BCOR 102

Fall 2016

Evolution and Phenotypic Variation in Goldenrod Species

Abstract

Evolution within a given species can be attributed to genetic variation. In this experiment, we attempted to observe genetic variation as a mechanism of evolution in *Solidago* plants. Prior to conducting our experiment, we hypothesized that there would be a statistically significant variation in height, as well as in stem diameter to imply that evolution is occurring. We will also look at the correlation between height and diameter across different goldenrod species to deduce a pattern and compare differences. [1]

Introduction

Maynard-Smith et al. suggests that there has been a long history of debate regarding whether evolution is possible without geographic isolation. The reason why this argument cannot be easily dismissed is because without a geographical barrier between species, it is sometimes quite difficult to definitively conclude that two species living in the same area are evolving (1966). The genus *Solidago* contains all species of the Goldenrod plant. Worldwide, there are 125 different species of Goldenrod, 45 of which are found in the northeastern United States. Phenotypic differences between species of Goldenrod can be very minute and distinguishing species of goldenrod from physical characteristics can be difficult. If all of these species of Goldenrod living in the same area descended from a common

[1] The abstract tries to go from broad to specific; however, being too broad can come across as being vague and not clear. I failed to address the major methods and results of the experiment, which was specifically required in the rubric. I also failed to state the hypotheses and if they were supported from our results. Furthermore, I failed to state the conclusions drawn from the results of the experiment. The most careless mistake in the whole abstract is the use of the future tense in discussing the analyses used. One of the most important things to remember in writing lab reports is use of the past tense.

ancestor, than what evolutionary mechanism could account for this speciation? When evolution occurs by means of speciation for two groups who are not geographically isolated, it is referred to as sympatric speciation. One evolutionary mechanism at play is natural selection which is the principle of survival of the fittest. In this case, Goldenrod that develop desirable traits through random variation will be more likely to reproduce and pass on these desirable traits. Natural selection could explain the divergence of Goldenrod species. For example, Goldenrods with a greater height could potentially receive more sunlight and have a greater chance of reproduction. The Goldenrods that have an increased height will have an advantage and could eventually become their own species.[2]

Methods

We carried out this experiment in Centennial woods making observations on 30 different Goldenrod plants. 10 of the plants sampled were Canada goldenrods (*S. canadensis),* 10 were smooth-stemmed goldenrods *(S. gigantea),* and 10 were rough goldenrods *(S. rugosa).* We used a taxonomic key to identify the different *Solidago* species, using physical characteristics to distinguish between them. The data we collected was the height in cm of the bottom of the inflorescence, as well as the diameter of the main stem at a height of 25cm. Height was obtained through the use of a meter stick, and stem diameter was measured using a caliper. Data was analyzed in multiple stages using the computer program R Studio. Each group compiled their data to yield observations on 258 individual plants. First we plotted scatterplots to compare height and stem diameter between the three species. We then constructed histograms showing the frequency distributions of height and diameter for each species. Finally, we constructed boxplots to analyze the variance in the data and calculate and r value or correlation between height and stem diameter for each species. The last step was to conduct two p

[2] The main issue with the introduction is that all of the background information has no significance if the writer fails to relate it to the study. This introduction provides little insight into what was actually studied because all of the research from outside sources is not applied to the experiment. The writing could be much more concise and the research question and hypothesis should be more clearly stated. Basically, what should be clearly explained in the introduction is what was done in the experiment and why.

tests, one for height and one for diameter. We hypothesized that the variance in height and stem diameter would be statistically significant enough to claim that evolution was occurring within the goldenrod population of centennial woods. [3]

