ONTARIO INSECTS

THE NEWSJOURNAL OF THE TORONTO ENTOMOLOGISTS' ASSOCIATION

VOLUME 26, NUMBER 2 June 2021

CONTENTS

Meetings, Insect Counts & Field Trips 31

Announcements and Short Notes 32

Social Media Updates 33

Monarch News 34

- Monarch Overwintering Update 34
- Good News for People Who Rear Monarchs 35
- Monarch Actions Now 36
- Presqu'ile Tagged Monarchs Recovered in Mexico 36
- Newly Released Book: Bicycling with Butterflies (2021) by Sara Dykman 37

TEA Meeting Summaries 38

The Endangered Mottled Duskywing: A Strategy for Recovery 41

The Butterfly Proboscis – More than a Drinking Straw 43

Are Butterfly Hybrids Just Not Fit for Survival? 44

Lives Lived: In Memoriam 45

Book Reviews 47

Black Witch Moths 50

Abstracts – 2021 TEA Student Symposium 52

Compton Tortoiseshells 55

Front cover photo credit: Thelma Beaubien
A male Monarch (*Danaus plexippus*) in flight.

DEADLINE INFORMATION - Members Please Note:

The deadline for submissions to the September issue of Ontario Insects is **August 15th**. Late submissions may be added at the discretion of the Editor after that date. If there are any questions or concerns regarding submissions, please feel free to contact Charlotte Teat at the address below.

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Mission Statement

The Toronto Entomologists. Association (TEA) is a non-profit educational and scientific organization formed to promote interest in insects, to encourage co-operation among amateur and professional entomologists, to educate and inform non-entomologists about insects, entomology and related fields, to aid in the preservation of insects and their habitats and to issue publications in support of these objectives.

Membership Information:

Annual dues are as follows:

Individual	$30
Student	Free
Family	$35

Chris Rickard, Treasurer, 16 Mount View Court, Collingwood, Ontario, L9Y5A9. (705) 444-6671. e-transfers can be sent to crickard@sympatico.ca

Advantages of a TEA membership include:

- 3 issues of Ontario Insects per year
- Annual Ontario Lepidoptera Summary
- Members may join the TEA permit, permitting the rearing of Monarchs and swallowtails: info@ontarioinsects.org

THE TEA IS A REGISTERED CHARITY (#131303141); ALL DONATIONS ARE TAX CREDITABLE.

MEETINGS

Saturday, September 25, 2021. 1:15 pm
MEMBERS' MEETING

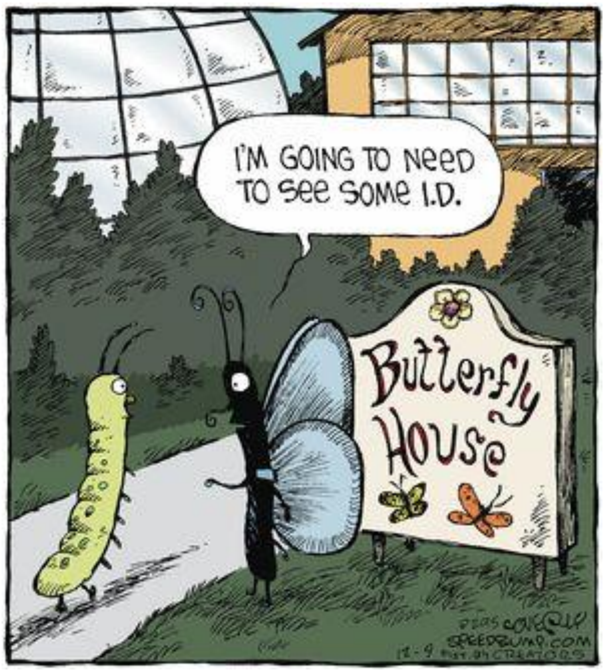
The topic will be "how you spent your summer insect-wise." Further information will be sent out by email, as we don't know if this will be an in-person meeting or by Zoom.

INSECT COUNTS

COVID-19 continues to affect insect counts. As with last year's counts, some organizers are planning to run counts on a modified basis. For example, the organizer might arrange in advance how the count area is to be divided up, and assign particular people to each area, without any overall meet-up. For counts in which you may have participated in the past, please contact the count organizer.

FIELD TRIPS

This would be nice, by only if COVID-19 protocols consider this to be a safe activity. Stay tuned for further developments.



Cartoon by Dave Coverly

Announcements and Short Notes

Glenn Richardson Research Award

This $800 award is in memory of past TEA president Glenn Richardson and is presented to a graduate or undergraduate student at an Ontario university studying insects or arachnids. Eight applicants were considered this year by the TEA award committee. We announced the awards to two applicants at this year's Student Symposium at the end of March. Although we normally give only one award per year, a gift through the estate of long-time TEA member Tony Holmes has allowed us to expand the program. We expect to continue this for subsequent years as well.

One of the award winners, Sara Khan, also spoke at this year's Student Symposium on March 27. Sara is in her first year of the M.Sc. program in biology at Carleton University, working under Dr. Jayne Yack in the Yack Lab. Her project is: "Acoustically mediated anti-predator strategies in group-living caterpillars." She has a passion for conservation, ecology, and entomology, specifically caterpillars. She is currently interested in insect communication and how it can be used in pest management strategies.

The other award winner is Kelly Murray-Stoker. She has been a PhD student in Dr. Shannon McCauley's lab at the University of Toronto Mississauga since the summer of 2019. Her project is: "Forces structuring trichopteran communities: Biogeographical to anthropogenic effects." She is interested in ecology, taxonomy, and systematics of caddisflies (Trichoptera), especially the microcaddisflies (Hydroptilidae). Her general area of interest is how studying the evolutionary history of communities can influence our understanding of the impacts of urbanization and other anthropogenic effects on river systems. She holds a B.S. (Ecology), B.S.E.S. (Entomology) and M.S. (Entomology), all from the University of Georgia.

New online checklist of the moths of Ontario

An online checklist of the 3,250 species of moths recorded in Ontario is now posted on the TEA website under "Moth Checklist" – see the link from the left-hand side of every TEA page. Also see the instruction page, which is linked to the Checklist page.

A key benefit of this checklist is that for every species, most of the online information about that species is provided in one place. Using the Luna Moth as an example, there is a link to its iNaturalist page (showing the number of records and a map), its BugGuide page, and its Moth Photographers Group page. The number of iNaturalist records as of the end of January (research-grade only) and the page number in the Peterson Field Guide are also shown.

The list of species has been provided by David Beadle, Mike King and Phill Holder, and is an update of the list included in their 2020 publication Ontario Moths: A Checklist (Hawk Owl Publishing, Newcastle, ON). That list, in turn, is an update of the Pohl *et al*. (2018) Ontario list. The computer work was done by Alan Macnaughton in collaboration with Chris Cheatle, Ross Dickson and Bev Edwards. A similar list maintained by Ken Sproule for the High Park Moth Study Group was the inspiration for this effort.

Please send comments, questions and suggestions for improvement to Dave Beadle and Alan Macnaughton at info@ontarioinsects.org.

Social Media Updates

TEA Joins Twitter

The TEA joined Twitter in April (@OntarioInsects).
See screen grab of the heading of the Twitter account.

Bipin Dhinsa set this up, at the suggestion of TEA president Jessica Linton. Anyone who is on Twitter might wish to follow @OntarioInsects for updates. Bipin writes: "Another great way to reach even more people and get young and old interested and excited to meet their natural world from a bugs eye perspective!"

TEA joins Facebook

Carolyn King has set up a TEA page on Facebook (see picture). You will find announcements of TEA meetings, news and research about insects and spiders in Ontario, Monarch updates, our members' insect-related activities, photographs and video links, information about insect surveys, collecting, rearing, light traps, and more. Visit us, like us and comment on our posts. Find the site using Facebook's search engine, or use this link: https://www.facebook.com/Toronto-Entomologists-Association-106016655001416

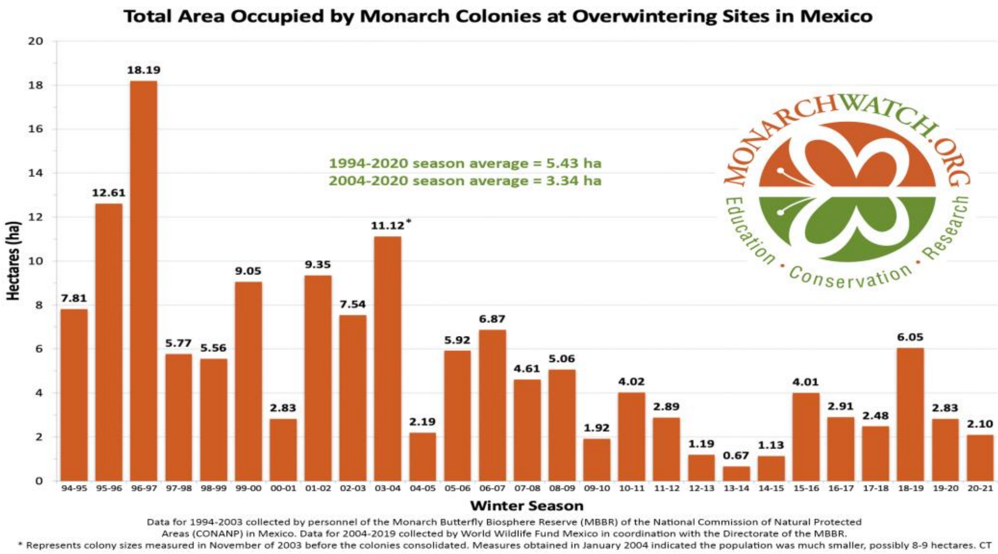
MONARCH NEWS

By Don Davis

Monarch Overwintering Update

There was bad news regarding overwintering Monarchs this year:

- On January 29, Xerces Society announced that less than 2,000 wintering Monarchs were counted along the California coast – a 99.9% decline from the 1980's.
- On Feb 25, WWF Mexico and partners announced that the Mexican overwintering colonies occupied 2.10 hectares in December 2020. This is a 26% decline from the previous year, and a 19% drop from the average of the 10 previous years. See this chart from Monarch Watch:



Also released was data about the degradation of the Monarch wintering forest in the Monarch Reserve from 2019-20. The percentage of degradation quadrupled from the previous year, mostly due to illegal logging but also because of other factors such as drought and wind falls.

Observers in Canada and the United States were not surprised by this population decline, as reduced numbers were seen during July 1st counts and the fall migration. Droughts and record high temperatures in July impacted reproduction, quality of milkweed plants and availability of nectar sources. One Monarch Waystation, situated on a cliff overlooking Lake Ontario in the Port of Newcastle – flourishing in August 2019 - was a darkened shell, with a few Bee Balm blooming.

Severe winter storms and record cold temperatures struck Texas and northern Mexico from Feb. 10–20, 2021. Nearly all above ground vegetation and insects died back. The size of the summer Monarch population in Canada is driven by the early reproductive success of Monarchs in Texas and the southern United States.

Still, even if Monarchs had been abundant in the northern breeding range, that is no guarantee of a high overwintering population, as the year 2019-20 taught us. The Monarchs here must still survive the migration to Mexico and wintering conditions there.

The 10-year high point was 2018/19, when the population covered 6.05 hectares, but the Monarch population can fluctuate considerably depending on habitat availability and weather conditions. Scientists have estimated that 6 hectares is the extinction threshold for Monarch survival in North America, and conservation efforts should be focused on reaching that number.

What are the predictions for 2021/22? Too early to tell. So far, eastern North America has been spared the abysmal drought conditions plaguing the western half of the continent. BUT....that could change.

Good News for People Who Rear Monarchs

Alan Macnaughton (amacnaughton@uwaterloo.ca)

Tenger-Trolander *et al*. (2019) suggested that Monarchs raised completely indoors, with no natural light, did not show a consistent pattern of flying south (toward their Mexican wintering grounds) when released. This was a troubling finding for many hobbyists who seek to augment the dwindling Monarch population by captive rearing – we all want our reared Monarchs to arrive in Mexico safely. Still, many hobbyists thought that this result would not apply to their activities because normal rearing in houses and apartments would involve at least some exposure to natural light. However, this escape hatch was eliminated by Tenger-Trolander and Kronfrost (2020), who showed that this result – no consistent pattern of southerly flight when released – was still obtained when Monarchs were exposed to natural light through a window during development.

Both Tenger-Trolander studies measured the direction of flight using a "flight simulator." This standard research technique involves inserting an L-shaped rod into the Monarch's thorax (avoiding flight muscle) and then gluing it into place. The Monarch then flies, attached to a tether, without going anywhere. The key point is that the Monarch could fly in any direction that it wished, and this direction was recorded for some minutes. The validity of this technique is supported by the fact that Monarchs caught in the wild late in the season in southern Ontario consistently fly southwards in the flight simulator.

As Wilcox *et al*. (2021) notes, the difficulty with this flight simulator approach is that it does not consider the possibility that Monarchs may "learn" after they have been released. Would Monarchs released in the wild be able to recalibrate their flight to the normal southern direction after exposure to natural skylight over a period of days? Past research showed that the sun's position in the sky may act as a cue for the Monarch's direction of migratory flight. This cue is perceived through the Monarch's eyes and through a light-sensitive molecular clock in their antennae. These two pieces of information are then integrated in the Monarch's brain. Thus, disruption of these mechanisms by restricting natural light could result in disoriented flight.

Wilcox *et al*. test this hypothesis by attaching small radio transmitters to the released Monarchs so they could be tracked through radio towers. The tags weigh 0.2 grams, and large Monarchs (the only ones used in this study) weigh over 0.3 grams, so the tag could increase the Monarch's body weight by as much as two-thirds (0.2/0.3). Each radio transmitter emitted a unique pulse about every 5 seconds for an average of four days (until the battery gives out). A network of 100 Motus radio towers across southern Ontario and the northern US track the Monarchs' progress. However, because the signal could only be received at 3 kilometres or less from each radio tower, only about 40% of the Monarchs released were detected in this way outside the area of release. These detections ranged from 12 kilometres to 200 kilometres from the release sites of Guelph and Cambridge, Ontario. Only the first such detection was considered in assessing the direction of flight.

The findings of this study were clear: 97% (28 of the 29 Monarchs detected) flew between due south and southeast (see infographic). In short, Monarchs learn, and indoor rearing does not cause a problem. This learning appears to take from 24-48 hours from the time of release.

One concern with the validity of the study is that the researchers did not have a control group – that is, they did not capture wild Monarchs and confirm that their direction of flight, as assessed by this radio-tracking method, was also south to southeast. However, a radio-tracking study which used Monarchs caught in the Bruce Peninsula showed that Monarchs oriented southeast prior to crossing Lake Erie. And, of course, decades of Monarch tagging show that Monarchs fly south from Ontario in the late summer and fall.

Another issue that might be raised is whether the Wilcox *et al*. study differed in some other way from the two Tenger-Trolander studies, and it was this factor that caused the different findings about the direction of flight. To avoid this source of error, Wilcox *et al*. replicated the flight simulator test with a group of their Monarchs and found the same result: Monarchs tested using the flight simulator did not show any consistent direction of flight. Unfortunately, it was not possible to do both flight simulator testing and radio tracking work on the same Monarchs because of the invasive nature of the flight simulator test.

One interesting "loose end" from these studies is why the Monarchs needed to learn. In particular, the second Tenger-Trolander study provided some natural light from a window as the Monarch were in the pre-adult life stages. Why wasn't this enough? Wilcox *et al*. note that previous research has shown that Monarchs need exposure to ultraviolet light to develop proper directional orientation. Sunlight through a window might not provide this, because ultraviolet light is fully or partially blocked by glass. Try getting a suntan from inside your house or apartment!

Wilcox *et al*. conclude with an endorsement of the work of Monarch hobbyists: "…[T]he popular activity of rearing Monarch butterflies from caterpillars in captivity could still be a viable conservation tool and important education element to conserve both Monarch and other butterfly species, at least under the context of certain rearing conditions that were followed in this study."

See infographic of the Wilcox *et al*. study on the back cover of the issue.

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- Tenger-Trolander, A. *et al*. 2020. "Migration Behavior of Commercial Monarchs Reared Outdoors and Wild-derived Monarchs Reared Indoors" 287 Proceedings of the Royal Society B.
- Wilcox, Alana A. E. *et al*. 2021. "Captive-reared Migratory Monarch Butterflies Show Natural Orientation When Released in the Wild" 9 Conservation Physiology, forthcoming. Available at https://academic.oup.com/conphys/article/9/1/coab032/6274228

Monarch Actions Now

Your reports and observations for all life stages of Monarchs to the Ontario Butterfly Atlas and eButterfly will be particularly important in assessing the status of the Monarch population in Ontario this year. With extensive virtual school learning across North America this year, consider your "first sightings" to Journey North.

Monarch Butterfly Fund (MBF), a U.S. based non-profit organization that is chaired by Don Davis, will again be funding reforestation projects in the Monarch Reserve, and workshops to benefit local communities. These workshops will include building high efficiency wood stoves and water cisterns, and sustainable farming and forestry practices. MBF is financing a searchable database of Monarch related scientific papers and articles, in English and Spanish, for use by academics and others: https://redmonarca.org/en/documentation-center/.

MBF held a highly successful webinar entitled "Monarchs in Mexico, People Care!" on January 27 2021, later posting a link to YouTube and a fact sheet based on questions posed by the 300 participants. See: https://monarchconservation.org/webinars/

Presqu'ile Tagged Monarchs Recovered in Mexico

Monarch Watch has updated the Monarch tag recovery database for Central Mexico. About 670 tags were purchased in Spring 2021 by a Monarch Watch representative, who visited some of the Mexican communities where Monarchs winter. Needless to say, the COVID-19 pandemic made this work more challenging! A separate database compiles "domestic" recoveries (observed in Canada, U.S.A., and northern Mexico en route to Mexico). Scroll down to examine these databases: https://monarchwatch.org/tagging/

For Presqu'ile Provincial Park, a wild male released on Sept. 5, 2020 was recovered, and a wild female, released on Sept. 1, 2019 during the 34th Monarchs and Migrants Weekend, was also purchased – both at the El Rosario sanctuary. The direct distance from Presqu'ile to El Rosario is about 3,429 km. Locals are paid 50 pesos (about $3.20 Canadian) for each tag turned in. Poverty abounds in the region, and this sum represents a significant addition to household income.

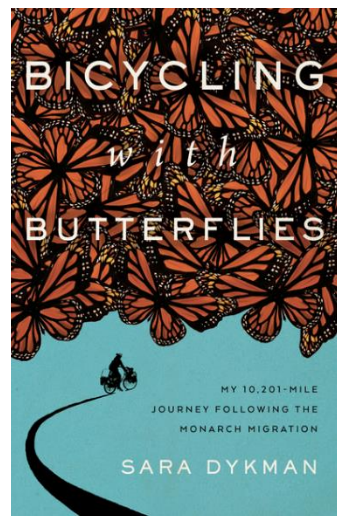
Over the past 20 years, Don Davis has had Monarchs recovered in Mexico every year except for two. His best year was 2001, in which 43 were recovered (of 2,056 tagged). Tags purchased in any given year are often from Monarchs recovered in a previous year because for some Mexicans a year or two can pass between meetings with the Monarch Watch representative.

The Monarch Watch program was founded in 1992 by Dr. Orley "Chip" Taylor. Tagging kits are ordered from https://shop.monarchwatch.org/. The per-tag cost is lower if you purchase a large number of tags. "Citizen Science" projects contribute important data which can be analyzed and studied by scientists. Many young people have developed an interest in nature and the environment through their participation in Monarch tagging and conservation-related activities.

While the tagging method is very easy to learn, one is required under Ontario Fish and Wildlife Conservation Act to apply for a Wildlife Scientific Collector's Authorization permit, and to submit a detailed report on activities to MNRF at the end of each tagging season. This link describes laws pertaining to Monarchs and other invertebrates: https://www.ontarioinsects.org/laws/

TEA members can request to have their name added to our group permit, covering both monarch rearing and tagging. Your name and the data you are required to compile will be later submitted to MNRF. See: https://www.ontarioinsects.org/permit/.

Newly Released Book: Bicycling with Butterflies (2021) by Sara Dykman



Don Davis met Sara Dykman on August 14, 2017, during the return leg of her 10,000-mile cycling trek to follow migrating Monarchs, from their Mexican wintering sanctuaries, to Canada, and back again. Sara was guest speaker at Greenway Blooming Centre in Breslau. This confident, informed, and energetic lady was traveling alone, spending the nights sleeping behind trees on roadsides in her tent, preparing daily meals, cycling on her "Frankenstein bike made from a collection of used parts", with a 70-pound load of supplies.

Don has kept in touch, and was delighted to receive a copy of her new book on the morning of its release. During a virtual book launch with Chip Taylor, Sara stressed how warmly she was received in southern Ontario, with many offering her meals, accommodation and support.

Sara Dykman has often reinvented herself, working as an amphibian research, in outdoor education, and going on long adventures. She created beyondabook.org to connect students to her adventures in order to foster lifelong learners, boundary pushers, explorers, and stewards.

