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# ABUNDANCE AND DIVERSITY OF INSECTS ON THE JUNIATA COLLEGE CAMPUS

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## ABSTRACT

On planet earth, insects make up the largest percentage of organisms in the world. They are the most diverse group of animals with over a million species and counting. With so many species to take into account within Pennsylvania, our study wanted to identify and compare insect species abundance and diversity in three environmental types: tall trees, low shrubs, and a combination of both. Capture attempts at the three environmental types occurred in managed (Juniata College Campus) vs unmanaged (Peace Chapel) locations to see if this had an effect on diversity and abundance. We hypothesized that the combination environment at the unmanaged location would have the largest abundance and diversity. For every specimen collected the location and environment type they were found was recorded and insects were later identified after collection attempts. Once all raw data was collected, we conducted analyses to determine how abundance and diversity differs in our field sites. We found several different outcomes for the insects in our sites. The low brush habitat on campus had the lowest diversity. The most diversity in insects was found in the tall tree and low shrub environment at Juniata College along with the low shrub environment at the Peace Chapel. For abundance, the combination habitat at the Peace Chapel was the least abundant and the most abundance of insects was found to be in the low shrub environment on campus. Our findings do not support our hypothesis, but they were not statistically significant.

*Keywords: Simpson's diversity index, abundance, diversity, insects, Chi-Square test*

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## INTRODUCTION

In Pennsylvania 1,111 species of insects have been identified (Pennsylvania Insects 2017). Species richness is determined by numerous extrinsic factors such as area, habitat and resource diversity, and niche partitioning. In this study, we will be focusing on habitat diversity. With a high richness of insect species, we were interested in testing the abundance and diversity of insects in variable environments. The variable environments investigated will include areas of low shrubs, high trees, and a combination of the two.

In a previous study, abundance and diversity were observed on a college campus in Harrison, NY using the same three environment types. We've expanded our study to include an off-campus location, The Peace Chapel in Huntingdon, PA, as well as the manicured quad sample locations on the campus of Juniata College. The goal of this expansion is to compare how the abundance and diversity differ between human-managed areas compared to an untouched natural location. If we find that we collect a smaller number of species of insects on campus then this demonstrates how natural

locations, such as The Peace Chapel, allow for more species to be successful because the manicured lawns of a campus quad do not provide the correct habitat for a larger diversity of species.

## METHODS AND MATERIALS

### *Field Site*

This study was conducted at the campus of Juniata College in Huntingdon, PA as well as The Peace Chapel located in the same town (Latitude: 40° 30' 14.8608". Longitude: -78° 0' 7.308"). Locations on the campus included either side of the library which simulated a short shrub environment and a combination environment as well as behind the Brumbaugh Academic Center which simulated the tall tree environment. The Peace Chapel was selected as the natural environment where short shrubs, tall trees, and a combination environment were present.

### *Materials*

This study utilized three sweep nets of the same size to collect specimens. Small collection jars containing 90% ethanol were used to preserve insect specimens for later counting and identification. Online resources were utilized for insect identification. *Methods* The method for capture utilized sweep nets as well as wood planks. The sweep nets were dragged across each environment type at both Juniata College and Peace Chapel. The sweep net method of capture was performed three times at each collection site once

a week for two weeks. The collection attempts occurred on 4/12/22 and 4/26/22. Wood planks were placed at each environment on the ground after the first capture attempt on 4/12/22 and were recovered on 4/26/22. The goal of the planks was to allow insects to hide under them for later capture. Temperature and time of capture attempt for each week were recorded to note any possible variability. After two weeks of collection, insects were identified via online resources and counted. Once all species were identified and counted, abundance was measured, and diversity was calculated using Simpson's diversity index.

### *Statistical analyses*

A chi-Square goodness of fit test and a test for independence were conducted to determine whether the sample represents the whole as well as if diversity and abundance are independent of location and environment type respectively.

## RESULTS

Qualitative data regarding the different insect families captured was recorded as well as the quantitative data separating the number of taxa found at each location on each collection day. There were very few repeats of insect family captures and often only one individual captured per insect family with exceptions to the Lampyridae family.

