Factors that potentially mediate the ecological host range of *Trissolcus japonicus*

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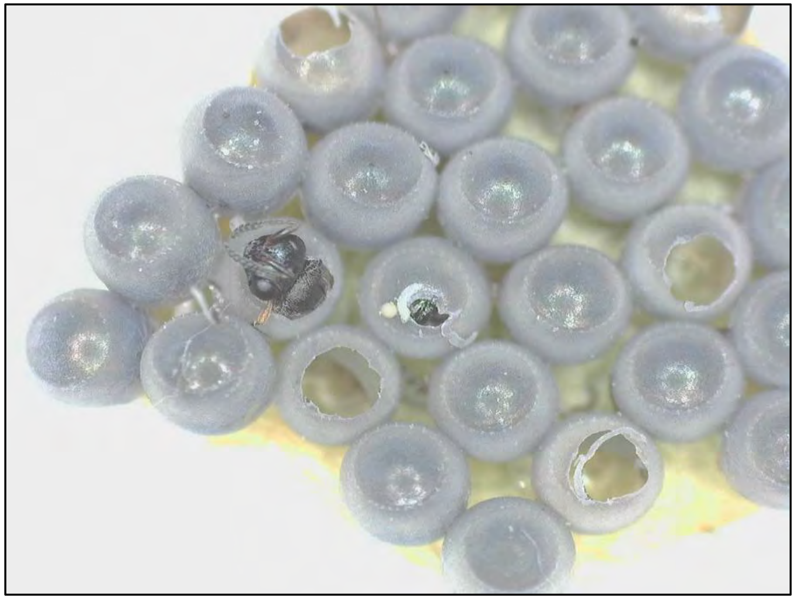
Brown Marmorated Stink Bug (BMSB)
BMSB Integrated Pest Management (IPM) Working Group Meeting
November 30, 2016

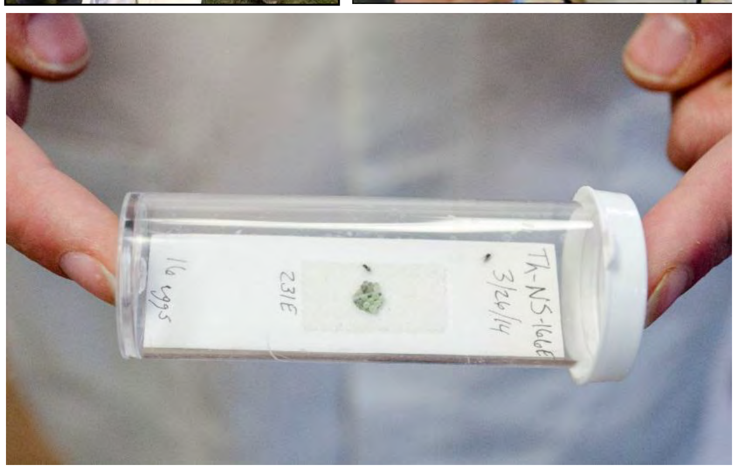
Trissolcus japonicus (Ashmead) (Hymenoptera: Platygastridae)



High parasitism rates in the native range (60 to 80%)

Physiological Host-Specificity Tests (PHST)

