A Survey of Arthropod Pests and IPM Strategies for Archbold Tropical Research and Education Center in Dominica, W.I.

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Date: 26 June 2016

Abstract

The Phylum Arthropoda includes some of the most abundant animals that live on earth. Many arthropods have evolved to live in close association with humans. However, only a fraction of these arthropods are considered pests. This survey was conducted in order to determine the diversity and abundance of arthropods that reside in buildings at the Archbold Tropical Research and Education Center (ATREC) in Dominica, W.I. In order to assess arthropod diversity, pest management glue boards were placed on the floor of the rooms that were surveyed. Pan traps were also placed in some of the rooms in order to catch flying insects that would not be otherwise caught by the glue boards. Glue boards were used in two trials, while the pan traps were used only in one trial. The arthropods caught with each trap kind were identified to the lowest taxonomic group possible and tabulated to show arthropod diversity across the different rooms surveyed. I collected a high diversity of taxonomic groups using both the glue boards (11 different taxa) and pan traps (10 different taxa). Based on these results, I provide recommendations for Integrated Pest Management at ARTEC, aimed specifically at the most commonly encountered pest arthropods.

INTRODUCTION

Humans share their living space with a variety of invited and uninvited guests, from large vertebrates to microorganisms (Martin et al., 2015). The most diverse and abundant group of multicellular life found on Earth, as well as in human-built structures, are arthropods (Bertone, 2016). Arthropods have been co-inhabiting spaces with humans since humans created fixed habitations. The wide diversity of arthropods that co-inhabit man-made structures have evolved with humans in order to accommodate the different environmental conditions that they are exposed to by living in a structure as opposed to living outside. Many arthropods have been very successful in adapting to live within man-made structures, an ecological niche that has likely enabled them to use the human body as a source of food and water (Bertone, 2016). Over the last thousands of years, home construction, animal domestication, agriculture, and the ability to store food has brought different arthropod species into the domiciles and daily lives of humans (Bertone et al., 2016). This has caused certain arthropods to cause damage to structures, be bothersome, and even harm humans.

The arthropods that live inside structures with humans are called urban pests. Because some arthropods are well adapted to live and thrive inside man-made structures, pest control has grown into a multi-billion dollar industry. The spread of certain arthropods worldwide like the House fly (*Musca domestica)*, the German cockroach (*Blatella germanica),* and the fruit fly (*Drosophila melanogaster)* is likely due to human travel, as these insects in particular are heavily associated with humans (Keller, 2007). However, of the arthropods that occur on earth, only a very small percentage are considered pests. These pests if not tended to properly, can reach staggering levels above the economic damaging threshold (Robinson, 2005).

A vast amount of research has been conducted on insect pests of medical and economic importance, including cockroaches, termites, bed bugs, fleas, and mosquitoes (Robinson, 2005). However, not much research has been conducted on identifying the arthropods that reside in man-made structures. In particular, there has been no research done in Dominica, W.I., exploring the diversity of arthropod pests living in human domiciles. Therefore, the purpose of this study was to identify the pest arthropods that are commonly found at the Archbold Tropical Research and Education Center (ATREC). Most of the man-made structures at ATREC are used by people to eat, sleep, and live for extended periods of time throughout the year. In particular, I wanted to determine the type of arthropods found inside structures at ATREC. I also wanted to determine some of the Integrated Pest Management (i.e., "IPM") strategies that can be shared in order to help limit the amount of pests. Finally, I wanted to explore the possible reasons that might lead to high abundance of certain arthropod pests. To address these questions, I surveyed 10 rooms in 3 different buildings around ATREC using Trapper Max and 288i glue boards to catch crawling arthropods. I also placed pan traps in the same rooms to catch any flying insects. Finally, I make recommendations for IPM based on our results.

MATERIALS AND METHODS

Study sites. The study area of this experiment was the Archbold Tropical Research and Education Center (ATREC) located at 15°20'48"N 61°22'08"W at an elevation of 170 meters above sea level in Dominica, West Indies. A total of three buildings were surveyed. Before traps were placed, I conducted a walkthrough of all the 10 rooms that traps would be placed in. During the walkthrough, notes were taken on how many traps each room would need due to the varying size of the rooms. Once the walkthrough was completed, traps were placed in each room.

