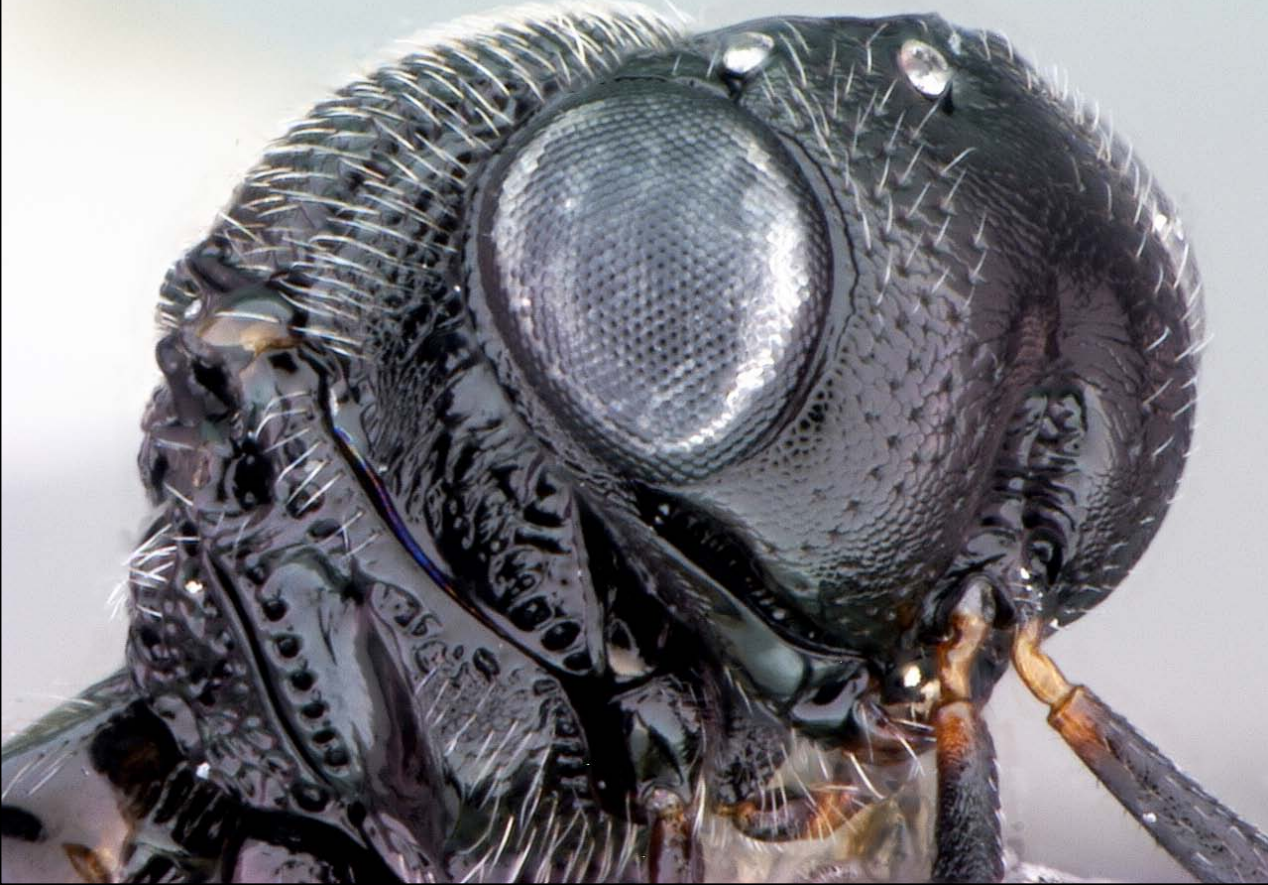


# Taxonomy of scelionid wasps and biological control of invasive stink bugs

*Trissolcus strabus*



*Gryon* sp.



“Simply put, it is impossible to conduct meaningful ecological research without being able to accurately and repeatedly identify the species involved.”

Dangerfield et al. (2001)

# **Biological control programs require accurate identification**

- Science hinges on repeatability
- High cost of incorrect identification
- Taxonomic name is needed to introduce biocontrol agents

## **Taxonomic preparedness enables efficient response**

- Rapid identification of parasitoids for host range testing
- Discovery and provenance of adventive populations
- Information about host associations
  - necessary for biocontrol
  - educated guesses about taxa of interest

## **Collaboration is necessary and synergistic**

- Molecular diagnostics
- Molecular phylogenetics
- Biological and behavioral data
- Parasitoid identification tools and workshops

*Halyomorpha halys* (Stål)

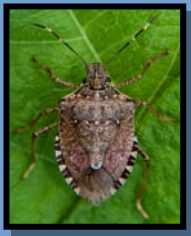


Photo by Stephen Schoof

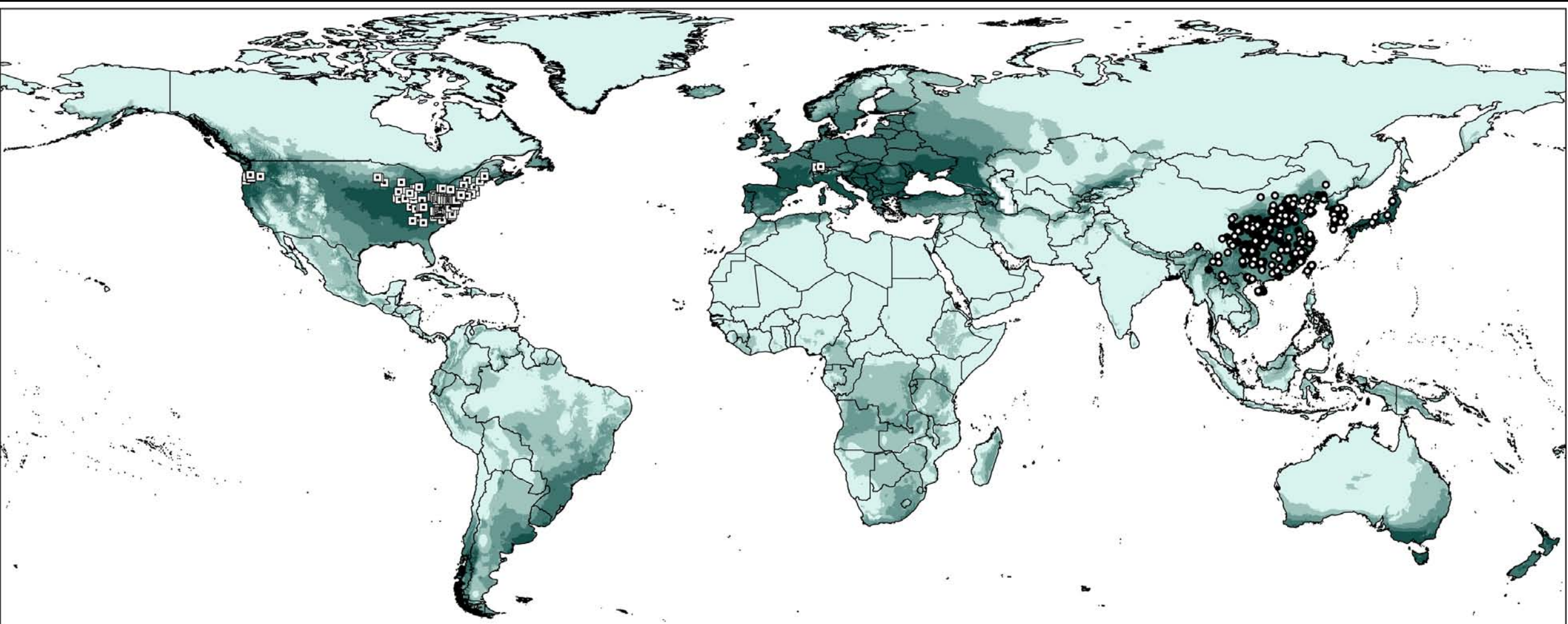
*Bagrada hilaris* (Burmeister)