In the book, Sara recounts this remarkable 9-month trip with excitement and humor, through three countries and two languages, cycling on uncharted roads, giving presentations to school children, dealing with border officials and others, all the while scanning for Monarchs, eggs and caterpillars. Sara regularly posted on her blog (when she had access to wi-fi), created drawings along the way. Oh yes…the hazards! By mile 4851 on July 12th, 3 flat tires. Sara shares with us her observations on humanity and her love of nature. Definitely worth reading.

"An extraordinary story in which Dykman seamlessly weaves together science, a real love of nature and the adventure and hazards of biking with butterflies from Mexico to Canada and back. They share an epic journey and encounter hardships, but they do not give up…" —Dr. Jane Goodall, DBE, Founder of the Jane Goodall Institute & U.N. Messenger of Peace

April 14, 2021 - Article published in Smithsonian Magazine: https://tinyurl.com/yj8z78f8
April 23, 2021 – Virtual interview with Sara about her book: https://tinyurl.com/yjaepb4a

TEA Meeting Summaries

By Albert Tomchyshyn (albert.tomchyshyn@gmail.com)

Videos of the January and March talks are available (www.ontarioinsects.org/meetings). Oops, we forgot to press record for the February talk, but the speaker's slides are posted.

Saturday, January 23, 2021. 1:15 pm on Zoom (video posted online)
PROJECT SWALLOWTAIL
Clement Kent, York University

For the past few years there has been a global decrease in insect pollinator populations. These declines are largely attributed to the current 'Climate Crisis', pesticide use and climate change that alters and exacerbates the loss of habitats required by these pollinator species. To combat this, several initiatives to preserve, restore and create habitats while encouraging pollinator diversity have been proposed. These strategies include connecting existing green spaces within the urban environment by planting ecosystem corridors and creating gardens with host plant species that can handle warmer climate conditions while supporting existing pollinator populations and pollinator diversity.

In response, Clement Kent gained permission from the City of Toronto to plant Kathy's Garden in Stanley Park. The garden is the first of many gardens that Clement hopes to create and connect into a habitat corridor throughout the city of Toronto. Currently Kathy's Garden provides several flowering plant species that are available from early spring to late summer and supports several of the local insect pollinator species and hummingbirds through the year. Since the garden was planted, the diversity of insect pollinators (mainly *Bombus* spp.) seen in Stanley Park has increased and the project caught the attention of several groups including the Canadian branch of the World Wildlife Fund and the David Suzuki Foundation. These groups have similar goals to preserve and improve insect pollinator populations by providing corridors that connect the greenspaces and natural habitats throughout the Toronto area. Hence, they reached out to Clement to start a collaborative initiative know as Project Swallowtail.

The goal of Project Swallowtail is to encourage overall pollinator diversity within Ontario by creating habitat corridors and pollinator gardens that focus on providing habitat for several Swallowtail butterfly species. This is to be achieved by encouraging gardeners to plant several southern swallowtail host plant species and flowers that are fire and drought resistant. These plants include the Pawpaw tree to encourage the Zebra Swallowtail (*Eurytides marcellus*) to become more common within Ontario and Hoptrees that support Giant Swallowtail (*Papilio cresphontes*) populations. Currently the Project has several Block Ambassadors who encourage their neighbours to plant gardens that support Swallowtails. However, the Project hopes to expand during 2021 to teach gardeners how to identify pollinators, post their observations on iNaturalist, provide pamphlets on the different plants and their insects, and get people involved as Seed Stewards to grow and provide the plants required for the gardens. In 2022, the Project is hoping to move beyond swallowtail species and provide other host plants like New Jersey Tea to support the Mottled Duskywing (*Erynnis martialis*) and Wild Senna to support the Cloudless Sulphur (*Pheobis sennae*).

Photo credit: Charlotte Teat

Saturday, February 27, 2021. 1:15 pm on Zoom (slides posted online)

A HODGEPODGE OF HYMENOPTERA: CHECKLISTS OF NORTHERN NORTH AMERICA, ICHNEUMONID NATURAL HISTORY AND A REVIEW OF THE AQUATIC WASPS OF THE WORLD

Andrew Bennett, Canadian National Collection of Insects, Arachnids and Nematodes

The speaker touched upon four separate topics in his talk: the rapid expansion of the number of species of various insect orders recorded in Canada; the new checklist of the Hymenoptera (sawflies, wasps, bees and ants) of Canada, Alaska and Greenland; the diversity and natural history of ichneumonid wasps; and the aquatic wasps of the world.

Species Numbers

In the 22 years since the book Canada and its Insect Fauna (H. V. Danks, Biological Survey of Canada, 1979) was published, the expansion in the number of described species recorded in Canada has been rapid: 34% in Lepidoptera, but even more in two other orders: 66% in Diptera (flies) and 71% in Hymenoptera. Part of this is due to better records of the Canadian fauna, and part is due to new species being described.

One measure of the potential number of species is the number of Barcode Index Numbers (BINs) – which, roughly speaking, is the number of biological units with significantly different DNA profiles. The number of BINs recorded in Canada is, for Hymenoptera, twice the number of recorded species. For Diptera this comparison is even more extreme: the number of BINs is triple the number of described species. Thus, the number of species of these two insect orders could expand greatly in the years to come. (Interestingly, a slide shown by the speaker indicates the number of BINs of Lepidoptera is less than 10% more than the number of species.)

The new checklist

A checklist of the Hymenoptera co-authored by the speaker is expected to be published this year. It is said to be similar in format to previous lists of the Lepidoptera (Pohl *et al*., 2018), Coleoptera (Bousquet *et al*., 2013) and Hemiptera (Maw *et al*., 2018). A slide showed that it provides species lists by province. (Update: as of May 1, three of the ten parts of the checklist are available without charge online in the Journal of Hymenoptera Research.)

Ichneumonid Wasps

There are a lot of species of ichneumonid wasps: they have the most species of any family of Hymenoptera, and they make up about 2% of all insect species. Almost all are parasitoids of insects and spiders. They may live on the exterior of the host, live inside the host, or may parasitize the larvae of other parasitoids. Most species that live on the exterior of the host hatch and immediately begin to feed (and kill) the host. On the other hand, most of the species that live inside the host hatch but do not continue development until later, typically at the prepupal stage (a mature larva which has finished its growth and will transform into the pupa without further feeding). Examples of ichmeumonid wasps (with their hosts shown in brackets) are *Trogus pennator* (swallowtail caterpillars), *Megarhyssa macrurus* and *M. atrata* (wood-boring sawfly larvae) and *Polysphinata* spp. (spiders).

Aquatic Wasps

We have little idea how many species are aquatic because the vast majority of described Hymenopteran species have no ecological or behavioural data. However, about 0.1% of Hymenoptera in the world are currently classified as aquatic.

Hymenopteran species can be classified as aquatic if there is “unequivocal evidence that they spend some of their life in water.” This evidence can be through direct observation or by phylogenetic inference. Direct observations can include seeing a female wasp entering water to oviposit her eggs, a newly enclosed adult leaving the water or finding parasitoid wasp larvae inside aquatic hosts. Phylogenetic inference may be used to classify a species as aquatic if the species has unknown biology but belongs to a genus whose known host range is entirely aquatic (and the genus is a demonstrated monophyletic group).

Examples of aquatic wasps include *Eustochus cinctus* (egg parasitoid of diving beetles), *Tiphodytes gerriphagus* (egg parasitoid of water striders), *Agriotypus chaoi* (parasitoid of pupal caddisflies), and *Tanychela pilosa* (parasitoid of aquatic crambid moths). For this last species, the speaker played a YouTube video (www.youtube.com/watch?v=-vQj2cDPBJY) showing that the adults have special claws on the end of their tarsus to hold onto stream beds.

Saturday, April 24, 2021. 1:15 pm on Zoom (video posted online)

NATURAL HISTORY 2.0

Morgan Jackson, McGill University

Natural history has been historically viewed as a hobby rather than a natural science. In the past there were many expeditions and collection of specimens for pleasure and science. One of the more famous examples being the expeditions and collections of Charles Darwin. Today, the study of natural history is pretty much the same. However, with the introduction of cell phones and social media, these technological advancements have made it easier to discover and document new species and track species range expansions. This includes several sites and apps specifically meant to monitor species abundance and location, like iNaturalist, eButterfly, eTick, and BumbleBeeWatch and non-specialized sites like Facebook and Twitter.

With cell phones and social media, many new species have been discovered and documented. This includes a new species of honeydew plant and new funguses on millipedes. Most notably, pictures posted on Twitter led to the discovery of a new mite species in Japan. A photo of the species was originally posted on Twitter and taxonomic experts realized it was something new. After contacting the person who originally posted the image, they found the species on a dock. The species is now named *Ameronothrus twitter* due to its original posting on the social media site. Similarly, if the species is unique enough, a new species can be described by photographs when a specimen is difficult or impossible to collect. In the case of a new bee fly species found in South Africa, the insect flew away before it could be collected. However, the scientists observing the species did manage to take a photo and write a description of the species because it looked distinct compared to other closely related species.

While new species can be discovered using social media, apps like iNaturalist make it possible to track and monitor the ranges of known species. In 2017 Paula Oviedo Rojas, an undergraduate student discovered the European Fire Bug in her Toronto backyard and identified it on iNaturalist. The species was not recorded in Canada before and is part of a family, genus and super family that is novel to Canada. Since 2017, observations of the insect have been increasing within urban environments in the Toronto area and has been documented in Grimsby, Ontario. Recently the species is now spreading toward Hamilton and may be a concern to conservation efforts because it feeds on Mallows. While the effects are currently unknown, it is possible that the insect may feed on the endangered Swamp Rose-mallow that grows within the Hamilton area. Other non-native species that have been similarly discovered in Canada include the Box Tree Moth, which was originally posted on Facebook and subsequently observed on iNaturalist in 2018, and the discovery of Elm Zigzag Sawflies on the Island of Montreal. As more observations of these species become available on iNaturalist, it may become possible to monitor the spread of these species as well.

Currently, iNaturalist has 4.6 million observations and 103,000 observers in Canada with more people joining exponentially. While iNaturalist does provide identification for most classes, many of the new observations are insects. Of the entomological observations posted in Canada from 2019 to 2020, 47.9% were Lepidopteran (butterflies and moths) and many were Odonata (dragonflies and damselflies). Meanwhile, 51.4% of Canadian entomological observations have been given an identification by the community with most identifications being correct. In comparison to the Biological Survey of Canada’s collection from 1863 to 2021, observations from 2019 to 2020 on iNaturalist cover 55 of 57 insect orders, 660 of 1123 families and 9,801 of 44,103 species that are expected in Canada. Additionally, iNaturalist observations have discovered 5 new families for Canada that were not recorded within scientific literature. These families are: Cyphoderidae (spring tails with ant associations), Troguidae (a short-legged Daddy Longleg), Epipyropidae (parasitic Lepidopteran caterpillar that feeds on leaf hoppers), Amphientomidae (a bark louse), and Microheruridae (a spider).

While social media is helpful from a scientific viewpoint, it can also provide support for people who are bullied because of their interests in the field. A kindergartener, Sophia Spencer, was bullied because of her interest in insects but she was able to publish a children’s book titled “The Bug Girl”, because of support from social media. Dr. Morgan Jackson recommends this book for both boys and girls since it also provides several interesting facts about insects and can show children it is okay to like different things regardless if others approve of your interests. Additionally, Sophia Spencer’s story has triggered several movements including #BugsR4Girls to raise awareness and get more people involved in science and natural history.

The Endangered Mottled Duskywing: A Strategy for Recovery

Jessica Linton (jlinton@nrsi.on.ca)

A year ago it was announced that a research project was awarded $825,000 over five years in federal government funding to support Canadian populations of the Mottled Duskywing (*Erynnis martialis*). The idea was to use captive rearing to reintroduce this species to two locations in southwestern Ontario and possibly to also augment existing populations. This project, supported by the Natural Sciences and Engineering Research Council (NSERC), is led by researchers from the University of Guelph and Western University and is supported by a variety of other researchers and groups. This project is an outgrowth of previous work, beginning in 2017. This article reports on the project and the progress to date[1].

Photo credit: Jessica Linton

Background

The Mottled Duskywing is an endangered butterfly that in Canada is restricted to southwestern Ontario and southeastern Manitoba. It has been lost from the majority of historically occupied locations in Canada and is declining throughout North America due to habitat loss, habitat fragmentation, and poor management of habitat. Most locations where Mottled Duskywing currently occur in Ontario and possibly Manitoba are geographically isolated and appear to have extremely small population sizes.

This species is associated with some of the rarest ecosystems in Canada, such as oak savannas, oak and pine woodlands, tall grass prairies, and alvars with early successional habitat supporting its larval host plant (*Ceanothus* spp., of which the most well-known species is New Jersey Tea). Single-generation populations of Mottled Duskywing lay eggs in May and June, overwinter as mature larvae, then become pupa in the early spring before transforming into adults.

The largest and most numerous populations of Mottled Duskywing occur in the Rice Lake Plains area. In this area, the research team is working with Nature Conservancy of Canada and the Alderville Black Oak Savanna and Tallgrass Prairie. The traditional and continued management of this area by First Nations, NCC and the Rice Lake Plains Partnership has created, protected, and enhanced high quality, early successional habitat for Mottled Duskywing.

There are also small populations of Mottled Duskywing in the Halton area which are geographically isolated and threatened by urban environmental pressures and gypsy moth insecticide control. Pinery Provincial Park was occupied by Mottled Duskywing until the early 1990s. Several factors likely contributed to the loss of this species, including fire suppression and extensive deer browsing of larval food plants. Today, the park has dramatically improved the quality of the oak savanna habitat through prescribed burning, invasive species control, and deer management.

In 2018, the Nature Conservancy of Canada (NCC) began to research, restore, and manage land in Norfolk County, ON for the purpose of improving habitat for butterfly species at risk, including the Mottled Duskywing. One of these properties has been identified as particularly suitable for this species. Although this property is not known to have been occupied by the Mottled Duskywing, habitats near it have been so occupied. A prescribed burn was carried out in 2019 and large quantities of larval host plant for the Mottled Duskywing was seeded.

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[1] For further information, see Jessica's hour-long presentation to the Hamilton Naturalists Club in May 2020, "Protection and Recovery of the Mottled Duskywing in Ontario," (https://hamiltonnature.org/protection-and-recovery-of-the-mottled-duskywing-in-ontario/).

Governments have become interested in preservation of the Mottled Duskywing. A federal status report and a provincial recovery strategy have been prepared. The Ontario Butterfly Species at Risk Recovery Team was created in 2017, and it serves as the vehicle for collaboration among a number of groups interested in this species. Its website (www.onbutterflysar.com) should be going live in the next few weeks.

The research project described below involves principal investigator Prof. Ryan Norris of the University of Guelph, co-applicant Prof. Nusha Keyghobadi of Western University, collaborator Prof. Richard Westwood of the University of Winnipeg, and their respective research labs and graduate students. Also involved are cost-sharing partner organizations (NCC and Wildlife Preservation Canada) and other partner organizations (Cambridge Butterfly Conservatory, Alderville Black Oak Savanna, Ontario Parks and my employer, Natural Resource Solutions Inc.). My role in the project is to act as Project Manager. The Weston Foundation and Lambton Wildlife Inc. also made generous contributions to this grant.

<u>Rearing and Releases</u>
In 2018, the Cambridge Butterfly Conservatory carried out captive rearing trials using the Wild Indigo Duskywing (*E. baptisiae*) -- a closely related but more common species. In 2019 and 2020, 12 female Mottled Duskywings were successfully translocated from wild populations in the Rice Lake Plains area to the Cambridge Butterfly Conservatory. Over 1,800 eggs were laid, resulting in the first data on life-history parameters, such as oviposition rates, and survivorship of juveniles and adults. In 2019 and 2020, this captively reared stock was released back to the collection site.

The first re-introduction is to occur at the Pinery in July 2021, with the first controlled release of captive-reared adult butterflies. This site is the first priority because this site is fully ready now for the re-introduction. A comprehensive four year monitoring program coordinated by Wildlife Preservation Canada will examine: 1) dispersal and habitat colonization, 2) overwintering survival, 3) oviposition and larval development, 4) habitat use/associations, and 5) mating activity. Continued releases for up to three more years (2022-2024) are anticipated. A sample of individuals will also be genotyped to monitor genetic diversity to identify any potential issues with erosion of diversity or inbreeding. The success of the project will inform the approach for each year of the project and for future reintroductions.

A second introduction is to take place in 2023 to the above-noted NCC property in Norfolk County. Results from the reintroduction and associated monitoring program at Pinery Provincial Park will inform actions at this site. Releases may occur for up to three more years (2024-2026). A four year monitoring program will also be developed and implemented based on the program implemented at Pinery.

Population augmentation is another strategy which is being considered, since most locations where Mottled Duskywing currently occur in Ontario and possibly Manitoba appear to have extremely small population sizes. Data collection on site-specific populations and habitats will determine if these sites should be considered for augmentation using captively rearing butterflies. This aspect of the project will include collaborative efforts with land managers responsible for managing extant subpopulations and will be directly informed by other project activities such as research related to population demography and genetics.

<u>Other Research</u>
For the reintroductions and population augmentation to be successful, critical knowledge gaps must be filled in. This has three aspects:

- The distribution of the Mottled Duskywing in Manitoba is poorly understood. Small colonies have been observed in recent years and the population as a whole may currently be stable in southeastern Manitoba. However, several threats remain. Forestry mapping will be carried out to identify logged areas and roadside areas where larval foodplants may occur. Field surveys to map the current distribution of Mottled Duskywing, model available habitat, and identify site-specific threats is being undertaken by Dr. Richard Westwood.
- Experiments will also be carried out around Pinery PP to determine host plant responses to different land management treatments. Various 20 x 20 metre plots will be treated with either: prescribed fire or mowing/manual removal shrubs, and either assisted or natural seed dispersal (n = 6 replicates/treatment). These results will be used to inform habitat management activities throughout the species range.

- The genetic structure and diversity of the species must be addressed. The project will: 1) develop genetic markers for Mottled Duskywing, 2) complete genetic sampling of the species throughout its range in Ontario and Manitoba, and 3) assess genetic structure and diversity, including determining effective population size and gene flow. Also, since naturally-occurring bacteria are common parasites in lepidoptera that can interfere with reproduction, the captive rearing component of the project will include screening for the presence of Wolbachia and other bacterial endosymbionts.

Project Outputs

In addition to the goal of recovery and maintenance of self-sustaining populations of the Mottled Duskywing, the project should have several other outputs: scientific publications; dissemination of information to the public by project partners and the Toronto Zoo; a full-length documentary by Pinegrove Productions (www.pinegroveproductions.ca) about the reintroduction to Pinery PP and the recovery team; and continued work by academic participants and project partners on the Mottled Duskywing and other species at risk.
Future projects may consider re-introduction to other oak-savanna butterflies that are now extirpated in Ontario: the Frosted Elfin (*Callophrys irus*) and the Karner Blue (*Plebejus melissa samuelis*). Research has shown that the Frosted Elfin would be easier to reintroduce as it requires a smaller amount of wild lupine (the larval foodplant of both species).

The Butterfly Proboscis – More than a Drinking Straw

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A stream of research papers in the last ten years has generated new insights into how the butterfly proboscis functions.

When a butterfly first emerges from its chrysalis, its proboscis is actually in two parts, which are then fused ("zippered" together) forming a hollow tube. The proboscis actually consists of two C-shaped fibres held together by tiny hooks to form the central tube.

Early research suggested that the proboscis functioned like a drinking straw. A sucking pump, located within the butterfly's head, would draw liquids and small particles from pools contained in flowers up the proboscis and into the gut. However, the drinking-straw model did not adequately explain how the proboscis functions when the butterfly drinks from wet soil or rotting fruit. New research indicates that butterflies actually rely on "capillary action" – a process by which water can flow through very small channels on its own, even against the force of gravity, through the "sticking force" between water molecules caused by hydrogen bonding.

The proboscis is now thought to be a porous straw that acts like a sponge. Tiny pores along the length of the proboscis absorb microdroplets from a substance using capillary action. By flexing its proboscis, a butterfly can alter the terminal opening of the tube as well as the flow of fluid. A muscular pump in its head then pulls the liquid from the tube into its gut.

If you have watched a butterfly using its proboscis while perched on damp mud or fresh animal droppings, called "puddling", you may have assumed that it was sipping up some invisible liquid. The butterfly is actually using saliva from tiny pores in the proboscis to dissolve the sugars, salts and/or minerals in the mud or animal dropping, and capillary action to return them to the tube.

Fossil records suggest that the first moths appeared before flowering plants. Some researchers hypothesize that the early stubby proboscis was originally used to suck up tiny amounts of sap (which the plants used to trap pollen). However, over millions of years, the diverse flowering structures put evolutionary pressure on moths to specialize by developing an intricate proboscis that is both capable of reaching nectar hidden in elongated blossoms and extracting minerals from mud.

Researchers have also discovered that the proboscis of each species is fine-tuned to the main food source. For example, a Question Mark, which feeds on tree sap, has a proboscis tip that is mop-shaped. The Monarch, which feeds on flower nectar, has a smooth proboscis.

