

NOTES AND COMMENTS



Honey bee colony losses in Canada.

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The parasitic mite *Varroa destructor* Anderson & Trueman, was first reported in Canada in 1989 (McElheran, 1990), but slowly spread to most beekeeping regions in the country by 2002. Limited migratory movement of colonies between provinces and beekeeping regions and effective control of mites through the use of two registered products, fluvalinate (Apistan[®]) and formic acid, mitigated the spread and impact of *V. destructor* in Canada during this period.

Resistance of *V. destructor* to fluvalinate was first confirmed through laboratory testing by Provincial Apiarists in Canada in 2001, but was not present in all provinces (Fig. 1). Prior to the development of fluvalinate resistance, coumaphos was not registered for use in Canada. Emergency use permits to allow applications of coumaphos (CheckMite+[®]) were permitted only after resistance to Apistan[®] was documented within a region. Resistance of *V. destructor* to coumaphos was first noted in an isolated region of Ontario in 2002, but has since become more widespread, and is now present in most provinces (Fig. 1).

Since the development of acaricide resistance to fluvalinate in Canada, colony winter losses within each province have been recorded annually by the Canadian Association of Professional Apiculturists (CAPA). Surveys began after the winter of 2002-3 (Fig.1). Beekeeper statistics on colony losses were collected through telephone and / or written surveys conducted by Provincial Apiarists to establish an estimate for their respective province.

Colony winter mortality varied considerably in different regions of the country over the study, and was highly variable within regions, with some areas within provinces experiencing losses substantially higher than the provincial average. Winter losses were slightly higher than "normal" (5 to 15%) (reviewed by Furgala and McCutcheon, 1992) during the winter of 2002-3, but returned to near "normal" levels in most regions by 2006. In the winter of 2006-7, however, winter mortality increased dramatically with 231,034 colonies dying over the winter (36% winter and early spring mortality), and colony mortality was similar in the winters of 2007-9 when 203,597-208,142

colonies (34 -35%) died. Winter mortality rates we found were very similar to the overall losses reported in the United States in each of those two years (32% and 36%, respectively) that have been associated in part with the symptoms of Colony Collapse Disorder (CCD) (vanEngelsdorp *et al.*, 2008). Despite similar rates of mortality in our study in Canada and that in the U.S., the collection of symptoms characteristic of CCD in the U.S. have not typically been associated with these colony losses in Canada. The main causes of mortality identified by professional apiculturists in each region were high levels of *V. destructor* associated with treatment failure caused by acaricide resistance (Fig. 1), unusual fall and winter weather that affected mite and bee population growth patterns, timing of treatments, forage for bee populations or fall feeding of colonies in preparation for winter and / or in the spring build-up period, and in some cases presence of *Nosema* spp. may have been a contributing factor. These factors may have acted alone or in combination with each other depending upon the individual region and / or apiary sampled.

Despite relatively large fluctuations in winter survival rates, the overall number of colonies wintered in Canada (and within each region; Fig. 1) has remained fairly stable between 575,705 to 639,119 hives from 2003 to 2009. This is due to the fact that, even though high losses have occurred, beekeepers were able to recover from losses through the purchase of replacement colonies and by making splits of existing colonies.

Other pathogens linked to CCD, Israeli acute paralysis virus (IAPV) and *Nosema ceranae*, have been identified from Canada. IAPV has been detected in several Provinces (BC, MB, ON, QC) and is probably widely distributed throughout Canada, although extensive surveys for this disease have not been carried out. Detections of *N. ceranae* were first made from samples collected in 2006 and 2007 from the Canadian Maritime Provinces (Williams *et al.*, 2008), but the oldest sample from which this parasite has been identified was one originally collected in 1994 from Northern Alberta (Pernal, unpublished data). Finding

