The Correlation Between Algae and Clay

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Abstract

The varying amounts of clay creates a parallel to the amount of growth in algae, and it has been shown that areas with a higher amount of clay have a higher amount of algal growth. Higher percentages of clay help to create a higher growth of algae because soil rich in clay can hold on to nutrients that the algae need. The 2018 ESSRE Biota Survey found unusually high algae densities in Microclimate 1 (42.5 mm^2) given the absence of moisture in the soil there. We hypothesized the soil in this Microclimate might have a higher amount of clay, creating the conditions for a higher density of algae. The study was performed in Microclimates 1 and 4 (these were the extremes for the percentage of clay found), taking samples from the areas with low, medium, and high clay levels (1%-84%). At each of the six locations, a soil core texture sample 15 cm deep and 2 cm diameter was taken, and algae density was tested using an implanted slide technique. This was done for three days. Soil core samples were then tested for the levels of clay, and algae slides were observed at a 40X power using a compound light microscope. Our data was inconclusive and neither affirmed or denied our hypothesis. In the future, we would like to test how varying soil compositions compare to water levels to determine how the soil texture is affected.

Introduction

Algae are autotrophic, aerobic microorganisms found in soils abundant in moisture and sunlight (Vidyasagar, 2016), and healthy soils may have as many as 3 billion per 30 grams (Nardi, 2003). However, only two of the four main classes of algae -Chlorophyta (grass-green algae) and Xanthophyta (yellow-green algae)- are found in the soil (Bailey, 2018), where they provide necessary resources such as oxygen and simple sugars for the other soil microbes. This microbial community then contributes to the process of plant succession (Metting, 1981). Hence, soil algae play a critical role in the health of terrestrial ecosystems. Algae thrive in moist environments, receiving nutrients from the water in their ecosystems, and water is also important to the process of photosynthesis. An environment containing more water makes the process easier (Biomara, 2012).

The ESSRE 2018 Soil Biota Survey (ESSRE 2018) revealed discrepancies. Therefore, when the observed and expected amount of algae in both ESSRE Microclimate 1 (N 39.358065; W. 76.6398625) and ESSRE Microclimate 4 (N 39.357685; W.76.638895) were different, we were puzzled. The soil in Microclimate 4 is significantly moister than the soil in Microclimate 1 (see Figure 1).

Figure 1: Site 1 (left) and Site 4 (right)

Yet Microclimate 4 contained a lower density of algae (avg=4.52/mm^2) despite having direct access to a stream, while Microclimate 1 contained the highest density algae (avg=42.5/mm^2) despite having a dry climate.

Burt, Enderson, Fraiman, and Villanueva (2017), though, have demonstrated a connection between the percentage of clay in soil and algae growth, and soil rich in clay is better at holding on to nutrients used by plants (Soil Quality Pty Ltd, 2018). This makes it likely that algae would still be able to grow in a dry climate if there was enough clay in the soil to retain the water and nutrients algae need to survive. Therefore, to explain the anomaly, we hypothesized that locations with higher percentages of clay in the soil would be the cause of higher algae growth in the soil.

Methods

5 research locations were determined based on the percentage of clay (range: 1% to 84%) found during the soil texture test conducted during the ESSRE 2018 Biota Survey (ESSRE 2018): Quadrants 2 (N 39.35822; W 76.63970) and 3 (39.35795; W76.63960) from Microclimate 1 and Quadrants 1 ((N 39.35791; W 76.63898), 2 (N 39.35741; W 76.63885), and 4 (N 39.35766; W 76.63893) from Microclimate 4. Algae levels (#/mm2) were determined at each location using a modified implanted slide technique (Pipe and Cullimore, 1980); (Drum, Askew, and Wilson, 2016). Following slide implantation, slides were collected after 48 hours and algae counts were taken at 40X with a compound light microscope. A soil core sample, 15 cm deep with a 2 cm diameter, was taken next to each implanted slide. And each soil core was tested for its percentage of clay using a water/phosphate flocculation technique. The soil cores were collected on July 18, 23, and 24 of 2018.

