How Fertile Is our Soil?:

Students Find DNA Barcodes of Worms From Van Cortlandt Park

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Abstract

This experiment tested the various species and possibly subspecies of earthworms present in Van Cortlandt Park. Our main goals were to find how many different species and subspecies of earthworms live in Van Cortlandt Park and to find where these types of earthworms live. In addition we tried to find what kind of environments they live in so we could conclude the small adaptations each species or subspecies has made to the environment or what about that environment caused the species or subspecies to concentrate there. We know that although Van Cortlandt Park is very large and has different environments, they are still pretty similar, so we looked at environment on a smaller scale such as the plants that grow around there and if there is a pond nearby as opposed to the mountains or oceans it is near.

Introduction

Although earthworms are an important part of the North American ecosystem today, they are not actually a Native species. In reality, earthworms were brought over when the British colonized the Americas. The worms themselves were accidentally shipped with the importation of British goods and quickly took over the American landscape. In the present day, they play a pivotal role in many ecosystems through their contributions to the soil. Having over 6,000 species worldwide, there are more than 180 species of earthworms in America, 60 of which are invasive such as the night crawler. Earthworms help the environment by allowing air and water into the soil through the holes that they dig as well as breaking down matter such as leaves that are then usable materials for plants. They also leave behind waste that can act as a fertilizer for soil it travels through. Van Cortlandt Park, is a New York State Park in Riverdale. It contains many playing fields, gardens, trails, and a lake; all of which create ecosystems of their own. The purpose of our experiment was to discover the distribution and variety of earthworms in separate locations throughout Van Cortlandt Park and to find the correlation between earthworm species, and plant life. We hypothesised that the areas with the most vegetation would be home to the *Eisenia fetida* species of earthworm because that species is the best at fertilizing soil.

Materials & Methods

For our experiment, we collected earthworms from Van Cortlandt Park. To collect our samples, we overturned rocks and leaves, and dug lightly into the soil (with a gardening spade) to extract Earthworms from the ground. After finding an earthworm, we documented the location from where it was extracted within the park, and what the environment was like using pictures. Additionally, we labeled each specimen by number so that we knew which species were found where after the DNA data is processed. We took the specimen back to the lab (at our school) in a small styrofoam cooler and once in the lab, we began to isolate the DNA from the earthworms. The PCR products isolated were analyzed through gel electrophoresis. The results from the gel electrophoresis were sent to The Urban Barcode Project to be sequenced. Finally, we used the DNA Subway and bioinformatics to analyze our results and identify the species of earthworms.

Our research question was answered by recording detailed accounts of the plant life in the ecosystem of each earthworm was found. This was done so that once we got our results, we could relate the species of earthworm to the vitality of the plant life.

Earthworm Extraction Sites

JZS-009 Ecosystem

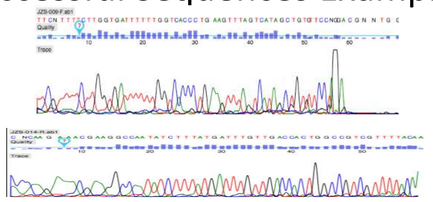
JZS-014 Ecosystem

Results

Although there was some trouble sequencing parts of the DNA for each sample, a good amount of genomes were still able to be identified. Two out of a total seven samples had identifiable DNA on both strands and another three had one identifiable strand . The samples were denoted JZS-009 up to JZS-015. Samples JZS-009 and JZS-011 were the two where both the forwards and reverse strands were able to be identified as well as the forward strand of JZS-013, the forward strand of JZS-015, and the reverse strand of JZS-014. These identifiable strands were then compared to known sequences of different species of invertebrate to determine which species the sample's DNA was similar to. The first sample that had similar DNA to other earthworm species, JZS-011, showed BLAST hits with *Amynthas corticis*, *Amynthas homochaetus*, *Amynthas heterochaetus*, *Amynthas sp.*, *Amynthas diffringens,* and *Megascolecidae sp.* This sample was found in an area near a footbridge in dark, wet soil with heavy plant life. There was a small marsh on one side, but the surrounding area was covered in leaves. The second sample with BLAST hits similar to other earthworm species, JZS-014 R, showed commonalities with the DNA sequences of *Cyanea sp.*, *Aniculus aniculus*, and *Eukrohnia hamata*. This sample was found in a patch of thin grass next to a section of the pond. There were few other plants aside from the grass. The tree below suggests the relations of the identifiable samples to each other.

Phylogenetic Trees

Successful Sequences Examples



Discussion

Our research question was what is the correlation between the species of earthworm living in the soil and how fertile the plant life is throughout different ecosystems of Van Cortlandt Park. To answer this we sequenced the DNA of 7 earthworms from 2 different ecosystems of the park. Our hypothesis was not supported by our results because none of the earthworms were of the species *Eisenia fetida*. In addition, many of our samples did not produce clear DNA sequences and therefore could not be identified. This can be attributed to experimental errors during the DNA extraction and amplification processes.
Our positive results suggest that the soil containing earthworms of or most similar to the species *Amynthas corticis*, *Amynthas homochaetus*, *Amynthas heterochaetus*, *Amynthas sp.*, *Amynthas diffringens,* and *Megascolecidae sp* is more fertile than soil containing earthworms of the species *Cyanea sp.*, *Aniculus aniculus*, and *Eukrohnia hamata.*
Further studies could attempt to support our findings by completing the process in reverse. For the experiment, we would place earthworms of different species in different locations under identical conditions and observe which ecosystem produced the most plant life; this experiment could give support to our claim that the earthworms are causing the fertility.

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