Status of *T. japonicus* in the US

Kim A. Hoelmer

USDA ARS Beneficial Insects
Introduction Research Unit
Newark, DE

Funding

USDA United States Department of Agriculture National Institute of Food and Agriculture
Specialty Crop Research Initiative

Collaborating Institutions

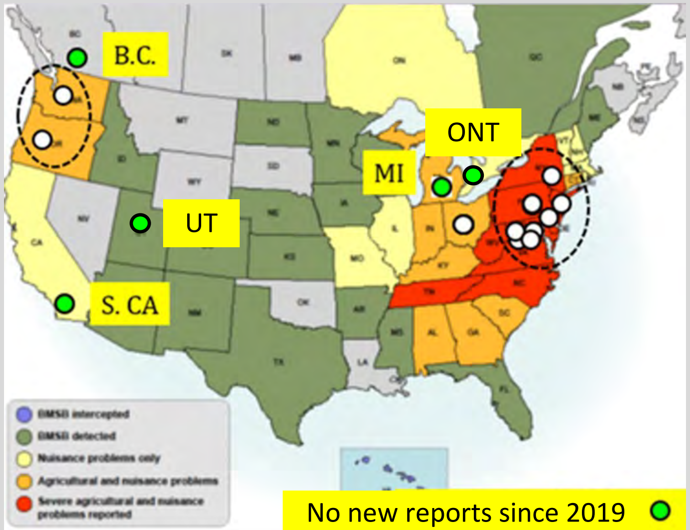
ars, NC State University, PennState, OSU Oregon State University, University of Maryland, University of Georgia, Washington State University, Northeastern IPM Center, Cornell University, Utah State University, Rutgers University, The Ohio State University, University of Kentucky, UC Davis, University of Minnesota, Virginia Tech, Berkeley, Michigan State University, UC Riverside

StopBMSB.org

This material is based upon work that is supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, Specialty Crop Research Initiative under award number 2016-51181-25409.

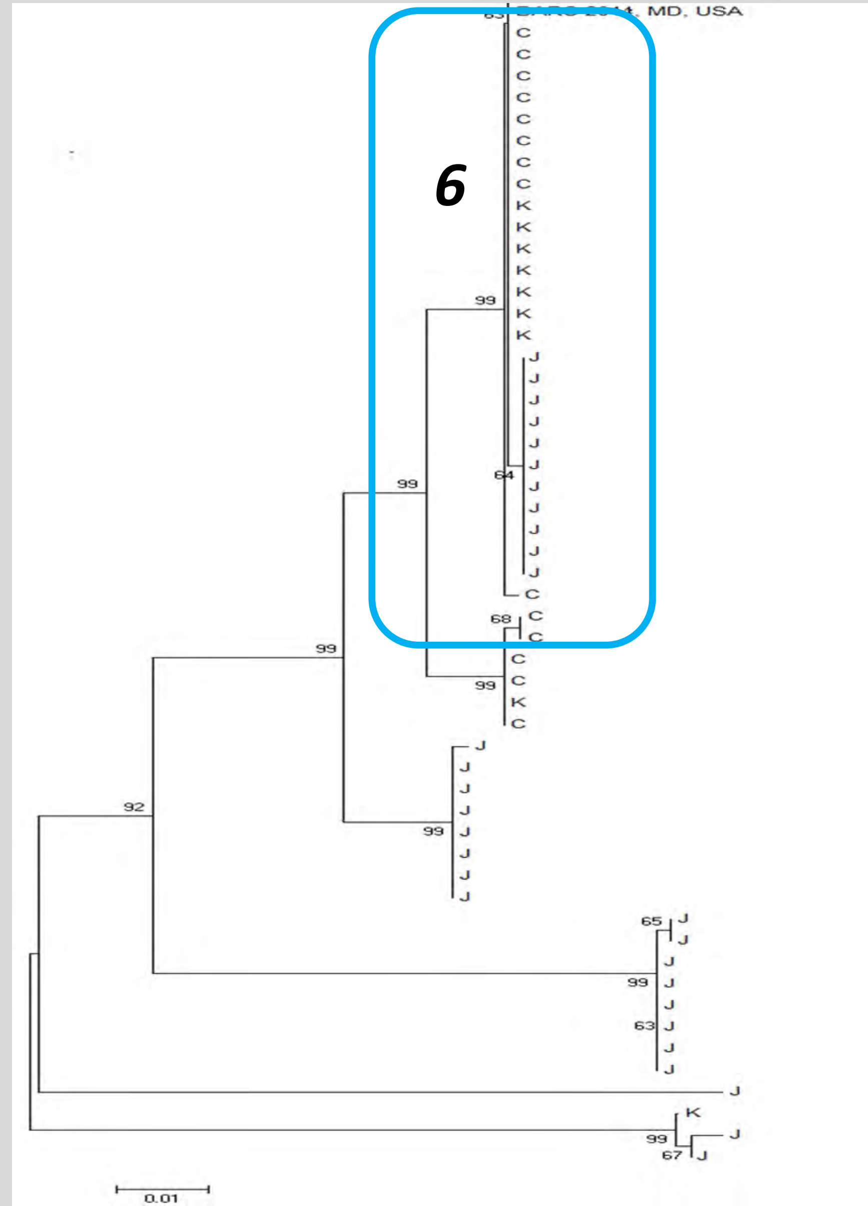
- Adventive populations of *T. japonicus* in North America
- Redistribution efforts of these populations
  - By state
  - Mass Rearing advances
- Conservation of *T. japonicus* for IPM
- Status of a Petition for Field Release & Redistribution of quarantine and adventive populations

Slide data from MC Bon / USDA ARS EBCL



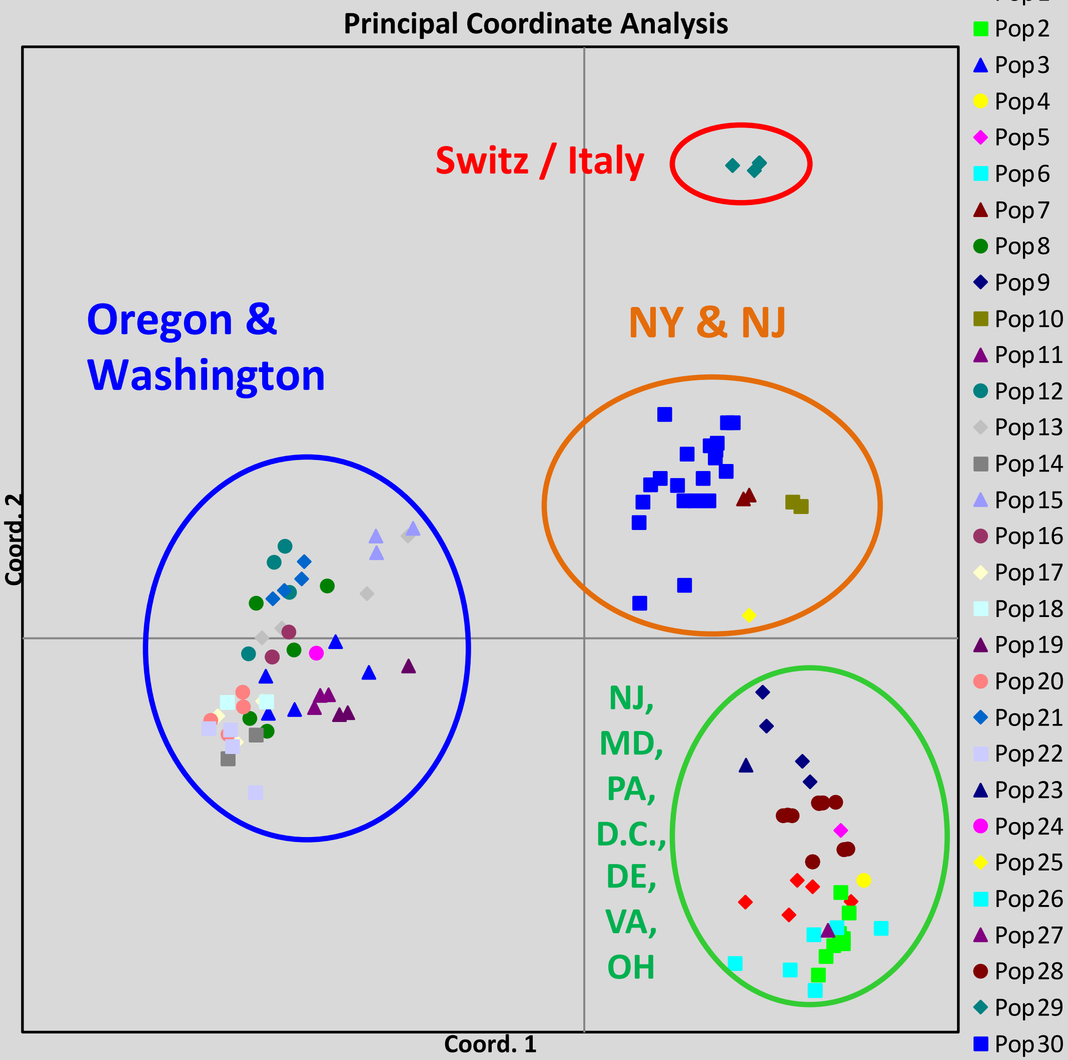
What does *CO1* (barcode) sequencing tell us so far?