Results

<u>Day 1:</u>

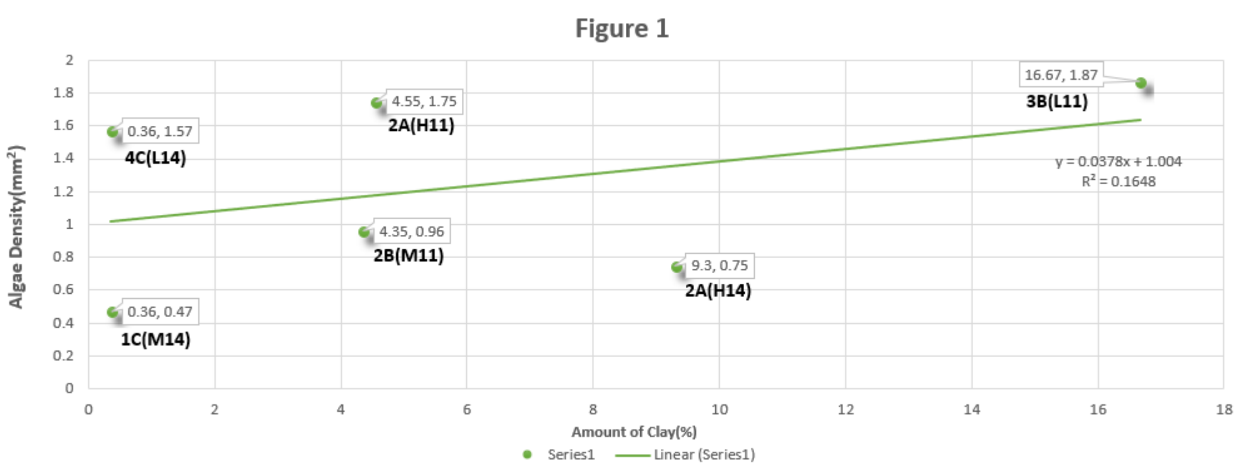

Figure 1 is a graph without statistical analytical adjustment. The clay percentages represent the amount of clay found in the six testing locations. The algae count represents the average calculated value of algae found in each of the six testing locations.

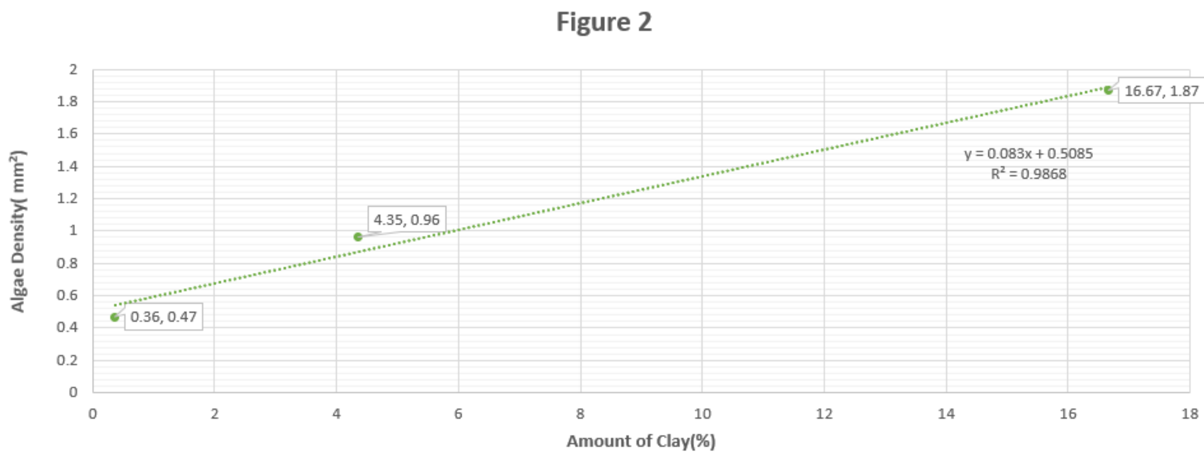

Figure 2 is a graph with statistical analytical adjustment. It was determined that only 1C, 2B, and, and 3B displayed significant from each other (p=0.41;p=0.0017).

