School Malaise Trap Program

2013 Program Report

The 2013 School Malaise Trap Program was a huge success and your participation made it happen. This short report summarizes the program — its procedures and results — and all of the interesting discoveries from your work. Before we get to the results, let’s review what the School Malaise Trap Program was all about and how we worked together to complete it.

The Biodiversity Institute of Ontario (BIO), at the University of Guelph, is a research institute dedicated to rapidly identifying and documenting life in Canada and in the world. This is no easy job since there are millions of different species of animals and plants across the globe, and about 100,000 of them occur in Canada. In addition, it’s often difficult to separate closely related species by their appearance, even for experts. Fortunately, BIO has developed a new tool that makes identifying species quick and easy — it’s called DNA barcoding. Just like a can of beans in a grocery store, where the barcode lets the cashier quickly know it is different from a can of peas, each species has a small piece of DNA that can be used to distinguish it from other species. BIO is assembling a DNA barcode reference library for all of the world’s species, called the Barcode of Life Database, and we’re doing it through a huge research project called the International Barcode of Life project. We need help to complete it, and that’s where your class and the School Malaise Trap Program fit in.



Collecting Specimens

In February 2013, we began visiting classrooms across southcentral Ontario in our mobile research vehicle, the BIObus. We visited Grade 6 and Grade 12 classrooms in 60 schools and gave them a lesson on biodiversity, DNA barcoding, and the star of our program — the Malaise trap. Because this tent-like apparatus is so effective at collecting insects, we provided each class with its own trap to explore biodiversity in their schoolyard. We asked each class to set up its trap and collect insects during the same two weeks (April 22 — May 3). To obtain comparative results, we also partnered with six great organizations that agreed to run Malaise traps: Point Pelee National Park, Georgian Bay Islands National Park, Pukaskwa National Park, Conservation Halton, The Toronto Zoo, and Grand River Conservation Authority. In addition, we set one up on our property at BIO. At the end of the two weeks, all traps and collection bottles were picked up and returned to BIO to allow analysis to begin.

Sorting Specimens

Once the collection bottles arrived, BIO staff recorded details on the collection locality from each bottle and compiled the weather data recorded by the students in each class. Next, the contents of each bottle were poured into a sorting dish, and, using a microscope, every specimen was counted in each trap. Our staff then attempted to pick as many different species as possible, selecting up to 285 animals to DNA barcode from each trap. Each selected specimen was then placed in an individual well of a DNA tissue plate. If a specimen was too large to fit in a well, one leg was removed and placed in the well. This process led to the assembly of 239 plates, each plate containing tissue from 95 specimens for a total sample size of 22,705 individuals! Once these plates were ready, they were transferred to the molecular laboratory for the next phase of barcode analysis.




Sequencing Specimens

The first step in the laboratory was DNA extraction. All of the plates, each containing 95 specimens or legs, were incubated overnight in a special solution that extracts DNA out of the cells. The next day, the DNA was separated from other cell materials using one of our robots, lovingly called Franklin (after Rosalind Franklin, who helped to discover the structure of DNA in the 1950s). The second step in our analysis employed a clever technique called the polymerase chain reaction or PCR. By adding a cocktail of reagents to the DNA , then rapidly heating and cooling it several times, we created millions of copies of the DNA barcode region for the sample of DNA in each well. All these copies are necessary for the final laboratory step — DNA sequencing where each well was analyzed on one of our DNA sequencers that use a laser to read the letters (A, C, G, and T) of each DNA barcode. And there you have it, that's how we determined the DNA barcode for each insect (or other invertebrate) caught in your trap!




For a fun classroom activity that shows how to query a DNA barcode on the Barcode of Life Database, click here.

Analyzing the Sequences

Although the molecular work was complete, there was one more critical step – the analysis of your sequence results. Your DNA barcodes needed to be compared with the records in BOLD, the Barcode of Life Database to obtain identifications. When one of your DNA barcodes matched a record in BOLD, we could confidently assign its source specimen to that species, for example, to the Zebra spider (*Salticus scenicus*) or to the Twice-stabbed lady beetle (*Chilocorus stigma*). In other cases, BOLD indicated that your record derived from a distinct species, but it could only assign it to a group such as the Feather-winged beetles (Ptiliidae) or Moth flies (Psychodidae). In some cases, your barcodes did not find a match; they were brand new DNA barcodes for BOLD! We will discuss these exciting discoveries later in this report. All of the identifications were then compiled for each trap to create the report that you are now reading. We're very excited to share the news, so let's get to the results.

