

# SEARCHING FOR STREPSIPTERA: Museomics in the study of host-parasite relationships

RJ Millena

 AMERICAN MUSEUM  
OF NATURAL HISTORY



AMNH\_IZC\_004075





# Outline

Strepsiptera & Challenges

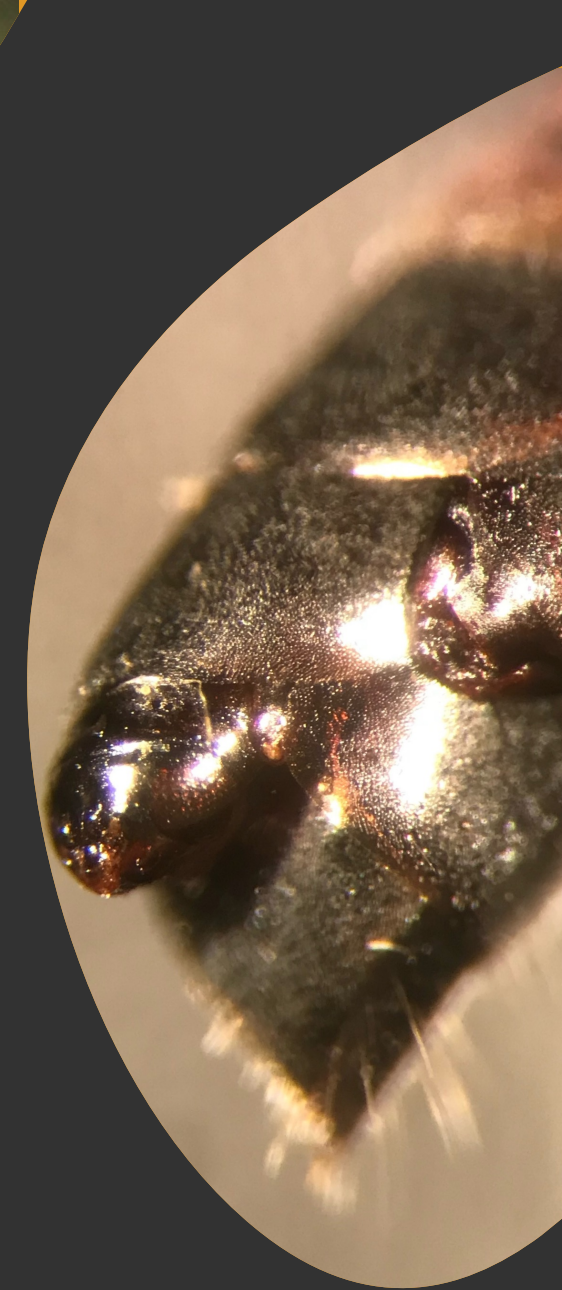
Ecological and Biological Questions

Museomics & Evolutionary Questions

Planned Work



Image by Maria (rockwolf)



