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NSERC-CANPOLIN
CANADIAN POLLINATION INITIATIVE

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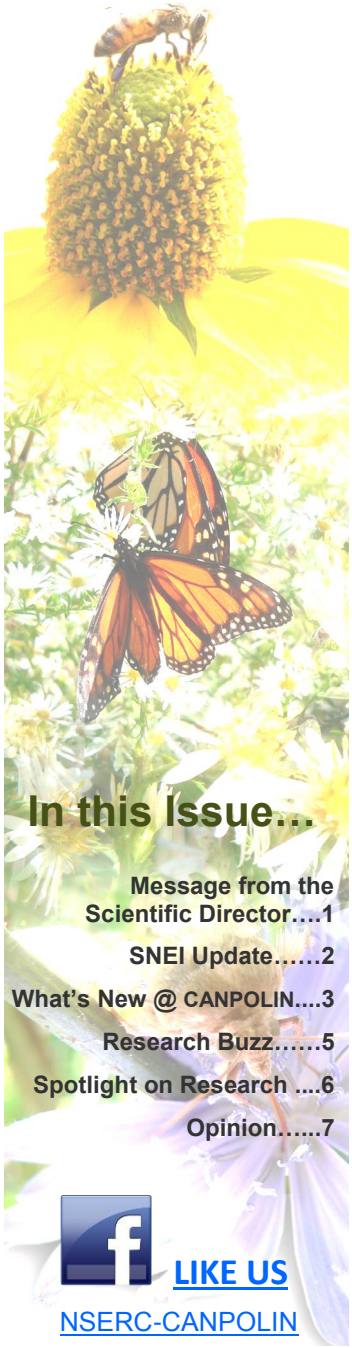

In this Issue...

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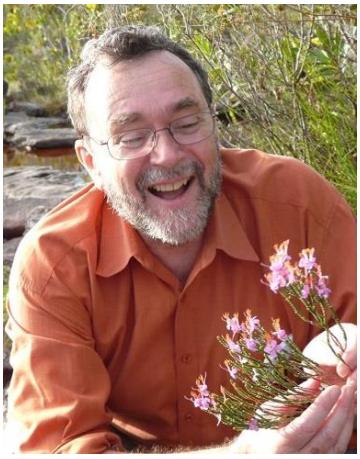
MESSAGE FROM THE DIRECTOR



In the last newsletter I was able to brag about the progress CANPOLIN has made over its 4 year existence! We continue to advance in leaps and bounds with 86 papers now listed as CANPOLIN contributions, more graduate students (now 25) have completed their studies with us, and numerous grower and like articles have been published. We are making a huge impact nationally and internationally with our science!

One of NSERC's expectations was that we work with the private sector. That we have done, especially in the areas of managed pollinators, pollinator health, crop production and protection. In the first and last mentioned context, the incorporation of Bee Vectoring Technology Inc. is especially noteworthy. BVT Inc. has placed the technology of using managed pollinators to disseminate biocontrol agents to crops (for more info, see page 4). BVT Inc. continues to work with CANPOLIN as it develops world and domestic markets through joint research, development and innovation.

CANPOLIN's success in assisting with lowbush blueberry production through applied pollination ecology has been well received in eastern Canada and interest is growing in ON and BC for highbush blueberries. CANPOLIN has made strides with highly profitable pollination management for some oil-seed production, notably for sunflowers in ON. Our continuing attempts to share our interdisciplinary skills with the canola industry, both for hybrid seed production (for which pollination is recognized as a concern) and commodity seed (for oil) production (for which the value of managed pollination remains unknown and downplayed) have been frustrated by agribusiness interests. Having said that, overseas interests in Europe, Latin America, and USA in some of our practical and theoretical expertise are growing. Dan Schoen and his team have recently added to this expertise with an exciting new discovery about self-incompatability in mustards that could be potentially valuable for crop production (see page 4).