2013 Program Results

Drumroll please! It's time to share results for the 2013 School Malaise Trap Program. Let's begin with a general summary. This year's program involved 60 schools in 42 cities, 77 classrooms, and 2003 amazing students that we enjoyed meeting. Your classroom's trap was one of 82 traps deployed from April 22 to May 3, 2013. Happily, only one trap was vandalized, so 81 traps collected specimens. The weather was cool for much of April in Ontario, but warmed up just in time for trap deployment. Average daytime temperatures were 6.7°C for Week 1 and 14.4°C for Week 2, which meant there were lots of insects flying.

To check out where all the schools and traps were located, play with the interactive map here.

Click on the each of the icons to see the school name and the results from that trap.

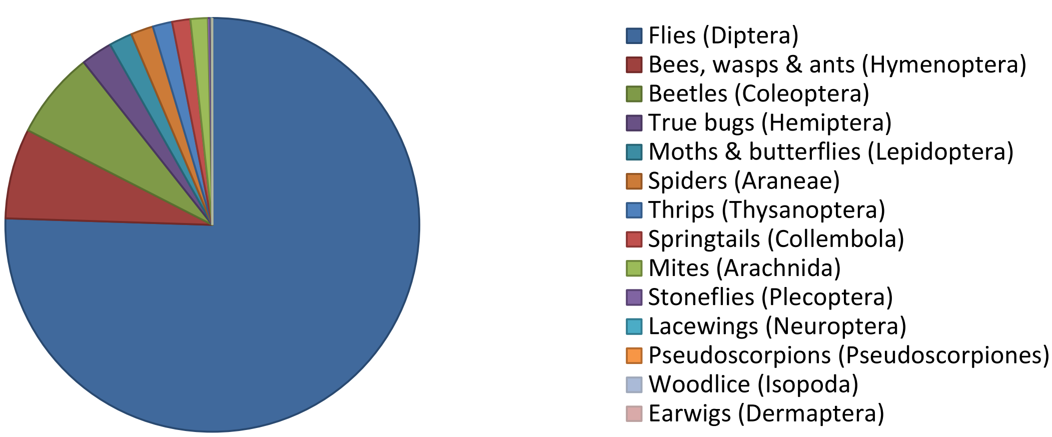
We were surprised that your trap catches were so high; but it seems that insects like warm spring days just like humans. The 81 traps collected an average of 326 specimens in Week 1 and 854 specimens in Week 2, for an average total of 1180 specimens for the collecting period. The total number of specimens showed considerable variation among traps, from a low of 110 to an incredible high of 22,500 specimens. It might surprise you that so many insects were collected in your schoolyard. If so, remember that you only collected for two weeks while insects fly in Ontario for eight months of the year!

Did you know that the BIObus that visited your school is on Facebook and Twitter? Like or follow BIObus_Canada so you can share in the BIObus adventures.

In five days, the staff at BIO sorted the 95,500 specimens present in your 81 traps and selected 22,705 specimens for barcode analysis. Five days later, the molecular work was complete with 21,535 (95%) of the specimens delivering a DNA barcode. Because we excluded a few short barcodes, the final dataset included 19,501 barcodes. The analysis of these barcodes revealed that you collected 1392 species in just two weeks of sampling. That's very impressive because there are only 70,000 species known from all of Canada so you collected 2% of them. Roughly half of these species were uncommon since 652 species were only collected in a single trap. More excitingly, your collecting efforts provided the very first records for 276 species. You should feel proud that you have made such an important contribution to the International Barcode of Life project!

All 1392 species that you collected were arthropods — invertebrates with a hard external skeleton. If you look at the pie chart below, you'll notice that most (76%) of the species were flies (scientific name: Diptera). Some groups of flies were particularly diverse; there were 250 species of midges (Chironomidae) and 53 species of fungus gnats (Sciaridae). The most abundant species was also a fly — the onion fly (*Delia antiqua*). After flies, the next most abundant group was bees, wasps, and ants (Hymenoptera), followed by beetles (Coleoptera). Most of the species in these groups have wings, so it's not surprising that they were collected in your Malaise traps. However, your traps also collected some groups that don't fly, such as) woodlice (Isopoda), spiders (Araneae), springtails (Collembola), mites (Arachnida), and pseudoscorpions (Pseudoscorpiones).

To see a list of all 1392 species collected in the 2013 School Malaise Trap Program, click here. To just see a picture of each species, click here.






