame hive, large-scale beekeeping for honey production has become an important sector of rural Canadian agriculture. Throughout the past century, whenever war or recession has posed a threat to food supply, urban beekeeping has increased. The highest number of beekeepers ever recorded in Canadian history was during the sugar rationing period of the Second World War.

Fluctuations have occurred according to whether beekeeping was profitable (good honey prices, opportunities for pollination service rental) or not profitable (low honey prices, honeybee colony losses, high cost of replacement bees). Honeybees are also important pollinators of agricultural crops, and colony numbers increased after research showed the importance of bees for improving crop production. Colony increase occurred in two cycles: from 1960 to 1985, pollination service expansion was for tree fruit and berry crops, and since 1991 the demand for pollination services has been driven by the canola seed industry. Other managed pollinators such as alfalfa leafcutter bees, bumble bees and mason bees offer some potential for greenhouse-crop pollination and as complementary pollinators, but their availability and short flight range have been limiting factors for large-scale crops.

Canada's beekeeping industry was significantly affected by the arrival of a new parasite, *Varroa* mite, in 1989. Beekeeper numbers dropped steadily for two decades from their peak in 1985. Recently, there has been a measurable upward trend of urban beekeepers and colony numbers following the Global Financial Crisis (2008–2010) and its accompanying recession. This period also corresponded with a surge in media interest and public awareness of honeybee colony losses. Many consumers are concerned about the plight of pollinators and want to obtain food locally, so demand for urban bees is high. With recent changes in city bylaws, it is clear that the trend to urban agriculture and urban beekeeping is here to stay.

Native pollinators and the diversity of bees

C. S. Sheffield, *Royal Saskatchewan Museum, Regina, SK*

The last decade has revealed that we are so reliant on one species, the European honeybee (*Apis mellifera* L.), for crop production via pollination that we now face a possible food-security issue with its continuing decline. Our best hopes may not lie in putting all our research efforts and resources into helping this charismatic species, but in also including other native bee species into the crop-pollination equation.

Canada has over 800 species of bees, and many show much potential as managed and encouraged pollinators. Wild bees can be encouraged to live in many terrestrial habitats, including agricultural ones, by conserving and providing ample pollen and nectar resources and nesting sites and habitats. Cavity-nesting bees, primarily the family *Megachilidae*, show great potential as alternative managed pollinators, because many species accept artificial nesting sites (i.e., nesting blocks) and show strong preferences for some crop plants. As well, combinations of crop and non-crop plants that flower in sequence can be used to promote bee-population growth in crop systems. By considering what bees need, and then providing it, we can supplement pollination services. In addition, most of the things that we do to help native bees will also benefit honeybees, which allows us to meet concerns for all pollinators.

Colony collapse disorder, farm chemicals, and pollinator declines

P. van Westendorp, *British Columbia Ministry of Agriculture, Abbotsford, B.C.*

Since 2000, pollinator declines have been reported in many parts of the world. This decline has not been limited to honeybees (*Apis mellifera*), but also to other Hymenoptera pollinators. French beekeepers first reported high losses of apparently healthy colonies near corn and potato plantings. Neither of these crops is of interest to bees as forage sources. Similar losses were reported by beekeepers in other European countries, which led to the suspicion of a link between colony losses and the insecticides used on these crops.

In the late 1980s, the neonicotinoid insecticides were introduced in Europe; since then, formulations have been registered in more than 120 countries. The neonicotinoids mimic the natural plant derivative of nicotine, which is characterized by its rapid knock-down effect, short efficacy period, and rapid breakdown. On the other hand, neonicotinoids have proven highly effective at disrupting an insects central nervous system, as well as for their systemic action and high persistence in the soil. Furthermore, neonicotinoids display low to moderate toxicity to mammals, affecting only their peripheral nervous systems.

In the fall of 2006, U.S. beekeepers reported catastrophic losses of apparently healthy colonies without the identification of the causal agent(s). The phenomenon was dubbed "colony collapse disorder" (CCD). The extent of the losses was so significant that it seriously jeopardized the production of a range of pollinator-dependent crops, most notably almonds. Despite intense research efforts, no definitive causal agent of CCD has been identified. It is generally accepted that CCD is caused by various biotic and abiotic factors. In particular, mite parasitism of the obligate, host-specific *Varroa destructor* has had a highly destructive impact on honeybees. The situation has been exacerbated by bee viruses vectored by the *Varroa* mite. Other factors include management, bee genetics, dietary deficiencies, and exposure to farm chemicals. However, until now, there has been no scientific evidence of a direct link between CCD and neonicotinoid insecticides.