Trapping techniques. The glue traps that were used were Trapper Max glue boards (Bell Laboratories Madison, WI) and Catchmaster 288i glue boards (AP&G Co. Brooklyn, NY). The Trapper Max glue boards were used on the floor to capture crawling insects, while the 288i monitors were used in plumbing voids and in windows sills. I placed traps in a total of 10 rooms in three buildings, as follows:

The first building contained three rooms. Room 1 was the men's sleeping room, where 8 Trapper Max glue boards as well as 4 Catchmaster 288i glue boards were placed in areas of high arthropod activity (Table 1). Room 2 was the wash area, which was divided into two subunits because it had two levels. Both the upper level and lower level received 2 Trapper Max but no 288i monitors because there was no suitable area to place them at. Room 3 was the wet laboratory, which received 3 Trapper Max and no 288i monitors because there were no plumbing voids.

The second building contained three rooms. Room 4 was the dry laboratory, where 3 Trapper Max traps as well as 1 288i monitor was placed in the window. Room 5 was the dining room, where only 5 Trapper Max were placed. Room 6 was the women's sleeping room, where 7 Trapper Max and 4 288i monitors were placed throughout. Room 7 was the men's bathroom and room 8 was the women's bathroom, inside of which 3 Trapper Max glue boards were placed behind toilets and one 288i monitor was placed behind the sink.

The third and final building to survey was the kitchen, which was all one room. It included the store room, the cook line, and the dish area. In the kitchen, 8 Trapper Max glueboards as well as 3 288i monitors were placed. 3 Trapper Max were placed along the cook line, 2 were placed in the store room, and finally 3 were placed in the dishwashing area. These traps were left from the afternoon of 11 June to the evening of 15 June 2016. The same number of traps per room as well as collection and retrieval time was replicated from 18 to 22 June 2016. Three days of no collecting in between the two trials was implemented in order to let arthropod populations recover.

The next step was to place pan traps with soap and water to capture flying insects. Each of the 10 rooms was sampled using one pan trap for only one trial. To prepare the traps, yellow plastic pans (SOLO Cup Company Lake Forest, IL) were filled with orange scented dish soap (Colgate-Palmolive Company New York, NY) and water. The soap and water were combined in plastic Nalgene bottles (Thermo Fischer Scientific Inc. Waltham, MA) and shaken to help ensure that the soap would combine with the water to attract more arthropods. The mixture was then poured in the pan traps once they were placed strategically along a wall with a window above it. Pan traps were placed in the morning on 18 June and collected in the afternoon on 22 June 2016.

Specimen retrieval. Once the traps containing specimens were collected, we used a pipette (BioQuip Inc. Rancho Dominguez, CA) to dispense Crisco vegetable oil (The J.M. Smucker Company Orrville, OH) over the trapped specimen. Each arthropod that was on the glue board was removed by pipetting a small amount of oil onto the glue board and then using fine tipped forceps (BioQuip Inc. Rancho Dominguez, CA) to lift the specimen off of the glue. We then placed the specimens in vials with 75% ethyl alcohol for identification.

Specimen identification. Specimen identification was done by placing all the samples from each trap into a sorting pan (Gage Inc. Lake Oswego, Oregon). Specimens were then counted and identified to the lowest taxonomic level possible using Borror and DeLong (2005). While most specimens were identified to the level of family, a few specimens could be identified to the level of genus or even species. Once all of the specimens were identified and counted, calculations were completed to show diversity through percentages as well as how abundant certain families of insects were. All graphics and percentages were computed by using Microsoft Excel.

RESULTS

In the first sampling, 9 arthropod taxonomic groups were identified (Figure 1). Of these, the majority were ants (Formicidae) and the least abundant were termites (Termitidae). In the second sampling, 11 distinct taxonomic groups were found, with 9 taxonomic groups overlapping from the first sampling. 11 total different taxonomic groups were found on the glue boards. There were 10 different taxonomic groups found in the pan traps with 6 taxonomic groups overlapping from the glue board samplings. In total, 15 different arthropod taxonomic groups were found between the two samplings of glue boards as well as the pan trap sampling (Fig. 1-5). Also, the percentage of abundance of each taxonomic group at each location was computed for all trials (Fig. 1-3). The percentage of each taxonomic group at each location within the Springfield station is highly variable throughout both glue board samplings and even throughout the pan trap sampling (Figures 1-3). Lastly, the percentage of total arthropod taxonomic groups was calculated for both pan traps and both of the glue board trials (Fig. 4, 5).

