PREFERRED SOIL CONDITIONS OF INVERTEBRATES AT SUNY PURCHASE

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ABSTRACT

There is a lack of research and experimentation into the habitat preferences of invertebrate organisms, but what has been well documented is that higher abundance and diversity of soil invertebrates indicate a healthy soil. In our experiment, we aimed to collect soil samples from four different sites with four different soil quality types. In each soil sample we measured the moisture content, pH, temperature, and the invertebrate diversity. The four types of soil were: Site 1-hot/dry, Site 2-cool/dry, Site 3-cool/moist, Site 4-hot/moist. We found that there weren't large differences of temperature between the soil samples and the pH differences between the soil samples were consistent. Between the different soil sites the largest difference was the abundancy and the diversity of different invertebrate species. While site 2 (cool/dry) had a higher diversity of invertebrate, site 4 (hot/moist) had a larger amount of invertebrate organisms.

Keywords: Ecosystem, Invertebrate diversity, Soil Content

INTRODUCTION

Soil is the relatively shallow upper layer of the earth's surface and it crucial to all living organisms. It is formed by several factors such as climate, organic and inorganic materials. These factors affect major ecosystem processes, such as primary production, decomposition, and nutrient cycling, which lead to unique soil types and ecosystems. Organisms have evolved in the soil since the pre-Cambrian era (600 million years ago) and many soil-dwelling prokaryotes are responsible for the fixing of atmospheric molecules that are imperative to the evolution of plant and animal life on the planet. Soil ecosystems are comprised of many largely unseen domains, with an array of biota, such as microbes, vegetation and herbivore, carnivore and detritivore consumers, which affect and are affected by mineral, organic, aquatic and aerial habitats. Soil ecosystems can be viewed as the intersection of four principal entities: the atmosphere, biosphere, lithosphere and pedosphere (Coleman et. al. 1992). Therefore as climate changes, the effects it has on the conditions present in the soil will be translated to every aspect of biodiversity. This is why scientists are interested in understanding soil ecosystems and how rising temperatures may affect it (Kardol 2011).

As with all ecosystems, biodiversity is an important factor in measuring the overall health of the soil. An ecosystem's ability to sustain a wide array of organisms is a great indicator that the environment is nutrient-rich and has a high economic value (Renaud et al. 2017). In contrast, if biodiversity is suffering in an environment we can note that the health of the environment is being affected negatively. Because of this, ecologists are concerned with distribution and abundance of organisms in the environment. Thus, in soil habitats, collecting data on invertebrate species diversity, which consume organic matter in the soil such as termites and earthworms, indicates soil health. (Waring et al. 1985).

Invertebrates, as with all living things, must deal with the consequences of human actions. Climate change has had a measurable effect on these organisms and this effect varies wildly. Ants have started borrowing deeper into the soil to escape the rising soil temperatures at the surface (Del Toro et al. 2015), increased ocean temperatures have moved whole ecosystems to higher latitudes (Takolander et al. 2017) and even worst of all warmer temperatures coupled with invasive species have led to instability that could cripple an ecosystem altogether (Holopainen et al. 2016, Ransom et al. 2015).

Aside from the indirect effects caused by climate change, the direct effects that humans cause still create a heavily detrimental outcome on the ecosystem. Agriculture and all the processes involved with it, have caused hardship for various species of invertebrates (Callaham et al. 2003, Houston et al. 2014). Pollution from factory wastes have contaminated the surrounding soil (Vincent et al. 2018) affecting the delicate balances, such as pH, required for invertebrates to survive (McCay et al. 2017).

With all the different artificial stresses, this gives rise to the question of how the variables will manifest. In experimental forests, Nitrogen levels are artificially manipulated to be higher in accordance with predicted values in an effort to observe the most realistic outcome (Romanowicz et al. 2017). Experiential treatments of the different microbial communities present in the ecosystems are also being observed in order to determine how they will adapt to environmental changes (Noronha et al. 2017). Both areas of studies focus on similar variables but the reaction of different organisms will be heavily observed.

In our experiment, we compared the species diversity of macrofaunal invertebrates present in four separate soil conditions: warm and dry, warm and moist, cool and dry and cool and moist. With a focus on comparing the effects of the two main abiotic factors (temperature and moisture) on the organisms abundance and distribution. It is known that conditions present in tropical rainforests, higher temperatures and greater precipitation, lead to greater biodiversity than dryer and colder environments located at higher latitudes. Based on this information and discounting other environmental factors, it is hypothesized that invertebrates will be more abundant in soil that is both warm and moist.