*Table 1. Qualitative data showing which insect families were present at each location and environment type.*

<b>Environment</b>	<b>Family</b>	<b>JC</b>	<b>PC</b>
High	Tenebrionidae	X	
	Reduviidae		X
	Syrphidae		X
	Ixodidae	X	
	Forficulidae	X	
	Araneidae	X	
	Culicidae	X	

	Chironomidae	X	
	Araneidae	X	
	Lepismatidae		X
	Opiliones		X
	Coreidae		X
Low	Leptothea		X
	Carabidae		X
	Formicidae		X
	Pentatomidae		X
	Agelenidae	X	
	Reduviidae	X	
	Lampyridae	X	
	Pisauridae		X
	Reduviidae		X
Combination	Araneidae	X	
	Rhipiceridae	X	
	Salticidae	X	
	Agelenidae	X	
	Mycetophilidae	X	
	Salticidae	X	
	Elateridae		X
	Theridiidae		X

Table 2. Quantitative data showing the number of insects found (red columns) at each location and environment type on both collection dates.

Date	Taxa JC High	Taxa PC High	Taxa JC Low	Taxa PC Low	Taxa JC Combo	Taxa PC Combo						
4/12	Tenebrionidae	1	Reduviidae	1	NA	NA	Leptothea	1	Araneidae	1	NA	NA
			Syrphidae	1			Carabidae	1	Rhipiceridae	1		
							Formicidae	1	Salticidae	1		
							Pentatomidae	1	Agelenidae	1		
4/26	Ixodidae	1	Lepismatidae	1	Agelenidae	1	Pisauridae	1	Mycetophilidae	1	Elateridae	1

	Forficulidae	1	Opiliones	1	Reduviidae	1	Reduviidae	1	Salticidae	1	Theridiidae	1
	Araneidae	1	Coreidae	1	Lampyridae	3						
	Culicidae	1										
	Culicidae	1										
	Chironomidae	1										
	Araneidae	1										

To measure diversity of insects at the two testing sites and each of their environments, we utilized Simpson’s diversity index and substituted calculating species for families due to identification difficulties. Abundance was calculated by dividing the number of families from one location and environment type by the total number of families at both locations at that same environment type. For example, the number of individuals found in the tall tree environment will be divided by the total number of individuals found at the tall tree environments at both Juniata College and Peace Chapel.

Figure 1. Bar graph demonstrating summary data for abundance and diversity at each location and each environment.

The low brush environment at Juniata College had the lowest diversity, whereas the combination environment at the Peace Chapel was the least abundant (Fig. 1). The most diversity occurred in the tall tree environment at Juniata College, the low shrub environment at the Peace Chapel, and the combination environment at Juniata College. The most abundance was seen in the low shrub environment at Juniata College.

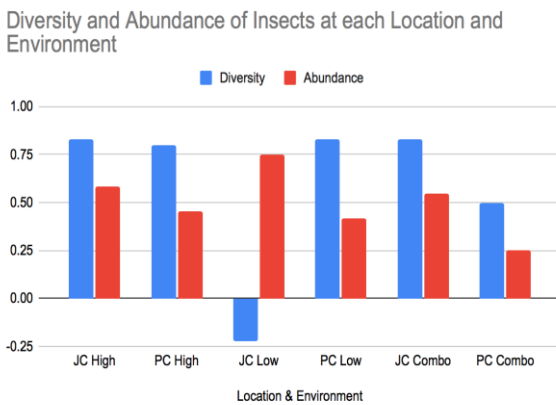


Table 3. Test for independence showing the observed and expected values of each location and environment type.

