Odonata Diversity in Van Cortlandt Park

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Abstract

Dragonflies and damselflies are integral parts of lake and pond ecosystems throughout the world. The goal of this study is to identify the numerous species of dragonflies and damselflies in different parts of Van Cortlandt Park. Twenty-six samples were collected, gel electrophoresis was run on all 26 samples, and 12 samples had results. Of those 12 samples, there were 10 results identifying Odonates from their DNA sequences. Two dragonfly species and two damselfly species were discovered in Van Cortlandt Park.

Introduction

- Dragonflies and damselflies are part of an order of species called Odonates, consisting of both Anisoptera (dragonflies) and Zygoptera (damselflies).
- There are over 7,000 species of dragonflies and 3,000 species of damselflies
- Odonates live on every continent but Antarctica, mostly in tropical regions
- In New York, where the experiment was conducted, there are around 200 species of Odonates (Gilbert and Fawcett, 2021).
- Odonates are predators, and eat tadpoles, minnows, worms, and crustaceans (Encyclopedia Britannica, 2020).
- Odonates are usually around ¼- 2½ inches as nymphs and can grow to 1.5-4 inches by adulthood.
- Dragonflies can fly up to 35 miles per hour (National Geographics, 2021).
- Odonates are aquatic species and their eggs, which are laid in the water, hatch in 7 or 8 days, becoming nymphs that can live in the water for up to 3 years.
- In their adult state, Dragonflies can live for anywhere between a week to six months (Nikaci, 2022).
- Damselfly adults can be red, blue, and yellow among other colors.
- In nymph state, damselflies are mostly a tan or brown color.
- Damselfly nymphs breath from three gills on the ends of their tails
- The main difference between damselflies and dragonflies are that damselflies are lighter, more delicate, and able to fold their wings up when resting (Wikipedia, 2021).
- Damselflies' eyes are located on the sides of their heads while dragonflies' eyes are on the top of their heads (Bioweb, 2021).

Materials and Methods

- **Collecting Samples**: A trip was taken to Van Cortlandt Park on October 14, 2021 to collect Dragonfly and Damselfly nymphs. They were then placed in 1.5 ml Test tubes filled with ethanol to be euthanized and preserved.. (Specimens were logged by location)
- **Water quality tests** were run to determine conditions such as pH levels, lead levels, nitrites, and temperature.
- **Extracting DNA:** Samples were individually ground up and lysis solution was added and then samples were centrifuged. Silica Resin, wash buffer, and then distilled water were added. The supernatant was then transferred to a fresh tube to be stored.
- **Amplification of DNA:** An invertebrate COI primer set number was used for DNA amplification by PCR. The tubes were then put in a thermal cycler for programmed sequence.
- **Gel Electrophoresis:** Once a 2% agarose solution had been solidified in the tray, it was placed into the chamber with 5 µL of the newly amplified DNA. The gel was run and then was photographed (using UV transillumination).
- **DNA Sequencing and Analysing:** Once the DNA has been sequenced, DNA subway was used to see how many different species of dragonfly and damselfly nymphs were found.

Results

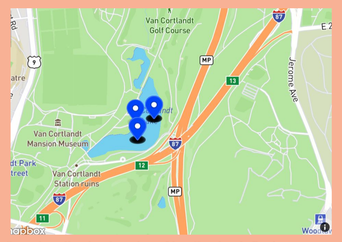

Figure 1. Sample collection location - Van Cortlandt Park
The pins on this map represent three different locations where samples were collected in the park. That being said, there were more than three locations where samples were found. The other locations however are too close to these three distinct places on the map to appear as different pins.

all measurements are in pp	Oak Tree Pond (Location 1)	Under Bridge (Location 2)	Marsh near bridge (Location 3)	Bald Cypress (Location 4)	Creek by Bald Cypress (Location 5)	Road with golf carts (across from site 1) (Location 6)
pH	6.5	6.5	6.5	7	6.5	6.5
Hardness	100	50	250	100	50	100
Hydrogen sulfide	0.5	0	1	0	0	0
Iron	0	0	0.5	0	0	0
Copper	0.5	1	0	0.5	0.5	0
Lead	0.5	30	0.5	30	0	15
Manganese	0	0	0	0	0	0
Total Chlorine	0.5	0.5	0.5	0	0	0.5
Free Chlorine	0.5	0.5	0.5	0	0	0.5
Nitrate	0	0	5	0	0	0
Nitrite	0	0	0.5	0	0	0
Sulfate	0	0	0	0	0	0
Zinc	5	5	5	0	0	0
Fluoride	0	4	2	4	0	0
Sodium Chloride	0	50	0	50	0	1
Total alkalinity	80	120	120	120	0-40	0-40
Temperature	23 C close to shore and 20 C about 3 ft deep		18 C		18 C	22 C

Table 1. Water Quality Results.
Water quality results for the locations where samples were collected in Van Cortlandt Park. Unfortunately, these data do not provide much information to make conclusive conjectures about water quality's effect on Odonata diversity given that the results are pretty much the same throughout the different locations.