As CANPOLIN begins to wind down, I extend a warm invitation to all to attend this year`s Entomological Society of Canada meeting which will take place in Guelph in October. CANPOLIN`s wrap up activities will include an all-day symposium at the ESC meeting that will highlight some of our many results. I look forward to seeing you there!

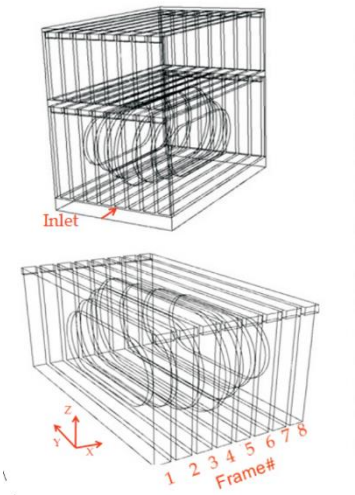
Peter Kevan, Scientific Director

SNEI Update

CANPOLIN is pleased to announce that it has received additional funds from NSERC's 2013 Strategic Network Enhancement Initiative (SNEI) program in support of knowledge transfer, collaboration building and graduate student training activities. See below for a full list of newly-funded activities that will take place in 2013/2014.

New SNEI Activities for 2013/2014

1) **Pollination, Climate Change and Invasive Species in Arctic and Alpine Ecosystems Workshop (Kluane Lake Research Station, Yukon).** CANPOLIN is hosting a small, targeted workshop for arctic and alpine researchers and stakeholders, with the goal of identifying emerging issues and priorities and developing new partnerships and collaborations. (N.B. This workshop is now full!)
2) **Workshop for Pollination Biologists in Training (Simon Fraser University, BC):** This unique summer workshop will provide Network students with the opportunity to share tips, tricks and techniques related to conducting pollination biology research. Students will also receive training in a range of professional skills (N.B. This workshop is now full!)
3) **Bees, Biology and Math Workshop (Tempe, AZ):** CANPOLIN mathematics researchers are organizing a one-day workshop on June 14 in conjunction with the Society for Mathematical Biology annual meeting.
4) **Bees and Math Workshop for Beekeepers (date and location TBA):** How can mathematical models help beekeepers manage disease in their hives, or lead to better hive design? This "knowledge transfer" workshop for apiculturalists and beekeepers will highlight CANPOLIN's research progress in this area.

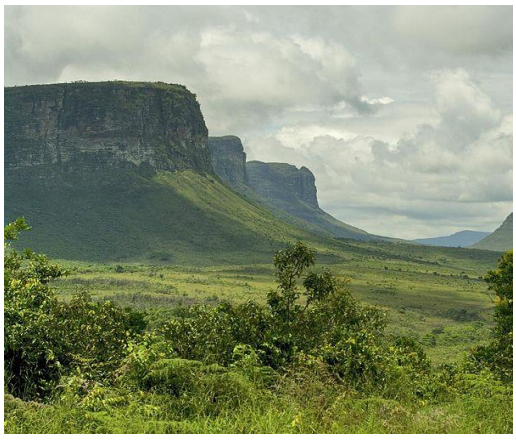


Bees and Math: Modelling ventilation and thermoregulation in beehives—one application of using math to improve bee management (picture by R. Sudarsan)

5) **Bee Image Bank.** Laurence Packer`s lab is taking its taxonomic work one step further with the development of a user-friendly online bee image bank for naturalists, conservations, gardeners, teachers and others interested in distinguishing between the 800 species of bees in Canada. The image bank will contain over 2000 high quality images covering the different colour morphs and castes of all known Canadian species in Canada. The project is expected to be available online in late 2013.

