National Science Foundation Louis Stokes Alliance for Minority Participation

Tampa Bay Bridge to Baccalaureate Alliance Undergraduate Research Experience

2020-2021 St. Petersburg College Student Research Projects

This material is based upon work supported by the National Science Foundation under Grant No. 1712738 and Grant No. 2007989*. Any opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.*

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About the Tampa Bay Bridge to the Baccalaureate Undergraduate Research Experience Report

The Tampa Bay Bridge to the Baccalaureate (TB-B2B) Program provides resources and support to St. Petersburg College (SPC) Science, Technology, Engineering, and Mathematics (STEM) students as they work to achieve their 4-year STEM degree. The program is grant funded by the National Science Foundation (NSF) as part of the Louis Stokes Alliance for Minority Participation (LSAMP).

A goal of the NSF LSAMP TB-B2B grant, is for each College in the TB-B2B alliance to provide undergraduate research experiences (UREs) to students during their first and second years of undergraduate studies. Final reports of each URE conducted at SPC during 2020-21 are contained within this document.

Background

Prior to the start of each semester in 2020-21, TB-B2B enrolled students who had not yet completed a research project, were informed that 8-week research opportunities within their STEM major were available during the following semester, and included a paid stipend of $250. Interested students were provided the name of a professor in their field, and were directed to schedule a meeting with the professor to discuss their research interests. SPC's URE Model is provided in Appendix A.

Six St. Petersburg College TB-B2B students participated in 8-week UREs within their field of interest during 2020-21. Students received their stipend after all research project requirements were met at the conclusion of the eight weeks, including the completion of a final report. UREs included research projects in four categories, Microbiology, Environmental Science, Robotics Technology, and Cybersecurity Technology

Upon completing a URE, students are surveyed to measure their perspective about the impact the UREs had on them, and assist the college to continuously improve. The survey was adapted from the Community College Undergraduate Research Initiative (CCURI), and the Undergraduate Research Student Self-Assessment (URSSA) from the University of Colorado, and with their permission, we removed a few questions that were not applicable to our URE model.

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Undergraduate Research Experiences (UREs)

Listed below are the names of six students who completed UREs with guidance from St. Petersburg College professors in four STEM disciplines, and submitted the final reports contained within this document.

Microbiology UREs conducted with Professor Shannon Ulrich, PhD

- Jada Batten *Testing the effects of essential oils on bacterial growth*
- Valjean Pulido Pardo *Analyzing bacteria on the surface of cell phones*

Environmental Science URE conducted with Professor Erin Goergen, PhD

- Sandra Perea *Plant-Pollinator Interactions in a Suburban Environment*

Environmental Science URE conducted with Professor Maura Scanlon, PhD

- Travol Johnson *Microplastics in soil and fiddler crabs*

Robotics Technology URE conducted with Professor Dawn Ellis, MS

- Adelle Bradley *Lego Mindstorms EV3 Education Free Falling Engineering Lab*

Cybersecurity Technology URE conducted with Professor John Duff, PhD

- Jesse Dominguez *Identified case studies involving security incidents*

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Undergraduate Research Experiences (UREs) Survey Results Highlights

The URE survey was administered to twenty students who completed UREs between 2018 and 2020, and eighteen responded resulting in a 90% response rate. Below are several survey results highlights.

I. GAINS IN THINKING AND WORKING LIKE A SCIENTIST: APPLICATION OF KNOWLEDGE TO RESEARCH WORK:
How much did you GAIN as a result of your URE: 100% reported 'Great Gain' or Moderate Gain'
Percent of respondents who reported 'Great Gain'

- Figuring out the next step in a research project: 100%
- Problem-solving in general: 94%
- Understanding the relevance of research to my coursework: 83%

II. PERSONAL GAINS RELATED TO URE: 94% reported 'Great Gain' or Moderate Gain'
Percent of respondents who reported 'Great Gain'

- Comfort in discussing scientific concepts with others: 94%
- Confidence in my ability to contribute to science: 89%
- Understanding what everyday research is like: 89%

III. GAINS IN SKILLS: How much did you GAIN as a result of your URE:
Percent of respondents who reported 'Great Gain' or Moderate Gain'

- Writing scientific reports or papers: 100%
- Explaining my project to people outside my field: 100%
- Keeping a detailed lab notebook: 100%
- Conducting observations in the lab or field: 94%

Percent of respondents who 'Strongly Agree' or 'Agree' with the following statements:

- Doing research confirmed my interest in my field of study: 94%
- My URE has prepared me to transfer from a 2-year to a 4-year institution: 94%
- Doing research clarified for me which field of study I want to pursue: 88%

IV. Compared to your intentions BEFORE doing research, HOW LIKELY ARE YOU NOW to:
Percent of respondents who are now 'Extremely More Likely' or 'Somewhat More Likely' to:

- Complete your Associates degree? 94%
- Transfer to a 4-year institution? 88%
- Complete your Bachelor's degree in science, mathematics, or engineering? 82%
- Enroll in a Master's program in science, mathematics, or engineering? 53%

Student Comments

"really solidified my wish to pursue a master's or doctorate in Cybersecurity/computer science"
"I am more interested now in continuing my education"
"helped me learn about ecology/ conservation and it opened my eyes to more possibilities"
"networking and establishing connections with people have been great help with finding my own career path"
"It sparked an interest for a scientific career"

Source: This survey was adapted from the Community College Undergraduate Research Initiative (CCURI), and the Undergraduate Research Student Self-Assessment (URSSA) from the University of Colorado.

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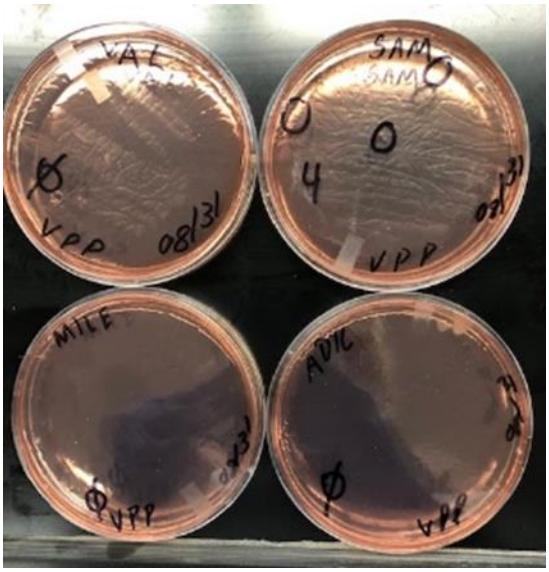
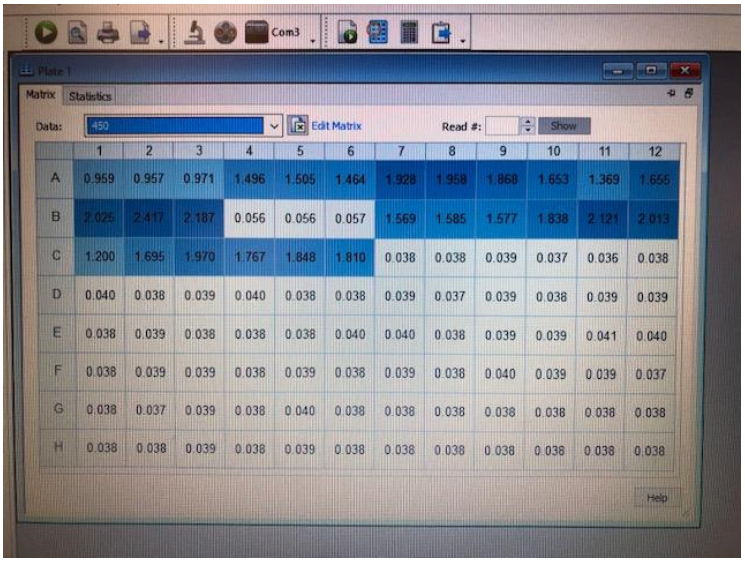
Microbiology Research Projects





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A	0.959	0.957	0.971	1.496	1.505	1.464	1.928	1.958	1.868	1.653	1.369	1.655
B	2.025	2.417	2.187	0.056	0.056	0.057	1.569	1.585	1.577	1.838	2.121	2.013
C	1.200	1.695	1.970	1.767	1.848	1.810	0.038	0.038	0.039	0.037	0.036	0.038
D	0.040	0.038	0.039	0.040	0.038	0.038	0.039	0.037	0.039	0.038	0.039	0.039
E	0.038	0.039	0.038	0.038	0.038	0.040	0.040	0.038	0.039	0.039	0.041	0.040
F	0.038	0.039	0.039	0.038	0.039	0.038	0.039	0.038	0.040	0.039	0.039	0.037
G	0.038	0.037	0.039	0.038	0.040	0.038	0.038	0.038	0.038	0.038	0.038	0.038
H	0.038	0.038	0.039	0.038	0.039	0.038	0.038	0.038	0.038	0.038	0.038	0.038

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Tampa Bay Bridge to Baccalaureate (TB B2B) STEM Program Student Research Final Report

Name: Jada Batten **Professor:** Shannon Ulrich, PhD
Date: 10/19/2020

Outline of Responsibilities

- Attending a weekly microbiology research meeting Mondays from 4:00-5:00PM
- Performing primary literature research and/or laboratory experiments
- Meeting with Professor Ulrich on a weekly basis for status updates and determination of the following week's goals
- Complete compiled report of the research/activities done each week (e.g. results observed, assumptions, and/or conclusions, learning achieved)

Weekly Reports & Data

Week 1: 8/24/2020
Met with Dr. Ulrich to discuss possible research topics and toured the lab. Learned about the equipment used in the lab. Decided to test the effects of essential oils on bacterial growth. Researched essential oils and potential antibacterial effects. The following essential oils were chosen for analysis: Valerian, Frankincense, Tea Tree Oil, and Bergamot. A gram positive, *Staphylococcus aureus*, and gram negative, *Pseudomonas aeruginosa*, bacteria were chosen for analysis.

Week 2: 8/31/2020
Test bacteria were cultured into broth. Experimental design was discussed and 96-well plate set-up was determined (Figure 1).

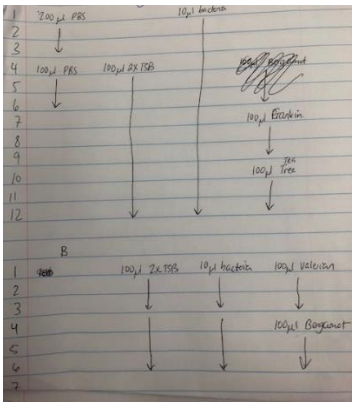


Figure 1. Initial 96-well set up.

Week 3: 9/14/2020
The 96-well microtiter plate was inoculated with *Pseudomonas aeruginosa* with and without essential oils (Figure 2). The plate was covered with an adhesive film to prevent evaporation and was then incubated at 37°C for 24 hours.

Figure 2. Inoculating the 96-well microtiter plate with *Pseudomonas aeruginosa*.

Week 4: 9/21/2020
Close inspection of the 96-well microtiter showed significant deterioration of the adhesive film. The results of the experiment could not be concluded because the sample was compromised due to the breakdown of the adhesive film. The experiment was repeated using *Staphylococcus aureus* and the same microtiter set up with essential oils (Figure 3). Adhesive film was not used, instead parafilm was wrapped around the lid to prevent evaporation.

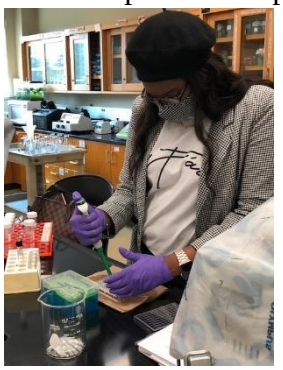


Figure 3. Inoculating the 96-well microtiter plate with *Staphylococcus aureus*.

Week 5: 9/28/2020
Close inspection of the 96-well microtiter showed significant deterioration of plastic on both the lid and microtiter wells (Figure 4).

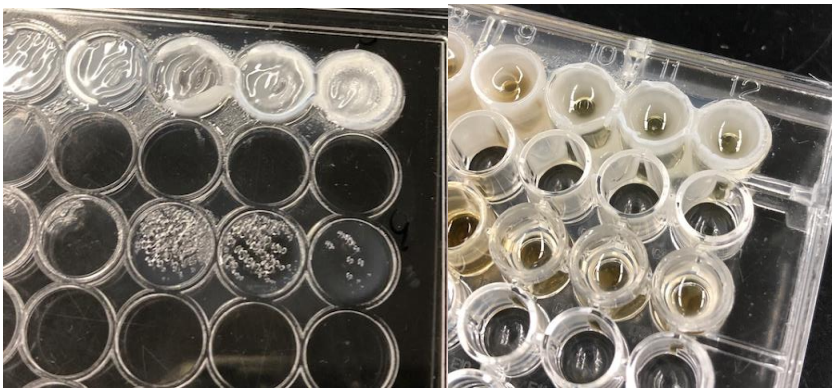


Figure 4. Breakdown of plastic on both the microtiter lid and wells.

Devised a new experimental plan using glass test tubes (Figure 5). Glass tubes were prepared and autoclaved for sterilization.

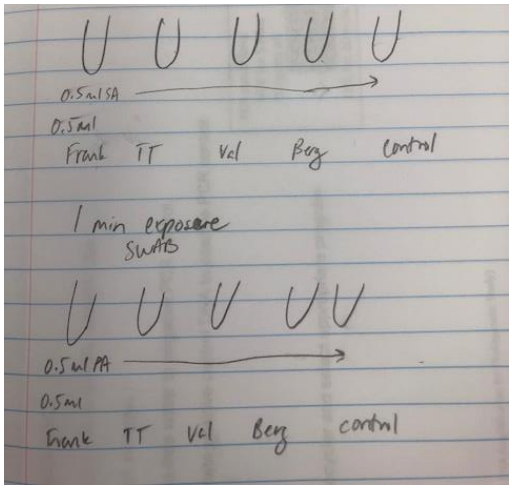


Figure 5. Outline of revised experimental plan.

Week 6: 10/5/2020

Table 1 represents the mixture added to each test tube. Each tube was swirled for 60 seconds. A swab was then used to sample the contents of the tube and inoculated onto a Tryptic Soy Agar (TSA) plate. All plates were incubated at 37°C for 24 hours.

Table 1. Revised experimental set up with specific mixture for each test tube.