Photo by Ton Rulkens



# BMSB



# BMSB threatens \$40 billion of agriculture



# Beneficial Insect Introduction Research Unit (USDA/BIIRU)



Kim Hoelmer



Christine Dieckhoff

# 2013: Two candidate biocontrol agents

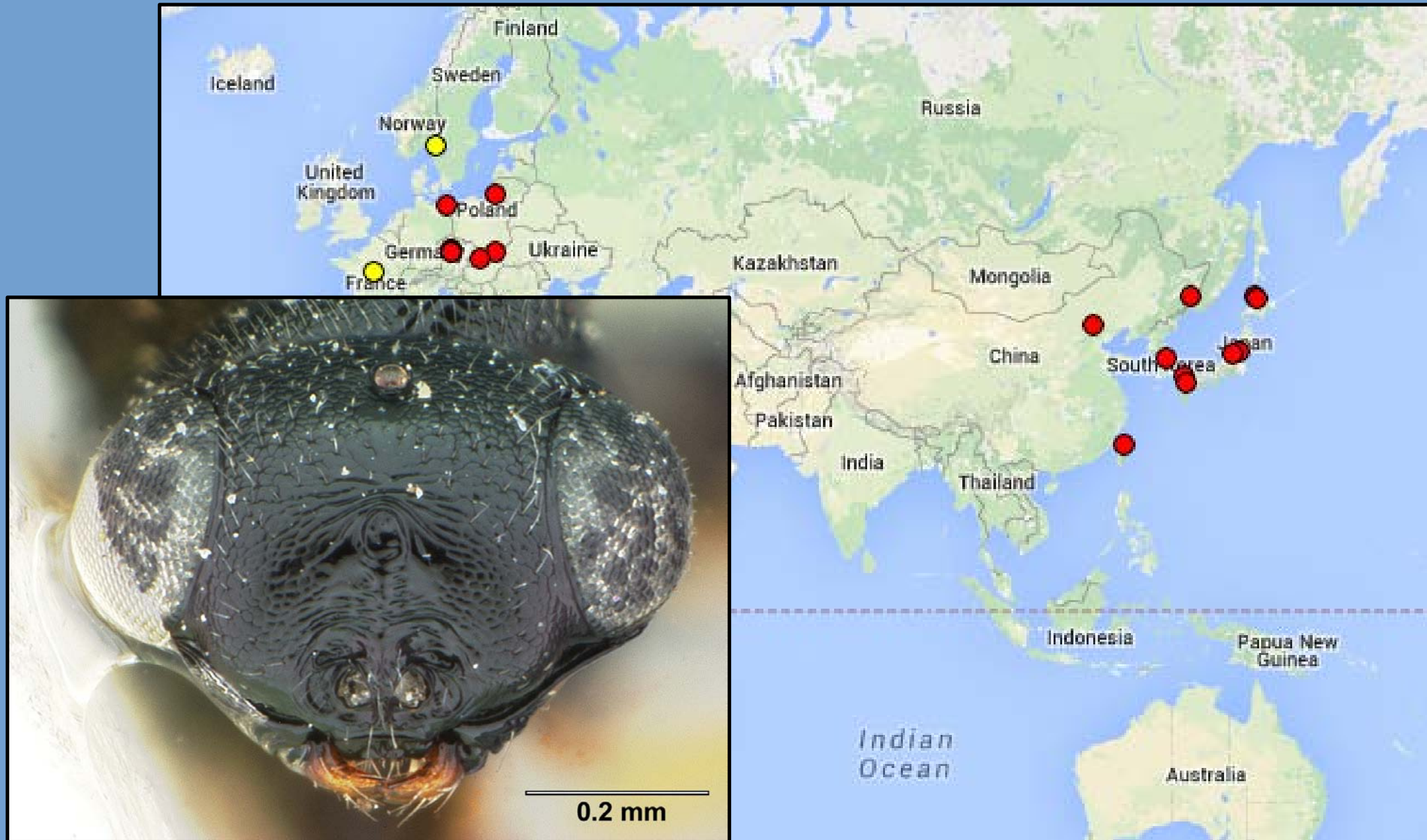


*Trissolcus flavipes*

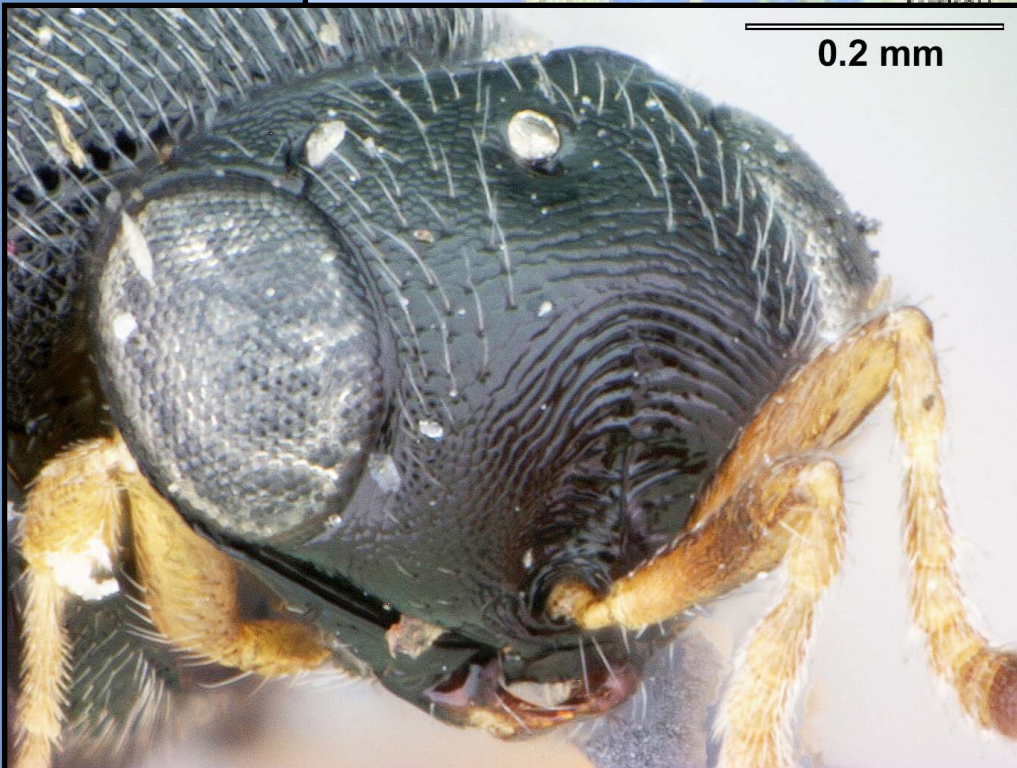


*Trissolcus halyomorphae*

# *Trissolcus flavipes* (Thomson) 1860



# *Trissolcus cultratus* (Mayr) 1879



*T. cultratus* erroneously synonymized  
with *T. flavipes* by Kozlov in 1968



All literature since 1968  
uses the wrong name



# *Trissolcus halyomorphae*



## A New Species of *Trissolcus* (Hymenoptera: Scelionidae) Parasitizing Eggs of *Halyomorpha halys* (Heteroptera: Pentatomidae) in China with Comments on Its Biology

ZHONG-QI YANG,<sup>1,2</sup> YAN-XIA YAO,<sup>1</sup> LAN-FEN QIU,<sup>3</sup> AND ZHONG-XIN LI<sup>4</sup>

Ann. Entomol. Soc. Am. 102(1): 39–47 (2009)

**ABSTRACT** A new species of *Trissolcus* Ashmead (Hymenoptera: Scelionidae), *Trissolcus halyomorphae* Yang, sp. nov., is described from China. It is a solitary parasitoid in eggs of *Halyomorpha halys* (Stål) (Hemiptera: Pentatomidae), an economic pest that causes severe damage to pear, apple and other fruit and that also feeds on the leaves and stems of ornamental and forest trees. The new species is the principal natural enemy of the stink bug, with parasitism rates up to 70% and an average annual rate of 50%. Because of its high parasitism rates and other biological features, it has good potential as a biocontrol agent of the pest. Type specimens are deposited in Insect Museum, Chinese Academy of Forestry, Beijing, China.

**KEY WORDS** *Halyomorpha halys*, *Trissolcus halyomorphae*, new species, egg parasitoid, biocontrol

*Halyomorpha halys* (Stål) (Hemiptera: Pentatomidae) is native to Asian countries, including China, Korea, and Japan (Hoffmann 1931, Hsiao 1977, Zhang 1985, Yasunaga et al. 1993, Kang et al. 2003). In China, it was formerly misidentified as *Halyomorpha picus* (F.) with the common name “brown marmorated stink bug” (Hsiao 1977, Zhang 1985, Zhang et al. 1993). In Japan, the bug has recently become a serious pest of fruit such as persimmon and apples (Goto et al. 2002; Funayama 2003, 2004; Toyama et al. 2006). In China, *H. halys* has become a serious polyphagous pest of soybean, vegetables, and tobacco, as well as many forest and ornamental trees, being especially harmful to orchards. It attacks many fruit, including pear, apple (He 1997, Zhang et al. 2007), peach, plum, cherry, pomegranate, common jujube, citrus, persimmon, mulberry, hawthorn, apricot, grape, kiwifruit, and strawberry. Adults of *H. halys* generally feed on the fruit, whereas nymphs feed on leaves, stems, and fruit. Damage by *H. halys* caused the surface of the fruit to become concave and unshapely, decreasing serious yields as well as quality decline, and resulting in economic loss. Furthermore, *H. halys* is recorded as a vector of *Paulownia* witches’ broom disease, an extremely destructive phytoplasma disease of *Paulownia* trees in China. Because of the economic importance of *Paulownia tomentosa* (Thunberg) Steudel, both the disease and *H. halys* have been considered to be se-

rious problems for forestation and “greening” in China (Jin et al. 1981).

*H. halys* was accidentally introduced into the United States (Hoebke 2002; Hoebke and Carter 2003; Bernon et al. 2003, 2004). It was first collected in September 1998 in Allentown, PA, but probably arrived several years earlier. As of April 2007, it was recorded in 24 counties in the state (Jacobs 2007). Subsequently, it was confirmed from several Mid-Atlantic states, as well as in Oregon, California, western Maryland, and West Virginia (Hamilton and Shearer 2003, Hamilton and Nielsen 2005). The list of states from which the pest is recorded will continue to increase as awareness increases (LaBonte 2005). In Pennsylvania, 73 economic plants are known to be hosts, of which 21 species are common hosts, including row crops (soybean), fruit trees (both stone fruit and pomes), ornamentals (butterfly bush), and vegetables (leaves also attacked) (Bernon 2004). According to Bernon (2004), the final distribution of the pest in North America will be similar to *Acrosternum hilare* (Say), the green stink bug, which ranges from Quebec and New England west through southern Canada and the northern United States to the Pacific Coast and south and southwest to Florida, Texas, Arizona, Utah, and California (Bernon et al. 2003). Increasing attention is now being paid to *H. halys* in North America, and there are many studies being made on tracking its expanding distribution, its natural enemies, biocontrol, and integrated pest management (Bernon 2004, Hamilton and Nielsen 2005, Rider 2008).

*H. halys* severely attacks many fruit in China. In Heze, Shandong Province, normally 10–25% of pears and sometimes up to 35% of pears were damaged (Ming et al. 2001), whereas 40–60% of pears in Hebei

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<sup>4</sup> Plant Protection College, Shandong Agricultural University, Tai'an 271018, Shandong, China.

# *Trissolcus halyomorphae*



No primary types examined

## A New Species of *Trissolcus* (Hymenoptera: Scelionidae) Parasitizing Eggs of *Halyomorpha halys* (Heteroptera: Pentatomidae) in China with Comments on Its Biology

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<sup>3</sup> Research Institute of Beijing Horticulture, Beijing 100102, China.

<sup>4</sup> Plant Protection College, Shandong Agricultural University, Tai'an 271018, Shandong, China.

## New synonymy of *Trissolcus halyomorphae* Yang

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Corresponding author: Elijah J. Talamas (talamas.1@osu.edu)

Academic editor: Stefan Schmidt | Received 23 May 2013 | Accepted 24 June 2013 | Published 1 August 2013

**Citation:** Talamas EJ, Buffington M, Hoelmer K (2013) New synonymy of *Trissolcus halyomorphae* Yang. Journal of Hymenoptera Research 33: 113–117. doi: 10.3897/JHR.33.5627

### Abstract

*Trissolcus halyomorphae* Yang **syn. n.** is treated as a junior synonym following examination of the holotype of *T. japonicus* (Ashmead).