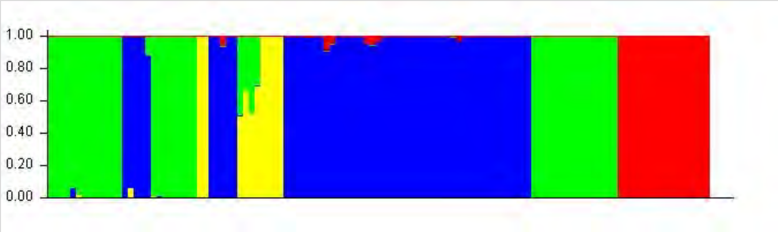
- *Trissolcus japonicus* comprises six maternal lineages across the native Asian range
- Some lineages are only present in one country (e.g., Japan)
- All adventive populations in North America and Europe (Italy and Switzerland) belong to the same lineage (*6*), widely distributed in China, Korea and Japan



What do population genetic markers (microsatellites) tell us ?

Genetic Structure of adventive populations of *T. japonicus* based on
Principal Coordinate Analysis (PCoA) and Structure





Structure analysis: K=4 chosen as optimal

- Three distinct genetic clusters in U.S. :
  - NW, NE & mid-Atlantic
- U.S. genetic groups are different from European population
- CA, UT, MI & Canadian populations not shown in this analysis

Slide data from MC Bon / USDA ARS EBCL

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- Survey & Redistribution efforts of wild populations

  - MI: Released 7,200 *T. japonicus* at 16 sites in 2019 and 2020. Adults recovered at 4 sites with YSTs and sentinel eggs at low rates, but indicating overwintering, reproduction, and dispersal and summer activity.

  - OH: 3,000+ *T. japonicus* released at 5 commercial farms in 2018 and 5 more in 2019. No recoveries made at these sites, but repeated recoveries made at OSU research farm where *T. japonicus* was 1st found.

  - NY: *T. japonicus* releases began in 2017 with parasitized eggs, 2018 w/hybrid egg and adult releases, 2019-2020 with adult only releases. Overwintering recaptures were made at 13 of 14 sites from previous years releases.

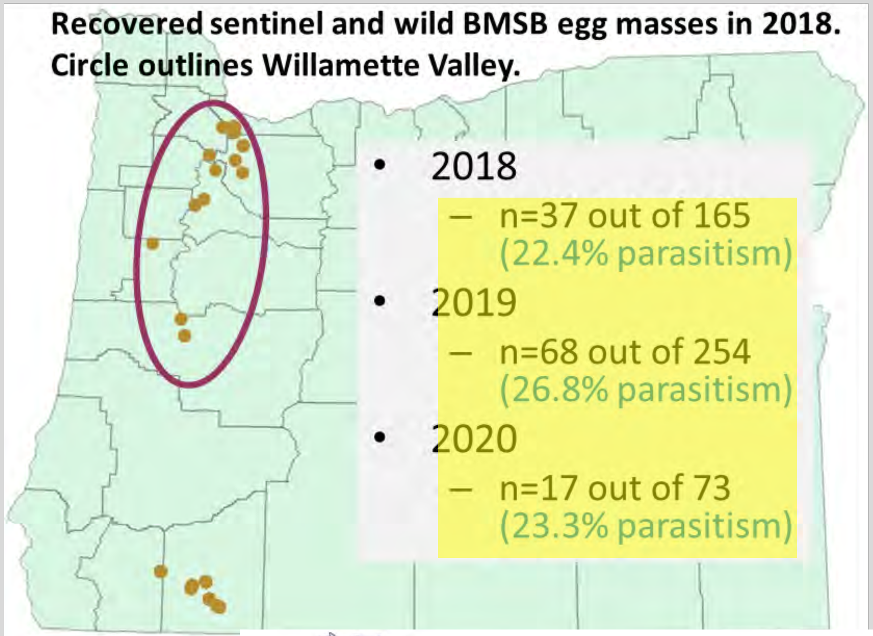
  - WA: 56 egg masses were deployed to release 1,476 adult *T. japonicus* in Skagit Valley in N WA, and sentinel egg masses were deployed at 2 sites between June and August 2020 but no parasitism was detected. 7,000 were also released near population centers thoughout the state.

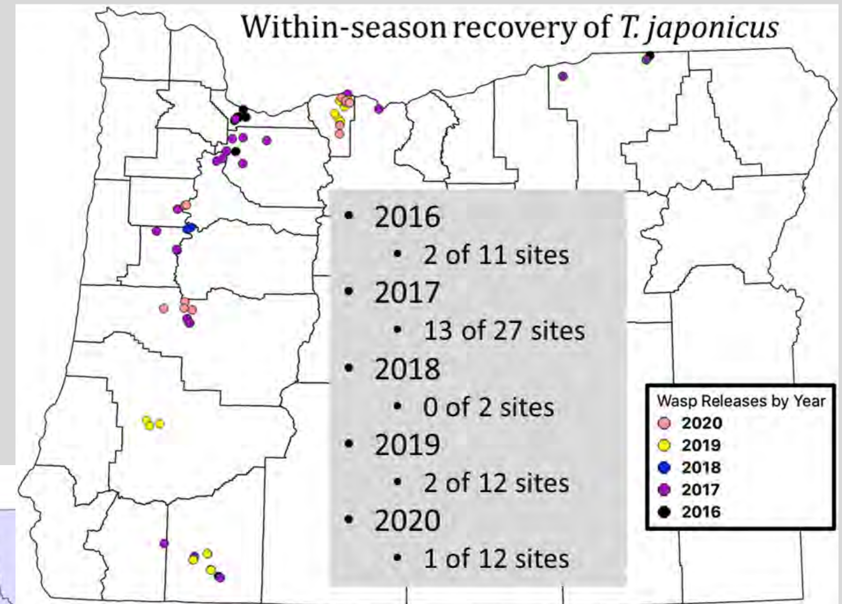
Mass Release of *T. japonicus* in 2020 - WA

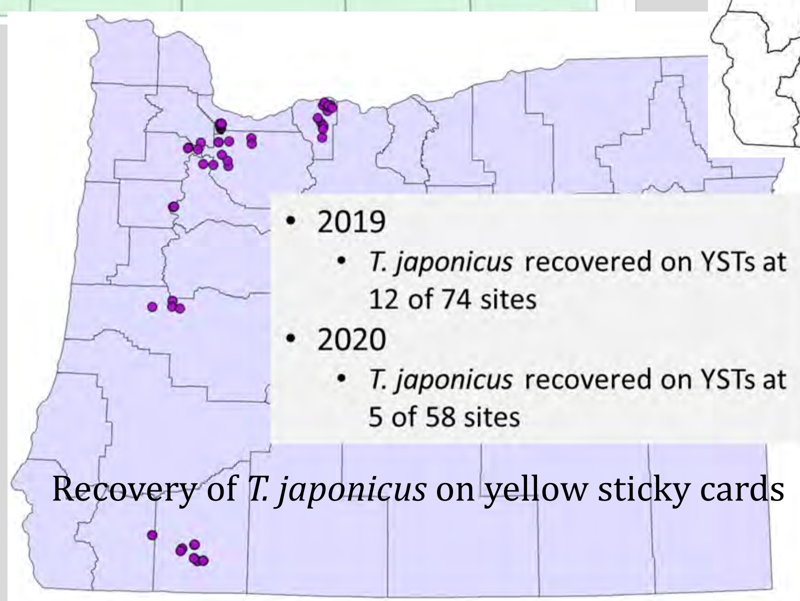
[redacted]	[redacted]
Columbia Gorge	788
Seattle	2,288
Rock Island	1,950
Tri-Cities	1,239
Spokane	740
Total:	**7,005**