Tube	Bacteria added	Essential oil added
1	0.5-ml of *S. aureus*	None
2	0.5-ml of *S. aureus*	Bergamot
3	0.5-ml of *S. aureus*	Valerian

4	0.5-ml of *S. aureus*	Frankincense
5	0.5-ml of *S. aureus*	Tea Tree Oil
6	0.5-ml of *P. aeruginosa*	None
7	0.5-ml of *P. aeruginosa*	Bergamot
8	0.5-ml of *P. aeruginosa*	Valerian
9	0.5-ml of *P. aeruginosa*	Frankincense
10	0.5-ml of *P. aeruginosa*	Tea Tree Oil

Week 7: 10/12/2020

Plates were observed for bacterial growth. Both control plates exhibited a continuous lawn of bacteria indicating robust growth. The results for both *S. aureus* and *P. aeruginosa* followed similar trends with growth completely inhibited with Valerian, moderate inhibition with Tea Tree Oil and only slight inhibition with the Bergamot and Frankincense (Figure 6).

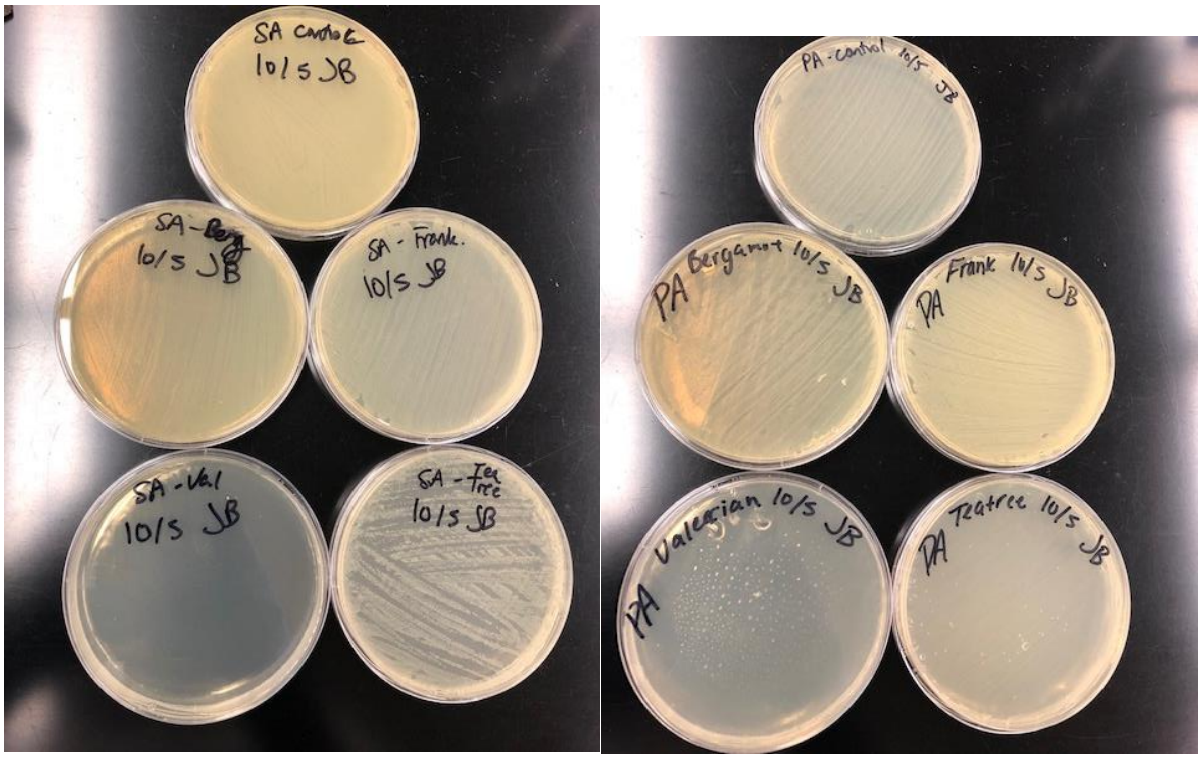
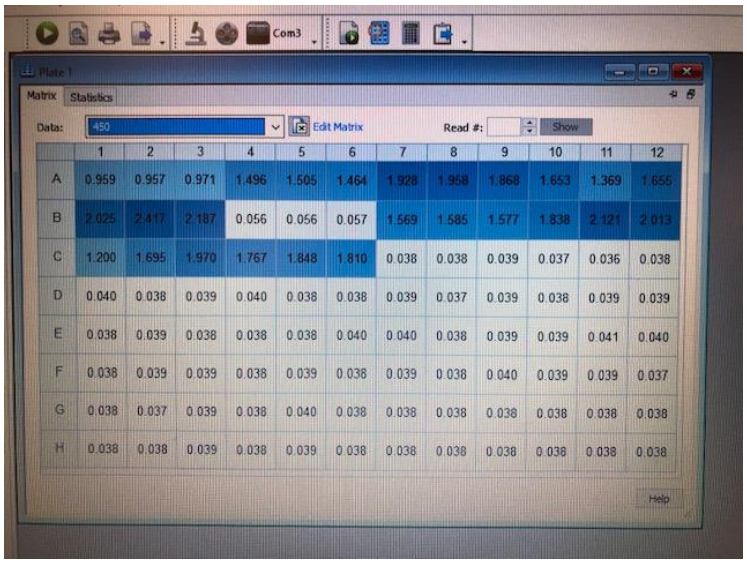


Figure 6. Resulting growth of *S. aureus* (left) and *P. aeruginosa* (right) after exposure to no essential oils (control – top) or essential oil.

To quantify bacterial growth, the bacterial suspensions were made from each plate. Briefly, 5-ml of sterile 1X phosphate buffered saline (PBS) were added to the surface of each plate. The

plates were rocked for 2 minutes to loosened cell attachment from agar. Then, a sterile cell spreader was used to scrape the culture from the surface of the agar plate and homogenize the sample. A total of 100 µl from each plate was collected in triplicate and placed into a 96-well microtiter plate. A spectrometer was used to measure the absorption of each well to indirectly measure growth of the bacteria (Figure 7).



	1	2	3	4	5	6	7	8	9	10	11	12
A	0.959	0.957	0.971	1.496	1.505	1.464	1.928	1.958	1.868	1.653	1.369	1.655
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G	0.038	0.037	0.039	0.038	0.040	0.038	0.038	0.038	0.038	0.038	0.038	0.038
H	0.038	0.038	0.039	0.038	0.039	0.038	0.038	0.038	0.038	0.038	0.038	0.038

Figure 7. Absorbance results.

Week 8: 10/19/2020

The absorbance results were averaged and graphed for data analysis. Figure 8 illustrates the effects of the essential oils on the growth of bacteria.

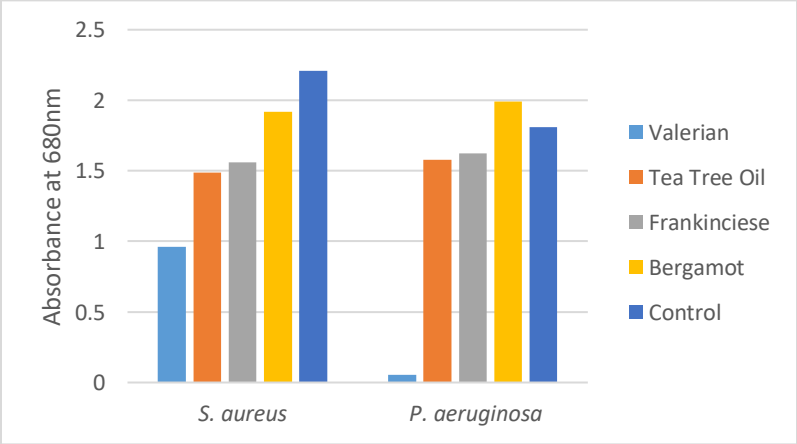

Figure 8. Indirect measure of bacterial growth after exposure to essential oils.

Conclusions

Initially, we tested the effects of essential oils on biofilm but as seen in Figure 4 the microtiter lid and wells began to break down significantly due to the different chemicals in the essential oils that broke down the polystyrene. We decided to alter the way we observe the bacteria. The mixture of essential oils and bacteria was added to glass test tubes to better analyze growth inhibition. The results were similar between the 2 types of bacteria, *S. aureus* (Gram positive) and *P. aeruginosa* (Gram negative), however I did expect tea tree oils to completely inhibit bacterial growth because of all the said antibacterial and anti-inflammatory claims. Overall, Valerian showed the greatest inhibition of bacterial growth for both *S. aureus* and *P. aeruginosa,* although it had a greater inhibition on *P. aeruginosa.*

Techniques Utilized

Microbiological techniques learned:

- Aseptic techniques
- Micropipetting
- Data analysis

Tampa Bay Bridge to Baccalaureate (TB B2B) STEM Program Student Research Final Report

Name: Valjean Pulido Pardo **Professor:** Shannon Ulrich, PhD
Date: 10/19/2020

Outline of Responsibilities

- Attending a weekly microbiology research meeting Mondays from 3:30-4:30 PM
- Performing primary literature research and/or laboratory experiments
- Meeting with Professor Ulrich on a weekly basis for status updates and determination of the following week's goals
- Complete compiled report of the research/activities done each week (e.g. results observed, assumptions, and/or conclusions, learning achieved)

Weekly Reports & Data

Week 1: 8/24/2020
Met with Dr. Ulrich to discuss possible research topics and toured the lab. Learned about the equipment used in the lab. Decided to analyze bacteria on the surface of cell phones. Received sample collection kit. Sampled 4 cell phones before the next lab meeting.

Week 2: 8/31/2020
Swabbed cell phone samples onto Mannitol Salt Agar (MSA) plates (Figure 1). All samples were incubated at 37°C for 24 hours. Media was prepared for the following week (Figure 2).


Figure 1. Inoculating MSA with swab of cell phone.


Figure 2. Pouring MSA plate.

Week 3: 9/14/2020
Resulting colonies on the MSA plates were counted. A total of 4 colonies were counted on one plate and all other samples were negative (Figure 3). Results are summarized in Table 1. Four-

quadrant streak method was used to inoculate and isolate the four bacteria samples on the MSA media (Figure 4). All plates were incubated at 37°C for 24 hours.

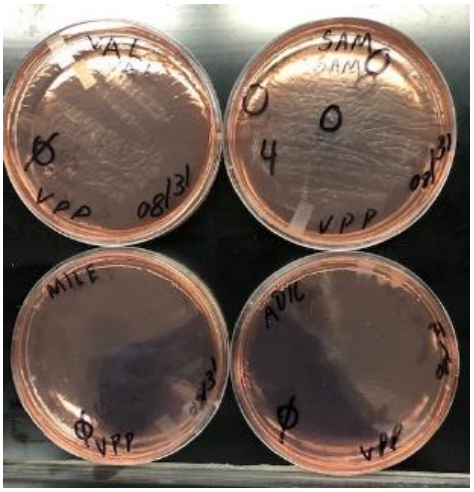

Figure 3. Results from MSA plates.

Table 1. Results of MSA plates.

Sample	No. of Bacteria
VAL	0
SAM	4
MILE	0
ADIL	0

Figure 4. Valjean using the four-quadrant streak method to isolate bacteria on MSA plates.

Week 4: 9/21/2020
Bacterial isolates were aseptically transferred into broth (Figure 5). All isolates were stained using the Gram stain procedure. All bacterial isolates presented as gram-positive, cocci shaped bacteria (Figure 6).

Figure 5. Gram staining the bacterial isolates.

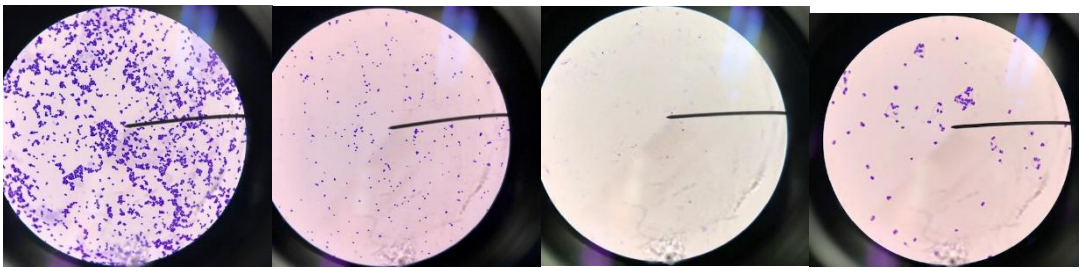

Figure 6. Results of Gram staining procedure.

Week 5: 9/28/2020
DNA was extracted from the bacterial broth cultures.

Week 6: 10/5/2020
DNA was used as template in a 16S PCR reaction to test for the presence of bacteria.

Week 7: 10/12/2020
DNA was used as template in a STAPH PCR reaction to test for the presence of *Staphylococcus* bacteria. The 16S PCR products were separated via electrophoresis and visualized using UV light. All samples were positive for the 16S PCR and therefore classified as bacterial isolates (not fungi) (Figure 7).

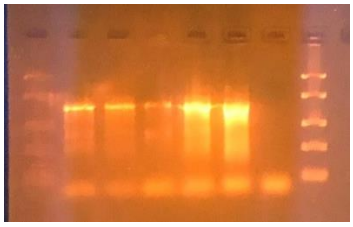

Figure 7. 16S PCR gel analysis.

Week 8: 10/19/2020
The STAPH PCR products were separated via electrophoresis and visualized using UV light. All samples were positive for the STAPH PCR indicating all samples were of the *Staphylococcus* genus (Figure 8).

Figure 8. STAPH PCR gel analysis.

Conclusions

After collecting bacteria from the surface of cell phones and analyzed them, we got to the conclusion that all the isolated colonies through the four-quadrant streak method were bacteria. Then, with some steps and through a STAPH PCR reaction, we found out that the bacteria were *Staphylococcus* bacteria. This research project was impressive!