### Keywords

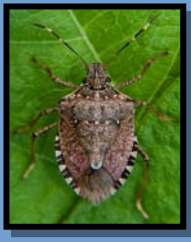
*Halyomorpha halys*, *Trissolcus japonicus*, *Trissolcus halyomorphae*, brown marmorated stink bug

### Introduction

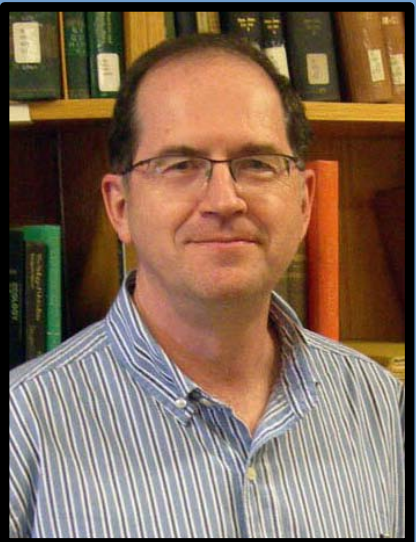
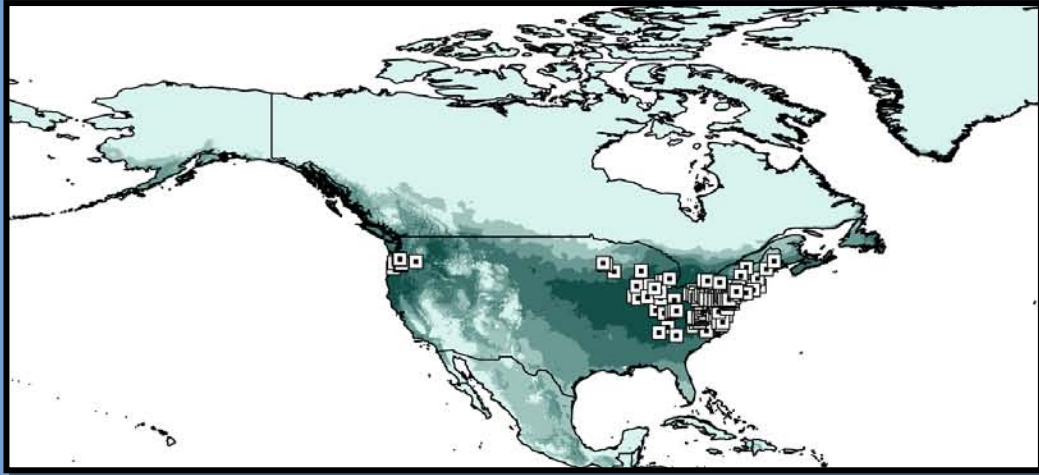
*Halyomorpha halys* (Stål) (Hemiptera: Pentatomidae), commonly called the brown marmorated stink bug, is a polyphagous invasive pest in the Mid-Atlantic United States and is recorded from 39 of the 48 contiguous states (Carter and Hoebeke 2003, Leskey et al. 2012). It has also become established in Switzerland (Wermelinger et al. 2008) and has been intercepted in New Zealand (Harris 2010). The distribution and abundance of this insect in both North America and Europe are expected to grow (Zhu et al. 2012), drawing increased attention to the need for management strategies, including biological control. Multiple species of egg parasitoid wasps in the genus *Trissolcus* (Hymenoptera: Platygasteridae) are currently the subject of a biological control



*Trissolcus japonicus*



# Nearctic *Trissolcus*



REVISION OF THE NEW WORLD SPECIES OF THE THYANTAE GROUP OF  
*TRISSOLCUS* (HYMENOPTERA: SCELIONIDAE)

NORMAN F. JOHNSON  
Department of Entomology, The Ohio State University, Columbus, Ohio 43210

REVISION OF THE NEARCTIC SPECIES OF THE  
*TRISSOLCUS FLAVIPES* GROUP  
(HYMENOPTERA: SCELIONIDAE)

NORMAN F. JOHNSON

SYSTEMATICS OF NEW WORLD *TRISSOLCUS* (HYMENOPTERA: SCELIONIDAE):  
SPECIES RELATED TO *T. BASALIS*

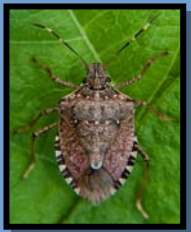
NORMAN F. JOHNSON  
Department of Entomology, The Ohio State University, Columbus, Ohio 43210

Cleaned up the historical  
mess in North America

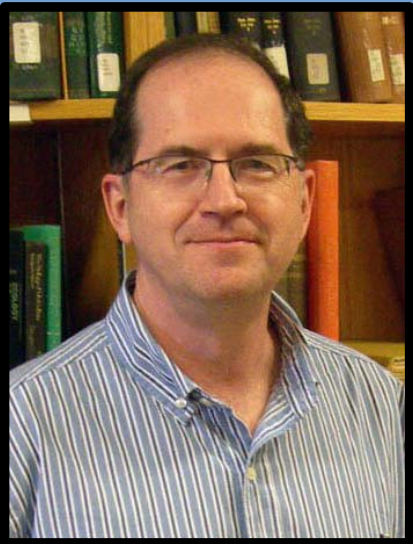
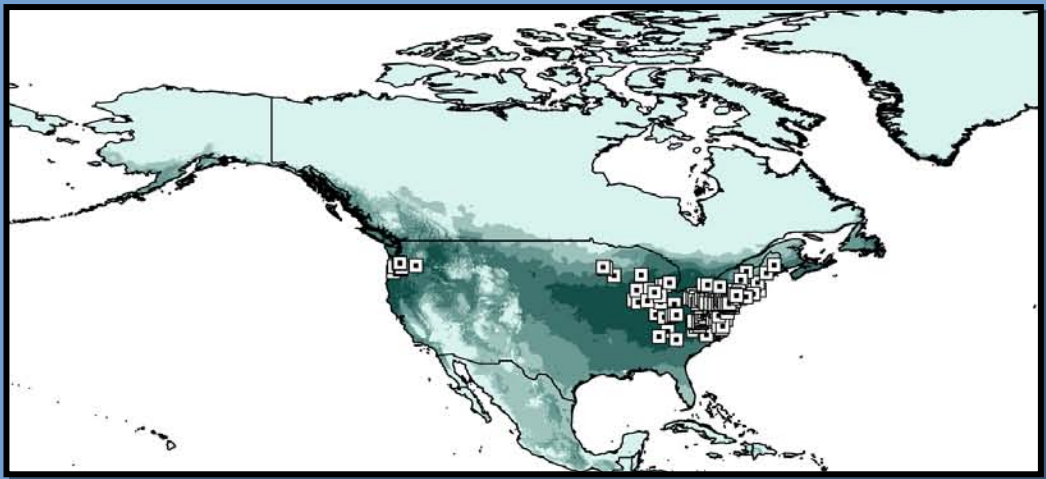
Numerous synonymies

Species concepts based on  
geographically diverse  
specimens

Norman Johnson



# Nearctic *Trissolcus*



## REVISION OF THE NEW WORLD SPECIES OF THE THYANTAE GROUP OF *TRISSOLCUS* (HYMENOPTERA: SCELIONIDAE)

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## REVISION OF THE NEARCTIC SPECIES OF THE *TRISSOLCUS FLAVIPES* GROUP (HYMENOPTERA: SCELIONIDAE)

NORMAN F. JOHNSON

## SYSTEMATICS OF NEW WORLD *TRISSOLCUS* (HYMENOPTERA: SCELIONIDAE): SPECIES RELATED TO *T. BASALIS*

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JHR 43: 45–110 (2015)  
doi: 10.3897/JHR.43.8560  
<http://jhr.pensoft.net>

MONOGRAPH



JOURNAL OF  
**Hymenoptera**  
The International Society of Hymenopterists  
RESEARCH

### Key to Nearctic species of *Trissolcus* Ashmead (Hymenoptera, Scelionidae), natural enemies of native and invasive stink bugs (Hemiptera, Pentatomidae)

Elijah J. Talamas<sup>1</sup>, Norman F. Johnson<sup>2</sup>, Matthew Buffington<sup>1</sup>

<sup>1</sup> Systematic Entomology Laboratory, USDA/ARS c/o NMNH, Smithsonian Institution, Washington DC, USA  
<sup>2</sup> Department of Evolution, Ecology and Organismal Biology, The Ohio State University, Columbus, OH 43212, USA

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<http://zoobank.org/400C0A04-5BB0-4653-9A87-535B5CA22D0C>

**Citation:** Talamas EJ, Johnson NF, Buffington M (2015) Key to Nearctic species of *Trissolcus* Ashmead (Hymenoptera, Scelionidae), natural enemies of native and invasive stink bugs (Hemiptera, Pentatomidae). *Journal of Hymenoptera Research* 43: 45–110. doi: 10.3897/JHR.43.8560

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**Abstract**

*Trissolcus japonicus* (Ashmead) and *T. cultratus* (Mayr), **comb. rev.** are under study as classical biological agents to control the brown marmorated stink bug *Halyomorpha halys* (Stål) in North America. Here we present diagnoses for all Nearctic species of *Trissolcus*, including *T. japonicus* and *T. cultratus* **comb. rev.**, and identification keys to enable separation of these species from the existing fauna. *Trissolcus cultratus* **comb. rev.** is removed from synonymy with *T. flavipes*. Two new species are described, *Trissolcus valkyria* **sp. n.** and *T. zakotos* **sp. n.** A neotype is designated for *T. brochymenae* and a lectotype is designated for *T. basalis*.

