

2.2.5 Asian Natural Enemies



Funding



United States
Department of
Agriculture

National Institute
of Food and
Agriculture

Specialty Crop Research Initiative
Grant #2011-01413-30937

Collaborating Institutions



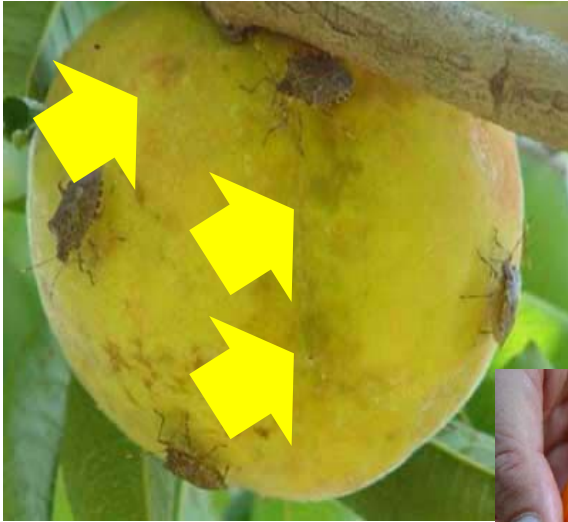
Cornell University



Virginia Tech



Halyomorpha halys – Brown Marmorated Stink Bug



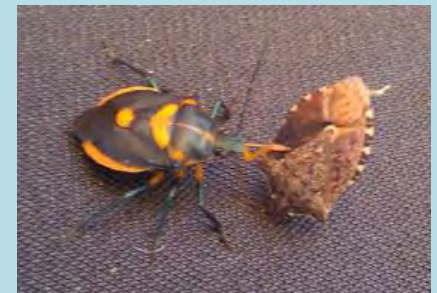
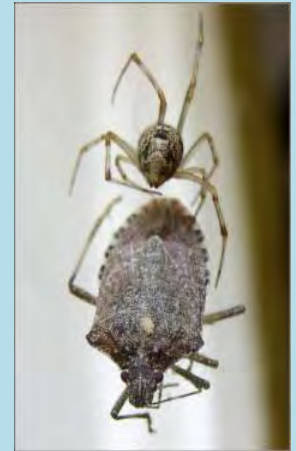
Natural biological control

Pathogens



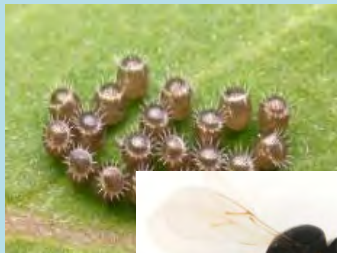
Metarhizium spp.
Ophiocordiceps spp.

Predators



Lacewings, predatory stink bugs, spiders,
ants, birds etc.