# What is Strepsiptera?



Image by Yuta Nakase





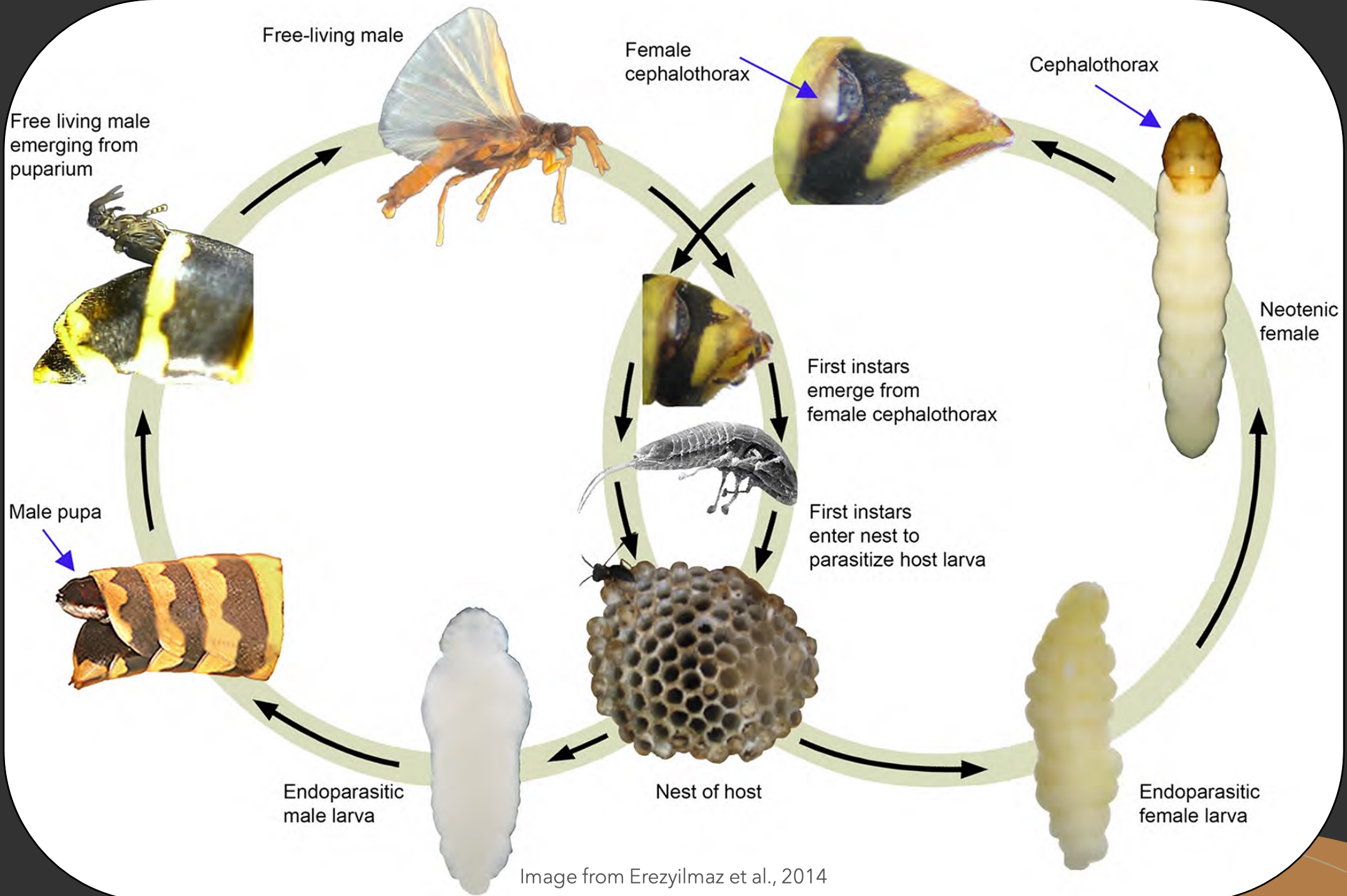


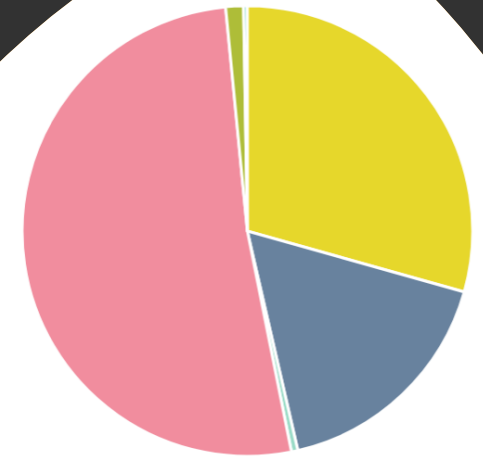
Image from Erezylmaz et al., 2014



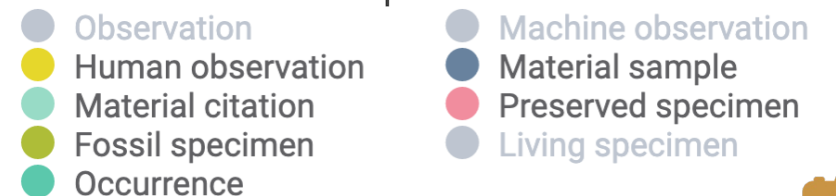


# Challenges in Study

- Extreme specialization
- Perceived rarity afield
- Distinctive genetic characteristics
  - High ribosomal DNA substitution rates
- Taxonomic confusion



Occurrences per basis of record



# Benefits of Museum Collections

- Accessibility
- Wealth of data
- Temporal and spatial reach
- Education





# Ecological and Biological Questions

**BIOLOGY LETTERS**

royalsocietypublishing.org/journal/rsbl

Research



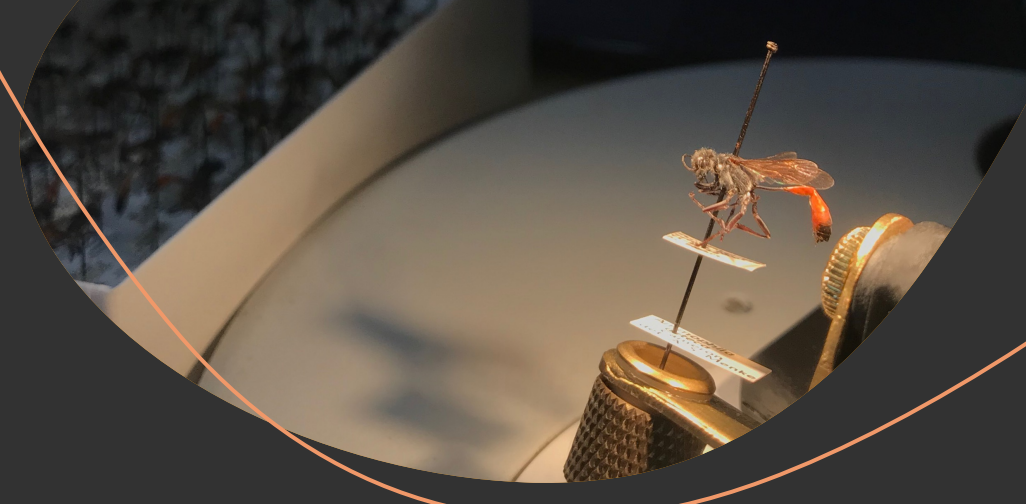
**Cite this article:** Millena RJA, Rosenheim JA. 2022 A double-edged sword: parental care increases risk of offspring infection by

## Evolutionary biology

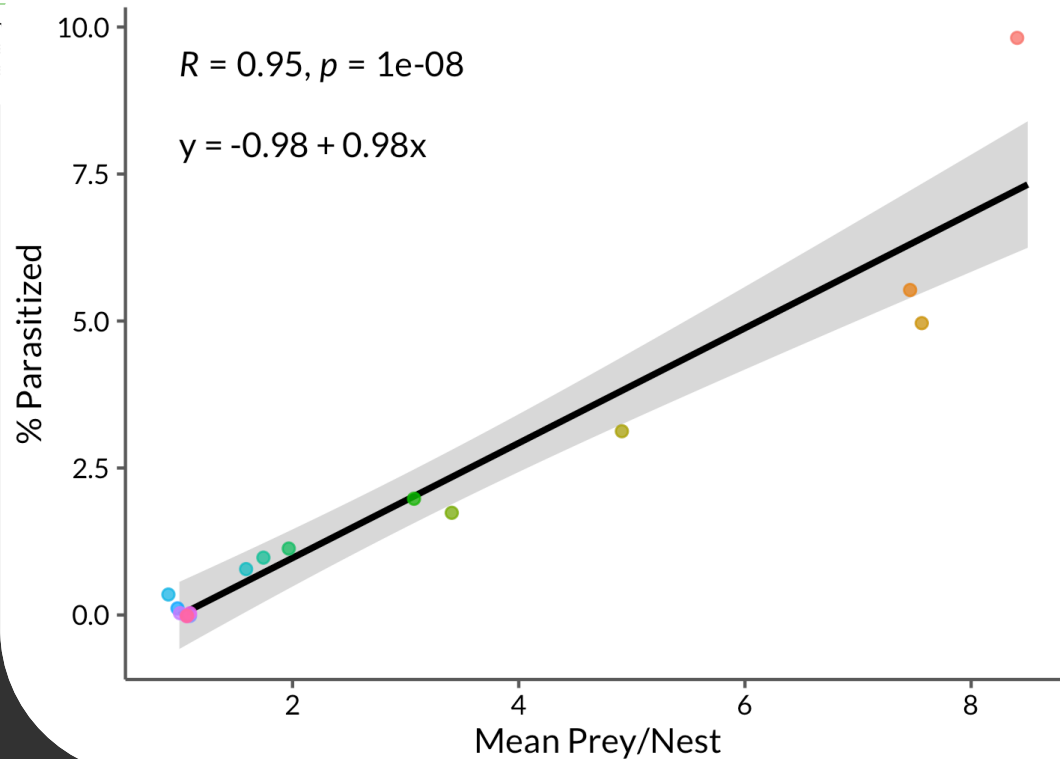
A double-edged sword: parental care increases risk of offspring infection by a maternally vectored parasite