Table 1. Description of room locations, sampling dates, and type of trap used to collect arthropods in building structures around ATREC. Check marks indicate the dates and traps used per site.

Site Number	Room ID	Type and number of trap used			Sampling dates	
		Trapper Max glue boards	Catchmaster 288i glue boards	Pan Traps	11-15 June 2016	18-22 June 2016
1-1	Men's Sleeping Room	8	4	1	✓	✓
1-2	Wash Area Upper Level	2	0	1	✓	✓
1-3	Wash Area Lower level	2	0	1	✓	✓
1-4	Wet Lab	3	0	1	✓	✓
2-1	Dry Lab	3	1	1	✓	✓
2-2	Men's Bathroom	2	1	1	✓	✓
2-3	Dining Room	5	0	1	✓	✓
2-4	Women's Bathroom	3	1	1	✓	✓
2-5	Women's Sleeping Room	5	2	1	✓	✓
3-1	Kitchen	6	3	1	✓	✓

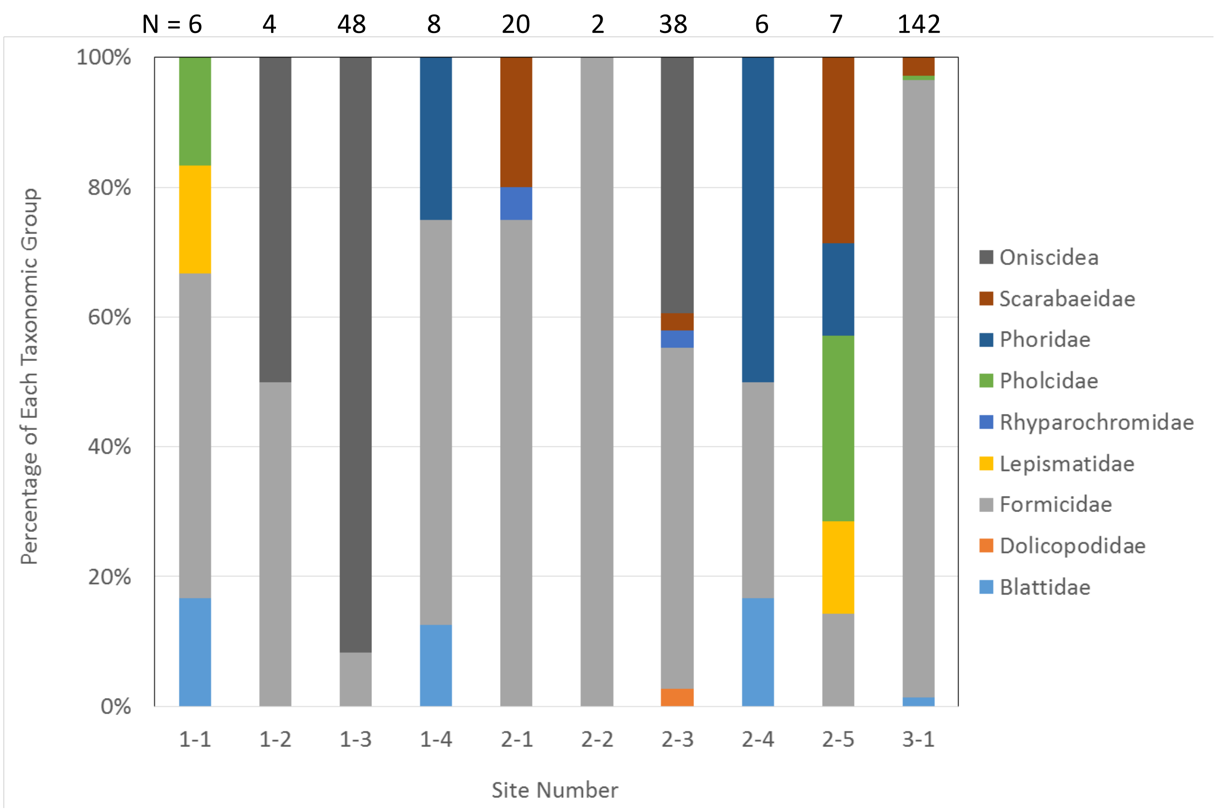

Fig. 1. Relative abundance of each taxonomic group of arthropods found in each location sampled at ARTEC using glue boards from 11 to 15 June 2016 (first sampling bout). The number of arthropods collected at each site (N) is provided above each bar.

