A Study of the Styrofoam-eating bacteria in the soil around the campus.

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Abstract

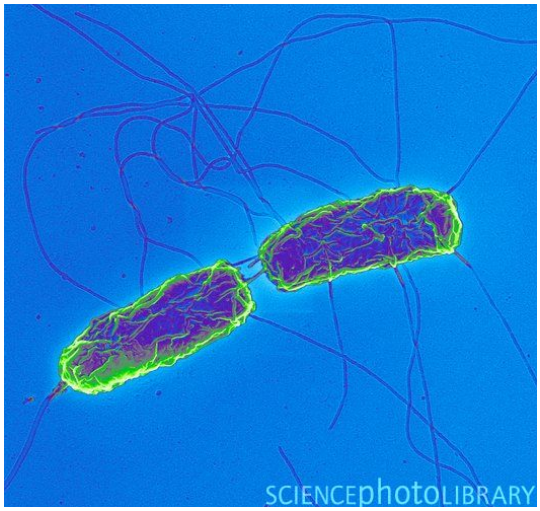
This project studied the Styrofoam-eating bacteria in the soil around the campus. Styrofoam is the most common plastic product that can be used for heat insulation, sound insulation and packing. Because it is very inexpensive and useful in daily life, people tend to throw it away, but it then becomes an environmental concern. The polystyrene foam cannot degrade by itself, so scientists are trying to solve the problem by recycling and reproducing it into other products. There may be species of bacteria in the soil that can corrode or destroy the surface or the structure of Styrofoam, and these bacteria likely exist in the soil around our campus. I collected soil from three places around campus and put them in three different buckets and bury 60 pieces of Styrofoam in each bucket. Then I waited for weeks to see the changes on the Styrofoam. Due to time limitations, there were no obvious and expected results. However, I found that in the three buckets, the Styrofoam on the bottom of the buckets changed their size and their color became lighter. The changes might not be due to the bacteria but might because of the pressure of the mass of the soil above those Styrofoam and the higher content of water at the bottom. However, the Styrofoam at the bottom of the bucket with wetlands soil changed most. Future studies should be based on extension of researching time and use soil from more places.

Introduction

As the most common plastic product that can be found everywhere every day, Styrofoam really made a huge difference to people's life. It is very useful and can be used for heat insulation, sound insulation and packing. It is the foam form of Polystyrene, a cheap and hard "petroleum-based plastic" ("Polystyrene foam report,"). It is described as "a very useful and versatile manufacturing material" because it can be used for building models, producing cups and appliances. A German called Eduard Simon discovered polystyrene in 1839(Bellis). It is produced by "free radical vinyl polymerization, from the monomer styrene" ("Polystyrene," 2005). Because it is very inexpensive and usual in daily life, people always throw them away randomly but the Styrofoam is so harmful to the whole environment. The Styrofoam that is thrown into the environment becomes a terrible environmental concern and it is very harmful for soil if people bury it underground. "By volume, the amount of space used up in landfills by all plastics is between 25 and 30 percent" ("Polystyrene foam report,"). The polystyrene foam cannot degrade by itself so it is just be broken up into pieces and breaking up into pieces that "choke animals and clog their digestive systems" ("Polystyrene foam report,"). Therefore, so many places in the world have decided that Styrofoam is illegal such as Taiwan and Portland, OR ("Polystyrene foam report,"). However there are still a huge amount of people using Styrofoam every

day, if they also outlaw the Styrofoam, it will bring them a lot of inconvenience and difficulties. People are trying their best solve the problem by recycling and reproducing it into other products; such as remanufacturing collected polystyrene cups into packing filler and other kinds of products. The process requires much more resources and creates more horrible pollution("Polystyrene foam report,"). Some scientists had also come out a lot of ideas to degrade the Styrofoam such as adding pseudomonas bacteria to the styrene oil, but there may be some kinds of bacteria in the soil in our daily life that can corrode or destroy the surface or the structure of Styrofoam. This project studies about the Styrofoam-eating bacteria in the soil around the campus.

