

Update on Biological Control of BMSB with Asian Parasitoids

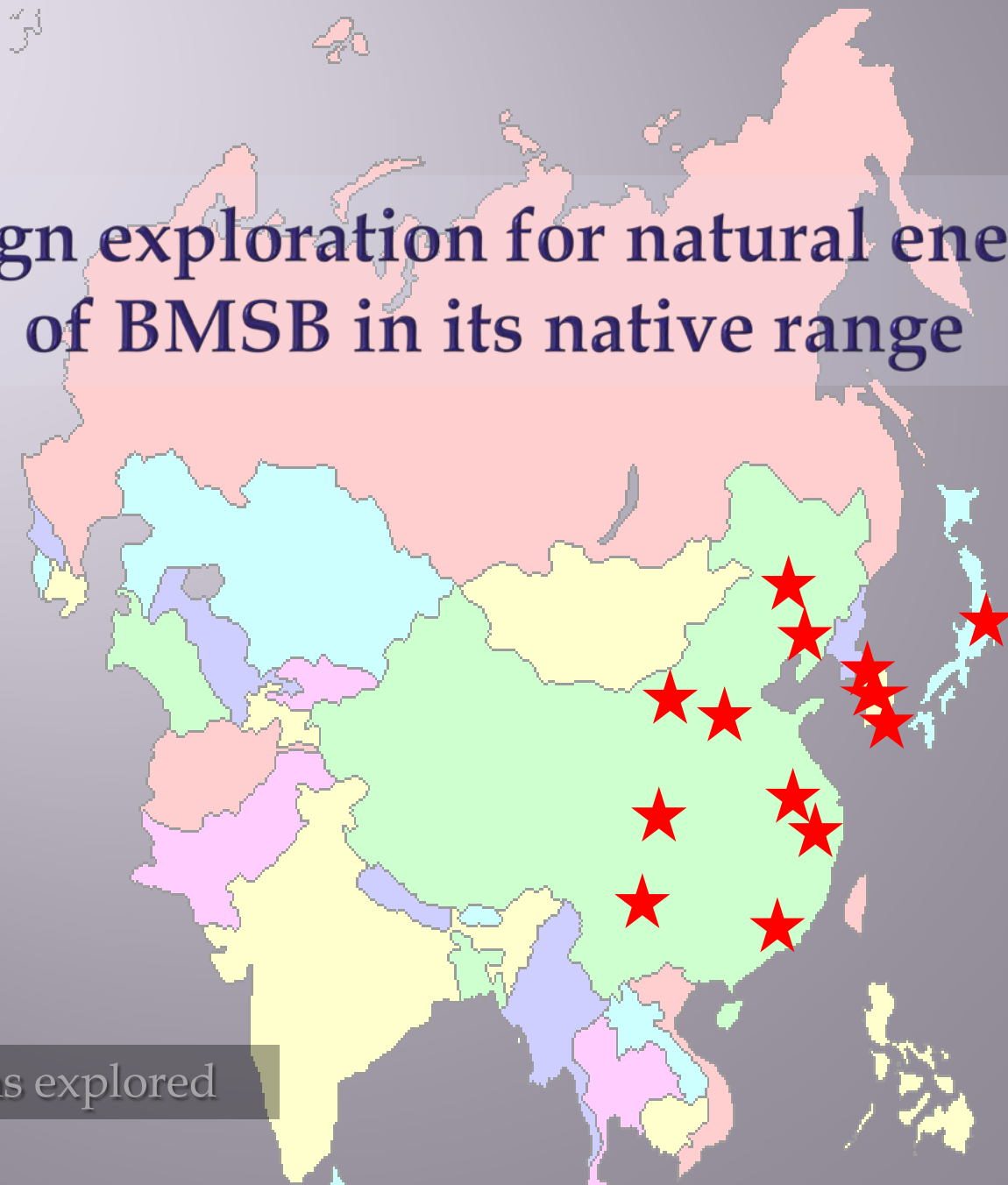
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Foreign exploration for natural enemies of BMSB in its native range

★ Locations explored



Asian *Trissolcus* spp.