Risk = Hazard x Exposure



PHST poses the risk <u>hazard</u> question,

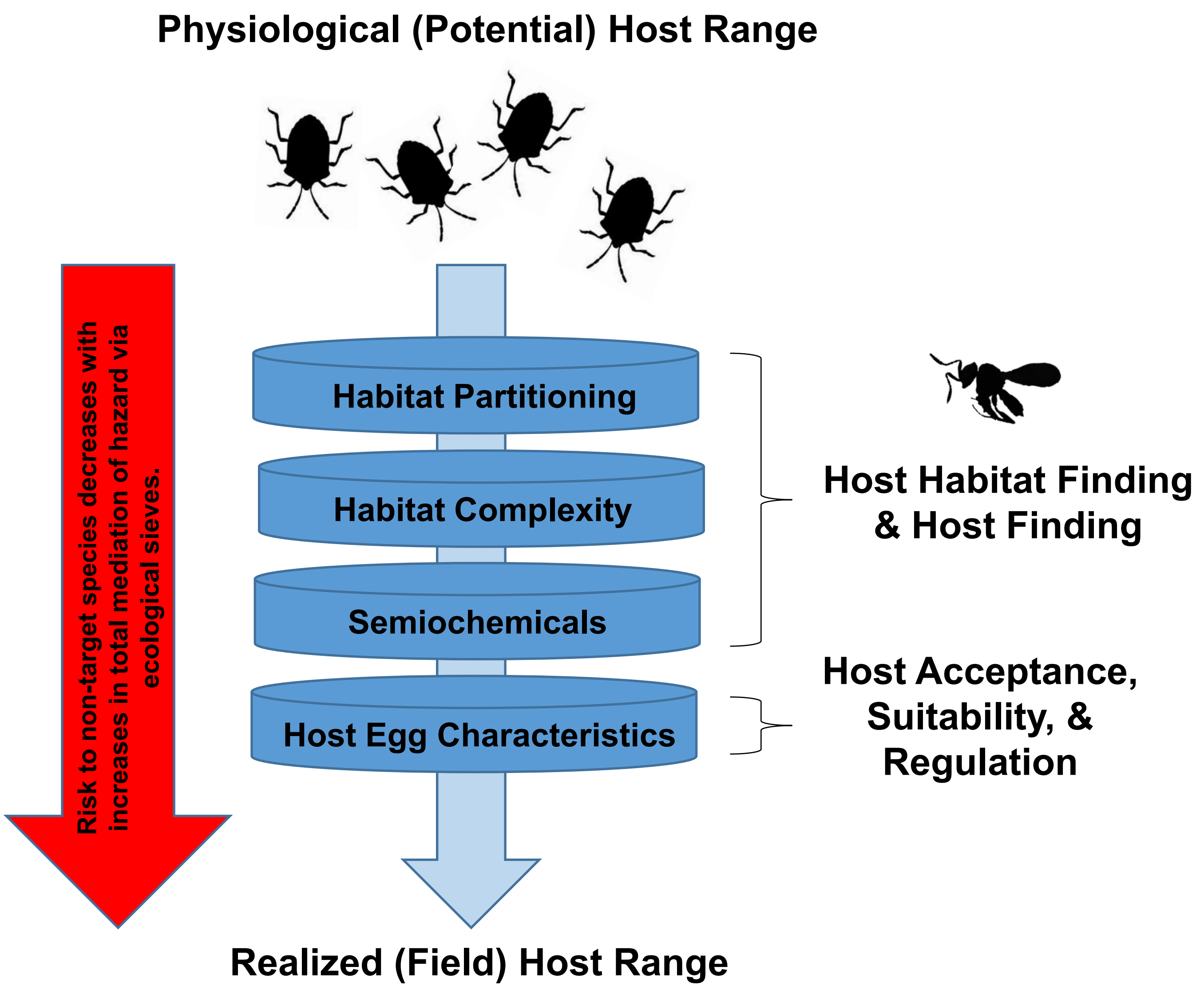
"<u>Can</u> *T. japonicus* attack non-target species?"

To determine this,

- **23 Pentatomoidea spp. were tested; and**
- **Development and emergence occurred on 15 species in 11 genera.**
- **Therefore, the hazard prediction is that *T. japonicus* <u>can</u> complete development on some native Pentatomoidea.**
- **But, what about the exposure analysis?**