Since the initial introduction of neonicotinoids, a wide range of systemic formulations have been developed for use in numerous crops. Acute toxicity to insects has never been in dispute, but due to their persistence in the environment, it is believed that neonicotinoids may cause pollinator declines due to their chronic exposure at sub-lethal levels, resulting in irreparable nerve damage. An increasing body of evidence shows that chronic exposure at sub-lethal levels results in memory loss, changes in foraging and reproductive behavior, and a suppression of the insect's immune response system.

While unequivocal scientific evidence of the impact of neonicotinoids on pollinators has not yet been produced, the environmental consequences of the constant application of farm chemicals are highlighted by the way these products are marketed and promoted. From the 1960s onwards, integrated pest management (IPM) programs were developed for most crops and considered the use of any chemical or drug only when monitoring data support the need for the chemical or drug. However, today, many farm chemicals are applied prophylactically, regardless of need. Neonicotinoid insecticides are applied to 100% of corn seed and 50% of soy seeds. Until recently, farmers had to pay a higher price for untreated corn seed. The departure from IPM principles is of great concern, because they are replaced by a management system that incorporates the indiscriminate and chronic use of chemicals into the environment, without clear evidence on the long-term impact these chemicals have on non-target organisms.

Decision-making by the Canadian Food Inspection Agency

H. Higo, *Canadian Food Inspection Agency, Surrey, B.C.*

The 2013 risk analysis on the importation of bulk honeybees from the continental U.S. was released by the Canadian Food Inspection Agency (CFIA) on 25 October 2013. The CFIA uses a standard protocol for evaluating potential risks of imports from other countries. This presentation outlines the general risk assessment protocol and details how this protocol was applied in the recent honeybee risk assessment.

The CFIA considered four disease and pest issues to be hazards: the Africanized honeybee, antibiotic-resistant American foulbrood, small hive beetle, and acaricide-resistant *Varroa* mites. These hazards were all estimated to be moderate or low-to-moderate risks. Because the risks had not changed significantly since the last risk assessment in 2003, no change in the importation status of bulk honeybees from the continental U.S. was recommended.

Bee integrated pest management

H. Higo, *Canadian Food Inspection Agency, Surrey, B.C.*

Honeybee colony losses have increased significantly in recent years, from an average loss of 10–15% prior to 2006 to 30% or more since then. The causes of these elevated colony losses appear to be multi-factorial, including diseases and pests (such as the *Varroa* mite, *Nosema* disease, and viruses transmitted by *Varroa* mites), reduced pollen and nectar availability with habitat loss and mono-cropping agriculture systems, and exposure to pesticides or other environmental factors in the field and in the hive. Integrated pest management (IPM) of *Varroa* mites and other diseases in the hive without relying heavily on harsh chemicals may help to reduce the honeybee decline.

This presentation outlines a novel project using proteomics—a potential new weapon in the IPM toolbox—to select for specific honeybee behaviours that combat *Varroa* mites and other diseases. Several honeybee antennal proteins were shown in a previous project to be closely associated with worker hygienic behaviour, in which workers selectively remove diseased or infested pupae from the colony before the disease or mite has a chance to reproduce. Beginning in 2011, we sampled and tested commercial colonies across western Canada for hygienic behaviour. Cooperating beekeepers allowed us to remove selected queens, and going forward we used a two-pronged selection protocol to breed three generations of bees, either using proteomics or traditional, laborious field tests for disease-resistance.

Early results appear promising, but final results from the 2013 mite and bacterial challenges of the F3 generation are still being evaluated. As well, economic evaluations are underway in Manitoba and Alberta, as are practical evaluations of F3 queens by commercial cooperators across western Canada. Results will be released in the summer of 2014, and proteomic testing could soon be a new IPM tool available to beekeepers.

This project involved researchers from the University of British Columbia (Leonard Foster, Marta Guarna, Amanda van Haga, Miriam Bixby), University of Manitoba (Rob Currie), Agriculture and Agri-Food Canada (Stephen Pernal, Abdullah Ibrahim, Shelley Hoover, Adony Melathopoulos) and bee breeders Liz Huxter and Heather Higo. Funding was provided by Genome Canada, Genome BC, Genome Alberta, Agriculture and Agri-Food Canada, University of British Columbia, University of Manitoba, and the B.C. Honey Producers Association.