<u>Day 2</u>**:**

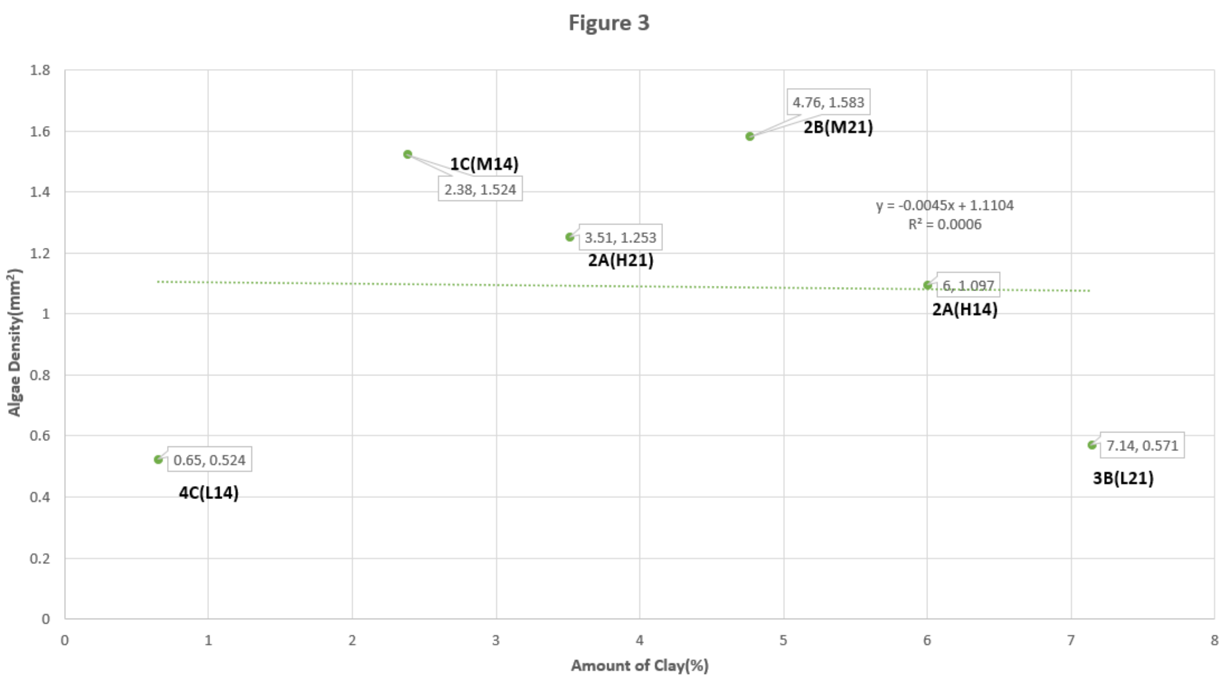

Figure 3 is a graph without statistical analytical adjustment. The clay percentages represent the amount of clay found in the six testing locations. The algae count represents the average calculated value of algae found in each of the six testing locations.

