The Effect of Plant Type and Plant Diversity On Centipede Populations

Brooke Christofferson, Kelley Gates, and Julie Taylor

Environmental Science Summer
Research Experience for Young Women
July 16, 2003

Abstract

Our group researched the effect of plant type and plant diversity on centipede populations. This decision was based on research done by Denno and Gratton (2003) which proved there is relationship between plant biomass and the predator to herbivore ratio below-ground. Results from the 2004 biota survey conducted by Environmental Science Summer Research Experience for Young Women showed through statistical analysis, a significant difference between centipede counts in site 3 (N 39.35797; W 076.63836) and site 4(N 39.35733; W 076.63840), and we sought to determine whether centipedes preferred site 3 because of specific species found there or the greater plant density found there.

We hypothesized that the plant type would effect centipede population more than plant diversity. We performed a centipede count on sixteen different half meter squares, eight experimental and eight negative control plots to test our hypothesis. Our experiment showed that specific plant species appear to have a greater affect on centipede population than plant diversity. Specifically, we found that centipedes seem to favor a monoculture of rhododendron.

Introduction

Recently, Denno and Gratton (2003) found that a decrease in the biomass of Spartina plants altered the herbivore to predator ratio in the soil. Plants are the cause of organic matter in the soil which affect the amount and type of herbivores present in the soil. Since the herbivores are the food source for predators the amount of plants affects the population of predators.

A predator discrepancy was recently found in a biota survey of the "backwoods" behind Roland Park Country School in Baltimore, Maryland during the Environmental Science Summer Research Experience for Young Women. We discovered that the density of centipedes in the soil of site 4 (N 39.35733; W 076.63840) was statistically lower than site 3 (N 39.35797; W 076.63836) and we wondered why.

Centipedes are a predator of herbivore arthropods with a segmented body, antennae, and fifteen or more pairs of legs (Col, 2001). They use their speed and venom to catch and kill their prey (Col, 2001), and in their role as predator, they control the populations of other arthropods. With 3,000 species of centipedes (Kornfeld, 2001), they are found in a wide variety of habitats, preferring dark, moist areas under decaying leaf matter (Sparks, 2002). Since such favorable conditions are found in both site 3 and site 4, the difference in density was all the more puzzling.

We realized that plant differences in sites 3 and 4 might be the source of the difference in centipede density. Furthermore, we realized the amount of plant diversity and type of plants in the two sites was greatly different. Site 3 has a microclimate that is located at the source of the stream, with a large rhododendron patch and a large amount of English ivy; whereas site 4 has a microclimate that is a wetland meadow with a monoculture of jewelweed. (Brock, 2003)

Because of centipedes' important role as a predator in the soil food chain, and the research showing that predators are affected by changes in plant biomass this was chosen as our research topic. The great difference in plant diversity and plant type between sites 3 and 4 led us to believe that these two factors were affecting the centipede population and not plant biomass. The research of Denno and Gratton (2003) shows a change in