METHODS

Field Sites. There were 4 different field sites that were chosen to collect soil samples. Field site 1 was located on the edge of a woodland area in direct sunlight with little to no moisture. Field site 2 was located within a woodland area that had a large canopy resulting in an area that was cool, little sunshine but also a low moisture area as well. Field site 3 was located on the south western bank of a stream within a woodlands area that also had a canopy resulting blocking much of the sunlight. This site was near a small stream making the area a high moisture area. Field site 4 was located on the northern edge of a roadside storm drain in direct sunlight. With the presence of the storm drain this also made the area a high moisture area.

The exact location of each field site was recorded using the GPS fuction of a Samsung Galaxy 5S smartphone. In conjuction to the the smartphone GPS tracking abilities, an app called Realtime GPS

Tracker was used to ensure the accuracy of the coordinates given by the Samsung Galaxy smartphone. The coordinates for the 4 field sites area as follows:

Site 1: 41°3'2.52" N 73°42'13.32" W

Site 2: 41°3'3.96" N 73°42'19.8" W

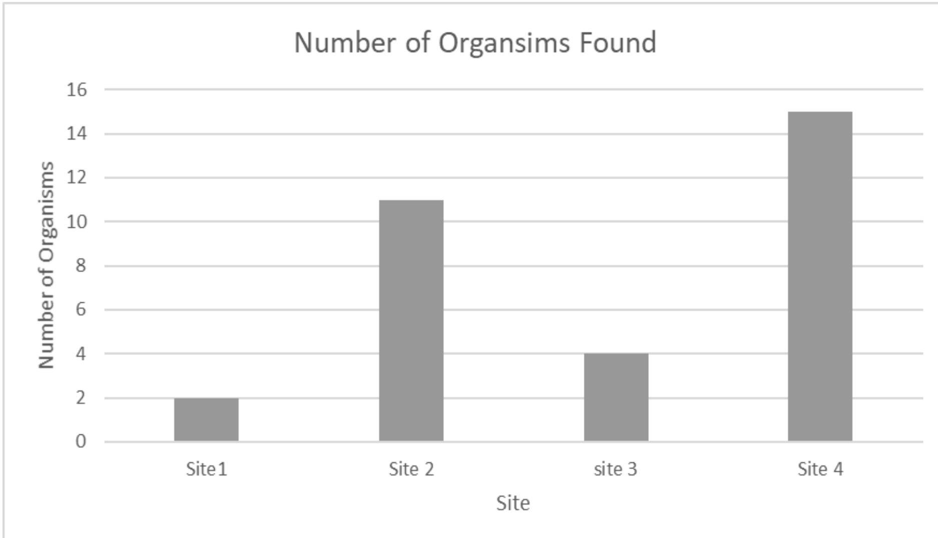
Site 3: 41°3'17.64" N 73° 42'13.86" W

Site 4: 41°3'11.16 N 73°41'15.12" W

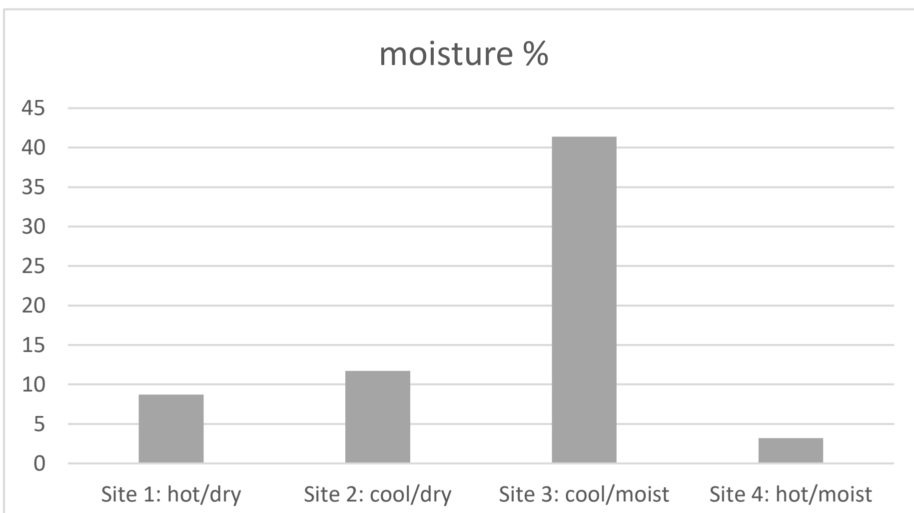
Soil Sampling. In each site a 200-mL soil sample was collected from a 2 by 2-meter area. Prior to collecting the soil sample, each field site was tested. A Covery 3-in-1 Soil Moisture Meter, Light and pH Tester was used to analyze the soil composition. A soil corer was used to collect the samples from each site. Once the soil was collected, it was then placed into a Ziploc bag and returned to the lab.

