The Effect of pH on Protozoa and Earthworm Levels

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Abstract:

Soil pH, earthworms, and protozoa are all factors that affect the environment. An extreme level of pH, such as a very low or very high number, is harmful to organisms in the soil like earthworms. However, although there might be a harmful soil pH, earthworms might be able to survive because of the availability of certain food sources. We hypothesized that despite a low soil pH, there was a healthy level of earthworms in the soil on the RPCS campus because of the high density of protozoa. We took 15 soil core samples per day for three days from five different locations and examined ½ m^2 transects at each location to count the number of earthworms. We then performed chemical tests to find the pH of each soil sample, and extracted protozoa to determine their density. After examining our samples, we determined that our hypothesis was indeed correct.

Introduction:

There are many factors that affect soil health and the environment. Three such things are soil pH, earthworms, and protozoa. Soil pH is the measure of how acidic or basic soil is. This measurement is based on a scale of 0 to 14, 14 being the most basic and 0 being the most acidic. A neutral soil pH of about 7 is where most minerals are available (Bickelhaupt, 2008). Changes in soil pH can affect the environment, particularly the plants and organisms living in the soil. Knowing the exact measurement of soil pH is important because pH can measure how available the nutrients in the soil are that are essential to plant and animal life, such as phosphorous and nitrogen (Spector, 2001).

However, certain organisms, such as the earthworm, can help regulate soil pH (Bickelhaupt, 2008). Earthworms eat all kinds of decomposing matter, increasing soil fertility in the process (Ramsey & Hill, n.d.), and in addition, they add a special compound to the soil that gradually shifts the pH of the soil towards neutrality, which is optimal for plant growth. It is for this reason that earthworms are very important to the planet, digesting dead and decomposing plants and animals and transferring the nutrients from this organic matter back to the surface of the earth ("Earthworms, your garden's best friend," 2007).

In the process of eating soil, earthworms also digest microorganisms such as bacteria and protozoa, which influences the availability of nitrogen in the soil ("Did you know… earthworms," n.d.). Protozoa are single-celled organisms found in almost every soil environment on the planet. They are very useful and hardy microorganisms that can exist even in the most extreme of conditions ("Protista: protozoa," 2006), and they are important because they give off nitrogen as a byproduct to plants (Ingham, n.d.).

In the 2008 E.S.S.R.E. Biota Survey (2008), our group noticed an anomaly in the normal relationship between protozoa, earthworms, and soil pH. The unusually low pH levels in Site 3 (N 39.35797; W 076.63836), quadrat 2 seemed inconsistent with the high protozoa and healthy earthworm levels. Further research into previous E.S.S.R.E. biota surveys showed that Site 3, quadrat 2 has had consistently high protozoa and earthworm levels compared to other research sites in spite of a consistently low pH level (E.S.S.R.E. Biota Surveys, 2006 and 2007). Since it is unusual for soil with such a low pH to have a healthy amount of earthworms, we hypothesized that despite an extremely low pH that would normally prove harmful to the earthworm population, large amounts of earthworms exist in Site 3 quadrat 2 because the high levels of protozoa found there serve as a source of food for the worms.

Methods:

Five E.S.S.R.E Microclimate quadrates were chosen for their historically varying protozoa levels to take samples from (E.S.S.R.E Microclimate Database 2006-2008): Site 3 (N 21.496 W 38.278) quadrate 2 (high) Site 3 (N21.455 w 38.193) quadrate 4 (medium high) Site 1 (N 39.357 W 076.639) quadrate 2 (medium) Site 4 (N 39.35739 W 076.63924) quadrate 2 (medium low) Site 4 (N 39.35977 W076.63747) quadrate 1 (low). Three samples 15 centimeters deep by two and a half cm in diameter. Simultaneously at each site, a half by half meter transect that was fifteen centimeters deep was dug and the dirt was sifted to count the number of earthworms in the transect. In the lab, each soil core sample was tested for pH using the LaMotte Combination Soil Model STH-14 Code 5010-01 test kit and for protozoa density using a modified Foissner/Uhlig process (Brockmeyer et al, 2007). The entire process was repeated for two additional days.

Results:

The following data were collected over the course of three days. Day three data was separated out because following re-hydration of the soil from day three, the soil was not refrigerated for the same amount of time that the samples from day one and day two were.