Techniques Utilized

Microbiological techniques learned:

- Aseptic techniques
- Enumeration of bacterial colonies
- Gram stain procedure
- DNA extraction
- 16S PCR
- STAPH PCR
- Gel electrophoresis
- Data analysis

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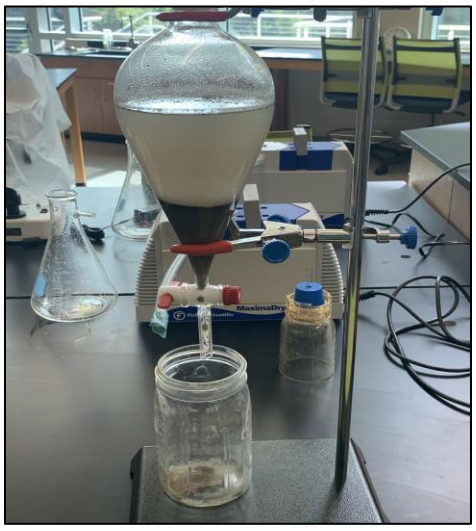
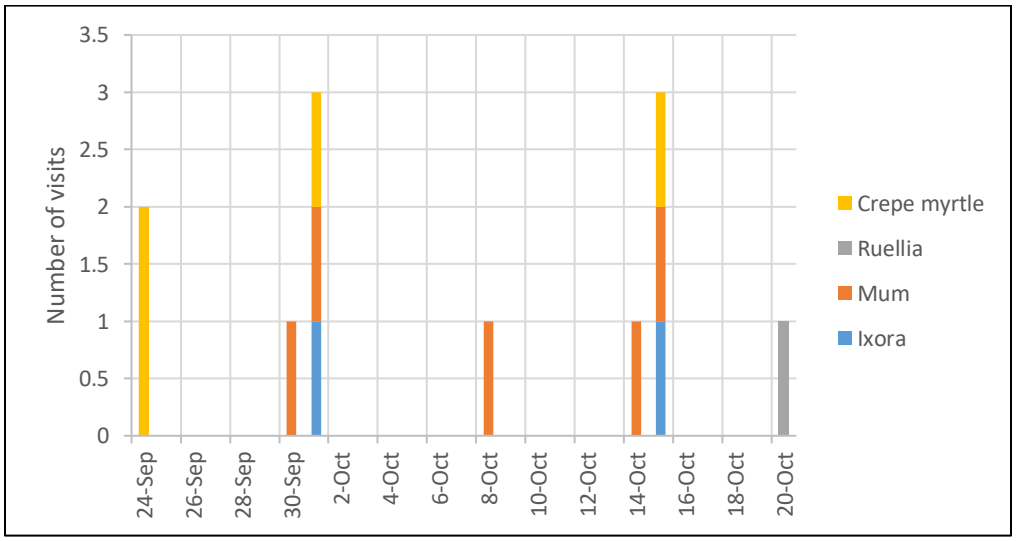
Environmental Science Research Projects





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Tampa Bay Bridge to Baccalaureate (TB B2B) STEM Program Student Research Final Report

Name: Sandra Milena Perea **Professor:** Erin Goergen, PhD

Date: 11/05/2020

Plant-Pollinator Interactions in a Suburban Environment

Outline of Responsibilities

•Performing primary literature research on pollinators with specific emphasis on beetle pollinators.

•Performing field experiments and collections.

•Meeting with Dr. Goergen via Zoom on a weekly basis for status updates and determination of the following week's goals

•Completing compiled report of the research/activities done each week (e.g. results observed, assumptions, and/or conclusions, learning achieved)

Purpose of Project

Survey of Pollination in an Urban Setting.

Pollinators serve an important role in all ecological communities, both urban and rural. However, in urbanized areas, the amount of habitat is greatly reduced and can have a negative effect on pollinator populations. The purpose of this experiment was to examine the frequency of pollinator visits as well as diversity and specialization of pollinators in an urban environment. Further, this project is part of a large citizen science collaborative project where data from all over the world is being combined to examine this ecological question on a larger scale.

My experimental design: In a suburban setting, green space is very limited and researching pollinator activity can be challenging. To better study pollinators in a suburban site, potted plants were placed in the front yard of the home to make the plants easy to observe and to ensure plenty of sunlight. The flowering plants studied can be found in any home improvement store. To complete this research, the plants selected were Ixora Maui Red, Yellow Mum, Mexican Petunia, and Crape Myrtle. A few of the key features of each plant can be found below.

1-A Ixora Maui Red

- Rubiacea Family
- Plant is low maintenance
- Requires full sun
- Tubular umbel flower
- Flowers throughout the

1-B Yellow Mum

- Scientific name: *Chrysanthemum morifolium*
- Plant is low maintenance
- Plant is water and sun loving
- Open flower / Flower head
- Hardy perennials

1-C Crape Myrtle

- Scientific name: *Lagerstroemia* spp.
- Plant is low maintenance
- Open flower
- Requires full sun and well-drained soil

1-D Mexican Petunia

- Scientific name: *Ruellia brittoniana*
- Plant is low maintenance
- Requires full sun and does well in drought conditions.
- Tubular flower
- Plant can be invasive

Figure 1. Images and descriptions of the plants used in this experiment.

Weekly Reports and Data

- Week 1 (September 10th) Meeting with Dr. Goergen to discuss the pollinator project being conducted and to find out best ways to approach the research. Reading provided literature to better understand the role insects play in pollination.

- Week 2 (September 17th) Meeting with Dr. Goergen to discuss requirements to carry out the research. Learned how to create a quadrat for research and how to properly perform quadrat sampling. Also, gained information in flower/pollinator recognition while learning how to properly care for each plant. Finally, a schedule for the observations was established. The observations would take place 2 times per week and 3 times each day. One observation in the morning before noon, the next one between 12pm and 2pm, and the last one mid to late afternoon.

- Week 3 (September 24th and 30th) First week of observations. On the 24th at 10:45am a wasp was observed going to a Crape Myrtle. At that moment, the skies were clear, with no wind, and the temperature was 28° C. At 3pm, on the same day, a wasp was spotted going to a Crape Myrtle. The temperature was 32°C, overcast, and light wind. It is important to mention that a predator (dragonfly) was noticed in the area which may have reduced the activity of pollinators. On the 30th only a gnat was seen going to the Yellow Mum. The temperature was 24° C, clear skies, and light wind for that day. This particular day was colder than usual for central Florida which may have impacted the movement of the insects.

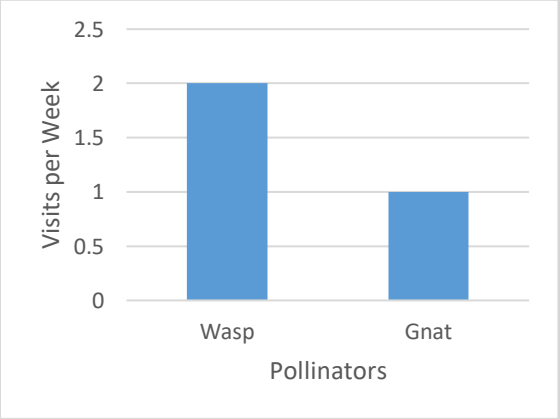

Fig.2 shows the number of visits for each pollinator for this week for all of the plants combined.

- Week 4 (October 1st and 7th) Second week of observations. On the 1st at 11:05am a fly was observed going to the Ixora. At that moment, the skies were clear, with light wind, and the temperature was 25° C. However, this pollination looked accidental since the fly landed on the leaves and it looked like it fell on the flower for a few seconds. At 3pm, on the same day, a wasp was spotted going to a Crape Myrtle and a gnat to the Yellow Mum. The temperature was 29°C, clear skies, and light wind. On the 7th there was no activity observed. This day very humid with highest measurement reaching 92% for humidity and 32°C for temperature.

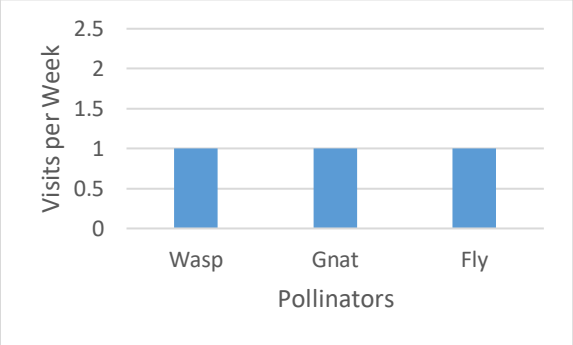

Fig.3 shows the number of visits for each pollinator for this week across all plants.

- Week 5 (October 8th and 14th) Third week of observations. On the 8th at 4pm a gnat was observed going to the Yellow mum. At that moment, the skies were clear, with light wind, and the temperature was 33° C. It is important to mention that the landscaping crew were out in the morning. Human activity and loud noises may have affected movement of the pollinators. On the 14th at 1:45pm a fly was observed going to the Yellow mum. At that moment, the skies were clear, with light wind, and the temperature was 31° C.

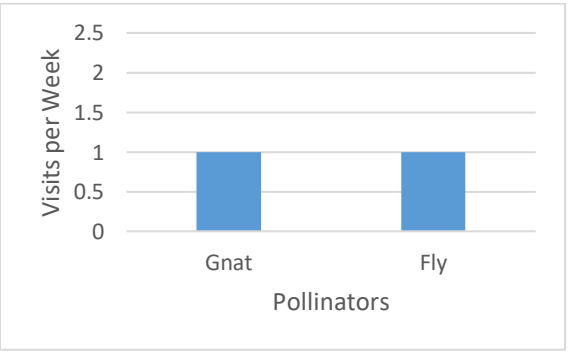

Fig.4 shows the number of visits for each pollinator for this week across all plants.

- Week 6 (October 15th and 20th) Fourth week of observations. On the 15th at 10:45am a gnat was observed going to the Yellow mum and then it moved to the Ixora. Also, a wasp was noticed at the Crape Myrtle. At that moment, the skies were clear, with light wind, and the temperature was 28° C. It is meaningful to notice that the landscaping crew were out in the afternoon and no insect activity was present. On the 20th at 12:51pm a bee was observed going to the Mexican Petunia. At that moment, the skies were clear, with light wind, and the temperature was 29° C.

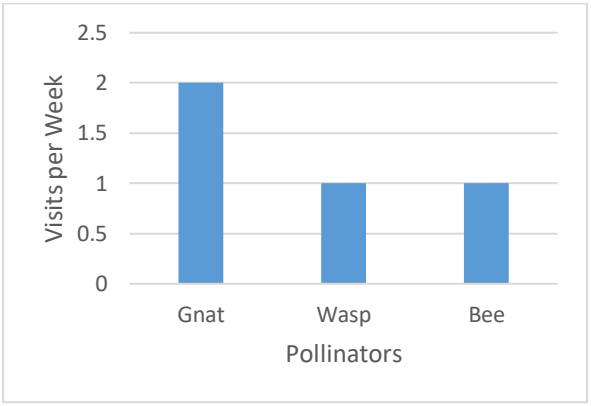

Fig.5 shows the number of visits for each pollinator for this week across all plants.

Fig.6 shows the bee pollinating the Mexican Petunia.

- Week 7 (October 29th) Data interpretation. At this weekly meeting we looked at the data and started to analyze the patterns observed. This involved entering the data into the database and creating graphs of the data collected over the entire experiment as well as creating a plant pollination interaction network map (Figure 7).

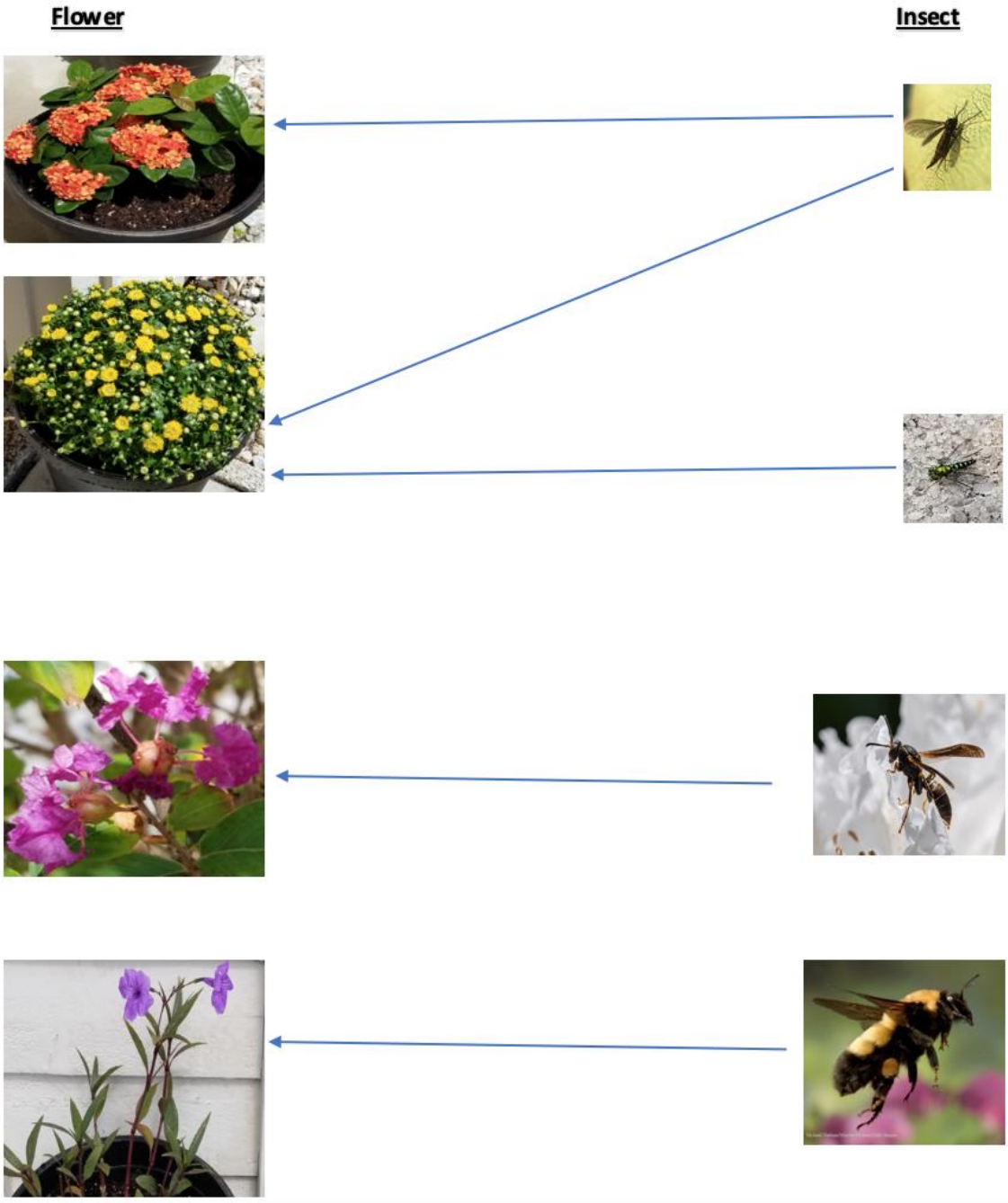

Figure 7 Plant pollinator interaction map. This shows that most insects were specials for the plants they were pollinating with the exception of the gnat.