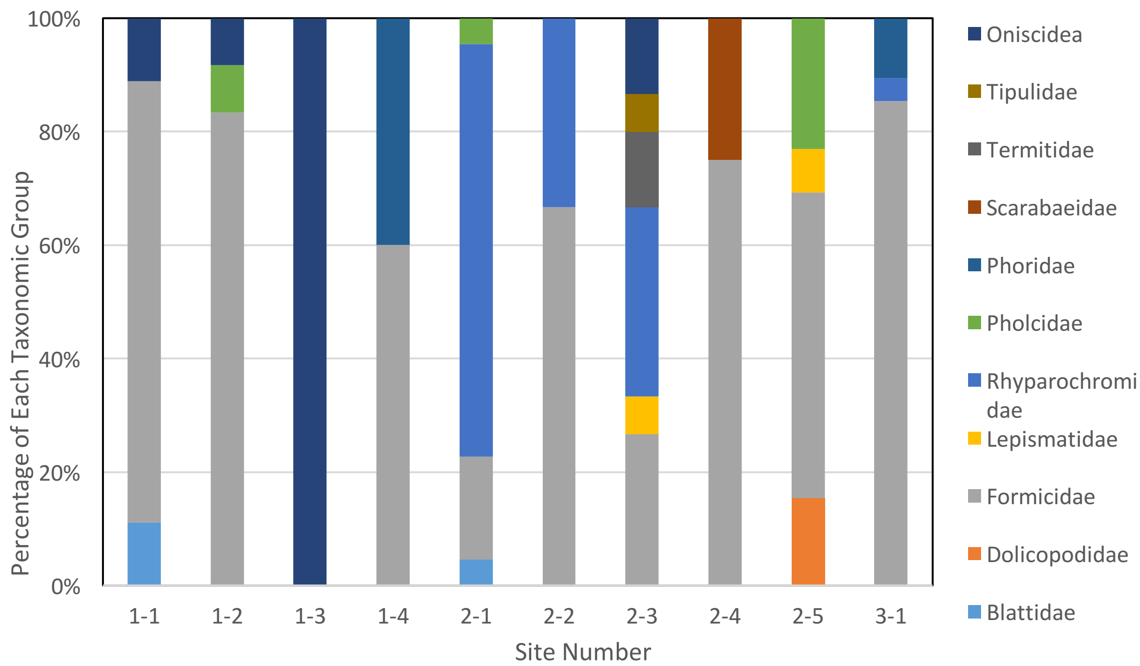

Fig. 2: Relative abundance of each taxonomic group of arthropods found in each location sampled at ARTEC using glue boards from 18 to 22 June 2016 (second sampling bout). The number of arthropods collected at each site (N) is provided above each bar