**30+ parasitoid populations at ARS BIIR
maintained for host range and efficacy testing**

China: *Trissolcus japonicus (halyomorphae)*

(Beijing 2007, Beijing 2009, Nanjing 2009)

Japan: *Trissolcus mitsukurii* (Tsukuba 2007)

Trissolcus japonicus (plautiae) (Tsukuba 2007, 2012)

Trissolcus flavipes (Tsukuba 2007, 2012)

Trissolcus itoi (Tsukuba 2012)

Trissolcus spp. (Tsukuba 2012)

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

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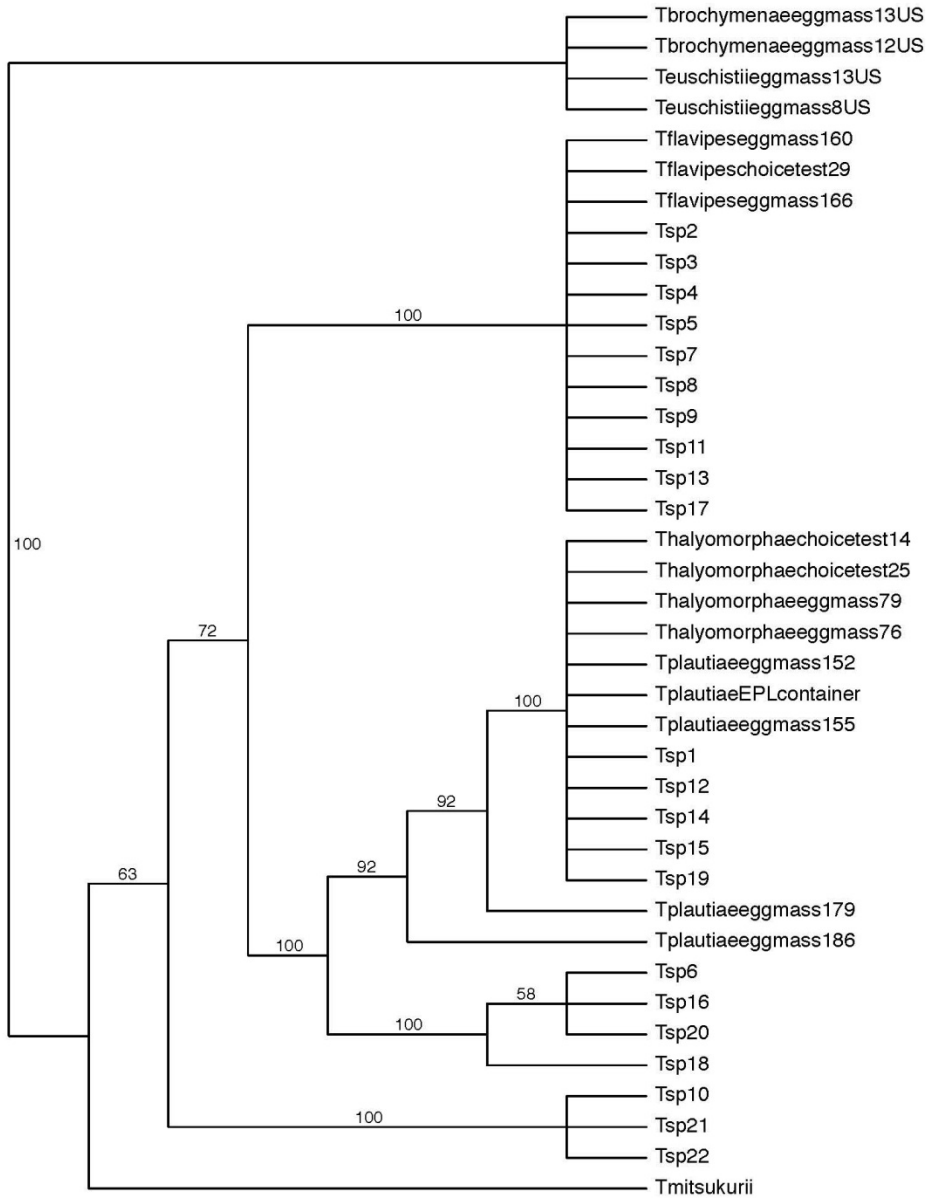
Trissolcus itoi (Tsukuba 2012)

Trissolcus spp. (Tsukuba 2012)

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

combined COI & ITS2

Bootstrap consensus tree



→ native *Trissolcus*

→ *Trissolcus flavipes*

→ *Trissolcus japonicus*

→ *Trissolcus* "sp" ??

→ *Trissolcus* "sp" ??

→ *Trissolcus* "sp"

→ *Trissolcus* "sp" ??