Week 8 (November 5th) Results. For this final week, I wrote a paper with overall results and patterns noticed.

Suburban environments might not be the ideal setting to study pollinators; however it provided some interesting data. After introducing decorative flowers, moderate insect activity was noticed. While the plants may not have had their usual pollinators, they were still fertilized by others. The Mexican Petunia (*Ruellia brittoniana*) was a perfect example of this. The most common pollinators for Ruellia according to Sharon Rico, a master gardener with the University of California, are butterflies and hummingbirds (Rico, 2013). However, in the suburban environment it was favored by bees (Figure 7). Also, wasps and flies showed a preference for open flowers (yellow mum and crape myrtle) while gnats had no preference between open (yellow mum) or tubular (ixora) flowers.

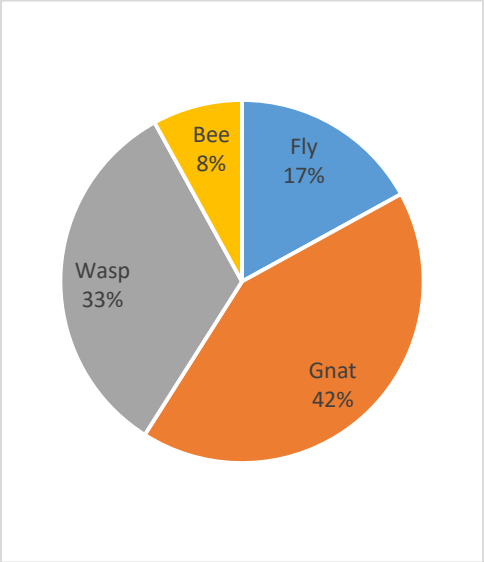

Fig.8 Shows the most active pollinator observed.

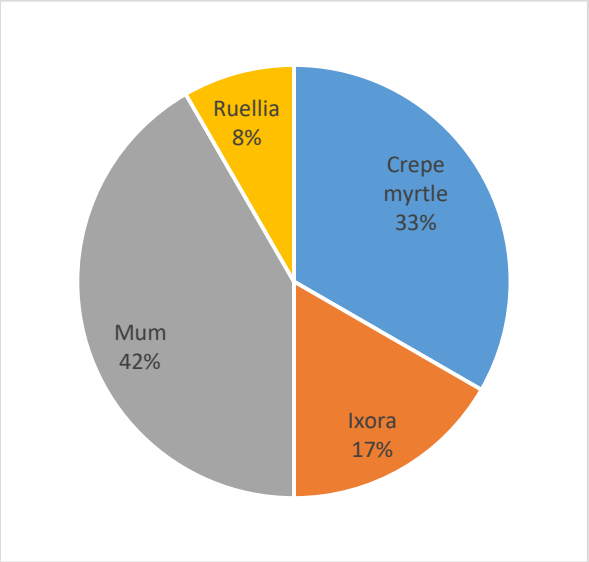

Fig.9 Shows the % of visits for each plant.

Most visits were noticed on the hotter part of the day while no visits were recorded during lower temperatures. Additionally, a few things that seem to affect pollinator visits are human activity (landscaping) and humidity. From all the pollinators observed gnats, with 42% visits, were the most abundant. Also, open flowers (yellow chrysanthemum and crape myrtle) had the

most visits with 42% and 33% respectively (Figure 9). It could be concluded that the easier access to pollen, that open flowers offer, increases their chances for fertilization.

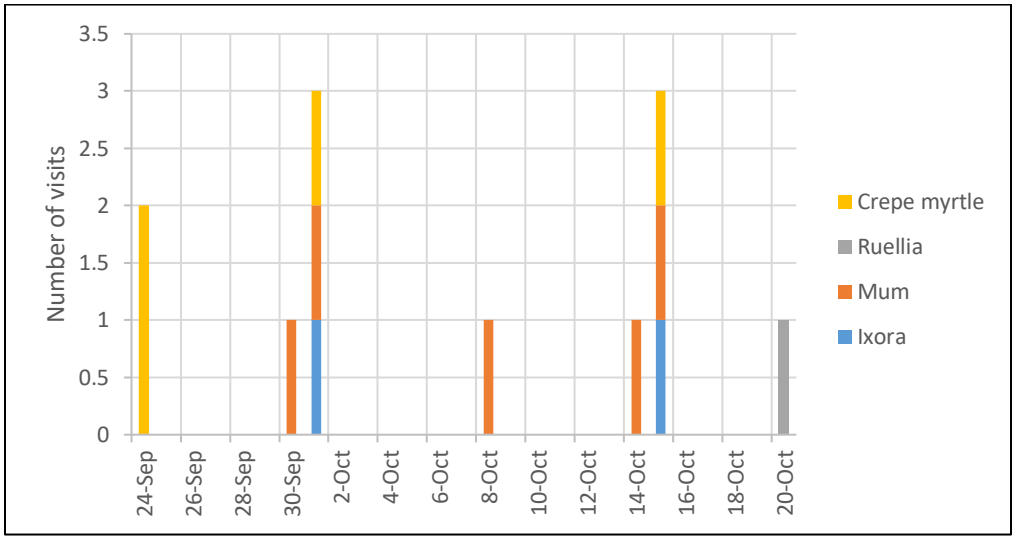

Fig. 10 Offers a breakdown of the most days with visits.

Conclusions

Results of this experiment show that although numbers are low, pollinator visits do occur in an urban setting, and having even a small number of potted plants around is helpful in providing habitat to pollinating insects. In this study, I found that most of the pollinators were fairly species specific (Figure 7), but it is not possible to tell if this is a general trend or due to the specific environment this study was conducted in.

Overall, analyzing pollination in a suburban setting, even with the space limitation that brings, is quite possible and can provide important information for habitat and population conditions for pollinators. This specific locale can be troublesome due to human activity, excessive landscaping, and pest control, among others. However, adding a few decorative flowering plants increased fertilization activity and provided much needed variety to a very controlled environment.

Techniques and Procedures Utilized

Literature research skills:

- Reading and summarizing scientific studies.
- Finding and recreating established sampling protocols so that data can be used in a global citizen science project.

Field sampling techniques learned:

- Quadrat sampling to determine pollinator visitations.
- Identification of floral characteristics and insect functional groups.

Data analysis techniques learned:

- Collection of data in a notebook and cataloging it in an online database.
- Interpreting the data by creating graphs to show the different patterns and trends.
- Writing up the major results of the study.

References

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Ixora https://gardeningsolutions.ifas.ufl.edu/plants/ornamentals/ixora.html

Lagerstroemia https://hgic.clemson.edu/factsheet/crape-myrtle/

Rico, Sharon. “Mexican Petunia.” ANR Blogs, 2013,

ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=10513

Ruellia https://plants.ces.ncsu.edu/plants/ruellia-simplex/

Tampa Bay Bridge to Baccalaureate (TB B2B) STEM Program Student Research Final Report

Name: Tavol Johnson **Professor:** Maura Scanlon, PhD

Date: October 30, 2020

Outline of Responsibilities

- Performing primary literature research
- Performing laboratory experiments
- Meeting with Professor either by phone or in person on a weekly basis for status updates and determination of the following week's goals
- Completing compiled report of the research/activities done each week (e.g. results observed, assumptions, and/or conclusions, learning achieved)

Weekly Reports & Data

Week 1: 9/6 – 9/12

In week one, I discussed the project in further details with my professor. We made a tentative schedule for each week and various tasks we hoped to get done. This meeting was done via Zoom and lasted for approximately 30 minutes. We also reviewed the contract and possible research topics for the paper. After much contemplation, we decided to do a research paper on microplastics in fiddler crabs and the soil environment.

The next six days were spent reading various literature on microplastics and their effects on fiddler crabs.

Week 2: 9/13 – 9/19

In week two, Professor Scanlon and I met at the St. Petersburg Bay Pines Research Center with the intention of catching fiddler crabs in the wetlands. Unfortunately, due to turbulent rainfall, the wetlands were flooded which only allowed us to catch one fiddler crab. We decided to use this crab as a test subject. We took him back to the lab and placed it in a glass jar with salt water and left him there for one week.

Week 3: 9/20-9/26

During week three of the project, Professor Scanlon and I met at the research center again. The fecal matter of the fiddler crab was examined for microplastics and recorded the results. The wetlands were no longer flooded so we were able to collect a total of ten fiddler crabs and some sand from the wetlands.

The crabs were placed in individual glass jars with salt water and the sand was placed inside a fume hood until it was completely dry. The method and materials section of the research paper was also written during this week.

Week 4: 9/27-10/3

Week four consisted of filtering the fecal samples from the fiddler crabs and the sand and examining them under a microscope in search of microplastics. A table was drafted on the white board to record the number of microplastics found in the fecal matter and the sand.

We later discussed the literature review and formulated the main points that were to be included in it. The first draft of the literature review was written.

Week 5: 10/4-10/10

During week five, the remainder of the fecal and soil samples were examined for microplastics at the research center. The first draft of the literature review was reviewed by Professor Scanlon and the necessary corrections were made. We later discussed the most effective way to present the results obtained from the samples.

Week 6: 10/11-10/17

Week six consisted of meeting through zoom to discuss the effectiveness of representing the data in the form of a barchart. We also discussed the main ideas that should be included in the discussion and the importance of using reliable sources and proper citations.

Week 7: 10/18-10/24

There was no zoom meeting as we decided the time would be best spent working on the research paper. At this point, the major elements of the research paper were completed and various edits have been made by the professor.

Week 8: 10/25-11/1

After much revision and editing, the final draft of the paper was now completed and ready for submission.

Conclusions

Although it is not certain where these microplastics came from, microplastics are present at the wetlands located at the St. Petersburg College Bay Pines STEM Center. Microplastics, specifically microfibers and micro fragments, are passing through Fiddler crabs as these organisms are eating from an environment where microplastics are found in widespread quantities. Fiddler crabs are a dominant low trophic, filter-feeding organism in this environment, making this finding an important one as it shows that microplastics are making their way into the food chain. These microplastics may have an impact on the survival of fiddler crabs and other organisms which could in turn disrupt the ecosystem of the wetlands. Future studies may want to explore additional trophic levels to determine if the concentrations of microplastics increase up the food chain, and how microplastics affect the different organisms they inhabit.

Techniques Utilized

Microbiological techniques learned:

- Aseptic techniques
- Filtration
- Enumeration of microplastics
- Data analysis/excel use

Microplastics in Soil and Fiddler Crabs (Genus Uca)

Tavol Johnson

Department of Science, St. Petersburg College

Professor Maura Scanlon

October 29,2020

Abstract

According to the National Oceanic and Atmospheric Administration (US Department of Commerce, 2016), microplastics are small plastic pieces less than five millimeters long which can be harmful to our ocean and aquatic life. Over the years, the production of plastic products and plastic use has risen quite rapidly. This has then led to the increase in plastic waste being released into the environment. These plastic wastes eventually break down into microscopic pieces, causing harm to organisms that live there. The purpose of this study was to see if there were microplastics present in the soil environment and whether they were moving through the food chain, specifically through fiddler crabs (genus Uca) collected from the wetlands at the St. Petersburg College Bay Pines STEM Center. Both soil samples and crab fecal samples were filtered and examined under a microscope to determine the number and the types of microplastics present. Microplastics were found in all samples. Since the soil serves as a habitat for other animals and fiddler crabs are an important low trophic organism and, this finding can possibly have profound effects on the entire ecosystem.

Literature Review

Plastics are hygienic, lightweight, versatile and extremely durable making it a popular choice in product packaging. Ever since mass production of plastic began in the 1940s, there has been a significant increase of plastics being manufactured, with approximately 270 million tonnes of trash being produced on a global scale (Ritchie and Roser, 2018). Plastic has several properties that lend itself to play a very integral role in our modern lives, which is the primary reason we rely on it.

Whilst the introduction of mass plastic production has revolutionized the modern world, our increasing dependence on this invaluable commodity has led to the manifestation of some environmental issues. More specifically, due to improper and indiscriminate disposal, plastic waste has been entering the marine environment through various channels such as inland waterways (Gregory, 2009). Over time, plastic waste will accumulate in the ocean and degrade into smaller fragments known as microplastics.

According to the National Oceanic and Atmospheric Administration (US Department of Commerce, 2016), microplastics are small plastic pieces less than five millimeters long which can be harmful to our ocean and aquatic life. Microplastics can come from a variety of sources including larger plastic pieces that have broken apart, resin pellets used for plastic manufacturing, or in the form of microbeads, which are

small, manufactured plastic beads used in health and beauty products. Due to its size, microplastics can be easily introduced into the food chain. The chemical and physical properties of microplastics make them potential toxins to organisms that are susceptible to feeding on them. For instance, microplastics can irritate the digestive tract of the organisms, leading to ineffective eating and poor digestion (Wright et al., 2013). They can also leach to waterborne organic pollutants which will inevitably introduce toxins from the lowest trophic level of the food chain (Teuten et al., 2009).

According to the Florida Microplastics Awareness Project (McGuire, 2019) launched by the University of Florida, microplastics are generated in various ways. Polyethylene microbeads used in toothpastes, facial scrubs and other personal-care products are one source, because many water-treatment facilities are unable to filter them out. For plastic garbage at sea, wave action and sunlight can weaken large items and break them into ever-smaller fragments. Some microplastic material is dust from construction or industrial processes that is carried to the ocean by wind or water.

Low trophic, filter-feeding organisms are the one of the first organisms to be affected by the presence of microplastics. Fiddler crabs are a dominant low trophic, filter-feeding organism that are present in many wetlands and an important indicator of how healthy the marsh/beach system is, since they are on the bottom of the food chain. One might believe that there should not be microplastics present in an environment that is

relatively undisturbed, such as Waties Island, SC, but a study conducted by Forbes and Rosch (2019) found otherwise – the fiddler crabs collected in both spring and fall seasons contained microplastics. The purpose of this study was to see whether microplastics were present in a more developed environment located in a more urban area such as the St. Petersburg College STEM Center at Bay Pines, and in what quantity.

Materials and Methods

Method for Soil Sampling

Using a procedure similar to one developed by the McGuire (2019), soil samples were taken from the SPC property at Bay Pines. I used a 0.5 meter square PVC pipe to mark two randomly selected locations in the fiddler crab habitat area, and then used a trowel to scrape the top centimeter of soil which was placed in a bucket and brought back to a lab room for processing. I then poured the contents of the container onto paper plates and stored them under a fume hood until they had sufficient time to dry.

