Relationship Between the Amount of Runoff and Mold Growth

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Abstract

In the soil, mold is a decomposer that helps nutrients in the ecosystem continue to cycle. Although it can grow in many different places, the most important factor influencing the growth of mold is the moisture level in the environment. The E.S.S.R.E. 2019 Biota Survey showed that two microclimates had a significantly higher mold density than the other three microclimates. Our original hypothesis attributed this to the differences in elevation between the five microclimates because the data clearly showed that the microclimates with a higher elevation had a higher mold density. We believed that this was because they received and retained more of the rainfall and therefore had a higher water content. This hypothesis was tested by taking soil samples 15cm deep and 2cm in diameter from five different elevations on the same hill that Microclimate 3 and Microclimate 5 abuts against. These were then plated on 3M Petriflim™ Yeast and Mold Count Plates to determine soil mold densities. We found that our hypothesis was not supported because the moisture content increased as the mold density decreased. However, our reasoning about elevation playing a role was supported because there were differences in the amount of leaf litter, a factor known to contribute to increased mold growth. In the future, we would test for other factors other than moisture because our experiment clearly showed that moisture is not the cause for the increased mold density. Specifically, we would test for leaf litter density.

Introduction

In an ecosystem, fungi are decomposers and recyclers that make it possible for members of the other kingdoms to be supplied with nutrients they need to survive. Some of these necessary nutrients that fungi release into the soil are nitrogen, phosphorus, potassium and iron, which are used to maintain plant and algae health. Similarly, fungi release the enzyme, depolymerases, that cause the degradation of polymers into carbon dioxide (Science Direct). The nutrients in the decomposing matter go back into the ecosystem and help fuel new life within the environment. (Virginia Cooperative Extension, 2009). Therefore, fungi are significant because they help with recycling organic matter in the environment (Boundless Biology).

The specific morphology of fungi that release the enzymes that cause decomposition are the molds, and in order for mold to grow in the environment, there are four conditions that must be met. These include mold spores, a food source, appropriate temperatures, and considerable moisture. Mold can grow anywhere as long as there is a food source because it can form a biofilm on any surface where nutrients are present. These can include starch and sugar if on a cellulosic surface or anywhere that has a layer of organic soil because of the nutrients in it. Mold also thrives in temperatures that are 21.11° C or higher, so they are most active in the summer months. However, the most important factor in mold growth is the water content in the soil; the higher the water content of the soil is, the more mold will grow. (Florida Solar Energy Center, 2014, Building Science, 2002). Therefore, if the environment has a higher water content, the more mold will grow.

The amount of moisture in the soil affects the amount of mold that will be present. Soil can only hold a limited amount of moisture, so when there is a lot of rainfall, any excess water that cannot be absorbed into the ground becomes runoff. Gravity causes runoff to move downward until it is deposited it into a bigger body of water or flat ground that can hold the water (Britannica, 2019).

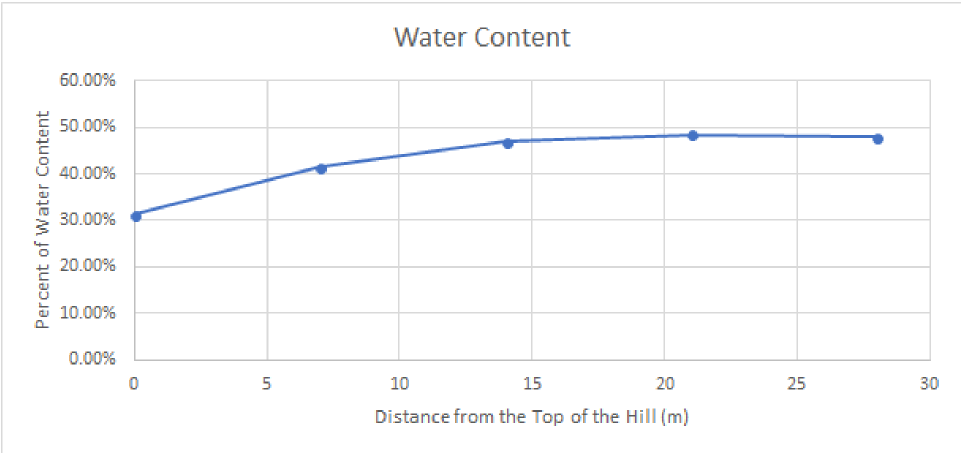
The data in the E.S.S.R.E. 2019 Soil Biota Survey (ESSRE 2019) showed that there were statistically significant differences between the amount of mold in both E.S.S.R.E. Microclimate 3 (N 39.35797; W 076.63836) at 58545.45/cc and E.S.S.R.E. Microclimate 5 (N 39.21508; W 076.38393) at 45036.36/cc compared to E.S.S.R.E. Microclimates 1 (N 39.35794; W 076.63977) at 16520/cc, 2 (N 39.35740; W 076.63893) at 22491.67/cc, and 4 (N 39.35733; W 076.63840) at 5525/cc. When looking at what was different between the sites that had a high amount of mold compared to the ones with a lower amount, we realized that the elevation of each site was different; the higher the site was, the more mold grew there. Because of the hills' differences in elevation, E.S.S.R.E. Microclimates 3 and 5 received and may have retained more of the rainfall because of their higher position on the hill; while the remaining water became runoff and flowed past E.S.S.R.E. Microclimates 1, 2, and 4 into the stream. As a result, the latter sites may have a lower water concentration. Because of mold's tendency to grow best in moist conditions, our group hypothesized that because of E.S.S.R.E. Microclimates Site 3 and 5's higher elevation and ability to retain more water, the living conditions provided an ideal environment for more mold to grow.