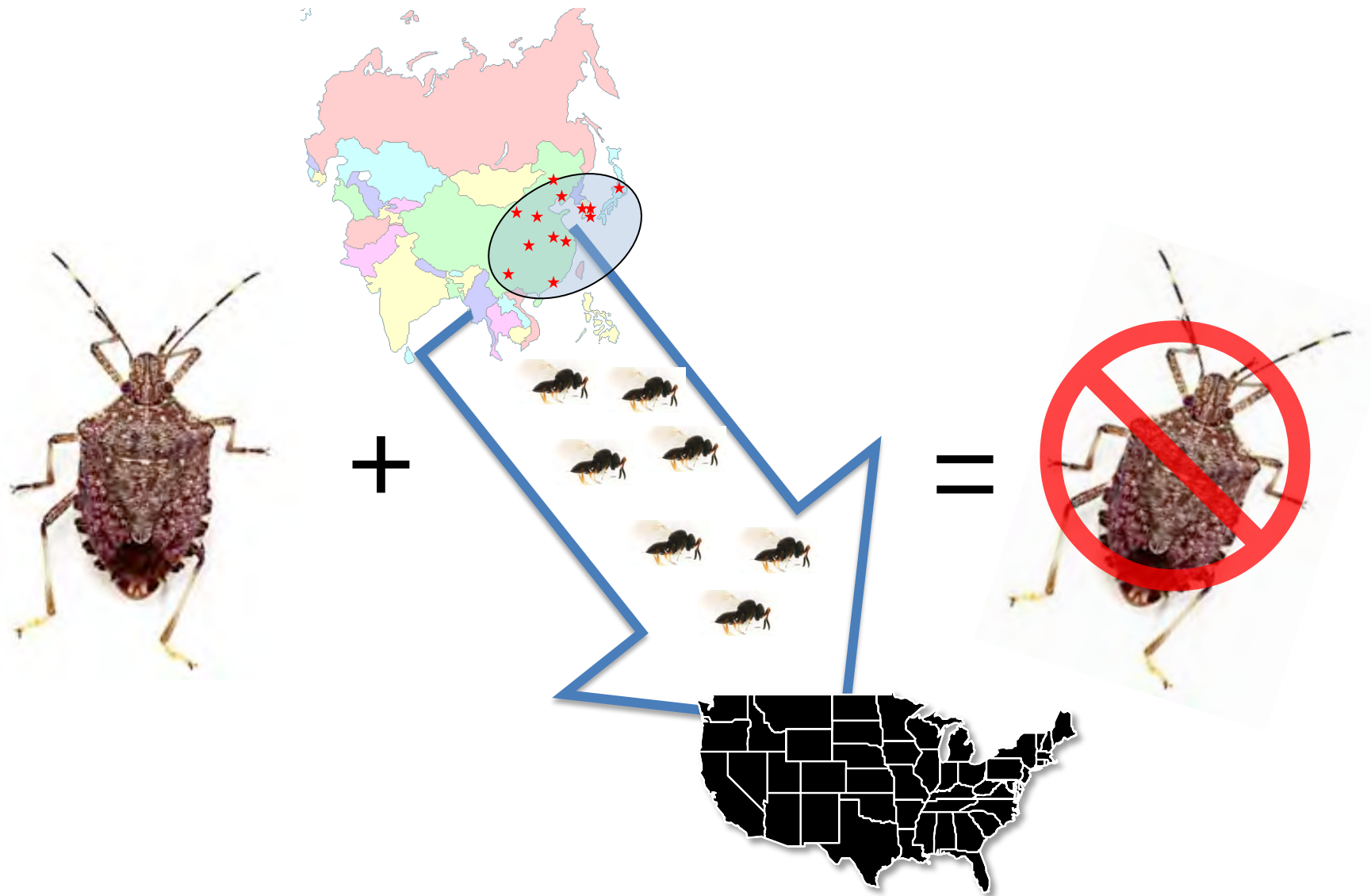
Parasitoids



Egg parasitoids



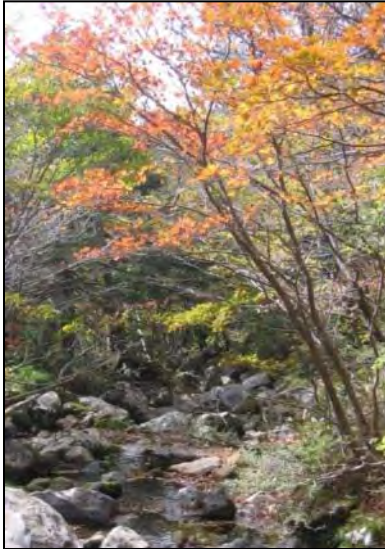
Parasitoids of adults



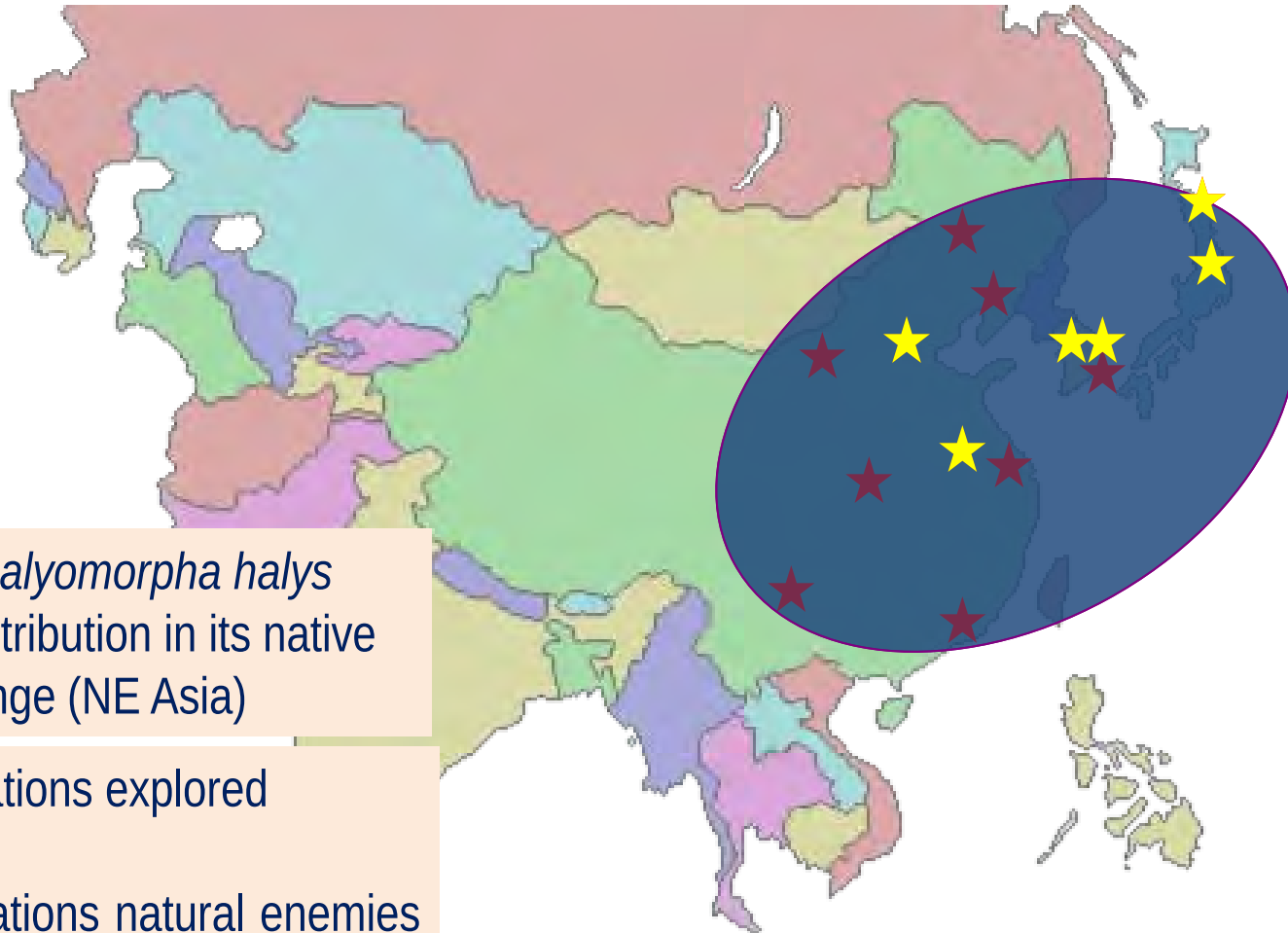
Classical biological control is the best hope for sustainable management of BMSB.

Foreign Explorations

Finding BMSB



Foreign Explorations



 = *Halyomorpha halys*
distribution in its native
range (NE Asia)

 = Locations explored

 = Locations natural enemies
recovered from



14 Parasitoid populations at ARS BIIR in Newark, DE - maintained for host range and efficacy testing:

China:

Trissolcus halyomorphae

(Beijing 2007, Beijing 2009, Nanjing 2009)

Japan:

Trissolcus mitsukurii (Tskuba 2007)

Trissolcus plautiae (Tskuba 2007)

Trissolcus flavipes (Tskuba 2007)