Releases near population centers thoughout the state

T. japonicus recoveries in western Oregon



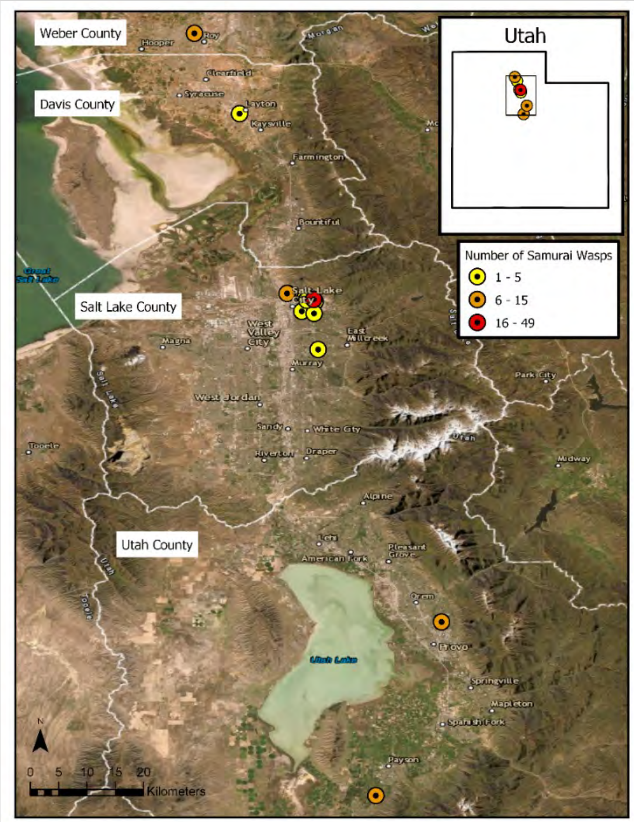




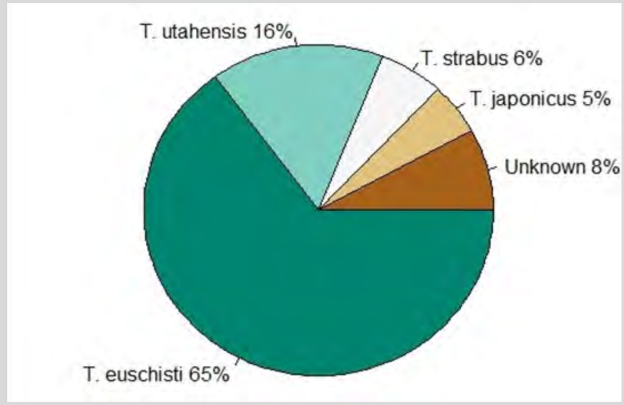
Oregon State University

Slide data from C. Donahoo/N. Wiman

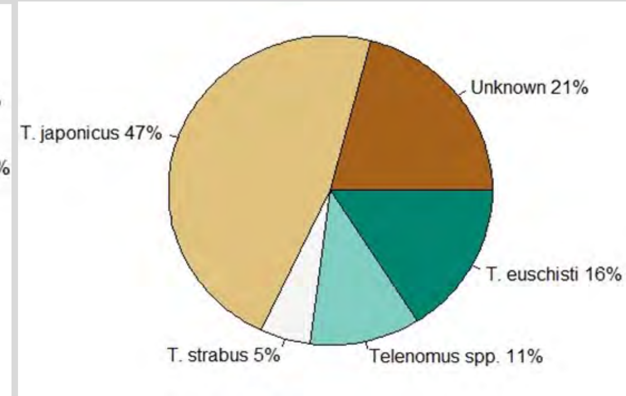
T. japonicus in Utah



T. japonicus **detections in northern Utah on sticky card traps between May and September, 2019-2020.**



On yellow sticky cards



From wild BMSB egg masses

Proportion of parasitoids recovered in 2020

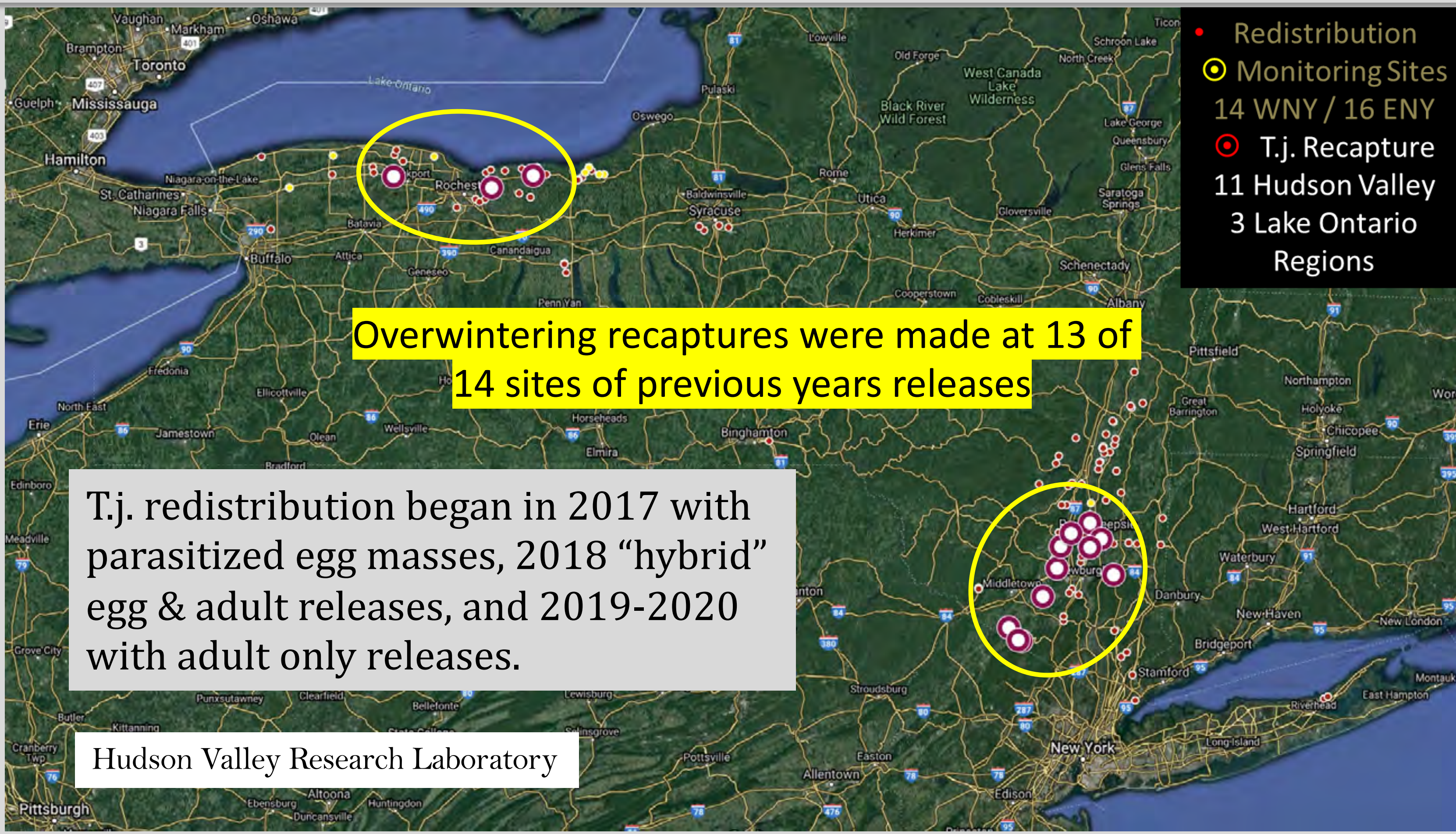
- *T. japonicus* made up only 5% of wasps found on yellow sticky cards
- It emerged from 47% of all parasitized wild *H. halys* egg masses in surveys
- Egg masses parasitized by *T. japonicus* had a mean emergence rate of 80%

- *T. japonicus* successfully overwintered from 2019 to 2020.
- Four new sites in 2020 compared to 2019.
- In May-September 2019-2020, *T. japonicus* was found at 13 sites in 4 counties.
- Highest density at the original detection site in Salt Lake City.

Data: Diane Alston, Lori Spears & Grad Students Mark Cody Holthouse & Kate Richardson / Utah State Univ.