To isolate the microplastics from the soil sample, I sifted the sediments through a sieve in order to capture the fine sand. The coarse sand that was left behind was examined for any obvious pieces of plastics which were then picked out and were set aside in a small container. I took the fine sand and poured it into a large cup that was

filled with tap water at the ¾ mark. I stirred the suspension well to allow the microplastics to float to the top.

I triple rinsed a 1-L separatory funnel then poured the sample into the funnel which was supported by a clamp on a heavy-duty stand, as shown in Image 1. The sample was left to settle for a few minutes and proceeded to drain off the sand that sunk to the bottom of the flask in a cup (which was discarded). Meanwhile, I rinsed the inside of a filter flask three times with pre-filtered water then covered the opening with a petri dish (it was only removed when samples were being added). This was done to reduce environmental contamination of the sample.

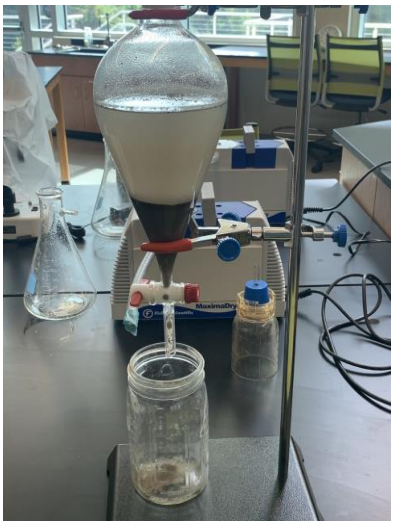

Image 1. Soil samples collected in the wetlands, in a separatory funnel in the lab at St. Petersburg College STEM Center at Bay Pines

One micron filter paper was inserted into the filtering apparatus and then I added a sample to fill the filter funnel. I placed the separatory funnel back on the clamp and allowed it to settle further. The sediments from the separatory funnel were drained as needed. With the cover over the filter funnel, I began to vacuum filter the sample. I continued adding more samples until it had all been filtered. I then rinsed the sides of the filter funnel with a small amount of filtered water and allowed the vacuum to pull this water through the filter.

When the sample was filtered, I released the vacuum pressure, I removed the filter paper from the apparatus and placed it into a clean petri dish. Each of the individual samples were covered with the petri dish lid and labeled. I proceeded to examine the filter papers under a microscope at 20X-40X magnification systematically by moving row by row to prevent double-counting or missing plastics.

Method for Sampling Fiddler Crabs:

Using a procedure similar to one developed by Forbes & Rosch (2019), I collected fiddler crabs from the SPC property at Bay Pines. Due to weather conditions, only one crab was obtained and kept for one week to serve as a test subject for the next collection. One week later, ten crabs were collected and brought back to the lab at the research center and placed in individual one-quart mason glass jars as shown in Image 2. After

sitting in the lab for five days, the live crabs were removed from the jars and released back into their environment. The water and fecal matter in the jars were filtered through one-micron filter paper using a filter funnel and vacuum. The filter paper was removed from the apparatus and examined under a microscope at 20-40x magnification.

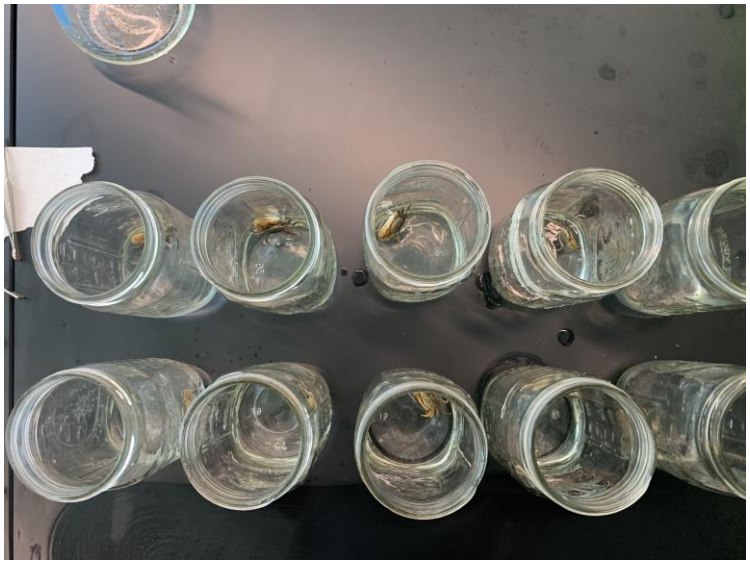

Image 2. Fiddler crabs collected from the wetlands in the lab at St. Petersburg College STEM Center at Bay Pines

Results

No macroplastics or visible microplastics were found in using the naked eye when sifting through the larger pieces of coarse soil samples. However, after mixing the fine sand with water and filtering it, 17 microfibers and 30 fragments were observed through the microscope.

Microplastics, specifically microfibers, were found in every sample of crab fecal matter taken. As shown in Figure 1 below, were a total of 37 microfibers and 1 micro fragment found in the ten fiddler crabs that were collected, with all average of 3.7 microfibers per crab.

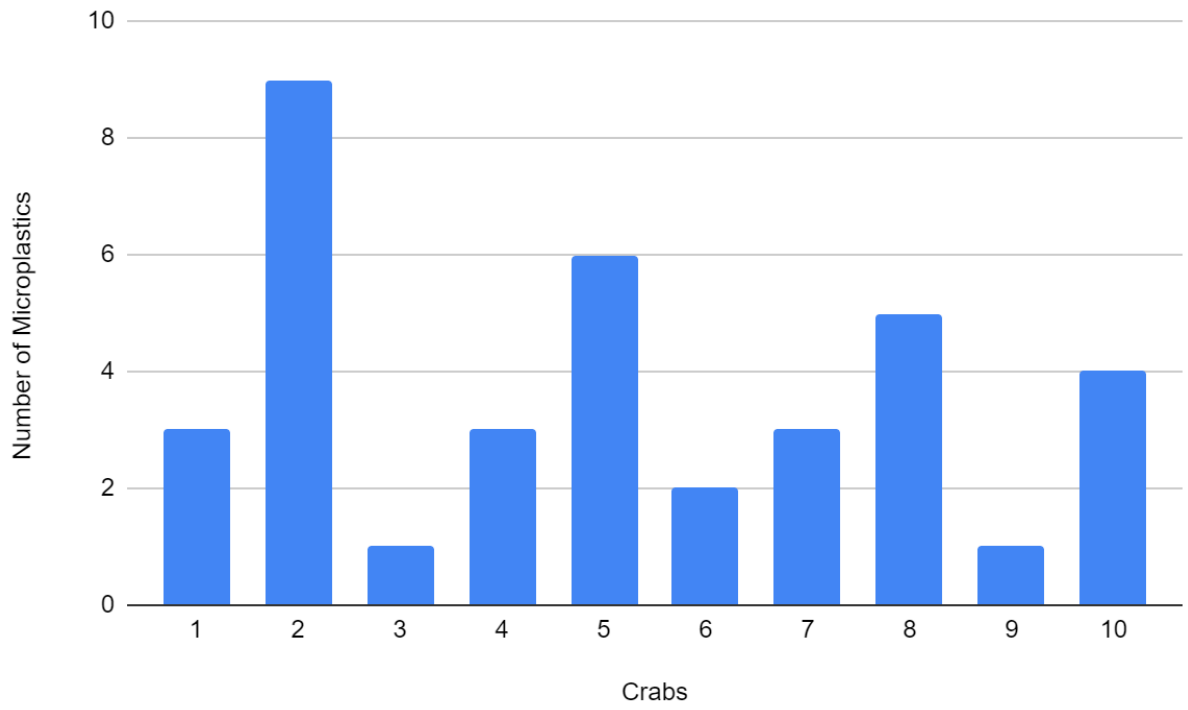

Figure 1. Microplastics, specifically microfibers, found in the fecal samples of ten individual Fiddler crabs

Discussion

Microplastics were found in all of the samples taken, showing that there are microplastics present in the wetland area. A majority of the plastics found in this study were microfibers. Microfibers are threadlike synthetic fibers that are approximately 1/100th the diameter of a human hair. Micro fragments are usually generated by the breakdown of larger pieces of plastics. The source of microfibers into the environment maybe attributed to the wetland area being located near various public spaces such as an elementary school, and a Veteran Affairs Healthcare Center. Wastes containing microplastics may also have also entered the ecosystem from these public places through the waterways. Although the sources of the microplastics in this particular study were not identified, later studies may choose to try to find their origin. One hypothesis where these microplastics came from, would be they arrived after being transported by the ocean currents or the wind (Zhang 2017).

Microfibers found in the soil samples in this study could have been introduced into their environment from the water that flooded the wetland that the crabs live in. Another possible source of the microplastics could be from the shedding of microfibers from shedding of clothes. Although the wetlands are relatively left undisturbed, students from the Bay Pines Research Center frequently conduct research projects here, and fibers easily could be falling from their clothing and making their way into the environment.

Since fiddler crabs eat by sifting through sand or mud for food particles of algae, bacteria and decaying plants, it would be logical to infer that the microplastics found in soil would transfer into the digestive system of the crabs. Even though the crabs sometimes eat in a puddle of water to help them separate the food from the sand, the microplastics are small enough to be ingested with the food particles, as was found in their fecal samples.

Conclusion

Although it is not certain where these microplastics came from, microplastics are present at the wetlands located at the St. Petersburg College Bay Pines STEM Center. Microplastics, specifically microfibers and micro fragments, are passing through Fiddler crabs as these organisms are eating from an environment where microplastics are found in widespread quantities. Fiddler crabs are a dominant low trophic, filter-feeding organism in this environment, making this finding an important one as it shows that microplastics are making their way into the food chain. These microplastics may have an impact on the survival of fiddler crabs and other organisms which could in turn disrupt the ecosystem of the wetlands. Future studies may want to explore additional trophic levels to determine if the concentrations of microplastics increase up the food chain, and how microplastics affect the different organisms they inhabit.

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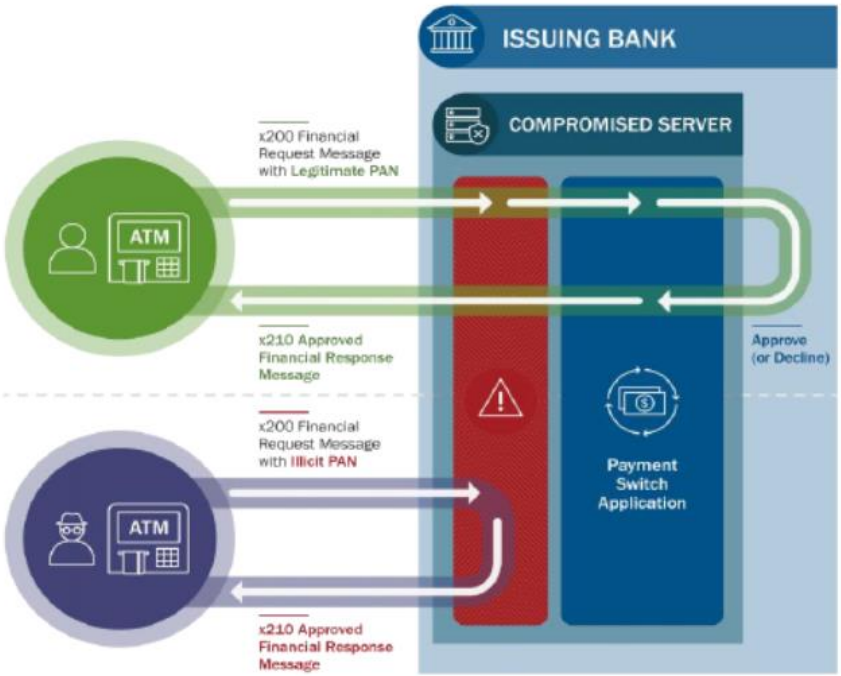
TB-B2B
STEM TRANSFER
BRIDGE TO BACCALAUREATE

NSF

Technology
Research Projects

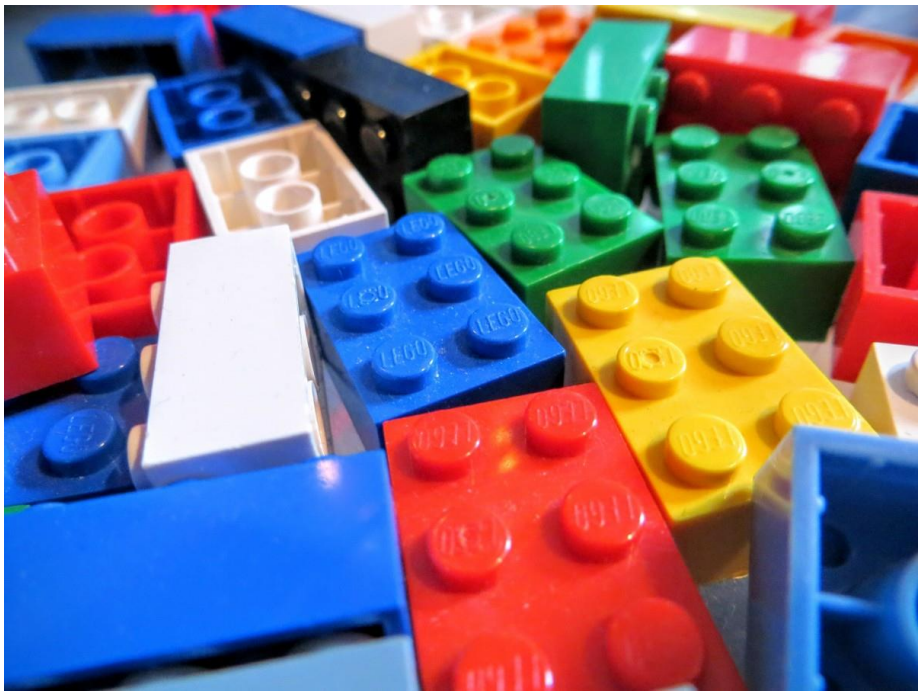


SPC St. Petersburg College

Name: Adelle Bradley **Professor:** Dawn Ellis, MS

Date: October 30, 2020

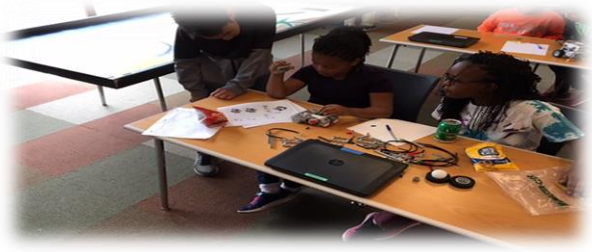
Lego Mindstorms EV3 Education Free Falling Engineering Lab



