Pollinating Insects- Native and Managed Pollinators

Figure 1: *Reproduction of the devastating honey bee parasite, the verrora mite, is limited to times when developing bees are present in the hive. Climate-induced changes in forage availability will affect timing and duration of brood rearing and will affect the management of this parasite.*
(credit: R. Currie)

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What is going on?

Insects are among the first organisms to show dramatic responses to variation in climate because they have short generation times and temperature-dependant developmental rates. Under a warming climate insect pests will undergo more generations per year, will have increased winter survival and will have earlier and more frequent migration into Canada from areas south of our borders. Invasive species and pathogens vectored by insects will initially thrive as they expand their wintering zones and enter into areas in which there may currently be no natural enemies. With bees and other pollinating insects our predictions are less clear, but there are some predictions that can be made, particularly with respect to managed species in agroecosystems.

Climate change is anticipated to affect native plant-pollinator relationships, especially along the northern ranges where assemblages of pollinators may be incapable of "tracking" climate change quickly enough to adapt and form stable relationships with host plants[1-5]. However, broad scale effects on pollination of native plants have not been identified (yet?): apparently, shifts in pollinator emergence have kept pace with shifts in growth of most plant species[1]. For managed pollinators like honey bees, measurements of honey flows using "scale" colonies show similar phenological shifts[6]. A 1°C increase in the U.S. resulted in a 7 day advance in peak colony weights in a 15-year period from 1992 to 2007[6]. Such shifts could affect bee management (Figure 2).

Honey bees in Canada have been suffering major winter colony losses from combinations of parasites, diseases and a variety of other stresses including extreme weather events and unusual patterns of forage availability[7]. Although honey bees are adapted to a broad range of climate conditions, increases in environmental variability and changes in annual patterns could pose problems for honey bees in the future[8]. Under some scenarios, pollination by managed honey bees is predicted to decline by about 15% (without management intervention) but increases by native pollinators could buffer some of these effects[9].

What is coming up?

Warmer winters and springs could benefit winter survival and spring "build up" of honey bee colonies – but climate change is not likely to be all "good news". Shifts in plant species and timing could affect bee nutrition. A shift from forages and oilseeds towards other crops that are less desirable or unsuitable for bee forage (e.g. corn and soybean) would increase nutritional stresses on bees. Shifts in plants that support bees when crops are not in bloom would make it more difficult to synchronize colony population size with peak periods of crop bloom needed to maximize honey production and pollination (Figure 2). Shifts in fall patterns of bloom for native plants could negatively affect production of young bees in the fall that are required for successful wintering. These nutritional shifts compounded with increased variability and unpredictability of weather patterns would pose increased challenges for management of colonies.

Management of leafcutting bees would also be affected by climate change. As a result of warmer spring temperatures, leafcutter bee producers could expect that a higher proportion of their bees would attempt to enter a second generation, which in both Canada and the U.S. results in lower levels of bee reproduction[10]. Both honey bee and leafcutting bee producers could anticipate more severe problems with parasites and disease. For honey bees, longer brood-rearing periods associated with expanded seasons would result in more generations of parasitic varroa mites being produced each year (Figure 1). This in turn would result in either longer exposure times or application frequencies for pesticides and thus greater chances for the development of pesticide resistance. Reduced ability to control mites and their associated pathogens going into winter would impact winter mortality. Leafcutter bee producers might expect to see an increase in diseases such as chalkbrood and more inviable offspring (pollen balls)[10]. This would lower bee reproduction rates and reduce producer income from bee sales.

Finally, "invasive species" such as the small hive beetle and africanized ("Killer") honey bee could expand their ranges and become significant pests in Canada[8]. Increased diversity and numbers of invasive crop-pest insect problems and the associated increase in the use of pesticides required to control them would also likely increase sublethal colony-level stresses on honey bees and result in reductions in survival rates of leafcutting bees.

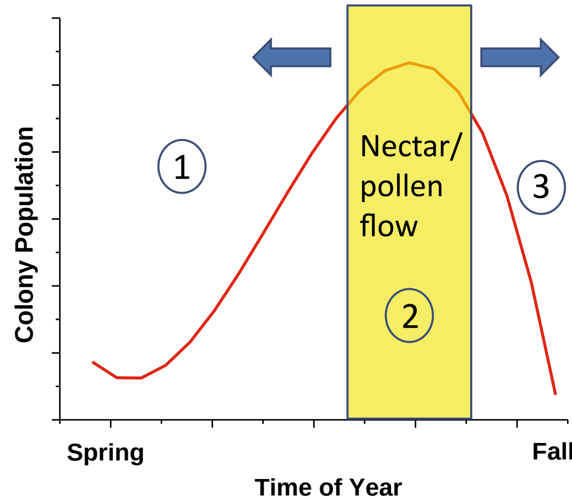

Figure 2: *Climate change could (1) influence conditions for honeybee colony growth and development in spring; (2) shift periods of the main nectar flow so that it would not coincide with peak populations of bees; or (3) influence forage availability during the sensitive period when the bees that will form the overwintering population are produced. Beekeepers will have to adopt new management paradigms to mitigate these effects.*

Does it matter?

In addition to the production of honey and other hive products valued at over $75 million per year, honey bees, leafcutting bees and other insect pollinators contribute to the yield of many fruit, forage and oilseed crops[11]. On the prairies, pollination by bees (primarily honey bees and leafcutting bees) is essential to the production of alfalfa and hybrid canola seed. The total value attributed to the contributions of bee-pollination to crops in Canada is estimated to be over 2 billion dollars[11]. Any climate change that directly or indirectly increases the level of stress on bees can contribute to population losses of managed pollinators having significant economic impact.

"climate change that increases the level of stress on bees can contribute to population losses"

What is being done?

Research into pollinator declines and the impact of such declines on native and managed ecosystems is underway[4] but we still need a better understanding of how climate change will interact with other stressors affecting the health of managed and native pollinators. New strategies to better manage parasites, diseases, beekeeper-applied pesticides, environmentally-applied pesticides and other stresses will have to be developed. Finally, coordinated technology transfer efforts are needed to ensure uptake of research solutions by beekeepers and growers.