References (all articles are available for free online):

Jarreau, Paige. 2013. "What Butterflies have in Common with Straws" North Carolina Museum of Nature website.

Kwauk, Karena J. *et al*. 2014. "Drinking with an Unsealed Tube: Fluid Uptake Along the Butterfly Proboscis" Annals of the Entomological Society of America 107(4): 886-892.

Moraenkova, Daria *et al*. 2011. "Butterfly Proboscis: Combining a Drinking Straw with a Nanosponge Facilitated Diversification of Feeding Habits" Journal of The Royal Society Interface 9, 720-726.

Are Butterfly Hybrids Just Not Fit for Survival?

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A species is often defined as the largest group of organisms in which any two individuals of the appropriate sex produce fertile offspring. By this definition, progeny, called "hybrids", of two species are not fertile and should not survive. This is true in the case of hybrids between the Red-Spotted Purple and the Viceroy (the rubidus form): although the male is fertile, the female is not.

An interesting question about hybrids is whether they are also less fit for survival in ways other than reproductive ability. This is a difficult question to investigate from field observation because hybrids are generally rare. However, rubidus hybrids are common enough in museum collections that it was possible to do a study of their proboscises.

In the study by Kramer *et al*., the authors compared 17 rubidus hybrids to 19 Red-Spotted Purples and 18 Viceroys. The hybrids, both male and female, had proboscises with a different architecture than their parents. Although the authors made no conclusions about fitness for survival of the males, they concluded that the females were less fit in three ways than their parents.

1. Hybrid females had shorter proboscises. This could cause a fitness problem in that visual clues might draw them to the flower species and other food sources that are attractive to the parental types but, from which, they might not be able to feed.
2. Hybrid females had thinner proboscises. This could provide less room for musculature and result in a proboscis with less coordination for probing surfaces while feeding.
3. Hybrid females had shorter sensilla (sensory receptors). This could adversely impact the acquisition of fluids from wet soil or fruit through capillary action (see the previous article for a discussion of this mechanism).

Female rubidus hybrids have not been observed in the wild but can be produced by hand-pairing, which would appear to be the source of the specimens used in the study. The proboscis issues noted above may be the reason why no wild specimens have been seen.

Interestingly, male rubidus hybrids, in a process called "backcrossing", can be bred with either parental form. The study did not examine the fitness of the second-level hybrids, rubidus X Viceroy and rubidus X Red-Spotted Purple.

Incidentally, this study provides good evidence of the need for pinned specimens. One couldn't do this kind of study from photographs!

The study is available for free online. The reference is: Kramer, Valerie R. *et al*. 2018. "Proboscis Morphology Suggests Reduced Feeding Abilities of Hybrid Limenitis Butterflies (Lepidoptera: Nymphalidae)" Biological Journal of the Linnean Society 125: 535-546.

Lives Lived: In Memoriam

Barry Harrison – by Bob Yukich

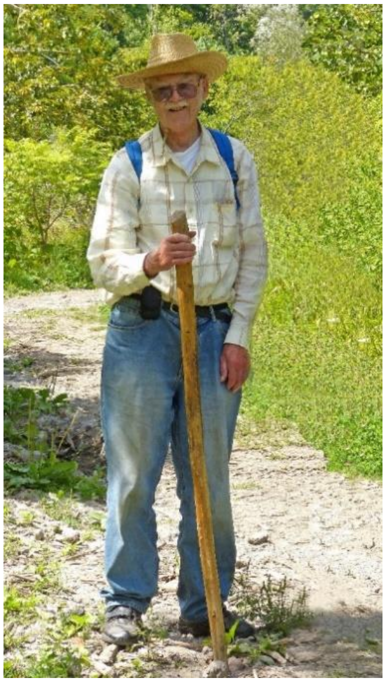
Barry passed away in January 2020 at the age of 83. He first became interested in the natural world when he was a teenager, watching birds and later painting them in watercolours. But it wasn't until he was in his 30s that he turned to butterflies, which eventually became his main passion in life. Barry also had an interest in moths, often spending time in the field with his friend, the late Jim Spottiswood.

After joining the TEA in the 1970s, Barry began putting together a checklist of the butterflies of the Toronto region. He used bar graphs to indicate butterfly abundance throughout the seasons, and also included historical records and subspecies. He used his own records as well as those gleaned from other TEA members such as the late Bill Edmonds who had contributed much to the information on butterflies of the Toronto region. This became "The Butterflies of the Toronto Region: 140 Years of History," published by the TEA. He occasionally updated the list, with the latest version appearing in 2007. Barry had a detailed knowledge of what butterflies occurred, or had occurred, in the Toronto area, more than anyone else I know.

Barry also wrote the section on the "butterfly year" for the "Butterflies of Toronto," published by the City of Toronto in 2011 as part of the Biodiversity Booklet series. The species list in that publication was based on Barry's Toronto Region checklist.

I met Barry in 1998 after he discovered the first Wild Indigo Duskywing for Toronto at Sylvan Park in Scarborough – we confirmed a colony there a week later. This was quite a surprise as the species was mainly known only from the Windsor area at that time. In 1987, at the base of Leslie St. Spit, Barry had discovered the first and only Orange-barred Sulphur ever reported for Toronto. Later in 2001, along the lakefront at Scarborough Bluffs, he discovered what may have been the only colony of Checkered Whites ever reported for Toronto – that year they bred at several locations along the Toronto waterfront.

Barry and I also spent much time at the ROM poring over butterfly specimens from the Toronto area, always looking for new additions for our area as well as confirming old records.



Later in life, as his health declined, Barry stayed closer to home. He often visited nearby locations such as Bellamy Ravine along the Scarborough Bluffs. He also spent time watching butterflies attracted to his garden where at various times he saw such rarities as Pipevine Swallowtail, Ocola Skipper and Funereal Duskywing. During the butterfly season we kept in close touch by phone, sharing our butterfly sightings, especially the unusual ones. Since Barry did not use a computer and had restricted mobility in recent years, I would keep him posted on significant sightings of butterflies in the province. Barry truly loved butterflies, and we both shared this passion.

I last saw Barry in September 2019 when my wife Karen and I took him to Vaughan to see European Common Blues. We were successful in finding several, and Barry was thrilled. It is fitting that in his last butterfly season he got to see a species he had never seen before in Ontario.

John Powers update – by Alan Macnaughton

The June 2020 issue carried a note on John Powers, a TEA member from Cambridge who was the driving force behind the establishment of what is now the Cambridge Butterfly Conservatory. When John died in 2019, he left behind about 90 display cabinets, most of which he had used in his displays in shopping malls across Ontario for different pest control companies (the "Flying Jewels" display, and others). In the attached picture, one of these cabinets is being held by Heather Gorman of the Niagara Butterfly Conservatory beside a Niagara Parks truck. Heather arrived on September 30 to pick up all of these cabinets – a donation from John's family. When the pandemic is over, look for them in the Conservatory's new auditorium.

Tony Holmes update – by Alan Macnaughton

Anthony (Tony) Holmes, one of the earliest members of the TEA and one of four co-authors of the TEA's pioneering 1991 book "The Ontario Butterfly Atlas," died in February 2019. The April 2019 issue carried a write-up about his life, co-authored with his son and TEA member Mark Holmes.

Tony has now left a generous $5,000 gift through his estate for the Glenn Richardson Research Grant program. Traditionally we present one $800 award, but Tony's gift has allowed us to expand to two awards for 2021 (see separate note for the winners in the announcements section). We expect to continue this for subsequent years as well. Thanks are due to Mark and his sister Melissa for making the arrangements for this gift. Glenn Richardson's brother Craig wrote to me: "My Mom and I are very happy to see the scholarship continue and even expand."

Book Reviews

David C. Lees and Alberto Zilli (2020). Moths: A Complete Guide to Biology and Behavior. Smithsonian Books, Washington, DC. 208 pages. About $27.

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This book is a wonderful read for the many people who want to understand moth biology and behaviour. The authors, curators of Lepidoptera at the Natural History Museum in London, England, discuss the latest research in an easy-to-understand manner and illustrate the text with numerous striking colour photos of living moths – one or two appear on most pages. Overall, the key message is that moths are extremely diverse in their biology and behavior, in comparison to butterflies. The species mentioned are from around the world, but especially from the U.K. Almost none are found in Ontario.

The book begins with asking a deceptively simple question: what is a moth? The answer from systematics research is that a moth is a non-butterfly, scaly-winged insect. Whereas, butterflies belong to one superfamily, the Papilionoidea, all other lepidopterans – 41 superfamilies in all – are moths. In all, there are seven families of butterflies (Hesperiidae, Hedylidae, Nymphalidae, etc.), versus 129 families of moths. In fact, moths make up at least 90% of all species of leps. In Ontario, this figure is even higher, about 95% (based on the number of species included in the TEA's atlas of butterflies and checklist of moths).

If moths are non-butterfly leps, then what is a butterfly? The book does not dwell on this, beyond noting two interesting facts: (1) skippers were not always considered to be butterflies, which is why, books were issued with titles like "The Butterflies and Skippers of Area X"; and (2) butterflies are now believed to include a mostly night-flying family from Central and South America, the Hedylidae.

After defining the term "moth", the book discusses moth anatomy. Although some parts are tough going because of all of the terminology to learn, there are lots of interesting facts. Perhaps the strangest is that for a few moth species the eggs develop within the female's body and hatch either within her abdomen or soon after being laid ("ovo-viviparity").

This chapter also provides an exceptionally thorough description of the various theories as to why some moths are attracted to light. However, the best summary of the state of the art in this area is not in the book but in an interview with one of the authors: "the most popular theory is that they're simply disorientated…they actually would normally navigate to a moon or stars or a distant light source, keeping the same angle to the light. And with our artificial, very bright, light sources, they are fooled and they keep turning inwards towards the light. And they just don't seem to be able to escape very easily[2]."

The next chapter concerns metamorphosis and life stages. One insight is that some moths have long periods of pupal dormancy before emergence: for example, periods of up to nine years have been observed in sphingids, saturniids, notodontids and zygaenids. Under artificial conditions, one species of yucca moth has been observed to have emerged after 16 to 30 years of diapause.

The chapter on feeding strategies of caterpillars and adults will perhaps be of the widest interest. The diversity documented here is astonishing. For example, some species of flightless bagworm moths lay their eggs in the pupal case. The larvae devour the motionless mother soon after hatching. The thinking is that this energy-rich meal boosts the offspring's chance of survival. Also, vampire moths really exist: in the genus Calyptra, ten species are capable of piercing the skin of mammals to feed on the blood, and three species can feed on humans. Hooks and barbs in the proboscis assist in this process. In Madagascar, one species has been observed drinking tears from the eyes of sleeping mammals.

The chapter on mating was the most interesting to me. I knew that many female silkmoths (such as our cecropia moth) stay in one place and release a pheromone to "call" wild males through the males' highly-developed sense of smell. I also knew that the pheromones of many pest species (e.g., the Gypsy Moth) have been isolated and may be

[2] Science Friday, https://www.sciencefriday.com/segments/moth-appreciation/#segment-transcript

used in determining where and when to spray insecticides. But what I did not know is that this pheromone-based calling system is "usual" for moths. Visual interaction for the purpose of mating, which is the norm for butterflies, seems to be confined to day-flying and dawn/dusk flying species of moths.
Although the book does not discuss this issue, I wonder whether moth observers of the future will use pheromone traps rather than light traps. Currently, pheromone baits are available and widely used to attract Sessiidae. Much more research is required to identify the pheromones for most species, and even where the pheromone is known, it is not commercially available. Perhaps someday, we can look forward to attracting Luna Moths in this way now that the pheromone is known[3].

The chapter on "moth warfare" will also be of wide interest. Various methods are discussed including camouflage, eyespots to misdirect predators' attacks, startle displays (e.g., Catocala), toxicity and mimicry (Monarch-analogues), parasites, and bat sonar and moth responses using acoustic defenses.

A sidebar in this chapter discusses variability of wing patterns (a type of polymorphism). An extreme case is the Tufted Button (*Acleris cristana*), a species found in the UK that is so variable -- having 116 separate forms -- that researchers thought they were separate species (and made a species description) 37 times. So why might wing patterns be so variable in moths? (In my opinion, this is greater than that in butterflies.) One proposed reason is "apostatic selection" – moths that are common and good to eat may be preferentially selected by predators as "good snacks" unless they diversify their appearance by having multiple colour forms (or simply wide gradations of patterns). Another reason, not mentioned in the book, would appear to be mating: as noted above, mating in moths is largely based on pheromones rather than visual clues, so variability might not deter mating.

The chapter entitled "diversity and distribution" addresses many partially-understood questions in this area of research. For example, the tropics lead in diversity of species, but why are there at least 2,300 species of moths in Australia in a family where the larvae feed on dead leaf litter?

The chapter "evolution in action" includes a discussion of the well-known example of the Peppered Moth (*Biston betularia*). Its dark form became common during the Industrial Revolution in England when soot on tree trunks would have been common. Later, as air pollution declined, the dark form became less common. A sidebar in this chapter discusses methods of sampling moth diversity, such as light traps and sugaring.

The last chapter, "of moths and man," discusses such issues as clothes moths, moths that itch and sting, dining on moths, habitat fragmentation and endangered species.

Readers might at first be surprised to see that the list of references and sources is only one page. However, reading the fine print shows that an additional 34 pages of this material has been posted online as supplemental material[4].

Gunnar Brehm et al., "Moths are Strongly Attracted to Ultraviolet and Blue Radiation" (2021) Insect Conservation and Diversity 188-198. Available at https://onlinelibrary.wiley.com/journal/17524598

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The authors used a carefully-controlled indoor experiment to see which of several light sources attract the most individual moths. The authors covered the windows of a classroom and placed different light sources with associated funnel traps in each of the four corners. Moths were released in the centre of the room and then the number collected in each of the four funnel traps (alive), or in the direct vicinity, was recorded at the end of each night. The position of each lamp was randomly assigned for each round of experiments. LED lamps were used for all experiments. Over 6,100 individual moths of 92 species were released. Each moth was used in the experiments for an average of 5 nights, for a total of 32,000 moth/nights.

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[3] Millar, J.G., Haynes, K.F., Dossey, A.T. et al. Sex Attractant Pheromone of the Luna Moth, Actias luna (Linnaeus). Journal of Chemical Ecology 42, 869–876 (2016). Available at https://doi.org/10.1007/s10886-016-0751-6
[4] Look on the Natural History Museum's website (https://nhm.openrepository.com) under the UK title of the book (Moths: Their biology, diversity and evolution).

The Science

Experiments 1 and 2 were designed to compare lamps with approximately the same radiant flux (the power output of a light source). In Experiment 1, four lamps were compared: UV, blue, green and cool white. The results were clear: 84% of the moths attracted to any lamp went to the UV lamp. In Experiment 2, the UV lamp was replaced with a red lamp. With the UV lamp absent, moths now gravitated to the blue lamp (63%). However, there was a decline in the percentage of moths attracted to all lamps combined.

Experiment 3 was more complex in that the lamps differed in their radiant flux (light emission). The four lamps used were the UV lamp (as used in Experiment 1) and three versions of the LepiLED lamp (https://www.gunnarbrehm.de/en/lepi-led): Mini, Standard and Maxi. Of the moths attracted to any of the lamps, the three LepiLEDs attracted the following percentages: 31% (Maxi), 24% (Standard) and 16% (Mini). The remaining 28% of the moths went to the UV lamp. This pattern did not differ across moth families or sexes except that individuals of Sphingidae and Erebidae occurred preferentially at the lamp with the highest emission (the Maxi). For all experiments combined, most moths did not go to any of the lamps. There was some difference by sex, but it was not extreme: 12% of the males were attracted to a lamp, but only 9% of the females.

The most surprising finding may be the high attractiveness of blue light. Previously it had been thought that blue and green lights would be equally attractive. Most insects have been shown to have trichromatic vision, with peak receptor sensitivity in the UV, blue and green spectral range. (UV light is invisible to most humans, so what we see at a blacklight is the blue and purple light in the visible range emitted by these lamps.) However, since Experiment 1 shows that blue light is dominated by UV light when both are present, the results do not suggest that an observer use blue light to attract moths.

Implications for Moth Observing

First, experiment 3 shows that of the three LepiLEDs, the Maxi (13 watt) seems likely to produce better results than the Standard (8 watt) or the Mini (4 watt). However, the difference is only a doubling from Mini to Maxi (from 16% to 31% of total catch) – rather than, say, increasing by a factor of ten. Thus, one must balance the increase in attractiveness of higher-wattage LepiLEDs against the increased weight and cost of batteries required by the higher power draw[5].

On the other hand, the authors hypothesize that "a stronger lamp in the field could attract more insects from longer distances because the radiation reaches further into the surrounding space" (p. 195). This effect is described as "not (or hardly) detectable within the given spatial design of our experiment" -- presumably because all lamps were only about 7 metres away from the release point of the moths in the classroom. Thus, the benefit to moth observers of using the Maxi may be greater than shown in the experiment. In the email with which this article was sent to me, Brehm notes that: "further publications with results from the field and the design of traps will follow."

Second, experiment 3 shows that the performance of the UV lamp in attracting moths was almost as good as the LepiLED Maxi (28% vs. 31% share of total moths). The UV lamp was created especially for the experiment and is not directly available for purchase. However, there appears to be a workaround that achieves the same result. There is a fourth model of the LepiLED, the LepiLED Maxi Switch. It is the same as the LepiLED Maxi, but it also has a switch that will turn off the visible light. One would expect that when operated in this UV-only mode, it should produce the same moth-attracting results as the UV lamp used in experiment 3[6]. But – and this is the key point -- when operated in this UV-only mode, it has a power draw of only 6.5 watts. This is just half of that of the LepiLED Maxi.

[5] The relative price of the different lamps is not much of a factor – the highest-priced version of the LepiLED is only about 10% more expensive than the lowest-priced version. Of course, all LepiLEDs are expensive, costing at least $500 Canadian plus shipping costs.

[6] Figure E.4, panel (A) of the supplementary information (available on the website for the paper at the end of the paper's "full text" version) shows that the radiant flux below 390 nanometres (that is, in the UV spectrum) of the LepiLED Maxi is about 0. 58 watts, based on a visual inspection of the graph. It seems reasonable to predict that operating the LepiLED Maxi Switch in UV-only mode would produce the same 0.58 watts. This is higher than the similar figure for the UV lamp (0.39 watt). Thus, one can predict that operating the LepiLED Maxi Switch in UV-only mode should produce at least the 28% share of the moth catch observed in experiment 3.

Hence, for a person who likes the moth-attracting qualities of the LepiLED Maxi but is put off by its high power draw (and the consequent need for an expensive and heavy battery), purchasing the LepiLED Maxi Switch and operating it in the UV-only mode might be an attractive option. Of course, where power draw is not an issue, the Maxi Switch can also be run in full-spectrum mode (duplicating the output of the Maxi).

The above option would appear to make purchase of the LepiLED Standard a poor choice: is has a higher power draw (8 watts instead of 6.5 watts) and, based on experiment 3, it should have worse moth-attracting results (24% share of total moths instead of a predicted 28%)[7]. Still, it remains to be seen whether the promised future field research changes this finding.

The final implication of this research for moth observing stems from the finding that moths do not seem to take much notice of red light. Thus, for moths at a sheet or bait that are skittish with the use of a normal white-light flashlight, it might be worthwhile to use a red flashlight. A yellow or orange flashlight might have a similar property, based on the findings of other studies of moth behaviour towards light.

Black Witch Moths

All of us would love to see the Black Witch moth (*Ascalapha odorata* – see picture here and on the following pager), but some lucky people get that opportunity more than others. Of the 30 Ontario records on iNaturalist, Tom Preney has chalked up five, all from near Windsor. Tom reports: “I have been very lucky to find three and the other two were reported to Ojibway Nature Centre where I work. I've been at the nature centre for 20 years but it seems in the last few years we have been getting more and more reports of Black Witch in our area, perhaps a sign of climate change.”

Male Black Witch; taken August 13, 2019 by Tom Preney

The Black Witch Moth is one of the largest moths in North America, and is similar in size to our native Cecropia Moth. The occurrence of this species in Canada results from migrations originating in Mexico, Central America or the southern US. It can be attracted by either bait or lights, but some people just see it resting in the daytime on a wall or tree.

Andrew Minielly saw a large tropical migrant moth that is even stranger than the Black Witch Moth (see photo on the following page). He reports about his September 10, 2018 sighting in Kitchener: “A portion of the office building I work out of is lit up all night. While walking into work I usually take a look at the outside walls to see if the lights attracted anything interesting the night before. The *Thysania zenobia* [Owl Moth] caught my eye right away as it is one of the bigger moths I've ever seen.” He reports it to be 12 to 15 cm (about 5-6 inches). This is the only Canadian record of this species on iNaturalist (https://inaturalist.ca/observations/16408556).

[7] The LepiLED Mini version could still be attractive where battery power is limited, as the power draw is only 4 watts.