And now the section of the report that many of you have been waiting for — to see how your schoolyard compared with the other schools and parks in southcentral Ontario. There are many ways to measure biodiversity, but we have adopted four metrics for comparisons among the sites:

The simplest metric compares the number of specimens collected by each trap. The great advantage of this method is that anyone can do it — so long as you can count! In practice, it's not a very informative measure of biodiversity, since it can be affected by one or a few very common species. However, there was tremendous variation in the total number of specimens caught, ranging from a low of 110 individuals at the most northerly site, Pukaskwa National Park, to the winner for this category — Bobby Orr Public School in Oshawa, which had a catch of 22,500 specimens -- congratulations!

For an advanced classroom activity, it would be interesting to test these three hypotheses:

1) Were the number of individuals and species collected higher in Week 2 than in Week 1?

2) Were the number of individuals and species collected associated with the average daytime temperatures of the site?

3) Were the number of individuals and species collected associated with the population of the city/town where the trap was deployed?

Number of Specimens Caught – Top 3:

School/Park	Trap #	Total Specimens
Bobby Orr Public School	EQP-CLL-562	22,500
Zorra Highland Park Public School	EQP-CLL-570	5500
Point Pelee National Park	EQP-CLL-590	3438

Click here to view the results from all 81 trap sites. In addition to the specimen and species counts, we've also compiled the weather and population data associated with each.

The second way to compare biodiversity, and certainly one of the best ways, is to count the total number of species in a sample. By using DNA barcoding, we were able to quickly determine the number of species at each site, even if some could not be assigned to a particular species. The total species count varied considerably among sites. Pukaskwa National Park had the lowest number with 20 species, undoubtedly due to low temperatures during the collection period (the average daytime temperature was a chilly 2°C). In contrast, the winner for the most species collected with an extraordinary 137 was Blessed Sacrament School in Burford — way to go team!

Number of Species Caught – Top 3:

School/Park	Trap #	Species Count
Blessed Sacrament School	EQP-CLL-552	137
Meaford Community School	EQP-CLL-555	133
Donald A. Wilson Secondary School	EQP-CLL-605	122

A third way to compare biodiversity is to consider the rarity of the species that were collected. The Barcode of Life Database (BOLD) has over 2 million DNA barcodes, including records for over 45,000 Canadian species, so it is not very often that one is able to add coverage for a new species. As a result, we were amazed that 276 new species were detected in your collections. When we compared the number of new species detected at each site, there were two winners— congratulations to Paris Central Elementary School in Paris and St. James Catholic School in Guelph for both collecting 17 species new to BOLD.

Number of New Species Added to DNA Barcode Library – Top 3:

School/Park	Trap #	Species New for BOLD
Paris Central Elementary School	EQP-CLL-508	17
St. James Catholic School (GUELPH)	EQP-CLL-592	17
Meaford Community School	EQP-CLL-555	14

Finally, biodiversity between sites can be compared by examining the overlap in species among sites. With 81 traps deployed for the same period, any species that was only collected in a single trap is certainly a 'rare' species. In total, there were 652 rare species and most sites had at least one. However, one classroom had the lead in collecting rare species — and it also ranked highly in two other categories — Meaford Community School. Let's give them a big round of applause for the high biodiversity in their schoolyard!

Number of Species Unique to Trap – Top 3:

School/Park	Trap #	Species Unique to Trap
Meaford Community School	EQP-CLL-555	21
Donald A. Wilson Secondary School	EQP-CLL-605	19
Hagersville Elementary School	EQP-CLL-526	18
Sacred Heart High School	EQP-CLL-573	18
Georgian Bay Islands National Park	EQP-CLL-614	18

The 2013 School Malaise Trap Program Team

If you would like to see how your school ranked in these four categories, click here for tables of all the results.

We would like to conclude by thanking all of the participants in the 2013 School Malaise Trap Program. This project would not have succeeded without the enthusiasm, curiosity, and dedication of every student, teacher, and colleague. Please check our website periodically for updates, and we'll be in touch when we roll out the 2014 program!

Some fun insect jokes to tell your friends in the schoolyard:

Q: Why did the fly never land on the computer?
A: He was afraid of the world-wide web!

Q: How do bees brush their hair?
A: With a honey comb!

Q: How do fireflies start a race?
A: Ready, Set, Glow!

Q: What do moths study in school?
A: Mothematics!

Q: What do you call a wasp?
A: A wanna-bee!

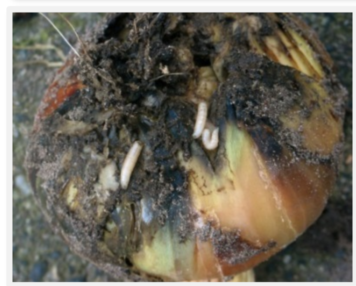
Q: Why wouldn't they let the butterfly into the dance?
A: Because it was a mothball.