→ *Trissolcus itoi*

→ *Trissolcus mitsukurii*

Funding for Host Range Evaluations:

Farm Bill funding (APHIS PPQ)

NIFA SCRI multi-institution BMSB grant

Collaborators:

University of Delaware

Florida Dept. Agriculture & Consumer Services, Division of Plant Industry

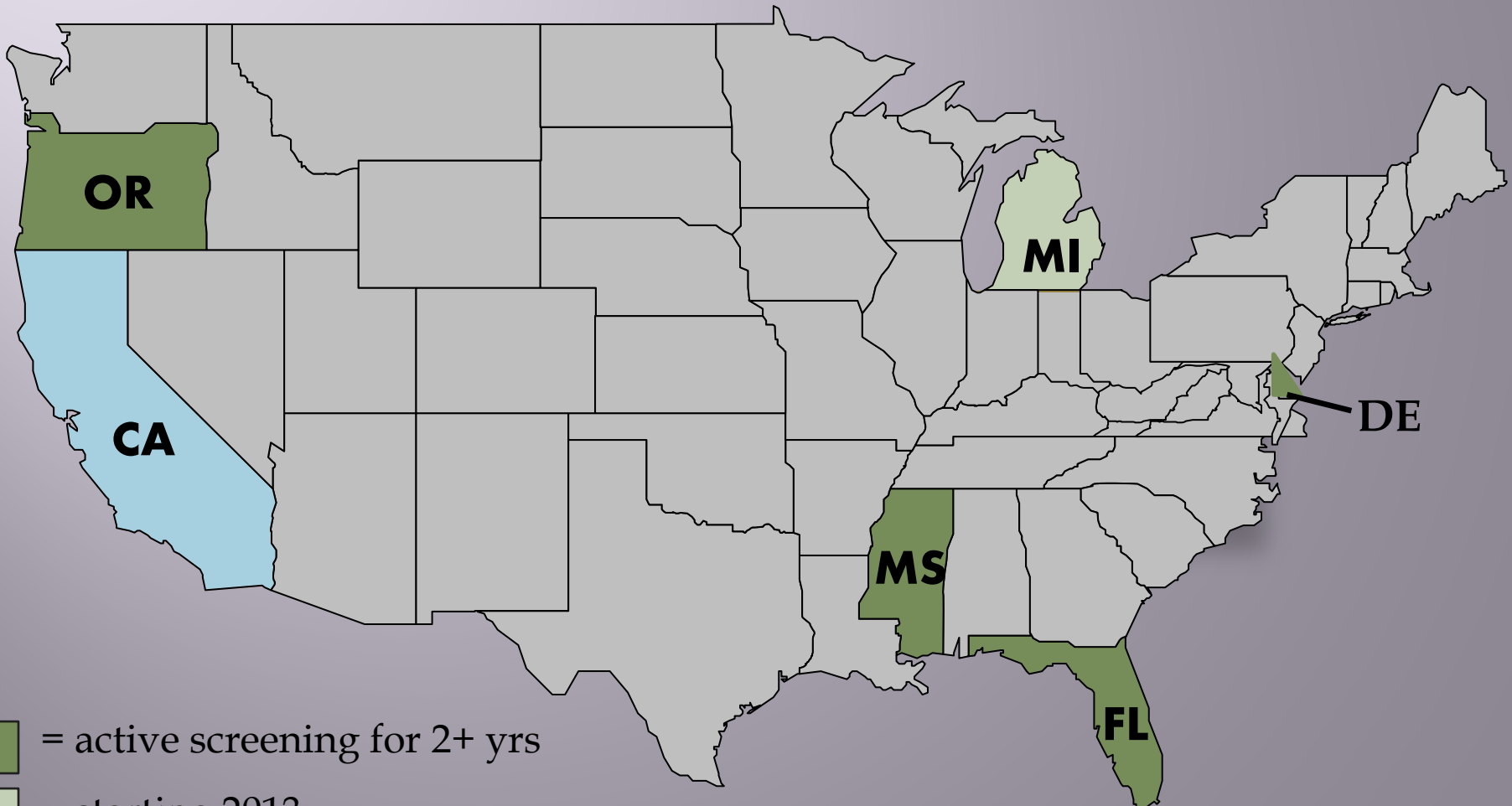
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Host Specificity Screening



-  = active screening for 2+ yrs
-  = starting 2013
-  = pending funding



Trissolcus japonicus (= *halyomorphae*)



- ▣ **Solitary egg parasitoid** of Pentatomidae
- ▣ **Short development time** – 2 to 3 weeks
- ▣ **Multiple generations/season**
- ▣ **Female-biased sex ratio**
- ▣ **High parasitism rates** in the native range (60 to 80%)