Rebecca Jean A. Millena<sup>1,2</sup> and Ja

<sup>1</sup>RGGS, Invertebrate Zoology, American Museum of Natural History, New York, NY, USA  
<sup>2</sup>Ecology and Evolution, Entomology and Nematology, University of California, Davis, CA, USA  
<sup>3</sup>Department of Entomology and Nematology, University of California, Davis, CA, USA



## Effect of Provisioning on Parasitism Rate Per Species



### Ammophila Species

- aberti (622)
- pruinosa (1412)
- azteca (2465)
- harti (32)
- urnaria (332)
- placida (445)
- femurrubra (435)
- dysmica (206)
- juncea (125)
- boharti (307)
- procera (1012)
- wrightii (659)
- marshi (346)
- stangei (241)
- nigricans (179)
- zanthoptera (138)



# Ecological and Biological Questions

## Climate and collections: Modeling Strepsipteran host-parasite dynamics with museum collections

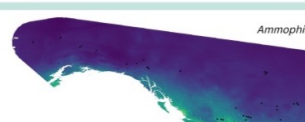
Wendy G. Frankel, Trinity Tobin, RJ Millena, Aaron Goodm

Title changed from: Strepsiptera parasitism rates across taxa in American

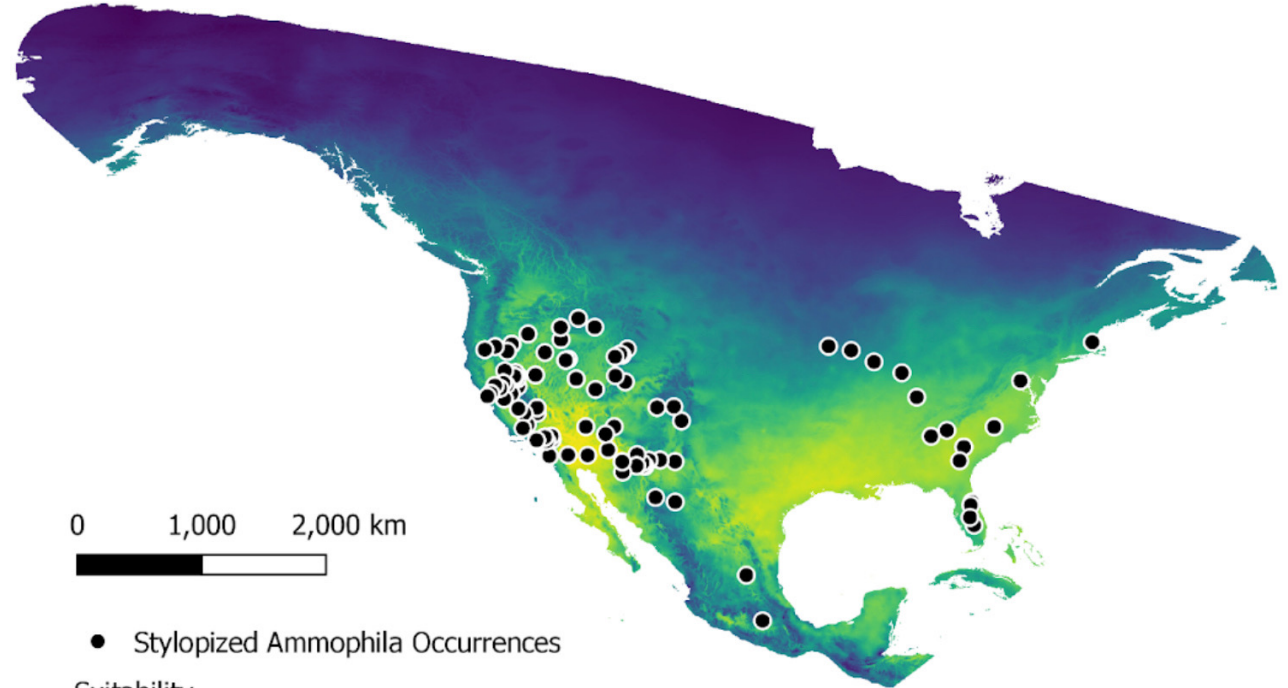
### Introduction

Rapid changes in climate are having widespread, and not well understood, effects on insect distributions. We chose to study one such distribution of a parasite and its host. *Styloxenus lugubris* is a member of the twisted-wing parasites (Strepsiptera), an enigmatic obligate endoparasite that styloposes a variety of insect orders.

### Models



### Map of Strepsiptera Ammophila Occurrences Against Ammophila Suitability





# Museomics

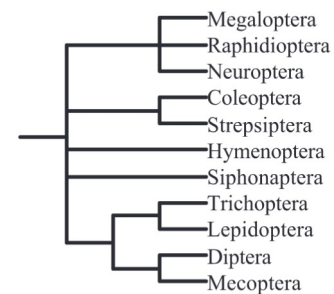
- The study of DNA sequences obtained from museum specimens
  - Archival storage vs natural degradation
- From short fragments of hDNA to whole genome
- Improving taxonomic coverage

hDNA target group	Specimen type	Sources for hDNA
Infectious diseases	Mammal dry skin Amphibian formalin/alcohol preserved skin	Skin or epithelial swabs
Microbial communities	Herbarium dry pressed	Leaf tissue
Plants	Herbarium dry pressed	Leaf tissue
Vertebrates	Anthropological material: Headdresses, clothing	Biological material
Mammals	Skins and hides	Hair, skin, muscle traces, claws
Mammals	Skeletal	Bone, teeth
Birds	Round and flat dry skins	Toe pads, skin
Birds; crabs	Eggs	Piece of egg or powder
Fishes Amphibians Reptiles	Fluid: formalin and/or ethanol preserved	Tissue including liver, muscle
Reptiles	Bone	Carapace, plastron, other bone elements
Insects Arachnids	Pinned, dried specimens	Whole limbs, whole specimens, subsamples
Bryozoa	Dried colonies	Partial specimens
Arachnids	Fluid: ethanol preserved	Whole or partial specimens

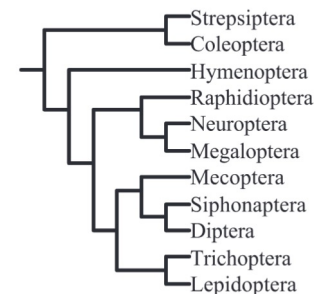


# Evolutionary Questions

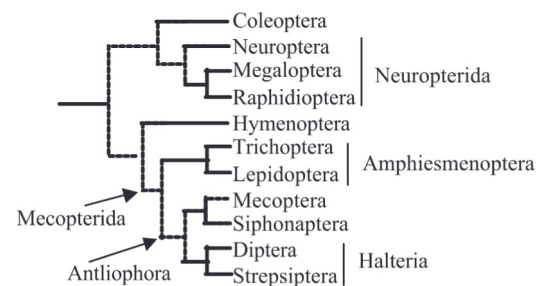
- Enigmatic placement in the insect radiation
- Unresolved intraordinal relationships
- Ancestral characteristics
- Evolutionary trends



