Citizen Science Uncovers Relationships between *Monotropa uniflora* and Arthropods

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Abstract

Citizen science is an underutilized practice that engages the public to aid in research. This relationship between researchers and citizen scientists is important as it builds understanding and trust in science and helps advance research in ways otherwise not possible. Here citizen scientists from different areas of the United States helped in locating and collecting a strange plant called Ghost Pipes or *Monotropa uniflora (Ericaceae: Monotropoideae).* These samples were dissected to better understand the arthropods associated with this ephemeral plant. This work expands on Arthropods such as Thrips and caterpillars known to be associated with the plant and for the first time reports others such as ants, mites, and spiders. These findings help to better understand this ghostly plant's ecology and shed light on how it fits into its local ecosystem.

Introduction

Ghost Pipes or *Monotropa uniflora* are hyperparasitic and steal their nutrients from parasitic fungi in the family Russulaceae. Spending most of their time below ground, they send white, ghostly flowers which last above ground for 1-2 weeks.

Thus, little is known about the plant's ecology. Focusing on pollinators, only three papers have recorded arthropods on their flowers. ***Therefore, this study utilized a mass sampling effort from citizen scientists to investigate what arthropods are associated with Ghost Pipes hypothesizing a wider range of arthropods to be associated with the plant than previously recorded.***

Fig 1. Ghost Pipes or Monotropa uniflora flowers.

Methods

We obtained 283 samples from citizen scientists across the United States via iNaturalist. Under our guidelines, these citizen scientists sampled a section of the *M. uniflora* flowers, leaving the rest to not excessively harm the plant, and sent them to us in 70%+ alcohol.

In the lab, we placed each sample into clean 95% ethanol and collected any arthropods found floating in the ethanol. We then carefully dissected the flowers under a microscope and collected any arthropods found among their petals and interiors. Specimens were then sorted by major taxon levels, e.g., Order or Family, recorded, and placed in a -80°C freezer for preservation and future study.

Fig 2. Freshly collected M. uniflora by a helping citizen scientist.

Fig 3. M. uniflora in 95% ethanol prepared for dissection.

Citizen scientists donated *M. uniflora* samples from all over the USA, but primarily from the Midwest, following the distributional patterns of the plant. Additionally, we also received and processed some samples from the East Coast and Pacific Northwest.

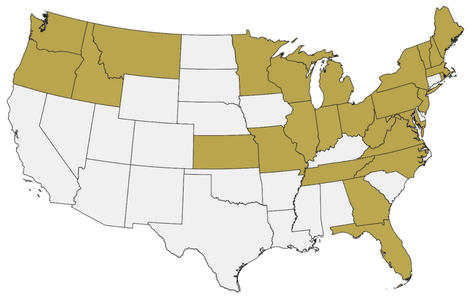

Fig 4. Distributional map with yellow indicating the states citizen scientists' collected from in the United States.

Results

The bar graph is an indicator of the different arthropods that were found within and around the M. uniflora. The two most found insects that were found in this study were Thrips and caterpillars. Inside the plant, 93 caterpillars were documented the most. However, 142 Thrips were found outside the plant which doubled any other species recorded.

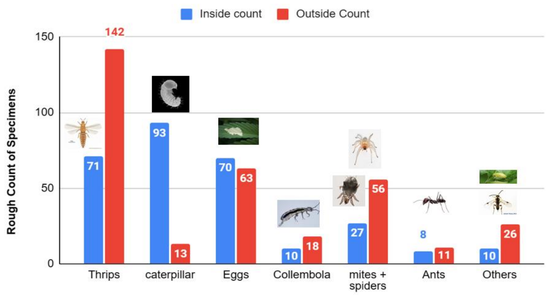

Fig 5. The cumulative abundances of various arthropods found in M. uniflora samples at different locations. Blue indicates the inside of the flower and Red indicates the outside of the flower.

After analyzing the specimens, **Table 1** below showcases the identified arthropods to order and to family. Thysanoptera: Terebrantia had the highest quantity at 213 that was collected from the M. uniflora. Collembola was the second highest with a total of 30 specimens recorded.

Table 1: Identified Arthropods to Family

Order	Family	Quantity
Arachnid	Dictynidae	1
	Unknown	5
	Total	**6**
Collembola	Entomobryidae	7
	Isotomidae	10
	Onychiuridae	10
	Unknown	3
	Total	**30**
Hemiptera	Cicadellidae	1
	Diptera	1
	Aphidae	4
	Total	**6**
Hymenoptera	Chalcidoidea	1
	Total	**1**
Thysanoptera	Terebrantia	213
	Phalaeothripidae	4
	Total	**217**

Discussion

Citizen science not only aided in addressing our questions but also promoted science in the public as well. People from all walks of life, from middle school Bioblitz teams to medical doctors helped with samples and we found many new arthropods associated with Ghost Pipes. Any person, no matter what age can participate in science from all walks of life. Citizen science brings new ideas to the table and to learn from these ideas. ***Confirming our hypothesis that this demonstrates great diversity in arthropods associated with ghost pipes***; however, the role and association of many of these arthropods with the plant is unknown. The results shows, Thrips and Collembola are associated with the M. uniflora the most. Others like Dipterans, Arachnids, etc. were found around this plant fewer times. Some could be pollinators while others could use it as a host or feeding ground and further study into this enigmatic system is warranted. Other future directions for this study include setting up an iNaturalist page to showcase our findings and the citizen scientists, more precise species identifications provided by group specialists, and investigations into habitat preferences for the plant and occupying arthropods. Through this, we hope to both demonstrate the power of citizen science and to better understand this biological system.

References:

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