Cornell University

Redistribution and Monitoring of *Trissolcus japonicus* for Management of the Brown Marmorated Stink Bug in NY State



Overwintering recaptures were made at 13 of 14 sites of previous years releases

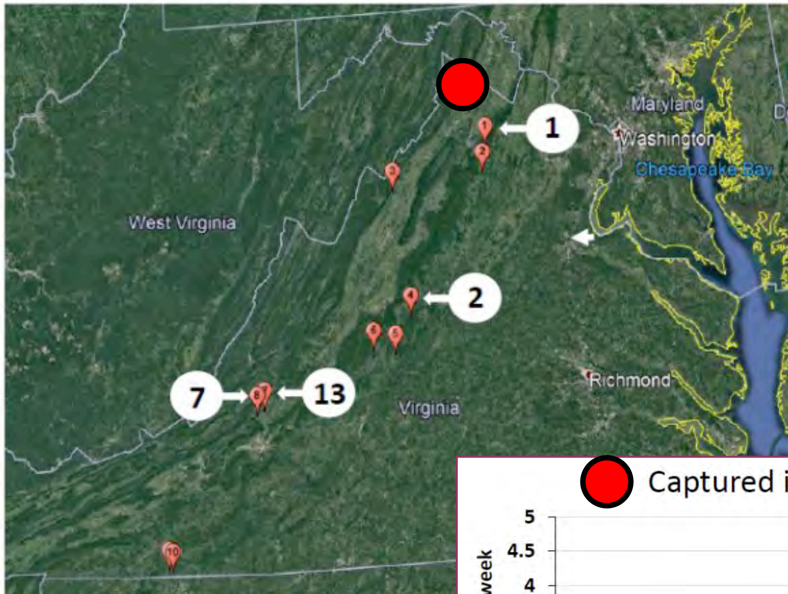
T.j. redistribution began in 2017 with parasitized egg masses, 2018 "hybrid" egg & adult releases, and 2019-2020 with adult only releases.

Hudson Valley Research Laboratory

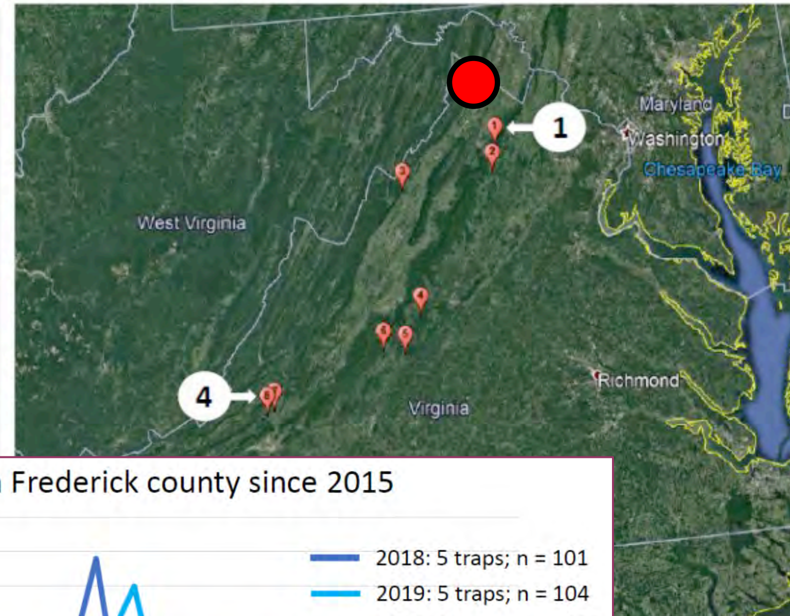
T. japonicus captures 2019 and 2020

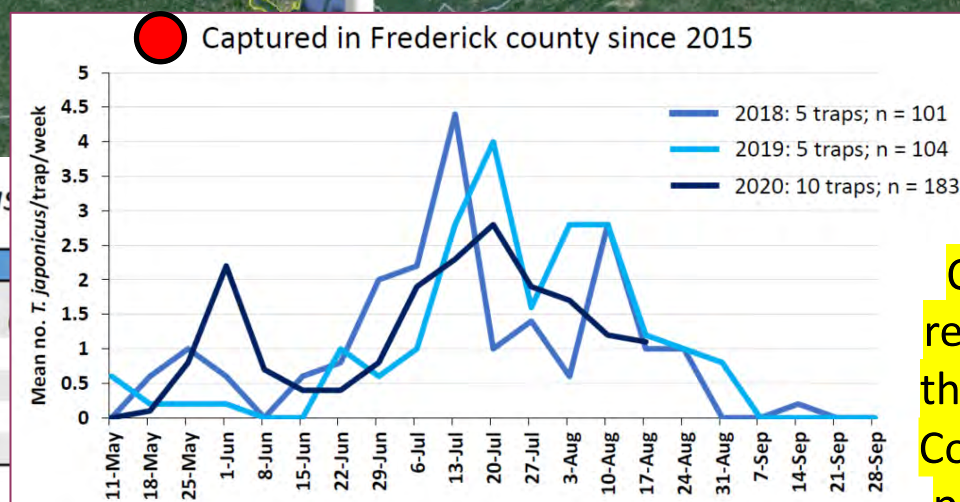
Virginia

2019



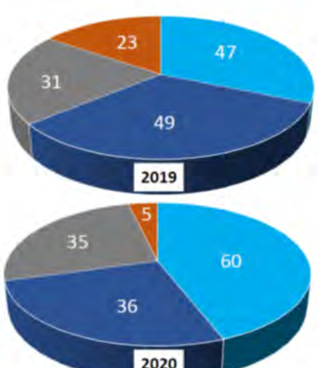
2020





Consistent recoveries at the Frederick Co. sites over past 5 years

Native Scelionid and *T. japonicus*



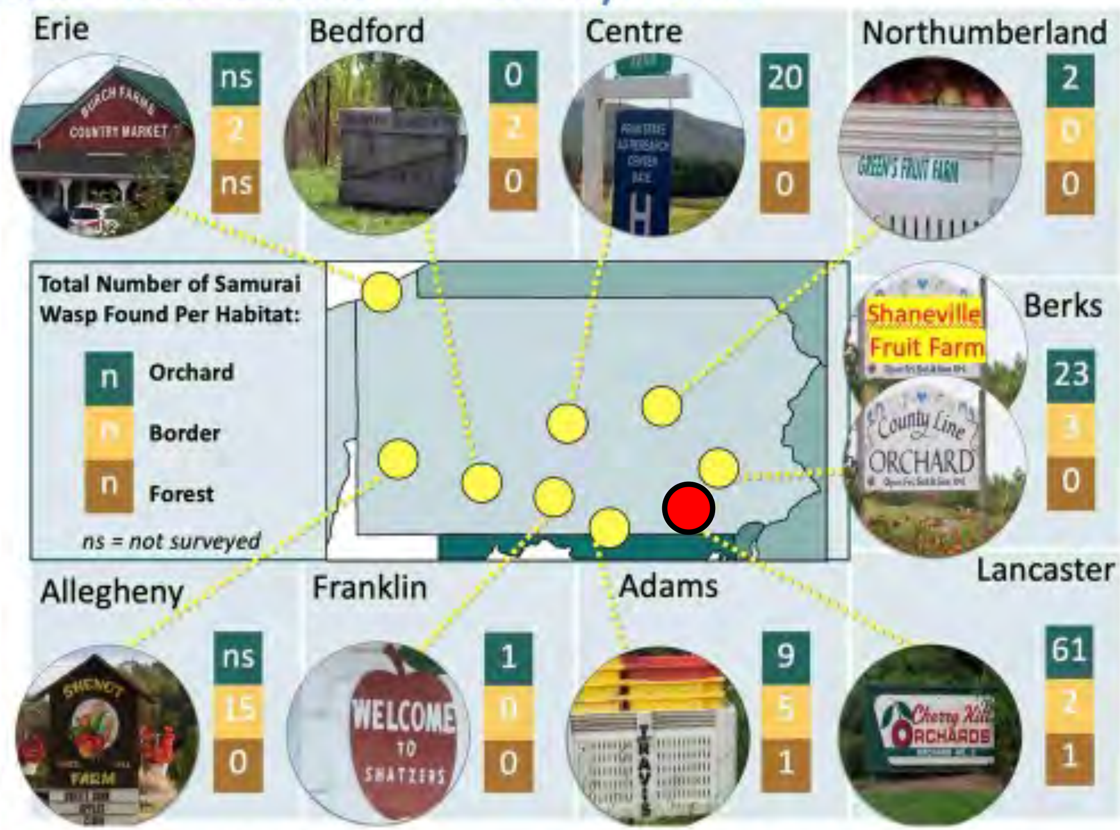
Species
Te. podisi
Tr. euschisti
Tr. brochymenae
Tr. japonicus

All are BMSB parasitoids

Abram et al. 2017. J. Pest Sci. 90: 1009-10520

PennState Entomology

T. japonicus detections in Pennsylvania



Yellow sticky traps placed in and around commercial fruit orchards located in various counties across PA. Trap data collected after multi-week exposure.