Female Black Witch; taken September 11, 2020 by Tom Preney

Owl Moth by Andrew Minielly

Abstracts – 2021 TEA Student Symposium

Videos of each of the eight talks are available online (www.ontarioinsects.org/meetings). Each talk is 10 minutes. Only the student who made the presentation is listed below, even though there may be co-authors.

Breeding program for *Varroa* mite resistance in Ontario honey bee populations

Alvaro De la Mora, School of Environmental Sciences, University of Guelph

The mite *Varroa destructor* is considered the main threat to honey bee health worldwide. In Canada, particularly in Ontario, *V. destructor* is responsible for the majority of overwinter colonies losses. *V. destructor* parasitizes larvae, pupae, and adult bees, feeding upon the haemolymph (blood) and fat body of its hosts, *V. destructor* also vectors and transmits viruses such as the deformed wing virus (DWV) reducing the lifespan of infested bees.

Most beekeepers control mite infestations using synthetic miticides, but the mites develop resistance to their active compounds, compromising their efficacy. Accordingly, it is necessary to have different control strategies. One way of reducing the impact of *V. destructor* parasitism is to breed *Varroa*-resistant strains of honey bees. If mite infestations are reduced through selective breeding, the damage caused by DWV may also be indirectly reduced.

In this project a breeding program is being implemented in Ontario to select for lower and higher rates of *V. destructor* population growth (LVG and HVG, respectively), monitoring infection rates of DWV. Collaborative institutions are the Ontario Queen Breeders Association, the Ontario Beekeepers Association, and the U of G Honey Bee Research Centre.

Preliminary results of this work show a six-fold difference in mite population growth between the LVG and HVG colonies. Additionally, DWV levels and winter colony mortality are significantly lower in LVG colonies than in HVG colonies. We will select additional generations of LVG and HVG colonies to analyze behavioural immunity and other parameters that could explain the divergence between the selected genotypes.

To pee or not to pee: how do female *Aedes aegypti* mosquitoes regulate anti-diuresis?

Farwa Sajadi, York University

Haematophagus insects, such as the female *Aedes aegypti* mosquito, face the challenge of excess ion and water intake after engorgement on a blood meal. To cope with this, adult female *A. aegypti* have a specialized excretory system that includes the Malpighian 'renal' tubules (MTs), which are under rigorous control by several neuroendocrine factors to regulate transepithelial movement of ions/water. Produced in the central nervous system, the mosquito anti-diuretic hormone is a member of the CAPA peptide family, which share homology to the vertebrate neuromedin U peptide. CAPA peptides inhibit fluid secretion of MTs stimulated by select diuretic factors, 5HT and DH_{31} through the NOS/cGMP/PKG pathway. However, the anti-diuretic signalling mechanism and downstream cellular targets remain unclear.

To investigate whether the V-type H^+-ATPase (VA) plays a role in CAPA inhibition, we performed fluid secretion assays in MTs treated with diuretics and bafilomycin, a known VA inhibitor. Bafilomycin significantly inhibited DH_{31}-stimulated fluid secretion while delayed responses were seen in 5HT-stimulated MTs. Alkalization of the secreted fluid in response to CAPA suggests inhibition of the proton pump, which may lead to constrained cation entry across the apical membrane of the MTs. Furthermore, adult female MTs treated with DH_{31} resulted in an increase of VA activity, while tubules incubated with both DH_{31} and CAPA had a lower VA activity resulting in activity levels comparable to saline control levels. Investigating the pathway of CAPA inhibition and its role in countering diuresis will help provide a deeper understanding of the critical process of diuresis and its signaling mechanism.

A revision of the genus *Scipopus*: Solving the *Scipopus* problem

Kate Lindsay, University of Guelph

Scipopus Enderlein is a large group of Neotropical flies often recognized by their orange heads and black bodies. Despite their seemingly conspicuously appearance, the genus lacks a proper generic definition and diagnosis. The goal of my research is to identify synapomorphies to define the genus and to differentiate *Scipopus* from the other three closely related genera in the *Scipopus* group: *Pseudeurybata* Hennig, *Phaeopterina* Frey and one undescribed genus.

Preliminary DNA barcode data shows these four genera as distinct clades. The *Scipopus* group, along with several other Micropezid genera are relatively easily separated on the species level but on the generic level show high occurrences of homoplasy and character overlap, making them an evolutionarily interesting group to study.

Evaluating methods used in Canadian bumble bee status assessments
Jocelyn Armistead, Brock University

Bumble bees (genus *Bombus*) play important roles in the pollination of plants, both wild and crop, and maintaining healthy ecosystems. Many insect populations have shown declining trends in abundance in recent years, including some of Canada's bumble bee species. To be considered for federal protection in Canada, status assessments outlining a species' level of risk must be completed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Six such bumble bee species have already been assessed. Set criteria must be met for a bumble bee species to be considered threatened, and determining this often requires assessing abundance and distribution.

There are a variety of different ways to collect and analyze bumble bee abundance and distribution; my project aims to evaluate these different methods for their strengths and weaknesses. Additionally, some newer collection methods, such as community science photographs, blue vane traps and yearly roadside surveys, may produce data that could be a valuable asset to these status assessments, and I intend to evaluate them as well. The ultimate goal will be to provide recommendations about which collection and analysis methods produce the most reliable data for Canadian bumble bee status assessments. These assessments play critical roles in ensuring species receive the protection they need, so it is essential that they are based on the most accurate data and analysis. By identifying the most accurate methods, my research will aid in helping to protect bumble bee species across Canada.

Farming fecund crickets: fruitful female fertility after feeding crickets royal jelly
Matt J. Muzzatti, Carleton University

Canada is experiencing a boom in entomophagy. With industry-leading Entomo Farms offering delicious and safe edible cricket products over the past decade, and the recent multi-million dollar grant awarded towards the development of Aspire Foods cricket production facility, Ontario has developed into a central-hub for farming crickets. A primary goal of agricultural research is to increase yield, and while increased body size in cricket farms is desired, we have little knowledge on how to do it at such a large scale. Diet supplementation using honey bee royal jelly is a potential solution, as there is evidence that royal jelly enhances body size of other insect species. The mechanisms behind how royal jelly does this remain unclear.

To determine the effect of royal jelly on a farmed cricket species, 96 *Gryllodes sigillatus* were individually housed, and split into two treatment groups: half were reared on a commercially available cricket diet, while the other half were reared on the same diet mixed with 15% w/w fresh royal jelly. Body size and mass measurements were taken weekly for six weeks (approximate time to adulthood). We discovered a female-only effect of royal jelly on *G. sigillatus*: females fed the royal jelly diet grew to be 21% heavier, and this effect was driven by significantly longer abdomens containing 66% more eggs each compared to those fed the basal diet.

Mushroom-associated insects: diversity and host preferences
Sydney Gram, Ecology & Evolutionary Biology, University of Toronto

Insects and fungi are two of the most diverse forms of life on Earth, and the fossil record suggests that insects have been using mushrooms for food and shelter for at least 400 million years. In temperate forests, many flies and beetles deposit their eggs in/on mushrooms, where their larvae will emerge into a nutritious food source and be relatively shielded from predators. However, the unpredictability of mushroom growth and the diverse physiochemical properties of fungi (e.g. toxicity and longevity) make the relationship between mushrooms and insects more unique and complicated than simple symbiosis or parasitism. Unfortunately, for many decades the study of these interactions has been hindered by the near-impossibility of identifying mushroom-associated insects in their egg or larval stages. As a result, mushroom-associated insects likely represent a large pool of undescribed insect species in Ontario.

This study is the first in North America to use DNA-based methods to identify insects collected from wild mushrooms. We find that flies tend to lay eggs in soft, ephemeral mushrooms, whereas beetles more often lay eggs in tough, decayed fungi. However, there is wide variation in mushroom preferences among species, and more extensive sampling is needed to better characterize these interactions. We also report numerous insect species not previously known to interact with fungi, and many species that have never been recorded in Ontario. Importantly, we note that while most beetles were able to be identified to the species level from DNA barcode sequences, reference databases for species-level identification of mushroom-associated flies are largely incomplete.

Why do caterpillars go "buzz"? Exploring the roles of vibratory communication in social *Drepana arcuata* larvae

Sara Khan, Carleton University

Larval stages of many insect species living in social groups must communicate for many contexts, including recruitment, shelter-building, and defense. However, the communication mechanisms used by social larvae have not been well studied. At present, there is little understanding about how and why social caterpillars communicate using vibrations.

My research explores the role of vibratory communication amongst social larvae of the moth species, *Drepana arcuata*. Early instars of this species live in small groups and are reported to generate four vibrational communication signals: anal scrape, buzz-scrape, mandible scrape, and mandible drum. My research tested the hypothesis that these caterpillars use the buzz-scrape signal to announce their movement to conspecifics, to announce “friendly” vibrations. If this hypothesis is supported, then it is predicted that buzz-scrapes would be followed by movement of the signaller, and that the movement of the signaller causes vibrations. Videos with simultaneous laser vibrometer recordings of social groups were monitored. Ethograms were conducted to tabulate all behaviours that could be scored. These ethograms were then analyzed for the frequency of movement preceding and following a buzz-scrape, in solitary caterpillars and groups of two and four. Later, these frequencies were compared and analyzed using a paired t-test.

The results confirm that buzz-scrape has a high rate of being followed by a movement, specifically crawling. Also, crawling movements followed by buzz-scrape produced vibration cues that could be detected by the laser vibrometer within the caterpillar shelter. These results support the hypothesis that caterpillars could alert conspecifics that the vibration is coming from a safe source, instead of a dangerous one. These caterpillars are small and have limited vision, so using these different vibratory communication signals could be necessary for their survival.

The effect of soil sand content on earthworm seed digestion and seed coat damage

Shu Han (Julie) Gan, University of Toronto

Earthworms are found throughout North America and can have profound impacts on seeds as seed dispersers and granivores. Earthworms use sand from their environment to help physically digest food, but it is unknown how different sand contents affect earthworm granivory. We hypothesized that higher soil sand content will increase the earthworm digestion rate of seeds and overall seed coat damage of undigested (egested) seeds.

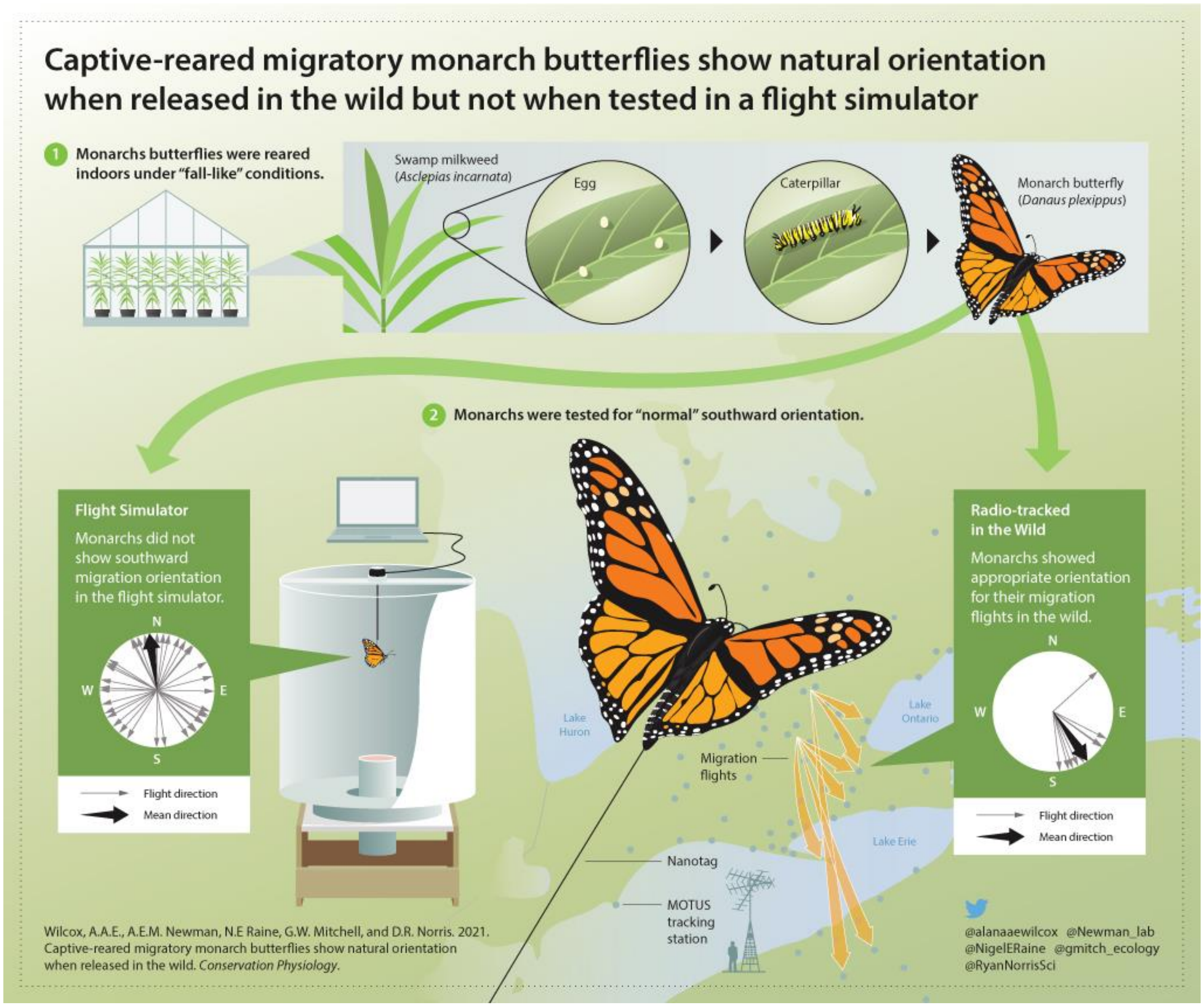
In this study, earthworms (*Lumbricus* terrestris) were kept on substrates varying in sand content by weight (0%, 25%, 50%), then fed garlic mustard (*Alliaria petiolata*) seeds. Egested seeds were visually examined and sorted into four damage classes. The results showed that sand content significantly influenced the seed digestion rate. As well, increasing sand content was associated with significantly higher seed coat damage levels. These results provide new information about the basic ecology of earthworm granivory and suggest how earthworm impacts on seed banks may vary between environments with different soil sand contents.

Compton Tortoiseshells

While Compton Tortoiseshells (*Nymphalis l-album*) have been present in southern Ontario in surprisingly large numbers in the past couple of years, the largest numbers may have been in northern Ontario. Robert Foster, a consulting biologist who gets back into the bush a lot, saw this amazing puddling group of at least twenty-five individuals (see picture below) on August 15, 2020. The location was about five kilometres north of Marathon (Lake Superior area), on a silty/sandy road along the flood plain of the Pic River.

Photo credit Robert Foster

Infographic by Wilcox *et al*. 2021. See article on page 35 of the issue.



ONTARIO INSECTS

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CONTENTS

Meetings, Insect Counts & Field Trips 1

Announcements and Short Notes 2

Award for TEA Member Rick Cavasin 2

My Life with Insects 2

Financial Report 2020-2021 3

Which Bee Species Require Conservation Efforts? 4

MONARCH NEWS 6

Monarch Populations, 2021 6

How I Became a Monarch Advocate…and Tested for OE 7

TEA Meeting Summaries 12

Butterfly Counts: My Personal Experience 15

Ontario Butterfly Counts in Summer 2021 20

27th Annual Toronto Centre Butterfly Count 22

Plant-Pollinator Interactions and Garden Planting Strategy 23

Controlling the DD Moth – The good, the bad, and the ugly 26

Front Cover: Monarch butterfly with an interesting colour of the left forewing. Nick Godfrey, observation in Oakville on September 6, 2021 (www.inaturalist.org/observations/93912054).

DEADLINE INFORMATION - Members Please Note:

The deadline for submissions to the April issue of Ontario Insects is **March 15th**. Late submissions may be added at the discretion of the Editor after that date. If there are any questions or concerns regarding submissions, please feel free to contact Charlotte Teat at the address below.

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Mission Statement

The Toronto Entomologists. Association (TEA) is a non-profit educational and scientific organization formed to promote interest in insects, to encourage co-operation among amateur and professional entomologists, to educate and inform non-entomologists about insects, entomology and related fields, to aid in the preservation of insects and their habitats and to issue publications in support of these objectives.

Membership Information:

Annual dues are as follows:

Individual	$30
Student	Free
Family	$35

Chris Rickard, Treasurer, 16 Mount View Court, Collingwood, Ontario, L9Y5A9. (705) 444-6671. e-transfers can be sent to teacrickard@bell.net

Advantages of a TEA membership include:

- 3 issues of Ontario Insects per year
- Annual Ontario Lepidoptera Summary
- Members may join the TEA permit, permitting the rearing of Monarchs and swallowtails: info@ontarioinsects.org

THE TEA IS A REGISTERED CHARITY (#131303141); ALL DONATIONS ARE TAX CREDITABLE.

Meetings, Insect Counts & Field Trips

MEETINGS

Meetings will resume in January. The next dates are Saturday, Jan. 22 and Saturday, Feb. 26.

INSECT COUNTS

Insect counts are many months away, and it is too early to say what will be possible at that time. In summer 2021, some organizers ran counts on a modified basis. For example, the organizer might arrange in advance how the count area is to be divided up, and assign particular people to each area, without any overall meet-up. For counts in which you may have participated in the past, please contact the count organizer.

FIELD TRIPS

This would be nice, by only if COVID-19 protocols consider this to be a safe activity. Stay tuned for further developments.

Cartoon by Dave Coverly

Award for TEA Member Rick Cavasin

The following article is reprinted from the Bulletin of the Entomological Society of Canada, vol 53(3), September 2021.

The annual Norman Criddle Award recognizes the contribution of an outstanding non-professional entomologist to the furtherance of entomology in Canada. The 2021 recipient is Rick Cavasin. Rick has been a major force for improving the knowledge of butterflies in Ontario and Quebec, for which he richly deserves the Award. Rick is a photographer and naturalist based in Ottawa. He has been photographing butterflies for more than a decade, building knowledge of butterfly distributions through fieldwork, extensive verification of digital observation records, and active community leadership. His website (www.ontariobutterflies.ca) details most species occurring in the region. Rick's images from across Ontario (and beyond) have appeared in The Royal Ontario Museum Field Guide to Butterflies of Ontario, The Butterflies of Algonquin Provincial Park, and his self-published Pocket Guide to Butterflies of Southern and Eastern Ontario (and similar guides for Southern Quebec, and the Maritimes).

One of Rick's best-known discoveries is a range extension for the bog elfin butterfly, a globally vulnerable species, considered critically endangered in Ontario. Searching additional sites between 2016 and 2021, he (and now others) have increased the number of known populations from 3 to 15, including populations nearly 300 km west of previously known sites. Also, Rick verifies identifications for over 30 000 citizen science observations annually to ensure data integrity for the Ontario Butterfly Atlas. As part of this work, he also communicates with many butterfly enthusiasts to coordinate efforts to document little known butterflies and promote good observation practices.

Additional note for OI: The latest editions of "Pocket Guide to Butterflies of Southern and Eastern Ontario" and "Pocket Guide to Butterflies of the Maritimes" feature images of the butterflies that are isolated against a white background. This removes the distracting backgrounds and creates room for additional images. For the Ontario guide, additional species are included.

Photo below: Rick Cavasin (left) receiving the award from Hume Douglas (right).

My Life with Insects

Bipin Dhinsa (president@ontarioinsects.org), TEA President

In high school in Windsor, I had an amazing science teacher, Maurice Bottos, who had in the classroom insects, arachnids, and even a python. Almost every day, I got to see them, interact with them and watch them move about. I even got to hold scorpions, tarantulas, and the Giant African Millipede (*Archispirostreptus gigas*). This got my curiosity going and helped build within me a strong connection to our wildlife and insects.

At Fanshawe College in London, I started by taking courses in computers and in business, but I realized that I wanted to get back into my true passion, insects. So, I went on to university and finished undergraduate zoology and entomology courses, which led to a career working with insect conservation and education.

I have now worked for more than ten years doing field work across Ontario as well as giving presentations across Canada within schools and with businesses and environmental groups. In 2021 I gave 85 presentations.

With covid-19, I do more work closer to home, working out of a small town outside London. I continue to do field work and give in-person and virtual presentations across the province. I sit on the board of directors of an organization helping our homeless community and I volunteer with the Thames Talbot Land Trust (www.thamestalbotlandtrust.ca).

In entomology I am a generalist, devoting attention to many insect orders. My iNaturalist userID is bipindhinsa and my Instagram account is @bipindhinsa. I also maintain the TEA's Twitter account, @OntarioInsects.

After being a member of the TEA for the past few years, I was elected for a 2-year term as TEA president this past September. I knew now was the time to put my name forward to try to create positive change and cause more Ontarians to love insects. This is a challenge in covid-19 times, but with all the amazing technology at our fingertips and being able to still get outdoors, we can create something amazing with a little work together. We need to be able to adjust what we are currently doing to stay relevant to both those who are just getting into the entomology world and those who are more experienced in life and entomology.