In the lab each soil sample was sifted individually using a SE GP2-14 Patented Stackable 13-1/4" Sifting pan, and a ¼" Mesh Screen. After sifting each soil large rocks were removed from the sample and the sample was analyzed. Any invertebrate found were placed in small beaker containing ethanol to preserve the organisms. Each site had its own ethanol beaker for the invertebrates found. The invertebrates were later counted and classified by Genius and Species. The data collected from each soil site was recorded and graphed using Microsoft Excel Spreadsheet.

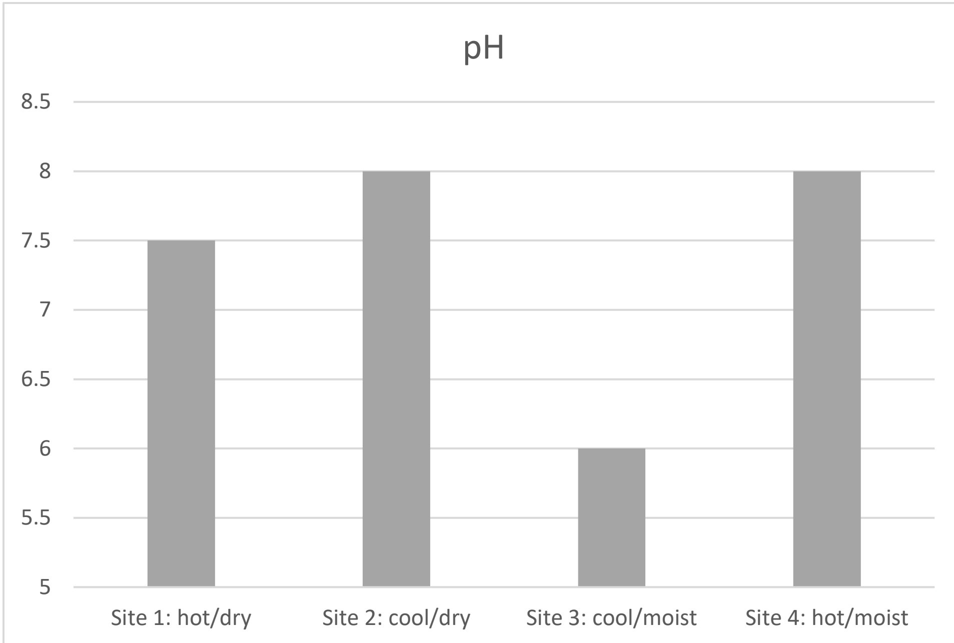
RESULTS



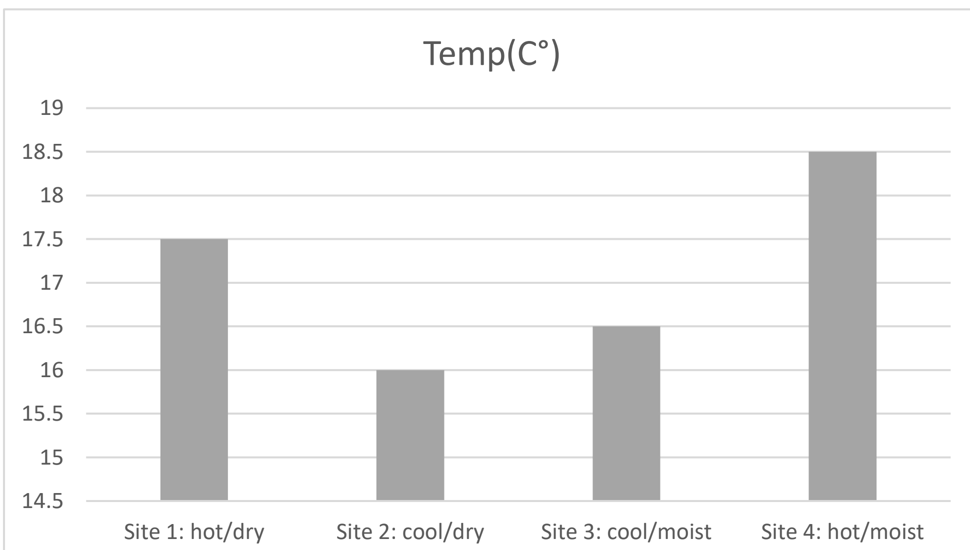
The site with the highest number of Organisms was site 4 with 15 individuals. Site 2 was second most with 11 individuals, followed by site 3 with 4 individuals and site 1 with 2 individuals.