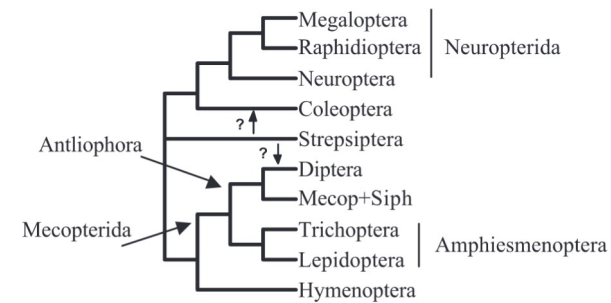
A. (Hennig)



B. (Boudreaux)



C. (Whiting)



D. (Kristensen)

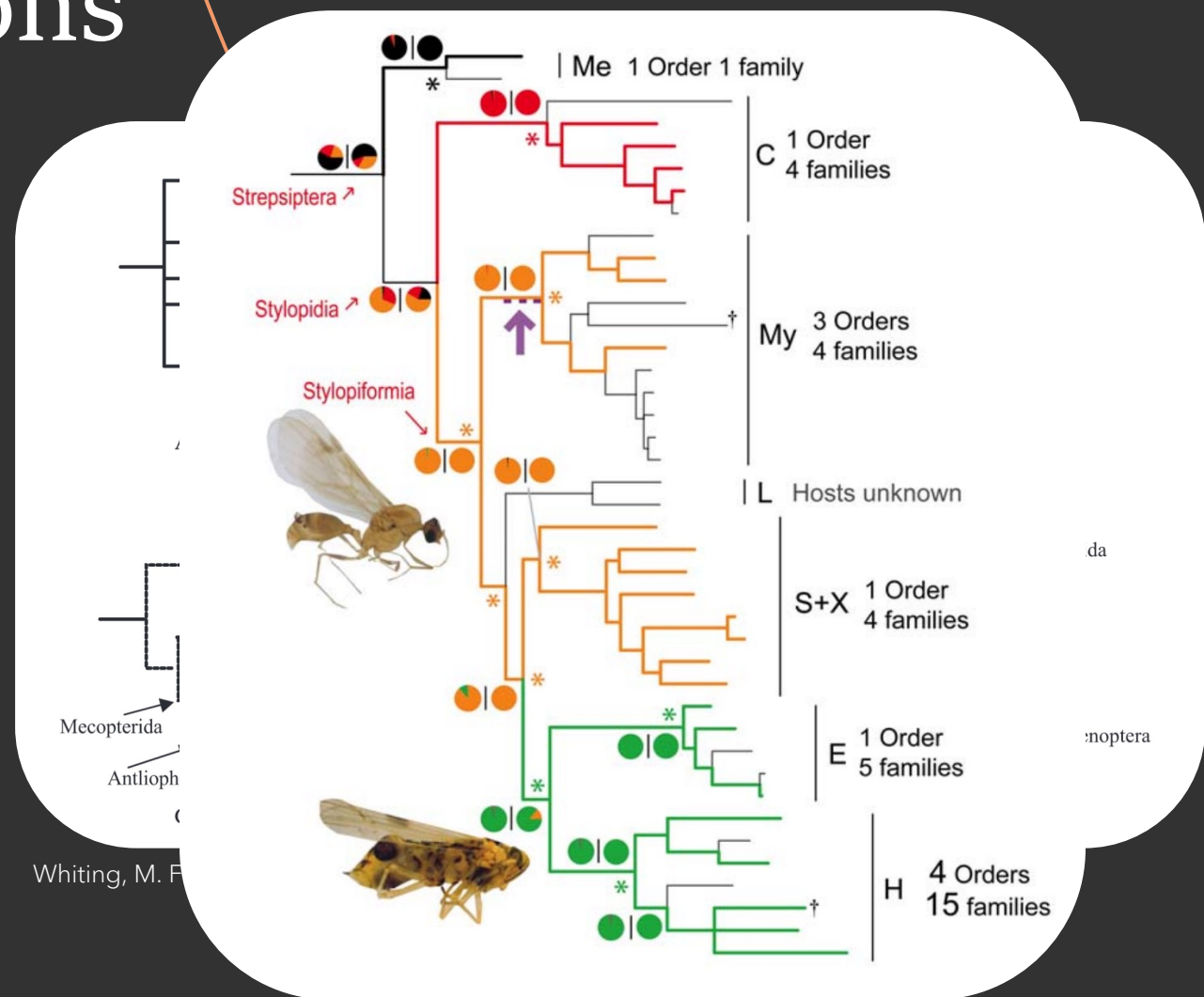
Whiting, M. F. (2002). Zoologica Scripta, 31, 3 - 15





# Evolutionary Questions

- Enigmatic placement in the insect radiation
- Unresolved intraordinal relationships
- Ancestral characteristics
- Evolutionary trends