Host Specificity Screening

- Standard test protocol for all collaborators
- Parasitoid females used in the tests:
 - ❖ 24 h old
 - ❖ Mated but naïve (no previous experience)
 - ❖ 24 h exposure to each egg mass
- 20 replicates of each non-target species



Screening Procedures



No Choice Test

Single egg mass of non-target species:



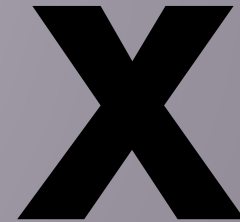
Followed by a BMSB control for an additional 24 hours:



**no attack of
non-target**



**no parasitism
recorded**



**no further
testing
required**



Screening Procedures



No Choice Test

Single egg mass of non-target species:



Followed by a BMSB control for an additional 24 hours:



**Non-target
attacked**

**Parasitism
recorded**

Choice Test

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



Presented together

Screening Procedures

Measures of host acceptability:

- Attack rate (# eggs parasitized/egg mass)
- Proportion of undeveloped parasitoids in eggs
- No. of viable adult parasitoids emerged
- Size of emerged parasitoids
- Sex ratio (proportion adult males : females)



| Genus | Species | State Tested | Genus | Species | State Tested |
|-----------------------------|--------------------------|--------------|-------------------------|-----------------------------|---------------|
| <i>Alcaeorrhynchus</i> | <i>grandis</i> | FL | <i>Holcostethus</i> | <i>abbreviatus</i> | OR |
| <i>Banasa</i> | <i>dimiata</i> | DE, OR | <i>Holcostethus</i> | <i>limbolarius</i> | FL, DE |
| <i>Banasa</i> | <i>euchlora</i> | DE | <i>Homaemus</i> | <i>proteus</i> | FL |
| <i>Brochymena</i> | <i>quadripustulata</i> | DE | <i>Hymenarcys</i> | <i>nervosa</i> | DE |
| <i>Chinavia</i> | <i>hilaris</i> | OR, DE | <i>Loxa</i> | <i>flavicollis</i> | FL |
| <i>Chinavia</i> | <i>marginata</i> | FL | <i>Megacopta</i> | <i>cribraria</i> | FL |
| <i>Chlorochroa</i> | <i>ligata</i> | OR | <i>Menecles</i> | <i>insertus</i> | DE |
| <i>Chlorochroa</i> | <i>saucia</i> | DE | <i>Mormidea</i> | <i>pama</i> | FL |
| <i>Chlorochroa</i> | <i>sayi</i> | DE | <i>Murgantia</i> | <i>histrionica</i> | FL, DE |
| <i>Chlorochroa</i> | <i>senilis</i> | DE | <i>Nezara</i> | <i>viridula</i> | FL |
| <i>Cosmopepla</i> | <i>intergressa</i> | OR | <i>Oebalus</i> | <i>pugnax</i> | FL, DE |
| <i>Cosmopepla</i> | <i>lintneriana</i> | DE | <i>Orsilochides</i> | <i>guttata</i> | FL |
| <i>Edessa</i> | <i>bifida</i> | FL | <i>Orsilochides</i> | <i>guttata</i> | FL |
| <i>Edessa</i> | <i>floridan</i> | DE | <i>Perillus</i> | <i>strigipes</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>Euthyrhynchus</i> | <i>floridanus</i> | FL | <i>Trichopepla</i> | <i>semivittata</i> | DE |

DE Host Range Test List

| species in testing | species to be tested (if available) |
|-------------------------------------|--|
| <i>Chinavia hilaris</i> | <i>Banasa calva</i> |
| <i>Cosmopepla lintneriana</i> | <i>Banasa dimiata</i> |
| <i>Edessa florida</i> | <i>Banasa euchlora</i> |
| <i>Euschistus servus</i> | <i>Brochymena quadripustulata</i> |
| <i>Euschistus tristigmus</i> | <i>Chlorochroa saucia</i> |
| <i>Euschistus variolarius</i> | <i>Chlorochroa sayi</i> |
| <i>Murgantia histrionica</i> | <i>Chlorochroa senilis</i> |
| <i>Podisus maculiventris</i> | <i>Holcostethus limbolarius</i> |
| <i>Thyanta custator</i> | <i>Hymenarcys nervosa</i> |
| <i>Thyanta custator accerra</i> | <i>Meneclis insertus</i> |
| <i>Trichopepla semivittata</i> | <i>Mormidea lugens</i> |
| | <i>Oebalus pugnax</i> |
| | <i>Perillus bioculatus</i> |
| | <i>Stiretrus anchorago</i> |