In each soil sample moisture, pH level, temperature, and invertebrate content was measured and recorded. Each site held varying amounts of moisture. Site 3 held the most amount of moisture at 41.4%. Site 2 had the second largest moisture content of about 11.7%. Site 1 had a moisture content of 8.72% and Site 4 had the least amount of moisture content of 3.22%.



The pH was also recorded for each soil sample as well. While all of the soil sites held a pH near 7 (neutral) they were not all neutral soil samples. Site 3 had the most acidic soil measuring at pH of 6. Site 2 and Site 4 held a more basic pH value measuring a pH of 8. While Site 1 had a nearly neutral value pH of 7.5.



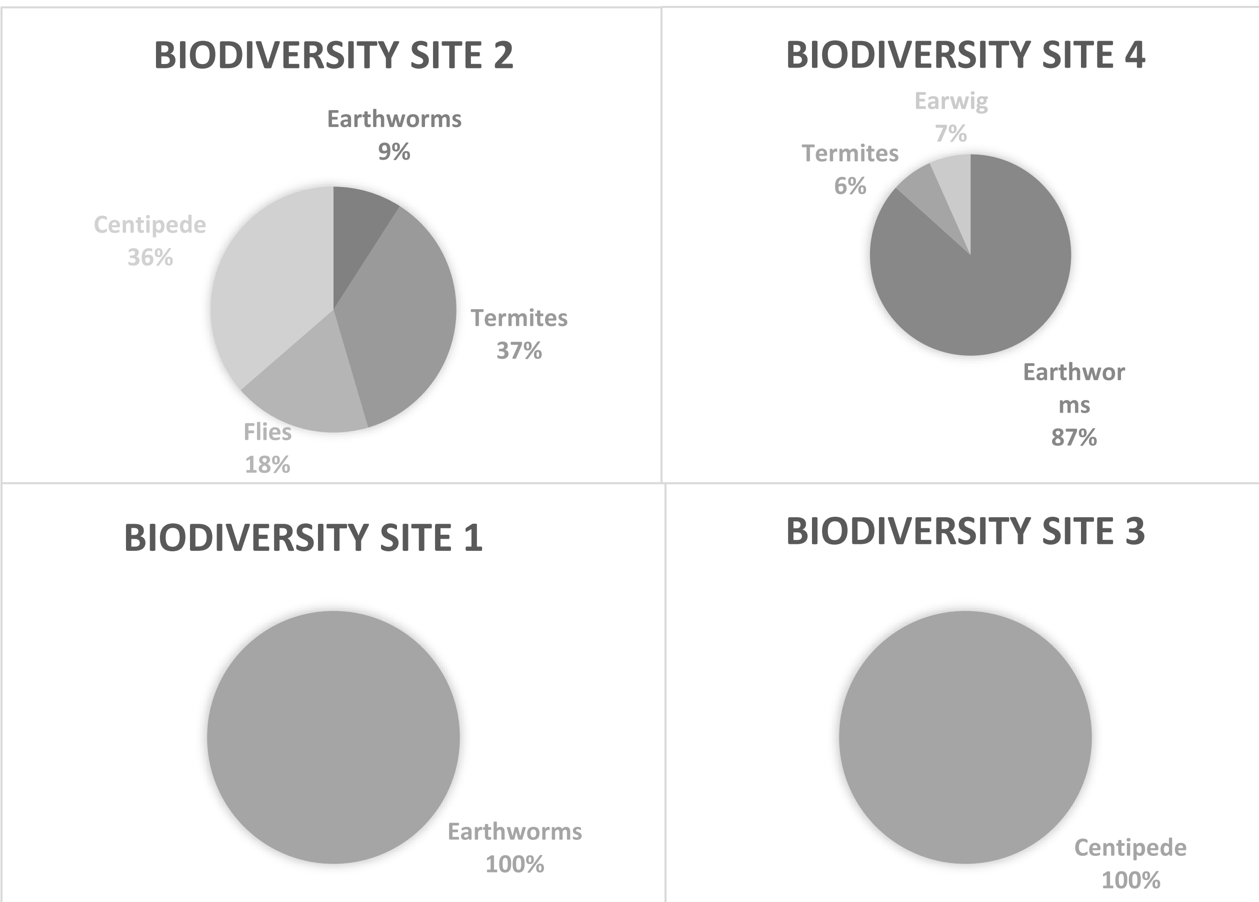
Similar to the moisture content and the pH, the temperature of the different soil sites were fairly consistent. There wasn’t large variety in temperature of all the soil sites.