The **Bee Image Bank** will contain over 2000 images of Canadian bees (picture by L. Packer)

6) **Biovectoring Workshop (Harrow, ON):** CANPOLIN researchers have made excellent progress in using bumble bees to deliver biological control agents to crops as they pollinate flowers. This workshop will update end users (including beekeepers, greenhouse growers and field producers) of some of the exciting developments in this area. The date for this workshop has not yet been set.
7) **International Pollination Biology Course (Lencois, Brazil):** CANPOLIN will once again be able to support the participation of up to four graduate students in the Network. This year's course will take place December 2-14, 2013. See page 4 for information on how to apply.
8) **Blueberry Pollination Workshop (Moncton, NB):** This workshop will highlight the findings of the CANPOLIN blueberry "crop squad" - a multidisciplinary research team that has focused on blueberry as a model system to address several important questions related to pollination. The workshop is scheduled to take place in late February, 2014. Watch the CANPOLIN website for more details.
9) **CANPOLIN Research Digest:** One of CANPOLIN's capstone deliverables will be a lay-friendly summary of CANPOLIN research activities and findings. The digest will provide information on the full range of CANPOLIN research, from biodiversity and bee health to plant reproduction, crop pollination, climate change impacts and the economic valuation of pollination services. The digest will be available in print form and on-line. Stay tuned more details!



Chapada Diamantina National Park ,site of the next International Pollination Biology Field Course (picture courtesy of deltafrut/Wikicommons)

Study Brings Historical Perspective to Modern Beekeeping Crisis

Her data sources may be found deep in the historical archives, but Jennifer Bonnell is looking to bring a fresh perspective to the current global honeybee crisis. A historian at the University of Guelph, Bonnell is examining social, environmental and economic aspects of beekeeping during the last 150 years. Her goal is to provide a historical context for the challenges faced by modern beekeepers.

Jennifer Bonnell is looking to the past to better understand the problems facing modern beekeepers

"Today's crisis is due to the interaction of several different threats facing bees. These threats are not a random coincidence, but a symptom of the profound changes in beekeeping and agricultural practice, particularly during the 20th century," says Bonnell.

According to Bonnell, the 20th century is usually viewed as a 'plateau period' in the history of apiculture because not a lot of technological change took place. "But in fact, it was a period of great change throughout the industry. Pollination contracts became a major source of revenue, and beekeepers began to rely increasingly on miticides and antibiotics to combat honeybee pests." It was also a period of significant land use change, from the loss of hedgerows and roadside wildflowers to the growing dominance of monoculture cropping – all factors that have had a dramatic impact on bees and beekeepers.

To untangle the roots of the current crisis, Bonnell is delving into historical records kept by beekeepers as well as old trade journals, scientific reports, agricultural census data, and beekeeping association records. She's also utilizing oral histories and historical geographic information systems (HGIS) to study landscape changes in selected areas. Meanwhile, CANPOLIN researchers at the University of Guelph are assisting with the study by providing modern expertise on honeybee diseases and management.

Bonnell's preliminary work focuses on two key events in beekeeping history: the outbreak of American foulbrood disease in the late 19th and early 20th century, and the conflict that emerged between fruit growers and beekeepers in the late 1800s after new insecticide treatments caused significant bee kills.

"These are examples of events where the responses of beekeepers, scientists and government officials shed light on how agricultural, ecological and social change intersect," says Bonnell. She believes that using an interdisciplinary, historical approach can add a valuable dimension to the search for long-term solutions to ongoing honeybee declines.

The project was launched as part of a two-year SSHRC post-doctoral fellowship awarded to Bonnell, and will continue through her new appointment as adjunct professor in the Department of History. For more information about the study, contact jbonnell@uoguelph.ca.

Pernal Receives Diamond Jubilee Medal

WG2 researcher Steve Pernal is a recipient of a prestigious Queen Elizabeth II Diamond Jubilee Medal, a commemorative medal created in 2012 to mark the 60th anniversary of the Queen's accession to the throne. Nominated by Agriculture and AgriFood Canada for his outstanding work and service to Canadians and the agricultural sector, the medal recognizes Steve's leadership in apiculture, his efforts to launch the first National Honey Bee Diagnostic Centre in partnership with Grand Prairie Regional College, and his management of the Beaverlodge Research Farm. NSERC-CANPOLIN extends a heartfelt congratulations to Steve!