Soil is a natural body containing "mineral constituents of variable thicknesses" (Wikipedia, 2011). Wetlands are the areas near water and there are many plants, amphibians and birds ("Wetland soil & climate,"). The soil in the wetlands is full of water for the most part of the year ("Wetland soil & climate,"). The soil is always saturated not because It has good absorptive ability but because of the location of wetlands. Because the wetlands are always in the lowest point of the areas that water can't escape for the most time. The soil in the Wetland are known for their moisture and more importantly known for their organic content which is very high; the organic content of most wetlands is usually higher than other terrestrial soil. The chicken coop is the place where hens live (Wikipedia, 2011). When the hens walk around the area, they may excrete on the ground and their manure may get into the soil nearby the coop. There are a huge amount of bacteria in chicken manure. The manure usually contains salmonella bacteria and campylobacteria which can make people sick ("Health risks of chicken manure,"). Salmonella is the main cause of a lot of food poisoning in the world and can exist in the soil with animal's manures ("Salmonella," 2009). And the image it shows under SEM is like the picture below:



("Salmonella bacteria, SEM,")

Sometimes the manure that can be used as fertilizer on farming contains antibiotic-resistant bacteria that should be kept away from people ("Antibiotic-resistant bacteria persist," 2009) The reason that I chose the three spots around the campus (wetlands, chicken coop and the goat fold) is to make it easier to compare. Wetlands soil is very wet and almost aquatic; the soil around the chicken coop and the goat fold is territorial and drier than the soil in wetlands. Also, there are different animals living in those three places so each kind of animal contains different bacteria. Therefore, I can do comparison depending on the wetness of the soil and the animals that dwell in the places.

Bacteria are microorganism which can reproduce by fission quickly in the befitting conditions. Mostly, the bacteria in the soil live around the plant roots. The bacteria in the humid and watery soil have flagella and can swim. Most bacteria that live in the soil are aerobic bacteria and they need oxygen to survive. Anaerobic bacteria which need no oxygen often can cause putrefaction of dead organism, and the saturated soil can be the right place for those anaerobic bacteria to dwell. Wetlands are regarded as important ecosystems which are transitional between open water and terrestrial ecosystems. In the wetlands, the main feature of the bacteria in the soil is anaerobic when the “soil is saturated and air is excluded from soil pores” (Scharf) and the characteristics/features should be shown on the surface or near the surface of the soil. The soil next to the chicken coop and goat fold are moist and there are plenty of other kinds of bacteria from animal’s excrement. The bacteria there should mostly be aerobic.

After I get the plates of Styrofoam out of the buckets of soil in the Green House, I will

observe using my naked eyes and then put them under the Scanning Electron Microscope to do the further and clearer observation. Scanning Electron Microscope (SEM) is a microscope which uses electrons to form an image and often used for medical and physical areas, under the SEM, scientists can see "a much bigger variety of specimens" (*Scanning electron microscope*, 2011). It can let more than one specimen to be observed at the same time, and the resolution is always higher than traditional microscopes. When I am working with SEM, I should make sure the specimens are in vacuum conditions, the water should be removed from the samples to make a perfect vacuum condition.

The project studied the Styrofoam-eating bacteria in the soil around the campus. The question was "is there any bacteria that can be good at dissolving Styrofoam under the certain temperature and time period among the bacteria in the soil near the goat fold, near the chicken coop or near the wetlands?" Our original hypothesis was the bacteria in the soil near the Chicken coop may do a better job at dissolving Styrofoam under the certain temperature and time period. Among the soil collected in three spots around the campus (Wetlands, Chicken coop and goat fold) we are going to observe under the Scanning Electron Microscope, there should be at least one plate of Styrofoam has changed its appearance, size and even colors. The independent variables are the plates of Styrofoam in the soil and the growing amount of bacteria after the fission in the soil. The dependent variables are the outside temperature and humidity in the Green House. My goal is to find out if there is a place where contains bacteria that can eat Styrofoam around the campus and which kind of bacteria it is.