Slides by H. Peterson and G. Krawczyk, Penn State University

Releases were made only at the Lancaster (RED) site – all others represent natural dispersal

Ohio

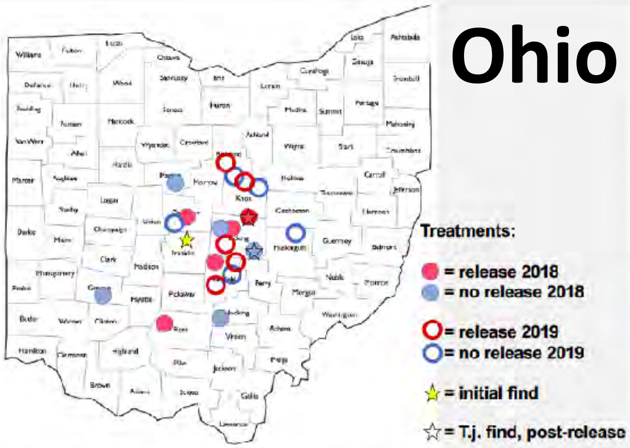
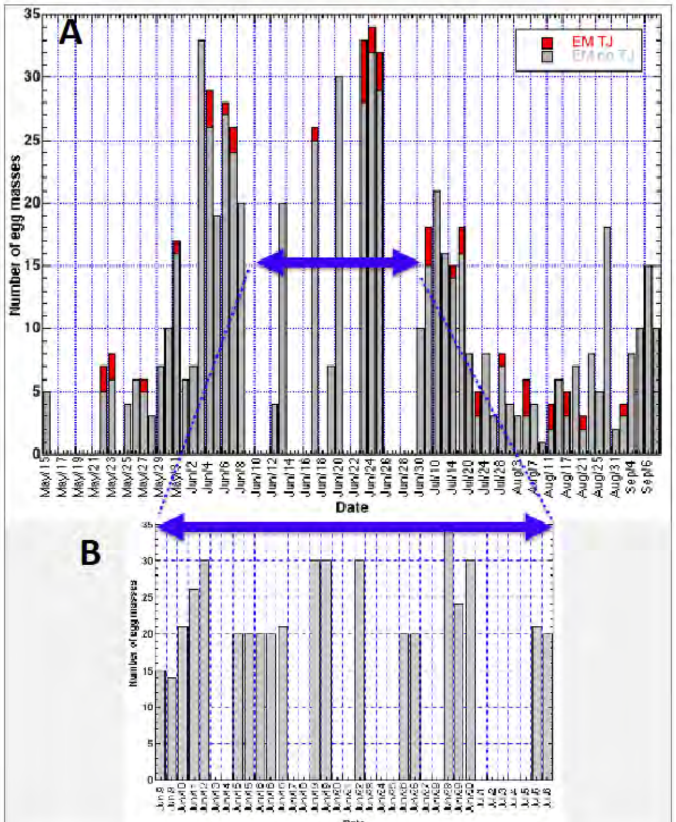


Figure 1. Map of Ohio locations used for re-distribution trial, marked with positive finds of *Trissolcus japonicus*.



- no new releases made in 2020
  - surveys with sentinel eggs, all 20 farms, June 2020
  - surveys with 5 yellow sticky cards per farm, 20 farms, 2-week period, July 2020

- In 2020, no TJ were found at any of the 10 release or the 10 no-release sites with sentinel eggs or yellow sticky traps (Table 1).

- TJ has been found each year at the OSU research farm where 1st detected in 2017. Sentinel egg parasitism was 2 to 41% (Table 1).
- Seasonal trends at OSU research farm in 2020 (Fig. 2A) show TJ occurred from late May through August, even in small samples (3-8 egg masses/day). There were no TJ detections at commercial farms with larger samples (Fig. 2B).

T. japonicus shows promise

- *T. japonicus* made up low % of wasps on yellow sticky cards
- It emerged from significant % of parasitized wild BMSB egg masses in some surveys
- Populations at some sites are consistently high
- Egg masses parasitized by *T. japonicus* show a high rate of successful emergence
- *T. japonicus* was not the most abundant parasitoid wasp detected on sticky cards; however, it out-performed other species in parasitizing *H. halys* egg masses.
- It has overwintered successfully at many different locations
- *T. japonicus* has spread widely on its own in some regions

Improvements in Mass Rearing of *T. japonicus*

Provides support for:

- Redistribution efforts
- Local seasonal inoculations
- Areawide programs
- Field experiments

Journal of Economic Entomology, XX(XX), 2021, 1–11
doi: 10.1093/jee/toaa307
Research

OXFORD

Biological and Microbial Control

An Effective Cold Storage Method for Stockpiling *Halyomorpha halys* (Hemiptera: Pentatomidae) Eggs for Field Surveys and Laboratory Rearing of *Trissolcus japonicus* (Hymenoptera: Scelionidae)

Warren H. L. Wong,[1,4] Matt A. Walz,[2,3] Angela B. Oscienny,[2,3] Jade L. Sherwood,[2,3] and Paul K. Abram[3]

Biological Control 156 (2021) 104534

Contents lists available at ScienceDirect

Biological Control

journal homepage: www.elsevier.com/locate/ybcon

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Biological Control

Check for updates

Optimization of *Trissolcus japonicus* cold storage methods for biological control of *Halyomorpha halys*

Theresa Cira, Erica Nystrom Santacruz, Robert L. Koch *

Environmental Entomology, XX(XX), 2021, 1–11
doi: 10.1093/ee/nvaa183
Research

OXFORD

Biological Control - Parasitoids and Predators

Influence of Holding Conditions and Storage Duration of *Halyomorpha halys* (Hemiptera: Pentatomidae) Eggs on Adventive and Quarantine Populations of *Trissolcus japonicus* (Hymenoptera: Scelionidae) Behavior and Parasitism Success

Dalton C. Ludwick,[1,2,7] Layne B. Leake,[3] William R. Morrison III,[4] Jesús R. Lara,[5] Mark S. Hoddle,[5] Elijah J. Talamas,[6] and Tracy C. Leskey[1]

- Adventive populations of *T. japonicus* in North America
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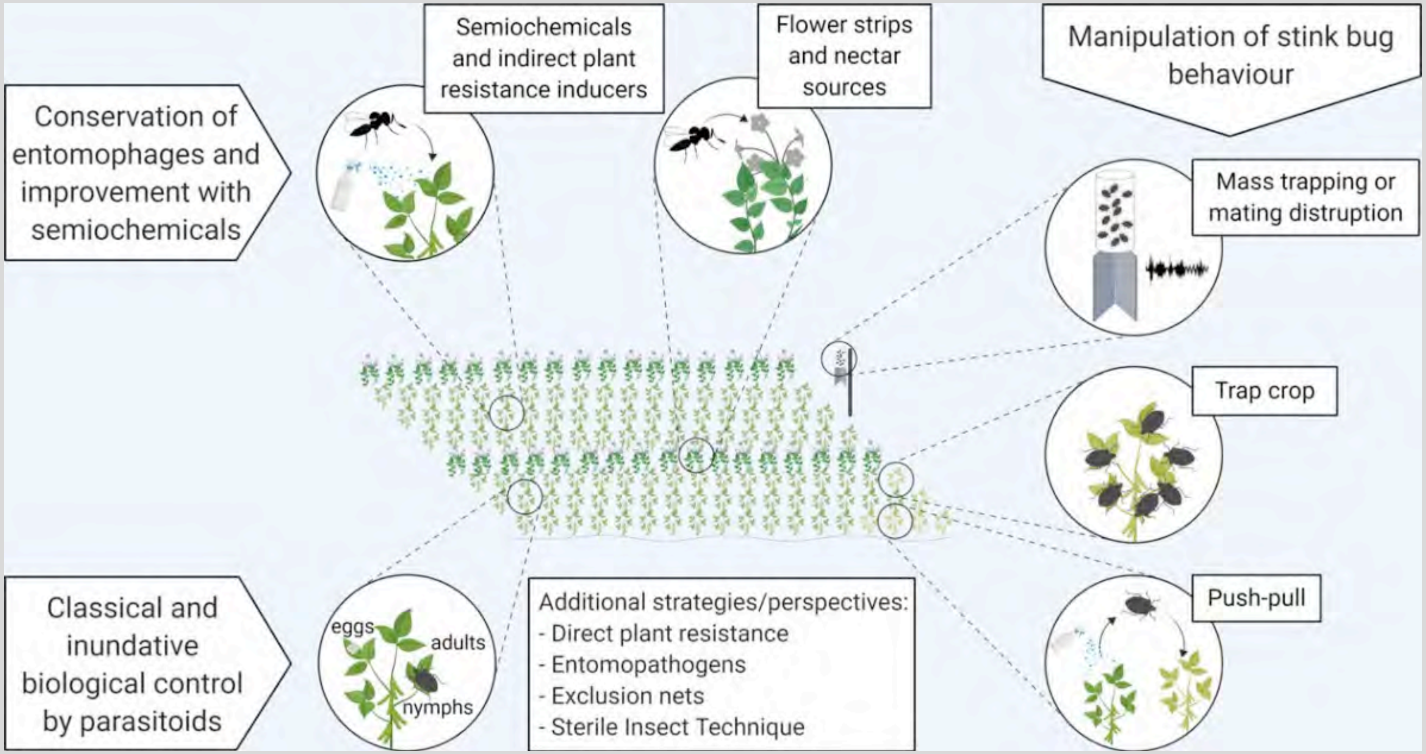
Options for combining biocontrol with semiochemical-based approaches & other methods to increase natural enemy efficacy in managing BMSB