**Keywords**

*Trissolcus japonicus*, *Trissolcus cultratus*, *Trissolcus flavipes*, *Halyomorpha halys*, *Trissolcus*, Scelionidae, biological control, identification key, egg parasitoid

Means for identifying *T. japonicus*  
in North America

Norman Johnson



# Nearctic *Trissolcus*



## BMSB Working Group

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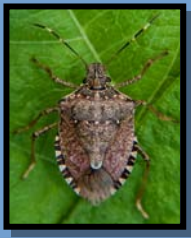
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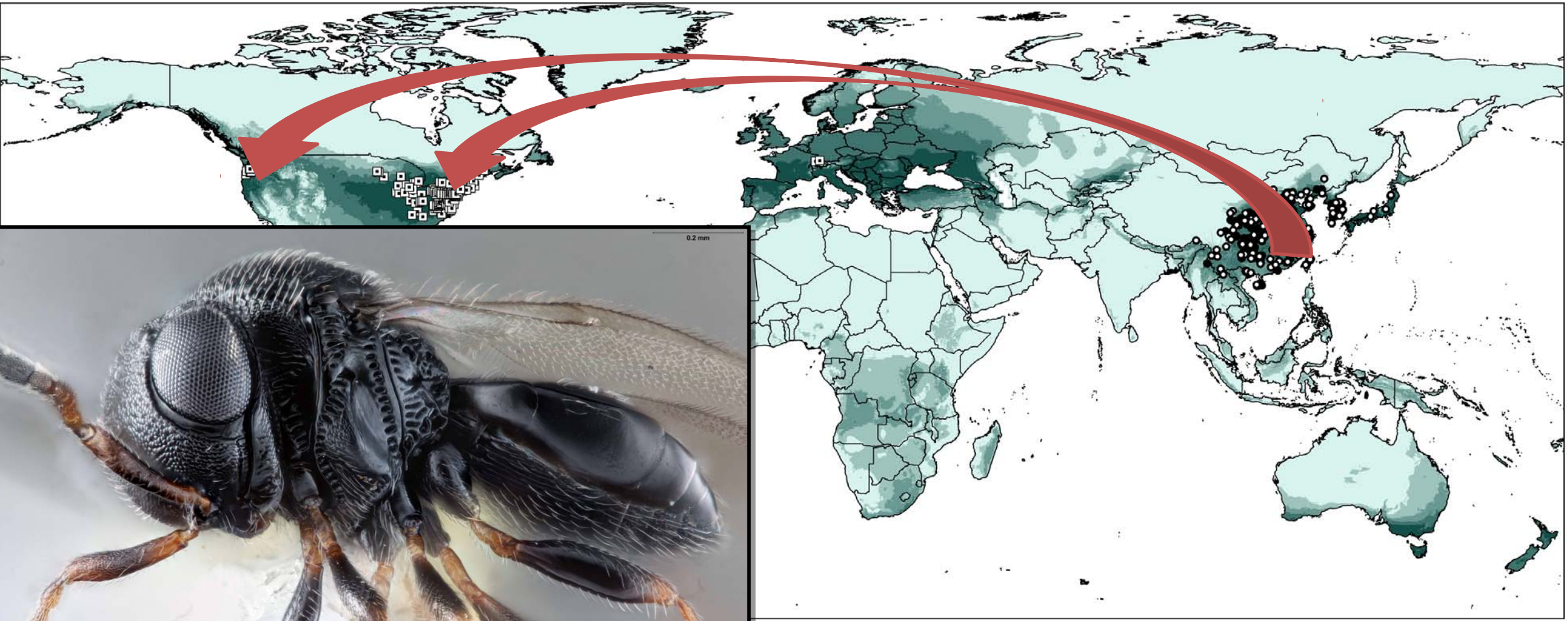
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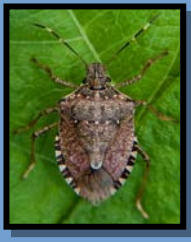
Means for identifying *T. japonicus*  
in North America



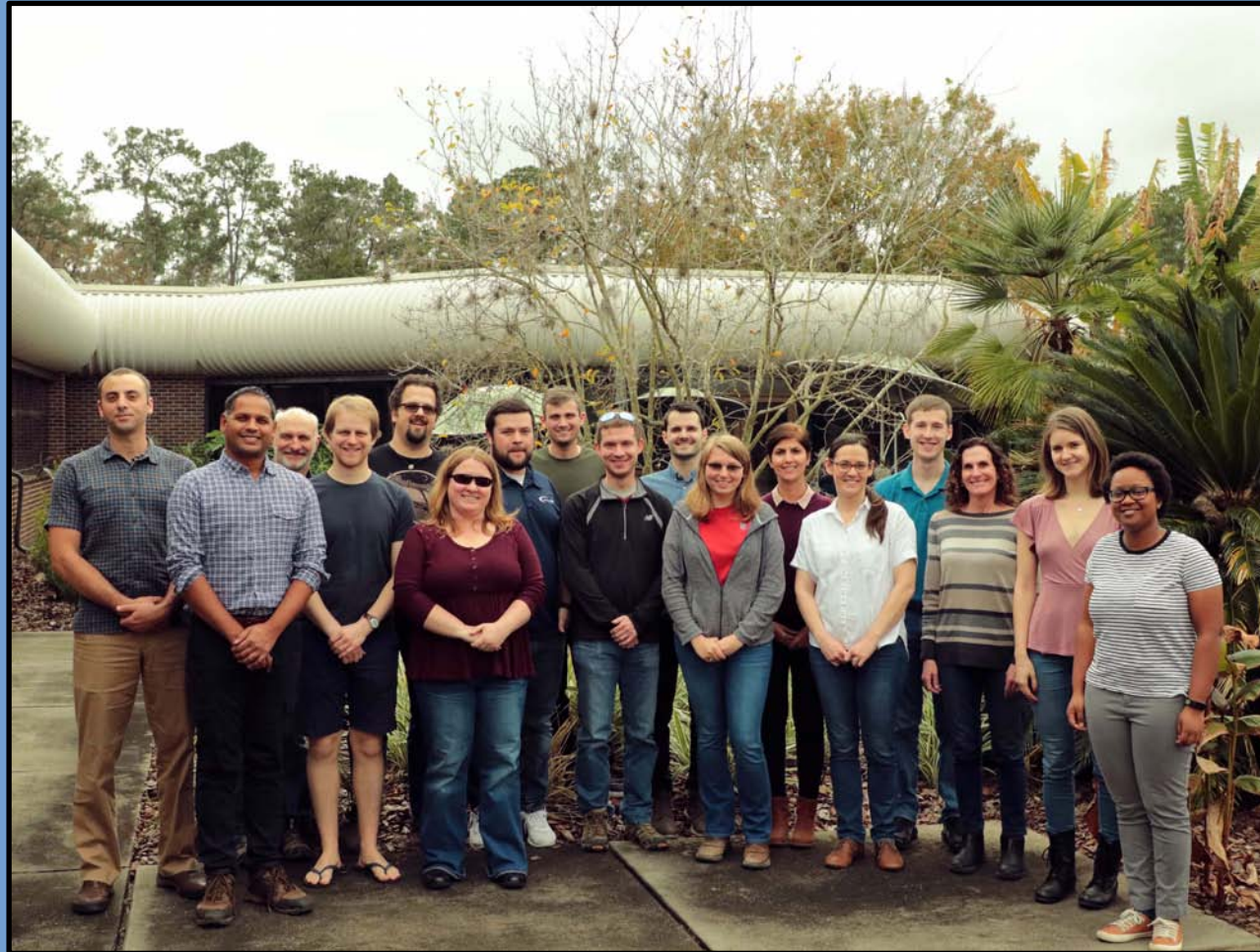
# Movement of *Trissolcus*



*Trissolcus japonicus*



# *Trissolcus* workshops



Annual workshops since 2013

- parasitoid identification
- protocols for preservation
- how to make life easy for me
- establish working relationships
- emphasize collaboration

Gainesville, Florida, 2019



# *Trissolcus* workshops



Montpellier, France, 2019



# Palearctic *Trissolcus*

JHR 56: 3–185 (2017)  
doi: 10.3897/jhr.56.10158  
<http://jhr.pensoft.net>

MONOGRAPH

JOURNAL OF  
**Hymenoptera**  
RESEARCH

## Revision of Palearctic *Trissolcus* Ashmead (Hymenoptera, Scelionidae)

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Academic editor: *M. Yoder* | Received 10 August 2016 | Accepted 26 April 2017 | Published 21 June 2017

<http://zoobank.org/C3D00EFB-D19C-4F86-95FF-C9D01780A9A1>

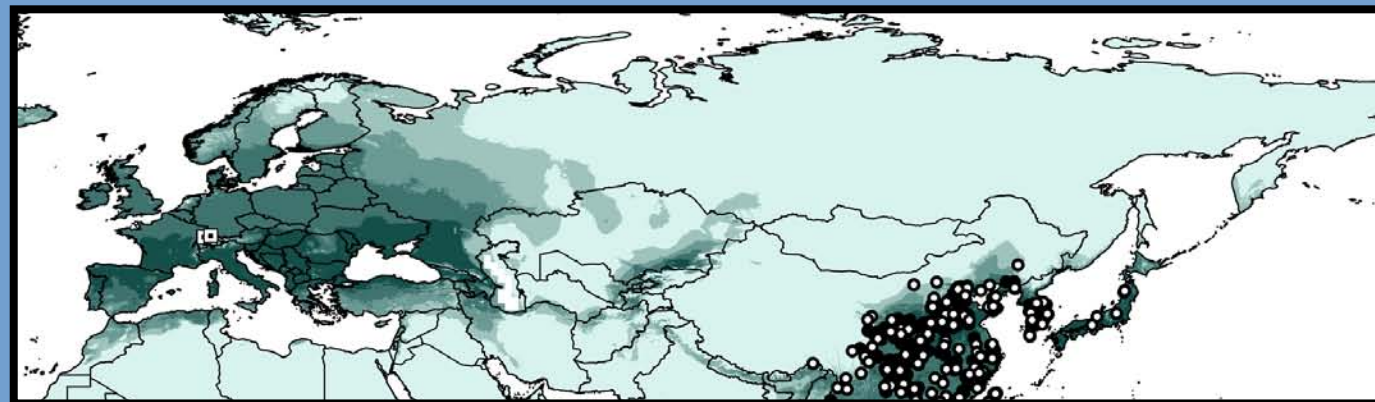
**Citation:** Talamas EJ, Buffington ML, Hoelmer K (2017) Revision of Palearctic *Trissolcus* Ashmead (Hymenoptera, Scelionidae). In: Talamas EJ, Buffington ML (Eds) Advances in the Systematics of Platygastridae. Journal of Hymenoptera Research 56: 3–185. <https://doi.org/10.3897/jhr.56.10158>

### Abstract

Species of *Trissolcus* Ashmead are potent natural enemies of stink bugs (Pentatomidae). Research on biological agents to control the brown marmorated stink bug, *Halyomorpha halys* (Stål) (BMSB), in Western Europe requires reliable taxonomic resources for identification of *Trissolcus* wasps. To aid this research endeavor, we present a species identification key to females of Palearctic *Trissolcus*. Morphological characters and concepts of the genus and species groups are discussed. We discovered a number of nomenclatural and identification issues that we here rectify.