I believe that we need to continue to make sure we are welcoming to all, no matter what our experience level is, what age we are, what gender we associate ourselves with, or the color of our skin. Science is for everyone, and our love for insects and other wildlife is for everyone to enjoy equally.
I welcome all new members to the TEA. Please feel free to email me with any questions, concerns, thoughts or ideas at president@ontarioinsects.org.

Picture below: Bipin visiting a school in London and examining milkweed pods with a student.

Financial Report 2020-2021

Chris Rickard and Alan Macnaughton

The TEA ended its 2020-21 fiscal year on July 31. This year we had a surplus of about $4,100. This is a large surplus. Revenues and expenses vary quite a bit from year to year in unpredictable ways, and this year these factors worked in our favour. There were three reasons:

- Printing and mailing costs were down because we had only two issues of the OI newsletter (instead of the usual three) and there was no seasonal summary. Publication of the seasonal summary is to resume in the winter of 2022.
- Due to covid, we did not have in-person meetings. Thus, our only room rental expenses were amounts for winter 2020 for which we did not receive the bills until this fiscal year.
- There were 22 donations to the club in the fiscal year. This has become an important source of our revenue.

As of the end of the fiscal year, we have assets of $42,483 and no debt. We have a small publications inventory, but we consider that to be not of enough value to enter in the financial statements.

There was no Hess lecture in the fall of 2020 due to covid. The Hess lecture is expected to return in the fall of 2022. The Hess family's unused $3,000 contribution in 2020 will be used to fund the 2022 lecture.

Some of the $42,483 of assets can only be used for restricted purposes. A total of $11,515 ($2,540 + $8,975) is allocated for two specific funds:

- The Glenn Richardson Research Award Fund, which funds our research grants for students. The balance was $3,640 going into this fiscal year. A donation of $600 was made to the fund. A total of $1,600 was spent. So, the balance going into the next fiscal year is $2,640.
- The Butterfly Conservation Fund. The balance was $8,550 going into this year. An additional $425 was received. No expenditures were made as the group sponsoring the Mottled Duskywing reintroduction received other funds this year and had no need to draw on the TEA fund. So, the balance going into the next fiscal year is $8,975.

For the year 2020-21, we have 176 members. The breakdown of the membership is: 47 families, 108 individuals, 21 students (who have free membership). In addition, there are 2 institutions that receive our publications. Last year we had 166 members. About 72% of our members live outside the Greater Toronto Area. About 100 of our members have signed up to be on the Ontario government permit for raising Monarchs and swallowtails – contact amacnaughton@uwaterloo.ca if you want to be included. Much of our membership increase from last year is due to people joining because of the permit.

For the 2020-21 fiscal year, we had the following revenues and expenditures:

Revenue	
Donations	$2,175
Memberships	$5,677
Items sold	$32
GST/HST refund	$623
Interest income	-
Total Revenue	**$8,507**
Expenditures	
Expenditures from Glenn Richardson Research Award Fund	$1,600
Speakers' honoraria	$200
Room rental for meetings	$520
Expenditures from Butterfly Conservation Fund	-
Expenses for Hess lecture	-
Printing of members' publications	$700
Mailing of members' publications	$654
Printing of publications for sale	-
Website hosting	$460
Ontario Nature Network Dues	$55
Bank fees	$15
Donation to High Park	
Total Expenditures	**$4,404**
Surplus	*$4,103*

Which Bee Species Require Conservation Efforts?

Tiffani Harrison, Wildlife Preservation Canada (admin@wildlifepreservation.ca)

Toronto is home to a diversity of wildlife, including more than 360 species of bees. Bees are one of the most important pollinator groups. However, one of the most commonly known bee species is the European honey bee (*Apis mellifera*), which is not native to North America.

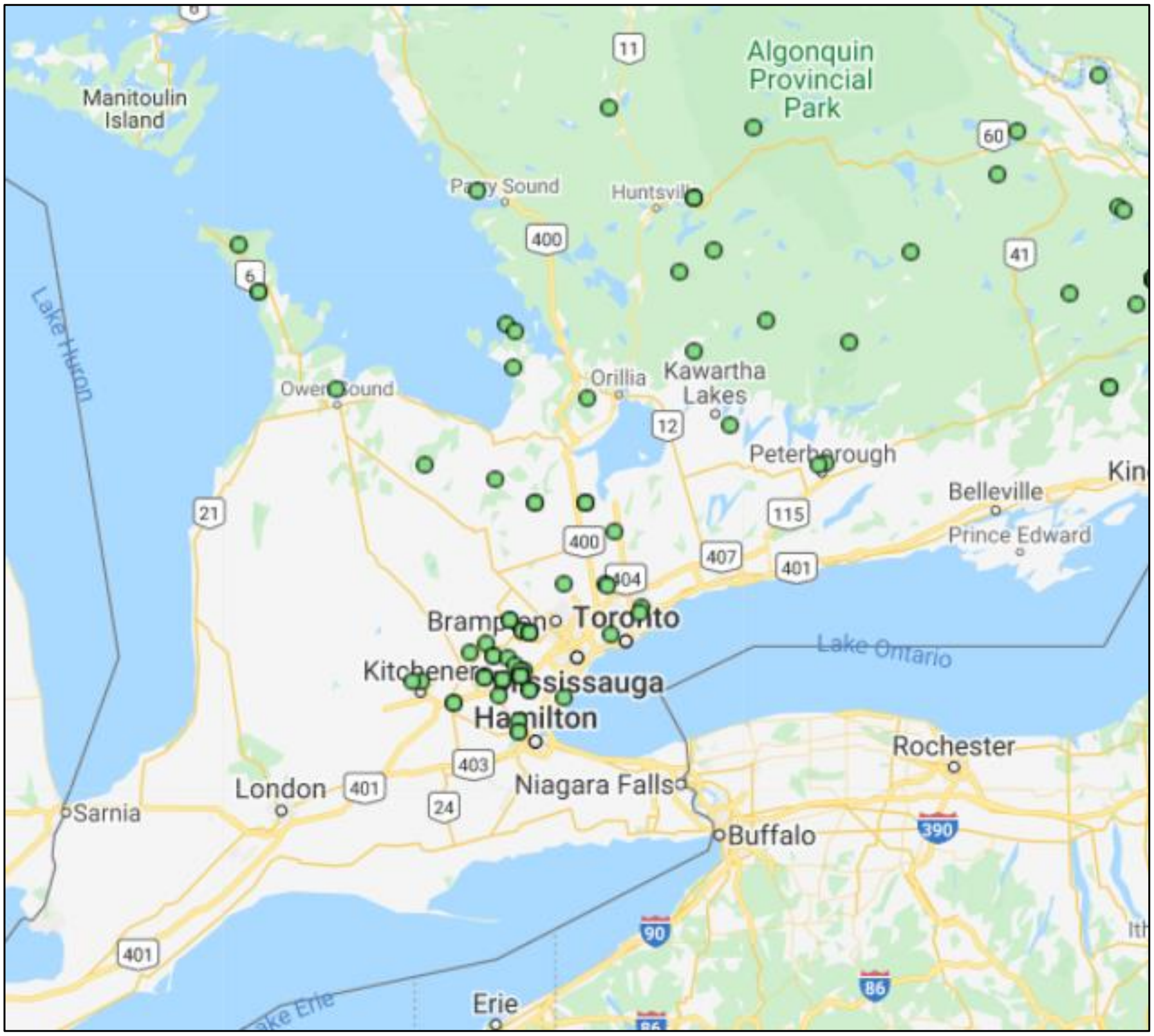
Although honey bees can play a crucial role in agricultural pollination and honey production, its non-native status sets it apart from our other bee species when it comes to conservation concern. Honey bees have strangely become the flagship species for the "save the bees" movement, propelling this larger misconception that they are an endangered species – although that is not true as they are a managed species and non-native to Canada. Due to this widespread misconception, what falls through the cracks instead is our native bees, of which many are at risk and are deserving of real conservation effort and focus. Native species are particularly important to conserve as they are locally adapted and have co-evolved special relationships with our native flora.

There are many native bees who are worthy of our support, but bumble bees (genus: *Bombus*) in particular, are especially important. Bumble bees are a vital group of native pollinators that help pollinate many of our crops and wildflowers. Due to their large and hairy morphology, they transfer pollen very well, making them efficient pollinators. They, like some other native species (but not honey bees), are capable of performing a specialized pollination technique called *buzz pollination*, or *sonication* – where they vibrate their strong flight muscles to help dislodge pollen firmly held within the flower. In fact, there are a variety of plants (such as tomatoes and blueberries) that require this type of pollination for reproduction.

Sadly, it is estimated that about a quarter of bumble bee species globally are at some level of decline. More locally, Toronto is in the range of 3 (federally and provincially) at-risk bumble bee species. Both the rusty-patched bumble bee (*Bombus affinis*) and the gypsy-cuckoo bumble bee (*Bombus bohemicus*) ranges are within Toronto and both species are currently listed as Endangered. The range of the yellow-banded bumble bee (*Bombus terricola*) is also within Toronto, and it is currently listed as being of Special Concern.

In 2013, Wildlife Preservation Canada initiated their Native Pollinator Initiative, and more specifically their Bumble Bee Recovery Program. One project is developing conservation breeding techniques for at-risk bumble bee species in the hopes of using captive bred bees for future reintroductions, just as is currently being done for the Mottled Duskywing butterfly in southern Ontario. In addition, the program monitors bumble bees across Ontario, collaborates on bumble bee research projects, leads outreach opportunities focused on native pollinators and how to conserve them, and manages an ongoing community science monitoring program for bumble bees at Pinery Provincial Park in Grand Bend. In this community science program, volunteers participate in surveys over the summer to continue the search for the rusty-patched bumble bee, since this is where it was last found.

Consider submitting bumble bee observations to Bumble Bee Watch, a collaborative North American wide community science initiative, where users can submit photos online (or via a phone app) of bumble bees to be identified by experts. These observations help researchers answer crucial questions and help drive important decisions on conserving Canada's bumble bees.



Map produced in Bumble Bee Watch showing yellow-banded bumble bee (B. terricola) observations submitted in and around Toronto area (observations to date: Nov 19, 2021)

Monarch Populations, 2021
By Don Davis (donald_davis@yahoo.com)

Ontario
As in past years, the southward monarch migration began in early August, but became more pronounced and noticeable about mid-August. While not as robust a migration as seen in past years, one could easily find monarchs in good numbers along the north shores of Lakes Erie and Ontario, particularly where numerous nectar sources were present.

From late August to September 27th, I tagged 2,383 monarchs, almost exclusively in Northumberland County, including 911 in Presqu'ile Provincial Park (my 37th year there). While the pandemic has put the annual Monarchs and Migrants Weekend on hold again this year, a special unadvertised two-hour tagging event was held at the Amphitheatre at Presqu'ile for park guests on September 5th with pandemic precautions in place.

Monarch roosts of about 1,000 each were reported on August 22nd at Huron-Kinloss and on August 30th at Kincardine. At the tip of Point Pelee, the following roost estimates were provided: 800 on Sept. 9; 2,000 on Sept. 17; 850 on Sept. 18, 1,000 on Sept. 25-26; 1,300 on Sept. 27. These Point Pelee numbers are substantial but far from the record: The largest flight of monarchs at Point Pelee took place on Sept. 17, 1996, between 7:50 am and 9:20 am, when an estimated 300,000 monarchs flew past 4 ornithologists who were experienced at counting large numbers of birds. These birders had mounted their scopes earlier at the tip of Point Pelee hoping to spot pelagic bird species blown into Ontario.

The author at Presqu'ile Provincial Park, Sept. 5, 2021.

Eastern North America as a Whole
The monarch's recolonization of the summer breeding area this past May and early June was quite favorable. Monarchs generally arrived on time and in good numbers. This evidence favoured a large migratory population, provided that summer temperatures were within 2 degrees Fahrenheit of the long-term average. Fortunately, the weather seems to have been in this range over most of the summer breeding area.

Monarchs were much more abundant in Oklahoma and Texas than usual this past summer, due perhaps to adequate rainfall and moderate summer temperatures, There was no evidence of a drought in Texas or elsewhere, which could diminish the possibility of surviving the passage to the overwintering sites. However, portions of the eastern Dakotas and western Minnesota were much warmer and drier than is generally ideal for monarch population development.

Overall, conditions for population growth have been favourable. This suggests a larger overwintering population in Mexico this year than in the last two winters (2.83 hectares for 2019-2020 and 2.10 hectares for 2020-2021). However, the overwintering population is likely to be less than the 6 hectares reached in 2018.

How I Became a Monarch Advocate…and Tested for OE

By Christina Enright (christinaenr@gmail.com)

In the summer of 2019, following an injury to my hand, I found myself unable to participate in my usual activities and with an abundance of idle time. I had never been in this position before — I was a multi-tasker, a full-time information developer working in software development, with a too-long list of hobbies and interests. But there I was, unable to do much with the days stretching long before me.

One thing I could do, however, was walk. In rural eastern Ontario where I live, a walk around my 'block' is 11 km and takes almost three hours. I began walking...and walking...and walking. For possibly the first time since I was a child, I began noticing the nature that surrounded me. The sounds of the birds and the bees, and the brilliant colours of many of the wildflowers growing along the roadsides were captivating. I've always been inquisitive, and so it was that before long I was climbing down into the ditches and walking along the farm fence lines to be as up close and personal as possible with my new discoveries.

We have plenty of common milkweed growing along our roadsides, so it wasn't long before I encountered my first monarch caterpillar. I must have watched that caterpillar devouring its milkweed leaf for at least an hour. I was fascinated! And, it wasn't as if I had anything else to do. Before long, it seemed like everywhere I looked I saw a monarch caterpillar. And a plan began to form in my mind. Before long I had purchased a huge glass fishbowl, found some netting and an elastic with which to secure it, and set out walking to find some fresh milkweed and a monarch caterpillar to bring home and call my own.

That monarch caterpillar saved me that summer. I had a new purpose! I studied that caterpillar from sunup to sundown. I spent hours searching the Internet for the most reliable, scientific information I could find to explain what I saw unfolding before my eyes. I joined monarch groups, read books, watched YouTube videos, and found experts for my unanswered questions. My caterpillar grew, pupated as I watched, and later became the monarch butterfly that stole my heart.

Today, I am a TEA member and successfully raise monarchs under the TEA's OMNRF permit. I host groups, families, and individuals at my outdoor monarch habitat; I work with church and other groups interested in creating native gardens for pollinators; and I'm an advocate for pollinators — most especially monarchs — across the United Counties of Stormont, Dundas, and Glengarry.

One of the monarch groups I joined, the Facebook group 'The Beautiful Monarch', has over 62,000 members, most of whom seem to live in the southern United States. The group's primary administrator, Holli Hearn, is a wealth of knowledge. With so many members of this group living in the southern states and able to enjoy non-migratory monarch butterflies year-round, a good percentage of the discussion feed centres around the *Ophryocystis elektroscirrha* (OE) parasite. In fact, most of the experienced individuals who post in this Facebook group practice extreme safety measures that include

- only rearing caterpillars from eggs;
- bleaching all gathered eggs to disinfect them, since caterpillars may initially become infected by eating their egg (an infected mother will shed OE spores as she lays eggs);

- bleaching all milkweed brought into the habitat, since OE spores may be shed onto milkweed by infected butterflies and subsequently eaten by the caterpillars;
- if caterpillars are brought home, keeping them segregated from existing caterpillars to avoid the risk of cross-contamination;
- testing butterflies for the presence of OE spores before release; and
- euthanizing all butterflies found to be severely infected.

A particularly relevant February 2021 scientific article stated that "...OE infection levels of monarchs at the northern edge of the eastern population distribution around Ottawa, Ontario, Canada … found extremely low levels of infection (~1% with upper confidence intervals close to 3%)"[1]. For this study, 140 monarch eggs and larvae were collected and reared to adult butterfly, and 27 adult butterflies were captured, tested, and released, at 29 different Ottawa-area sites over the period from June 28 to September 25, 2019. Among these 167 individuals, only one (1) female butterfly captured as an egg was infected with OE spores (a high rate of infection at greater than 1000 spores).

Despite this study's findings, I was still concerned about the presence of OE among our monarchs. Further, as I had made a commitment to be as responsible a caretaker as possible, I felt it incumbent upon myself to be informed. On a personal level, I needed to know that the monarchs I was rearing and releasing were healthy, and themselves contributing to a healthy monarch population.

It's important to differentiate between the active OE parasite and dormant OE spores. Only the monarch caterpillars can be infected with the OE parasite (the parasite is located inside the caterpillar's gut); in contrast, the adult butterflies can carry dormant OE spores (located on the outside of the butterfly's body on the scales).

An adult butterfly can have dormant OE spores on its scales by

- pupating from its larval stage as a caterpillar that had been infected with the OE parasite;

  The parasites first reproduce asexually inside the caterpillar; later, the parasites reproduce sexually inside the chrysalis, eventually coming together in pairs to form zygotes. Each zygote undergoes 3 nuclear divisions, ultimately becoming a seed-like spore that contains 8 individual OE parasites. The spores then migrate to the outside of the butterfly's body before the butterfly ecloses, where they remain dormant. The number of spores present when the butterfly ecloses depends on the number of parasites present inside the caterpillar when it pupated to form the chrysalis.
- coming into physical contact with an infected butterfly, such as during mating.

  During mating, the spores – which are most often located on the abdomen – are easily transferred from one butterfly to the other.

[1] Felipe Dargent, "Low prevalence of the parasite *Ophryocystis elektroscirrha* at the range edge of the eastern North American monarch (*Danaus plexippus*) butterfly population", *Canadian Journal of Zoology*, volume 99, number 5, May 2021. Available at: https://tspace.library.utoronto.ca/bitstream/1807/105487/1/cjz-2020-0175.pdf

A monarch caterpillar becomes infected with the OE parasite when the following occurs:

1. The caterpillar eats dormant spores present on its egg (the spores having been shed by its mother as she lay the egg) or present on milkweed (the spores having been shed by an infected adult butterfly
2. The caterpillar's digestive fluids dissolve the spore and single-celled OE parasites are released into the caterpillar's gut.
3. The released parasites migrate to the caterpillar's hypoderm, just below the skin.
4. Once in the hypoderm, the parasites multiply continuously.

The more parasites present – in other words, the younger the caterpillar was when it first ingested OE spores and the more time the parasites have to reproduce – the more weak and potentially deformed a newly-eclosed butterfly will be (some severely infected butterflies may not eclose at all). Visual evidence of an infected butterfly can include misshapen wings, an un-knitted proboscis or proboscis that doesn't curl, and weak legs. In addition, infected butterflies are often too weak to cling to the chrysalis when they eclose, and will fall to the ground before their wings are fully open.

Despite evidence that our northern migrating monarchs were not infected with the OE parasite to the extent that non-migrating southern monarchs are[2], I still wanted to be sure that I was releasing healthy butterflies into the general population.

Since it is impossible to tell if a larva or pupa is infected without dissecting it[3], identifying the presence of OE is done by testing the adult butterflies. Because monarch butterflies can be infected with the OE parasite and still appear healthy – and because OE spores can survive long periods and subzero temperatures[4], I believed that the only way I would know that the monarch butterflies I released were indeed healthy was by testing them myself. And so I did.

The most surprising thing about testing your monarch butterflies for the presence of the OE parasite is that it's not hard. In other words, it's easy. Believe me, if I can do it, anyone can – all you need is a microscope, some microscope slides, and some clear tape.

When I decided to begin testing the monarch butterflies I raised, I invested a total of $78 .00 in the following items:

- a handheld, lighted microscope with 100x-250x magnification that came with a smartphone camera clip (I paid about $40 including GST);
- a box of 100 microscope slides with 100 slide covers (I paid about $26 for mine, but as you won't need the slide covers you can likely find some that are less expensive); and
- a 3-pack of Scotch Tape with dispensers (about $12.00)

[2] The low presence of OE in northern migrating monarchs may be because 1) only the healthiest, strongest butterflies are capable of flying this far north, and 2) once here, their exposure to other affected butterflies is limited.
[3] Oberhauser, K.; Taylor, O.R.; Altizer, S.; Vickerman, D. "Parasite Control : *Ophryocystis elektroscirrha*", Monarch Watch. https://www.monarchwatch.org/biology/control.htm
[4] Ibid.

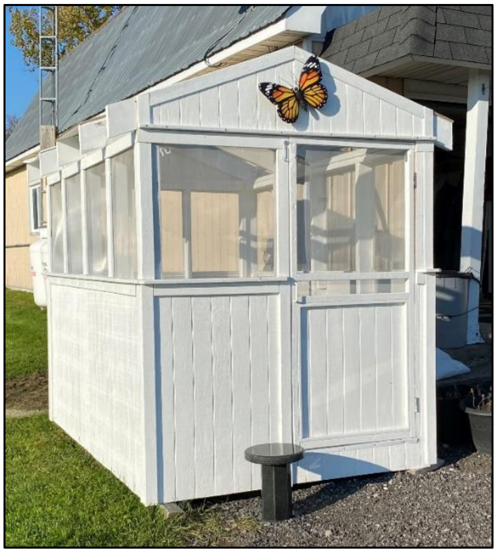


Figure 1. *Christina's monarch habitat, a natural environment and safe from predators*

Figure 2. *Carson Microflip and UV Lighted Pocket Microscope with Flip Down Slide Base and Smartphone Diaiscoping Clip.*

To test a butterfly for the presence of OE spores, simply:

1. Tear a 1” piece of tape from the dispenser, and then stick a corner of the tape piece on a clean surface nearby.
2. Grasp the butterfly and hold it so that its abdomen is exposed.
3. Retrieve the piece of tape, and gently touch the sticky side to the butterfly’s abdomen, ensuring that some of the black and white scales adhere to the tape.
4. Place the piece of tape on a microscope slide, pressing firmly to eliminate air pockets.
5. View the slide under the microscope.