Upcoming Courses

The International Pollination Biology Course will take place December 2-14, 2013 in Lencois, Brazil. CANPOLIN will provide travel support for up to four graduate students to attend the course. This popular field course combines lectures, lab and field demonstrations that cover topics ranging from plant mating systems to animal behavior and evolutionary ecology. Students also complete short research projects that lay the groundwork for broad understanding of pollination biology.

For more information or to apply for a spot, please email canpolin@uoguelph.ca. Deadline to apply is June 15, 2013.

Mating System Research Leads to New Patent

WG3 researcher Dan Schoen and his team at McGill University made a surprising discovery while sequencing the genes responsible for self-incompatibility in the mustard genus *Leavenworthia*: it turns out that self-incompatibility in the mustard family has evolved more than once. The findings have implications for the study of evolution of non-selfing in plants, and may also have important applications for the crop breeding industry. A patent application has been filed and a paper published in PLoS Biology (see pg. 5 for article details).


Photo courtesy of Wikipedia Commons

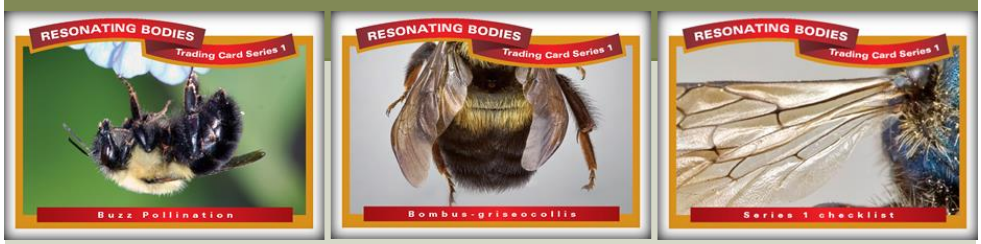
Biovectoring Technology Takes Off

Using honey bees or bumble bees to deliver biocontrol agents to crops as they pollinate flowers - or 'biovectoring' - has become a true research success story. In collaboration with partners at Agriculture and AgriFood Canada and Seeds of Diversity, CANPOLIN has helped make significant advances in developing this technology for use in greenhouse and field crops, and a new company based in Guelph (BVT or Bee Vectoring Technology Inc.) is working to commercialize it. Depending on the biocontrol agent used, the technology can offer crop protection against fungal plant diseases and/or insect pests. Hives are fitted with dispensing trays loaded with formulated biocontrol agent. Bees must pass through the tray to exit the hive to forage. In doing so, they pick up the inoculant and then deliver it to the crop blossoms. Field tests have shown that biovectoring can reduce the incidence of grey mold in strawberries by 90% compared to untreated fields. The incidence of head rot in sunflowers was reduced by 70-90%, with a 30-40% boost in yield. Other crops where this technology shows potential include greenhouse tomato and pepper, raspberries and blueberries. Orchard trials have been launched in Nova Scotia this year.


A "quad" bumble bee hive with biocontrol dispensers (photo by J. Sutton)

For more information about biovectoring research and its applications, contact BVT at beevectoring@gmail.com, Les Shipp (Les.Shipp@AGR.GC.CA) or Peter Kevan (pkevan@uoguelph.ca).

Native Bee Trading Cards Now Available Online



Resonating Bodies' (resonatingbodies.wordpress.com) native bee trading cards can now be purchased online through the Pollinator Partnership Canada website! Visit www.pollinatorpartnership.ca to order. Two sets are available, one for bees from eastern Canada, the other for bees of the eastern USA. The cards make outstanding outreach and education tools. Get yours today!