Ecological Sieves

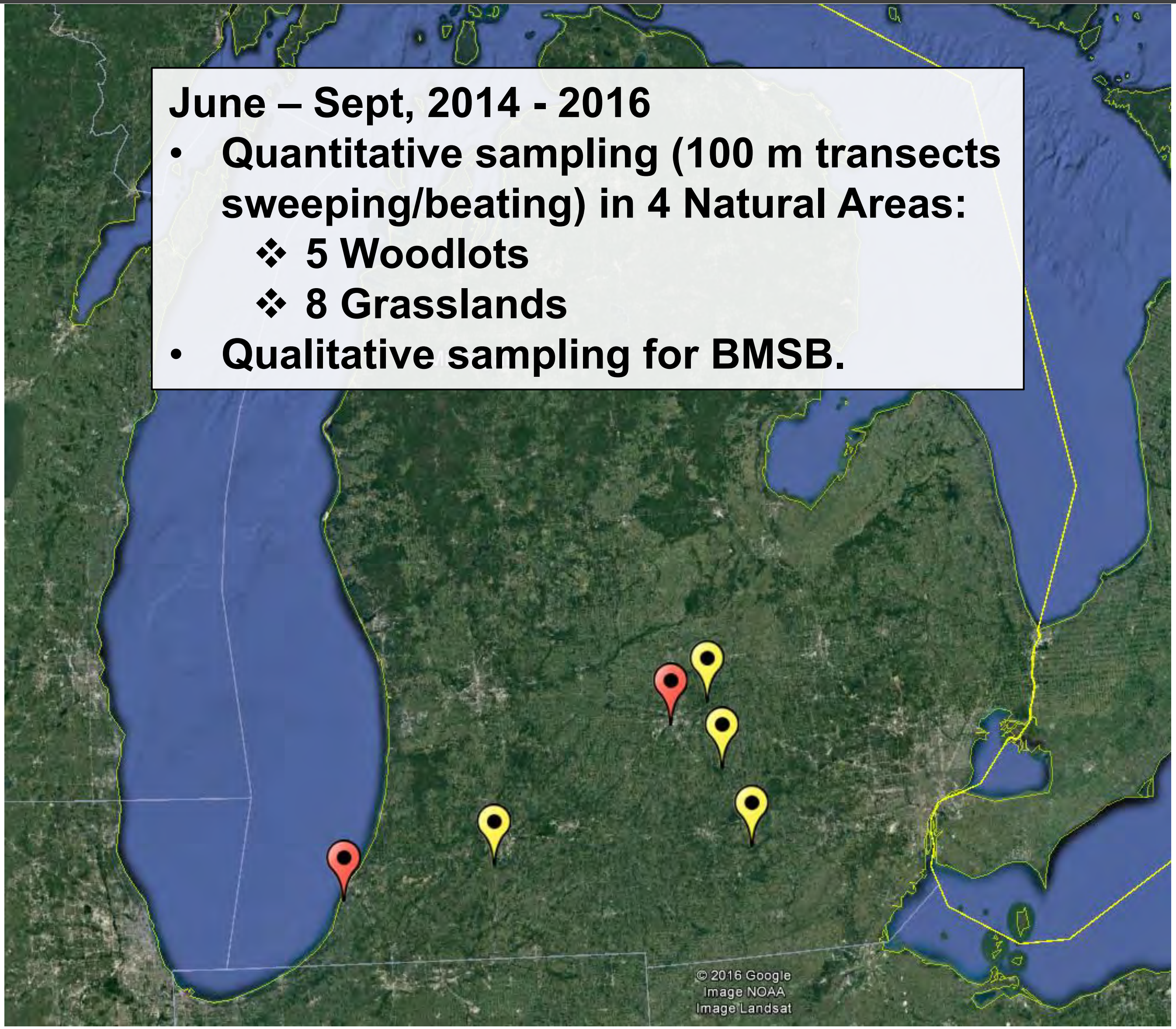
"<u>Will</u> *T. japonicus* attack non-target species?"