Figure 1

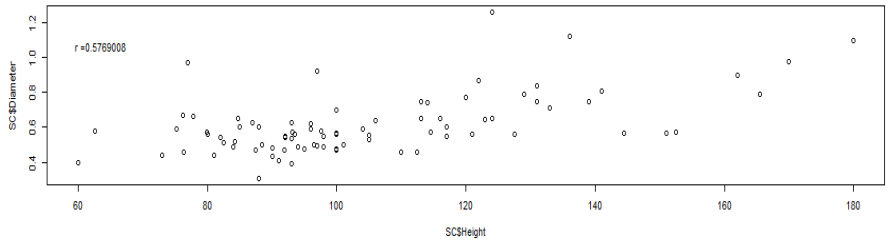

Figure 2

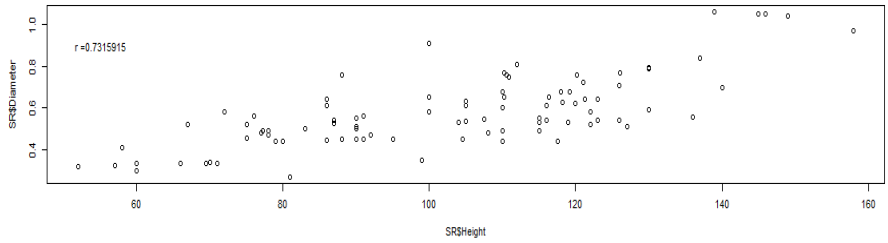

Figure 3

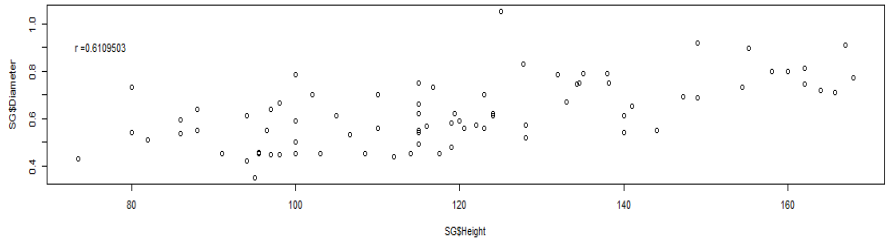

Figure 1: Figure 1 shows the correlation between height and diameter for *S. canadensis (r=0.5769008)*

Figure 2: Figure 2 shows the correlation between height and diameter for *S. rugosa (r=0.7315915)*

Figure 3: Figure 3 shows the correlation between height and diameter for *S. gigantea (r=0.6109503)*

[3] The methods section has a variety of issues. The numbers are all incorrect and points were deducted for this. Also, the statistical analysis used in the experiment was not clearly stated. In this case, an ANOVA, or analysis of variance, was used to determine the correlation between variables.

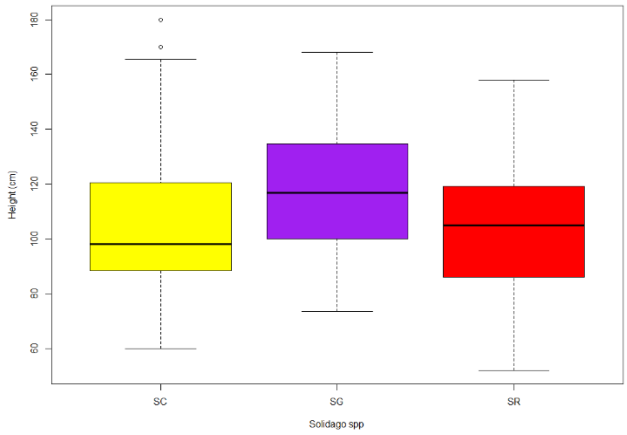

Figure 4

Figure 4: Figure 4 shows the distribution of heights for plants of each species.

Figure 5

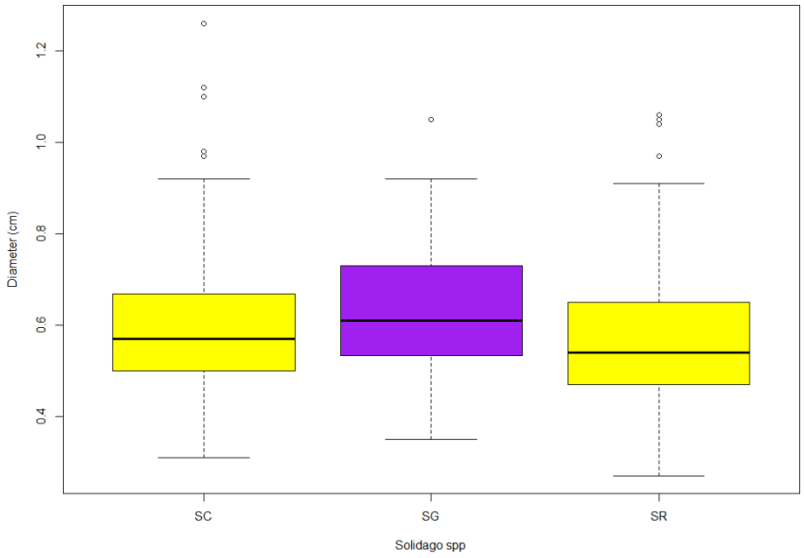

Figure 5 shows the distribution of stem diameter for each species.