Figure 3 shows a photograph of monarch butterfly scales free of OE spores, taken with my iPhone 11 smartphone using my handheld microscope’s smartphone camera clip. (You simply place the camera clip over your smartphone’s camera lens, and then snap the clip into the microscope’s eyepiece. When you open your smartphone’s camera, the image you see is whatever you are looking at under your microscope.)

Figure 4 shows scales from a butterfly infected with OE spores.

Zooming in on Figure 5, you can clearly see the clusters of spores circled in yellow, as well as individual spores scattered about, as identified by the red arrows

(Figures 3-5 are found on Page 32)

Choosing to test monarch butterflies for the presence of OE spores is a personal decision. Should you decide to begin testing, as I did, it’s important to understand the potential consequences of that choice. For example, you may find yourself in the position of having to decide whether to euthanize what appears to be a healthy butterfly.

In the case of my two infected 2021 butterflies, I was spared a difficult decision since both had mis-shaped wings, a proboscis that either did not curl up or had not been successfully joined, and they were extremely weak. Knowing that they would not be able to eat or fly made my decision easy. Unfortunately, not all cases are as clear cut as mine were.

At the end of the day, the goal that I've set for myself means that I will test all of the butterflies I raise, and I will make difficult decisions when necessary. The joy I experience spending endless days watching the caterpillars grow, pupate, and eclose as butterflies, and fly away, coupled with the unique opportunity I have been afforded to educate all who will listen make the small cost of testing worth every penny.

Further Reading and Viewing

- Parasite Control : *Ophryocystis elektroscirrha*", Oberhauser, K; .; Taylor, O.R.; Altizer, S.; Vickerman, D., Monarch Watch. https://www.monarchwatch.org/biology/control.htm
- Raising OE-Free Monarchs, Franklin, R. – http://www.monarchs-and-milkweed.com/raising-oe-free-monarchs.pdf
- Monarch Health Life Cycles, Journey North. https://journeynorth.org/tm/monarch/monarch_health_lifecycle.html
- Raising Monarch Butterflies – Alternative OE Testing (Help the Monarch Butterfly), MrLundScience -- https://www.youtube.com/watch?v=32IqyxjOUfM
- Project Monarch Health -- https://www.monarchparasites.org/

By Albert Tomchyshyn (albert.tomchyshyn@gmail.com)
Videos of the September, October and November meetings are available at www.ontarioinsects.org/meetings

Saturday, January 25, 2021. 1:15 pm – 3:00pm on Zoom (video posted online)

MEMBERS MEETING
The TEA members' meeting for the beginning of the 2021-22 season was held on September 25, 2021. To open the meeting, the TEA executive elections were held. This year there were two position changes, Bipin Dhinsa is our new President and Albert Tomchyshyn is our new Secretary. Alan Macnaughton continues as the Vice-President and Chris Rickard is the acting Treasurer until a replacement can be found – please volunteer!. The rest of the meeting consisted of 10 separate presentations where members of the association showed images from their summer observations.

Our first speaker was Lydia Wong, who presented several images of the bees (*Megachile* and *Osmia*) she was studying within the Colorado Rockies. Her observations also included several parasitic wasps that parasitize the nests of the bees she was observing.

Pedro Pereyra sampled suburban insect diversity by observing the species that visited his garden. These included several leafcutter bees, potter wasps and hoverflies.

Carol Pasternak reared Cecropia moths, observed the 2nd largest slug in the world and shared her experience of holding a garden and insect tour. Currently, she has a new book coming out known as *5 Butterflies*. The book involves an issue on butterfly farming and includes images from several other citizen scientists and butterfly conservancies.

Antonia Guidotti observed and collected termites in a Toronto school yard for the ROM collection. She also shared that she will be in TVO's program *Leo's Pollinators* showing beetles that pollinate goldenrod (Locust borer and *Glipa oculata*).

Brent Turcotte was pleased to see a Compton Tortoiseshell butterfly. He also shared his observation of the Elfin Skimmer -- the smallest dragonfly in Ontario.

James Kamstra showed his moth traps which he uses for a hobby and for work. His traps consisted of mercury vapor lamps above a bucket filled with egg cartons. He observed that mercury vapor lamps attracted 3 times the moths as other bulbs and captured thousands of moths. Additionally, he observed a Black Witch moth which was blown by a tropical storm into the Durham area.

Karen Yukich kept a list of insect species she observed at home, this included weevils and several treehopper species.

Bob Yukich showed images of butterflies he observed in Ecuador at the beginning of 2019 and included several images of spreadwing skippers, grass skippers and satyr butterfly species that he observed on his trip.

Alan Macnaughton shared his moth photos from this summer which he attracted with mercury lamps and rotting bananas. His observations included a Black Witch moth in Kitchener and Luna Moths at the Cedar Creek Conservation Area. Alan also presented some Boston Dart observations and explained that these moths start their season in September, much later than any butterfly species.

Christina Enright built a monarch habitat in a shed. To rear the younger caterpillars, she would place them on potted milkweed plants and would rear the later instars on cuttings. With her setup, she was able to successfully release many monarch butterflies. She shared videos of 5th instar caterpillars spinning the silken pad required for the chrysalis stage. See her article under Monarch News, later in this issue.

Saturday, October 23, 2021. 1:15 pm - 3:00 pm. By Zoom (video posted online).
ANTS, SCIENCE AND CITIZEN SCIENCE - WE NEED YOU!
Ehab Abouheif, McGill University

Presently, approximately 15,000 known species of ants are known to science. The first records of ants are from around 115-135 million years ago. Today, there are 108 species of ants in Quebec and 99 of them are indigenous. Ants are diverse and ecologically dominant: they are found in almost every terrestrial habitat and are estimated to make up 1/3 of the earth's insect biomass. There are two reasons why ants are so successful. Firstly, they are eusocial: ants within a colony cooperate and divide labor between all individuals in the colony. Secondly, ants are polyphenic, meaning all ants within a colony share one genotype but many different phenotypes. For example, new queens produced by a colony start with wings, lay many eggs and can live up to 30 years while a worker, that shares the same genotype, is sterile and survives for about 3 months.

Genes are responsible for these differences between queen and worker ants. While several studies explore the relationship between genes, specific behaviors and morphology, these studies are typically conducted in controlled environments. However, the findings of these studies are limited because genes interact with the environment. This interaction with environmental conditions can lead to different genes being activated within the ant's genotype leading to the different ant types found within ant colonies.

Prof. Abouheif and his students have been studying this genetic potential within colonies of *Pheidole* ants. This hyper-diverse genus of ants are known to have a variety of different ant types ranging from workers, to big-headed soldiers and, in some species found in Arizona and Mexico, large super soldiers. The reason these super soldiers exist is to protect their nests from soldier ants that roam the forest floor. Soldier ants do not have a nest: rather, they travel on the forest floor and eat anything that happens to cross their path. This includes raiding the nests of other ants. *Pheidole* ants that survive soldier ant raids protect their nests by blocking their nest entrances with the heads of their super soldiers. Meanwhile other *Pheidole* species that do not face soldier ant raids (such as those in Austin, Texas and Long Island, New York state) typically do not have super soldiers.

However, during his studies on Long Island, Prof. Abouheif collected a super soldier ant from a species of *Pheidole* ants not known for having super soldiers. This anomaly prompted him to attempt to replicate this discovery within his lab. By increasing the levels of juvenile hormone present in *Pheidole* larvae during a specific stage of their development, he was able to produce similar 'super soldiers' within several other *Pheidole* species that do not have super soldiers within wild colonies. This was interesting as it was previously thought that super soldiers within different ant species independently evolved of each other. However, this finding suggests that an ancestral species of ant evolved super soldiers and eventually lost the phenotype later on. While super soldiers are not present in many of the species that descended from this ancestral species, the genetic potential is still within these ant species' genotype and can be reactivated if the environmental conditions are just right. In the future, he is hoping to replicate these results in other families of ants to determine which ants have this genetic potential and are potentially descended from this ancestral species.

In addition, the Abouheif lab is hoping to determine how the environment influences other behaviors of ant colonies. However, they are hoping to make these discoveries with the help of citizen scientists. Originally, Prof. Abouheif gained his passion for ants through meeting Ray Sanwald, a citizen scientist who was studying kidnapping behavior of ants for 60 years. Kidnapping behavior occurs in several ant species and the kidnapping species are host specific. This behavior occurs when a species of kidnapping ants raid the nest of their host species and steal several eggs and larvae. These eggs and larvae are then reared by the kidnappers and eventually work for their adoptive colony. Mr. Sanwald's notes included everything from when kidnapping behavior occurred to the weather conditions within his 3 acre backyard on Long Island for each day. Currently, Prof. Abouheif and Mr. Sanwald are analyzing the data, but it is clear there is a correlation between the frequency of ant raids and weather conditions.

Currently, Prof. Abouheif also has another initiative being developed by Benjamin Rudski, a graduate student in his lab, to get further involvement of citizen scientists in determining the environmental conditions that trigger ant nuptial flights. They hope to get citizens involved through their Ant-Nup-Tracker app (www.antnuptialflights.com). Currently, the app is only for iOS but an upcoming update will involve an Android release. The app is similar to iNaturalist as users can upload images of ant nuptial flights to a database hosted by the Abouheif lab. The app automatically gathers the location and weather conditions from nearby weather stations and users can contribute to identifying the observed species. It is hoped that this data could be used to determine what environmental conditions trigger ant nuptial flights, allowing scientists to collect ant queens for study without damaging existing nests. The code for the app is open source and the data is publicly available for use by the public through the Abouheif lab.

Saturday, November 27, 2021. 1:15 pm - 3:00 pm. By Zoom. (video posted online).
INVISIBLE BIODIVERSITY -- THE HIDDEN WORLD OF MITES BENEATH OUR FEET
Marla Schwarzfeld, Canadian National Collection of Insects, Arachnids and Nematodes

(A summary of this talk is to be included in the first issue of this newsletter for 2022.)

Butterfly Counts: My Personal Experience

James Kamstra (james.kamstra@aecom.com)

Butterfly counts have been a passion of mine for decades. Back in 1992, I was invited to participate in a butterfly count by my friend Don Sutherland, who lived near Long Point. I had never heard of such a thing, but since I was intrigued by butterflies, I took him up on the offer: I joined a group which included Mary Gartshore and Peter Carson. We were out hunting for butterflies for the whole day, counting every individual. It was great fun. At day's end, the count coordinator Chauncey Wood invited all groups to his home for a barbecue and a tally of results.

The following year 1993, I decided to start my own butterfly count near Oshawa. I chose a count circle (a standard 24 km in diameter) at the south end of Lake Scugog, centred on the Oak Ridges Moraine as I knew there would be good habitat. I notified people I knew who were interested in butterflies, including members of the TEA and Durham Region Field Naturalists. I had quite a good turnout with 12, and I hosted a barbeque in my backyard to do a tally of the count. It became an annual event.
Later I discovered a more productive area for butterflies in the north part of Durham, along the rail trail near Blackwater. In particular, the abundance of Baltimore Checkerspots along the trail caught my attention, as it was virtually unknown in south Durham. I established a second count circle, which I called Sunderland. This circle was set up to maximize the amount of rail trail. Both Durham counts have been going for more than twenty-five years now.

North American butterfly counts were started by the Xerces Society, an insect conservation group based in the US, back in 1975. They borrowed very heavily from the protocols of the Christmas Bird counts, using the same sized circle – 24 kilometers (15 miles) in diameter. Participants break out into parties that go out all day to cover their piece of the circle, and count every individual butterfly seen. They keep track of hours and mileage, then compile all of the data at the end.

The North American Butterfly Association (NABA) has taken over count coordination from the Xerces Society. It publishes an annual report with all of the counts. There are now about 400 counts per year, mostly in the US, but some in Canada and a few in Mexico.

Many new counts were established in Ontario since I started my first. We had 33 counts across the province in 2019, the most of any year. About 25% of them did not operate in 2020 and 2021, however, because of covid. The counts are almost all in southern Ontario, with very few in the north. Figure 1 shows where all of the 2019 counts were located (except for two in northwestern Ontario). There is good representation in central Ontario, south central Ontario, and in the Carolinian area. There are big gaps, and some former counts are no longer done. It would be great to have more counts in the vast area of northern Ontario which has many species rarely encountered on southern counts but there are few lepidopterists there.

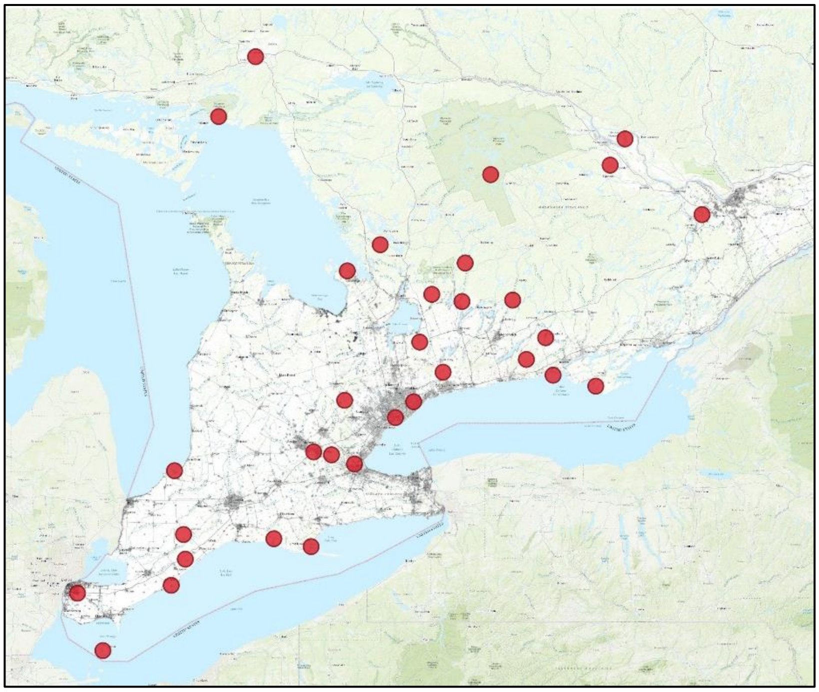


Figure 1. *Location of Southern Ontario Butterfly Counts in 2019*

Organizing a Butterfly Count

To me, a 24 km circle is much too large to effectively cover -- even with many participants. Anyone who has participated in Christmas bird counts will know how hard it is to count the birds in an area of this size. Imagine trying to count butterflies! Groups do the best they can, avoiding the vast areas of inhospitable butterfly areas present in most circles. I have found that one of the advantages of having such a large circle is that it stimulates groups to search out and find the best available habitats instead of concentrating on small areas.

Suitable weather is needed on count day in order to get comparable results. Butterflies are sun-loving organisms that seek shelter when it is cold, rainy, or heavily overcast. Counts should be cancelled if the forecast is bad, which is why many counts have a rain date to fall back on if necessary.

To capture a good range of species, a butterfly count should be held on an appropriate date. Many of our butterfly species and most skippers are single brooded. They might be on the wing for only three or four weeks of the year. For example, Arctic Skippers are out in early June, hairstreaks mostly fly in July, while Leonard's Skipper emerges in August. Hitting the peak flight period for all species is just not possible. Most counts are done between late June and the end of July to capture the maximum number of species. The flight period of some species can vary from year to year due to weather. With a warmer spring, butterflies emerge earlier, while a delayed spring results in later emergence. For example, the Baltimore Checkerspot hibernates as a caterpillar, comes out in the spring to feed for a month before pupating. The sooner that plants leaf out in spring, the sooner the caterpillar can feed to get on with its life cycle. Warmer weather speeds up the process. Thus, the results of counts that are held on roughly the same date each year can vary because of weather factors.

Human factors are also important in butterfly count results. More groups of people give better coverage, but they need to know how to find and identify the different species, so each team should have at least one expert. Nevertheless, inexperienced newcomers are always welcome, and over the years some of those become experts.

It is also important to survey a range of habitats since some butterflies live in meadow marshes, others prefer dry fields while others occur in the semi-shade of forest gaps.

One of the goals is to find all of the butterfly species present in a given count circle. Sometime a bit of friendly rivalry develops between the groups to see who can find the most or the rarest species. This just adds to the to the fun and anticipation of finding out what others have found at day's end.

Findings

Every year between 90 and 100 species are tallied on all of the Ontario counts, with an accumulated total of 126 species recorded in the last 12 years.

The Sunderland count has one of the highest numbers of species of any Ontario count, with a high of 62 species attained in 2014. Manion Corners finally tied this record in 2021. Any Ontario count should be able to tally at least 40 with adequate coverage and many record 50 or more. Number of species vary from one year to another but sometimes the stars seem to align with perfect weather, presence of migrants, hitting species at their peak. With a few rarities thrown in, one can have a really stellar butterfly count.

Estimating or counting the number of individuals seen on a count is a challenge when numbers are large. European skippers can be unbelievably abundant. On the Haliburton Highlands count in 2019, I estimated over 24,000 individuals in my area alone. They flew up in clouds with every stem on some fields. An accurate count in these situations is impossible, but it is important to be as diligent as possible. In such instances, I would estimate flying butterflies by groups of 10 or even 100.

If a count is conducted when the European Skipper population peaks, this species can make up 75% of all the butterflies. However, the peak period is very short; therefore, in most years the proportion attributable to this species is much smaller. Whether this super abundant butterfly has displaced or impacted populations of native skippers has not been well demonstrated, but it seems intuitive that they must be having some effect.

See the table below for the ten most abundant species across all Ontario butterfly counts over the past 12 years. Note that the two most abundant species are not native.

***Table 1**. Most Abundant Species on Ontario Butterfly Counts*

Rank	Species	% of all butterflies
1	European Skipper	32.0
2	Cabbage White	12.0
3	Clouded Sulphur	5.1
4	Dun Skipper	4.7
5	Northern Crescent	4.6
6	Monarch	3.4
7	Common Wood-nymph	3.3
8	Little Wood-satyr	3.1
9	Summer Azure	3.0
10	Orange Sulphur	1.7

Using the absolute numbers of butterflies tallied on a count does not always provide an effective comparison, either with other counts or between years in the same count circle. One must take into account the field effort, as a higher field effort can inflate these numbers. The number of hours in the field is by far the most useful measure, but one can also record the number of kilometres walked. Either measure should be recorded as precisely as possible.

The variation in butterfly numbers from one year to another is often surprising. For example, an average of 12 Eastern tailed Blues would be counted on the Sunderland count, the pattern for many years. Then in 2013 we documented almost 400: that year they were suddenly everywhere. The next year, they were back down to 14.

Butterfly count data is most useful for documenting population trends in large conspicuous, easily identifiable species since even less experienced observers are able to accurately count those.

There is a lot of interest in Monarchs, a migratory species whose numbers fluctuate considerably from one year to another. The graph in Figure 2 shows the number of Monarchs per hour of effort across all Ontario counts in a given year. In 2012 Monarchs were numerous but the population plummeted the next year by 90 percent. This was the period when the Monarch butterfly decline really hit the news. Monarch numbers stayed low for a few years, but then picked up again.

Note that Monarch numbers usually peak in late summer, but butterfly counts are conducted in early to mid summer. If counts were held in late August or early September, the count results would show much greater numbers. However, 2021 showed a reverse trend where Monarch numbers were high during the count period but then plummeted later in the summer. In most years, the count results do reflect the Monarch population trends.

