School Malaise Trap Program

Fall 2013 Program Report

The Fall 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.

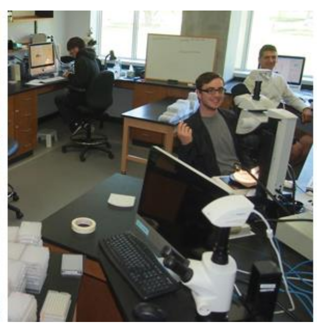
Collecting Specimens

In September 2013, we sent out Malaise trap kits to 18 schools across south-central Ontario. Each kit included a Malaise trap and an instructional video that gave each class 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 asked each school to set up its Malaise trap and collect insects during the same two weeks (September 23 — October 4). To obtain comparative results, we also partnered with two great organizations that agreed to run Malaise traps: Conservation Halton (Mountsberg) and Grand River Conservation Authority (Guelph Lake). In addition, we set one up on our property at BIO. At the end of the two weeks, all traps and collection bottles were returned to BIO to allow analysis to begin.

Sorting Specimens

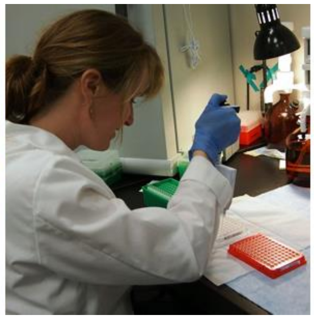
Once the collection bottles arrived, BIO staff recorded details on the collection locality from each bottle and compiled the weather data recorded by the students in each class. Next, the contents of each bottle were poured into a sorting dish, and, using a microscope, every specimen was counted in each 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 63 plates, each plate containing tissue from 95 specimens for a total sample size of 5,985 individuals! Once these plates were ready, they were transferred to the molecular laboratory for the next phase of barcode analysis.

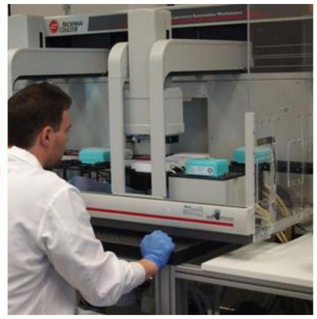





Sequencing Specimens

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!





Analyzing the Sequences

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

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 summer flier sedge (*Limnephilus submonilifer*) or to the Halloween lady beetle (*Harmonia axyridis*). 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 ichneumon wasps (Ichneumonidae) or brown lacewings (Hemerobiidae). 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.

Fall 2013 Program Results

Drumroll please! It's time to share results for the Fall 2013 School Malaise Trap Program. Let's begin with a general summary. The fall program involved 18 schools in 15 cities, 22 classrooms, and 659 amazing students. Your classroom's trap was one of 21 traps deployed from September 23 to October 4, 2013. We had typical fall weather during the trap deployment period. Average daytime temperatures were 12.6°C for Week 1 and 16.2°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 each of the icons to see the school name and the results from that trap.

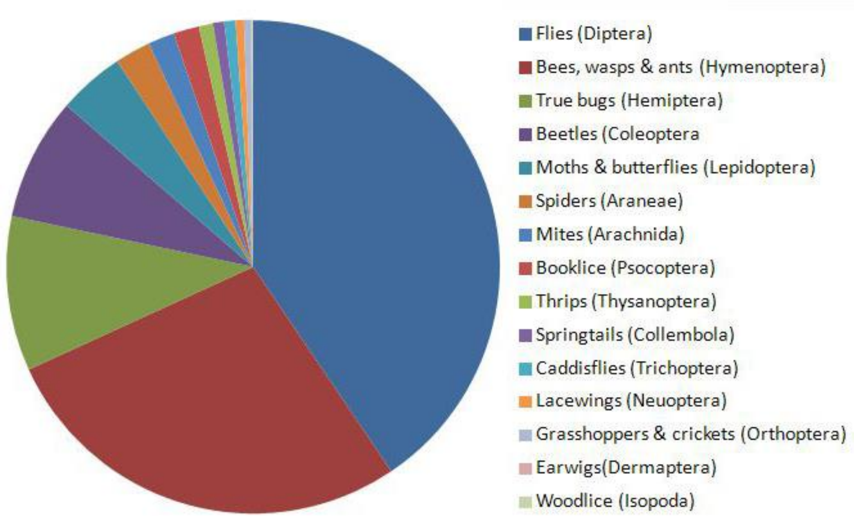
The 21 traps collected an average of 666 specimens in Week 1 and 672 specimens in Week 2, for an average total of 1,338 specimens for the collecting period. The total number of specimens showed some variation among traps, from a low of 377 to a high of 3,043 specimens. It might surprise you that so many 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 was mentioned in your classroom video is on Facebook and Twitter? Like or follow BIObus_Canada so you can share in the BIObus adventures.