### Keywords

*Halyomorpha halys*, Platygastridae, biological control, identification key, egg parasitoid



*Trissolcus rufiventris*



# Palearctic *Trissolcus*

JHR 56: 3–185 (2017)  
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MONOGRAPH



## Revision of Palearctic *Trissolcus* Ashmead (Hymenoptera, Scelionidae)

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**Citation:** Talamas EJ, Buffington ML, Hoelmer K (2017) Revision of Palearctic *Trissolcus* Ashmead (Hymenoptera, Scelionidae). In: Talamas EJ, Buffington ML (Eds) Advances in the Systematics of Platygastroidea. Journal of Hymenoptera Research 56: 3–185. <https://doi.org/10.3897/jhr.56.10158>

### Abstract

Species of *Trissolcus* Ashmead are potent natural enemies of stink bugs (Pentatomidae). Research on biological agents to control the brown marmorated stink bug, *Halymorpha halys* (Stål) (BMSB), in Western Europe requires reliable taxonomic resources for identification of *Trissolcus* wasps. To aid this research endeavor, we present a species identification key to females of Palearctic *Trissolcus*. Morphological characters and concepts of the genus and species groups are discussed. We discovered a number of nomenclatural and identification issues that we here rectify.

### Keywords

*Halymorpha halys*, Platygastroidea, biological control, identification key, egg parasitoid

- >50 species treated as junior synonyms
- Required significant efforts to examine types
  - Hanoi, Vietnam
  - St. Petersburg, Russia
  - Many curators contributed
- Taxonomic decision based on primary types
  - all types photographed, publicly available
  - “photo trail” of evidence
- Taxonomy is an iterative process



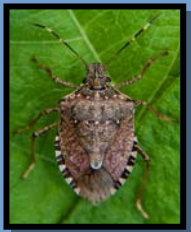
# Palearctic *Trissolcus*

- The oldest names in *Trissolcus* were from 1830's
  - Francis Walker's specimens in Dublin, Ireland
  - Visit to photograph types in 2018



*Trissolcus belenus* (Walker), 1836

0.5 mm

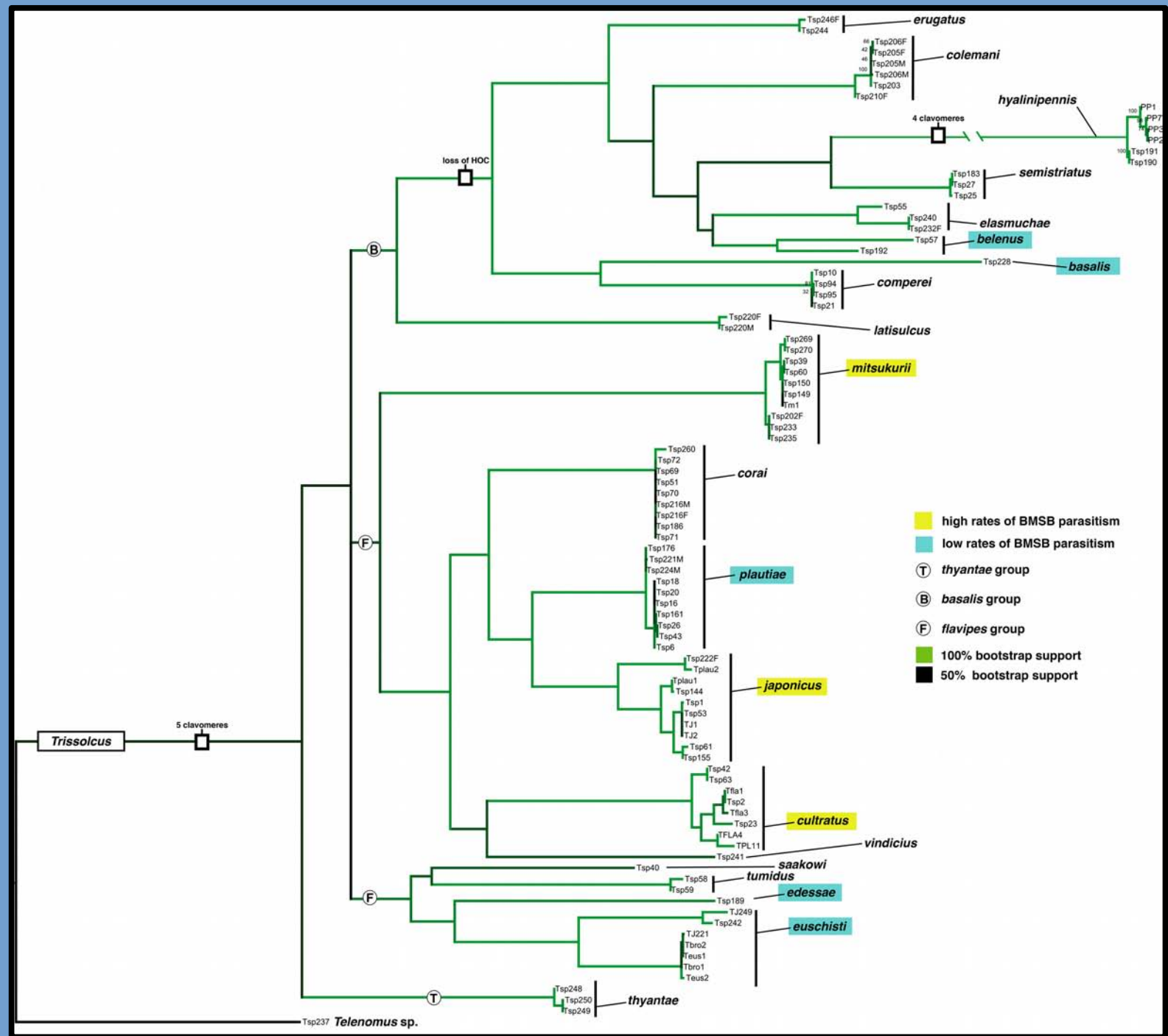


# Palearctic *Trissolcus*

- **Museum visits to Paris and Genoa in 2019**
  - Meeting with Francesco Tortorici
  - Determined that my concept of
    - *T. semistriatus* was a complex
    - of 4 species
  - Breeding experiments and molecular data



# Phylogeny of *Trissolcus*





# Palearctic *Trissolcus*



*Trissolcus belenus* (Walker), 1836



A peer-reviewed open-access journal  
**JOURNAL OF Hymenoptera**  
The International Society of Hymenopterists RESEARCH

**ADVANCES IN THE  
SYSTEMATICS OF  
PLATYGASTROIDEA II**

EDITED BY  
ELIJAH TALAMAS



*Proterosceliopsis plurima* Talamas, Shih & Ren

73 ♦ 2019  
Special Issue

[jhr.pensoft.net](http://jhr.pensoft.net)



**A morphological, biological and molecular approach  
reveals four cryptic species of *Trissolcus* Ashmead  
(Hymenoptera, Scelionidae), egg parasitoids of  
*Pentatomidae* (Hemiptera)**

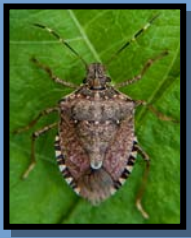
Francesco Tortorici<sup>1</sup>, Elijah J. Talamas<sup>2</sup>, Silvia T. Moraglio<sup>1</sup>, Marco G. Pansa<sup>1</sup>,  
Maryam Asadi-Farfar<sup>3</sup>, Luciana Tavella<sup>1</sup>, Virgilio Caleca<sup>4</sup>

<sup>1</sup> Dipartimento di Scienze Agrarie, Forestali e Alimentari (DISAFA), Entomologia Generale e Applicata, University of Torino, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy <sup>2</sup> Florida Department of Agriculture and Consumer Service, Division of Plant Industry, Gainesville, Florida, USA <sup>3</sup> Department of Plant Protection, Faculty of Agriculture, Urmia University, Urmia, Iran <sup>4</sup> Department of Agricultural, Food and Forest Sciences, University of Palermo, Edificio 5, Viale delle Scienze, 90128 Palermo, Italy

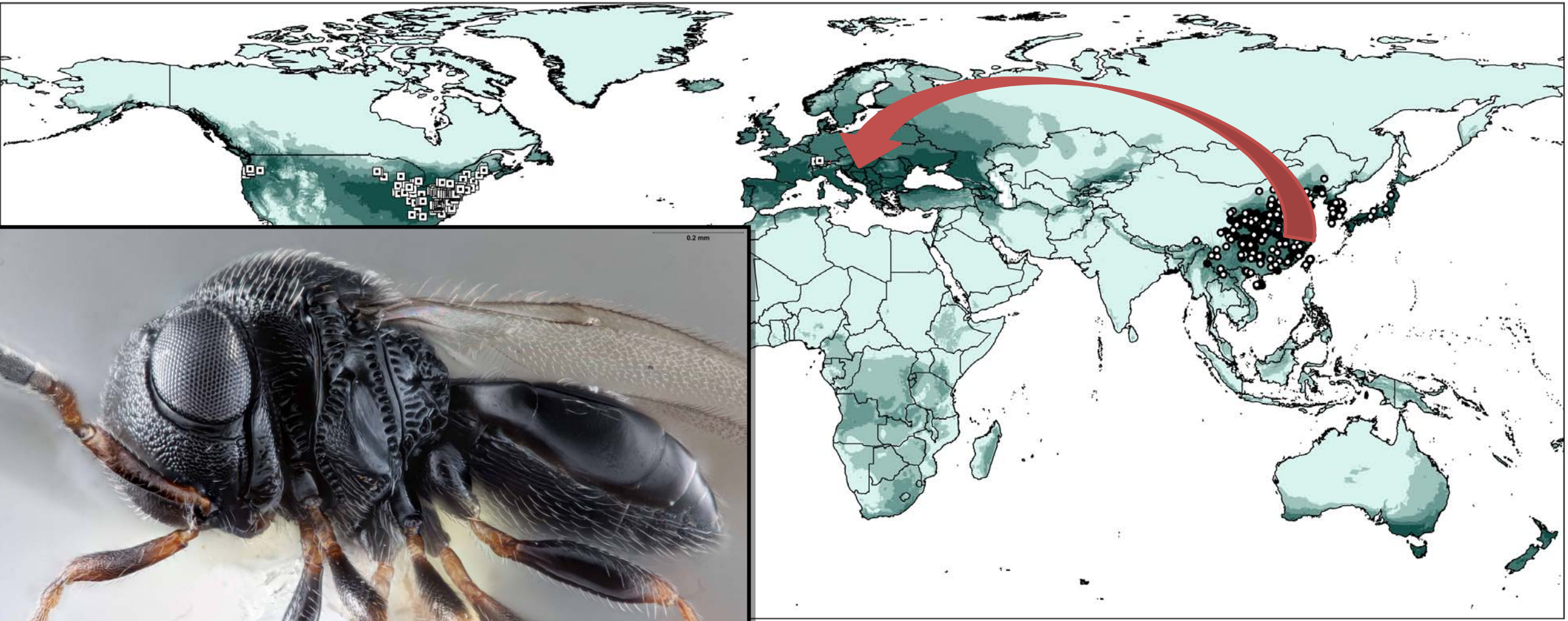
**Molecular phylogeny of *Trissolcus* wasps  
(Hymenoptera, Scelionidae) associated with  
*Halyomorpha halys* (Hemiptera, Pentatomidae)**