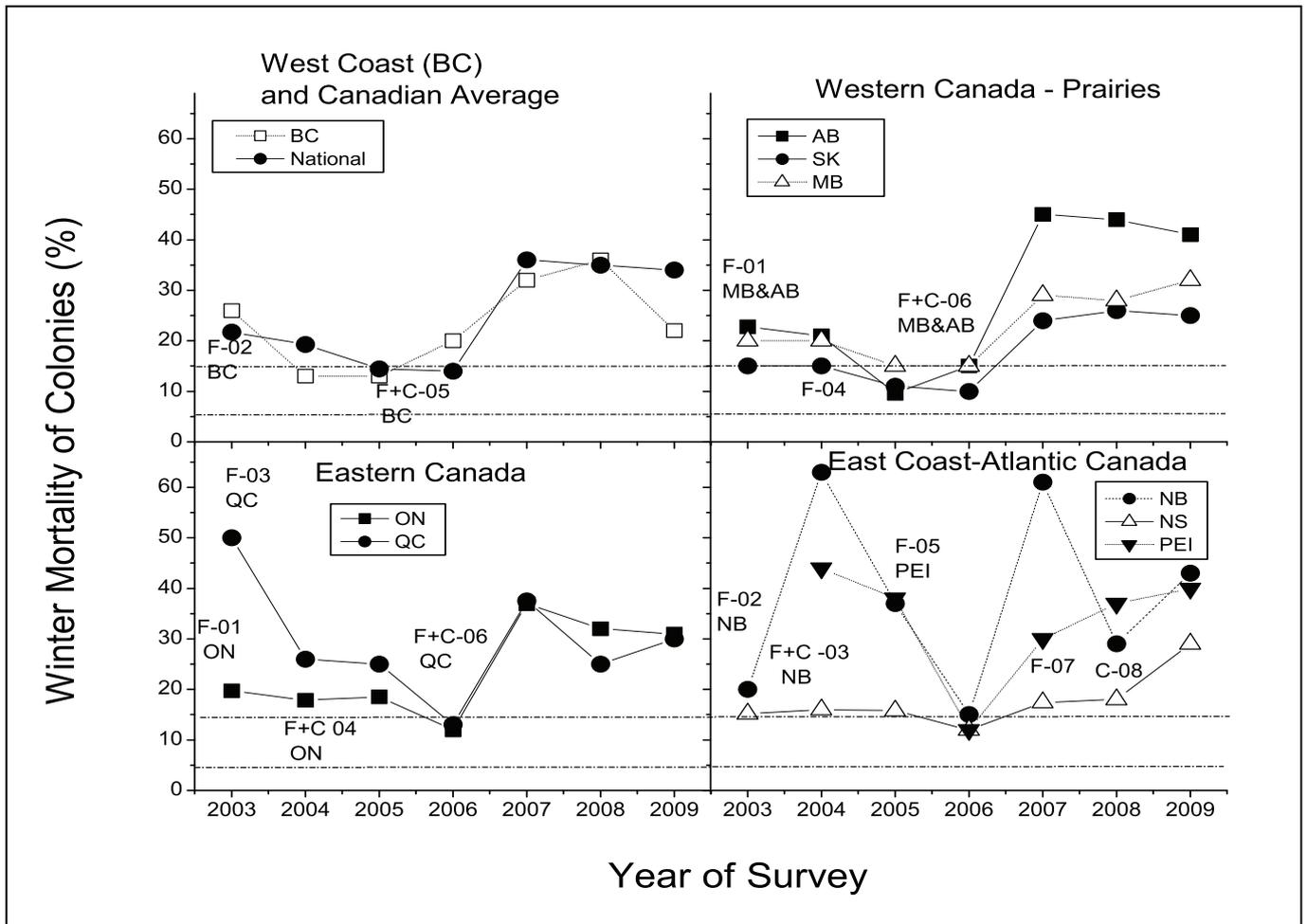


Fig. 1. Total proportion of honey bee colonies that died each winter in four different regions of Canada (West Coast, Western Canada (Prairies), Eastern Canada and Atlantic Canada) during each winter (including spring losses associated with non-viable dwindling colonies) between 2003 and 2009. National = total proportion of colonies that died in all of Canada ($n = 605,288 \pm 9,620$ colonies). Initials in capital letters represent Provinces within Canada: BC= British Columbia ($n = 46,227 \pm 1,963$); AB=Alberta ($n = 237,060 \pm 5,060$); SK=Saskatchewan ($n = 103,857 \pm 3,027$), MB=Manitoba ($n = 81,371 \pm 925$); ON=Ontario ($n = 75,342 \pm 1,154$); QC=Quebec ($n = 31,113 \pm 1,964$); NB=New Brunswick ($n = 8,626 \pm 599$); NS=Nova Scotia ($n = 18,788 \pm 268$); PEI=Prince Edward Island ($n = 3,188 \pm 270$). n = mean number of colonies in each region averaged over all years (\pm SEM). Horizontal dashed lines represent the range of "normal" winter mortality. Letters and numbers adjacent to lines on graphs indicate first report of resistance to acaricides fluralinate (F) or coumaphos (C) (followed by year of first report) in each Province. F+C indicates resistance to both acaricides.

N. ceranae in a sample as old as this supports previous contentions that *N. ceranae* has been present in North America for many years (Chen *et al.*, 2008).

Based on a need to understand *Nosema* prevalence and distribution in Canada, voluntary submission of *Nosema* containing samples was coordinated by Agriculture & Agri-Food Canada (AAFC) in 2007. Seventy nine samples were tested, submitted from all provinces except BC and NL. From samples in which DNA from *Nosema* could be amplified, 19 were found to contain only *N. ceranae*, 22 to contain only *N. apis* and 25 to contain both species. In contrast, analysis of 43 samples collected from colonies at the AAFC Beaverlodge Research Farm in the fall of 2007 showed *N. apis* to be predominant, with 37 samples containing exclusively *N. apis*, four samples containing only *N. ceranae* and two samples containing both species. During the spring of 2009,