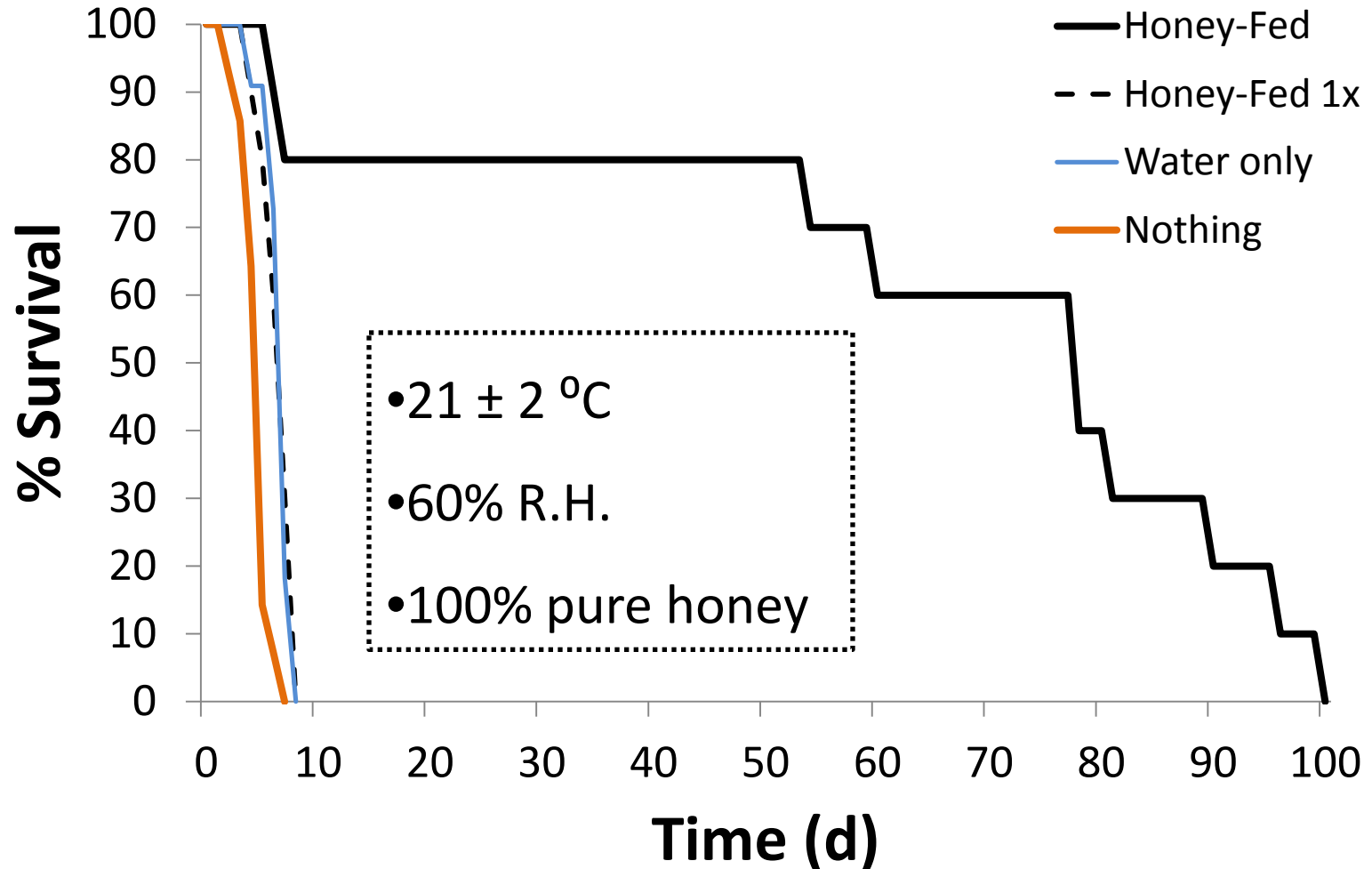
S. Korea: *Trissolcus plautiae* (Seoul 2009, 2010)



Asian *Trissolcus* spp.

- **Solitary egg parasitoids** of Pentatomidae
- **Short development time**
- **~ 10 generations/year**
- **Female-biased sex ratio**
- **High parasitism rates in *Trissolcus halyomorphae***
compared to other *Trissolcus* spp. in the native range