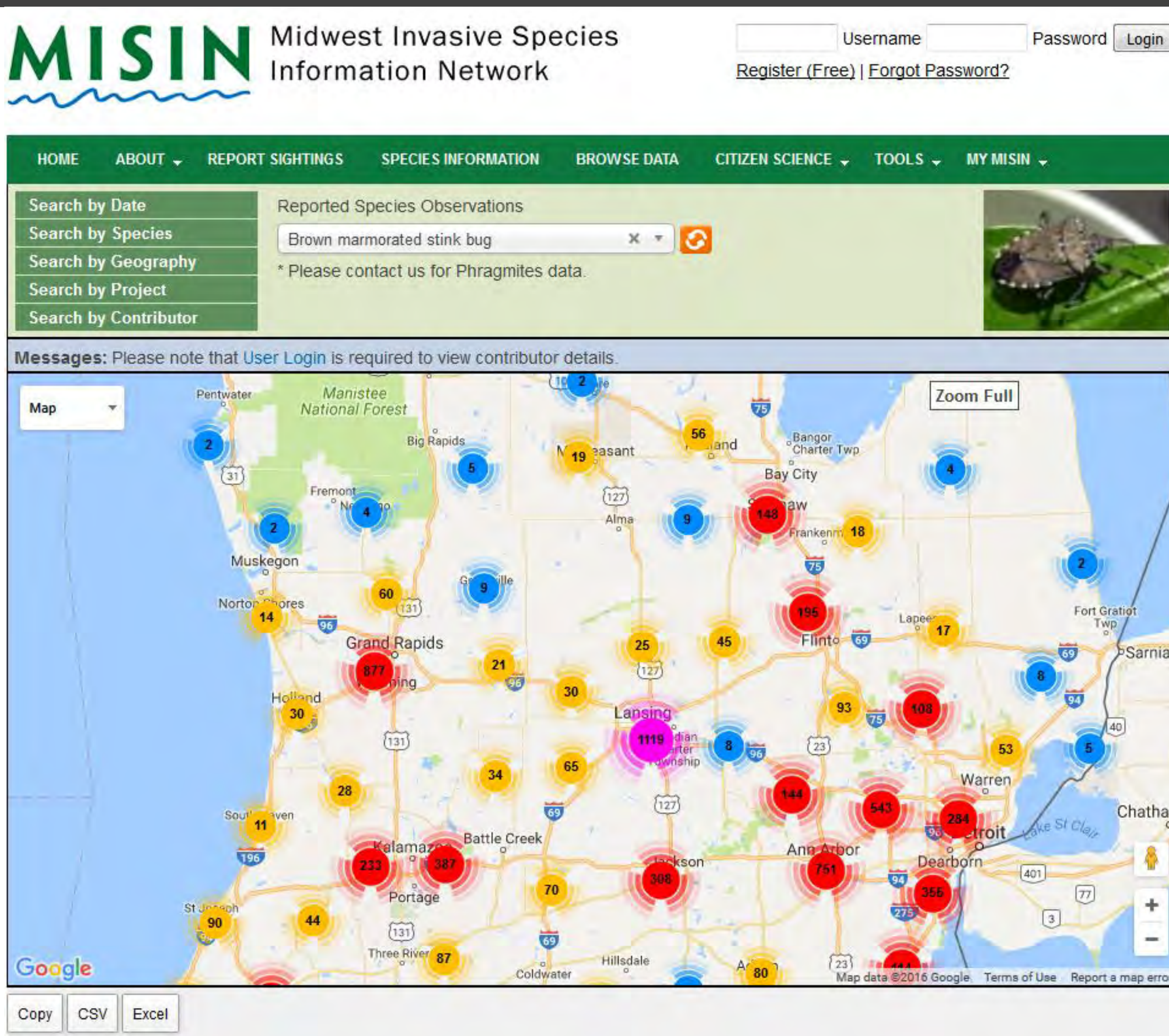
Sampling in Michigan

June – Sept, 2014 - 2016

- **Quantitative sampling (100 m transects sweeping/beating) in 4 Natural Areas:**
  - ❖ **5 Woodlots**
  - ❖ **8 Grasslands**
- **Qualitative sampling for BMSB.**



Current Distribution in Michigan
Reported in 46 Counties



BMSB Sampling

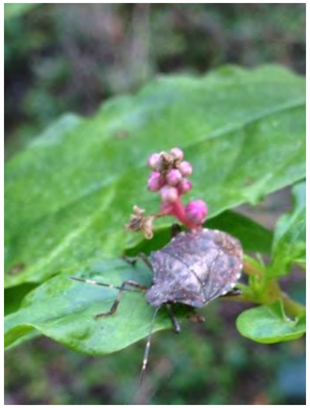
Host Plants:

June – Sept:

- Tree of Heaven
- Honeysuckle
- Ash
- Boxelder
- Eastern White Cedar
- Black Locust
- Pokeweed

Sept:

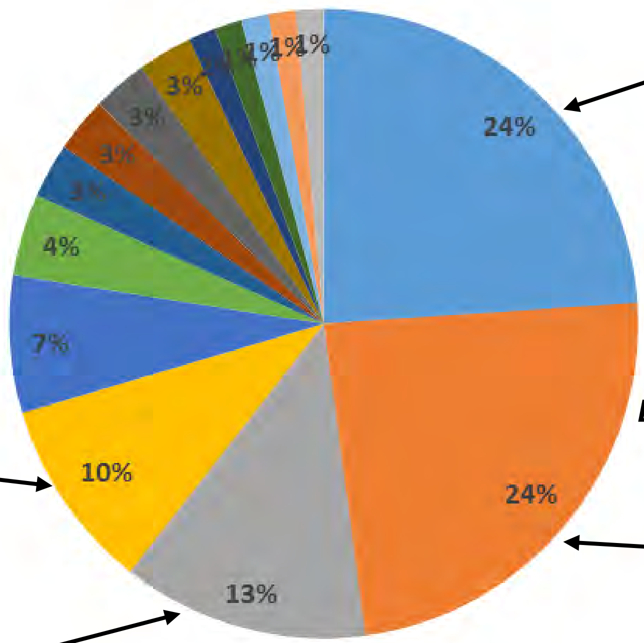
- Soybean



Pentatomidae in Woodlot Communities

- **15 species.**
- ***Banasa dimidiata*** **- 24%**
- ***Euschistus tristigmus luridus*** **- 24%**

Banasa dimidiata



Chinavia hilaris

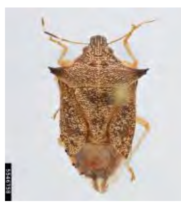
Euschistus tristigmus luridus

Dendrocoris humeralis

Pentatomoidea in Grassland Communities

- **16 species.**
- ***Cormelaena* spp.- 59%**
- ***Euschistus variolarious* - 16%**