Conti et al. 2020. Biological control of invasive stink bugs: review of global state and future prospects. Ent. Exp. Appl. – *in press*

How will presence of insecticides affect *T. japonicus*?

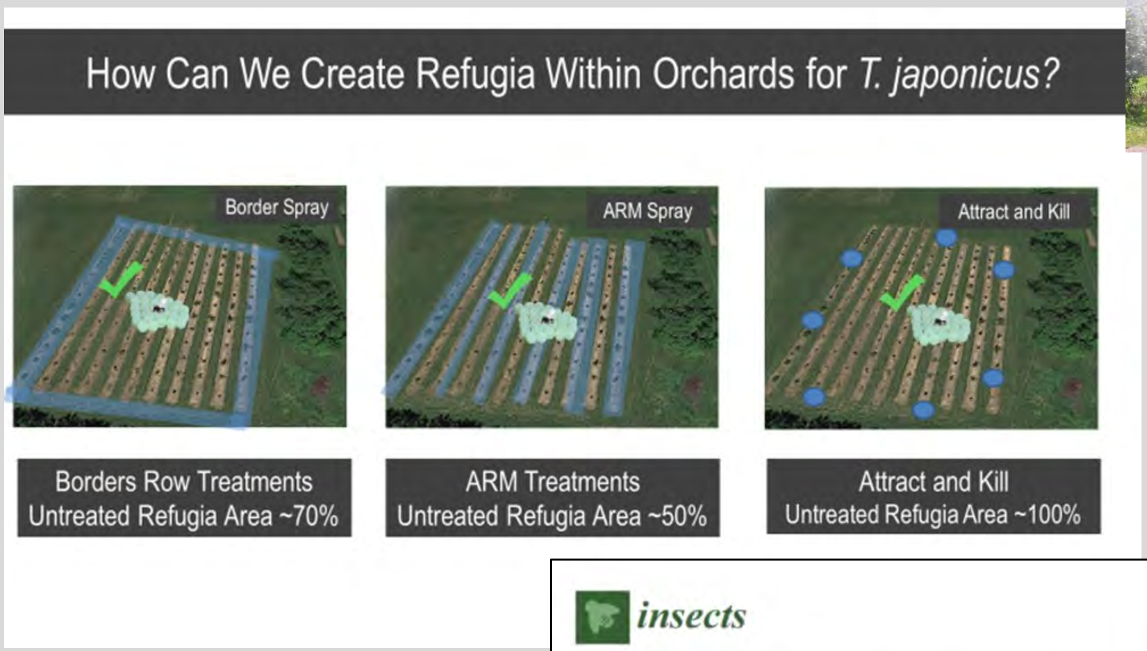
- How does insecticide exposure impact *T. japonicus* foraging in treated vs. untreated areas of orchard agroecosystems?
- How does insecticide exposure impact *T. japonicus* emergence of progeny?
- What impact does insecticide exposure have on developing *T. japonicus* larvae inside egg masses in treated and untreated areas of orchard agroecosystems?

Photo Credit: TJ Mullinax

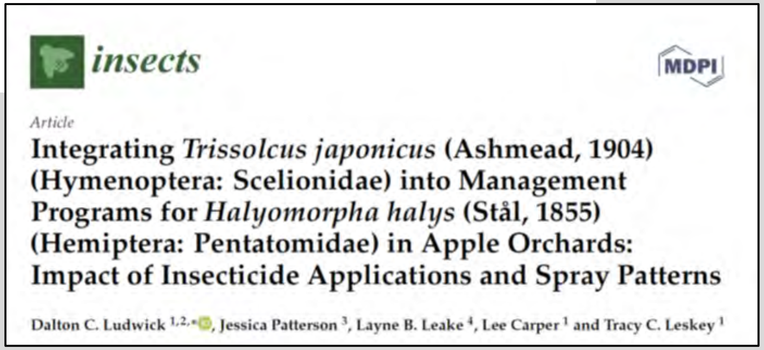
Insecticides Evaluated
Lannate(Methomyl)
Belay (Clothianidin)
Endigo (Thiamethoxam + λ-cyhalothrin)
Brigade (Bifenthrin)

Spray Patterns
Border
Alternate Row Middle
Complete

Egg Mass Deployment Locations
Treated Border Row
Treated Interior Row
Untreated Interior Row
Untreated Woodline



Slide data from
T. Leskey
USDA ARS



insects

MDPI

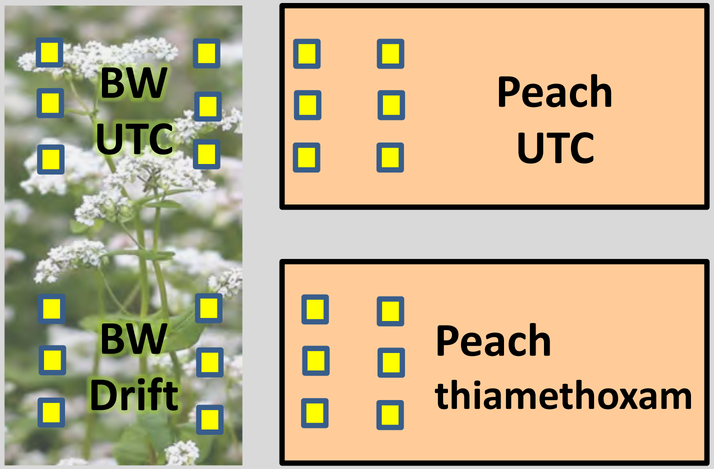
Article

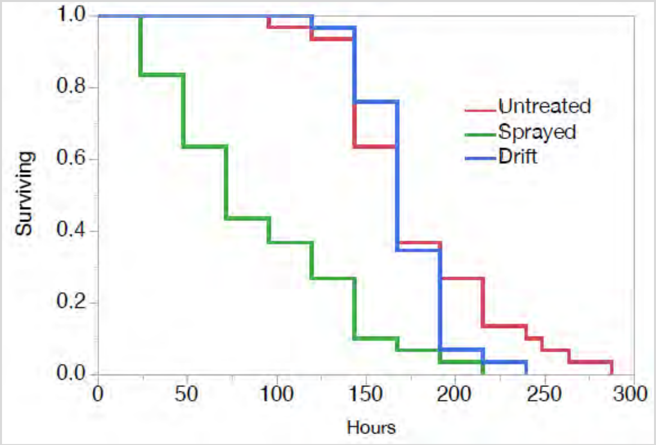
Integrating *Trissolcus japonicus* (Ashmead, 1904) (Hymenoptera: Scelionidae) into Management Programs for *Halyomorpha halys* (Stål, 1855) (Hemiptera: Pentatomidae) in Apple Orchards: Impact of Insecticide Applications and Spray Patterns

Dalton C. Ludwick [1,2,*], Jessica Patterson [3], Layne B. Leake [4], Lee Carper [1] and Tracy C. Leskey [1]

Does Insecticide Drift Impact T. japonicus?