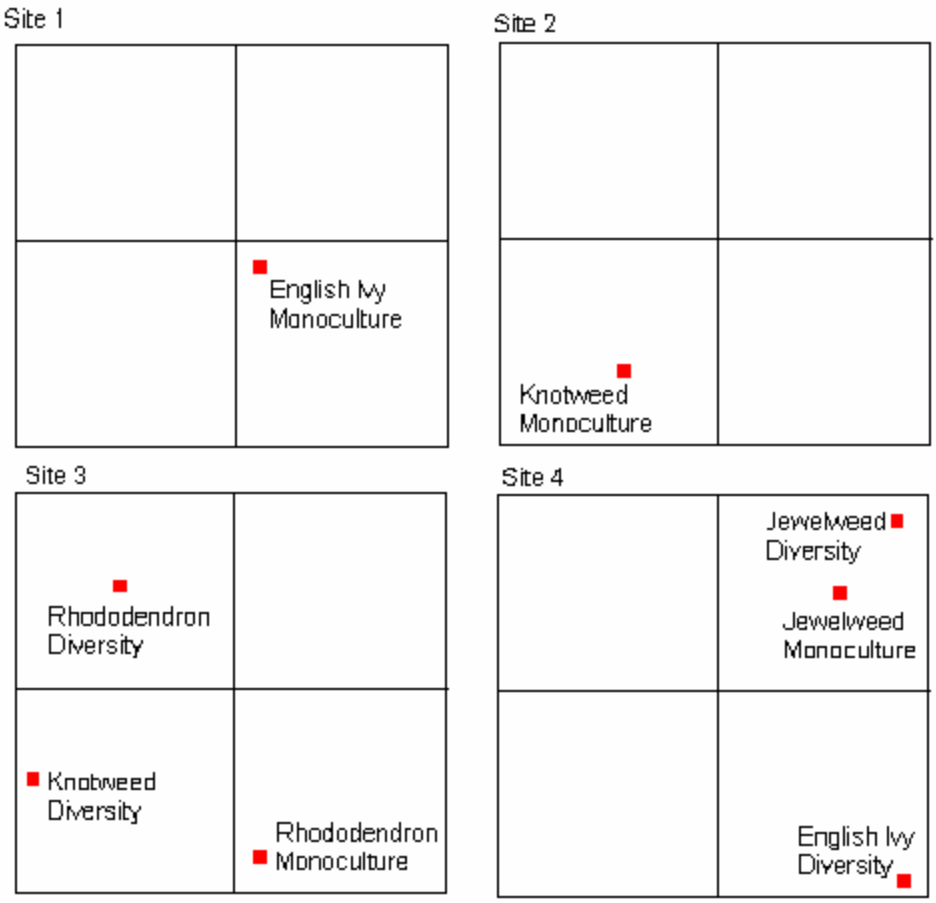
predator population when there is a change in plant biomass. The biota survey shows a statistically lower amount of centipedes in site 4 compared to site 3 and both plant diversity and plant type are very different between the two sites. From this research our question became “Does plant diversity or plant type affect the population of centipedes?”

Methods

We preformed our experiment using the sites marked out by the Environmental Science Summer Research Experience for Young Women. Each of the sites is a different microclimate. Site 1 is a riparian seasonal flood plain located at N 39.35794; W 076.63977. Site 2 is a heavily eroded stream bed at the base of a concrete dam located at N 39.35740; W 076.63893. Site 3 is a microclimate located at the source of the stream, with a large rhododendron patch and a great amount of English ivy located at N 39.35797; W 076.63836. Site 4 is a wetland meadow located at N 39.35733; W 076.63840. (Brock, 2003)

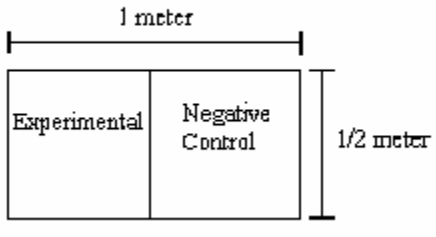
We first set out to examine the sites and determine which plant life to use in our tests of the effect of plant types on the amount of centipedes. We controlled for our experiment by using the four different sites. By using different microclimates, we sought to show that only plant type or diversity would affect the centipede population and not other randomly different environment factors. We decided to use four plots containing monocultures of, English ivy, knotweed, rhododendron, and jewelweed *(See figure 1).*