The staff at BIO sorted the 28,110 specimens present in your 21 traps and selected 5,985 specimens for barcode analysis. When the molecular work was complete 5,572 (93%) of the specimens delivered a DNA barcode. Because we excluded a few short barcodes, the final dataset included 4,736 barcodes. The analysis of these barcodes revealed that you collected 1,493 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 2.1% of them. Roughly half of these species were uncommon since 819 species were only collected in a single trap. More excitingly, your collecting efforts provided the very first records for 113 species. You should feel proud that you have made such an important contribution to the International Barcode of Life project! We did a school Malaise trap project this past spring and when comparing both datasets we found that just 404 species were shared between the fall and the spring projects. Quite a few species seem to be around for just a part of the year.

All 1,493 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 (41%) of the species were flies (scientific name: Diptera). Some groups of flies were particularly diverse; there were 157 species of midges (Chironomidae), 55 species of fungus gnats (Sciaridae), and 44 species of scuttle flies (Phoridae). The most abundant species was also a fly — a chironomid (*Paraphaenocladius impensus*). After flies, the next most abundant group was bees, wasps, and ants (Hymenoptera), followed by the true bugs (Hemiptera). Most of the species in these groups have wings, so it's not surprising that they were collected in your Malaise traps. However, you also collected some groups that don't fly, such as woodlice (Isopoda), spiders (Araneae), springtails (Collembola), and mites (Arachnida).

To see a list of all 1,493 species collected in the Fall 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 south-central 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 variation in the total number of specimens caught, ranging from a low of 377 individuals at the most northerly site, Owen Sound C.V.I., to the winner for this category — Hagersville Elementary School in Hagersville, which had a catch of 3,043 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
Hagersville Elementary School	EQP-CLL-495	3,043
Sacred Heart High School	EQP-CLL-593	2,488
Mornington Central School	EQP-CLL-556	1,961

Click here to view the results from all 21 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 among sites. Woodcrest Public School had the lowest number with 88 species and in contrast, the winner for the most species collected with an extraordinary 177, was Sacred Heart High School in Walkerton — way to go team!

Number of Species Caught – Top 3:

School/Park	Trap #	Species Count
Sacred Heart High School	EQP-CLL-593	177
Huron Heights Secondary School	EQP-CLL-563	175
St. James Catholic School	EQP-CLL-557	173

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 113 new species were detected in your collections. When we compared the number of new species detected at each site, the numbers were close — congratulations to our winner Huron Heights Secondary School in Kitchener for collecting 12 species new to BOLD and to the runner ups Grand River Conservation Authority in Guelph and Walpole Island Elementary School in Wallaceburg for both collecting 10 species new to BOLD.

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

School/Park	Trap #	Species New for BOLD
Huron Heights Secondary School	EQP-CLL-563	12
Grand River Conservation Authority	EQP-CLL-619	10
Walpole Island Elementary School	EQP-CLL-508	10

Finally, biodiversity between sites can be compared by examining the overlap in species among sites. With 21 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 816 rare species and most sites had at least 10. However, one school had the lead in collecting rare species — and it also ranked highly in two other categories — Huron Heights Secondary 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
Huron Heights Secondary School	EQP-CLL-563	61
Walpole Island Elementary School	EQP-CLL-508	57
St. James Catholic School	EQP-CLL-557	52

The Fall 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 Fall 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

Discoveries for Fall 2013

Bees

Bees, like ants, are actually a specialized form of wasp. They play an important role in pollinating flowering plants. In July 2013 the world's 20,000th bee species was officially described by a researcher from York University in Toronto. Your Malaise traps collected 14 species of bees and among those were common species such as the honey bee (*Apis mellifera*) and the common eastern bumble bee (*Bombus impatiens*).