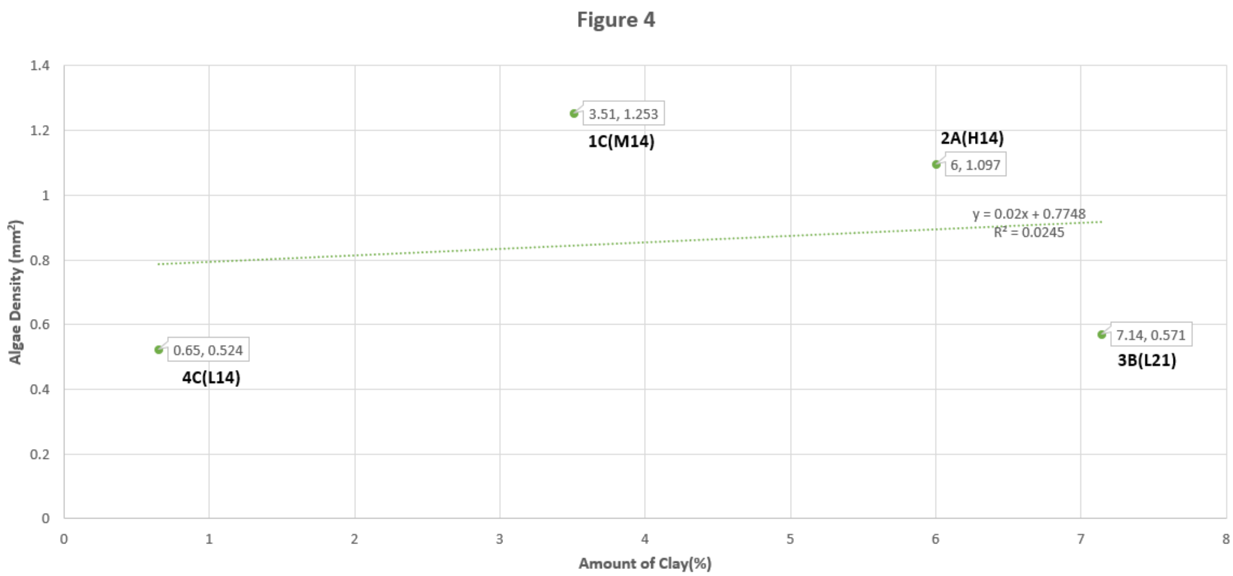

Figure 4 is a graph with statistical analytical adjustment. It was determined that only 4C, IC, 2A, and 3B displayed significant difference from each other (p=0.01, p=0.4, p=0.089).

Day 3:

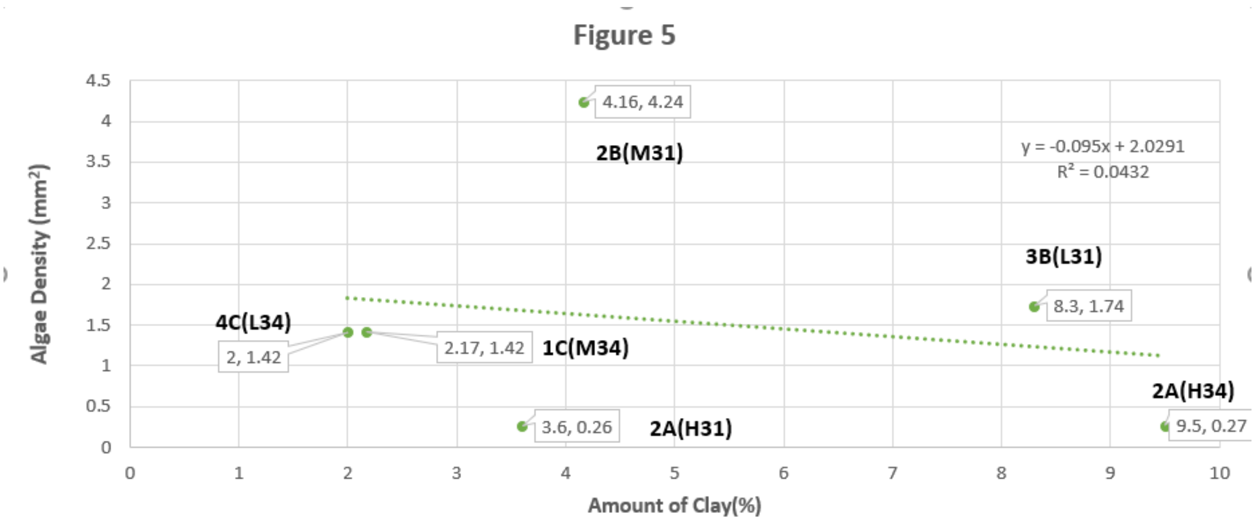

Figure 5 is a graph without statistical analytical adjustment. The clay percentages represent the amount of clay found in the six testing locations. The algae count represents the average calculated value of algae found in each of the six testing locations.