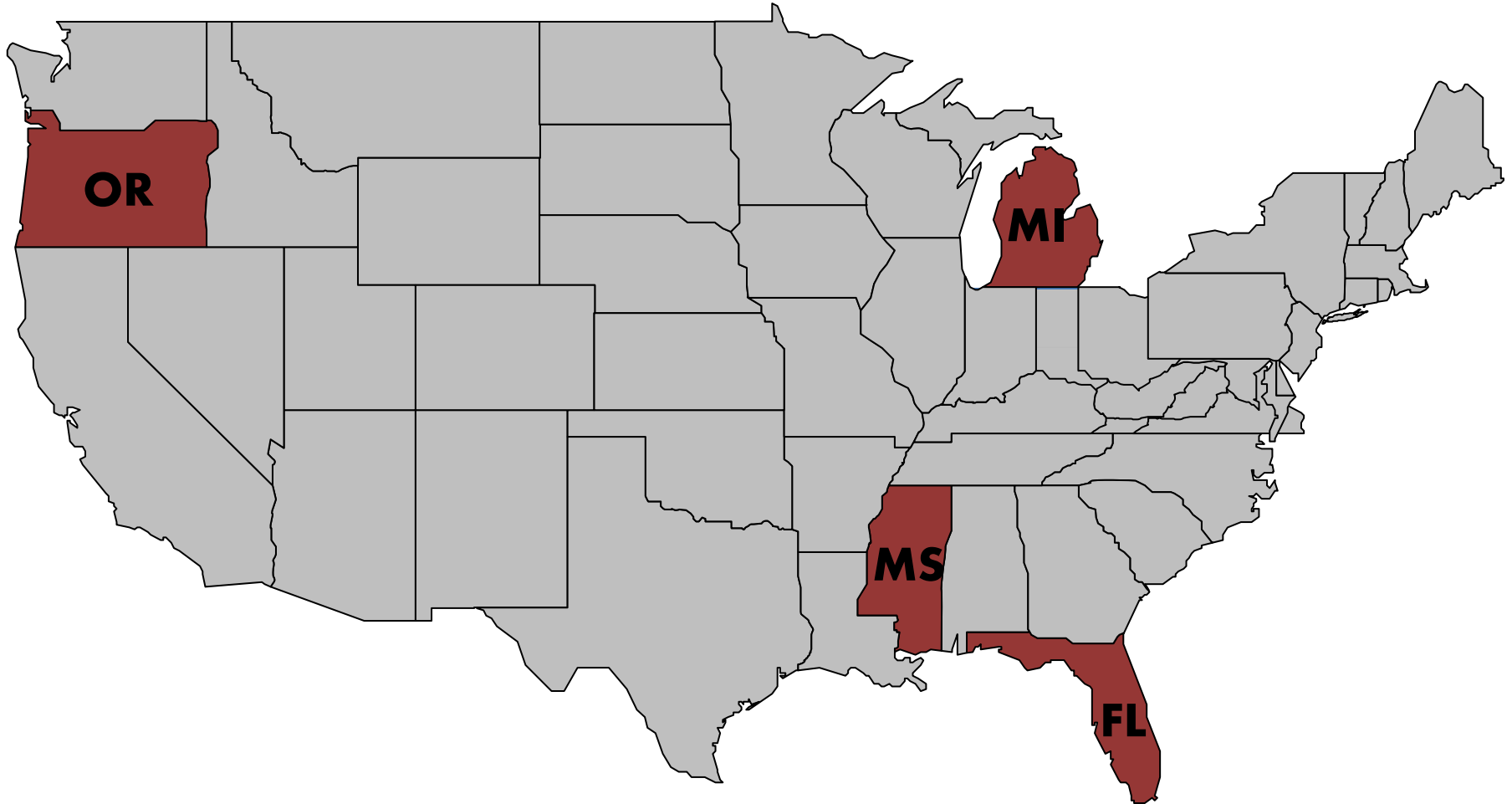
Longevity – *Trissolcus halyomorphae*



Host Specificity Screening – Why?

- In the U.S., classical biological control agents regulated by USDA-APHIS-PPQ
- APHIS issues/denies permits for release of the agents based on anticipated direct and indirect environmental risks
- Applicants have to provide information on
 - Life history and biology
 - Potential environmental risks
 - Host specificity of the agent