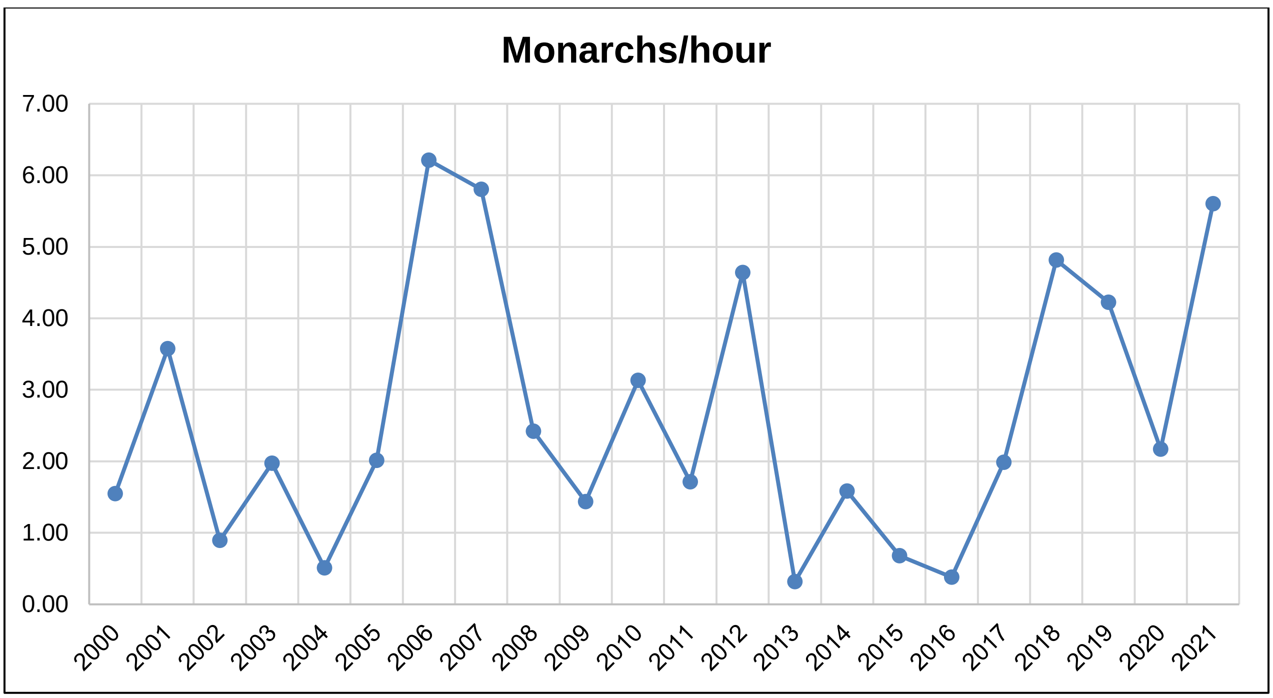


Figure 1. *Number of Monarchs/Hour on Ontario Butterfly Counts*

Red Admiral and other migrant species show great variations in abundance between years. Figure 3 shows how three conspicuous species vary from one year to another on the Sunderland butterfly count. The figure shows that in contrast to the Monarch and Red Admiral, White Admiral does not vary much from year to year. Sunderland averages 75 hours of effort per count and therefore makes a good example to use for comparative results.

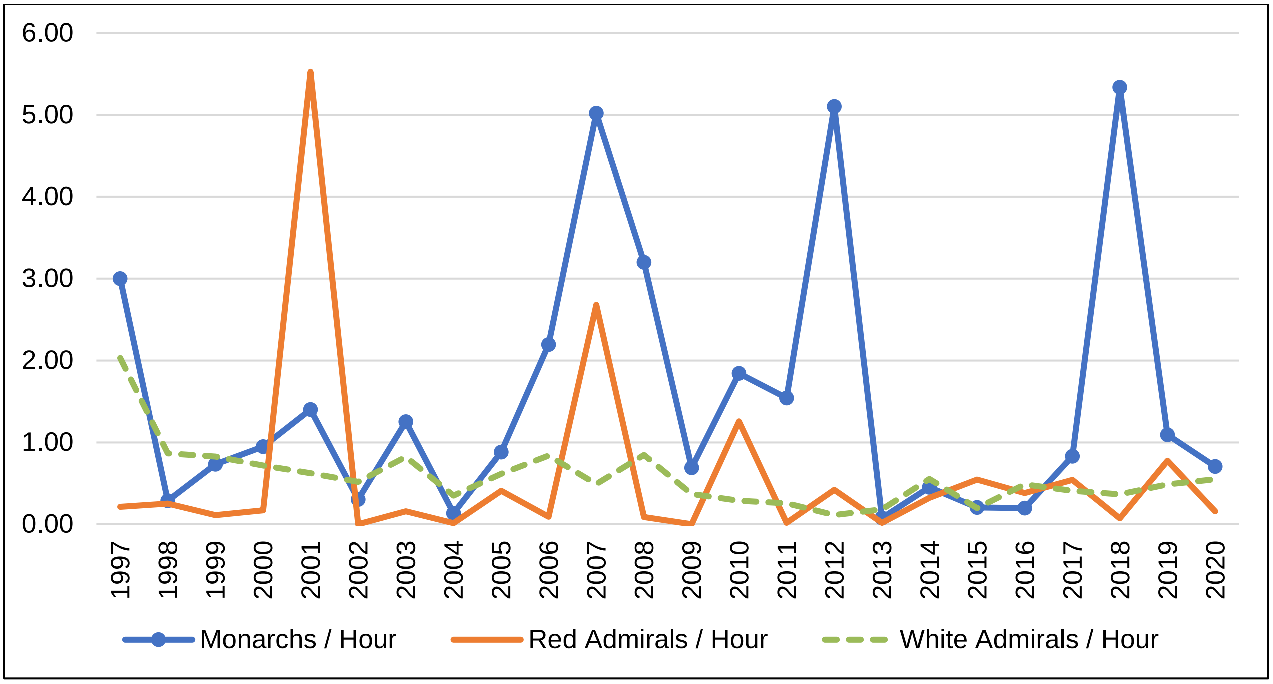


***Figure 2.** The Fluctuations of Three Butterfly Species on the Sunderland Count*

Counts also show the relative abundance of the two subspecies of *Limenitis astyanax*, with Red-spotted Purple being southern and White Admiral being northern. For example, on the two Durham Region counts (where both occur), the ratio has been very consistent: 90% White Admiral and 10% Red-spotted Purple. In Hamilton, the results are opposite, and south of there, White Admirals are almost absent.

Using count data to show population trends for the more obscure species does not work so well: the amount of effort between counts varies considerably, and less experienced counters often do not pick out these species. In particular, skippers -- which make up about a third of the species – are more difficult to identify and are more difficult to count (because of their small size).

With so many eyes intently searching on count day, unexpected species sometimes turn up. In the 2020 Sunderland count, one participant (Rayfield Pye) found Atlantis Fritillary, a new species for Durham Region. Counts have documented range expansions of northward moving species. The first Delaware Skipper and Dion Skipper observations for Haliburton County were made on Haliburton Highlands butterfly counts in the late 1990s. Both species have become common there since. Then in 2020 Toronto Centre was the first North American count to record European Common Blue. Many more Ontario counts will likely be finding it in the near future. Check the TEA's Ontario Butterfly Atlas (www.ontarioinsects.org/atlas) for the latest data. And contribute your butterfly count observations to eButterfly (www.e-butterfly.org) or iNaturalist (www.inaturalist.ca).

Some unexpected surprises, particularly southern vagrants, have appeared on butterfly counts including Pipevine Swallowtail, Cloudless Sulphur, Dainty Sulphur, Marine Blue, Variegated Fritillary, Horace's Duskywing, Sachem and Zabulon Skipper.

Butterfly populations can shift over time, which can be seen in some of the counts that have been conducted for many years. For example, during the first years of the Sunderland count in the mid 1990s, remarkably high numbers of butterflies were found along that rail trail that traverses marshes, meadows and thickets. In recent years the numbers along the rail trail have been significantly less. Extensive habitat is still present but it's not the same. Thickets have grown in from the edges, becoming denser, which is less favourable for the sun-loving butterflies. The slow process of succession has gradually reduced the amount of milkweed and other nectaring plants.

Non-native plants such as dog strangling vine, Phragmites and common buckthorn have transformed many former productive butterfly habitats over the years that I have been doing butterfly counts. This appears to be another reason for a gradual reduction in butterfly numbers. Invasives not only outcompete nectar plants that butterflies seek but also larval food plants.

Conclusion

Counts have become a tradition for many Ontario butterfly enthusiasts who eagerly participate in several counts through the 'butterfly season'. Interestingly, Ontario has done a better job than nearly any other jurisdiction in North America in terms of effectively conducting a large number of butterfly counts with higher totals and species numbers. This is a result of the effort by compilers and parties in covering their areas well. I believe that the TEA has played a big role in making the counts so successful in this province. All of the counts are advertised on the TEA website, which helps members as well as other interested naturalists a way of finding out about counts near where they live. Butterfly counts have not become so popular in other parts of Canada. In fact, many provinces have never held a formal count.

Could counts be extended to other insects? Butterflies are the optimal group because they are large, diurnal, with a comparatively small number of species that are easier to identify than most groups. A few dragonfly and damselfly counts are regularly held, which are conducted in a similar approach as butterfly counts. New protocols would be needed for other groups starting with smaller sample areas. With the growing interest in moths perhaps a standard count could be developed for them.

In summary, butterfly counts are a great citizen science program that the interested public can participate in. Every year more people are getting out to participate (bar covid). It has been a good way for generating an interest in butterflies and nature in general including youth. Counts contribute records to the TEA's butterfly atlas and eButterfly. I have found that the concerted effort by many parties on my two Durham counts, have contributed to identifying important butterfly habitats, finding rare species and a better understanding of our local butterfly fauna.

Ontario Butterfly Counts in Summer 2021

James Kamstra (james.kamstra@aecom.com)

Twenty-one butterfly counts were held in the province in 2021, but at least ten other regularly held counts were cancelled mostly due to COVID precautions. Most of the provincial park counts were cancelled. The post-count tallies and social dinners that are held at the end of many counts did not happen for the second consecutive year. Instead, the results were sent to the compilers by email.

Only one count was done in northern Ontario – Atikokan, conducted by a single counter. All of the others were south of the French River. One new count was established, Upper Credit River in the municipality of Peel.

Butterfly counts generally follow the protocols of the North American Butterfly Association (NABA) where groups make their best effort to cover and record all of the butterflies in a 15 mile (24 km) diameter circle area in one day. Some counts cover a much smaller area. The results from 13 counts were submitted to NABA for inclusion in the North American butterfly count report.

Manion Corners counted a remarkable 62 species, which ties the all-time record high Ontario count first set by Sunderland in 2014. Long Point was not far behind with 59 species followed by Petroglyphs with 56.

Sunderland (4575) recorded the greatest number of individual butterflies followed closely by Toronto Centre (4526) and Petroglyphs (4387). Cumulatively, 94 species were tallied on all counts (compared to 98 in 2020 and 100 in 2019). Nine of those species were only recorded on a single count, however. Long Point attracted the most participants (35) followed by Manion Corners (28) and Toronto Centre (25). Dates of the counts ranged from June 8 to July 26 with the majority taking place through July.

The spring of 2020 arrived late with a cooler than normal May. June warmed up but was exceptionally dry. July continued to be dry and hotter than normal. Most butterfly species emerged slightly later but close to their average dates.

Toronto Centre reported 107 European Common Blues, considerably up from the 6 observed last year. It is still the only North American count to find this newly established butterfly.

Few southern wanderers were present this summer. There were no reports of Buckeye, Little Sulphur, or Pipevine Swallowtail, while Fiery Skipper was found only at Clear Creek. Compton's Tortoiseshell was more numerous than usual, turning up on more than half of the counts and well south of where they normally occur.

Monarchs were in high numbers with an average of 154 per count compared to 72 per count in 2020 and a low of only 10 per count in 2016. Nevertheless, Monarch numbers were much lower by late summer than in the past several years. This was in contrast to the usual trend where Monarch numbers normally increase as summer progresses. The other migrant butterflies were in low numbers, especially Painted Lady and American Lady.

The count names, number of species, individuals, number of participants, dates and compilers are summarized on Table 1. The species and numbers of all species on all counts will be presented in the upcoming TEA publication of Ontario Lepidoptera 2021 that is scheduled to be published in Spring of 2022.

Table 1. *Ontario Butterfly Counts Held in 2021*

Count Name	# Sp.	# Individ.	Partic.	Hours	Region / County	Date	Compiler
Atikokan	18	67	1	5	Rainy River	08-Jun	Dave Elder
Awenda Provincial Park	36	793	24	33	Simcoe	10-Jul	Teegan Nettin
Cambridge RARE Reserve	32	444	4	13.5	Waterloo	18-Jul	Jenna Quinn
Carden Plain	39	646	13		Kawartha Lakes	17-Jul	Bob Bowles
Clear Creek	49	1972	14		Chatham-Kent	25-Jul	George Prieksaitis
Fenelon Falls	40	472	12	15	Kawartha Lakes	22-Jul	Martin Parker
Haliburton Highlands	48	3659	20	65	Haliburton	10-Jul	Ed Poropat
Hog Island	26	197	5	11.5	Renfrew	21-Jul	Jean Brereton
Lake Dore	30	467	4	8.5	Renfrew	29-Jul	Jean Brereton
Long Point	59	3762	35	64	Norfolk	03-Jul	Adam Timpf
Manion Corners	62	2364	28	39	Ottawa-Carleton	03-Jul	Jeff Skevington
Mississauga	27	397	22	49.9	Peel	23-Jul	Felicia Radassao
Oshawa	43	1548	10	33.3	Durham	27-Jun	James Kamstra
Petroglyphs	56	4387	25	52	Peterborough	17-Jul	Jerry Ball

Count Name	# Sp.	# Individ.	Partic.	Hours	Region / County	Date	Compiler
Rice Lake	22	167	8	7	Northumberland	20-Jun	Val Diezel
Rondeau Prov. Park	41	2206	22	47	Chatham-Kent	18-Jul	Laura Penner
Skunks Misery	50	3982			Middlesex	03-Jul	George Prieksaitis
Sunderland	50	4575	23	71	Durham/York	04-Jul	James Kamstra
Toronto Centre	44	4526	25	64	Toronto	10-Jul	John Carley
Toronto East	39	1337	7	33	Toronto/York/Durham	01-Jul	Carolyn King
Upper Credit River	18	379	10	7.5	Peel	24-Jun	Laura Timms

27th Annual Toronto Centre Butterfly Count

John Carley (johnrcarley@gmail.com)

On Saturday, July 10, 2021, the Twenty-Seventh Annual Toronto Centre Butterfly Count took place under the auspices of the North American Butterfly Association Annual Count. Twenty-five observers, in 11 parties on 9 routes, counted butterflies in the 15 mile diameter count circle centred on the intersection of Dundas Street West and Bloor Street West, Toronto. We welcomed one new participant to the count!

The areas censused included the Leslie Street Spit, the Toronto Waterfront, midtown ravines, High Park, the Humber River, Lambton Prairie, Downsview, and other parklands, ravines, and so-called wastelands in the City. This year, after a Covid-year hiatus, the Toronto Islands route was again censused. We are one of the few (if not the only) NABA Counts entirely within a major metropolis.

On count day, the temperature ranged from 20ºC at 9:00 am at the lakeshore to a high of 25ºC, with generally sunny skies overall.

In all, 44 species were tallied by 25 counters: this species total ties our all-time high counts of 2004, 2006, and 2016! Our total count was 4526, our fourth highest ever! There have been only 3 counts with higher totals, the highest being year 2 at 6069. The other high numbers were in 2004 and 2006.

We added a new species - Appalachian Brown - to our overall list, which now stands at an amazing 68 species. Not a bad total for an urban metropolis! The Island route reported 9 Appalachians in all. Also rare for count day was the single Gray Comma spotted on the Downsview route: only our second ever.

The day before our count, I received the 2020 North American Butterfly Association (NABA) Report. Incredibly, our Toronto Centre Count recorded the 2020 continent-high totals for four species: Acadian Hairstreak, Northern Cloudywing, and Wild Indigo Duskywing, and, of course, European Common Blue. NABA’s listing software is such that they didn’t even have a spot for this new-to-the-NABA-count species.

However, what was big news in 2021 is almost “old hat” now. Last year, six observers saw a total of 6 European Common Blues at 4 different sites, the first time this species had ever been recorded on a NABA count. This year, 107 Common Blues in total were seen, spread across six of our nine routes. Interestingly, it was the three waterfront routes that didn’t record one, suggesting that this species’ GTA expansion has been from north, moving southerly.

High counts were achieved for 5 additional species. Harvester, at 6, doubled last year’s high count. The 172 Pearl Crescents, reported from every route, smashed the 2012 high of 122. Of interest, 45 Northern Crescents were reported, and, when one adds in the 51 crescent sp. reported, it was indeed a very good year for crescents. The 409 Monarchs tallied eclipsed the previous high of 366, set in 2010.

Silver-spotted Skippers were also seen on all routes, and, at 242, surpassed the 2012 high count by 112. Finally, the 257 Northern Broken-Dash recorded well-surpassed the 1999 high count of 170. All routes recorded Mourning Cloak, and their total of 66 was our second-highest ever (highest being 79 in 2006). Similarly, all routes reported Common Wood-Nymph, which at 192, was also the second-highest total over the history of the count (highest was 246 in 2005). Also providing a second-highest total were Eastern Tailed-Blue, at 216, seen on all routes too. Crossline Skippers, at 69, were another "second highest". The 585 Summer Azures seen were our third-highest total ever.

Of interest, in addition to the single Gray Comma reported, singletons were recorded for seven other species: Northern Azure, Compton Tortoiseshell, Painted Lady, Viceroy, Northern Pearly-Eye, Eyed Brown, and Hobomok Skipper.

Perhaps the most notable miss was Midsummer Tiger Swallowtail, seen on 25 of the previous 26 counts. (And, in case you were wondering, the other "miss" year was 2007.). No White Admiral/Red-Spotted Purples were seen (they'd been seen on 21 prior counts). Coral Hairstreak was a regular for the count's first 12 years, but none were seen this year, and they were recorded only once in the past seven counts. Little Glassywing went unrecorded: only the third time in count history. Finally, Long Dash, seen for the past five years (and 17 times in the last 26) was also unrecorded.

Other statistics: 11 parties, 64.25 party-hours, and 82.5 party-kilometres on foot. Full count results will be reported in the seasonal summary.

The 2022 count date is set for Saturday, July 9th (the second Saturday of July). Those interested in participating in the Twenty-Eighth Annual Toronto Centre Butterfly Count should contact the writer at (416) 930-6987 or johnrcarley@gmail.com.

> 2021 Observers (25 total): A. Adamo, C. Biggin, M. Brubacher, J. Carley (compiler), H. Currie, N. Godfrey, R. Gottesman, A. Guidotti, N. Huculiak, A. Keaveney, M. Kelch, R. Kortright, S. LaForest, M. Locke, T. Mason, N. McPherson, B. Naday, E. O'Connor, D. Riley, G. Riley, K. Seymour, G. Stuart, D. Worthington, K. Yukich, R. Yukich.

Plant-Pollinator Interactions and Garden Planting Strategy

Vicki Wojcik, Pollinator Partnership Canada (info@pollinator.org)

Which nectar plants are attractive to which pollinators? Knowledge of this information will allow you to select plants for your garden that will attract the type of pollinators that you desire. Look on the web for my organization's ecoregional planting guides (pollinatorpartnership.ca), which sort garden plants by the type of pollinator that they attract.

Thinking more conceptually, the concept of pollinator syndrome allows you to look at the shape, colour, scent, and reward characteristics of a flower and match these characteristics with the morphology, behaviour, and nutritional needs of potential pollinators. The following chart shows the preferences of different insect orders for various flower characteristics and introduces the associated botanical terms (e.g., psychophily: butterfly pollination).

Pollinator relationships are not one-to-one, most pollinators visit more than one plant species, and most plant species are visited by more than one pollinator. Syndromes are correct-ish, but the truth is that pollinator systems have a lot of redundancies, which builds resilience, and that's good news for us. Planting for one pollinator helps another.

Table 1. Insect Pollinator Syndromes

Floral Trait	Colour	Shape	Nectar Guides	Odour	Pollen	Nectar	Bloom
Canatharophily (beetle)	pale/dull, white, green	large, bowl-shaped	none	strong fruity or foul	abundant	accessible nectaries	day
Melittophily (bees, pollen wasps)	yellow, blue, purple, ultraviolet	complex, disc, or tubular	present, obvious	fragrant, pleasant	abundant	abundant	day
Psychophily (butterflies)	red, purple, bright	disc shaped, landing pad	present	strong and fragrant	limited	abundant, deep	day
Phalaenophily (moths)	pale, cream, white, yellow	tubular, with and without landing pad	none	strong and fragrant	limited	abundant, deep	day and night
Myophily (flies)	yellow, white	disc shaped	present	strong and fragrant	limited	abundant	day and night
Sapromyophily (carrion flies)	marron, green, dull	funnel or trap, small	none	strong and putrid	limited	absent	day and night
Myrmacophily (ants)	varied	open, small	none	none	varied	abundant, extra-floral nectaries	day

Insect Orders' Different Preferences

Most pollinators don't look for pollen. They are after nectar, and they get covered with pollen incidentally. So truthfully, with some exceptions for specialized mutualisms, bees are the primary functional pollinators for plants, with flies coming in a close second. Butterflies, moths, beetles, and ants pollinate, but not exceptionally well. We can think of them as messy eaters.

Butterflies like to take a rest when they eat – hence they need to have flowers with a shape that lets them land and enjoy their meal. Disk shaped flowers, or compound floral structures are the best, and likely the ones that you are seeing butterflies on. Butterflies also prefer flowers that are pink, reds (they can see red), purple, or orange.

Moths often hover when they feed, something butterflies cannot do. They also tend to feed on flowers that are more receptive at dawn and dusk. You commonly see moths feeding on bell-shaped flowers.

