

Documenting Invasive Leaf Miner and Host Preference on Ulmus
Genus

Richard Megarry, Nathan Stockbridge, and Riya Patel

ABSTRACT

Leaf Miners are insects that can cause damage to the plant populations they target. These insects feed on the mesophyll inside of leaves, and leave the leaf vulnerable to infection (Bernardo et. al 2015). Over time, this can destroy the populations of the host plants. A leaf miner, likely to be *Stigmella multispicata*, was found infesting a Resistant American Elm (*Ulmus Americana*). The only known host for *multispicata* is the Siberian Elm (*U. pumila*), which suggests that this insect has swapped hosts. We aim to collect data on all *Ulmus* present on the University of Massachusetts Amherst campus and determine the presence of leaf miners, and the characteristics of infected leaves. We intend to sample two trees of every species, as far apart as possible on campus, as well observe the mine locations relative to the symmetry of the leaves in order to understand the selection tendencies of the leaf miner. It is important to document and understand these invasive insects because of the possible threat they represent to Elms. The possibility for

leaving the elms susceptible to infection, while already being under threat of the dutch elm disease, makes the careful observation of such insects necessary in order to insure the continued existence of the Elm.

SPECIFIC AIMS

Overall objective

To select different Elm species for sampling on the University of Massachusetts Amherst campus in order to obtain data on the leaf mining insects that infest them, as well as to help understand the oviposition habits of these insects.

Specific Aim 1

To sample each species of Elm present on the UMass Amherst campus, and to survey them for leaf mining insects. In the preliminary work, leaf miners were found inhabiting a resistant American Elm (*U. americana*). This leaf miner is likely to be *Stigmella mulltispicata*, however, they have only been observed on Siberian Elms (*U. pumila*) We will attempt to screen a sample of each Elm species on campus in order to observe the host swapping behavior of this leaf miner.

Specific Aim 2

To categorize infected leaves and identify factors related to the predation of infected leaves. The literature suggests

that leaf miners have a specific oviposition tendency based upon the structure of the leaf (Apape 1995). As we collect data on the leaf miners, we want to confirm this phenomenon while also analyzing for other contributing factors.

BACKGROUND

Leaf miners are insects that eat the tissues of plants in their larval stages (Christiano, 2007). They feed on the leaf tissue between the upper and lower surfaces (Christiano, 2007). Most leaf miner tunnels are referred to as serpentine mines, consisting of thin, winding, whitish trails, or as blotch mines which are broad and whitish or brownish in color (Møller, 1999). These mines are a sign of infestation, which can cause the leaves and the entire plant to turn brown by late spring (Walkzac et. al, 2018).

Leaf miners feed on the tissues in between the outer layers of leaves causing them to turn brown and the leaf to decay. Damages can be found on broadleaf trees, including elm trees, aspen, hawthorn, and poplar as well like shrubs and bushes, including lilacs. Damage can be limited in certain stages of infestations, but the damage can increase as leaf miner numbers multiply, and can lead to the death of the host plant (Christiano, 2007; Bernardo et. al 2015). This can be caused by

the leaf miners weakening the leaves and allowing pathogens routes inside of the leaf. Leaf miners can cause poor harvest numbers in gardens by weakening vegetable plants (Christiano, 2007). These insects are able to successfully colonize new host plants based upon factors such as the phylogenetic relatedness to the old host, and the structure of the leaves in the new host (Walczak et al. 2018).

The aim of this study is to sample each species of Elm (Ulmus) present on the UMass Amherst campus, and to survey them for leaf mining insects and to categorize infected leaves and identify factors related to the predation of infected leaves. We will attempt to screen a sample of each Elm species on campus in order to observe the host swapping behavior of this leaf miner. As we collect data on the leaf miners, we want to confirm this phenomenon while also analyzing for other contributing factors. Our hypothesis is that asymmetrical leaves will have leaf miners while symmetrical leaves will not have leaf miners.

RESEARCH DESIGN

Specific Aim 1

To sample each species of Elm present on the UMass Amherst campus, and to survey them for leaf mining insects.

Approach and Analysis

This experiment aims to sample leaves from every available Elm on the University of Massachusetts Amherst campus. There are currently 293 Elms on campus, and 16 unique species. Two of each Elm species will be searched for evidence of leaf miners by observing an accessible branch of the tree. The branch will be searched for leaf miners on the last foot of the branch. All observed leaf miners will be removed from the infected tree. The leaves will be kept in a bag marked with the specific identification of the tree.

Specific Aim 2

To categorize infected leaves and identify factors related to the predation of infected leaves.

Approach and Analysis

After obtaining a collection of infected leaves, we intend to check the symmetry of the vein placement on the midrib of the leaf relative to where the leaf miner was found. If the vein is staggered, the measurement will be taken to the next closest vein. It will be noted what type of vein, staggered or in line, the mines cross on each infected leaf. An Analysis of this data will be made to notate trends in leaf miner behavior regarding these symmetrical traits.