Host Specificity Screening



Genus	Species	State Tested	Genus	Species	State Tested
<i>Alcaeorrhynchus</i>	<i>grandis</i>	FL	<i>Euthyrhynchus</i>	<i>floridanus</i>	FL
<i>Banasa</i>	<i>dimiata</i>	DE, OR	<i>Holcostethus</i>	<i>abbreviatus</i>	OR
<i>Banasa</i>	<i>euchlora</i>	DE	<i>Holcostethus</i>	<i>limbolarius</i>	FL, DE
<i>Brochymena</i>	<i>quadripustulata</i>	DE	<i>Homaemus</i>	<i>proteus</i>	FL
<i>Chinavia</i>	<i>hilaris</i>	OR, DE	<i>Hymenarcys</i>	<i>nervosa</i>	DE
<i>Chinavia</i>	<i>marginata</i>	FL	<i>Loxa</i>	<i>flavicollis</i>	FL
<i>Chlorochroa</i>	<i>ligata</i>	OR	<i>Megacopta</i>	<i>cribraria</i>	FL
<i>Chlorochroa</i>	<i>saucia</i>	DE	<i>Menecles</i>	<i>insertus</i>	DE
<i>Chlorochroa</i>	<i>sayi</i>	DE	<i>Mormidea</i>	<i>pama</i>	FL
<i>Chlorochroa</i>	<i>senilis</i>	DE	<i>Murgantia</i>	<i>histrionica</i>	FL, DE
<i>Cosmopepla</i>	<i>intergressa</i>	OR	<i>Nezara</i>	<i>viridula</i>	FL
<i>Cosmopepla</i>	<i>lintneriana</i>	DE	<i>Oebalus</i>	<i>pugnax</i>	FL, DE
<i>Edessa</i>	<i>bifida</i>	FL	<i>Orsilochides</i>	<i>guttata</i>	FL
<i>Edessa</i>	<i>floridan</i>	DE	<i>Piezodorus</i>	<i>guildinii</i>	FL
<i>Euschistus</i>	<i>conspersus</i>	OR	<i>Podisus</i>	<i>maculiventris</i>	FL, DE
<i>Euschistus</i>	<i>quadrator</i>	FL	<i>Proxys</i>	<i>punctulatus</i>	FL
<i>Euschistus</i>	<i>servus</i>	FL, DE	<i>Stiretrus</i>	<i>anchorago</i>	FL, DE
<i>Euschistus</i>	<i>tristigmus</i>	DE	<i>Thyanta</i>	<i>custator</i>	OR, DE, FL
<i>Euschistus</i>	<i>variolarius</i>	DE, OR	<i>Thyanta</i>	<i>custator accerra</i>	DE
			<i>Trichopepla</i>	<i>semivittata</i>	DE

Host Specificity Screening

- Standard protocol for all collaborators
- Parasitoid females used in the tests:
 - 24 h old
 - Mated but naïve
 - Exposed to an egg mass for 24 h
- 20 replicates per parasitoid-host species combination



Screening Procedures



No Choice Test

Single egg mass of non-target species:

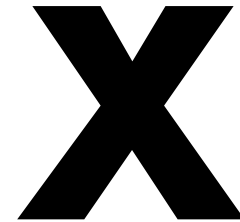


Followed by a BMSB control for an additional 24 hours:



NEGATIVE

i.e. No Parasitism





Screening Procedures



No Choice Test

Single egg mass of non-target species:



Followed by a BMSB control for an additional 24 hours:



POSITIVE

i.e. Parasitism

Choice Test

One egg mass each of the target and non-target species:



Screening Procedures

Physiological Variables recorded:

- Parasitism rate (# eggs parasitized/egg mass)
- # viable adult parasitoids
- Dissection of “unsuccessfully” parasitized eggs
- Sex ratio (i.e. % adult males)



Results – No Choice Tests - Finished

Genus	Species	Collaborating State	No Choice Tests	Choice Tests
<i>Euschistus</i>	<i>conspersus</i>	OR	Negative	X
<i>Euschistus</i>	<i>quadrator</i>	FL	Negative	X
<i>Megacopta</i>	<i>cribraria</i>	FL	Negative	X
<i>Mormidea</i>	<i>pama</i>	FL	Negative	X
<i>Murgantia</i>	<i>histrionica</i>	FL	Negative	X
<i>Nezara</i>	<i>viridula</i>	FL	Negative	X
<i>Oebalus</i>	<i>pugnax</i>	FL, DE	Negative	X
<i>Piezodorus</i>	<i>guildinii</i>	FL	Negative	X
<i>Proxys</i>	<i>punctulatus</i>	FL	Negative	X