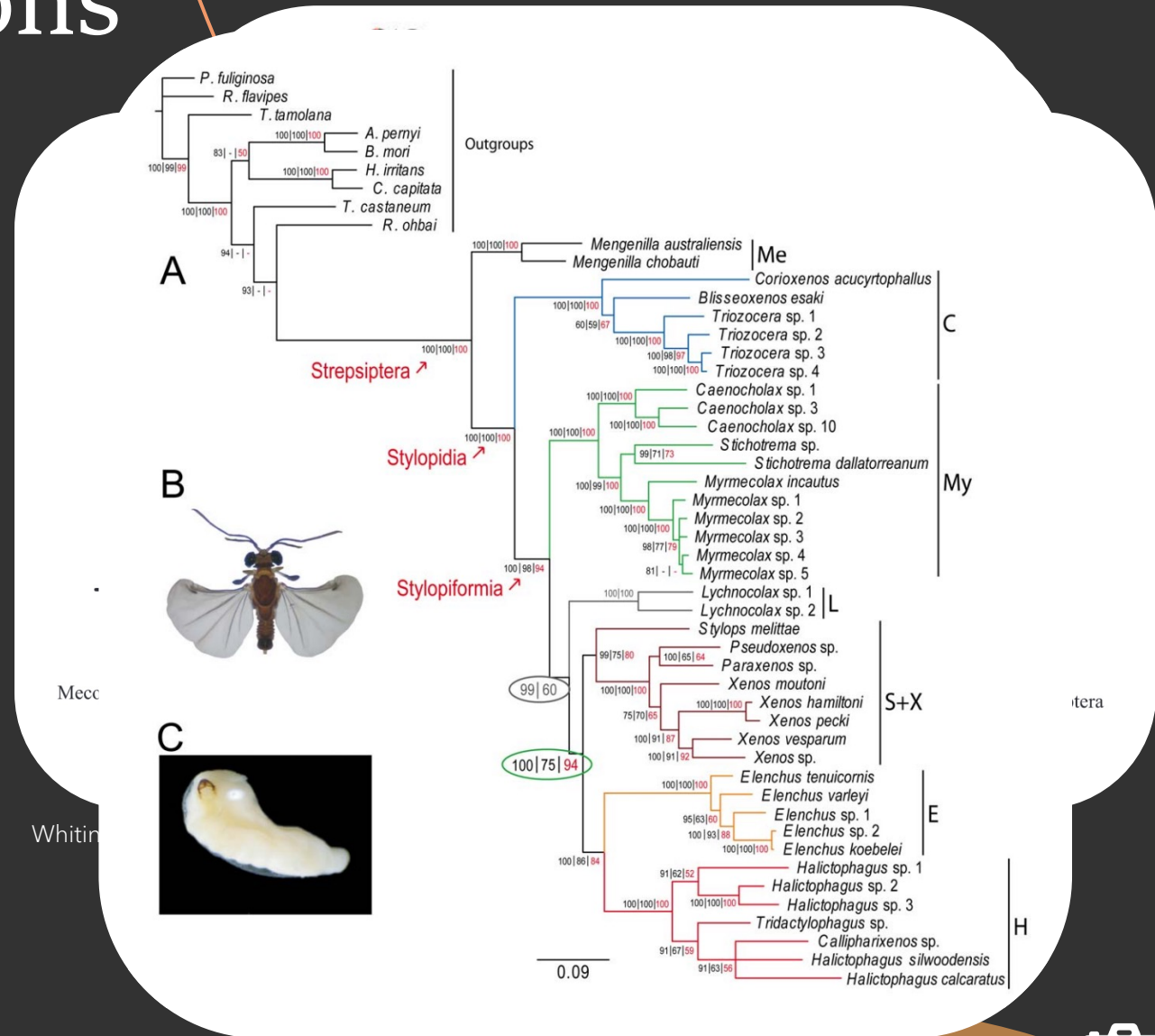


McMahon et al. (2011). PLoS ONE 6(6), e21206.



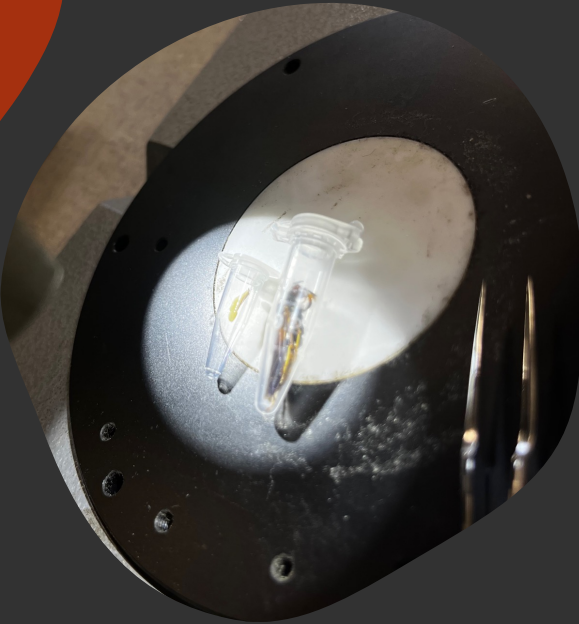
# Evolutionary Questions

- Enigmatic placement in the insect radiation
- Unresolved intraordinal relationships
- Ancestral characteristics
- Evolutionary trends





# Goals and Methods



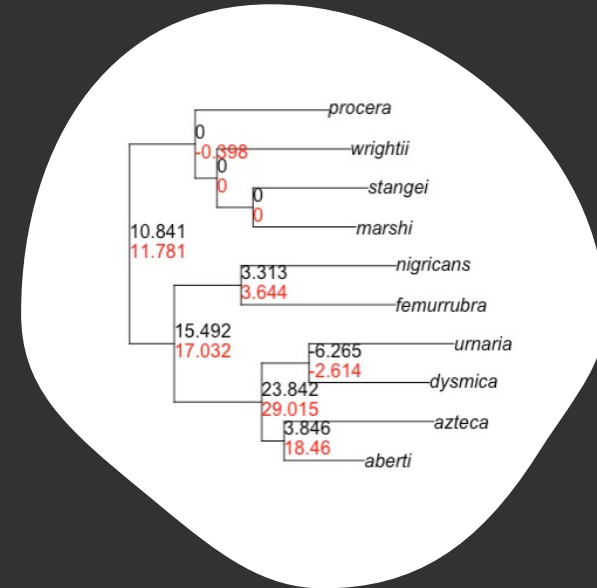
Find and dissect  
Strepsiptera from  
preserved hosts