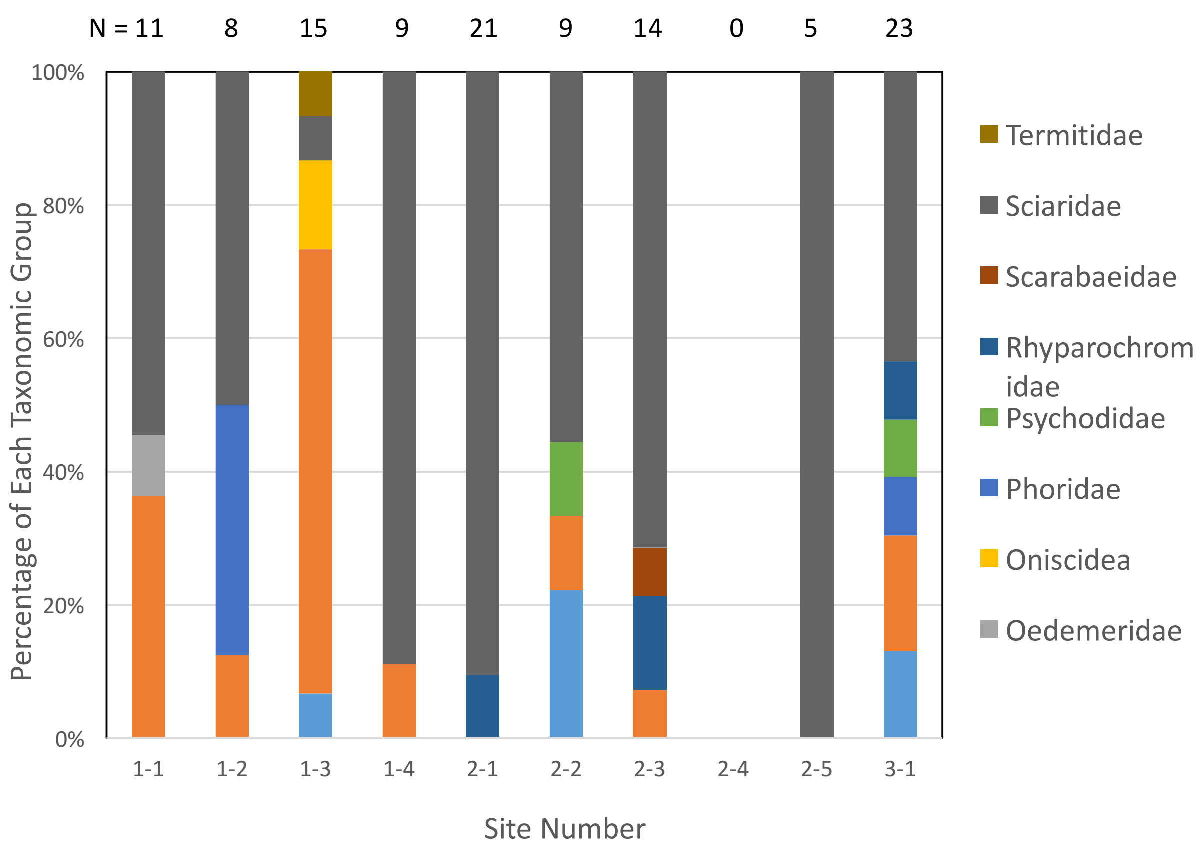

Fig. 3. Relative abundance of each taxonomic group of arthropods found in each location sampled at ARTEC using pan traps from 18 to 22 June 2016. The number of arthropods collected at each site (N) is provided above each bar

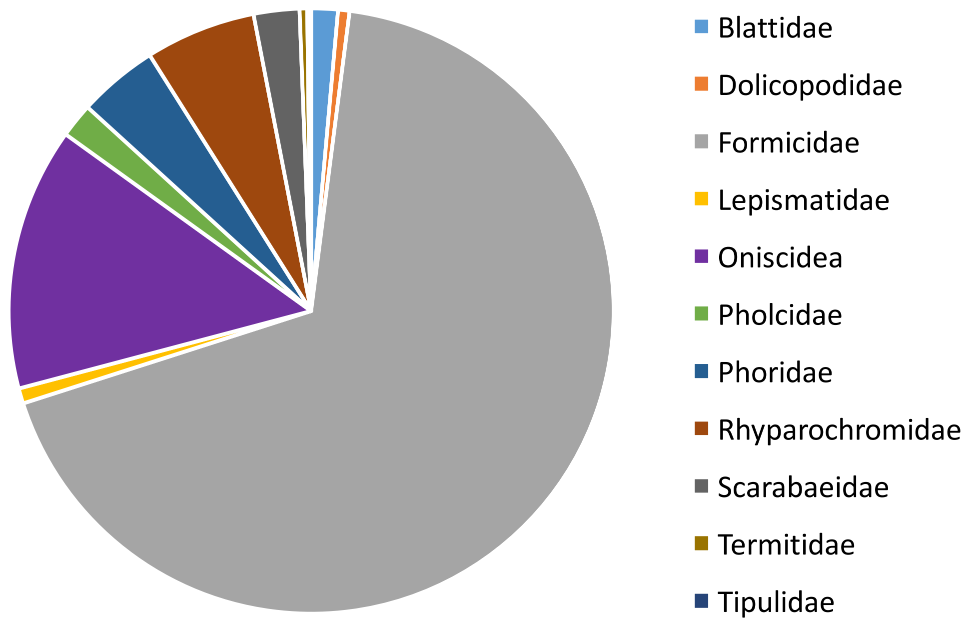

Fig. 4. Distribution of each taxonomic group of arthropods represented as the percentage of the total number of arthropods caught on glue boards through both trials.