SIGNIFICANCE

Invasive pest species can cause the health of host plants decline and eventually result in the death of host plant. It is important to track the ability of invasive species to infect new hosts in order to gain an understanding of any pest control measures that must be taken. Our study intends to provide data on one such pest, and possible factors that may provide insight into the patterns by which these insects select their host. This information may prove useful to future researchers in determining the prevalence and threat these insects may pose to *Ulmus* genus, and aid in the development of protective measures.

REFERENCES

- Bernardo U, van Nieuwerkerken EJ, Sasso R, Gebiola M, Gualtieri L, Viggiani G. 2015. Characterization, distribution, biology and impact on Italian walnut orchards of the invasive North-American leafminer *Coptodisca lucifluella* (Lepidoptera: Heliozelidae). *Bulletin of Entomological Research*. 105(2): 210-224
- Christiano, R. S. C., Dalla Pria, M., Jesus Junior, W. C., Parra, J. R. P., Amorim, L., & Bergamin Filho, A. 2007. Effect of citrus leaf-miner damage, mechanical damage and inoculum concentration on severity of symptoms of Asiatic

citrus canker in Tahiti lime. Crop Protection. 26(2):
59-65.

Møller, Anders Pape. 1995. Leaf-Mining Insects and Fluctuating
Asymmetry in Elm *Ulmus glabra* Leaves. The Journal of Animal
Ecology. 64(6): 697.

Møller, Anders Pape. 1999. Elm, *Ulmus Glabra*, Leaf Asymmetry and
Dutch Elm Disease. Oikos. 85(1): 109-116.

Walczak U, Bogdziewicz M, Zytowski R, Karolewski P, Baraniak E.
2018. Maladaptive host choice by an alien leaf miner
Phyllonorycter leucographella (Lepidoptera: Gracillariidae)
has the potential to limit its invasiveness. European
Journal of Entomology. 115: 318-325.

Unformatted Writing, Kept for group use purposes

General Group Notes/Suggestions

Specific Aims Working Draft

Overall objective: To select different Elm species for sampling on the University of Massachusetts Amherst campus in order to obtain data on the leaf mining insects that infest them, as well as to help understand the oviposition habits of these insects.

Specific Aim 1. To sample each species of Elm present on the UMass Amherst campus, and to survey them for leaf mining insects. In the preliminary work, leaf miners were found inhabiting a resistant American Elm (*U. americana*). This leaf miner is likely to be *Stigmella Multispicata*, however, they have only been observed on Siberian Elms (*U. pumila*) We will attempt to screen a sample of each Elm species on campus in order to observe the host swapping behavior of this leaf miner.

Specific Aim 2. To categorize infected leaves and identify factors related to the predation of infected leaves. The literature suggests that leaf miners have a specific oviposition tendency based upon the structure of the leaf (Apape 1995). As we collect data on the leaf miners, we want to confirm this phenomenon while also analyzing for other contributing factors.

SPECIFIC AIMS

****To collect data on leaf miners infesting elm trees, this would include trying to identify them in the book, and cataloging them**

****To collect general data on elm leaves, this is probably mostly through literature, however, we can still go and make observations**

****To try and discern the causes behind the different leaf miners, with specific interest on the *stigmella multispicata* and the trees it may or may not have affected, this includes the different types of elms but we may also consider searching the nearby trees for evidence of the miner as well**

The main goal is to see if a symmetric leaf has leaf miners or an asymmetrical leaf has leaf miners. ((They said in the article that asymmetrical leaves have leaf miners- we need to experiment this))

BACKGROUND - I say we make this an annotated bibliography and when we're ready we can almost just pull everything from the summaries

From the book - Background section provides context by describing what is presently known. Funnel large contextual background to the subject of the study in this format

Background/known

Unknown/problem/need

aim/hypothesis

Need (the convincing part of why its important we do this)

summary(optional)

Information order: leaf miners in general, leaf miner *multispicata*, the different elms

Unknown: host swapping of *multispicata*, and leaf miners of elms,
oviposition habits

Aim: to identify and categorize leaf miners and oviposition based on
symmetry

Leaf miners are made by a number of species of insects in which the larval stage eats the tissue of the plant (Christiano, 2007). They feed on the leaf tissue between the upper and lower surfaces (Christiano, 2007). Most leaf miner tunnels are referred to as serpentine mines, consisting of thin, winding, whitish trails, or as blotch mines which are broad and whitish or brownish in color (Møller, 1999). These mines are a sign of infestation, which can cause the leaves and the entire plant to turn brown by late spring (Walkzac et. al, 2018).