No Choice Tests : No successful parasitism

| Genus | Species | State | No Choice | Choice |
|-------------------|--------------------|--------|-----------|--------|
| <i>Euschistus</i> | <i>conspersus</i> | OR | Negative | X |
| <i>Euschistus</i> | <i>quadrator</i> | FL | Negative | X |
| <i>Euschistus</i> | <i>servus</i> | DE, FL | Negative | X |
| <i>Euschistus</i> | <i>variolarius</i> | OR | 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> | DE, FL | Negative | X |
| <i>Nezara</i> | <i>viridula</i> | FL | Negative | X |
| <i>Oebalus</i> | <i>pugnax</i> | FL | Negative | X |
| <i>Piezodorus</i> | <i>guildinii</i> | FL | Negative | X |
| <i>Proxys</i> | <i>punctulatus</i> | FL | Negative | X |

No Choice Tests : some parasitism recorded*

(*further tests in progress to determine impact)

| Genus | Species | State | No Choice | Choice |
|----------------------|----------------------|------------|-----------|---------------|
| <i>Banasa</i> | <i>dimiata</i> | DE, OR | + | + |
| <i>Chinavia</i> | <i>hilaris</i> | DE, OR | + | (in progress) |
| <i>Chinavia</i> | <i>marginata</i> | FL | + | negative |
| <i>Chlorochroa</i> | <i>ligata</i> | OR | + | (in progress) |
| <i>Euthyrhynchus</i> | <i>florianus</i> | FL | + | (in progress) |
| <i>Holcostethus</i> | <i>limbolaris</i> | DE, FL | + | (in progress) |
| <i>Orsilochides</i> | <i>guttata</i> | FL | + | (in progress) |
| <i>Podisus</i> | <i>maculiventris</i> | DE, FL | + | + |
| <i>Thyanta</i> | <i>custator</i> | DE, FL, OR | + | + |

Trissolcus japonicus : No-Choice Tests (DE)
 (data shown are preliminary)

| | # Replicates to date | # Attacks | Non-target Host | | | BMSB - Control | | |
|----------------------------------|----------------------------|--------------|---------------------------|---------------------------------------|--|---------------------------|-----------------------------|--|
| | | | % Parasitism (mean) | % Parasitoids emerged (mean) | Sex ratio (mean; proportion male) | % Parasitism (mean) | % Parasitoids emerged | Sex ratio (mean; proportion male) |
| <i>Chinavia hilaris</i> | 8 | 1 | 1 | 0 | - | 100 | 99 | 0.16 |
| <i>Euschistus servus</i> | 11 | 0 | 0 | 0 | - | 91 | 91 | 0.09 |
| <i>Podisus maculiventris</i> | 16 | 11 | 44 | 72 | 0.06 | 75 | 97 | 0.09 |
| <i>Thyanta custator</i> | 18 | 5 | 8 | 0.0 | - | 88 | 97 | 0.12 |

Note the different levels of acceptance & successful emergence
 between non-target and BMSB

Non-target attack: choice vs. no-choice (data shown are preliminary)

| | No-choice | | | Choice | | |
|------------------------------|-----------------------------------|---------------------------------------|-----------------------------------|-----------------------------------|---------------------------------------|-----------------------------------|
| | Proportion of Egg Masses Attacked | Proportion Of Eggs Parasitized (mean) | Sex Ratio (proportion male; mean) | Proportion of Egg Masses Attacked | Proportion Of Eggs Parasitized (mean) | Sex Ratio (proportion male; mean) |
| <i>Chinavia marginata</i> | 0.36 | 0.02 | 0.38 | 0 | - | - |
| <i>Podisus maculiventris</i> | 0.40 | 0.22 | 0.14 | 0.25 | 0.07 | 0.21 |
| <i>Thyanta custator</i> | 0.51 | 0.40 | 0.40 | 0.25 | 0.04 | 0.50 |

Note reduced levels of attack in Choice vs. No-choice conditions

Further Assessments

I. *Choice Tests*

II. *Behavioral Observations*

- Searching Behavior (role of plant texture, chemical cues etc.)
- Patch Residence Times & Leaving Tendency
- Oviposition Behavior
- Intra- and Interspecific Competition

III. *Role of Parasitoid Physiology*

- Effect of parental experience & physiology on host choice behavior
- Effect of host choice on offspring (sex ratio, fitness, size)

Thank you!



Trissolcus mitsukurii

Photo: Steve Valley - ODA