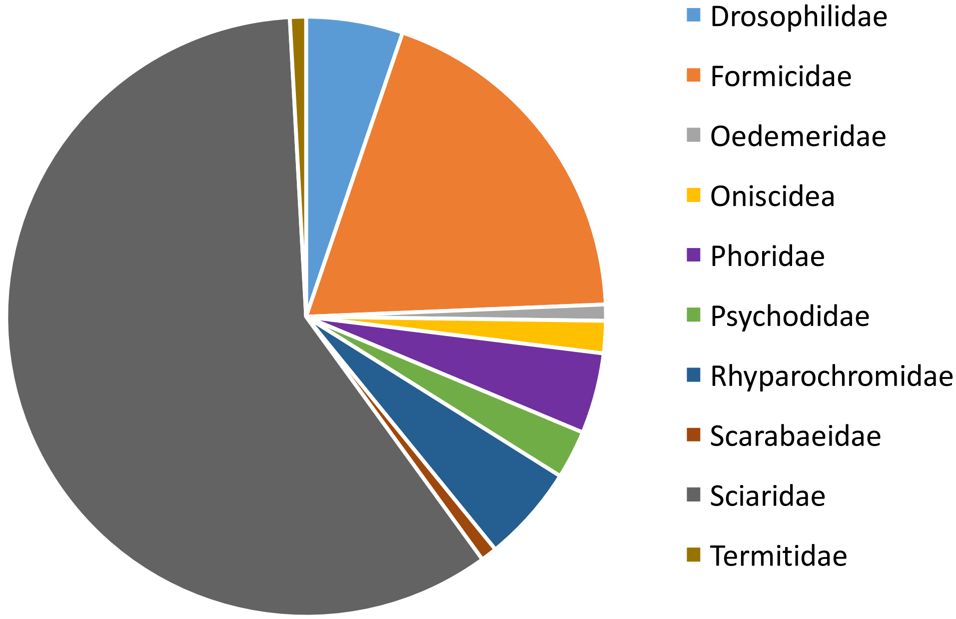

Fig. 5. Distribution of each taxonomic group of arthropod represented as the percentage of the total number of arthropods caught in pan traps.

DISCUSSION

This is, to the best of my knowledge, the first survey of its kind to have been conducted at ATREC in Dominica. There were 11 different and distinct taxonomic groups of arthropods collected from the glue boards that were placed throughout the different rooms of the station. The highest concentration of arthropods was in the kitchen because of the harborage sites as well as a readily available food source. As stated above, formicids were the most common, however there are some arthropods that were seen quite often. This includes members of the families: Pholcidae, Scarabaeidae, and Blattidae. Some phorid flies were seen, but they were mainly concentrated in areas that surrounded the trash cans because that is where they breed and have a very easy food source. However, the reason that some blattids were seen is because of the plumbing as well as there is no seals on doors and no barriers to keep any arthropods from entering any rooms. The results are overall interesting and quite unique. However for the pan trap sampling of the women's bathroom there were no insects recorded. This could be due to many reasons including that it was placed in an area of no insect activity. It also could be due to the fact that it may have been tipped over spilling the contents of the pan trap at any point during the day.

Interestingly, almost 70% of all arthropods caught on the glue boards were from the Formicidae. This was most likely because a few invasive geckos were accidently caught in the traps, which could have attracted an abnormally high number of ants, which are typically the first insect to start to feed on the decaying flesh of vertebrates. While picking up the traps, many ants were swarming all over the geckos that were dead. Furthermore, many additional formicids were caught in the kitchen, which is to be expected because of the food and other sources of habitation for them like an ample supply of water and hiding places. Overall, the pan traps were an effective capturing method and caught 10 distinct taxonomic groups of arthropods. There was a high concentration of the family Sciaridae in the pan traps, which could be due to the fruit that is left out near all the rooms at the station as well as the open doors and windows.