Results – No Choice Tests - Pending

Genus	Species	Collaborating State	No Choice Tests	Choice Tests
<i>Alcaeorrhynchus</i>	<i>grandis</i>	FL	Pending	
<i>Chinavia</i>	<i>hilaris</i>	DE	Pending	
<i>Chlorochroa</i>	<i>uhleri</i>	OR	Pending	
<i>Cosmopepla</i>	<i>intergressa</i>	OR	Pending	
<i>Cosmopepla</i>	<i>lintneriana</i>	DE	Pending	
<i>Edessa</i>	<i>bifida</i>	FL	Pending	
<i>Edessa</i>	<i>florida</i>	DE	Pending	
<i>Euschistus</i>	<i>variolarius</i>	DE, OR	Pending	
<i>Euschistus</i>	<i>tristigmus</i>	DE	Pending	
<i>Euthyrhynchus</i>	<i>floridanus</i>	FL	Pending	
<i>Homaemus</i>	<i>proteus</i>	FL	Pending	
<i>Loxa</i>	<i>flavicollis</i>	FL	Pending	
<i>Stiretrus</i>	<i>anchorago</i>	FL, DE	Pending	
<i>Thyanta</i>	<i>custator accerra</i>	DE	Pending	

Results – Choice Tests - Pending

Genus	Species	Collaborating State	No Choice Tests	Choice Tests
<i>Banasa</i>	<i>dimiata</i>	DE, OR	Positive	Pending
<i>Chinavia</i>	<i>hilaris</i>	OR	Positive	Pending
<i>Chinavia</i>	<i>marginata</i>	FL	Positive	Pending
<i>Chlorochroa</i>	<i>ligata</i>	OR	Positive	Pending
<i>Euschistus</i>	<i>servus</i>	FL, DE	Positive	Pending
<i>Holcostethus</i>	<i>abbreviatus</i>	OR	Positive	Pending
<i>Holcostethus</i>	<i>limbolaris</i>	FL, DE	Positive	Pending
<i>Orsilochides</i>	<i>guttata</i>	FL	Positive	Pending
<i>Podisus</i>	<i>maculiventris</i>	FL, DE	Positive	Pending
<i>Thyanta</i>	<i>custator</i>	OR, DE, FL	Positive	Pending

Pitfalls Encountered

- Seasonality of egg mass production (fall/winter depression)
- Availability of non-target species
- Host plant requirements of non-target hosts unknown or incorrect
- Limitation of space and man-hours
- Disease outbreak in stink bug lab colonies

Where to go from here ...

I. Behavioral Observations

a) Oviposition behavior

- Behavioral sequences
- Searching time within a patch
- Rejection behavior

b) Competition within and between species

c) Searching behavior

- Role of surface texture of the plant that an egg mass is attached to
- Role of chemical cues in the search for and detection of host egg masses (e.g. oviposition-induced volatiles, host plant volatiles, cues associated with egg mass)

Where to go from here ...

II. Role of Parasitoid Physiology

- Parasitoid feeding status (hungry vs. fed)
- Parasitoid age (young vs. old)
- Parasitoid egg load (high vs. low)



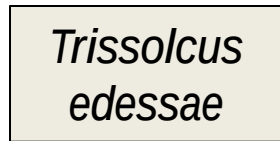
Consider
non-target hosts

Focus on
Target host

Where to go from here ...

III. Interactions with Native Egg Parasitoid Species

- Surveys identified at least 7 native egg parasitoid species attacking BMSB in the Eastern U.S.



Native Egg Parasitoids – Workshop series



Parasitoids of the Brown Marmorated Stink Bug A specialized training workshop



The brown-marmorated stink bug, *Halyomorpha halys*, is an invasive species native to Asia. Since its confirmed detection in the U.S. in 2001, *H. halys* has become a serious agricultural and nuisance pest. Preliminary surveys have shown that some indigenous natural enemies, including hymenopteran and dipteran parasitoids, will attack *H. halys* in the U.S.

The goal of this two-day workshop is to provide participants who plan to conduct their own surveys with the tools necessary to identify indigenous parasitoids of *H. halys*. USDA ARS entomologists will provide an introduction to the parasitoid guild that has been found attacking egg and adult parasitoids of *H. halys* to date.

Participants will learn to identify parasitoids to family, genera, and species level using specimens collected in the Northeastern U.S. Examples of exotic Asian parasitoids currently undergoing host range evaluation as potential classical biological control agents will be included. A brief introduction to the identification of pentatomid egg masses other than *H. halys* will be given to interested participants.

Who should attend?

Entomologists, extension specialists, and graduate students working on brown marmorated stink bug biological control. Some prior knowledge of parasitoid taxonomy will be useful but is not required.

Organizers and Workshop location

Dr. Kim A. Hoelmer, Dr. Christine Dieckhoff, and Kathy Tatman

U.S. Department of Agriculture – Beneficial Insect Introduction Research Unit
501 S. Chapel Street
Newark, DE 19713

Workshop dates: Tuesday & Wednesday, 10-11 April 2012

Beverages and a light afternoon snack will be provided during the workshop.