figure 1



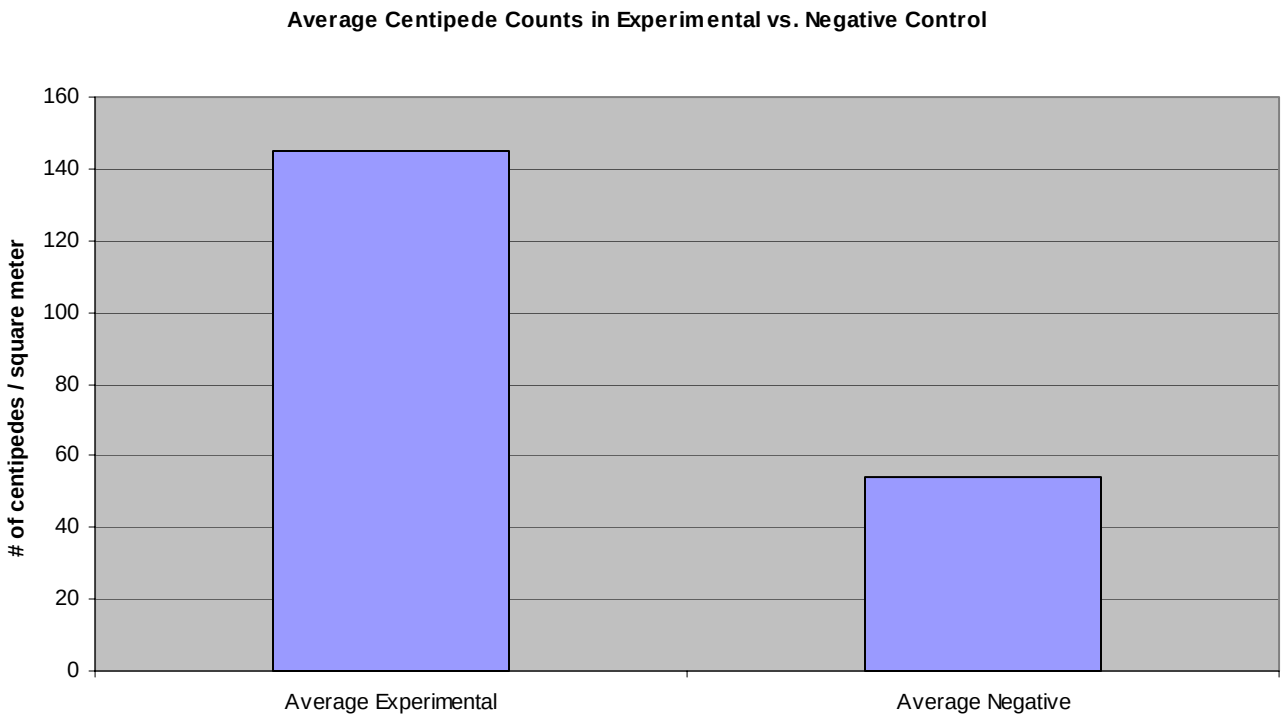
We then found four other areas that were not monocultures, but a mixture of the four chosen monocultures with other plants, used to test the effect of plant diversity. These diversity plots contained respectively: rhododendron, English ivy, and knotweed; English ivy, knotweed, ground ivy, and poison ivy; jewelweed and mild water pepper; milkweed, English ivy, and sweet fern *(See figure 1)*. At each plot, we set up two 0.5 m by 0.5 m side by side plots *(See figure 2)*. We then cleared one 0.5 m by 0.5 m of each pair all plant life, leaf litter, and sticks out of a half meter square area

