Analyzing the biodiversity of Formicinae ants as potential indicators of toxic heavy metal pollutants in the soil adjacent to the Long Island Sound through DNA barcoding

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Abstract

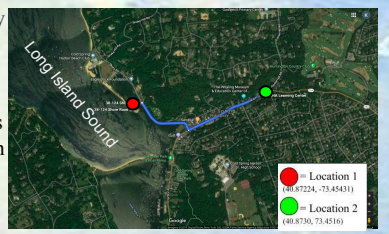
The purpose of this project was to determine whether heavy metal pollution is present in the sediment outside the Long Island Sound by using the biodiversity of Formicinae ant populations as bioindicators because of heavy metals' toxicity to human health. Formicinae samples were collected from both a coastal (Long Island Sound shoreline) and suburban location and analyzed using DNA Barcoding. Heavy metals were tested in this experiment. There was more biodiversity present in Formicinae ant subspecies at the suburban location in comparison to the coastal location implying heavy metal pollutants there although this could also be to collection location or circumstances.

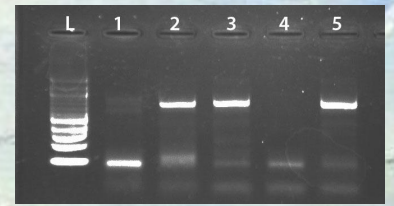
Introduction

This aim of this project was to determine whether heavy metal pollutants are present in the sediment lining the Long Island Sound using the biodiversity of Formicinae ant populations as bioindicators. By doing this, contaminated sediment on Long Island which negatively affects organisms living in this environment can be identified. Heavy metals, specifically lead, zinc, and mercury, are toxic to human health. They disrupt enzymatic activities, which negatively affects the brain and kidneys, interfere with metabolic processes, and lead to various disorders. If the Long Island Sound is polluted with heavy metal, the ground surrounding it may also be contaminated due to water seepage. This contamination may lead to decreased biodiversity of Formicinae in the area. Ants were used in this experiment because the Long Island Sound is inhabited by ants and humans, and ants can measure the quality of a coastal environment. This experiment can determine whether heavy metal pollution negatively affects the health of humans that are coming in contact with both variables.

Materials and Methods

Because only one species of Formicinae ants was found at the shoreline of the Long Island Sound coast and a sublocation further from the shore, the project was adjusted so the original coastal location could be compared to a suburban one. By doing this, the health of the coastline was more properly observed and the diversity of Formicinae ant populations was measured. Soil samples were also analyzed. The DNA barcoding procedure used in this experiment is from the Cold Spring Harbor DNA Barcoding website.






Ant #9


Ant #10


Ant #6


Ant #8

Results

There was more biodiversity present in Formicinae ant subspecies at the suburban location in comparison to the coastal location. Out of the five specimens collected at the coastal location, four were successfully analyzed and barcoded per the DNA Barcoding steps. These samples all proved to be part of the same species, Lasius neoniger, based off of what was initially guessed observed phenotypically (refer to tables 1 and 2). This conclusion was confirmed using DNA Subway and nucleotide BLAST analyzation. Five specimens were collected at the suburban location; however, barcoding analysis of the samples proved insufficient. This could be potentially due to errors with storing the ants or problems with DNA extraction. As a control, phenotypic observations were made showing varied Formicinae subspecies. References to scientific databases were also made in order to draw conclusions. After referring to the images taken of the suburban location specimens and with the aid of a taxonomist at the Cold Spring Harbor DNA Learning Center, a few of the ant subspecies that appeared to have been collected include: Prenolepis imparis (Ant Specimen #8), Formica lasioides (Ant Specimen #9), and Lasius neoniger (Ant Specimen #6). This conclusion is supported by the previously mentioned databases lists of Formicinae ant subspecies in New York.

Ants #1,3,5 Species	*% Identical*
Lasius niger	**100.00%**
Lasius sp.	**100.00%**
Lasius neoniger	**100.00%**
Lasius alienus	**99.96%**

Ant #3 Species	*% Identical*
Lasius niger	**99.69%**
Lasius sp.	**99.69%**
Lasius neoniger	**99.69%**
Lasius alienus	**99.37%**

Discussion

It was hypothesized that there would be limited to no biodiversity due to the coastal location's proximity to the Long Island Sound as a result of heavy metal pollution presence in the soil. This findings of this experiment proved the hypothesis to be correct, as only the Lasius neoniger species was found at the coastal location. Although the samples collected at the suburban location did not analyze, it could be noted that the ants appeared to be different species based off of phenotypic observations. Additionally, scientific databases such as AntWiki and Ant Maps have further cataloged there being dozens of Formicinae subspecies living on Long Island. This lack of diversity on the coast therefore leads to a belief that outside influences such as heavy metal pollution. Increased biodiversity was present further away from the coastline of the Long Island Sound at the suburban location. The main difficulty encountered in this experiment was the gathering of only one species of ant at the original coastal location. To further test the hypothesis and identify potential heavy metal pollution in the soil surrounding the Long Island Sound coast and the effect of the presence of ants there, a soil sample analyzation and a more expansive ant collection would be beneficial.

References: *"Heavy Metals in Sediment."; "Lead Concentrations in Sediment by Basin."; Ammerman; Bates; Brevik, Burgess; Jaishankar, Monisha, et al.; "Carpenter Ant."; "Heavy Metal Pollution Disturbs Immune Response in Wild Ant Populations."; Nummelin, Matti, et al.; Skaldic, et al.; Sorvari, Jouni, et al; "Seepage."*

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