Registration – **FREE!**

Space is limited to 20 participants!

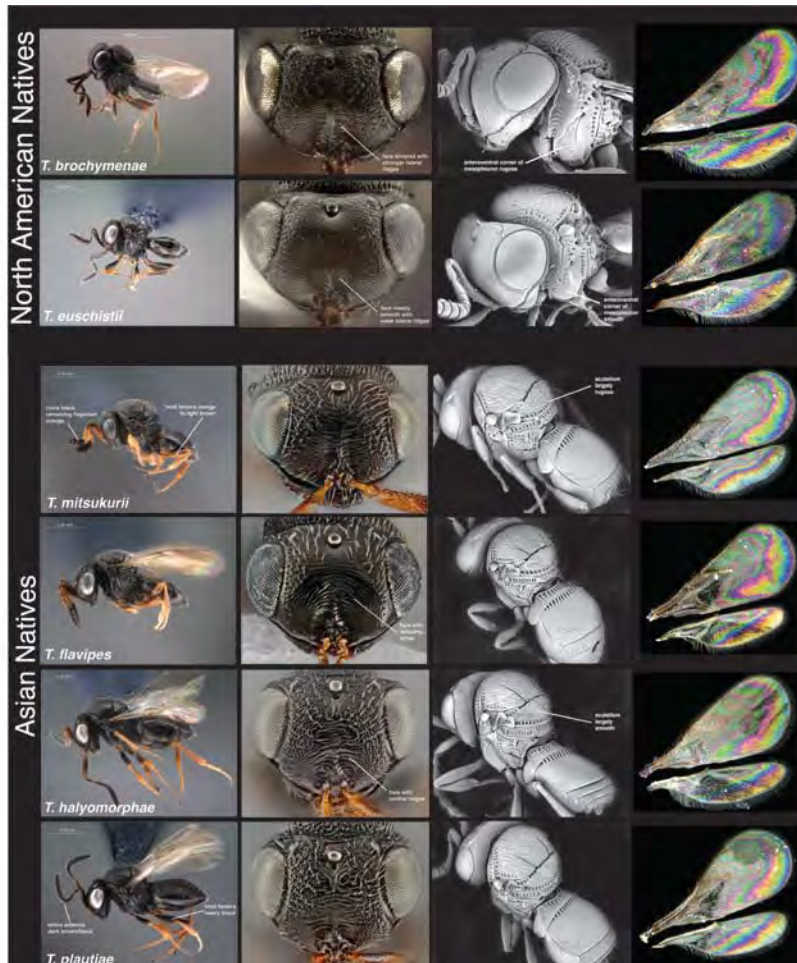
Deadline for registration: 22 March 2012

Contact: christine.dieckhoff@ars.usda.gov

A list of accommodations will be provided upon registration. A block of guest rooms can be held and government rates (for participants with proper identification) are available.

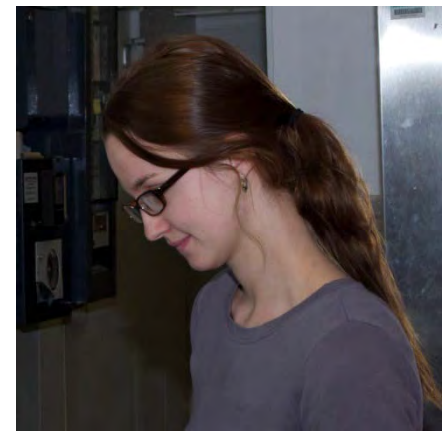
- 1st Workshop held 11-12 April, 2012 in Newark, DE
- Attendance: 24 scientists and grad students from across the U.S.
- 2nd Workshop planned for this spring
- And the beginning of a great collaboration ...

Taxonomy of *Trissolcus* spp.



- Collaboration with Dr. Matt Buffington (USDA-SEL), Dr. Norman Johnson (OSU), EBCL-France, Oregon Dept. of Agriculture
- Goal:
 - Deliver *Trissolcus* species data
 - Diagnose cryptic species
- Tools:
 - Behavioral, morphometric, and genetic data
 - Novel character systems

The Hoelmer Lab



Thank you!



Photo: B. Cutting