Methods

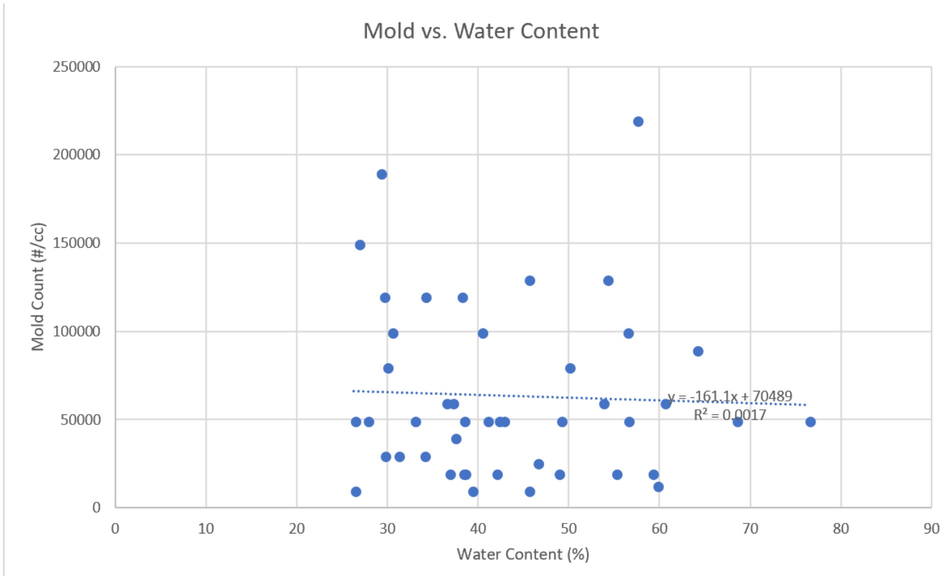
A research location was chosen east of E.S.S.R.E. Microclimate 5 (N 39.35797; W 076.63836) and north of E.S.S.R.E Microclimates 1 (N 39.35794; W 076.63977) and 2 (N 39.35740; W 076.63893). 5 plots were created going up the hill in a line perpendicular to the slope starting at N 39°21.488; W 076°38.375 with each successive plot 7 meters farther up the hill. Each plot was flagged for identification. 3 soil core samples 15cm deep with a diameter of 2cm were taken at each plot for a total of 15 samples. The first soil core sample for each specific plot was taken 1m west of a given flag, the second soil core sample was taken at the flag, and the third soil core sample was taken 1m east of it. All soil samples were tested for fungal density (#/cc soil) using serial dilution of 1cc of soil with sterile water to 10^{-2}. 100 ul of each dilution was then plated on its own 3M Petriflim™ Yeast and Mold Count Plate and left to grow for 72 hours before counting. Simultaneously, the water content of each sample was measured by massing the soil sample immediately after being diluted, baking the sample overnight at 105 degrees Celsius, and then massing again to determine the percent water content. One set of soil cores was collected on July 18th, a second set of soil cores was collected July 19th and a third set of soil cores was collected July 22nd.

Results

Graph A: This line graph displays the average water content in the soil from each distance from the top of the hill.



Graph B: This scatter plot shows the relationship between the mold count and the water content for each soil sample taken.



Graph C: This bar graph shows the ratio of mold to yeast for each distance from the top of the hill.