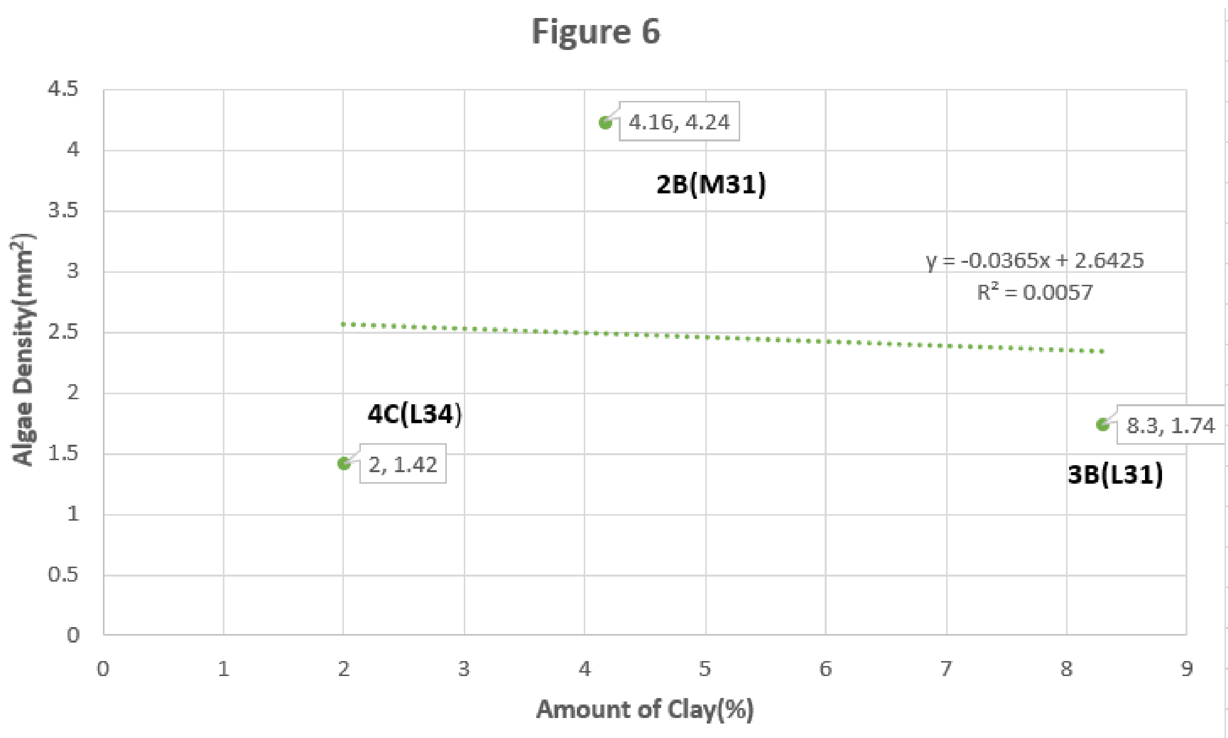

Figure 6 is a graph with statistical analytical adjustment. It was determined that only 2B, 4C, and 3B displayed significant amongst the other p-values(p=0.003, p=0.0016).