Elijah J. Talamas<sup>1,4</sup>, Marie-Claude Bon<sup>2</sup>, Kim A. Hoelmer<sup>3</sup>, Matthew L. Buffington<sup>4</sup>

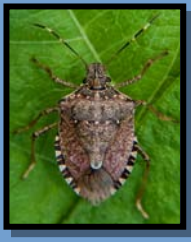
<sup>1</sup> Florida State Collection of Arthropods, Division of Plant Industry, Florida Department of Agriculture and Consumer Services, Gainesville, FL, USA <sup>2</sup> European Biological Control Laboratory, USDA/ARS, Montpellier, France <sup>3</sup> Beneficial Insects Introduction Research Unit, USDA/ARS, Newark, DE, USA <sup>4</sup> Systematic Entomology Laboratory, USDA/ARS c/o NMNH, Smithsonian Institution, Washington DC, USA



# Movement of *Trissolcus*



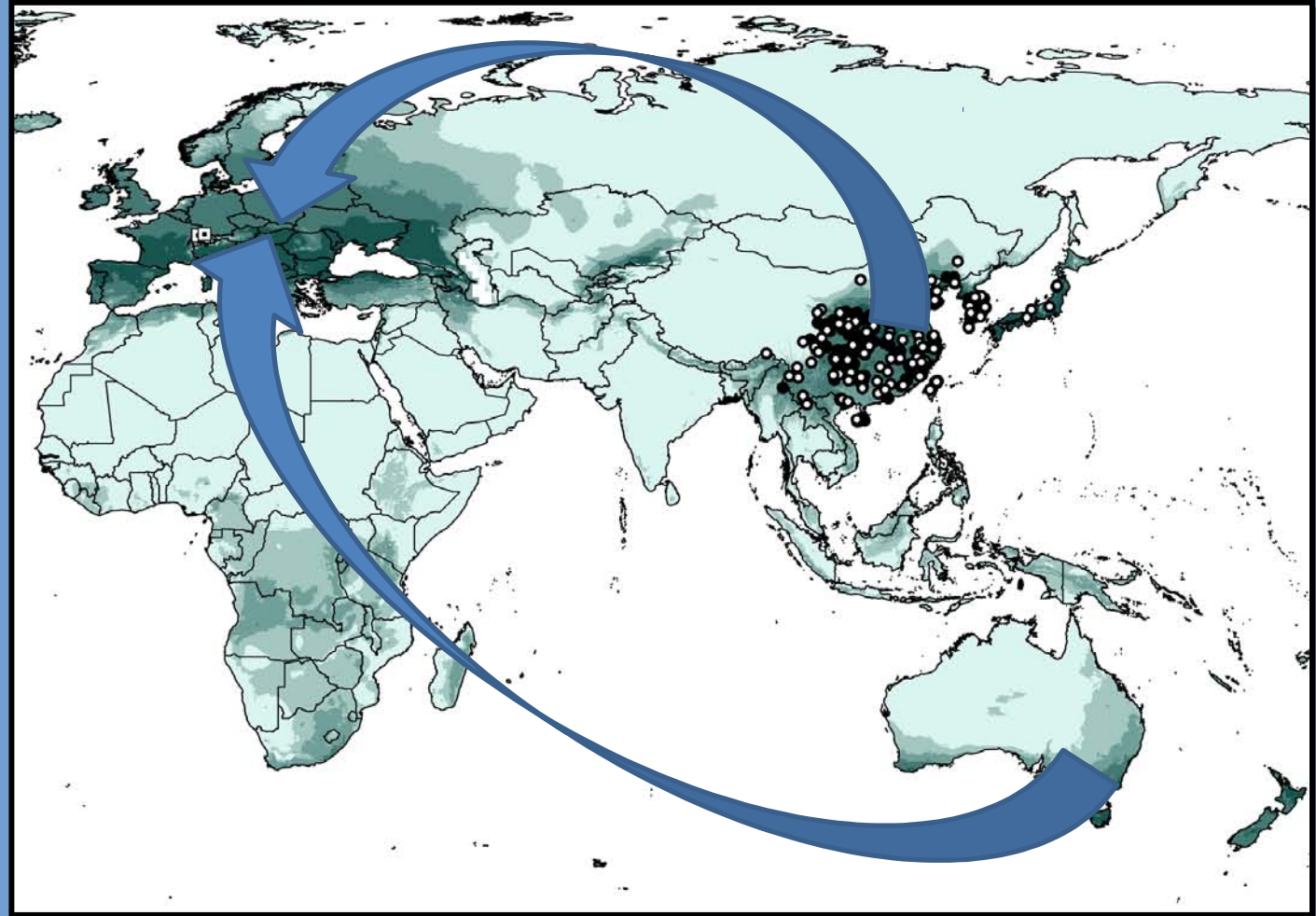
*Trissolcus japonicus*



# Movement of *Trissolcus*



*Trissolcus mitsukurii*





# Australasian *Trissolcus*

*Invertebr. Taxon.*, 1991, 5, 211–39

## Revision of Australasian *Trissolcus* Species (Hymenoptera : Scelionidae)

Norman F. Johnson

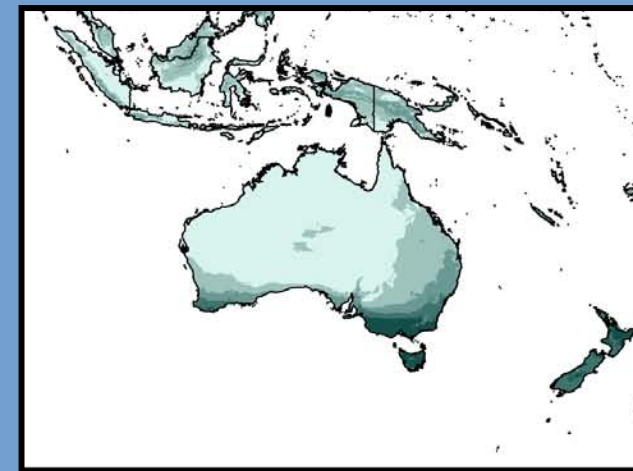
Department of Entomology, The Ohio State University,  
Columbus, Ohio 43210, U.S.A.

### Abstract

The species of *Trissolcus* Ashmead of the Australasian region (including New Guinea, the Bismark Archipelago and the Solomon Islands to Tahiti and New Zealand) are revised. *Trissolcus ancon*, *T. arctatus*, *T. cirrosus*, *T. maori*, *T. personatus*, *T. setifer*, *T. sipioides* and *T. strigis* are described as new. *Trissolcus eetion* (Dodd), *T. egeria* (Dodd), *T. ephyra* (Dodd), *T. euander* (Dodd), *T. flaviscapus* Dodd, *T. latisulcus* (Crawford), *T. mitsukurii* (Ashmead), *T. oedipus* (Dodd), *T. oeneus* (Dodd), *T. oenone* (Dodd), *T. ogyges* (Dodd) and *T. painei* (Ferrière) are redescribed. *Trissolcus basalis* (Wollaston) is a widely introduced Afrotropical species found throughout this region. The following new synonymies are proposed: *Trissolcus coriaceus* Dodd, 1915 = *T. egeria* (Dodd), 1914; *T. oecleus* (Dodd), 1913, *T. darwinensis* (Dodd), 1914, *T. erigone* (Dodd), 1914, *T. banksi* (Gahan), 1921 and *T. priapus* (Nixon), 1938 = *T. latisulcus* (Crawford), 1913; *T. oecleoides* (Dodd), 1914 = *T. mitsukurii* (Ashmead), 1904; *T. obliteratedus* (Dodd), 1914, *T. otho* (Dodd), 1914, *T. biproruli* (Girault), 1926b and *T. wilsoni* (Dodd), 1930 = *T. oenone* (Dodd), 1913; *T. oreas* (Dodd), 1913, *T. orontes* (Dodd), 1914, *T. atriscapus* (Girault), 1926a and *T. beenleighi* (Girault), 1932 = *T. ogyges* (Dodd), 1913.



*Trissolcus painei*





# *Trissolcus mitsukurii*

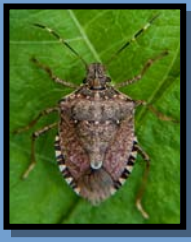




# *Trissolcus mitsukurii*



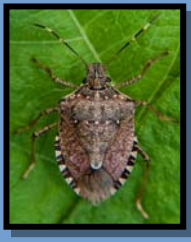
Holotype of *T. oecleoides* 1914



# Australasian *Trissolcus*

## 1) Photograph holotypes of Australasian species

- cryptic species
- morphological variation

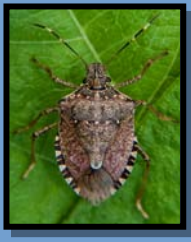


# Australasian *Trissolcus*

## 1) Photograph holotypes of Australasian species

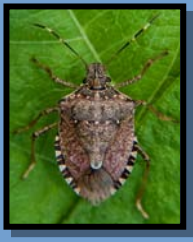
- cryptic species
- morphological variation





# Australasian *Trissolcus*

- 1) Photograph holotypes of Australasian species
- 2) Molecular analysis
  - characterize populations of Australian *T. mitsukurii*
  - CO1 barcoding for all Australasian *Trissolcus* species



# Australasian *Trissolcus*

- 1) Photograph holotypes of Australasian species
- 2) Molecular analysis
- 3) Methods for conducting surveys
  - yellow sticky cards
  - sentinel egg surveys