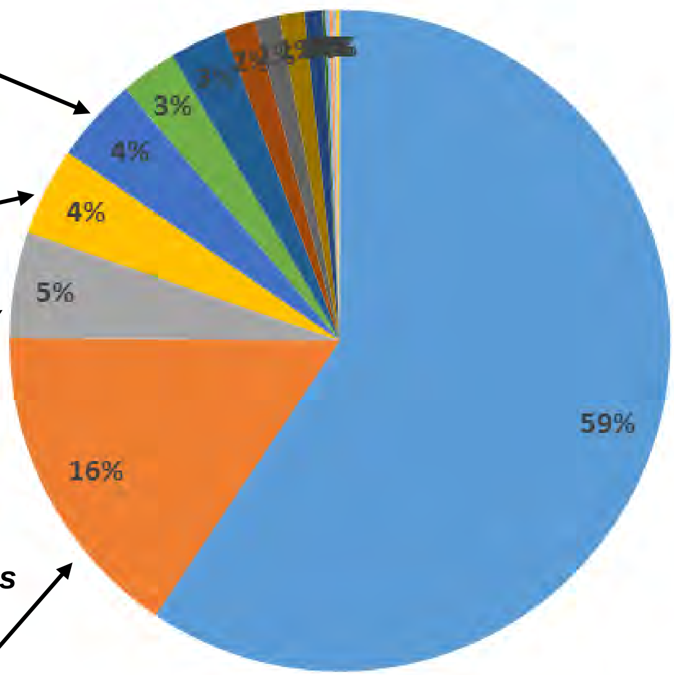
Podisus maculiventris



Euschistus servus

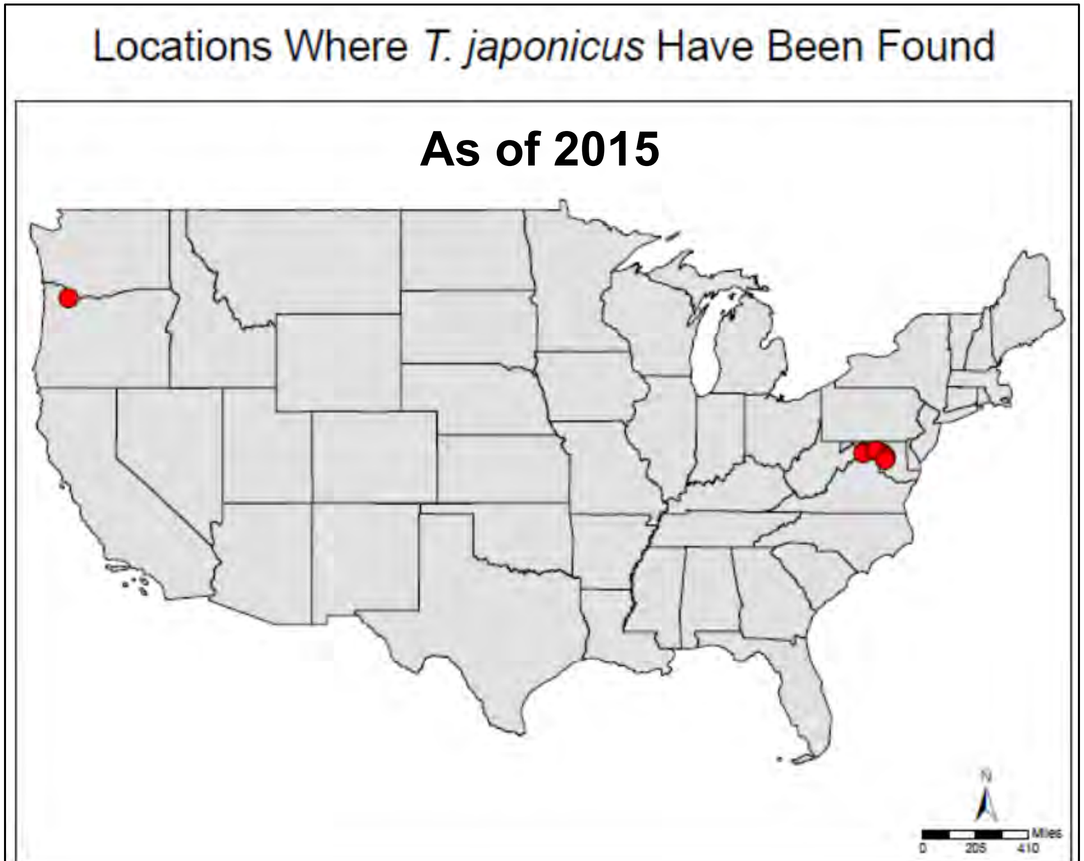
Coenus delius

Euschistus variolarious



***Cormelaena* spp.**
(Thyreocoridae)

Adventive *T. japonicus* in the Field



Trissolcus japonicus (Ashmead) (Hymenoptera, Scelionidae) emerges in North America

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Discovery of an Exotic Egg Parasitoid of the Brown Marmorated Stink Bug, _Halyomorpha halys_ (Stål) in the Pacific Northwest