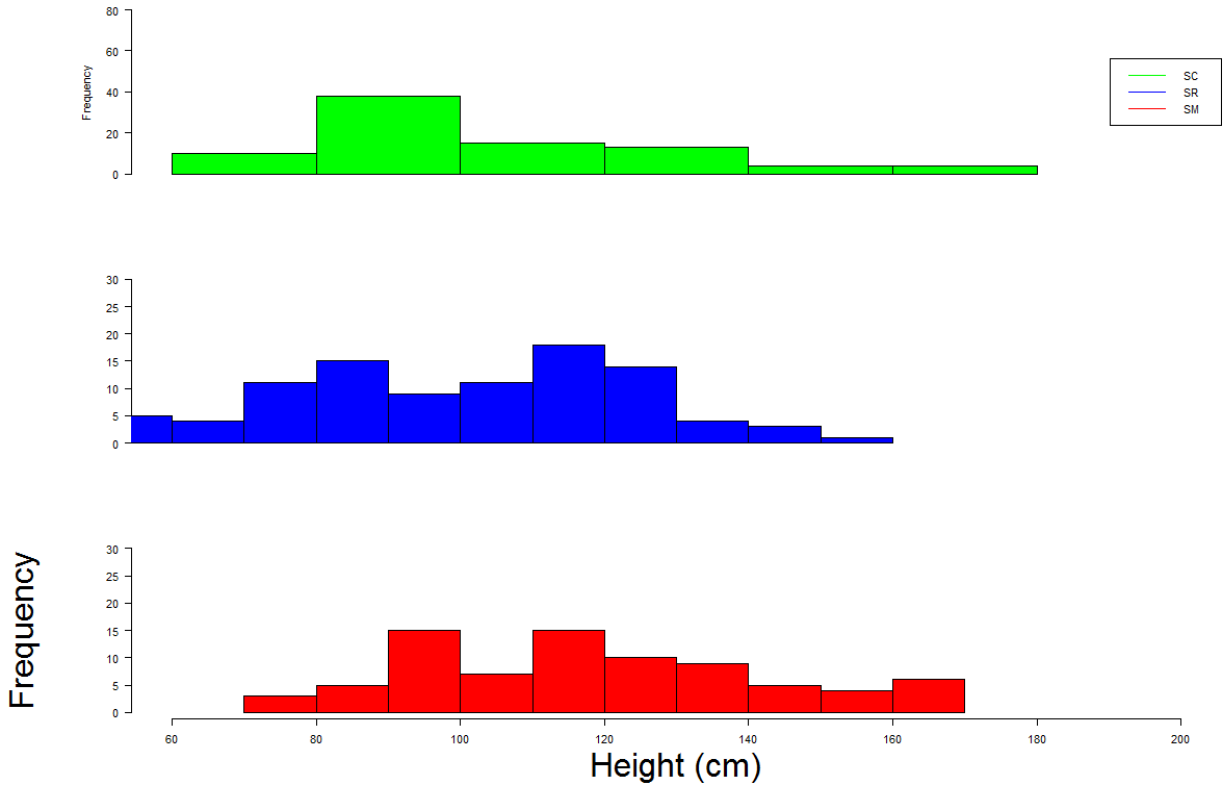

Figure 6: Figure 6 shows the distribution of the frequencies of different heights of each species.