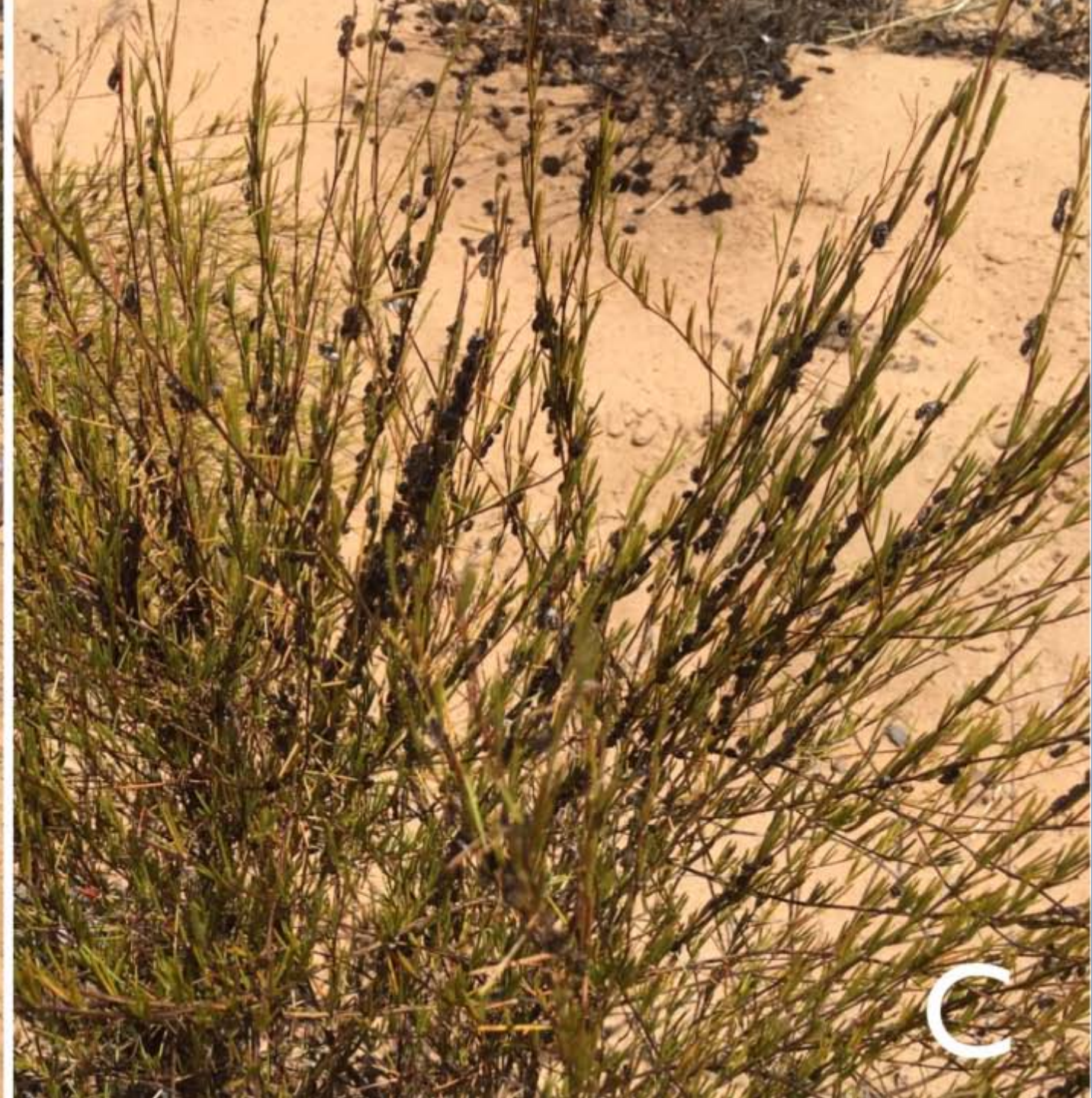
# Bagrada bug

*Bagrada hilaris*



Photo by Ton Rulkens





# Bagrada bug

*Bagrada hilaris*



Photo by Ton Rulkens



# Bagrada bug biocontrol

*Bagrada hilaris*



Photo by Ton Rulkens

*Trissolcus hyalinipennis*



India, Pakistan, Israel, Spain, and Turkey



***Trissolcus hyalinipennis* Rajmohana & Narendran  
(Hymenoptera, Scelionidae), a parasitoid  
of *Bagrada hilaris* (Burmeister) (Hemiptera,  
Pentatomidae), emerges in North America**

Fatemeh Ganjisaffar<sup>1</sup>, Elijah J. Talamas<sup>2</sup>, Marie Claude Bon<sup>3</sup>, Lisa Gonzalez<sup>4</sup>,  
Brian V. Brown<sup>4</sup>, Thomas M. Perring<sup>1</sup>

Department of Entomology, University of California, Riverside CA 92521 **2** Florida State Collection of Insects and Arachnids, Division of Plant Industry, Florida Department of Agriculture and Consumer Services, Gainesville, FL 32608, USA **3** USDA-ARS European Biological Control Laboratory, 810 Avenue du Campus Agropolis, 980 Montferrier le Lez, France **4** Urban Nature Research Center and Entomology Section, Natural History Museum of Los Angeles County, 900 Exposition Boulevard, Los Angeles, CA, 90007

Corresponding author: Elijah J. Talamas (talamas.1@osu.edu)

Academic editor: P. Jansta | Received 8 April 2018 | Accepted 2 July 2018 | Published 27 August 2018

<http://zoobank.org/1BE35FF6-4F02-44D6-90FF-6A28A5F98938>

**Abstract:** Ganjisaffar F, Talamas EJ, Bon MC, Gonzalez L, Brown BV, Perring TM (2018) *Trissolcus hyalinipennis* Rajmohana & Narendran (Hymenoptera, Scelionidae), a parasitoid of *Bagrada hilaris* (Burmeister) (Hemiptera, Pentatomidae), emerges in North America. Journal of Hymenoptera Research 65: 111–130. <https://doi.org/10.3897/jhr.65.25620>

## *Trissolcus hyalinipennis*

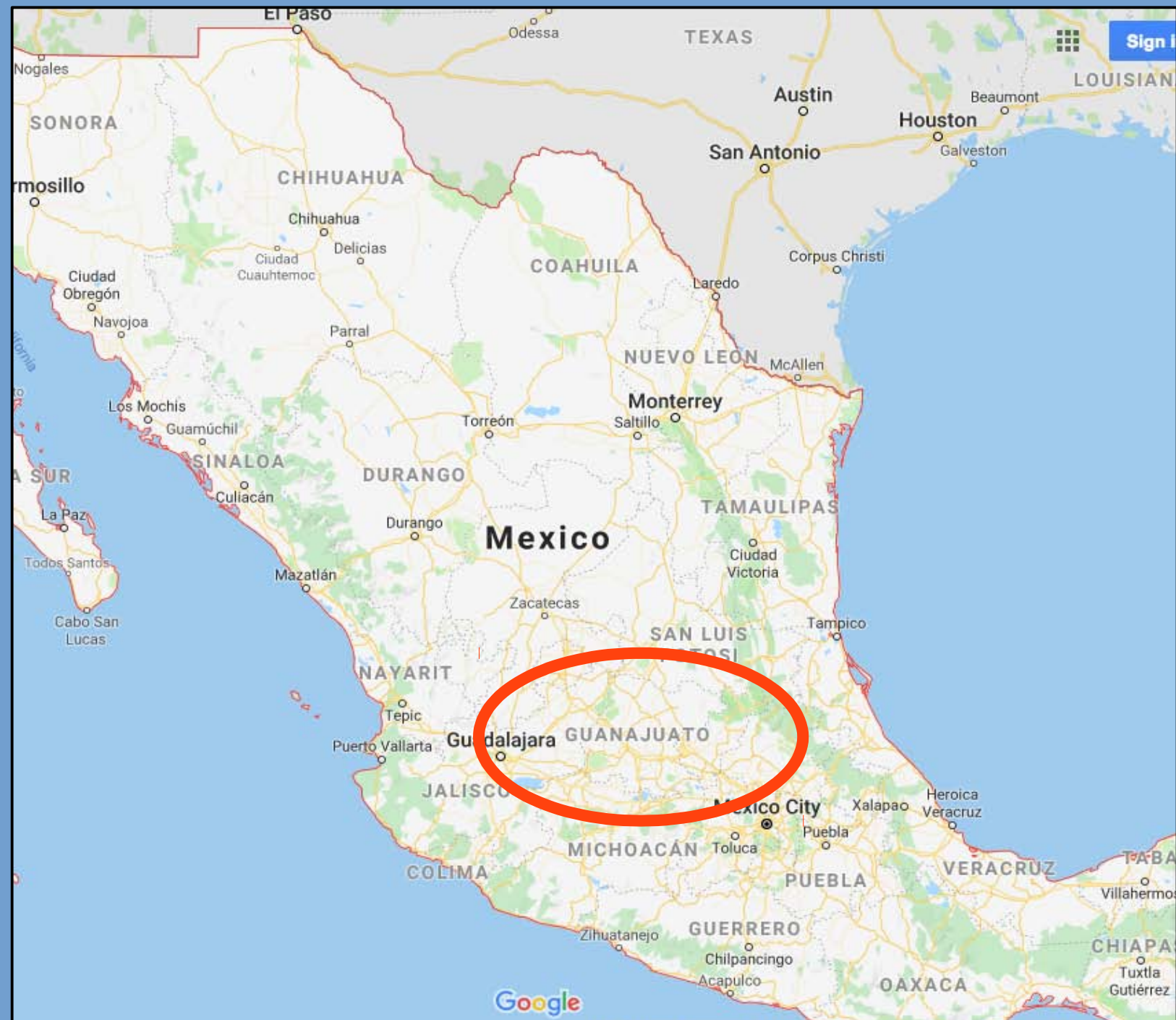


Known from India, Pakistan, Israel, Spain,  
and Turkey... and California!