- Three treatments:
  - Untreated control (UTC)
  - Thiamethoxam drift (peaches were treated)
  - Thiamethoxam treated (buckwheat [BW] sprayed)
- Buckwheat flowers were collected, added to vials with *T. japonicus,* and monitored daily for survival
- Preliminary data showed no significant difference in survival between drift and unsprayed buckwheat





Nielsen / Rutgers lab group findings:
Low persistence of *T. japonicus* in habitats (or poor recovery). Insectary plants can increase fitness and survivorship, but more studies on field-scale impacts to biological control are needed.

Conserving *T. japonicus* populations with floral resources

insects MDPI

Article

Floral Resources for *Trissolcus japonicus*, a Parasitoid of *Halyomorpha halys*

Hanna R. McIntosh [1,2,*], Victoria P. Skillman [3], Gracie Galindo [2] and Jana C. Lee [2]

insects MDPI

Review

Ecosystem-Based Incorporation of Nectar-Producing Plants for Stink Bug Parasitoids

Glynn Tillman

	Enhance longevity compared to water	Enhance energetic reserves compared to water
Alyssum, sweet	no	no
Buckwheat	yes	Higher sugar reserves
Cilantro	yes	Higher sugar reserves
Clover, red	no	no
Dill	yes	Higher sugar & glycogen
Marigold, Nema-gone	no	no
Mustard, yellow	no	no
Phacelia, lacy	no	no

USDA ARS / J Lee lab

Retention of *T. japonicus* with floral resources

- Egg masses in field plots
  - buckwheat, dill, alyssum, and wildflowers
- 83 parasitized egg masses released
- **Low recovery rate** (4/81 vacuum samples)

- Flowering buckwheat (resource rich)
- Mowed Grass (resource poor)
- Released 1600 adult *T. japonicus*
- **Low recapture rate** (yellow SC)

Impact of cover crop floral resources:
- Y-tube trials
- Longevity and fecundity studies

USDA ARS J Lee & OSU N Wiman labs

Utah State / D Alston/L Spears labs

Rutgers / A Nielsen lab

- Adventive populations of *T. japonicus* in North America
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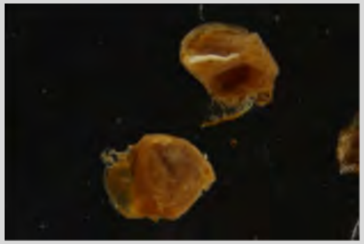
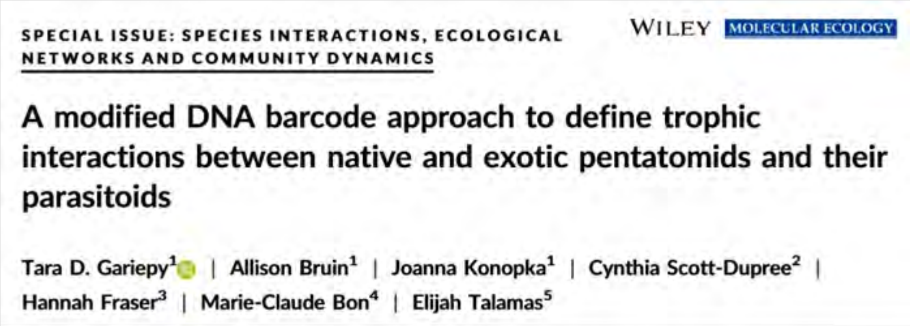
Potential non-target impacts of T. japonicus

Successful parasitism

Unsuccessful parasitism (but host also dies)



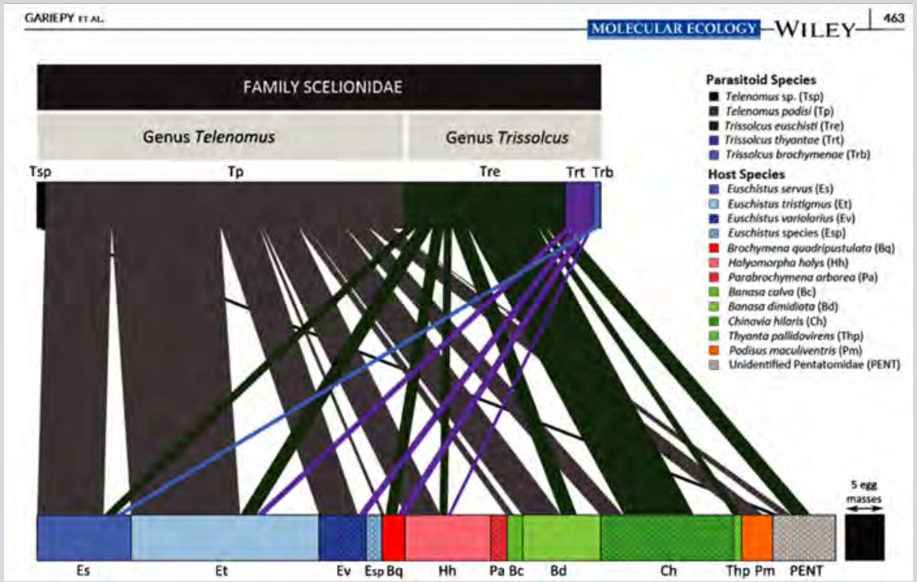


SPECIAL ISSUE: SPECIES INTERACTIONS, ECOLOGICAL NETWORKS AND COMMUNITY DYNAMICS

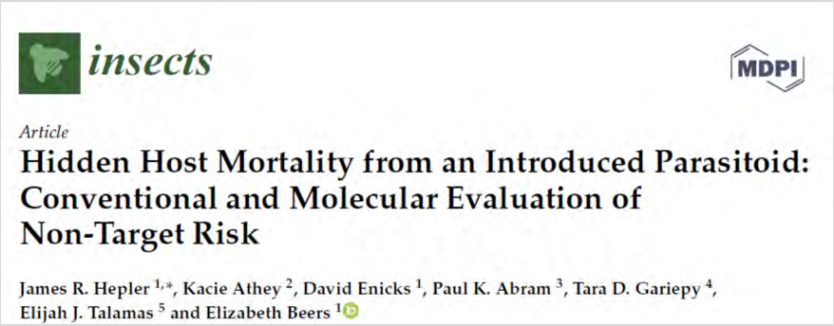
WILEY MOLECULAR ECOLOGY

A modified DNA barcode approach to define trophic interactions between native and exotic pentatomids and their parasitoids

Tara D. Gariepy[1] | Allison Bruin[1] | Joanna Konopka[1] | Cynthia Scott-Dupree[2] | Hannah Fraser[3] | Marie-Claude Bon[4] | Elijah Talamas[5]



Potential non-target impacts of T. japonicus



insects MDPI

Article

Hidden Host Mortality from an Introduced Parasitoid: Conventional and Molecular Evaluation of Non-Target Risk

James R. Hepler [1,*], Kacie Athey [2], David Enicks [1], Paul K. Abram [3], Tara D. Gariepy [4], Elijah J. Talamas [5] and Elizabeth Beers [1]

