The Effects of Ants and Soil pH

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Abstract

Ants are important contributors to the soil's ecosystem. They help the decomposition process by eating dead organic material and consequently altering the chemical makeup of the soil, specifically impacting pH. During the E.S.S.R.E 2018 Soil Biota Survey, an abundance of ants was observed in Microclimate 2 compared to all the other Microclimates (1, 3 and 4), while an unusually low level of pH was observed (5.3). It was hypothesized that a high density of ants might be helping the plants cope with this low pH, and 5 separate locations were tested for pH levels and the quantity of ants, using baited 32 oz pitfall traps 13 cm in diameter by 11 cm tall. Soil removed for the traps was tested for pH using a LaMotte Model STH-14 kit. A scatter plot of the data revealed that as the number of ants increased, there was no significant increase in pH values ($r^2 = 0.0014$). Hence, our hypothesis was incorrect. Additional research revealed that the temperature of the soil may of impacted the activeness of the ants and therefore their impact on decomposition rates. For further research, we would choose locations and days with specifically warmer temperatures for more activiness to more accurately explore the effect of ants.

Introduction

Soil pH is the measure of the concentration of hydrogen ions in the soil (Queensland Government, 2018), and for plants, the ideal range is from 5.5 to 7 (although some species have adapted to other ranges). pH controls nutrient availability for plants (Mosaic, 2018), and soils with pH levels outside this ideal range will not allow the flow of nutrients from the soil to the plants (Queensland Government, 2018).

Many factors can influence soil pH (and hence nutrient availability for plants), but some organisms in the soil actively regulate it. Ants, for example, change the pH in the soil by bring dead organic material that they find in the soil into their nests, which builds up nutrients in that area, increasing the rate of decomposition (Bates, 2017). The decomposition process then releases more sulfur in the form of sulfate, lowering the pH level and making the soil more acidic. Ants do this because their nests need a neutral pH level (Harvard University, 2011), and ants will adjust how much organic material they consume accordingly. For example, if the ants' nest is surrounded by acidic soil, then the nest will tend to be basic and vice versa (Ellison, 2014). Therefore, ants play a crucial role in regulating soil pH by keeping the soil as neutral as possible (Kim, League, Wilder, Roberts, 2017). In addition, by digging tunnels, ants aerate the soil, increasing the flow of water, oxygen, and further nutrients to plants. Hence, ants play a crucial role in the health of the soil ecosystem.

Figure 1

During the 2018 E.S.S.R.E Soil Biota Survey, there was an unusually low pH level (average=5.3) found in E.S.S.R.E Microclimate 2 (N 39.35740; W 076.63893), which is strongly acidic. This pH level is well outside the ideal pH range for plants, yet in Microclimate 2, there is abundant plant life (see Figure 1).

Knowing the relationship between soil acidity and ants, we speculated that the high density of ants (average=152 per m^2) found in Microclimate 2 during the survey might be helping the plants cope with the high pH. (E.S.S.R.E, 2018).

Methods

5 different plots of land were chosen in the E.S.S.R.E microclimates based on ant density observed in the E.S.S.R.E 2018 Soil Biota Survey (E.S.S.R.E, 2018). The locations chosen were E.S.S.R.E Microclimate 1 in Quadrant 1 (N 39.35794; W 076.63977) [avg ants = 16/m^2], Microclimate 2 in Quadrant 1 [avg ants = 268/m^2] and 3 [avg ants = 272/m^2] (N 39.35740; W 076.63893), Microclimate 3 in Quadrant 4 (N 39.35797; W 076.63836) [avg ants = 48/m^2], Microclimate 4 in Quadrant 3 (N 39.35733; W 076.63840) [avg ants = 0/m^2]. 32 oz pitfall traps 13 cm in diameter by 11 cm tall were set at each of the locations. Bait was prepared by boiling

100mL of corn syrup for 6-8 minutes and then left to cool down. Each trap was baited at the bottom with a 2.54 cm tall by 6 cm wide sized pool noodle painted with a thin layer of the corn syrup mixture and a 0.5cm^2 metal mesh sheet cover placed on top of the trap. Lose place leaf litter was placed over the metal mesh sheet and rocks were used along the edges to weigh down the traps. The pitfall traps were allowed to stay out for 24 hours while the removed soil was tested for pH 2-3 times for accuracy using a LaMotte Model STH-14 kit. After 24 hours, the contents of the pitfall traps were removed and analyzed for the number of captured ants. Data was collected on July 23th, 24th and 25th, 2018.