Each of the temperature recordings were measured in degree Celsius. Site 4 was the warmest of all the soil samples measuring a temperature of 18.5°C. Site 1 was the second warmest of the soil samples measuring at 17.5°C. Site 3 was the second coolest sample measuring at 16.5°C. Site 2 was the coolest out of all of the samples measuring at 16°C.

Measuring for biodiversity held the greatest amount of variability between all of the soil samples. Site 2 held the most diverse invertebrate organism that were collected. Termites made up for roughly 37% of organisms found at the site. Centipedes were the second largest organisms that were found roughly making up 36% of the organisms that were found. The rest of the sample from site 2 had consisted of earthworms and flies.

Site 4 was the second most diverse sampling site. Site 4 consisted of 3 different invertebrate species. Earthworms was the most abundant of the organisms that were found roughly making up about 87% of the invertebrate found. Earwigs were the second most abundant organism in site 4 roughly making up 7% of the invertebrate found in the site. Termites held roughly 6% of the invertebrate organisms found at site 4.

Measuring for biodiversity held the greatest amount of variability between all of the soil samples. Site 2 held the most diverse invertebrate organisms that were collected. Termites made up for roughly 37% of the Sites 3 and 1 held the least diverse samples. Site 3 consisted of only centipedes in the sample. While Site 1 only contained 1 earth worm. The diversity between these two sites were very little compare to site 2 and site 4.



DISCUSSION

Based on the data collected, the most invertebrate diversity was found in the cool and moist site. This was contrary to our original hypothesis, that the warm and moist site would have a large variety of invertebrates. Several factors may have contributed to these results. One of which could be due to the low sample size of our study, but it is also possible that the conditions of the selected sites were not varied enough to elicit an observable pattern. For example, the greatest difference in temperature between all sites was 2 C°. A variable unaccounted for in this survey is nitrogen concentration. Studies show that increases in soil Nitrogen provide earthworm species with preferable habitats to occupy (Romanowicz et al. 2017), thus nitrogen levels might explain the differences in earthworm numbers between the study sites.

This lack of Nitrogen data may explain why the cool and moist site showed the most biodiversity. If this is the case, the lower temperature of this site, fallen leaves from these trees and waste from animals that inhabit this area would no doubt increase the amount of nitrogen in the soil making the habitat more desirable to soil invertebrates. Further research on the Nitrogen characteristics of SUNY Purchase soil might clarify why each site contained what we found.

Our moisture measurement in site 4 which was labeled as cool and moist shows a discrepancy because of the content of the soil itself. The soil at this site had a high percentage of stones which contributed to the weight of the soil. Therefore when moisture was measured as the percent of water to the overall weight of the soil it was less than what was expected based on the wetness of the site.

The fact that this site showed the least amount of invertebrate diversity may be due to oversaturation of the soil caused by its proximity to Blind Brook as well as the large amount of rocks present. Although the site was not submerged at the time of sampling, its location within bankfull width would place it underwater during periods of high rainfall making the site inhabitable to many terrestrial arthropods.

More earthworms were found than any other invertebrate species. We were unable to identify the species of the earthworms we found, but it is possible that they are invasive. Invasive species often have an advantage in foreign environments because the center of the invasive species' evolutionary history is often located in different conditions, thus they can be uniquely adept at tolerating rare or unusual conditions in foreign lands (McCay et al. 2017).

Identifying the species name for earthworms present in SUNY Purchase would be an interesting addition to the study, and might help to further focus this project on invasive earthworm preferred environmental conditions.

It is also likely that the abundance of soil organisms on our campus is lower than that of a more natural system where human presence would be lower. Soil dwelling organisms often respond with high sensitivity to human disturbance and presence (Doran et al. 2000). This lower presence of soil organisms might have interfered with the accuracy of our sampling, likely exacerbated by the low sample size used. More complicated variables determine the distribution of invertebrates across the woodland sections of our campus. Overgeneralizations may not always be productive ways to describe ecosystem interactions (Kozlov et. al. 2017). Further sampling using both a larger quantity of samples and a larger variety of environmental conditions is required to make conclusive statements about how soil and invertebrate distributions on our campus are related.

CONCLUSION

Abiotic factors such as temperature and moisture may play an important role in the invertebrate diversity of soil ecosystems. However, biotic factors such as soil nutrient and microorganisms are also extremely important in the abundance and distribution of soil invertebrates. Sampling from field sites makes it impossible to control for all of the biotic variables, but this may be helpful in understanding the effects of abiotic factors on organisms in natural environments.

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