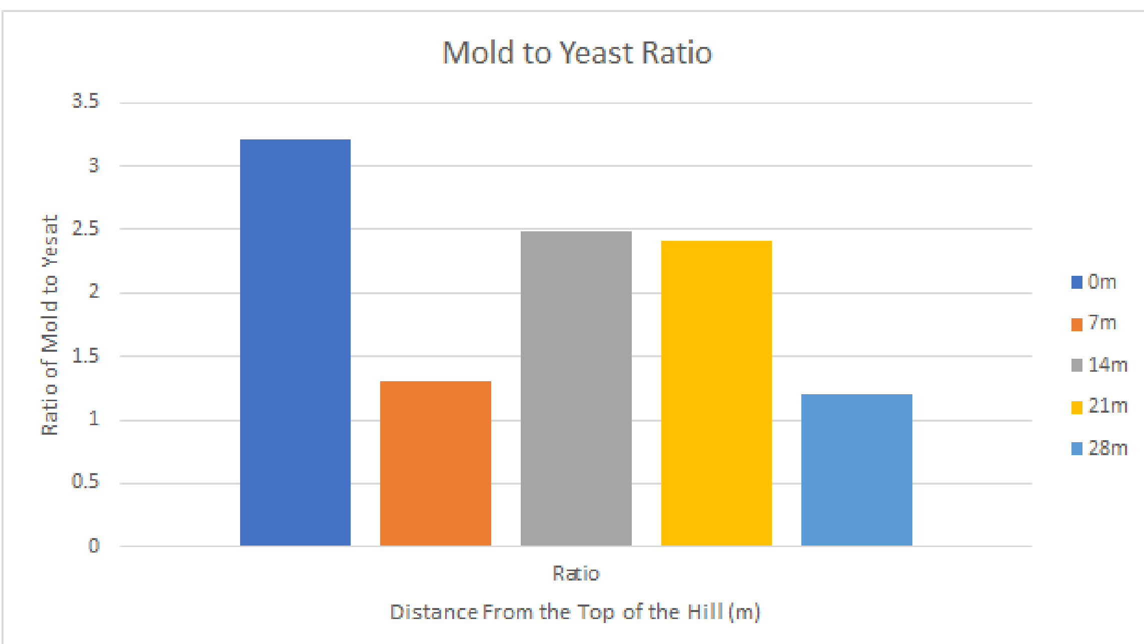


Table 1: This table displays a summary of all the relevant information.

Mold vs. Water Content Data				
Location	Yeast (#/cc)	Mold (#/cc)	Total Fungi (#/cc)	Water Content
1	26666.67	85555.56	112222.23	31.20%
2	70000	81333.34	171333.34	41.45%
3	26666.67	51444.45	72111.12	46.94%
4	20000	41111.12	61111.12	48.36%
5	30000	36222.23	66222.23	47.96%

Table 2: This table shows the p-values during the t-testing that we conducted.

T-Testing			
Mold		Moisture	
Comparison	p-value	Comparison	p-value
0m vs. 7m	0.85214	0m vs. 7m	0.04142
0m vs. 14m	0.17184	0m vs. 14m	0.00148
0m vs. 21m	0.07934	0m vs. 21m	2.09159
0m vs. 28m	0.05729	0m vs. 28m	0.0134

Discussion

We hypothesized that the elevation level and its effect on the moisture level of soil samples taken during the 2019 E.S.S.R.E. Biota Survey was the source of the different mold densities observed in each of the microclimates. We predicted that the higher a location was on the hill, the higher its moisture content would be and that we should consequently see higher mold densities at higher elevations. However, Graph A clearly shows that our initial supposition about the higher elevations having a higher water content was incorrect. 0m from the top of the hill actually had a lower water content than the rest of the hill, and in fact, as seen in Table 1, there is no correlation between elevation and the water content and the mold density. Therefore, our hypothesis as stated is incorrect.

Yet, Graph C shows that there is clearly a higher mold density at the top of the hill than the bottom of the hill, supporting our idea that elevation could be impacting mold densities. Furthermore, Table 2 supports this claim because the differences between the mold densities at each of the elevation levels show statistically significant differences ($p=0.06-0.17$).

Upon further research, we realized that the cause of the correlation between mold density and elevation may be due to differences in the amount of leaf matter as one moves down the slope of the hill. Organic debris causes mold to grow (PuroClean 2016), and as Figure 1 shows, there are significantly more dead leaves at the top of the hill, while the amount gradually decreased as we went down the hill until as Figure 2 shows, there is minimal leaf litter at the hill's bottom. We also observed that the trees at the top of the hill were denser and closer to the ground than the bottom of the hill (See Figure 3). Therefore, we believe the trend seen in Graph C is due to the significant differences in leaf litter as one moves down the hill. We would test this by counting how many leaves are in a given amount of space and comparing it to different elevations while sampling for soil mold densities.

Figure 1: the picture above is from site 1. It shows that the leaves are extremely apparent. They are stacked on each other and covering almost the entire ground.

Figure 2: This picture above is from site 5. It shows that the leaves are scarce and a lot of soil is showing.

Figure 3: The picture above is from sites 1 and 2. It shows very tall trees with a few openings that show the sky.

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