But have you ever heard of Sweat bees? This is the common name for any bees that are attracted to the salt in human sweat (Halictidae). Believe it or not, there are about 2,000 species of sweat bees known to science and eight of them were found in your schoolyards this fall.

Not all bees live in large colonies. Actually, many species are solitary, such as the Potter bees (*Anthidium*) that were found in the Malaise traps. They use conifer resin, plant hairs, mud, or a mix of them to build their nests.

Wasps

If we think of wasps we usually have in mind a small group of species that is also known as Yellow jackets. Yellow jacket is the common name of wasps in the two genera *Vespula* and *Dolichovespula*. Most of these wasps have a black and yellow striped pattern on their abdomen. Some are black and white like the bald-faced hornet, *Dolichovespula maculata*, which was found twice at St. Mary's school in Barrie. Yellow jackets live in colonies and many people fear them because the females of all species are capable of stinging and, as opposed to bees, they can sting repeatedly.

Three species of *Vespula* are very common in Ontario and all of them showed up in the School Malaise Trap samples. One of them is *Vespula alascens*is, which until 2010 was thought to be the common wasp (*Vespula vulgaris*). Actually, the common wasp is only found in Eurasia and has been introduced to Australia and New Zealand. Although, it is often said to occur in North America as well, the North American populations are a separate species, *Vespula alascensis*.

The Eastern Yellow jacket (*Vespula maculifrons*) is a very common species in Eastern North America and we were able to find it in several traps this fall. Even more abundant in our samples was the German wasp (*Vespula germanica*). As the name suggests this is a wasp that is native to Europe, but it was introduced and is now well-established in many other places such as North America (since 1975). In fact most Yellow jackets you encounter throughout the summer will be *Vespula germanica*. Maybe you got stung by one already as some people say they are aggressive if provoked.

However, most of the 386 wasp species we found in the School Malaise Trap samples are members of the big group of parasitic wasps. Parasitic wasps are not social, but they are extremely diverse, many laying their eggs in eggs or pupae of other insects, or sometimes paralyzing their prey by injecting it with venom. They then insert one or more eggs into the host or deposit them upon the host. The host remains alive until the wasp larvae are mature, serving as a food source for the young.

Ants

The other big group of social Hymenoptera is the ants. Ants form colonies that can range in size from a few dozen individuals living in small natural cavities to highly organized colonies that may occupy large territories and consist of millions of individuals. Ant societies are often very sophisticated. They have division of labour, communication between individuals, and an ability to solve complex problems. Overall, you collected 27 species of ants in your Malaise traps.

Among those we were able to find several individuals of the false honey ant (*Prenolepis impairs*). This species is noteworthy in that it is one of the few ant species that can forage even at near freezing temperatures. Surprisingly, despite their ability to withstand cold temperatures, their range does not extend much farther north than Southern Ontario.

Another species was found only once at the Sacred Heart School in Teeswater. *Stenamma schmittii* is a species that primarily lives in woodlands, ranging from fairly dry to moist habitats. Their colonies can be difficult to find but you can try checking in the soil beneath stones, logs, and debris. This is only the second time that this species has been found in Canada! The first official Canadian specimen was collected in Quebec.

Stenamma schmittii,© 2013 //antweb.org

Beetles

Beetles are the most diverse group in the animal kingdom, comprising 25% of all known animal species. 400,000 species have been described so far and many scientists believe that there are as many as 1 million beetle species on Earth. Beetles have inhabited our planet for more than 300 million years which means they have been around even before the dinosaurs.