Nondestructive  
protocol development  
& testing; extractions



Anchored hybrid  
enrichment (AHE)  
bait design

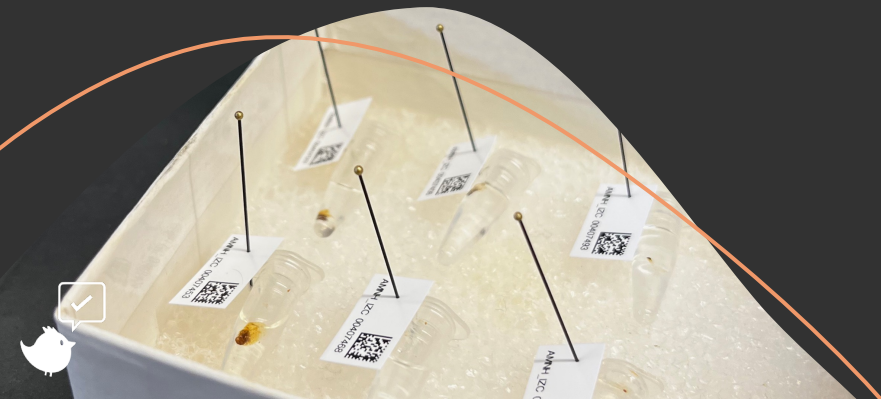
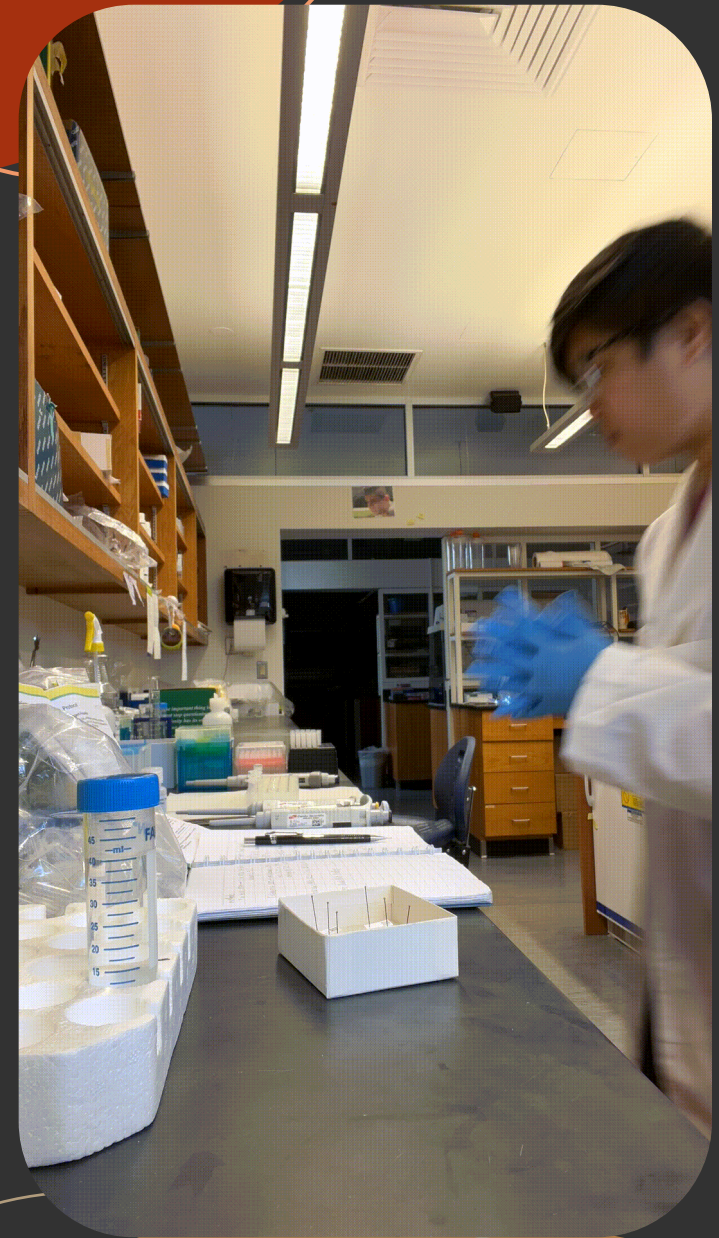


Phylogenetic  
analyses



# Nondestructive Protocol

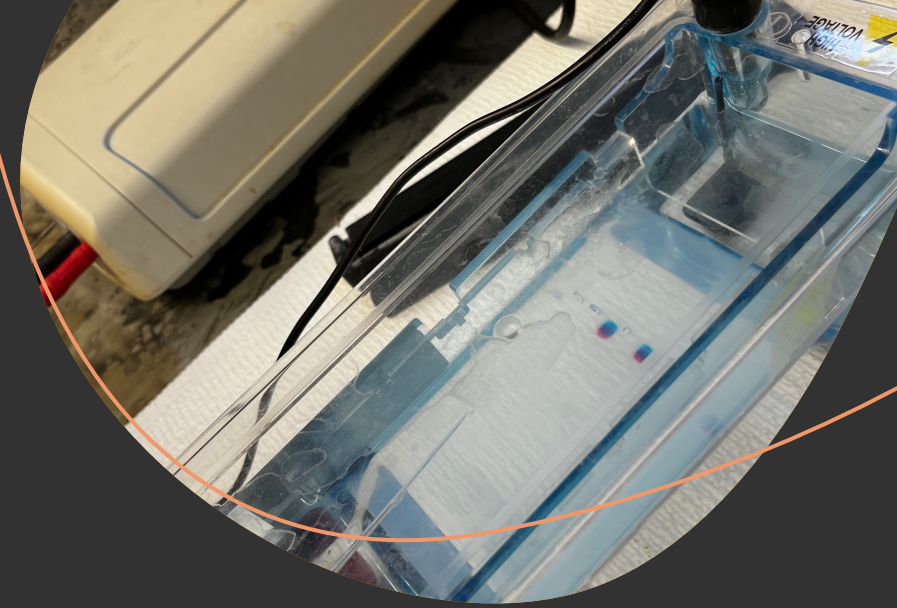
- Zymo Quick-DNA Miniprep Kit
- Whole body in proK and lysis buffer, 48 hr incubation
- Rinsed with ethanol, suspended in glycerin or slide mounted





# Testing the Protocol

- 6 specimens of *Paraxenos lugubris* from unidentified *Ammophila*
  - 2 USA, 4 ARG, 1974-2012
  - Malaise, dry
- Three tests
  - Preliminary: Nanodrop
  - PCR presence/absence test, Sanger
  - Oxford Nanopore MinION test