Biological Control 149 (2020) 104324

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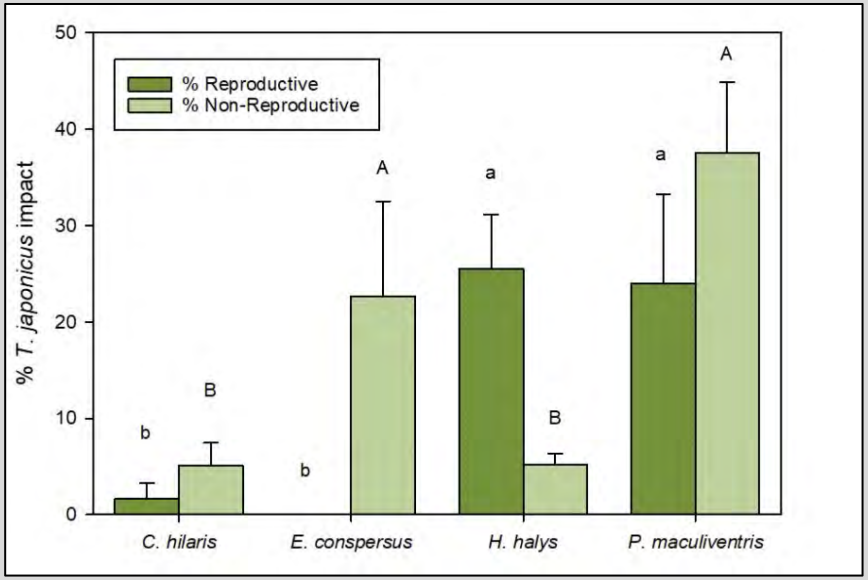
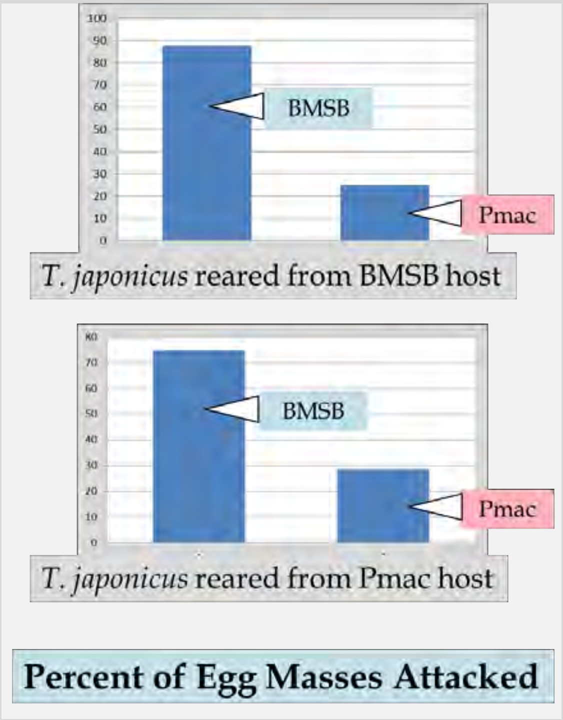
Biological Control

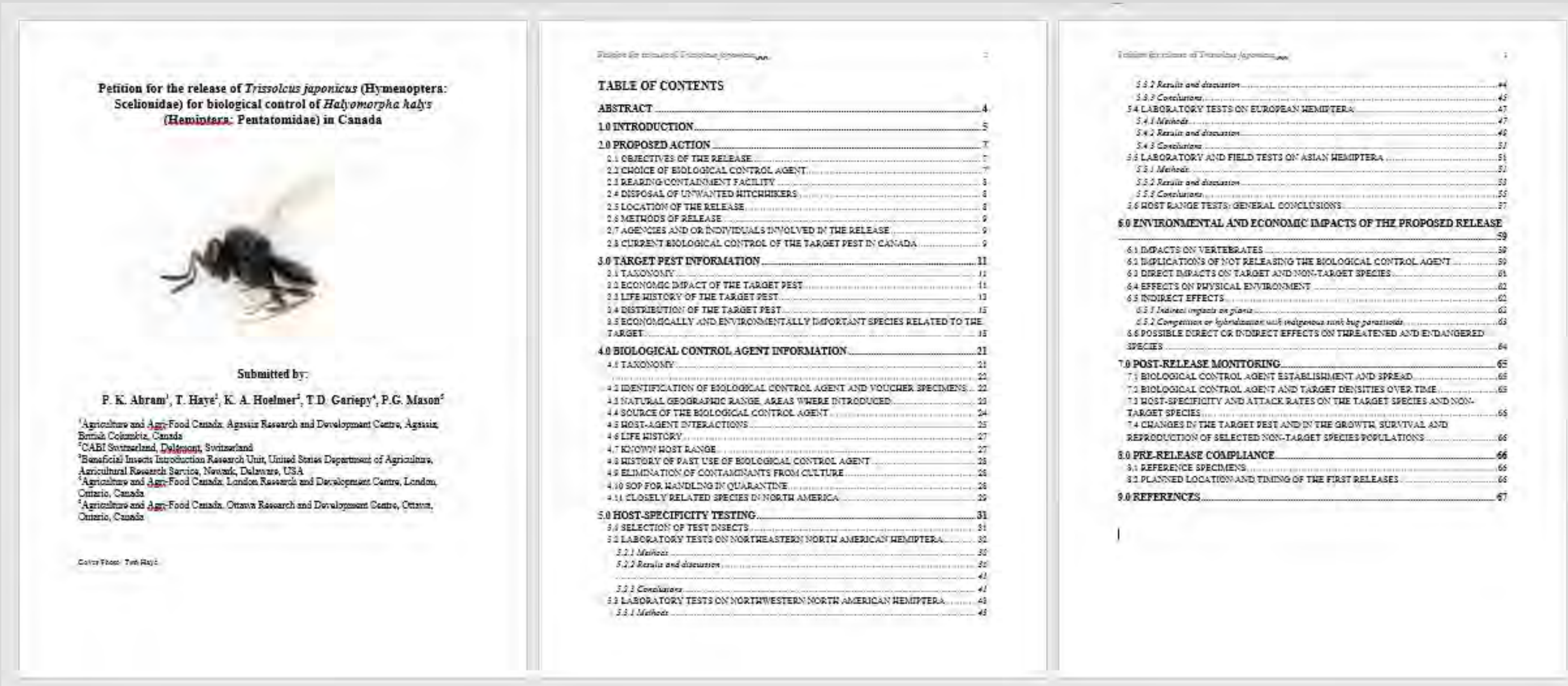
journal homepage: www.elsevier.com/locate/ybcon

Parental host species affects behavior and parasitism by the pentatomid egg parasitoid, *Trissolcus japonicus* (Hymenoptera: Scelionidae)

Sean M. Boyle[a,*], Donald C. Weber[b], Judith Hough-Goldstein[c], Kim A. Hoelmer[d]







Petition for the release of *Trissolcus japonicus* (Hymenoptera: Scelionidae) for biological control of *Halyomorpha halys* (Hemiptera: Pentatomidae) in Canada

Submitted by:

P. K. Abram[1], T. Haye[2], K. A. Hoelmer[3], T.D. Gariepy[4], P.G. Mason[5]

[1]Agriculture and Agri-Food Canada, Agassiz Research and Development Centre, Agassiz, British Columbia, Canada
[2]CABI Switzerland, Delémont, Switzerland
[3]Beneficial Insects Introduction Research Unit, United States Department of Agriculture, Agricultural Research Service, Newark, Delaware, USA
[4]Agriculture and Agri-Food Canada, London Research and Development Centre, London, Ontario, Canada
[5]Agriculture and Agri-Food Canada, Ottawa Research and Development Centre, Ottawa, Ontario, Canada

Cover Photo: Tim Haye

TABLE OF CONTENTS

- Petition for field release was filed in Canada in 2018
  - Rejected due to potential non-target risk, particularly to predatory pentatomids
  - Until/unless more data shows differences in host specificity between different geographic populations.
- Petition for field release in U.S. is nearly complete – will include redistribution of adventive populations and "Beijing" population


HEALTH AND BIOSECURITY
www.csiro.au

Biological control stocktake for the brown marmorated stink bug *Halyomorpha halys* Stål

Dr Valerie Caron

15 February 2019

- Studies of potential Australian natural enemies of BMSB needed
- *T. mitsukurii* is already present in Australia (introduced against *Nezara viridula*)
- Host specificity testing needed for *T. japonicus* & *T. mitsukurii*
- *T. japonicus* unlikely to be permitted if many native Australian pentatomids are attacked (77 spp. recorded)

Other countries regulatory approaches


EPA advice for application APP203336

Environmental Protection Authority
Te Mana Rauhi Taiao

Staff Assessment Report

June 2018

APP203336: An application to seek pre-approval to release *Trissolcus japonicus* (the Samurai wasp) as a biocontrol agent for brown marmorated stink bug should it arrive in New Zealand

Purpose	
Application number	
Application type	
Applicant	
Date formally received	


Environmental Protection Authority
Te Mana Rauhi Taiao

Decision

August 2018

Date	22 August 2018
Application code	APP203336
Application type	To import for release and/or release from containment any new organism with controls under section 38A of the Hazardous Substances and New Organisms Act 1996
Applicant	Brown Marmorated Stink Bug Council
Date application received	26 March 2018

Pre-emptive Biological Control of BMSB in New Zealand

- NZ EPA weighs both beneficial and adverse effects of introductions
- Conditional release of *T. japonicus* to support an eradication program in the event of a BMSB incursion.
- If BMSB becomes established, an unconditional release approval may be requested at that time.

Further research needed

- What factors influence the dispersal of *T. japonicus*?
- What factors influence the retention of *T. japonicus*?
- Occurrence of associated endosymbionts
- Occurrence of *Nosema* pathogens
- Overwintering limitations
- Diversity & composition of local vegetation
- Competition with native predators & parasitoids

Thank You

It’s time for a few polling questions