Among the 120 beetle species in the fall School Malaise Trap Program were quite a few pest beetle species especially those of the leaf beetle family (Chrysomelidae). So far we were able to identify six of them:
Strawberry rootworm (*Paria fragariae*)
Bean leaf beetle (*Cerotoma trifurcata*)
Northern corn rootworm (*Diabrotica barberi*)
Western corn rootworm (*Diabrotica virgifera*)
Tuber flea beetle (*Epitrix tuberis*)
Striped flea beetle (*Phyllotreta striolata*)

All of them are known to feed on particular fruits and vegetables as you can easily tell from their common name.

Harmonia axyridis is a well-known beetle which is native to eastern Asia, and was introduced to North America and Europe to control aphids and scale insects. Unfortunately, this species has itself become a pest for the wine industry. In the autumn, these beetles can aggregate in large numbers in vineyards and, if they are harvested along with the grapes, they release a chemical compound called methoxypyrazine that can spoil the aroma and taste of the wine. This species is also known to invade homes in October in preparation for winter, a phenomenon which earned it the common name of "Halloween lady beetle". Fittingly they are of orange colour with black spots. It is not a surprise that this beetle was widespread during the fall School Malaise Trap Program with specimens being collected at 16 out of 21 schools!

True bugs

True bugs are an insect order scientifically known as Hemiptera with about 80,000 species. You might know representatives such as cicadas, aphids, planthoppers, leafhoppers, and most prominently stink and bed bugs. We picked two interesting finds from this fall as we thought you might not know anything about them yet.

Although *Dicyphus errans* lacks a common name, we have dubbed this interesting find from the School Malaise Trap Program the European plant bug! As its name suggests, the bug is native to Europe and, since 2000, this species has been mass-reared and released in agricultural areas in Europe to control various pests, particularly flies and scale insects. A closely-related species, *Dicyphus hesperus*, is similarly used to control whiteflies in North America. However, these species are not ideal for controlling pests because they are generalist omnivores, consuming both small arthropods as well as plants, damaging the same crops that they were intended to protect along with neighboring plants. While there are many North American records of the closely-related species in our database, a specimen collected at Listowel Central Public School is the first record of the European plant bug in North America!

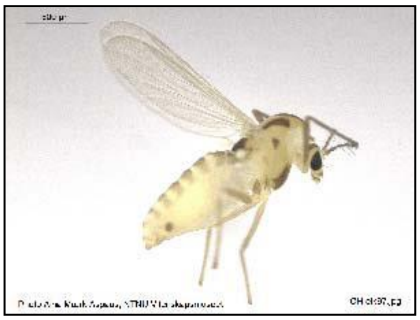
Zelus luridus is a unique species that is part of the assassin bug family (Reduviidae). There are currently 60 described species, most of which are found in Central and South America, with only 5 species being present in North America. Assassin bugs are as deadly as they sound to their prey of aphids, caterpillars and other common garden insects. After patiently lying in wait to ambush their next meal, the assassin bug strikes quickly and accurately to paralyze its victim by injecting a toxin that dissolves tissue. The assassin bug then sucks up the other insect's tissue. Adult assassin bugs can measure up to 1 inch long, and have a cone-shaped head and wide curving beak which can cause a painful bite to humans if captured. Even though they have nasty bites, remember that these bugs play an important role in keeping pests under control. Want to know more? Click here to watch an assassin bug ambush its prey!

Butterflies and moths

Another huge group of insects with perhaps 200,000 species worldwide are the moths and butterflies (together called Lepidoptera). Malaise traps are usually not the best traps to catch Lepidoptera, but some always find their way into our traps. This time we could identify 56 different species in all traps. The most common one was the bicolored sallow (*Sunira bicolorago*) that occurred in 15 different schools. This is a moth of the Noctuidae family (the name stems from noctua which is Latin for night owl).

Another interesting find was the pine tube moth (*Argyrotaenia pinatubana*) that occurs in eastern North America, throughout the range of its principal food source, the eastern white pine. These small slender moths have wingspans of 14mm and reddish-orange forewings. This colouration effectively camouflages the moths when they rest near the unopened buds of the pine tree. The species received its name because young larvae of the moth spin silk and tie together up to twenty pine needles to form a tube. The larvae then live within this tube and begin to eat the surrounding walls. When the tube walls have been mostly eaten down, the larvae will abandon their tubes and begin constructing new ones, eventually overwintering within the tubes as pupae. To view an image of a pine tube moth shelter, click here!