For pollinating flies, there are two categories: those that visit bright, sweet flowers for nectar, and those that are actually carrion feeding and are tricked into visiting flowers that mimic carrion. The flower flies (family Syrphidae) are perhaps more appealing, and certainly more common and better pollinators, but carrion flies do have a unique niche in the pollination equation. Beyond planting some great fly-attractive plants, you have to consider the full life cycle of flies, and where they lay their eggs and where their larvae develop. And for flies this is often leaf litter, dried plant stems, and the soil itself. A 'messy' garden provides great habitat.

Swallowtails

Many plants attract nectaring swallowtail butterflies. Those that grow well in the sun include: Golden alexanders, *Zizia aurea* ; Yellow pimpernel, *Taenidia integerrima;* Meadow sundrops, *Oenothera pilosella*; Dense blazing star, *Liatris spicata;* and Heath aster, *Symphyotrichum ericoides*. Those that grow well in the shade include: Prairie smoke, *Geum triflorum;* Wild strawberry, *Fragaria virginiana;* Hairy beardtongue, *Penstemon hirsutus;* Wild columbine, *Aquilegia canadensis*; Yellow and red Harebell, *Campanula rotundifolia;* Swamp milkweed, *Asclepias incarnata*; Fragrant Nodding onion, *Allium cernuum;* Grey goldenrod, *Solidago nemoralis;* and New England aster, *Symphyotrichum novae-angliae*.

Photo: Pale Swallowtail (western North America) showing a preference for a purple flower

Controlling the DD Moth – The good, the bad, and the ugly

Clement Kent, PhD (clementfkent@gmail.com)
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Many trees in High Park and elsewhere in Ontario have suffered badly from the latest outbreak of the DD moth (see explanation of the common name below): *Lymantria dispar dispar* (Linnaeus 1758), formerly known as gypsy moth. Although trees usually survive the first year of infestation, multiple years of DD infestation weakens trees severely and may kill them.

Figure 1. *L. dispar ♀ left (by 'Opuntia', GNU License 1.2), ♂ right, Didier Descouens - CB BY SA 4.0*

So, there's lots of pressure from the public to 'control' the DD moth. But before looking at good, bad, and ugly methods, let's look some more at the moth itself, at its evolution, ecology, and behaviour.
Linnaeus himself named this Eurasian species. *Lymantria* means 'destroyer', which is certainly apt, while *dispar* comes from the same root as 'disparate', referring to the visible differences between males and females. Since there is not yet a formal new common name, I'm going to use DD or 'disparate destroyer' here.

In the 263 years since its naming, the genus Lymantria has blessedly remained constant while taxonomists have changed the family and superfamily numerous times. The latest molecular/DNA data says: superfamily: Noctuoidea; family: Erebidae; subfamily: Lymantriinae – tussock moths; and tribe: Lymantriini.

Knowing the evolutionary relationships of DD helps when we look at control strategies. Moth fans know the Erebidae for having the largest moths (the Black Witch moth *Ascalapha odorata* Linnaeus 1758) to many tiny species in the Micronoctuini. Erebidae may have the largest number of moth species of any family. The subfamily Arctiinae includes the often-lovely tiger or woolly bear moths whose caterpillars are so noticeable. The Erebinae is one of the renamed subfamilies that used to be called the Catocalinae, after the underwing (*Catocala*) moths we enjoy.

In many Lymantriinae, caterpillars are covered in irritating hairs which are an important defense against some predators. This is one of the things people dislike greatly when their car or deck gets coated with DD caterpillars. Also, a rash can result from skin contact. Many species also have the adult 'disparity' between males and females, with females often being flightless in the European subspecies *L. dispar dispar* but flying in the Asian *L. dispar asiatica* and Japanese *L. dispar japonica*. Eastern North America females are from the European subspecies, so they emerge, mate, and lay eggs on the tree where they pupated.

So how does DD blanket entire forests with munching caterpillars? This is where the “gypsy” in the earlier species name came from. In spring first instar caterpillars hatch, climb up the tree, and dangle from a silk thread which acts as a parachute when the wind blows. Often this only gets them to the next tree, but the strong storms of springtime can send them many kilometers away. Silk ballooning, as it is called, has evolved in spiders, spider mites, and moths. Another human dispersal method works to our detriment: moving wood with egg sacs allows long jumps.

There are many stories to be told of DD moths, one of the worst of which is its introduction to North America. Étienne Léopold Trouvelot was a French artist and astronomer who emigrated to Medford, Massachusetts after ending up on the wrong side of a political coup. Trouvelot was also an amateur entomologist. Because some native silk-spinning caterpillars were susceptible to disease, Trouvelot imported DD in 1868 to breed a more resistant hybrid species. It escaped his control and became an invasive pest. Although entomologists and foresters might wish his name to live on in infamy, Trouvelot’s illustrations of astronomical phenomena were highly valued and he was invited to join the Harvard Astronomical Observatory and the American Academy of Arts and Sciences. Craters on the moon and Mars are named for him.

By 1889 major outbreaks were defoliating forests in New England. DD is now a major pest, causing around a billion dollars of damage each year. But DD is roughly cyclical – a large area may have an outbreak for up to 10 years, but any one location within will only have peak densities for 1 or 2 years. Why?

Natural enemies of DD moth are many, but since it is not native to our continent it doesn’t have as many here as in its Eurasian home. Deer mice are thought to be one of the most important predators (of pupae, moths, and egg clusters) when densities are low. Here the ecology gets interesting: deer mice are more abundant in years following an oak “mast” event when there are many acorns to eat. So a big acorn year is followed by a big deer mouse year which helps keep DD numbers down. But a big mouse year increases predators like foxes, and oaks don’t mast 2 years in a row so mouse populations can cycle down rapidly the 2^{nd} year. This can relieve mouse pressure on the moths. Other ground-based predators include shrews, voles, chipmunks, and caterpillar-hunter beetles. *Calasoma sycophanta* (Linnaeus, 1758) was imported to New England in 1905 to hunt DD.

Figure 2. *Calasoma sycophanta preys on a DD caterpillar - by Hectonichus CC BY-SA 3.0*

Winter songbirds probe the bark of trees for DD eggs, including chickadees and nuthatches. Spring birds that eat DD caterpillars include blue jays, catbirds, chipping sparrows, crows, cuckoos, grackles, orioles, red-winged blackbirds, robins, starlings, bluebirds, towhees, and vireos. Ornithologist Eugene Morton tells me he had an outbreak at his country property this year and that the cuckoos fed very well. Eugene also saw purple martins carrying as many as 5 male adult moths at a time in their beak to feed to nestlings.

The Australian entomologists and ecologists H.G. Andrewartha and L.C. Birch used long series of data on outbreaks of pest insects such as thrips and grasshoppers to establish how large a role factors like weather could play in insect ‘cycles’. Their classic books “The Distribution and Abundance of Animals” (1954) and “The Ecological Web” (1984) are well worth borrowing from a library. Their data and arguments suggest the interaction of ‘non-biotic’ factors such as weather and biological controls such as natural enemies is important. For the DD moth, 5 days at -25C kills the embryos, so the northern limits of their range will depend on how consistently cold winter is – making Hudson Bay fairly safe but all of Southern Ontario now vulnerable. And spring storm intensities govern spread, while hot dry summers increase larval survival. Climate change will likely increase DD outbreaks in Ontario in each of the 3 seasons above.

The Ugly. As entomologists, we know that some of the most important natural enemies of insects are other insects, especially the parasitoids: wasps, flies, and others. Around 1900, studies in Eurasia of DD showed that the tachinid fly *Compsilura coccinnata* (Meigen, 1824) attacked and killed DD moth caterpillars. Unfortunately, the studies missed the fact that *C. coccinnata* has 3 generations a year while DD has only one. It typically only parasitizes 5% of DD caterpillars in an outbreak, but then goes on to attack some of our most beautiful silkworm moth species and has greatly reduced their numbers. It has been found attacking over 150 moth and butterfly caterpillars. In 1952, Henri Raizenne of the Division of Forest Biology in Ottawa published “*Forest Lepidoptera of Southern Ontario and their Parasites Received and Reared at the Ottawa Forest Insect Survey Laboratory from 1937 to 1948*”. Raizenne found *C. coccinnata* in larvae of the Question Mark, Comma, Mourning Cloak, Io moth, Hickory Tiger moth, Sycamore Tussock moth, and probably many others (I only scanned the first 25 pages of this 280 page monograph.)

Given the catastrophic effects of this ugly biological control introduction on so many of our Lepidoptera, one must be careful when we look at other proposed biological controls. We should be especially vigilant about spread from the target DD species to others in the Erebidae.

The Bad. If parasitoids are better than predators as biocontrol, then the fastest reproducing, most efficient natural enemies should be the disease organisms. *Bacillus thuringiensis* (Shigetane, 1902) is a natural enemy of a large number of insect species. It’s a bacterium which multiplies in insect guts after the spores are eaten by the larva. It reduces gut efficiency, and when it multiplies it forms long-lasting spores and a set of toxins. These toxins disrupt the larva’s gut, often causing death.

There are multiple strains of *B. thuringiensis* in nature. Some are more toxic to lepidopterans, others to flies or Hymenopterans or beetles or nematodes. *B. thuringiensis kurstaki* (BTK) is the strain most toxic to lepidoptera. They have been used for ‘organic’ control of pests since the 1920s. A 100ml container of Safer’s biological insecticide will cost you $12.99 at Canadian Tire. A quart of Monterey B.t. is $53.99 on Amazon and contains “Bacillus thuringiensis subspecies kurstaki strain SA-12 solids, spores and Lepidopteran active toxins (At least 6 million viable spores per mg) ... 98.35%”.

One of the best reads on DD and BTK is by Simon Fraser University professor Mark Winston, winner of the 2015 Governor General’s award. In his 1997 *Nature Wars: People vs. Pests* he recalls a summer job in the early 1970’s: “wandering through through defoliated forests, smelling the stench of rotting gypsy moth larvae that had died from starvation and viral diseases after consuming every leaf in an outbreak area.”

Chapter 2 in *Nature Wars* describes the tumult in Vancouver in 1992 after DD moths arrived from the east of Canada on the side of someone's wooden canoe and in large numbers from Siberia on the sides of Russian freighters, leading to the spraying of BTK on 45,550 acres of Vancouver.

A side note: to Hemiptera and Homoptera fans - BTK only affects insects that ingest it from the leaf surface. Sucking insects have been shown to increase in densities after BTK application. Shall we celebrate the replacement of DD rash with aphid honeydew rain?

A digression: why do citizens get passionate about a DD outbreak? It would be nice to think they are passionate protectors of their trees, but I propose the rash and the mess on the car and the deck are the main motivators.

Whatever the cause, municipalities around Ontario have been besieged with calls to control DD outbreaks. BTK sprays are licensed in Canada. A survey I did in spring 2021 showed that many were contracting for spray applications. According to an interview by the CBC of a representative of one spraying company: "the company has committed to do aerial sprays for over 6000 individual contracts, eight municipalities and six reservations this year. He expects to cover about 50,000 acres of land throughout Ontario, ranging from municipal park lands, maple bushes, cottage areas and forestry woodlots."

The company is said to have sprayed four neighbourhoods of Sarnia on May 14 and 21 this year. Now, let's do a bit of ecological reasoning: BTK spray affects any lepidopteran caterpillar that eats it from tree leaves; the most favored species for DD moths are oaks; Douglas Tallamy has documented that oaks host more species and higher densities of caterpillars than any other genus of trees; Tallamy and many others have shown that caterpillars are the most common food of nestling birds; and the peak of nesting periods in Southern Ontario is from mid-May to June. Thus, it would appear that this spraying has drastically reduced baby food for birds in 50,000 acres of forest habitat in southern Ontario this year. I wonder if the passionate moth counters of the TEA have data before and after BTK spraying in specific Ontario locations.

Yet another digression*:* Bacteria are hard to put definitively into species buckets, because they promiscuously interchange DNA in the form of circular 'plasmids'. Research done on *B. thuringiensis* has shown that if you delete the plasmids encoding the gut toxin, it becomes nearly indistinguishable from the common soil bacterium *B. cereus*, and close to its kissing cousin *B.anthracis* (Koch, 1874) which causes anthrax.

Last digression, I promise*:* the DNA for BT toxin from *B. thuringiensis* plasmids has been transferred into genetically engineered crops such as corn, soy, and cotton. The plants themselves make the toxin. Bayer and Monsanto have patented these varieties. The side effects of this include insects which have evolved BT toxin resistance, such as pink bollworm (cotton), diamondback and cabbage looper moths (crucifers). BT toxin has been engineered into poplar trees which are widely used in plantations in China. The long-term effects of this on the forest Lepidopteran community are not yet known.

The Good: The City of Toronto's Urban Forestry division is proposing that for 2022 it would use the MNPV spray "BioVir." BioVir uses MNPV (short for multicapsid nuclear polyhedrosis virus), which so far as is known only attacks DD. Other moths and butterflies are said not to be affected. Other spray methods of control registered in Ontario use the bacterium BTK, which kills all moth and butterfly larvae that ingest it. One of the target areas is the Oak Savannah habitat in High Park. TEA has provided a letter of support to Toronto Urban Forestry for this use of the MNPV spray instead of BTK sprays.

High Park is an area of special environmental concern, containing one of the last Oak Savannah habitats in Ontario. Oaks are particular targets of DD moth. Losing the big old oaks in the savannah would be a huge environmental blow to the city and indeed to the province. I visited High Park numerous times this year and can testify to the large numbers of DD egg clusters on the trees this fall, suggesting a challenge next spring when they hatch.

A concern with the use of BioVir is that it has only conditional emergency registration for use in Canada. However, GypCheck, a product registered for control of DD in many US states, has the same MNPV active ingredient. GypCheck has been used for many years in the US, and has proven safe and effective.

Considerable testing work has been done with GypCheck to verify this. BioVir/GypCheck will not affect the many other species of caterpillars fed to baby birds. In fact, by reducing competition from DD caterpillars, it may increase the number of bird-friendly larvae to be fed to birds.

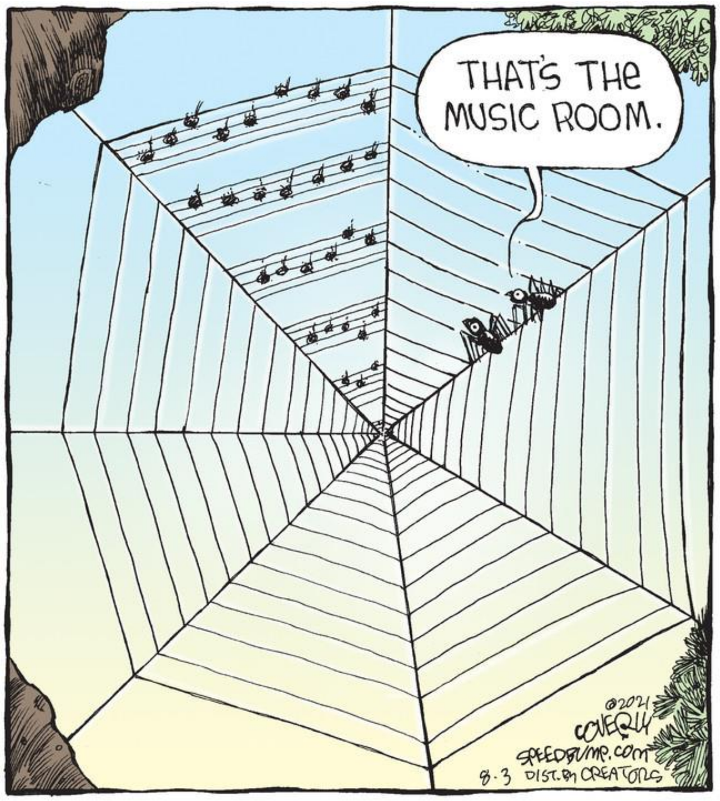
If the emergency use of BioVir in High Park is monitored and the effectiveness documented, it will give the many other areas in Ontario suffering from DD infestations hope for a biologically sound solution. I congratulate the City of Toronto's Urban Forestry division for proposing an ecologically safe and sound method of DD control. I hope this will go forward as planned.

I regard this as an ecologically safe and sound method of DD control, and I heartily endorse this proposal. But I'd like to suggest a caution: studies so far of MNPV spray haven't documented harm to other species. How many other tussock moth species have been tested?

The Unknown: The insect-eating fungi are a fascinating group. The genus name *Entomophaga* means just that: insect-eating. *E. maimaiga* is a Japanese fungus which attacks DD. "Maimaiga" is the Japanese word for DD moth. *E. maimaiga* was introduced in the Boston area 1910-1911, apparently without any effects. Several later introductions were tried, apparently unsuccessfully. But in 1989 DD caterpillar carcasses with *E. maimaiga* spores were found in the wild, and since then it has become an important control. According to Wikipedia: "*Entomophaga maimaiga* can only potentially affect lepidopteran larvae that are present in the spring, when gypsy moth larvae are present. 78 species which fit this criterion were tested. Only about one-third were able to be infected under optimal conditions. Infection was only consistently high among three species of tussock moths and one colony of a hawk moth. However, field studies showed that rates achieved in the laboratory are far higher than found in the field."

As with MNPV, I'd like to suggest that fans of tussock, tiger, woolly bear, and underwing moths try to keep an eye on caterpillars for signs of fungal infections.

I hope you've enjoyed this journey through the entomology, ecology, and behaviour of disparate destructor moths and their kin and controls. As Andrewartha and Birch said in 1984, we need to pay attention to 'the ecological web' when we try to control nature.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Figures 3-5 for article on pages 6-10:

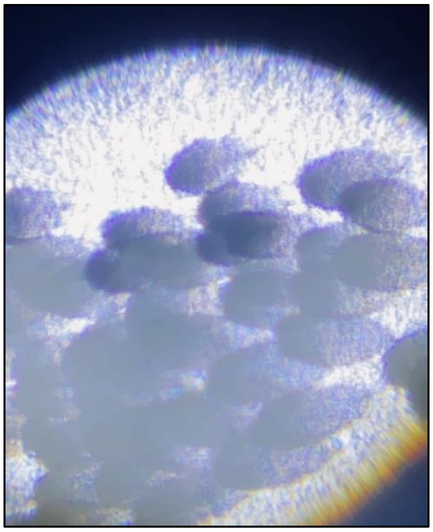

Figure 3. *Image of monarch butterfly scales with no evidence of OE spores; image taken with iPhone 11 camera using the microscope's digiscoping clip*

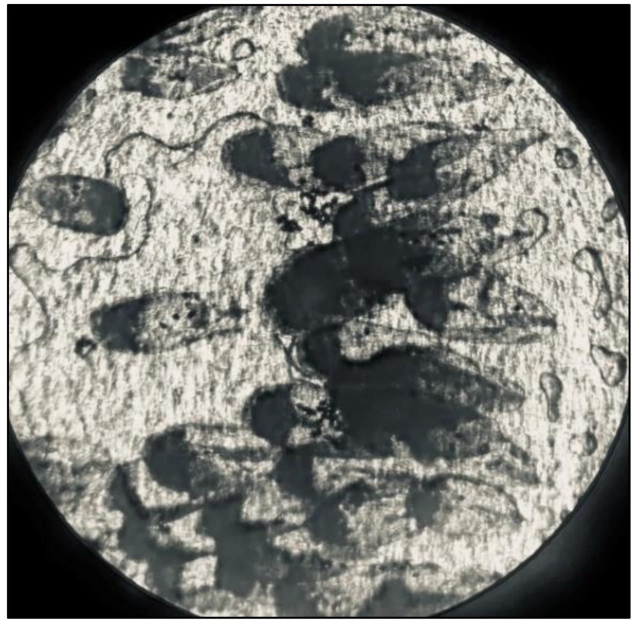

Figure 4. *Image of monarch butterfly scales showing evidence of OE spores; image taken with iPhone 11 camera using the microscope's digiscoping clip*

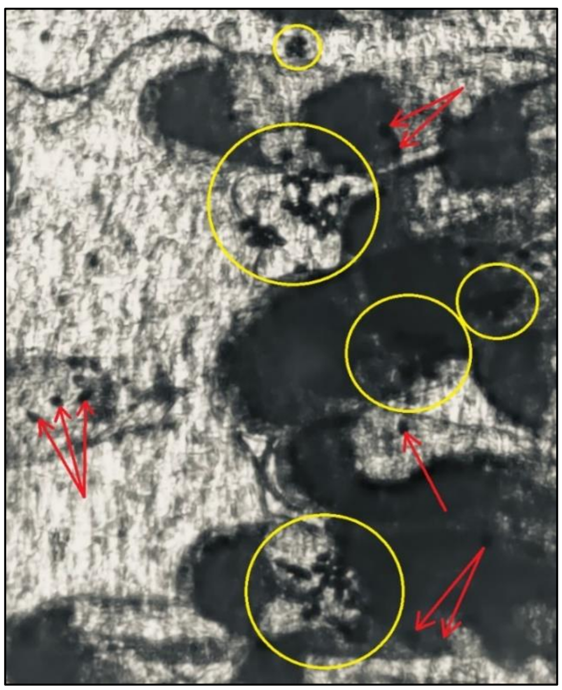

Figure 5. *Enlarged graphic of Image 4; clusters of OE spores are circled in yellow, individual spores identified with red arrows*