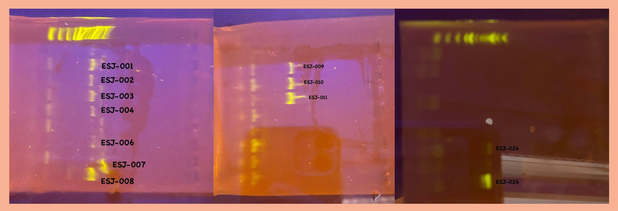

Figure 2a/2b/2c. Gel Electrophoresis results.
Results of all gel electrophoresis tests. Fig. 2a, Fig. 2b, and Fig 2c were taken on 2/17/21

Sample ID	Species	Bitscore	e	Mismatches
ESJ-001	Pachydiplax longipennis isolate	931	0	2
ESJ-002	Ischnura verticalis voucher	922	0	0
ESJ-003	Enallagma antennatum voucher	682	0	46
ESJ-004	Ischnura verticalis voucher	915	0	0
ESJ-008	Erythemis simplicicollis voucher	1047	0	4
ESJ-010	Pachydiplax longipennis voucher	1036	0	5
ESJ-011	Pachydiplax longipennis voucher	797	0	3
ESJ-026	Erythemis simplicicollis voucher	87.8	2e-15	2

Tabel 2. Results of DNA sequencing.
The results on the dragonfly and damselfly species were collected at Van Cortlandt Park. Pachydiplax Longipennis was identified three times, Ischnura Verticalis was identified twice, Enallagma Antennatum was identified once, Erythemis Simplicicollis was identified twice, and Latrodectus Hesperus was identified twice.

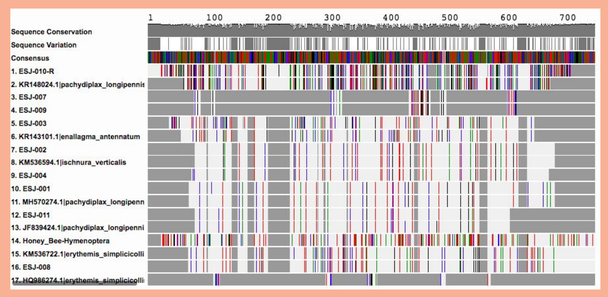

Figure 3. Untrimmed Multiple Alignment Created by MUSCLE.
In the 700bp of sequence conservation pictured here, the different colors here represent the different nucleotides. The top two bars show sequence conservation (shown in gray) and sequence variation (shown in white).

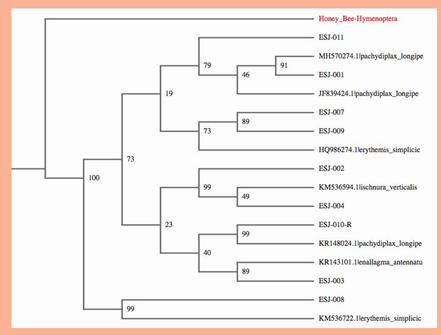

Figure 4. Phylogenetic Tree of Sequencing Results. Phylogenetic tree of samples which were identified (excluding sample ESJ-026) and the BLAST hits for this project. Outgroup here is a honey bee.

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Discussion

- Overall, eight out of the 12 DNA sequences sent to the lab matched either that of a dragonfly or damselfly.
- Two species of damselflies and two species of dragonflies were identified.
- All samples except for ESJ-003 and ESJ-026 had mismatches of 5 or below and bit scores of over 900

Two damselfly species found:

- Two samples were identified as Ischnura Verticalis
- One sample was identified as Enallagma Antennatum
- Both species are part of the Coenagrionidae family.

Two dragonfly species found:

- Three samples were identified as Pachydiplax Longipennis
- Two samples were identified as Erythemis Simplicicollis
- Both species of dragonflies are part of the Libellulidae family.

Errors

ESJ-003

- This sample (Enallagma Antennatum) had both the highest number of mismatches at 46 and the second-lowest bit score at 682
- There were many inconsistencies when comparing the expected Enallagma sequence in the MUSCLE to this sample
  - Caused by low-quality readings for sample's nucleotides

ESJ-010

- Only the reverse direction was read for this sample (which had 5 mismatches and a bit score of 1036)
  - This means there may have been errors in these readings.

ESJ-007, ESJ-009, and ESJ-026

- These samples were very short, meaning that the samples were not able to be trimmed before BLAST tests were run.
  - This means that these readings might also not have been accurate.
- Sample ESJ-007 and ESJ-009 were both identified as Latrodectus Hesperus voucher, a species of a western black widow spider.
- These results are very unlikely as the sequences which these readings came from were short and fairly degraded.
- Therefore, these results are not to be trusted and these specimens have been most likely misidentified.

ESJ-026

- When making the phylogenetic tree for these results (Fig. 4), sample ESJ-026 was omitted because it was such a poor sequence.
- The bit score for this sample was 87.8.

Overall

➔ **Sample identifications**: Sample identifications can be trusted for this experiment given that the Odonata species which were identified are commonly found in the areas where samples were collected.

➔ **Phylogenetic tree**: Sequences were not long enough for a phylogenetic tree to be able to identify how the different species found are related. For example, ESJ-010 and ESJ-011 were both identified as Pachydiplax Longipennis, but they do not appear closely related in the tree (Fig. 4).

➔ **Water samples**: Results were pretty similar throughout locations. That being said, sites 2 and 4 (Under the Bridge Location and Bald Cyprus Location) had higher levels of sodium chloride (50ppm) than all other locations. It has been shown that sodium chloride (in the form of road salts) degrades the immune system of dragonflies (Mangahas, Murray, and McCauley, 2019). None of the samples collected at these sites were identified as either dragonflies or damselflies, meaning these data can not be used to make conjectures about whether sodium chloride levels affect biodiversity.

➔ **In the future**: Larger sample sizes should be used to gain a clearer understanding of Odonata biodiversity in Van Cortlandt Park. Such a small sample size leaves ample room for error and the influence of chance, meaning that the results outlined here can not be truly used to represent the diversity of damselfly and dragonfly species in Van Cortlandt Park.

These References did not fit on the poster, so we are planning on printing them out on a separate sheet of paper and putting it on our table or the back of our posterboard

Additional References

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