Nonbiting midges



Chironomidae, commonly known as nonbiting midges, are a family of flies which can be found all over the world. A species from this family, *Paraphaenocladius impensus*, was the most abundantly caught insect during the fall School Malaise Trap Program! Of the specimens that were barcoded, 81 of them were *P. impensus* which were collected from 14 different schools. These midges come from a very large taxon (group) of insects; experts estimate that there are well over 10,000 different species world-wide! Many of these species superficially resemble mosquitoes, but they lack the wing scales and elongated mouthparts which a mosquito uses to feed on blood. The larvae and pupae of nonbiting midges are important food items for fish and other aquatic organisms. Furthermore, chironomids are important indicator organisms, meaning their presence or absence in a body of water can indicate whether pollutants are present or if environmental changes have taken place.

Snowy tree cricket or thermometer cricket (*Oecanthus fultoni*)

Oecanthus fultoni, also known as the snowy tree cricket or thermometer cricket, is a species of tree cricket from North America. This cricket is probably the most "famous" insect found during the School Malaise Trap Program, as the species recently made an appearance on the T.V. show *The Big Bang Theory* when the main character Sheldon wrongly believes that a common field cricket, *Gryllus assimilis*, found in his apartment is a snowy tree cricket. So where did this little cricket get its name? This insect is sometimes called a "thermometer cricket" because the rate at which it chirps correlates well with the temperature found around the cricket! This means the surrounding temperature can be estimated by counting the chirps of the cricket for 13 seconds and then adding 40, which will give you the approximate Fahrenheit temperature. This species was a rare find for the fall School Malaise Trap Program as only one specimen was collected at St. Marys District C.V.I. Click here to listen to the chirps of a snowy tree cricket – can you guess the temperature?

Spiders and their relatives

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

While Malaise traps are most useful for capturing flying species, 33 species collected in the Fall School Malaise Program were spiders which are certainly not known to fly. St. James Catholic School collected the greatest number of spider species, at seven, which included a species new to our barcode database, *Mermessus entomologicus*! This is a species of web spider that is native to North America. *Mermessus* spiders are generally small (1-3mm) and build inconspicuous webs at ground level, most often in the leaf litter.

Cheiracanthium mildei, the longlegged sac spider, was the most common spider species in your Malaise trap samples, being collected from 12 of 21 traps. Unlike *Mermessus entomologicus*, the longlegged sac spider is native to Europe and was introduced to North America in the 1940s and, as your samples suggest, they are now widespread and abundant in Ontario. This abundance is somewhat surprising because this species is commonly found inside houses. These spiders rest in a silken cell (the "sac") during the day and then actively hunt for prey at night.

Another interesting find was the zebra spider (*Salticus scenicus*) which was collected at John F. Ross C.V.I.. This is a species of jumping spider which, as the name suggests, can jump on its prey through a sudden straightening of their fourth pair of legs. Their mean jumping speed is 0.64–0.79 m/s! Jumping spiders also exhibit an interesting behavior during courtship with the male 'dancing' (waving his front legs and moving his abdomen) in an effort to impress the female. Take a look at this spider dance here!

Opiliones, an order of arachnids commonly known as harvestmen or "daddy longlegs" in North America, were also widely collected, particularly the species *Phalangium opilio*. Harvestmen are often confused as spiders but they in fact come from a distinct order and are not closely related. Unlike the largely predatory spiders, many species of harvestmen are omnivorous, eating primarily small insects, plant material and fungi. The stomach of a harvestman also differs from a spider's in that harvestmen can swallow chunks of solid food, not only liquids. Harvestmen are rumoured to be one of the most venomous animals in the world, even more so than spiders! This, however, is untrue as none of the known species of harvestmen have venom glands and their grasping claws are not strong enough to break human skin. To learn more about harvestmen, click here!