Observed				
	High	Low	Combo	Total
JC	7	5	6	18
PC	5	6	2	13
Total	12	11	8	31

<b>Expected</b>				
	High	Low	Combo	Total
JC	6.97	6.39	4.65	18
PC	5.03	4.61	3.35	13
Total	12	11	8	31

A Chi-Square test for independence and a goodness-of-fit test was conducted to assess the number of insects captured and their dependency on the environment and location as well as the difference between observed and expected individuals captured respectively. The null hypothesis for the test for independence states the number of individuals captured are independent of location and environment. The alternative hypothesis states that the number of

individuals found is dependent on location and environmental type. The test was conducted using two degrees of freedom and an alpha value of 0.05. The critical value was found to be 5.990 and the chi-square value was calculated to be 1.660. The p-value was found to be 0.44. Due to the chi-square value being less than the critical value we could not reject the null hypothesis; since the p-value is greater than our alpha value, the differences were not significant.

*Table 4. Goodness-of-fit test showing the observed and expected individuals captured at each location and environment type.*

<b>Goodness-of-Fit</b>						
	JC High	JC Low	JC Combo	PC High	PC Low	PC Combo
Observed	7	5	6	5	6	2
Expected	5.17	5.17	5.17	5.17	5.17	5.17

The null hypothesis for the goodness-of-fit test states there is an equal number of individuals found at each location and environment. The alternative hypothesis states that there are an unequal number of individuals found at each location and environment. The test was conducted using 30 degrees of freedom and an alpha value of 0.05. The critical value was found to be 43.77 and the chi-square value was calculated to be 2.862. The p-value was found to be one. Due to the chi-square value being less than the critical value we could not reject the null hypothesis; since, the p-value is greater than our alpha value, no significant differences were found. From both our statistical analyses we cannot make any significant conclusions regarding our project.

## DISCUSSION

As mentioned above, our results show that the highest insect diversity was in the tall tree environment at Juniata College, and the most insect abundance was seen in the low vegetation environment at Juniata College. This result of Juniata campus offering more suitable habitat for a variety of bug species, as concluded from our results above, does not support our original hypothesis but these results were found to be statistically insignificant. In terms of our collection method, we originally planned to only collect data from Juniata College. However, due to colder temperatures on our first collection date we had a low success rate. Dr. Glazier suggested we add wood planks at each test site to allow for bugs to hide

underneath it for later capture in addition to the use of sweep nets. We initially picked Peace Chapel as our off-campus testing site for its high density and variety of vegetation. Peace Chapel seemingly offered more suitable habitat for our specimens than on campus since it was more forested, but after merging our data we concluded this theory to be false yet statistically insignificant.

The evidence points to Juniata College campus, especially the tall trees environment, for having the highest diversity, possibly because of different tree species and vegetation at our testing sites. For both Peace Chapel and Juniata College, we did not consider the tree and vegetation species of our sites matching up. Perhaps at Peace Chapel the vegetation at low, high, and combo were simply not as desirable for many bug species, as the taller trees and shrubs at Juniata were. To look further into why the true forest at Peace Chapel had the least instances of diversity and abundance, we could analyze the differences in temperature, or rather temperature triggering bug activity. Bugs like termites, crickets, and mosquitos are more active in warmer temperatures. When we collected at Peace Chapel twice, versus the several instances we collected at Juniata before altering our methods, it was rather cold and even rained during our second collection date. This weather interference of rain and colder temperatures likely obstructed the diversity and abundance of bugs at Peace Chapel.

If we were to reanalyze the diversity and abundance of bug species at both Peace Chapel and Juniata College, we would use consistent vegetation, increase the number of collection dates, collect in warmer temperatures, and assess differences in site elevation. As mentioned previously, something we did not consider was the difference in vegetation at all six of our sites. There was no consistent low, high, or combo vegetation for each category. There were differences in physical height and differences in plants and trees. A second alteration would be to increase collection attempts to allow for more raw data. Another modification would be collecting in warmer temperatures. Temperatures and weather changes have

significant effects on what kinds of bugs are active. The capture methods used to collect specimens may not have been conducive so in addition to the sweep nets and planks we could add additional methods of capture. The last modification could be looking at the differences in elevation at all of our sites. Certain bugs may not be found at higher elevations even if it is their preferred habitat. Conducting more collection dates, picking sites with similar or the same vegetation, collecting in warmer temperatures, and assessing elevation differences may help our study have clear significant results of abundance and diversity at Juniata college and Peace Chapel.

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