# New Methods



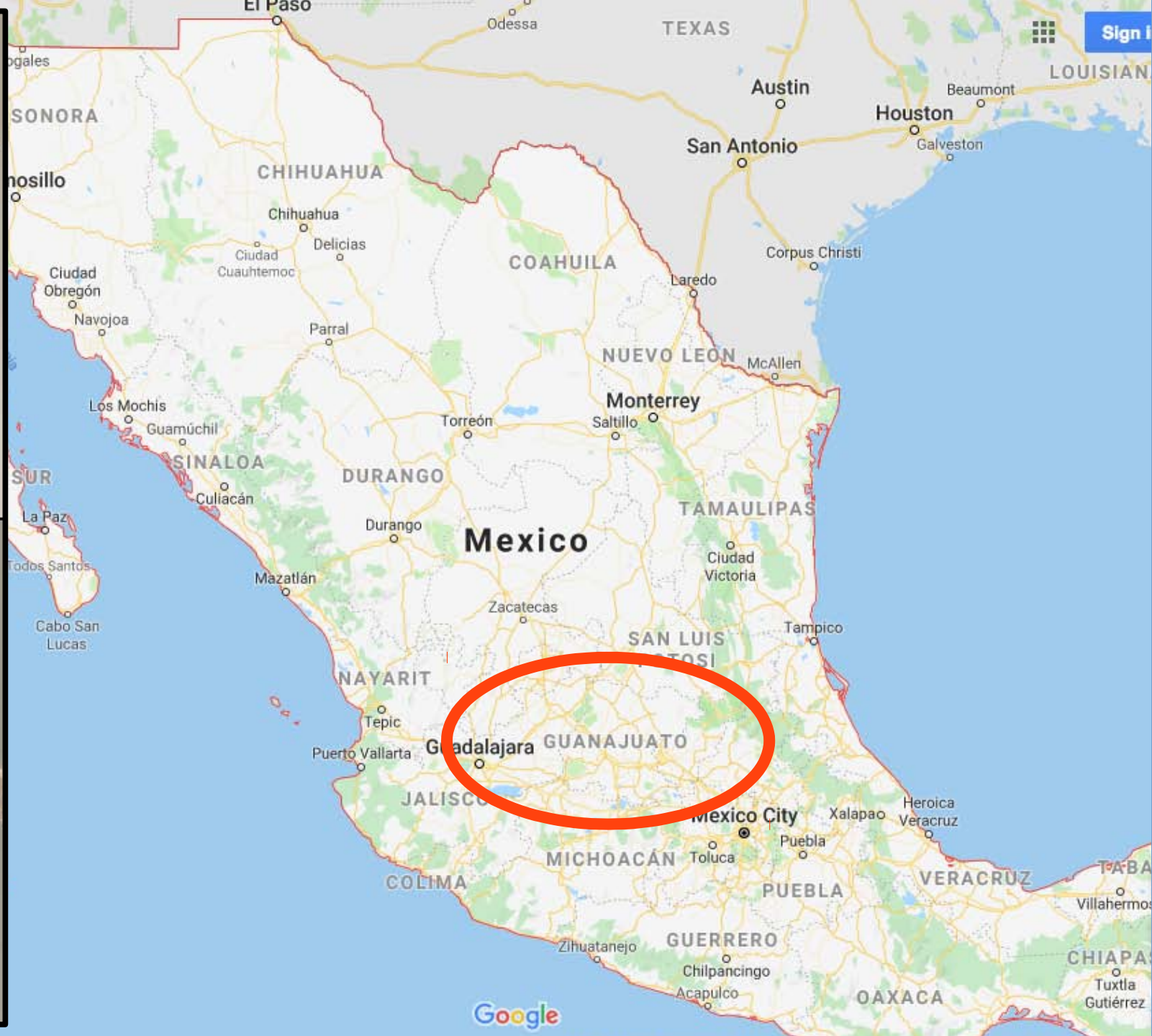
J. Refugio Lomeli Flores



3



5



3



## *Idris* (Scelionidae)

- parasitoids of spider eggs
- enormous genus with an estimated 1,000 species

5



3



## *Idris* (Scelionidae)

- parasitoids of spider eggs
- enormous genus with an estimated 1,000 species

5




1



2



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

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

<sup>1</sup>Agriculture and Agri-Food Canada, London Research and Development Centre, London, Ontario, Canada

<sup>2</sup>School of Environmental Studies, University of Guelph, Guelph, Ontario, Canada

<sup>3</sup>Ontario Ministry of Agriculture, Food and Rural Affairs, Guelph, Ontario, Canada

<sup>4</sup>USDA-ARS European Biological Control Lab, Campus International de Baillarguet, St. Gely du Fesc, France

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## Correspondence

Tara D. Gariepy, Agriculture and Agri-Food Canada, London Research and Development Centre, London, ON, Canada.  
Email: tara.gariepy@canada.ca

## Funding information

Agriculture and Agri-Food Canada; OMAFRA/University of Guelph Partnership—Emergency Management and Production Systems

## Abstract

The establishment of invasive *Halyomorpha halys* (Stål) outside of its native range may impact native species assemblages, including other pentatomids and their scelionid parasitoids. This has generated interest in defining species diversity and host-parasitoid associations in this system to better understand the impact of invasive alien species on trophic interactions in invaded regions. Information on scelionid-pentatomid associations in natural habitats is lacking, and species-level identification of these associations can be tenuous using rearing and dissection techniques. Naturally occurring pentatomid eggs were collected in areas where *H. halys* has established in Canada and were analysed using a modified DNA barcoding approach to define species-level trophic interactions. Identification was possible for >90% of egg masses. Eleven pentatomid and five scelionid species were identified, and trophic links were established. Approximately 70% of egg masses were parasitized; parasitism and parasitoid species composition were described for each species. *Telenomus podisi* Ashmead was the dominant parasitoid and was detected in all host species. *Trissolcus euschisti* Ashmead was detected in several host species, but was significantly more prevalent in *Chinavia hilaris* (Say) and *Brochymena quadripustulata* (Fabricius). *Trissolcus brochymenae* Ashmead and *Tr. thyanthae* Ashmead were recorded sporadically. Parasitism of *H. halys* was 55%, and this species was significantly less likely to be parasitized than native pentatomids. The scelionid species composition of *H. halys* consisted of *Te. podisi*, *Tr. euschisti* and *Tr. thyanthae*. Although these species cannot develop in fresh *H. halys* eggs, we demonstrate that parasitoids attempt to exploit this host under field conditions.

## KEYWORDS

biological control, DNA barcoding, host-parasitoid associations, invasive insects, parasitoid species composition, trophic interactions

## 1 | INTRODUCTION

Studies on the ecological effects associated with the establishment of exotic insects have primarily focused on the impact of invasive

pests on native biodiversity at the population and community level (Pimentel, Lach, Zuniga, & Morrison, 2000). For example, ecological effects associated with introduced or adventive exotic parasitoids include the potential for the decline or extinction of native, non-



Tara Gariepy  
AAFC, London,  
Ontario

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

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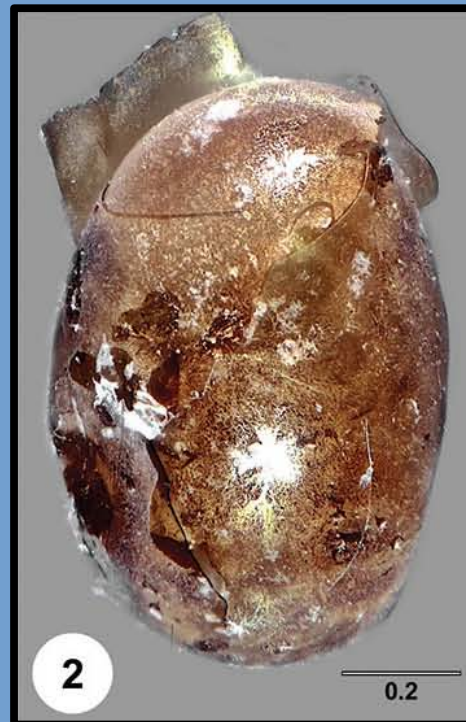
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## 1 | INTRODUCTION

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# 100% match



## Molecular Diagnostic



## Taxonomy



## Field Studies

JHR \$\$: @-@ (2019)  
doi: 10.3897/jhr.@@.38025  
<http://jhr.pensoft.net>

RESEARCH ARTICLE

JOURNAL OF  
**Hymenoptera**  
RESEARCH

# Field studies and molecular forensics identify a new association: *Idris elba* Talamas, sp. nov. parasitizes the eggs of *Bagrada hilaris* (Burmeister)

J. Refugio Lomeli-Flores<sup>1</sup>, Susana Eva Rodríguez-Rodríguez<sup>1</sup>,  
Esteban Rodríguez-Levya<sup>1</sup>, Héctor González-Hernández<sup>1</sup>,  
Tara D. Gariepy<sup>2</sup>, Elijah J. Talamas<sup>3</sup>

**1** Colegio de Postgraduados, Posgrado en Fitosanidad, Programa de Entomología y Acarología, Montecillo, CP 56230. Texcoco, Estado de México, México **2** Agriculture and Agri-Food Canada, 1391 Sandford Street London, Ontario N5V 4T3, Canada **3** Florida State Collection of Arthropods, Division of Plant Industry, Florida Department of Agriculture and Consumer Services, Gainesville, FL 32608, USA

Corresponding author: Elijah J. Talamas ([talamas.1@osu.edu](mailto:talamas.1@osu.edu))

Academic editor: J. Fernandez-Triana | Received 5 July 2019 | Accepted 26 August 2019 | Published @-@-@-@ 2019

<http://zoobank.org/31D390C3-85D1-4E44-BD8F-CA73D7B2DF7C>

**Citation:** Lomeli-Flores JR, Rodríguez-Rodríguez SE, Rodríguez-Levya E, González-Hernández H, Gariepy TD, Talamas EJ (2019) Field studies and molecular forensics identify a new association: *Idris elba* Talamas, sp. nov. parasitizes the eggs of *Bagrada hilaris* (Burmeister). In: Editor (Eds) Advances in the Systematics of Platygastroidea II. Journal of Hymenoptera Research @-@: @-@: <https://doi.org/10.3897/jhr.@@.38025>

## Abstract

A species of *Idris* Förster (Hymenoptera: Scelionidae) is found to parasitize the eggs of *Bagrada hilaris* (Hemiptera: Pentatomidae) and is described as new: *Idris elba* Talamas, **sp. nov.** This is the first association of an *Idris* species with a non-spider host, and the association is confirmed with molecular diagnostic tools that enable identification of parasitoid and host from the remains of parasitized eggs.

## Keywords

*Bagrada* bug, natural enemies, egg parasitoid, diagnostics

## Introduction

The bagrada bug, *Bagrada hilaris* (Burmeister) (Hemiptera: Pentatomidae), is an invasive alien species that has recently established in North America (Palumbo et al. 2016) and is one of the most important pests of Brassicaceae worldwide because of the eco-

# Acknowledgments

## Molecular analyses

Marie Claude Bon (EBCL)

Tara Gariepy (AAFC)

## Foreign Exploration

Kim Hoelmer (USDA)

René Sforza (USDA)

## **BMSB/*Trissolcus* Community**

too many to mention!

## **Farm Bill Funding & Cooperative Agreements**

- Taxonomy of stink bug egg parasitoids (USDA)
- Monitoring for the presence and impact of *T. japonicus*
- Biological Control of Bagrada Bug

## Collaborators

Lubomír Masner (CNCI)

Norman Johnson (OSUC)

Matt Buffington (USDA)

Charlie Pickett (CDFA)

Brian Hogg (USDA)

Tom Perring (UCRC)

Fatemeh Ganjisaffar (UCRC)