Q: What creature is smarter than a talking parrot?
A: A spelling bee!

School Malaise Trap Program

Top 10 Interesting Discoveries for 2013

Onion Fly *(Delia antiqua)*



The Onion Fly was the most abundant species collected in the School Malaise Trap Program – in fact, it was found in 79 of the 81 traps! Furthermore, it was found earlier in spring than previously recorded. This fly is found in the temperate regions of North America, Europe, and Asia. Onion flies are grey and look much like house flies, except their legs are longer and their body (abdomen) is narrower. Adults lay their eggs in the soil near onion bulbs. The larvae are 8-10 mm long, white, and feed almost exclusively upon onion plants. Damage due to the larvae feeding on young onion seedlings often results in plant death. Onion flies have three generations per summer in Ontario so there is great potential for widespread damage to onion crops. For more information, the Ontario Ministry of Agriculture and Food discusses the onion fly as a pest species here.

Pear Thrips *(Taeniothrips inconsequens)*

Pear thrips are an invasive species from Europe. They arrived in California the early 1900's and are now be found throughout most of the USA. They are tiny, measuring only 1.2 to 1.7 mm long, with brown-black colouration, two pairs of wings, and rasping mouthparts. They use these mouthparts to cut open leaves and buds of hardwood trees so they can feed on plant fluids. The collection of pear thrips by the School Malaise Trap Program marks the first time they have been barcoded from a Canadian location. They were found in 53 out 81 traps. This is a very interesting discovery, and could signal a threat to Canadian forests – in the late 1980's pear thrips were responsible for damage to 1.3 million acres of Pennsylvanian forest. In North America, only female pear thrips have been found; they reproduce by parthenogenesis, producing eggs that do not require fertilization by a male. To learn more about the possible effects of pear thrips on a forest, check out the following document and this site.

Handsome Fungus Beetle *(Phymaphora species)*

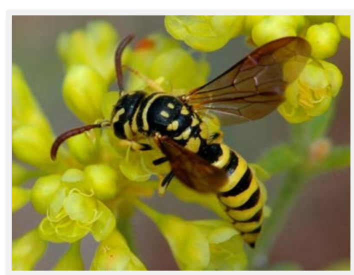
In North America, there are only two described species of Handsome Fungus Beetles. One beetle sampled in the School Malaise Trap Program is similar to *Phymaphora pulchella*, but its DNA barcode indicates it is likely a distinct species. This means that it is possibly a species that is new to science! Its closest relative, *P. pulchella,* is a tiny insect (3-4mm long) with a dark spot above its head, and another dark band across its back. It has yellow legs and antennae, and the particularly 'handsome' males have antennae with swollen tips. Handsome Fungus beetles occur all over the world, but this species is native to North America. These beetles feed on fungus that grows under the bark of trees. *P. pulchella* is most commonly collected at fresh wounds in trees, although the reason is still a mystery to entomologists. Congratulations to Wellington Hall Academy for possibly finding a new species to Canada! To see more photos, click here.

Pseudoscorpions *(Pseudoscorpiones)*

Pseudoscorpions are a type of arachnid, meaning that they are not insects, but are closely related to spiders. They are named "*Pseudo*" scorpions because they have pincers that resemble scorpions, but do not have a tail and stinger. They can be found anywhere from a tree canopy, to somewhere in your home where they feed on the larva of some household pests. They can also be found in leaf litter, where they feed on other tiny arthropods. Males use chemicals known as pheromones, and a fancy dancing behaviour, to attract females to mate. These arachnids construct a silken cocoon which they use to protect themselves during the winter. Pseudoscorpions occur all over the planet, but are rarely collected in Malaise traps. In total, four specimens were caught in the School Malaise Trap Program, by Centre Wellington District High School in Fergus and Zorra Highland Park Public School in Embro. For an interesting video of a pseudoscorpion hunting, click here.

Club-Horned Wasps *(Sapygidae)*

Species in this family of wasps have unusually thick antennae, but possess the black and yellow striped bodies like so many other bees and wasps. These wasps are parasites which lay their eggs in the nests of other solitary wasps. Their larvae consume the larvae of their host and any other nutrients in the nest such as pollen. This type of lifestyle is called cleptoparasitism. They are not considered as pests, although other wasps that they steal from no doubt regard them as criminals in the insect world. This family is widespread but rare with only 11 species in North America. Only one specimen was caught in the School Malaise Trap Program by St. Mary's Catholic School in Barrie. For more photos and information, click here.