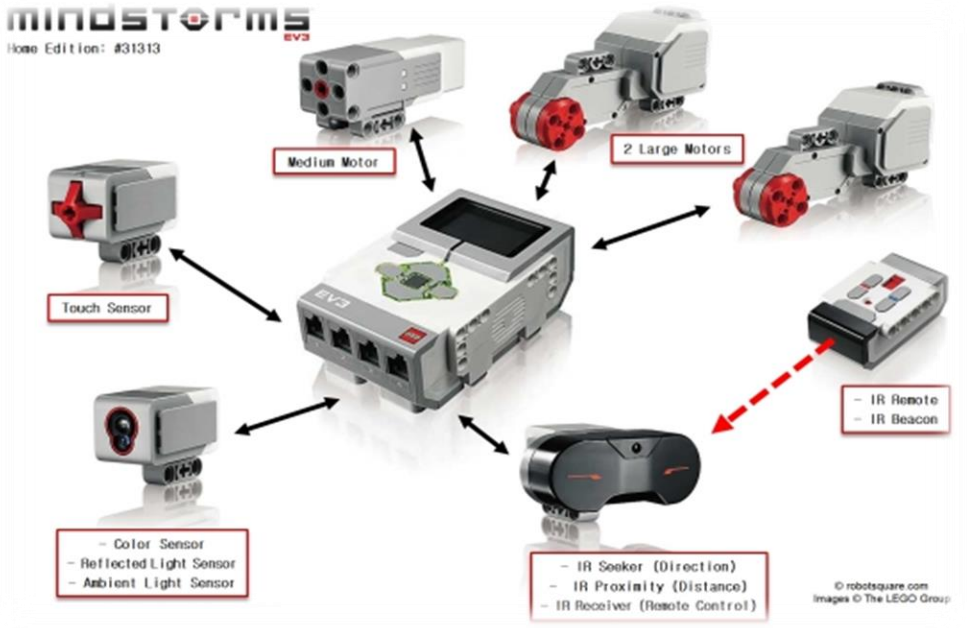
The knowledge of movement and space will be practiced through sensory-motor skills with developing spatial understanding and nurturing, while in an active and healthy body. As we begin to explore this Lego Education Free Fall Project. We are going to begin research then discuss why this project is so important also what it means to have free fall acceleration of an object, and then calculate the gravitational force, variables, height, and free fall times. Hello, class this is going to be an exciting experiment that is a going to be a great lead into the interest of **Engineering** as a youth as you know!

We will first begin to research then discuss why this project is so important also what it means to have free fall acceleration of an object, and then calculate the gravitational force, variables, height, and free fall times. What's a Free Fall? Free Fall describes the acceleration of an object exclusively due to gravity. (LEGO, n.d.). Kinematics (**Kin-e-mat-ics**), mechanics, gravity, and free fall are contained in this category. The project that you are to encounter is Mindstorms EV3 Lego Education (LEGO, n.d.) this is a hardware and software structure which is produced by Lego for the development and programmable robots, based on Lego robots and Lego buildings blocks that connect and build.

The Lego Mindstorms EV3 is the third generation Lego Mindstorms product. EV3 is a further development of the NXT. (Wikipedia, 2019.)The system was released on 1 September 2013. The LEGO MINDSTORMS EV3 set includes motors, sensors, the EV3 programmable brick, 550+ LEGO Technic elements and a remote control. The EV3 can be controlled by smart-devices.



Let's Begin Collaborating



Way to go on the reading of the first paragraph! I have mapped out a program that will work as an entirety. The plans are to get to know more and get more familiar with the program.

Before we start get to know your robot simply because as you program you very own module you

Are going to be able to view the actual download of your Lego Education format. There should be a green light when the operating system is on. And a red light when the operating system is off. As all of you enjoy your time looking over the uncreated robot you can discuss

a few things amongst that could reveal an icebreaker for the Lego Education Project. Here are some discussion topics that would help the middle school age children conduct this project.

- Explain why it is hazardous to sit under a tree full of ripe apples? (Apples may drop to the ground, and it is impossible to react quickly enough to get out of the way and apples have heavy intensive force that would hit the ground on impact).
- Explain why a person jumping out of an airplane at a great height needs a parachute. (Answer: They would fall to quickly otherwise be crushed upon impact).
- List everyday occurrences in which gravity plays a role. (Everything that falls, running water, moving and running things)

Lego Education has instructions that have the following Mathematic Key structure.

Mathematics and English Language Arts (literacy) ELA. This learning goal outline is what students such as yourself should be able to comprehend at the end of this project. (Core, n.d.).

Math Analysis number of fall times number velocity

1	0.332
2	0.347
3	0.341
4	0.339

v= Velocity

d= Drop Distance (19.5 in or 12ft & 7.5 in)

t= fall times

v= d/t

1. 58.735 = 19.5 /0.332
2. 56.20 = 19.5 /0.347
3. 57.185 = 19.5 /0.341
4. 57.522 = 19.5 /0.339

Classical Mechanics

To explain and define equations for a falling body the particular set of equations for a falling body are described as the metal object owing a constant gravitational force under normal earthbound conditions.

v= velocity

d=drop distance

t=fall times

v=d/t

d=0.5*g*t^2

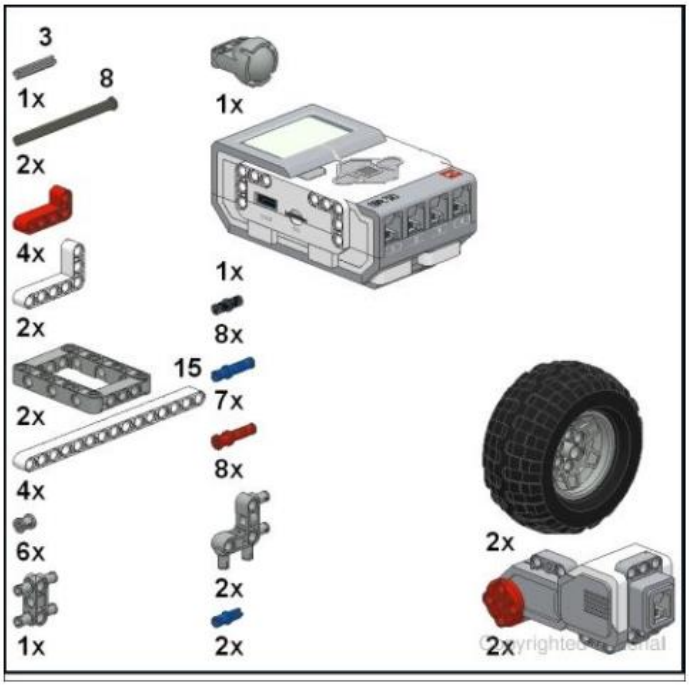
Solve the equation of the law of falling bodies for g. (LEGO, n.d.). Acceleration: The rate of change in velocity is the derivative of the velocity with respect to time. Now you as a class can review the Lego Education setting.

Interest at Play

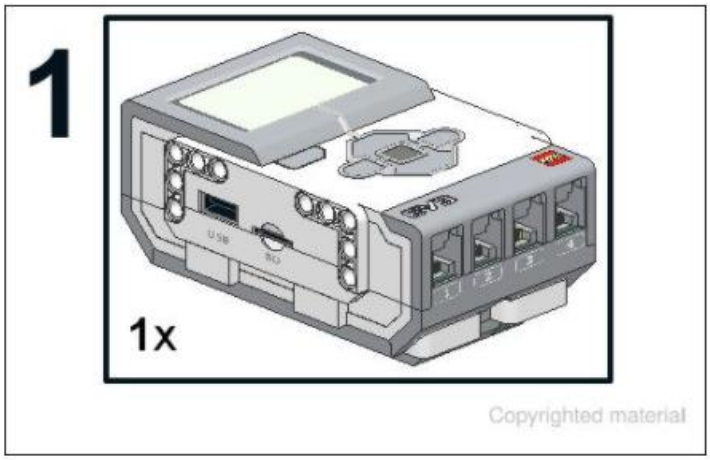
We will first need to gather the following parts from the EV3 set. The parts include several beams, pins, axles, EV3 Intelligent Brick, two large motors, and some wires.

You must charge up the battery included in your kit or install six AA batteries. You will also need to install the EV3 software on your computer. In brief we will follow these step by step instructions to build the fall tower robot. (Gary Garber, 2013)**.**

Examples of parts of the EV3 Mindstorms Lego Education



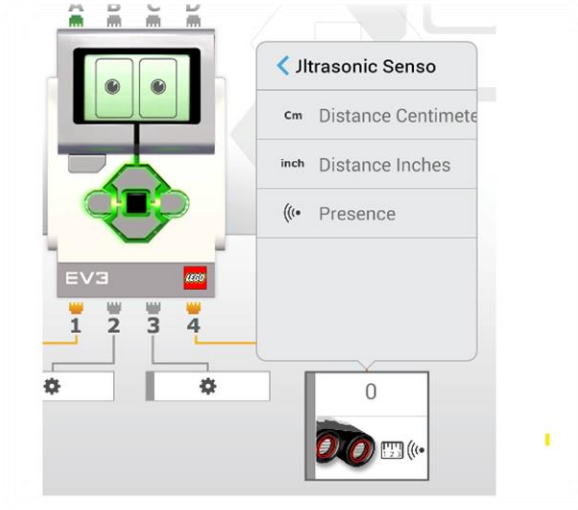
(Gary Garber, 2013)

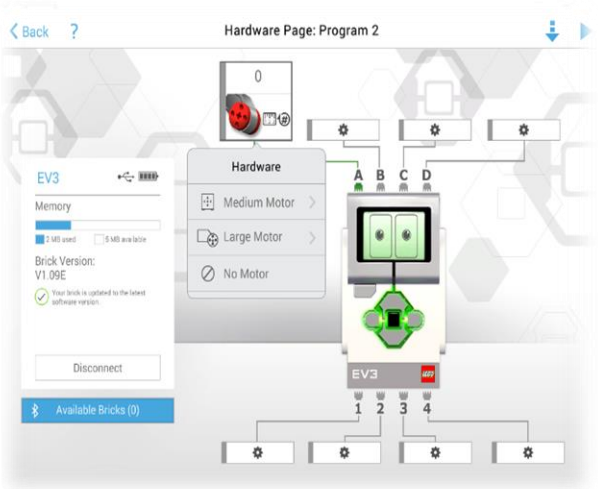


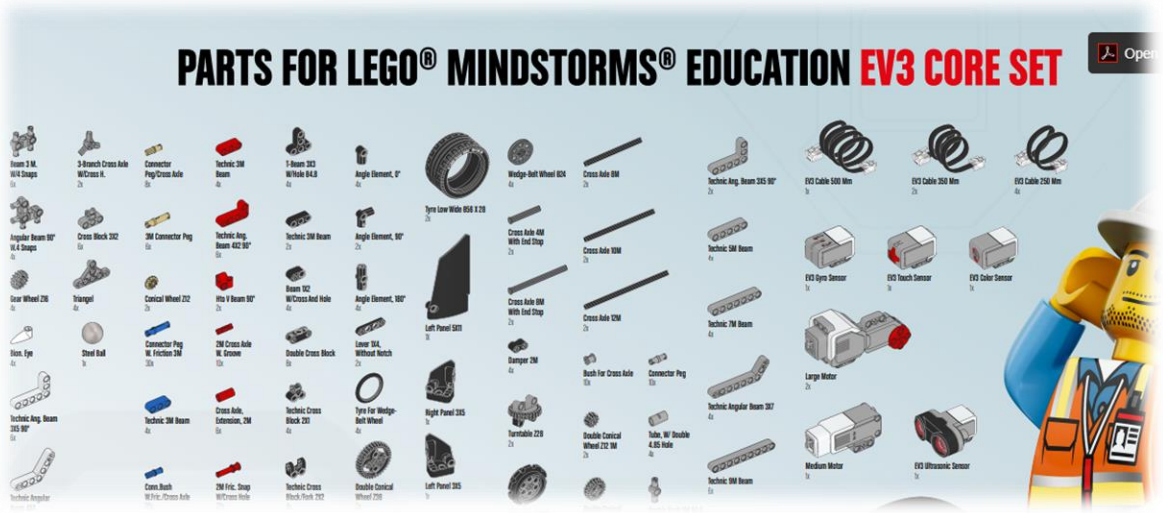
(Gary Garber, 2013)

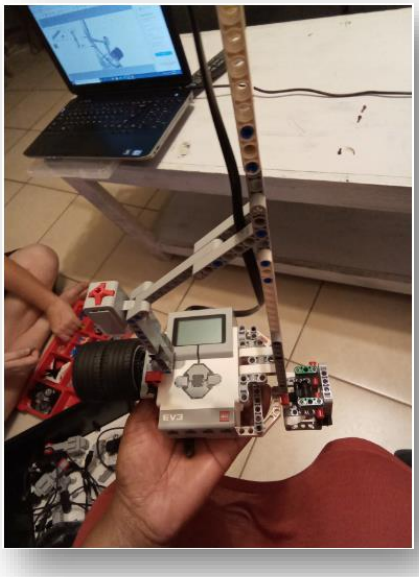
Mindstorms Education is a very unique way to develop skills in STEM Education. Here is the latest model of Microsoft Mindstorms EV3.