There are many insects and other arthropods that fly and crawl around the station constantly. This is what makes it difficult to determine what exactly a pest arthropod at ARTEC is. However, there were no mosquitoes collected during any sampling at any time and only a handful of mosquitoes were seen by anyone on the station. This may be due to the spraying that is done by airplanes over all the areas specifically targeting mosquitoes and leaving all other insects alone. This could also be due to the fact that there has been a high concentration of people taking care of the area around the station and making especially sure that there are no mosquito breeding sites because of the recent Zika virus outbreak. There could be many more reasons for the absence of mosquitoes in the samples collected during this study, but it is likely that the conscious effort to eliminate the breeding areas of mosquitoes around the station has contributed to this result.

Despite the abundance of arthropod pests in structures inhabited by humans, there is no pest control at ATREC. Barriers that would keep arthropods out of the rooms would go a long way in helping cut down on the amounts of arthropods seen in rooms. Barriers can include screens, door sweeps, etc. These barriers if put in place would help to relieve the many pests that are flying and crawling around ATREC. The next step in this survey is to find a way to catch more flying insects, as well as help inform employees on how to implement the IPM strategies to help control the amount of insects seen, without killing them. Another future study should be to use aspirators, vacuums, and other various collecting equipment to ensure that all arthropods are collected and identified. This survey was just an overview of the main pest arthropods encountered around the station, however if a more detailed account of what is inside structures around ATREC is wanted, then no traps should be used and collecting equipment should be used.

Acknowledgements: I would like to thank Amy Keiser, Adrian Fisher, Luke Chambless, Dr. Juliana Rangel and Dr. Kevin Conway of Texas A&M University for helping me complete my survey. Also, I would like to thank all of the staff at the Springfield station for allowing me to conduct this survey. Lastly, I would like to thank Dr. Ed Vargo and Dr. Janis Reed of Texas A&M University for helping me with ideas and helping me formulate my project.

Footnote: There is an IPM introduction at the end of this paper to help the people of Dominica limit the amount of pest arthropods that enter their homes.

REFERENCES CITED

Bertone, Matthew. 2016. Arthropods of the great indoors: characterizing diversity inside urban and suburban homes. *PeerJ 4*:e 1582 1-23.

Keller A. 2007. *Drosophila melanogaster*'s history as a human commensal. *Current Biology.* 17(3): R77-R81.

NESCent Working Group on the Evolutionary Biology of the Built Environment, Martin LJ, Adams RI, Bateman A, Bik HM, Hawks J, Hird SM, Hughes D, Kembel SW, Kinney K, Kolokotronis S-O, Levy G, McClain C, Meadow JF, Medina RF, Mhuireach G, Moreau CS, Munshi-South J, Nichols LM, Palmer C, Popova L, Schal C, Täubel M, Trautwein M, Ugalde JA, Dunn RR+16 more. 2015. Evolution of the indoor biome. *Trends in Ecology & Evolution* 30:223-232.

Robinson WH. 2005. *Urban Insects and Arachnids: A Handbook of Urban Entomology*. Cambridge. Cambridge University Press. Cambridge, UK.

Triplehorn, C. A. and N. F. Johnson. 2005. *Borror and Delong's Introduction to the Study of Insects*. Seventh Edition. Thomson Brooks/Cole. Belmont, CA.

Introduction to Integrated Pest Management (IPM) for Dominica, W.I.

Integrated Pest Management, or IPM, is a branch of pest control that deals with the development of strategies that limit the amount of pesticides used, as well as prevention of insects and other animals from reaching high population levels. A few common IPM practices include biological control, habitat manipulation, modification of cultural practices, and the use of certain pest-resistant strains of crops (University of California). The IPM system works in all areas of nature, including urban areas, rural areas, natural areas, and even wildlands (University of California). However, this introduction will apply only to urban IPM.