Bagworm Moth *(Dahlica triquetrella)*

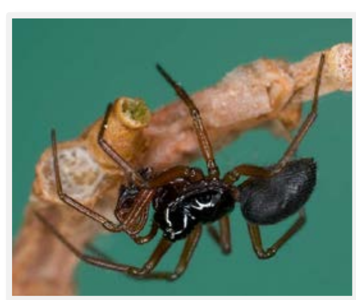
The Bagworm Moth is native to Europe, but was introduced to Canada around 1940 where it was first found in British Columbia. Some winged males occur in Europe, but the population in North America contains only wingless females. You might wonder how offspring are produced without males – the females reproduce through parthenogenesis, laying eggs without being fertilized by a male. The caterpillars, which feed on lichen, algae, and moss, make and retreat into a silken bag to spend the winter – this is why they are called "bagworms". The bag is covered with fine debris such as grains of sand and dead plant parts. The larvae pupate inside the bag and adult moths emerge in very early spring and deposit eggs into the bag they just emerged from. This species is an interesting discovery in the School Malaise Trap Program because it is the first time this species has been DNA barcoded in Ontario. Nice catch Julie Payette Public School! To see a Bagworm Moth larva in action, click here for a video.

Phytoseiid Mites *(Phytoseiidae)*

Phytoseiidae is a large family of mites, with more than 2500 described species. Phytoseiid mites are usually light to dark brown, with slightly hardened shells. These mites have very rapid life cycles, moving from egg to mature adult in less than 10 days. Some phytoseiids feed on plant tissue, but most are predators of small invertebrates and usually live on plants. Check out the video below to see one of these mites in action. Since phytoseiids are such good predators, they are commonly used to control pests that attack farmer's crops. New species may be able to help protect more crops and the School Malaise Trap Program caught seven phytoseiid species new to our DNA barcode library. In fact, these possibly represent new species to science. For a video of one mite eating another mite, click here, and read a great blog post here.

Dwarf spiders *(Erigoninae)*

Dwarf spiders are members of the sheet weaver spiders the second largest spider family in the world. There are more than 2000 described species of these spiders found around the world, with 650 in North America. They are very small, usually less than 1 mm, and vary in colour. Their small size allows these spiders to use "ballooning" as a method of transportation. When ballooning, the spider shoots out strands of silk that form a sort of parachute which is caught by the wind, floating them to a new location. As with most spiders, the Erigoninae are predators and play an important role in food webs. We were excited to find two new species for our DNA barcode library in this subfamily from the School Malaise Trap Program. One specimen of *Ceratinops crenatus* was collected by Wellington Hall Academy and two specimens of *Walckenaeria tibialis* were collected by Wellington Hall Academy and Milverton Public School. There is little available information about the biology of these two species as they are rare in nature. To see a video of dwarf spiders ballooning, click here.



Springtails *(Collembola)*

Springtails are six-legged arthropods which are closely related to insects, but are not true insects. They are relatively small, generally less than 6 mm long, variously colored, and are either round (globular springtail) or elongate (slender springtail). Most springtails have a long, forked appendage which can 'spring' them forward, propelling the creature into the air when threatened. If you have never seen these creatures before, take a look at the video below. Springtails are usually found in soil, moss, and leaf litter and they occur worldwide, often in very high numbers. It has been estimated that in one square metre of soil may possess up to 10,000 Collembola! Because of their abundance, Malaise traps often capture a very large numbers of springtails, but their species diversity tends to be low. Despite this, the School Malaise Trap Program led to the collection of 37 species of Collembola, including two species that were new to our DNA barcode library. For a clip on springtails from the documentary 'Life in the Undergrowth', click here.

Non-biting Midges *(Chironomidae)*

Chironomidae is a large family of flies whose members look much like mosquitoes. However, they do not possess the needle-like mouthparts of mosquitoes, so these midges do not bite (hence the name!). The males are easily recognized by their feathery (plumose) antennae and are often seen in large swarms over a landmark such as a rock or bush. Their larvae are very common in many aquatic environments, where they usually feed on algae or decomposing plant material. The flying adults have a short lifespan in which males often assemble into huge swarms. Females join these swarms to mate, and shortly after the males die. The adults rarely eat as their lifespan is so short they must focus on reproduction. The family Chironomidae is very diverse with over 8000 named species so far. As a result they are common in aquatic habitats around the world. They also proved to be dominant in the School Malaise Trap Program as chironomids were the most abundant and most diverse family of insects in the collections. For a more information on non-biting midges, click here, or check out a video of chironomid larvae here.

For a fun classroom activity, you could write similar descriptions for the interesting discoveries your classroom made.