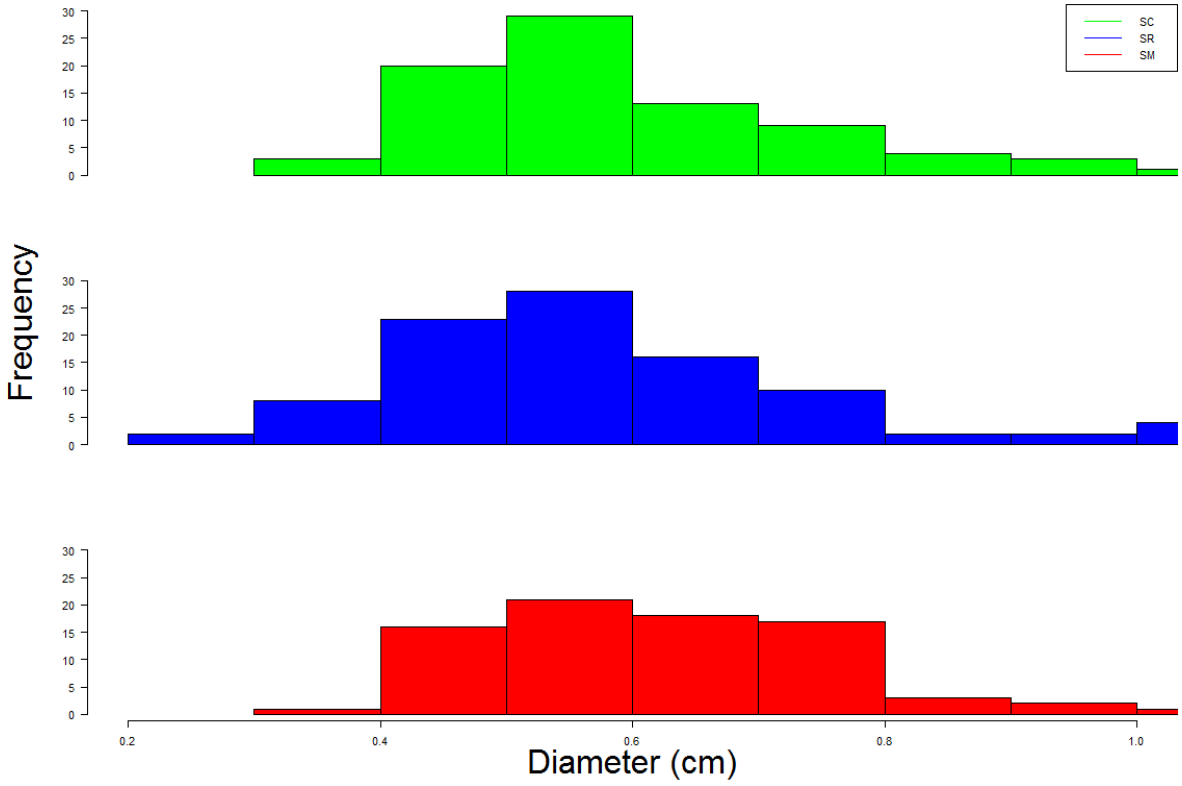

Figure 7: Figure 7 shows the distribution of the frequencies of stem diameter for each species.

Results

For all three species observed, there was a positive correlation between height and diameter. Figure one displays the height vs diameter for *S. canadensis* which had the weakest correlation of r=0.58 (Figure 1). *S. rugose* had the strongest correlation between height and diameter of all which was r=0.73 (Figure 2). The two boxplots shows the spread of the frequencies for both height and diameter of all three species (Figures 4 and 5). Figures 6 and 7 are histograms which plot height and stem diameter again frequency to show a distribution for all species. Each of our histograms followed a relatively normal distribution. Our ANOVA, or analysis of variance test yielded us a p-value of 1.15x10^-5 for height and a p-value of 0.11 for diameter.[4]

Discussion

Analysis of our data has prompted us to accept and reject certain parts of our hypothesis. We found that there was a statistically significant variance in height because the p-value of 1.15x10^-5 which is significantly less than 0.05 allowing us to reject our null hypothesis in favor of the alternative. This conclusion implies that evolution is occurring due to variation in goldenrod height. Our ANOVA analysis of diameter yielded a p-value of 0.11 which is greater than 0.05. This led us to accept our null hypothesis that variation in diameter cannot account for evolution in goldenrods. Our analysis of correlations between height and diameter gave us strong results. All three species showed a strong positive correlation between height and diameter suggesting that there is a positive linear relationship between height and diameter. Ding et al. suggests that goldenrod are an invasive species in many parts

[4] All of the graphs describing the results of the experiment were placed before the written section of the results, which is incorrect. Additionally the graphs themselves are, a) not clear to read, b) improperly constructed in that the axis labels in the graphs are still written in code and not adjusted to reflect the data, and c) the figure captions are not descriptive of what is being shown in the graphs. The written component of the results section does a good job of explaining what was being represented in the graphs; however, it failed to show trends in the data. Written results sections should reference numbers and patterns from graphs and figures.

of the world which would explain why goldenrod are constantly evolving to better adapt to their habitats (2008).[5]

Literature Cited [6]

Ding, J. 2008. China's Booming Economy Is Sparking and Accelerating Biological Invasions . BioScience 58.

Smith, Maynard J. "Sympatric Speciation." *The American Naturalist* 100.916 (1966): n. pag. *Jstor*. Web.

[5] The discussion section of this report is lacking multiple things. The discussion should begin with a brief summary of the experiment and this report failed to do so. This discussion section also lacked outside research to help explain the significance of the experiment. Outside research applied to the conclusions of the study should prompt the writer to address the possible next steps for the experiment, as well as what the results of the experiment mean in a broader sense, i.e. what was the significance of the results. Another thing excluded was possible errors made in conducting the experiment (which there almost always are).

[6] The literature cited section fails to meet the expectations of the rubric. There are only two citations instead of three, and on top of that the citations themselves are not in correct ecology format. The sources used did not necessarily all help further the understanding of the research topic. Put simply, the sources used should have some meaning in the context of the experiment.