Tables

Total averages for day 1 and 2

Site;Quadrat	**pH**	**Earthworms**	**Protozoa**
3;2	7.15	7	725547.65
3;4	7.58	6	55652.87
1;2	5.78	14	393158.89
4;2	6.57	10	158384.62
4;1	7.17	39	216774.01

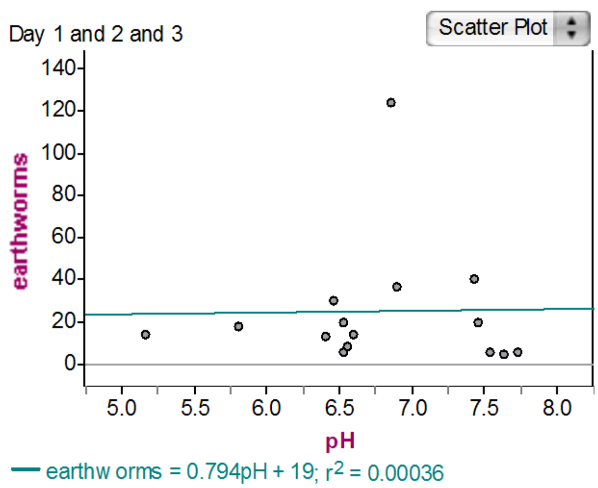
<u>Total averages for day 3</u>

Site;Quadrat	pH	Earthworms	Protozoa
4;1	6.86	124	174500.23
4;2	6.46	30	146241.35
1;2	5.8	18	179577.97
3;4	7.46	20	268570.26
3;2	6.53	20	110601.57

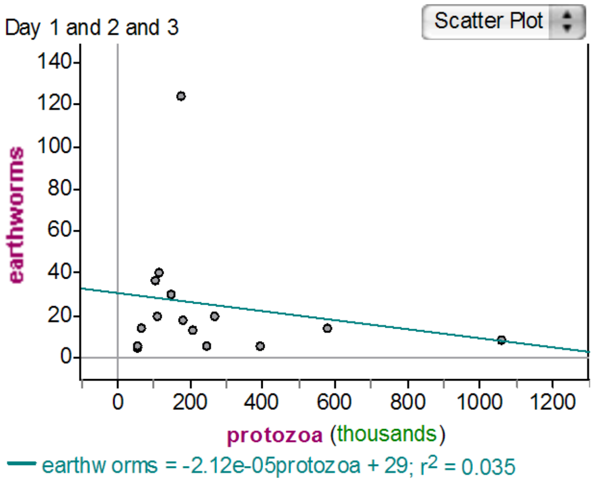
<u>Graphs</u>

The following graphs include all three days of data because Foissner's (1992) original protocol for protozoa traditionally counts the number of protozoa until two full days following re-hydration, and this condition was met for all three sets of data.

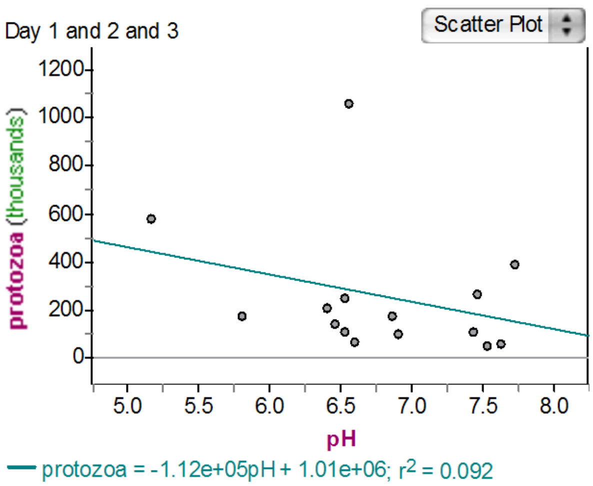
<u>Graph 1</u>



Graph 2



Graph 3



Discussion:

Our hypothesis was proven correct. As graph 1 shows, regardless of the pH, the number of earthworms found was unaffected. Based on our hypothesis, this is exactly what we expect to find. However, graph 2 would seem to contradict our hypothesis because it shows that as the number of protozoa increased, the earthworms found actually appeared to decrease. Based on our hypothesis, we would have expected the relationship to be the opposite. We can discount graph 2, though, because when the r^2 was calculated it was below .05. Therefore graph 2 shows there was no apparent relationship between the two variables and based on this information, we can discount the apparent trend observed in graph 2. Evidence for the expected relationship between protozoa and earthworms can be found by looking at both graphs 1 and 3. In the pH range of 6.5 to 7, the greatest number of protozoa data points were present as were the greatest number of earthworm data points. Had graph 2's relationship been valid, we would not have expected this to be the case. Therefore, the large number of earthworm data points in this range is only possible if the quantity of their food (i.e. the protozoa) is correspondingly high. This is indeed what graphs 1 and 3 show, proving our hypothesis correct.

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Acknowledgements:

We would like to extend thanks to the Human Capital Development Inc. & Toshiba America Foundation for funding the Environmental Science Summer Research Program for young women. We would also like to thank Roland Park Country School for providing the space for us to work, Mr. Brock for helping us through our entire experiment, and our teacher assistants who were a great asset to our learning process.