Methods

1) Collected three buckets with the similar shape and volume. Washed them and dried them. Then marked each of them with letter A, B and C to separate them.
2) Brought the bucket A to the wetland spot at the intersection of SW Vermont Street and SW Nicol Road. Collected soil using the shovel.
3) Used the small shovel to avoid the rocks, grass and wood pieces in the soil.
4) Put one layer of soil near the wetland into the first bucket, the later is around 4 to 5 centimeters thick.
5) Count 15 pieces of Styrofoam and added them above the soil and tried to keep them state separately.
6) Covered them with another layer of soil.
7) Used the shovel to make the soil tighter so the space between the soil and the Styrofoam was smaller so the bacteria in the soil could get onto the Styrofoam easily.
8) Added another 15 pieces of Styrofoam onto the soil and then covered with another

later of soil. After that added another 15 pieces of Styrofoam and covered with soil. Added the last 15 pieces of Styrofoam on the soil and put soil above them to cover them.

9) Used the shovel to make the soil tighter again. Then spread some water above the soil. Put the bucket cover back on.
10) Used tape to wrap around the edge of the cover to prevent other bacteria from the outside to get in easily.
11) Brought the bucket B to the chicken coop and repeat the methods 3) to 10).
12) Brought the bucket C to the goat fold and repeated the methods 3) to 10).
13) Brought the three buckets to the green house.
14) Rinsed the shovels.

Results

1. The Styrofoam in the bucket with the soil near wetlands:

The top layer of 15 Styrofoam hasn't change at all, however, as I dug the soil out, the second top layer of 1t Styrofoam shrank a little bit and the color changes from original light green to the lighter green. Then the layer after that shrank more and the color was lighter. The bottom layer looked much smaller than the first layer of Styrofoam and the color was close to white plus green.

2. The Styrofoam in the bucket with the soil near chicken coop:

The observation was similar as the first one.

3. The Styrofoam in the bucket with the soil near goat fold:

The observation was similar as the first one.

The bottom layer is smaller because of shrinking as the mass of the soil above them give more pressure on them so they shrink. The color change may be caused by the water in the soil. **Not enough time for the research, only 1 week may not have any good results.**

(photo taken by Bonnie Wu)

Discussion

My question is "Is there any bacteria that can be good at dissolving Styrofoam under the

certain temperature and time period among the bacteria in the soil near the goat fold, near the chicken coop or near the wetlands?" And my hypothesis is the bacteria in the soil near the Chicken coop may do a better job at dissolving Styrofoam under the certain temperature and time period. The time limitation became a huge problem and it was very hard to get data from the Styrofoam in the soil. Most of them had changes in color and their size became smaller because of the pressure of the soil above them. Instead of data, I only got observations.

However there are still many findings that are interesting in my project. First, even though the soil is all from the places around campus, they still have very different humidity, thickness and the colors. The soil from the wetland is much wetter and darker than the soil from the goat fold. However the goat fold had thicker soil. Second, the changes of the color of those Styrofoam in the soil caught my attention: they all turned into lighter green. And the closer those Styrofoam was close to the bottom of the bucket, the lighter the color was. Unluckily, the changes in size might not because of the bacteria because there was a lot of air inside the Styrofoam, and the surface of those Styrofoam was not destroyed.

I know how to improve my design in the future: First of all, I will start the experiments much earlier so that there is enough time for bacteria to react with Styrofoam. And I should have enough time to look at those pieces of Styrofoam under Microscope for better observations. Also, the humidity of the soil for three spots was different so there may be more factors that may lead to the changes to the Styrofoam instead of the bacteria, or use Scale to get the mass of the Styrofoam. Also, if I have to make more changes, I would like to find many more small buckets but put one piece of Styrofoam with enough soil in each bucket so that soil can fully surround the Styrofoam and the bacteria can get to the Styrofoam. This time I don't have data but only observations because time limitations, but after improvements and changes, I may get a lot of data and more detailed and exact observations and results.

Future studies should explore soil from much more places which may contain special bacteria. I'm going to explore if there is a place around the campus that contains the bacteria that can really eat the Styrofoam. And I am also interested in study about the soil from one place, but collect the soil when the weather is different, and compare the difference between the effects of the soil with different temperature or humidity on the surface of the Styrofoam.

I know there are a lot of factors can affect the characteristics of bacteria and there may be different kinds of bacteria when it is sunny and rainy. I think this should also be my future study.

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