Leaf miners feed on the tissues in between the outer layers of leaves causing them to turn brown and the leaf to decay. Damages can be found on broadleaf trees, including elm trees, aspen, hawthorn, and poplar as well like shrubs and bushes, including lilacs. Damage can be limited in certain stages of infestations, but the damage can increase as leaf miner numbers multiply, and can lead to the death of the host plant. ****More Sources, Strong... statement** (Christiano, 2007; Bernardo et. al 2015). This can be caused by the leaf miners weakening the leaves and allowing pathogens routes inside of the leaf. Leaf miners can cause poor harvest numbers in gardens by weakening vegetable plants. ****More Sources, Strong... statement** (Christiano, 2007).

****Transition about elm miners****

The aim of this study is to sample each species of Elm (Ulmus) present on the UMass Amherst campus, and to survey them for leaf mining insects and to categorize infected leaves and identify factors related to the predation of infected leaves. We will attempt to screen a sample of each Elm species on campus in order to observe the host swapping behavior of this leaf miner. As we collect data on the leaf miners, we want to

confirm this phenomenon while also analyzing for other contributing factors. Our hypothesis is that asymmetrical leaves will have leaf miners while symmetrical leaves will not have leaf miners.

WALCZAK U, BOGDZIEWICZ M, ZYTKOWIAK R, KAROLEWSKI P, BARANIAK E.

Maladaptive host choice by an alien leaf miner *Phyllonorycter*

leucographella (Lepidoptera: Gracillariidae) has the potential to limit its

invasiveness. European Journal of Entomology [Internet]. 2018 ;115:318 - 325.

Available from: <http://www.eje.cz/doi/10.14411/eje.2018.031.pdf>

Discusses a preference for leaf miners with regard to Specific Leaf Area and a small method for it.

Miller Apape. Leaf-Mining Insects and Fluctuating Asymmetry in Elm *Ulmus glabra* Leaves. The

Journal of Animal Ecology [Internet]. 1995 ;64(6):697. Available from:

<https://www.jstor.org/stable/5849?origin=crossref>

Møller, Anders Pape. "Elm, Ulmus Glabra, Leaf Asymmetry and Dutch Elm Disease."

Oikos, vol. 85, no. 1, 1999, pp. 109–116. *JSTOR*, www.jstor.org/stable/3546796.

Christiano, R. S. C., Dalla Pria, M., Jesus Junior, W. C., Parra, J. R. P., Amorim, L., & Bergamin Filho, A. (2007). Effect of citrus leaf-miner damage, mechanical damage and inoculum concentration on severity of symptoms of Asiatic citrus canker in Tahiti lime. *Crop Protection*, 26(2), 59–65. <https://doi.org/10.1016/j.cropro.2006.03.016>

Goes into detail about the symmetrical and asymmetrical properties of the leaves and how leaf miners are more common on the asymmetrical leaves.

RESEARCH DESIGN

- Systematically check elm trees throughout campus, develop a sampling system perhaps look at all the leaves on a set number of branches and categorize activity that way? I saw a paper that deemed it necessary to rate the leaves locations from the trunk should we define sections either fractionally or with set distance and catalog that information as well?
- Sample leaves for surface area/ density with procedure from Walczak, which had density weighed on leaves next to leaf miners as to get pre infected values

- Note leaf symmetry on any infected leaf? You have both read that paper and I have not but I feel like we should just be cataloging infected leaves in their general properties as they are the ones that got infected presumably for their structure
- Catalog all data and look to see relationships if any for the various leaf miners and trees?

RESEARCH DESIGN DRAFT

Specific Aim: To sample each species of Elm present on the UMass Amherst campus, and to survey them for leaf mining insects.

Approach and Analysis: This experiment aims to sample leaves from every available Elm on the University of Massachusetts Amherst campus. There are currently 293 Elms on campus, and 16 unique species. Two of each Elm species will be searched for evidence of leaf miners by observing an accessible branch of the tree. The branch will be searched for leaf miners on the last foot of the branch. All observed leaf miners will be removed from the infected tree. The leaves will be kept in a bag marked with the specific identification of the tree.

Specific Aim: To categorize infected leaves and identify factors related to the predation of infected leaves.

Approach and Analysis: After obtaining a collection of infected leaves, we intend to check the symmetry of the vein placement on the midrib of the leaf relative to where the leaf miner was found. If the vein is staggered, the measurement will be taken to the next closest vein. It will be noted what type of vein, staggered or in line, the mines cross on each infected leaf. An Analysis of this data will be made to notate trends in leaf miner behavior regarding these symmetrical traits.

IMPACT or SIGNIFICANCE

Invasive pest species can cause the health of host plants decline and eventually result in the death of host plant. It is important to track the ability of invasive species to infect new hosts in order to gain an understanding of any pest control measures that must be taken. Our study intends to provide data on such pest, and possible factors that may provide insight into the patterns by which these insects select their host. This information may prove useful to future researchers in determining the prevalence and threat these insects may pose to Ulmus genus, and aid in the development of protective measures.

ABSTRACT