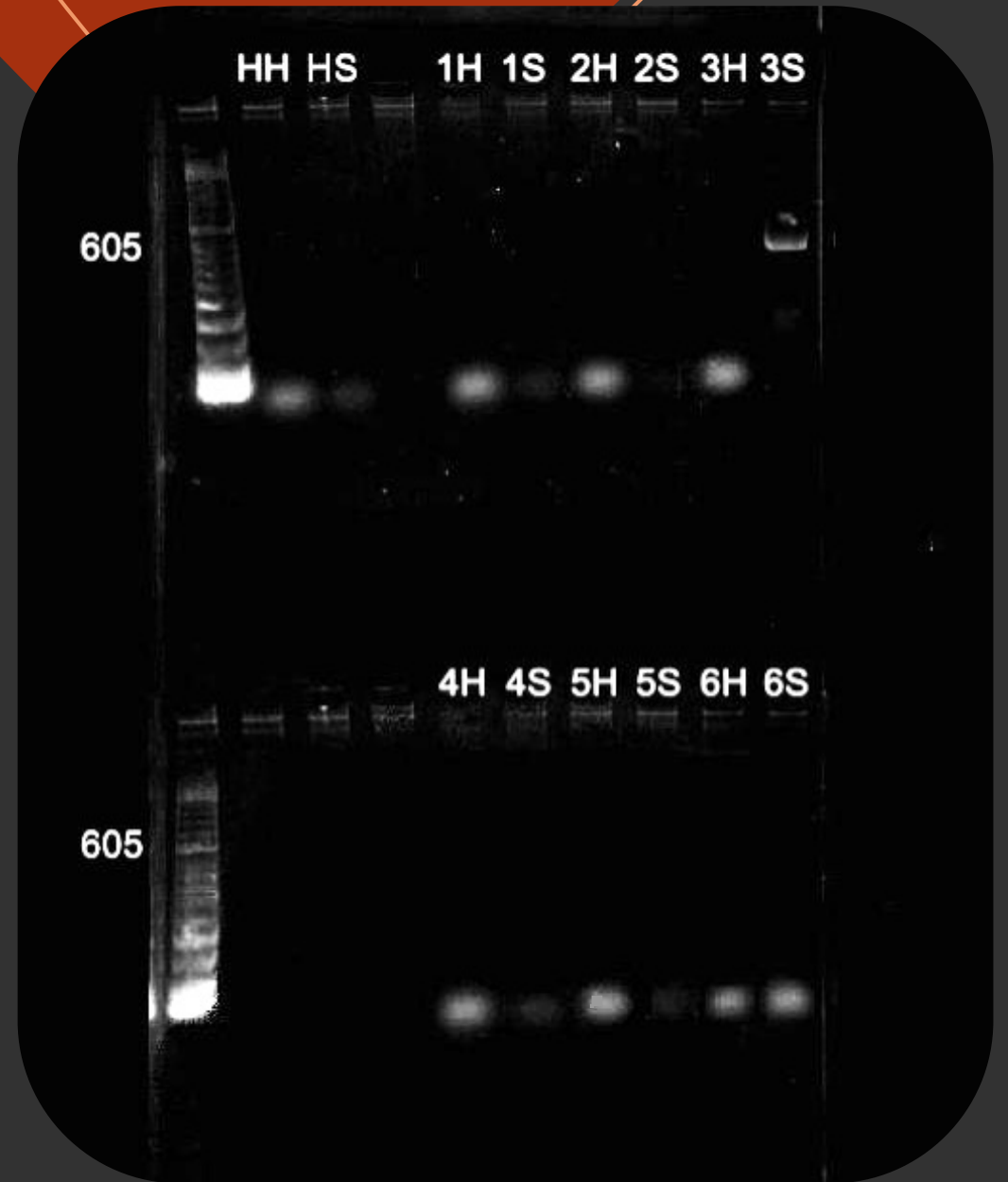
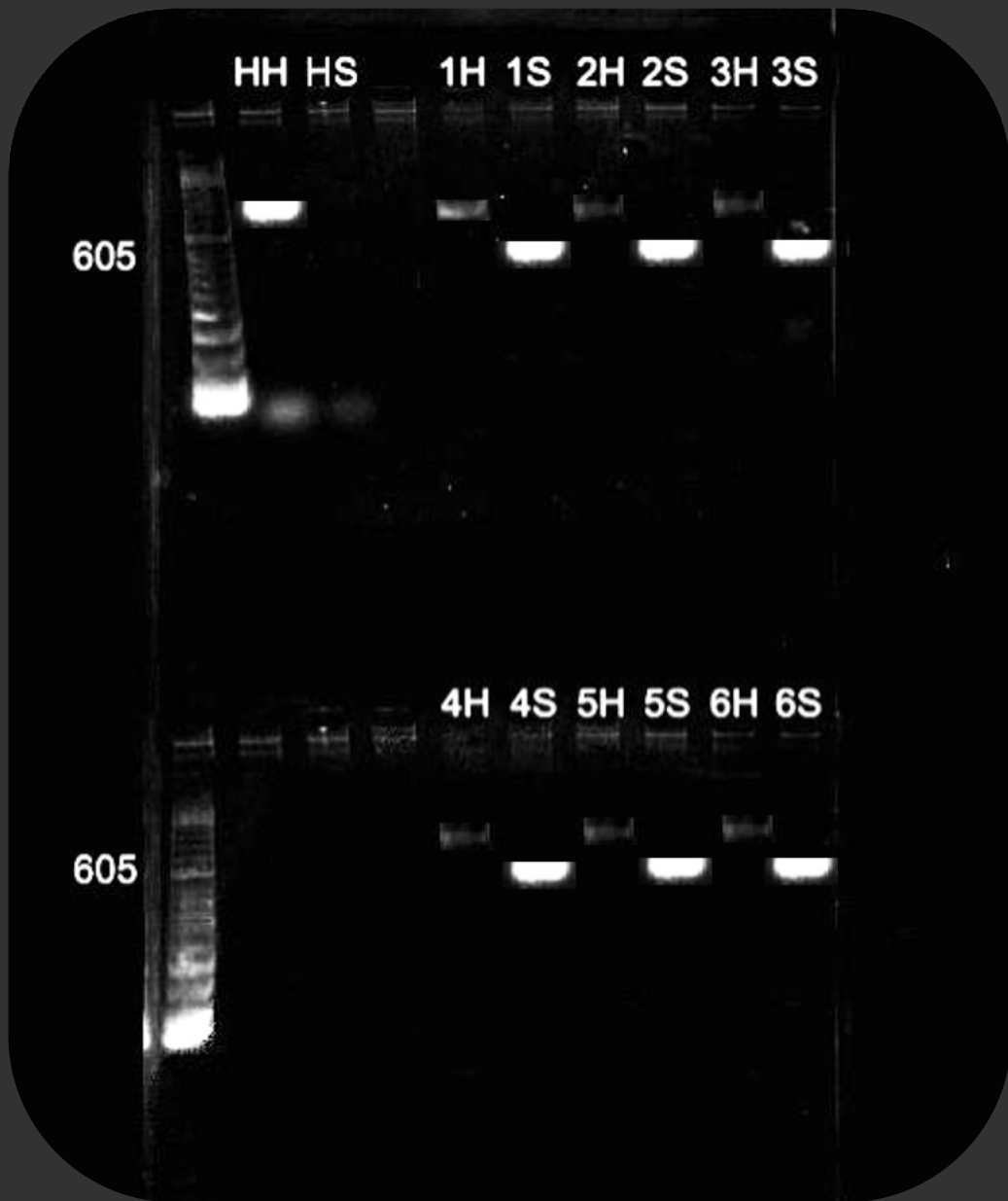