Lego Education Classroom Demo





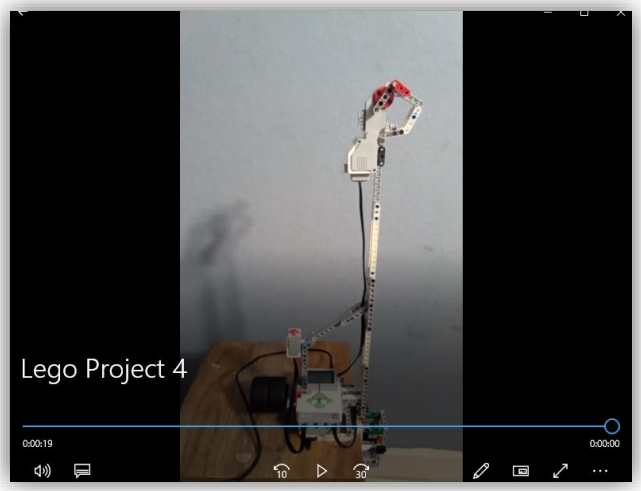




LEGO MINDSTORMS EDUCATION EV3 Acceleration of Gravity Programmed Professionally

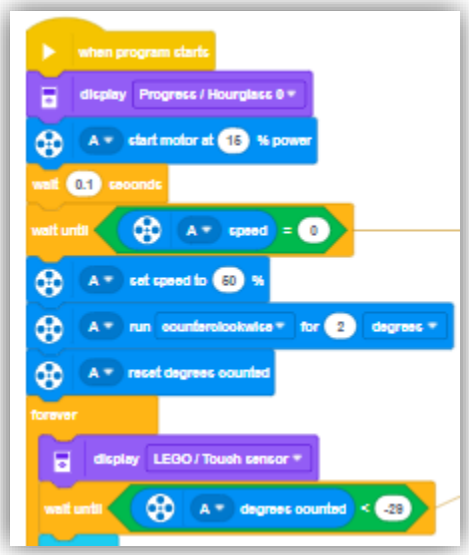
The download of the acceleration-of-gravity-ev3* is quite simple and once you program the operations. Within the Lego Education class room I have programmed the Free Fall Robot in this style as well. This is the Lego Education EV3 Classroom Program format. I hope when you read

this program and attempt the tries such as I did that you all win and have fun all at the same time!



Programming Steps: For the Professional

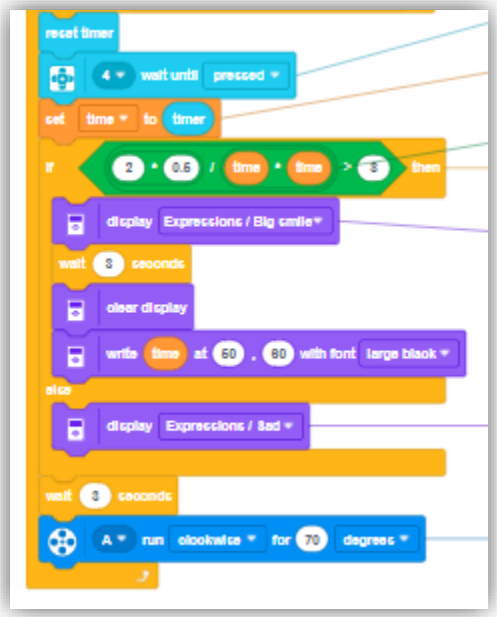
1. The programming stack waits for the Touch Sensor on the back of the “Drop Tower” to be pressed to start an experiment by opening the ball aim to release the ball.



2. Initialize the ball arm to the closed position. What until opening angle of the ball aim is wide enough for the ball to fall out before resetting the timer.

bottom of the “Drop Tower” is by the bail.

3. Wait until the touch sensor on the pressed

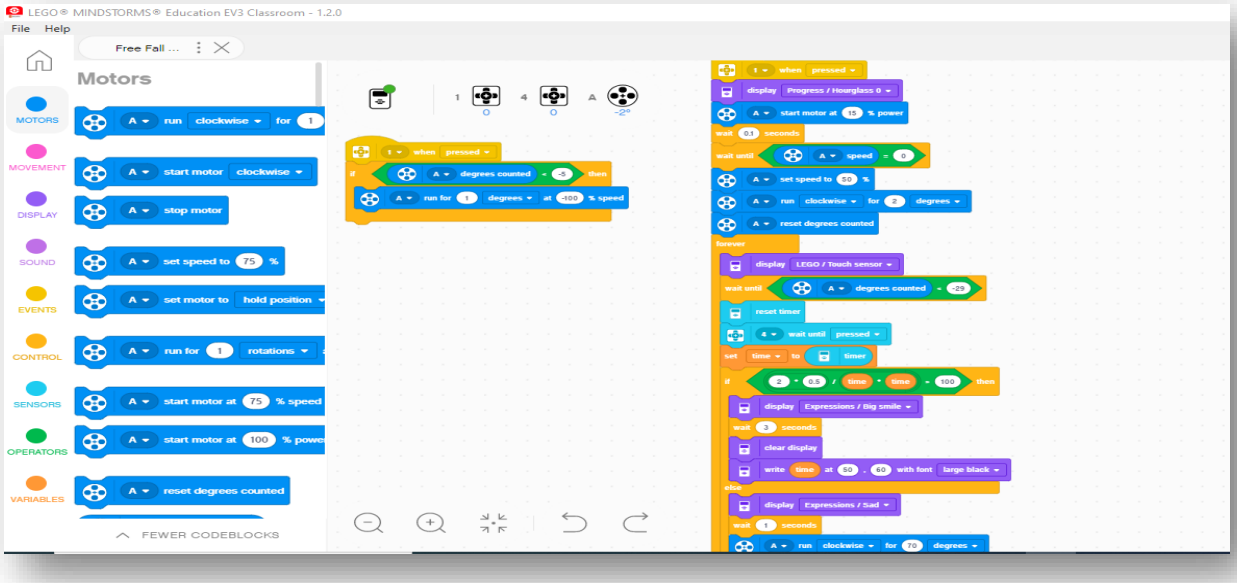


4. Store the fall time.

5. Use the fall time to calculate the acceleration of gravity. Check if the calculated acceleration of gravity has a sensitive value.

6. Display a big smile if the drop experiment was successful and display the fall time afterward. Display a sad face if the drop experiment failed. Closed the ball aim for the next experiment.

Final Result EV3 Lego Education 1.2.0 Classroom Edition



References

Core, C. (n.d.). *Common Core State Standards Iniative Preparing Students for College*. Retrieved from http://www.corestandards.org/Math/Content/8/EE/A/2/

Gary Garber. (2013, September). *Instant Lego Mindstorm EV3.* Retrieved from Google Play Books: https://play.google.com/books/reader?id=Bev7AAAAQBAJ&hl=en&pg=GBS.PP7

LEGO, E. (n.d.). *Free Fall Lego Education*. Retrieved from Engineering Lego Education: https://education.lego.com/en-us/lessons/ev3-engineering-lab/5-free-falling#assessment-opportunities

Wikipedia. (2019., March 25). *Lego Education EV3 Mindstorms*. Retrieved from Wikipedia: https://en.wikipedia.org/wiki/Lego_Mindstorms

Additional Lego References:

Free Fall Acceleration Worksheet

https://education.lego.com/en-us/lessons/ev3-engineering-lab/5-free-falling/student-worksheet

Learning Lego Mindstorms EV3 – Google Play Books

https://play.google.com/books/reader?id=beVrBgAAQBAJ&hl=en&pg=GBS.PA25.w.4.0.12

Name: Jesse Dominguez **Professor:** John Duff, PhD

Date: December 4, 2020

ISM4915 Cybersecurity Capstone Course

DRAFT Case Studies

ISM4915 is the capstone course for the BAS program in cybersecurity. This class will feature several case studies. These cases will involve security incidents and will require students to do analysis and research to then provide pragmatic recommendations to address issues identified in the case. This document describes three potential case studies that can be made available to instructors in ISM4915. It was created by Jesse Dominquez and Dr. John Duff as part of the Bridge to Baccalaureate research program.

Case 1: Hidden Cobra - Cybercrime and Financial Institutions

Details of this case are based on Alert (TA18-275A) issued by the Cybersecurity and Infrastructure Security Agency (https://us-cert.cisa.gov/ncas/alerts/TA18-275A).

Students will be provided with the following content, most of which is taken directly from the actual alert. Students will be asked to fully describe the attack(s) to demonstrate their understanding of the exploit. They will also be charged with provide a solution which may involve multiple steps as cited in the solution section below.

The financial sector has been the target of many cyberattacks. These attacks are increasingly complex and growing in sophistication. In some cases the threat actor is a nation state. In this case that threat actor has been identifies as North Korea. The U.S. Government refers to malicious cyber activity by the North Korean government as HIDDEN COBRA. Working with U.S. government partners, DHS, Treasury, and FBI identified malware and other indicators of compromise (IOCs) used by the North Korean government in an Automated Teller Machine (ATM) cash-out scheme—referred to by the U.S. Government as "FASTCash." FASTCash schemes remotely compromise payment switch application servers within banks to facilitate fraudulent transactions. The U.S. Government assesses that HIDDEN COBRA actors will continue to use FASTCash tactics to target retail payment systems vulnerable to remote exploitation.

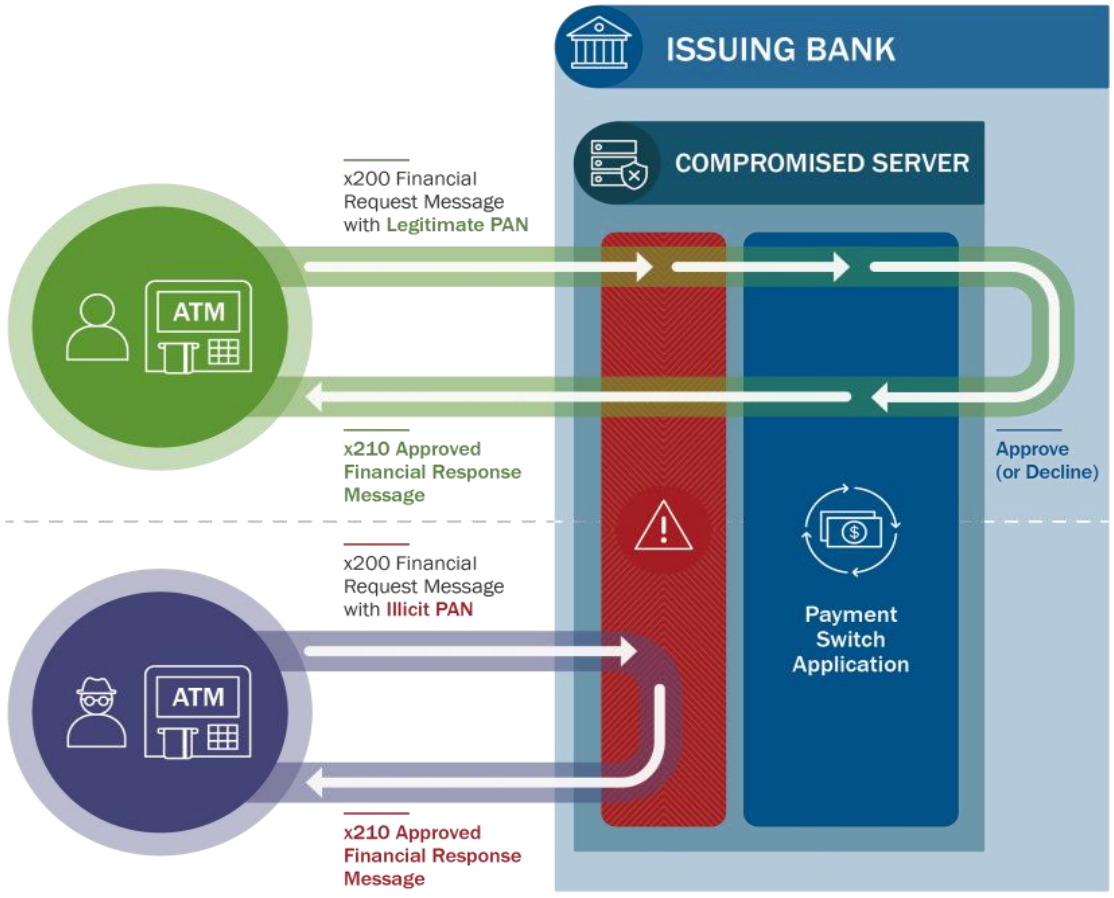
According to a trusted partner's estimation, HIDDEN COBRA actors have stolen tens of millions of dollars. In one incident in 2017, HIDDEN COBRA actors enabled cash to be simultaneously withdrawn from ATMs located in over 30 different countries. In another incident in 2018, HIDDEN COBRA actors enabled cash to be simultaneously withdrawn from ATMs in 23 different countries.

HIDDEN COBRA actors target the retail payment system infrastructure within banks to enable fraudulent ATM cash withdrawals across national borders. HIDDEN COBRA actors have configured and deployed malware on compromised switch application servers in order to intercept and reply to financial request messages with fraudulent but legitimate-looking affirmative response messages. Although the infection vector is unknown, all of the compromised switch application servers were running unsupported IBM Advanced Interactive eXecutive (AIX) operating system versions beyond the end of their service pack support dates; there is no evidence HIDDEN COBRA actors successfully exploited the AIX operating system in these incidents.

The threat actors were able to use malicious Windows executable apps, command line utility apps, along with other files in the scheme to perform transactions and interact with the banks and their switch applications server to make fraudulent transactions. The initial place of infection is unknown in the incidents but is thought the threat actors were using spear-phishing to target specific high profiled personnel in a company. It is likely that the threat actors used Windows-based malware to map out the bank's network to find payment switch application servers and other essential end points needed for their attacks.

By injecting malicious code to legitimate processes using the command-line utility application they are able to make fraudulent transactions and mask them as normal transactions on the switch application servers. The impact the attacks have on the company can be temporary or permanent loss of sensitive or proprietary information, disrupting regular operations, cost the company money to restore systems and files, as well as the harm to the organizations reputation.

HIDDEN COBRA actors exploited the targeted systems by using their knowledge of International Standards Organization (ISO) 8583—the standard for financial transaction messaging—and other tactics. HIDDEN COBRA actors most likely deployed ISO 8583 libraries on the targeted switch application servers. Malicious threat actors use these libraries to help interpret financial request messages and properly construct fraudulent financial response messages. The following graphic depicts the exploit and describes how FASTCash works.



- Malicious applications running on the compromised switch application server inspect inbound Financial Request Messages at the transport layer for particular account numbers using a CheckPan() function.
- If the Request Message does NOT contain one of the pre-identified illicit PANs, the payment switch application processes the message and routes it appropriately to the issuer.
- If the Request Message contains a pre-identified illicit PAN, the malicious applications generate a fraudulent Response Message using the GenerateResponseTransaction1() or GenerateResponseTransaction2() function to respond to the acquirer with a fraudulent Response Message and drops the Request before the payment switch application processes the message, leaving the issuer with no knowledge of the transaction.
- The malicious applications also have the capability to intercept and block declined response messages from the switch to the ATM, presumably as a check incase the switch receives the fraudulent request and passes in on to the issuer.

Analysts believe that malware—used by HIDDEN COBRA actors—inspected inbound financial request messages for specific primary account numbers (PANs). The malware generated fraudulent financial response messages only for the request messages that matched the expected PANs. Most accounts used to initiate the transactions had minimal account activity or zero balances.