Results

Figure 1: The Observed Relationship Between Ants and pH Levels in the Soils in Microclimates 1-4

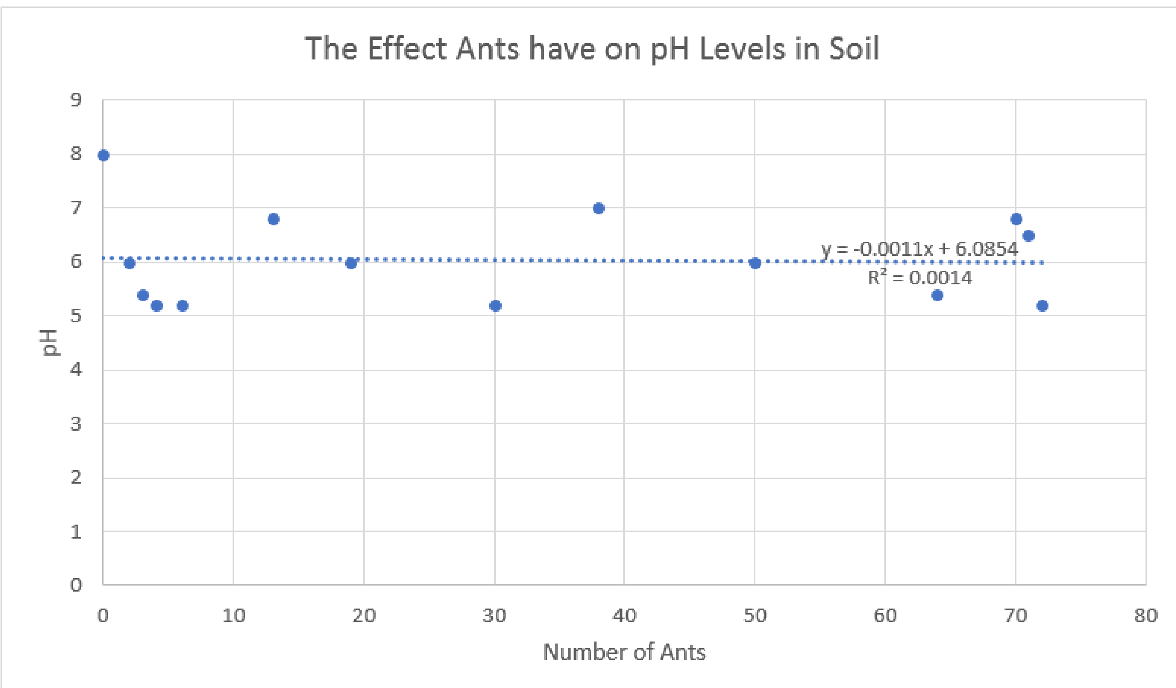

Table 1: The p-values from t-testing pH data from the sites compared from lowest to highest.

Site 4 Quadrant 3- Site 1 Quadrant 1 (lowest)	**0.435**
Site 1 Quadrant 1- Site 3 Quadrant 4	**0.796**
Site 3 Quadrant 4- Site 2 Quadrant 1	**0.758**
Site 2 Quadrant 1- Site 2 Quadrant 3 (highest)	**1**

Table 2: The p-values from t-testing of ant data from the sites compared from lowest to highest.

Site 4 Quadrant 3- Site 1 Quadrant 1 (lowest)	**0.691**
Site 1 Quadrant 1- Site 3 Quadrant 4	**0.218**
Site 3 Quadrant 4- Site 2 Quadrant 1	**0.450**
Site 2 Quadrant 1- Site 2 Quadrant 3 (highest)	**0.711**

Discussion

As Figure 1 indicates, there was absolutely no statistically significant correlation between an increase in the ant population and soil pH levels (r^2=0.0014); proving our original hypothesis incorrect. However, this total absence of correlation contradicts well-documented research into the impact of ants on soil pH levels (Bates, 2017; Harvard University, 2011; Ellison, 2014; Kim, League, Wilder, Roberts, 2017). Therefore, the significantly larger populations of ants observed in Site 3 Quadrant 4 on July 23rd and 24th, in Site 4 Quadrant 3 on July 24th, and in Site 2 Quadrant 1 on July 25th (the last four data points on the graph) should have had at least some degree of impact on the pH of the soils located there in comparison to the other samples. This anomaly requires as much explanation as the original one on which this study was based upon, and upon further research, we discovered temperature can affect the number of ants on the forest floor: as the temperature increases the rate at which the ants decompose increases as well; while in colder temperatures the ants decompose at a slower rate (Diamond et al., 2016). During the days of the original biota survey when the original arthropod extraction on which this study was based, the temperature was significantly higher than the days in which this study was performed (see figure 4). The ant population could have been consistent during both the biota survey and this study but because of the colder temperature on the days we were collecting data, the ants in our researched sites may simply have been less active, decreasing decomposition rates and failing to alter pH levels at our test locations. For future research to see how temperature affects the relationship between ant life and soil pH in deciduous forests, we would conducting our experiment at different times of the year.

Figure 4:

During Biota Survey

1-Jul	34℃
12-Jul	32℃
16-Jul	33℃

After Biota Survey and during independent research

23-Jul	30℃
24-Jul	28℃
25-Jul	30℃

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Acknowledgments

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