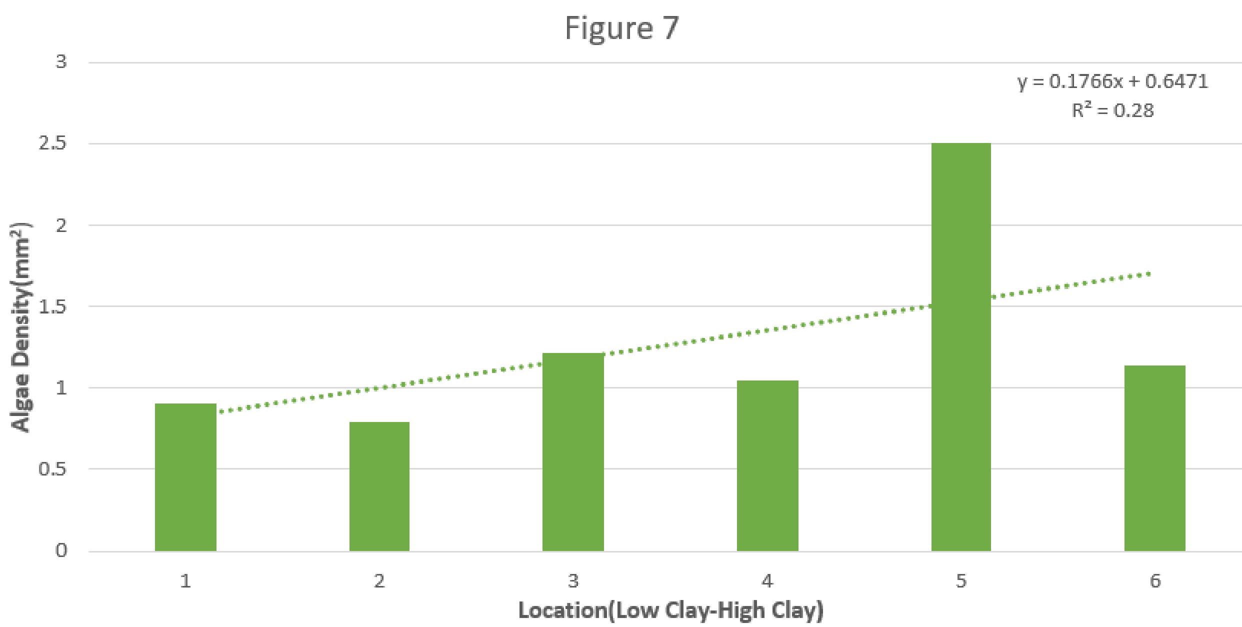

Figure 7 displays the average density of algae in each location. The x-axis is in a range from low clay to high clay. The graph displays that based on the data collected, our hypothesis is neither proven or disproven.

Discussion

Our results were inconclusive. Figure 2 shows a strong correlation between the percentage of clay found in the soil and the density of algae living there (r^2=.99), strongly supporting our hypothesis and the reasoning behind it. In addition, these samples were collected on the first day, following an extended period without any measurable precipitation (NOAA 2018), again supporting our original supposition that clay in the soils in Microclimate 1 was trapping water, making it available to the unusually large number of algae observed there in the original Biota Survey.

However, figure 4 only weakly supports our hypothesis, with a low correlation between the clay percentage found in the soil and the density of algae found there (r^2=.02). Furthermore, as figure 6 shows there was essentially no correlation between at all between clay and algae in the soils collected on the third day of the study (r^2=.006). Hence, with such strongly contradictory data, no substantive claims can be made about our original hypothesis.

However, figure 7 indicates that when the total collective data for each sampling location is examined, our reasoning behind our hypothesis remains justified, with the levels of algae in each clay condition growing at levels approximating what we originally predicted. In addition, the samples not supporting our hypothesis were collected on the second and third days of our study, when there were flood-level quantities of precipitation, making any moisture the clay might be retaining in the soils at our research sites irrelevant (NOAA 2018).

One potential reason for our inconclusive data could have been the method we used to collect our soil texture data. By only collecting samples next to where we were implanting our slides, we may not have gotten an accurate sampling of soil content at our research sites. In the future, we would collect the soil exactly beneath each algae slide after it is recovered for algae counting.

In addition, we now theorize after further research that it was indeed the weather in days 2 and 3 that affected our results. To further explore this idea and determine whether it is possible to confirm our hypothesis, an experiment using two independent variables should be done. We would manipulate both the percentages of clay and the amount of moisture in our samples to determine whether moisture in the clay or total moisture in the environment has a greater impact on algae density in the soil.

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