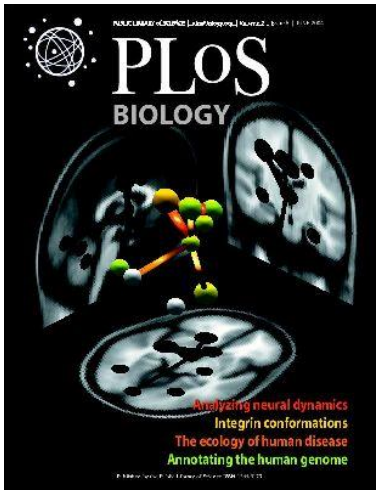
Research Buzz

CANPOLIN now has 86 research articles submitted, in press or published! Below are some recently published papers. For a full list of available PDFs, visit http://www.uoguelph.ca/canpolin/Publications/pubs.html **.**

Herman, A.C., J.W. Busch and D.J. Schoen. 2012. **Phylogeny of *Leavenworthia* S-ALLELES suggests unidirectional mating system evolution and an ancient POPULATION "bottleneck".** Evolution 66(6): 1849–1861

Spafford, R.D., C.J. Lortie and B. Butterfield. 2013. **A systematic review of arthropod community diversity in association with invasive plants.** Neobiota 16: 81–102, doi: 10.3897/neobiota.16.4190.

Boily, M., B. Sarrasin, C. DeBlois, P. Aras and M. Chagnon. 2013. **Acetylcholinesterase in honey bees (*Apis mellifera*) exposed to neonicotinoids, atrazine and glyphosate: laboratory and field experiments**. Environmental Science and Pollution Research International. DOI 10.1007/s11356-013-1568-2



Sheffield, C.S., A. Pindar, L. Packer and P.G. Kevan. 2013. **The potential of cleptoparasitic bees as indicator taxa for assessing bee communities.** Apidologie DOI: 10.1007/s13592-013-0200-2

COVER STORY Chantha, S.C., A.C. Herman, A.E. Platts, X. Vekemans and D.J. Schoen. 2013. **Secondary evolution of a self-incompatibility locus in the Brassicaceae genus *Leavenworthia***. PLoS Biology 11(5): e1001560. doi:10.1371/journal.pbio.1001560
(cover story in the May 2013 issue of PLoS Biology)

AGM Announcement

The final General Assembly Meeting for CANPOLIN researchers, graduate students and partners will be held in conjunction with the 150th Annual Meeting of the Entomological Society of Canada, in Guelph, ON, October 20-23, 2013. A special full-day symposium will be dedicated to CANPOLIN research on Wednesday, October 23. The symposium will be followed by a banquet and poster session for CANPOLIN members.

Watch your email for information about registration deadlines!

UNIVERSITY of GUELPH

SOCIETAS ENTOMOLOGICA CANADENSIS

NSERC-CANPOLIN CANADIAN POLLINATION INITIATIVE

Spotlight on Research

Biomarkers May Help Unravel Pesticide Mystery

How do you know if a bee has been sub-lethally poisoned by a pesticide, if the levels of pesticide in the bee are too low to be detected?

When it comes to the neonicitinoid family of insecticides, this is a question many bee health researchers would like to see answered. Neonicitinoids are the most commonly used type of insecticide around the world, and are toxic to honeybees at extremely low levels. They have been implicated in bee losses around the world, but there is no smoking gun that directly links colony losses to exposure to neonicitinoids.

WG2 researcher Madeleine Chagnon at the Université du Québec à Montréal says the answer may lie with what toxicologists call "biomarkers". Biomarkers are compounds that are affected by exposure to toxins and can be easily quantified. One such biomarker is the enzyme acetylcholinesterase, or AChE, which helps regulate the nervous system in animals. Insecticides that target the nervous system, such as organophosphates and carbamates, are known to cause a drop in AChE levels.

"Neonicitinoids also act on the nervous system, but they have a different mode of action," says Chagnon. "It is not known how these compounds affect AChE levels in honeybees, or if it could serve as an indicator of sub-lethal exposure."

Chagnon and her colleagues exposed bees in the lab to increasing but non-lethal doses of the neonicitinoid for ten days and then measured AChE levels. Unlike organophosphates, neonicitinoids caused the bees' AChE levels to increase.