Analysts believe HIDDEN COBRA actors blocked transaction messages to stop denial messages from leaving the switch and used a GenerateResponse* function to approve the transactions. These response messages were likely sent for specific PANs matched using CheckPan()verification (see figure 1 for additional details on CheckPan()).

HIDDEN COBRA actors used malicious Windows executable applications, command-line utility applications, and other files in the FASTCash campaign to perform transactions and interact with financial systems, including the switch application server. The initial infection vector used to compromise victim networks is unknown; however, analysts surmise HIDDEN COBRA actors used spear-phishing emails in targeted attacks against bank employees. HIDDEN COBRA actors likely used Windows-based malware to explore a bank's network to identify the payment switch application server. Although these threat actors used different malware in each known incident, static analysis of malware samples indicates similarities in malware capabilities and functionalities.

HIDDEN COBRA actors likely used legitimate credentials to move laterally through a bank's network and to illicitly access the switch application server. This pattern suggests compromised systems within a bank's network were used to access and compromise the targeted payment switch application server.

Upon successful compromise of a bank's payment switch application server, HIDDEN COBRA actors likely injected malicious code into legitimate processes—using command-line utility applications on the payment switch application server—to enable fraudulent behavior by the system in response to what would otherwise be normal payment switch application server activity. NCCIC collaborated with Symantec cybersecurity researchers to provide additional context on existing analysis [1]. Malware samples analyzed included malicious AIX executable files intended for a proprietary UNIX operating system developed by IBM. The AIX executable files were designed to inject malicious code into a currently running process. Two of the AIX executable files are configured with an export function, which allows malicious applications to perform transactions on financial systems using the ISO 8583 standard.

Solution

Mitigation Recommendations for Institutions with Retail Payment Systems

Require Chip and Personal Identification Number Cryptogram Validation

- Implement chip and Personal Identification Number (PIN) requirements for debit cards.
- Validate card-generated authorization request cryptograms.
- Use issuer-generated authorization response cryptograms for response messages.

- Require card-generated authorization response cryptogram validation to verify legitimate response messages.

Isolate Payment System Infrastructure

- Require two-factor authentication before any user can access the switch application server.
- Verify that perimeter security controls prevent internet hosts from accessing the private network infrastructure servicing your payment switch application server.
- Verify that perimeter security controls prevent all hosts outside of authorized endpoints from accessing your system.

Logically Segregate Operating Environments

- Use firewalls to divide operating environments into enclaves.
- Use Access Control Lists (ACLs) to permit or deny specific traffic from flowing between those enclaves.
- Give special considerations to enclaves holding sensitive information (e.g., card management systems) from enclaves requiring internet connectivity (e.g., email).

Encrypt Data in Transit

- Secure all links to payment system engines with a certificate-based mechanism, such as mutual transport layer security, for all traffic external or internal to the organization.
- Limit the number of certificates used on the production server, and restrict access to those certificates.

Monitor for Anomalous Behavior as Part of Layered Security

- Configure the switch application server to log transactions. Routinely audit transactions and system logs.
- Develop a baseline of expected software, users, and logons. Monitor switch application servers for unusual software installations, updates, account changes, or other activity outside of expected behavior.
- Develop a baseline of expected transaction participants, amounts, frequency, and timing. Monitor and flag anomalous transactions for suspected fraudulent activity.

Recommendations for Organizations with ATM or Point-of-Sale Devices

- Implement chip and PIN requirements for debit cards.
- Require and verify message authentication codes on issuer financial request response messages.
- Perform authorization response cryptogram validation for Europay, Mastercard, and Visa transactions.

Mitigation Recommendations for All Organizations

- NCCIC encourages users and administrators to use the following best practices to strengthen the security posture of their organization's systems:
- Maintain up-to-date antivirus signatures and engines.
- Keep operating system patches up-to-date.
- Disable file and printer sharing services. If these services are required, use strong passwords or Active Directory authentication.
- Restrict users' ability (i.e., permissions) to install and run unwanted software applications. Do not add users to the local administrators group unless required.
- Enforce a strong password policy and require regular password changes.
- Exercise caution when opening email attachments, even if the attachment is expected and the sender appears to be known.
- Enable a personal firewall on organization workstations, and configure it to deny unsolicited connection requests.
- Disable unnecessary services on organization workstations and servers.
- Scan for and remove suspicious email attachments; ensure the scanned attachment is its "true file type" (i.e., the extension matches the file header).
- Monitor users' web browsing habits; restrict access to sites with content that could pose cybersecurity risks.
- Exercise caution when using removable media (e.g., USB thumb drives, external drives, CDs).
- Scan all software downloaded from the internet before executing.
- Maintain situational awareness of the latest cybersecurity threats.
- Implement appropriate ACLs.

Case 2: Blackbaud

This case was based on an article published in BackinfoSecurity: https://www.bankinfosecurity.com/ransomware-attack-questions-persist-over-blackbaud-hit-a-14734

Blackbaud is a South Carolina-based, cloud computing provider which provides cloud-based marketing, fundraising and customer relationship management software used by thousands of charities, universities, healthcare organizations and others. Customers of Blackbaud include:

- Nonprofits
- Foundations
- Corporations
- Education institutions
- Healthcare organizations
- Religious organizations
- And individual change agents

Blackbaud bills itself as being "the world's leading cloud software company powering social good." It serves more than 25,000 organizations in more than 60 countries.

In a data breach notification posted on their website on July 16, 2020 Blackbaud stated that their engineers had discovered and stopped a ransomware attack. In a ransomware attack, cybercriminals attempt to disrupt the business by locking companies out of their own data and servers. After discovering the attack, Blackbaud's Cyber Security team—together with independent forensics experts and law enforcement—successfully prevented the cybercriminal from blocking system access and fully encrypting files; and ultimately expelled them from the system.

However, prior to locking the cybercriminal out, the cybercriminal removed a copy of a subset of data from Blackbaud's self-hosted (private cloud) environment. Most significantly Blackbaud paid the cybercriminal's demand with confirmation that the copy they removed had been destroyed.

Blackbaud did not however follow best practice post incident. More than two months after the breach occurred and 10 days after the company posted its data breach notification, the company had filed no documents with the U.S. Securities and Exchange Commission to alert investors that it had suffered a data breach and ransomware infection and paid a ransom - of an undisclosed amount - to attackers (see: SEC Releases Updated Cybersecurity Guidance).

Despite the breach occurring in May, affected customers apparently were notified on or around July 16, when Blackbaud also published its breach notification. Clearly Blackbaud did not follow General Data Protection Regulation which requires to submit a detailed case of any data breach and what was stolen.

Because the list of victims included organizations in the European Union which, under the General Data Protection Regulation, requires that regulators be informed within 72 hours of any breach about the details of what happened and what was stolen. Regulators such as Britain's Information Commissioner's Office may then require the breached organization to alert affected customers.

As a data processor, Blackbaud would have been required to notify not just an EU data protection authority, such as the ICO, but also data controllers - its customers - within 72 hours of learning about the breach. One victim, Scotland's University of Glasgow, said it first learned of the breach from Blackbaud on July 16. "The university has launched its own investigation and has contacted directly those who may have been affected. The university has also informed the Information Commissioner's Office of the breach and is awaiting further guidance," it says in its own data breach notification.

Exposed information included "web content and email messaging for alumni, donors and other contacts of the university," it says. "We deeply regret the worry and inconvenience that this incident may have caused."

Another victim was Australia's University of Auckland, which says it's informed regulators.

"The cybercriminal responsible was able to take copies of information belonging to a large number of universities and charities around the world ... [including] information from the University of Auckland," the university says it was told by Blackbaud. "Although the encrypted data included contact details and dates of birth as well as information regarding donations and engagement with the university, it did not include passwords or credit card details."

Other organizations that have confirmed that their information was exposed in the attack include the University of Liverpool, the University of Manchester and the University of Newcastle in England; the Boys & Girls Clubs of Delaware; Cancer Research Institute in New York; Emerson College in Boston; and the University of Western Ontario, among many others, the BBC reports. "The problem is so widespread across the higher-education sector that some universities - including the University of Edinburgh and Aston University, Birmingham - have posted notices to say their data was not involved," according to the BBC.

Other victims included the Boys & Girls Clubs of Delaware, Cancer Research Institute in New York, Emerson College in Boston, the University of Western Ontario, and others.

There are several issues for students to consider in this case. Students should consider how the attack vector which lead to the success of exploit. How and why was Blackbaud vulnerable to a ransomeware attack? Students must also consider the decision made by Blackbaud to pay the ransom. Was this a good business decision? What are the risks associated with paying a ransom? Can the attacker be trusted? How did Blackbaud confirm that the exfiltrated data was actually permanently destroyed? While there is no law in the U.S. or UK against paying a ransom, security and law enforcement experts

recommend never paying a ransom to attackers because it directly funds further attacks and further legitimizes this type of crime as a viable, albeit illicit, business model. Did Blackbaud do the right thing?

Additionally students must consider how companies should respond, particular with respect to notification requirements when operating internationally. Did Blackbaud meet its obligation in this area? Finally, what steps can Blackbaud take to reduce the attack surface and lessen the chances of future, similar incidents?

Case 3: Securing the Vote

The year 2020 has been a remarkable one for many reasons. However, the fact that a national election occurred during a global pandemic was truly unprecedented. One effect of the pandemic was to encourage many voters to cast their ballots by mail. At least 159.8 million Americans voted in the 2020 presidential election with a significant percentage of those votes being cast by mail. And while voter "turn out" was considered high, only 68% of eligible voters actually did vote.

Allegations of fraud have followed the election and continue to persist. Almost no aspect of the electoral process was immune to these allegations. The veracity of signatures on mail in and absentee ballots, the timing of the arrival of ballots, the voting machines and programming of the machines, and other aspects of the process was questioned.

For this case students are charged with designing a secure voting system that would allow citizens to cast their ballots using the Internet. The solution must anticipate, identify, and address any and all issues or challenges that such a system would encounter. This would include, but not be limited to, authentication of voters and voting servers, securing votes in transit, securing databases on servers where ballots are stored and counted, securing programs that count and process ballots, etc.

Students must provide a detailed designed that encompasses the voter all the way through to the final tally of votes. Students will work in a group to design such a system and will formally present their solution to a group that will include their peers and cybersecurity professionals.

Contact Information

Please address any questions or comments regarding this report to:

Magaly Tymms, MA
Co-Principal Investigator NSF LSAMP TB-B2B Grant
Institutional Effectiveness Director
St. Petersburg College, P.O. Box 13489, St. Petersburg, FL 33733
(727) 341-3195
Tymms.magaly@spcollege.edu

Appendix A

St. Petersburg College
SPC Academic Effectiveness

National Science Foundation Louis Stokes Alliance for Minority Participation (LSAMP) Tampa Bay Bridge to Baccalaureate Alliance (TB-B2B)

Undergraduate Research Experience (URE) Model

Purpose: A goal of the National Science Foundation Louis Stokes Alliance for Minority Participation (LSAMP) Tampa Bay Bridge to Baccalaureate Alliance (TB-B2B) grant, is for each College in the TB-B2B alliance to provide undergraduate research experiences (UREs) to students during their first and second years of undergraduate studies.

Background: In 2018, St. Petersburg College (SPC) developed and implemented a model for providing undergraduate students at SPC with UREs. The model was shared with other institutions within the TB-B2B alliance.

Undergraduate Research Experience Model:
The model includes a 'Student Research Commitment and Agreement' form which was developed to ensure consistency, accountability, student learning outcomes, and impartiality across all STEM Degree Majors (See Appendix A).

The learning activities (highlighted bullets) in the 'Student Research Commitment and Agreement' are revised by faculty based on the respective research project agreed upon by faculty and student during their first meeting. Submitting a compiled report (last bullet) of the research/activities completed each week, including results observed, assumptions, and/or conclusions, learning achieved, etc., is a required component of every research project. A research report submitted by a B2B student in 2018 is presented in Appendix B.

Communications:
Several weeks before a semester begins, Tier 1 B2B students who have not yet completed a research project, are informed that 8-week research opportunities within their STEM major will be available during the following semester, and will include a paid stipend of $250.

Faculty members who teach within the various STEM programs and have expressed a desire to conduct student research projects are contacted throughout the year, to ensure that sufficient faculty are available to conduct student research each semester.

Students who respond stating they are interested and available to complete a research project, are provided the name of a faculty in their field, and are directed to schedule a meeting with the faculty to discuss their research interests as well as the faculty member's research interests. During a student's first or second meeting with the faculty, the research project and learning activities are agreed upon, the learning activities are included in the agreement form, and the form is signed by both faculty and student.

St. Petersburg College
SPC Academic Effectiveness

Student Research Dissemination:
Each of the student research reports submitted at the conclusion of the respective research project will be included in an Annual B2B Student Research brochure, and shared with students, faculty, and the Alliance partners.

Throughout the year, students who have completed a research project will be encouraged to present their findings at local and national conferences. Students will receive guidance to develop poster presentations, and funding provided for travel and accommodations as available.

Contact Information

Please address any questions or comments regarding this evaluation to:

Magaly Tymms, M.A.
Director, Institutional Effectiveness
Co-Principal Investigator, NSF LSAMP TB-B2B
St. Petersburg College, P.O. Box 13489, St. Petersburg, FL 33733
(727) 341-3195
tymms.magaly@spcollege.edu

St. Petersburg College
SPC Academic Effectiveness

Appendix A

Congratulations! You have been offered a Student Research opportunity in the TB B2B STEM program.

Timeline: 8-week Session (March 25 – May 3)

Upon completing the learning activities listed below, you will receive a $250 stipend.

- Attending a weekly microbiology research meeting Tuesdays from 4:00-5:00PM
- Performing primary literature research and/or laboratory experiments
- Meeting with Professor Ulrich either by phone or in person on a weekly basis for status updates and determination of the following week's goals
- Completing compiled report of the research/activities done each week (e.g. results observed, assumptions, and/or conclusions, learning achieved)

Note that the stipend may be subject to taxes, and student financial aid may be affected.

Do you wish to "**Accept**" or "**Decline**" this opportunity?

☒ Accept
☐ Decline

I fully understand that to receive the $250 stipend, I must complete the activities listed above during the 8-week period of March 25 – May 3. If I am unable to be present for any mandatory activity, I will alert Professor as soon as I am aware.

Please sign below attesting to your understanding and agreement of these requirements.

---------- ----------
Student Professor

St. Petersburg College is committed to equal access/equal opportunity in its programs, activities, and employment. For additional information visit www.spcollege.edu/eaeo/. St. Petersburg College is an Equal Opportunity Employer.