figure 2

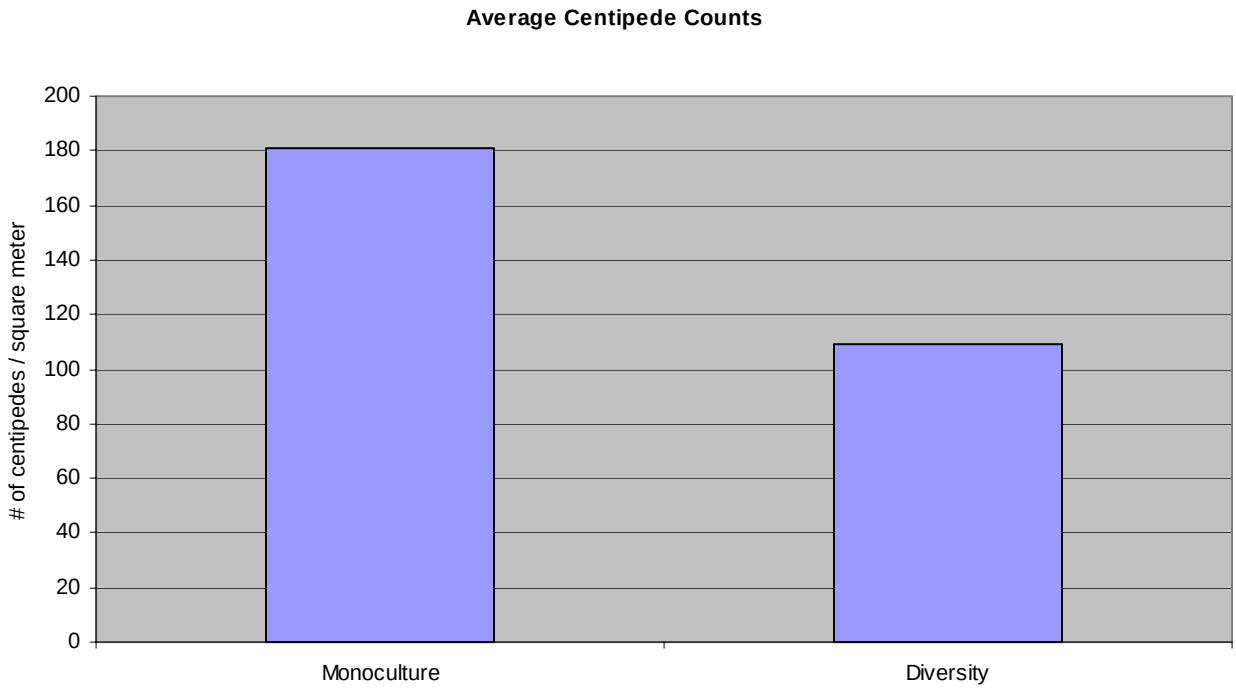


directly next to each experimental site. These were used as negative controls *(See figure 2)*. We had eight pairs of half meter areas to test. We then examined each of the half meter by half meter experimental sites down to fifteen centimeters deep counting the centipedes we found in each square. We examined the negative controls only after allowing them to sit for a minimum of four days.

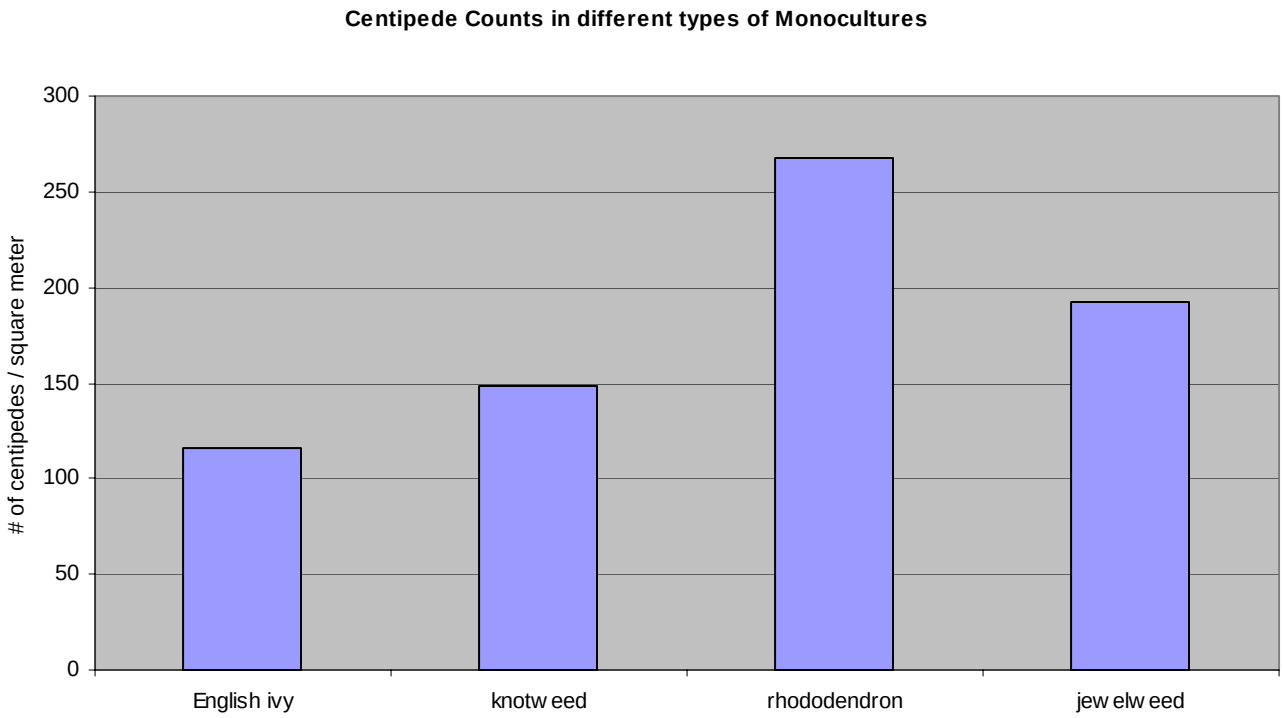
Results



As can be seen in graph 1 (above), an average of 91 more centipedes per meter square were found in the experimental plots then the negative control. Upon t-testing the data, a p-value of 0.006 was found. This shows that the difference in centipede density between the variable and the control plots was statistically significant.



As can be seen in graph 2 (above) there is on average 72 more centipedes/ meter square found in the plots containing a monoculture of plant species then a plot where plant species were diversified. Upon t-testing the data a p-value of 0.12 was found, which shows that there is only an 88% likelihood that the difference in centipede density is due to an absence of plant diversity.