field surveys of five commercial beekeepers from BC and AB, involving 368 colonies, showed the incidence of *Nosema* spp. to be highly variable within these operations (0.5%, 3.5%, 6.0%, 43.5%, 100%). Based on an analysis of a subset of these samples, 12 contained only *N. ceranae*, one contained only *N. apis*, while 18 contained both species. Collectively, these data suggest that *N. ceranae* is widely distributed across Canada, though the parasite may still be at a relatively low incidence in some regions. *Nosema* spp. incidence within individual beekeeping operations is probably highly dependent upon current management practices and the use of fumagillin, which is registered for use in Canada.

The health of over 400 colonies was more intensively studied within the Province of Ontario, between the fall of 2007 and the summer of 2008. These beekeeping operations, which averaged 27% winter

loss, had a high proportion of colonies infested with *V. destructor* during the fall (76%), and had 85% of their winter mortality significantly associated with high mite infestations. *V. destructor* infestations and *Nosema* spp. infections in the spring also significantly restrained bee population growth (Guzmán-Novoa *et al.*, 2010). In another study, analysis of 100 samples of *Nosema* spp.-infected bees collected in 16 Ontario counties between 2007 and 2008 showed that 47 tested positive for *N. ceranae* only, 41 tested positive for *N. apis* only and 12 were infected with both species (Guzmán-Novoa *et al.*, 2010; Van Alten *et al.*, unpublished data).

Increased rates of winter colony losses in Canada are probably the result of regional differences in weather patterns that affected forage availability for bees, fall feeding management, mite and bee population growth, *V. destructor* treatment timing, the presence of *Nosema* spp., viruses and other diseases and the spring build-up of colonies. These stressors interacting in combination with each other affected colony survival, but direct and indirect effects associated with acaricide resistance and the failure to control *V. destructor* mites are believed to be the most important factors related to colony loss in Canada.

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