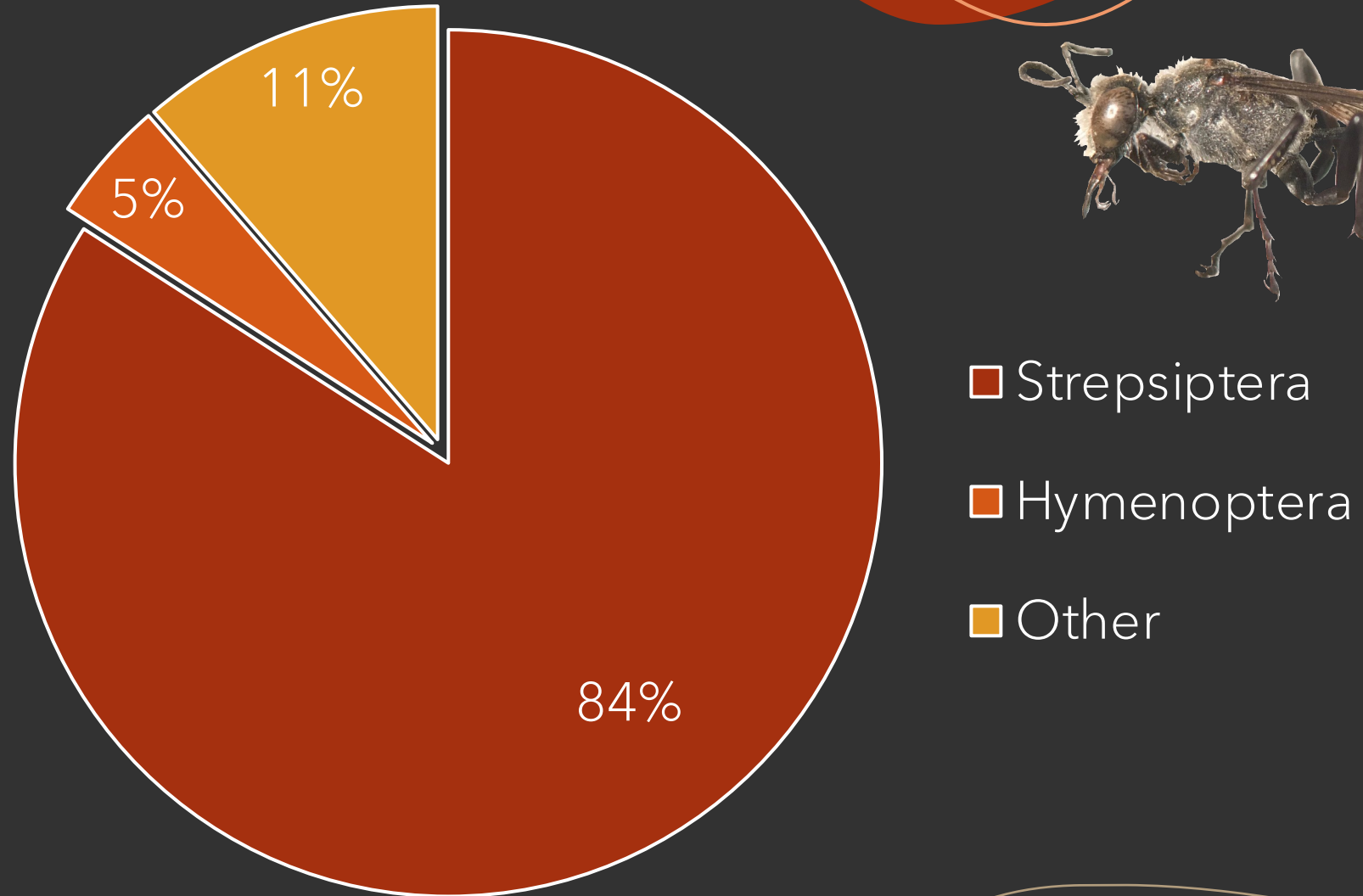
# Nanodrop Values

Sample #	Year Collected	ng/ $\mu$ L
1	1974	2.2
2	1974	2.2
3	2012	49.5
4	2012	1.6
5	1987	3.3
6	1992	2.7





# First BLAST Result for Nanopore Reads





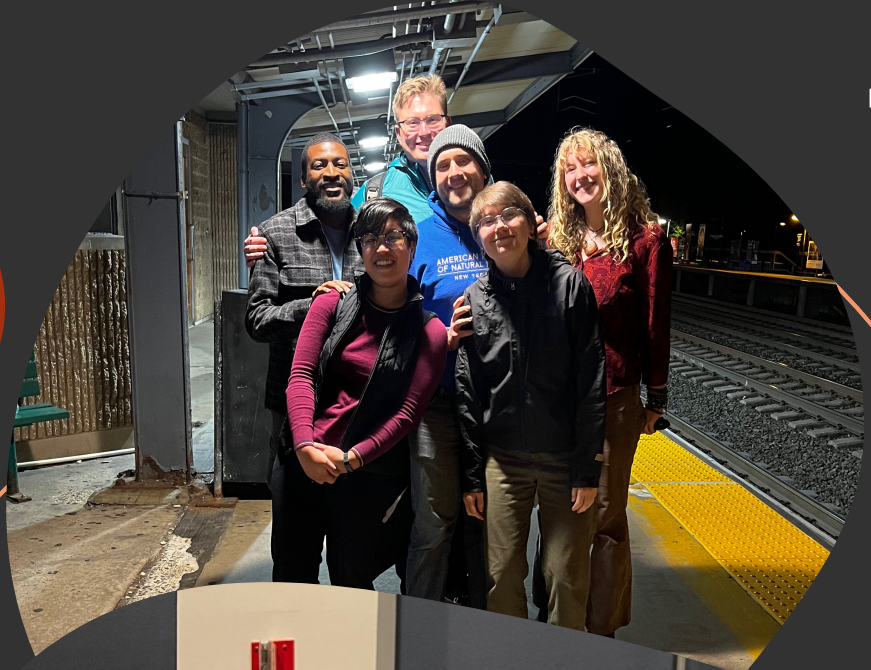
# Planned Work

- Nanopore sequence of *Xenos peckii* whole genome, assembly & annotation
  - Reference genome
- Probe design with BaitFisher, AHE analyses, total evidence
- Host-parasite associations
  - Via collections and in phylogenetic context
- Species richness of Strepsiptera
- Optimizing museomics protocols





# Thank You!



AMERICAN MUSEUM  
OF NATURAL HISTORY



ENTOMOLOGICAL  
SOCIETY OF AMERICA  
SHARING INSECT SCIENCE GLOBALLY



**UC DAVIS**  
UNIVERSITY OF CALIFORNIA

Ware Lab

Ruth Salas

Christine Labeau

Melody Doering

Dr. Randa Jabbour

Judith S. Herreid

Ryan Spahn

And Viewers Like You