To start, you may be asking what a pest is. A pest is any animal that is located in an area where it is a nuisance, a medical threat, or an economic problem. To start, there are three main groups of pests: insects, arachnids, and rodents. Each group of pests is handled differently. This introduction will be focused on arthropods, which are insects, arachnids, and a few other groups like millipedes and centipedes (Bertone, 2016). These animals are the most diverse and abundant group of multicellular life found in homes (Bertone 2016). Also, the main thing to keep in mind is that nothing is necessarily considered a pest until it reaches a certain population threshold in a particular area. Also, keep in mind that the threshold population levels vary for different animals. However, there are some exceptions like ants, roaches, mosquitoes, bed bugs, and wood destroying insects. If there is one of these insects in or around where you are in an urban environment, there are normally many more because of their social behavior, which makes them live together in groups. Most other arthropod pests are considered occasional invaders only coming in or around an establishment temporarily during certain times of the year. These pests, while bothersome, will not normally cause any damage to structure or be harmful health wise and also have a larger population threshold to be considered a pest.

Now that there is some clarification as to what a pest is and what certain pests do, here are some tips on how to keep insects out of your home or place of business. An easy way to keep flying pests out of a structure, especially mosquitoes and flies, is to have mesh covering the windows, which allows for air to flow in and cool the structure but also it allows for a barrier against insects. Also, for flying insects, you can try closing the doors to the structure as much as possible. Though it gets very hot when the doors are closed, try to minimize the amount of time and the number of doors that are open to help control flying insects. Also, try to limit the amount of fruits and vegetables that are left out on the counter and try to keep a clean trash can and a lid on the trash can in order to keep fruit flies as well as house flies away from the inside. The flies are attracted to the fruit and other decaying matter, so if you are able to eliminate the food source then the insects go away. For mosquitoes in particular, make sure that there is no standing water around the structure, as they breed in standing water. If you are able to eliminate their breeding sites, there will be fewer mosquitoes around the structures in question (University of California, 2016a). These are some good and helpful ways to keep flying pests out of urban structures.

When dealing with crawling pests, make sure you identify the insects first. Once you do that, here are some suggestions on how to control the most common crawling arthropod pests. For ants, figure out where they are coming from. Ants create trails and follow one another to where they are going. Once you find where they are trailing from, you can seal up their entry point with caulk (University of California, 2016b). Also, make sure that doors close all the way and have seals on the bottom in order to not allow ants in via doors.

For cockroaches, make sure that your doors are completely closed as well as there are no holes on the outside walls that they can be getting in through. Also, make sure that floors, cabinets, and especially kitchen equipment is clean and there is no trash or debris under it.

Silverfish are quite easy to deal with and their presence is easily detected. If you have books or other forms of glue in an area, silverfish will eat that material. In order to control them, keep all areas of the building clean and tidy. Dust provides a very important food source for the silverfish (University of California, 2016b).

To help prevent the infestation of termites, make sure that there is no wet wood or other form of damp cellulose that will attract them that is loose on the ground near a structure. Unfortunately however, for termites and bed bugs there are no readily available IPM methods for you to do once they have infested a structure. If they have invaded a structure, then the best thing to do is to call your local pest control professional (University of California, 2016a).

For spiders, first try to identify the specimen to determine how harmful it is to humans or any other valuable animal. Once their risk is assessed, it is best to move them to the outside of the structure and let them live, as they help eat away the insect population. If you find a harmful spider, kill it by hand using a piece of paper or even a shoe. Also, you can clean off the webs off the walls and baseboards in the structure in question to help eliminate the spiders (University of California, 2016b). Do not use any pyrethroid-based insecticides to kill them, as almost all spiders are beneficial. Most spiders are not social and thus live by themselves, so there may be a few in a structure, but they are not living together. However, if you are very concerned about spiders, then getting rid of insects around the structure is the best way to completely get rid of spiders due to the fact that you are once again eliminating the spider's food source.

These are some ways that you can help control some of the pest arthropods that you will find in and around structures. I hope this helps you to control some pests that you see in and around the buildings that you are at. Thank you for reading this and I hope you find this helpful and interesting.

References Cited

University of California. 2016a. What is Integrated Pest Management (IPM)? http://www2.ipm.ucanr.edu/WhatIsIPM/

University of California. 2016b. Pest Notes Library. http://ipm.ucanr.edu/PMG/PESTNOTES/index.html