As seen in Graph 3 the density of centipedes in the plot containing a monoculture of rhododendron was 76 greater than the next greatest monoculture plot. Upon performing a chi-square test, a chi value of 71.85 was found, showing that we can be 99.9% certain that plant type has a strong correlation to centipede populations and that the alternative hypothesis hold true. This statistical significance implies that centipedes prefer a rhododendron dominated environment over one dominated by jewelweed, knotweed and English ivy.

Discussion

To determine the validity of our experiment, a t-test was performed to see if there was a significant statistical difference between the centipede counts in our experimental plots verse those in our negative control plots, where all plant life had been cleared for a

minimum of four days. The test produced a p-value of 0.006 showing that we can be 99.4% certain that the larger density of centipedes is attributable to the presence of plant material in the experimental plots (See Graph 1). Our p-value, however, in comparing the centipede counts taken in plots containing a single plant species to those taken in diverse areas is 0.12. This value gives us only an 88% certainty that the results are not simply due to random chance. Thus, while this data very strongly implies that there is a greater density of centipedes in plots containing a single plant species, we can not prove it (See Graph 2). However, when we examine the negative controls for both the monoculture plots versus the plots with diverse plant life, the statistical analysis proves that any other environmental differences between the four site areas are insignificant, a p-value of 0.82. Here, the only probable cause of the differences between all plots is the difference in plant life, the p-value of 0.12.

One discrepancy that arose during the experiment was that the original difference between centipede densities in site 3 and 4 no longer appeared to exist in our experiment. We suspected that perhaps the original survey's statistically significant difference was due to the difference in plant density. So we tested plant density at both the original survey locations and our experimental locations and found that it was indeed the location at which centipede counts were taken that caused the original discrepancy in the biota survey. Wanting to rule out simple plant density as a significant factor in our experiment, we reexamined just those plots in sites 3 and 4 for any statistically significant differences between centipede counts in monocultures verse diverse areas. We found a p-value of 0.18, again implying that plant species and not simply density is the cause of higher centipede counts.

If we, then, examine graph 3, centipedes seem to prefer a monoculture of rhododendron. Doing a chi-square test of the monocultures shows a 99.9% surety that there is a significant difference between the centipede counts in the four different monoculture areas. The chi-value is 71.85 and the degree of freedom is 3. Rhododendron proves to be the most preferred. Thus although the p-value between diversity and monoculture plots is only 0.12 there is enough reason to believe that with a greater sample size results would prove the correlation between plant specie to centipede populations. Centipedes prefer a monoculture of rhododendron.

References

Col, Jeananda. (2001). Centipede. Retrieved July 13, 2004, from http://www.enchantedlearning.com/subjects/invertebrates/arthropod/Centipede.shtml

Gratton, Claudio & Denno, Robert F. (2003, October). Ecology [Electronic version]. *Inter-year carryover effects of a nutrient pulse on Spartina plants, herbivores, and natural enemies,* 89(10), 2692.

Kornfeld, Ari. (2001, November 27). Myriapods. Retrieved July 14, 2004, from http://www.humboldt.edu/~natmus/NorthcoastNature/Miriapoda/myriapoda.html

Church, S., & Holmes, C. (2004, June 10). Centipedes and Millipedes. Retrieved July 13, 2004, from http://www.lboro.org/~wwatch/Info%20pages/insect%20fact%20sheets/centipedes%20and%20millipedes.htm

Sparks, Beverly. (2004). Millipedes & Centipedes. Retrieved July 13, 2004, from http://www.ces.uga.edu/pubcd/b1088-w.html

Acknowledgments

We would like to thank Mr. David Brock, the director of the program, for investing his time into making this an enjoyable experience. We would also like to thank Emily Gates, the teacher assistant, for helping us through the three weeks.

Appendix

Number of centipedes / square meter

Location	Plant kind	Experimental	Negative
Site 1	Monoculture English ivy	116	16
Site 4	Diverse English ivy	124	8
Site 2	Monoculture Knotweed	148	112
Site 3	Diverse knotweed	120	108
Site 3	Monoculture rhododendron	268	12
Site 3	Diverse rhododendron	140	64
Site 4	Monoculture jewelweed	192	92
Site 4	Diverse jewelweed	52	20