The team also looked at levels of AChE levels in bees from hives placed in regular corn fields, organic corn fields and uncultivated fields. Bees were sampled weekly for four weeks. After two weeks of field exposure, bees in all three types of fields showed an increase in AChE levels – but the increase was highest in bees placed in conventional corn field.

"This is the first time that an increase in AChE has been shown in honeybees. It suggests the enzyme AChE may indeed be useful for monitoring exposure of bees to neonicitinoids," says Monique Boily, the team's ecotoxicologist. But she cautions that further research is needed. "There are many factors that can affect the dose-effect relationship, such as the age of the bees, their genetic background, and other toxins they have been exposed to."

This study was a collaboration between researchers at the Université du Québec à Montréal, the Centre de recherché en sciences animales de Deschambault and the Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs du Québec .

Boily, M., B. Sarrasin, C. DeBlois, P. Aras and M. Chagnon. 2013. **Acetylcholinesterase in honey bees (*Apis mellifera*) exposed to neonicotinoids, atrazine and glyphosate: laboratory and field experiments.** Environmental Science and Pollution Research International DOI: 10.1007/s11356-013-1568-2

A honey bee foraging for corn pollen (photo by J. Routledge)

WG2 Bee health researcher Madeleine Chagnon

Dead bees outside outside one of Chagnon`s test hives (photo by M. Chagnon)

The Great Pollination Myth?

Cultivars that can Self-Pollinate are No Guarantee of Full Yield

(The following is excerpted with permission from an article by Kevan et al. published in the May 2013 issues of The Grower. To read the full article, visit www.thegrower.org)

Plant breeders have contributed marvellously to yield increases in agriculture. Cultivars bred for greater productivity in seed and fruit crops are a mainstay of modern farming. One trait that breeders have incorporated into many modern crop varieties is self-compatibility. The flowers on self-compatible plants can fertilize themselves, getting around the age-old problem of needing insects and/or wind to transfer pollen from plant to plant.

Not all crop plants have been able to avoid the need for cross-pollination. Apples, pumpkins, blueberries and alfalfa are examples of crops for which cross-pollination remains essential. But for those crops that do have the ability to change, one can appreciate the advantage of growing a self-compatible cultivar. They reduce the need for insect pollinators, whether they be wild or managed. When self-compatible sunflowers became widely available for production in the 1960s, seed companies advertised that adding honeybee hives to fields was no longer needed and that production costs would be reduced.

But is it well and truly the case that pollinators are altogether unnecessary in self-compatible crops? Over the years, this unproven idea seems to have taken firm hold. The fact that pollen grains cannot jump by themselves from an anther to a stigma, even within same flower, is frequently overlooked. Growing evidence also suggests that even if spontaneous self-pollination takes place, the resulting seeds or fruits are of lower quality than if cross-pollination had occurred. It is the same basic principle that favours outbreeding over inbreeding – the genetic diversity introduced by cross-pollination produces bigger and higher quality fruits and seeds, as has been demonstrated in canola, sunflower, strawberry, peppers, sour cherry, and others. Plants may invest more in growing superior outbred seeds and fruit.

There are several crops commonly believed to *not* require cross-pollination by insects, but for which studies have shown an increase in yield quantity and/or quality when pollinators are added (see photos at right). The simple addition of pollinators to some self-compatible crops could increase yield by as much as, for example in canola, 20% - but strangely, the results of these studies, even those made in Canada, have been largely ignored.

Of course, the economics of managed pollination still needs to be taken into account. If a farmer can obtain a boost in yield from a self-compatible crop cultivar by adding managed pollinators to production practices, is the yield increase enough to make deploying pollinators economically worthwhile? With significant yield increases entirely possible, it is a question well-worth answering!

NSERC-CANPOLIN

c/o School of Environmental Sciences, University of Guelph, Guelph, ON, N1G 2W1

TEL: 519-824-4120 X58022 FAX: 519-837-0442

canpolin@uoguelph.ca • www.uoguelph.ca/canpolin