Author(s): Joshua M. Milnes , Nik G. Wiman , Elijah J. Talamas , Jay F. Brunner , Kim A. Hoelmer , Matthew L. Buffington and Elizabeth H. Beers
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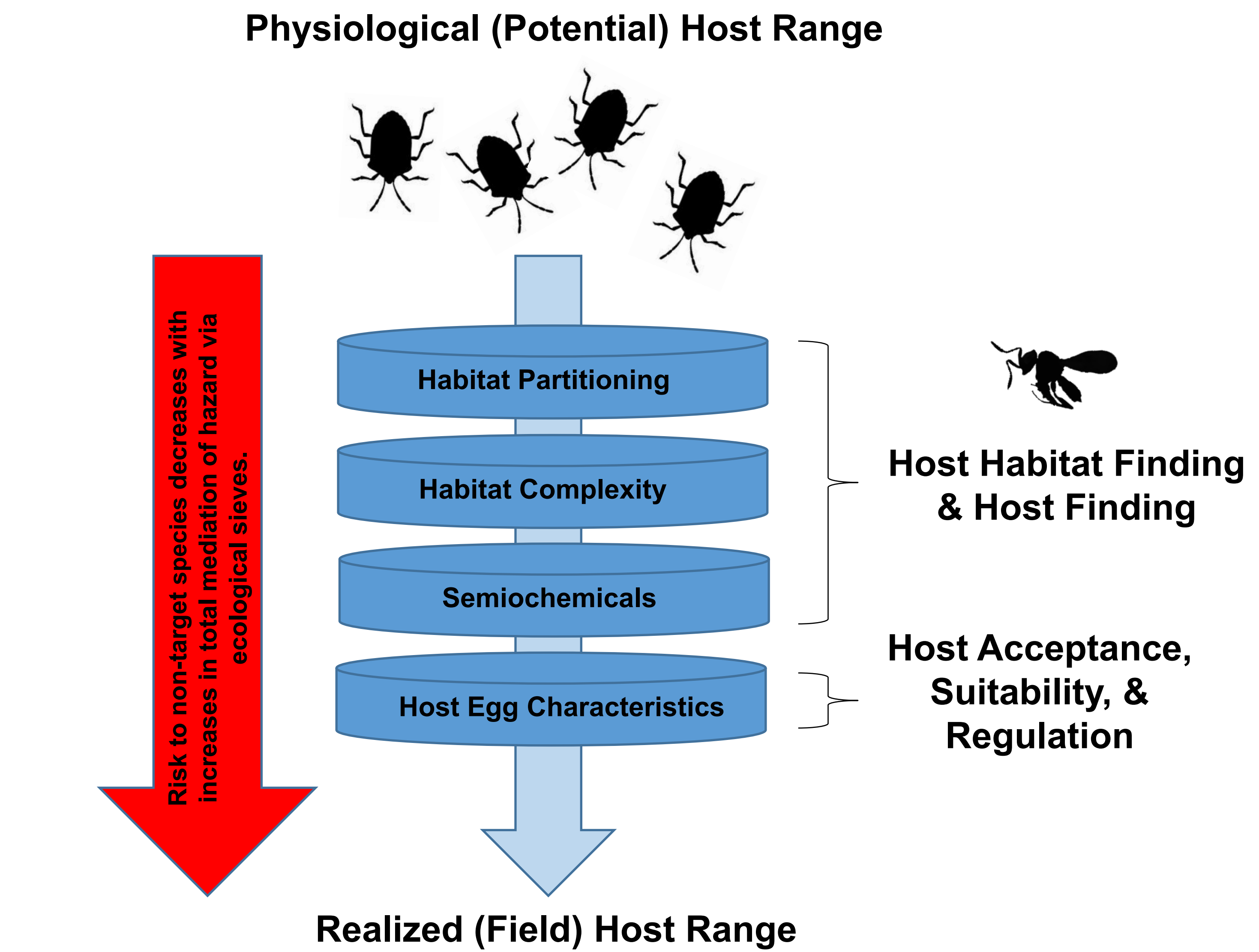
URL: http://www.bioone.org/doi/full/10.4289/0013-8797.118.3.466

MI Sentinel Egg Surveys

Parasitoids by Host Species. 2015

Host		Parasitoids		BMSB Eggs		
Common Name	Family	Species	Family	No. Put	Attacked	
				Out	No.	%
American hornbeam or Ironwood, *Carpinus caroliniana*	Betulaceae	*Trissolcus cosmopeplae*	Platygastridae	84	8	0.10
Milkweed, *Asclepias albicans*	Apocynaceae	*Ooencyrtus sp.*	Encyrtidae	84	8	0.10
Milkweed, *Asclepias albicans*	Apocynaceae	*Trissolcus euschisti*	Platygastridae	28	3	0.11
Wild Grape, *Vitis vinifera*	Vitaceae	*Trissolcus cosmopeplae*	Platygastridae	28	6	0.21
Wild Grape, *Vitis vinifera*	Vitaceae	*Ooencyrtus sp.*	Encyrtidae	27	4	0.15
Hawthorn, *Crategus rhipidophylla*	Rosaceae	*Ooencyrtus sp.*	Encyrtidae	56	6	0.11
American basswood, *Tilia americana*	Tiliaceae	*Trissolcus cosmopeplae*	Platygastridae	28	1	0.04
American basswood, *Tilia americana*	Tiliaceae	*Trissolcus euschisti*	Platygastridae	28	2	0.07
American basswood, *Tilia americana*	Tiliaceae	*Trissolcus brochymenae*	Platygastridae	20	1	0.05
			Totals	383	39	0.10

Ecological Sieves



Habitat Complexity Experiments

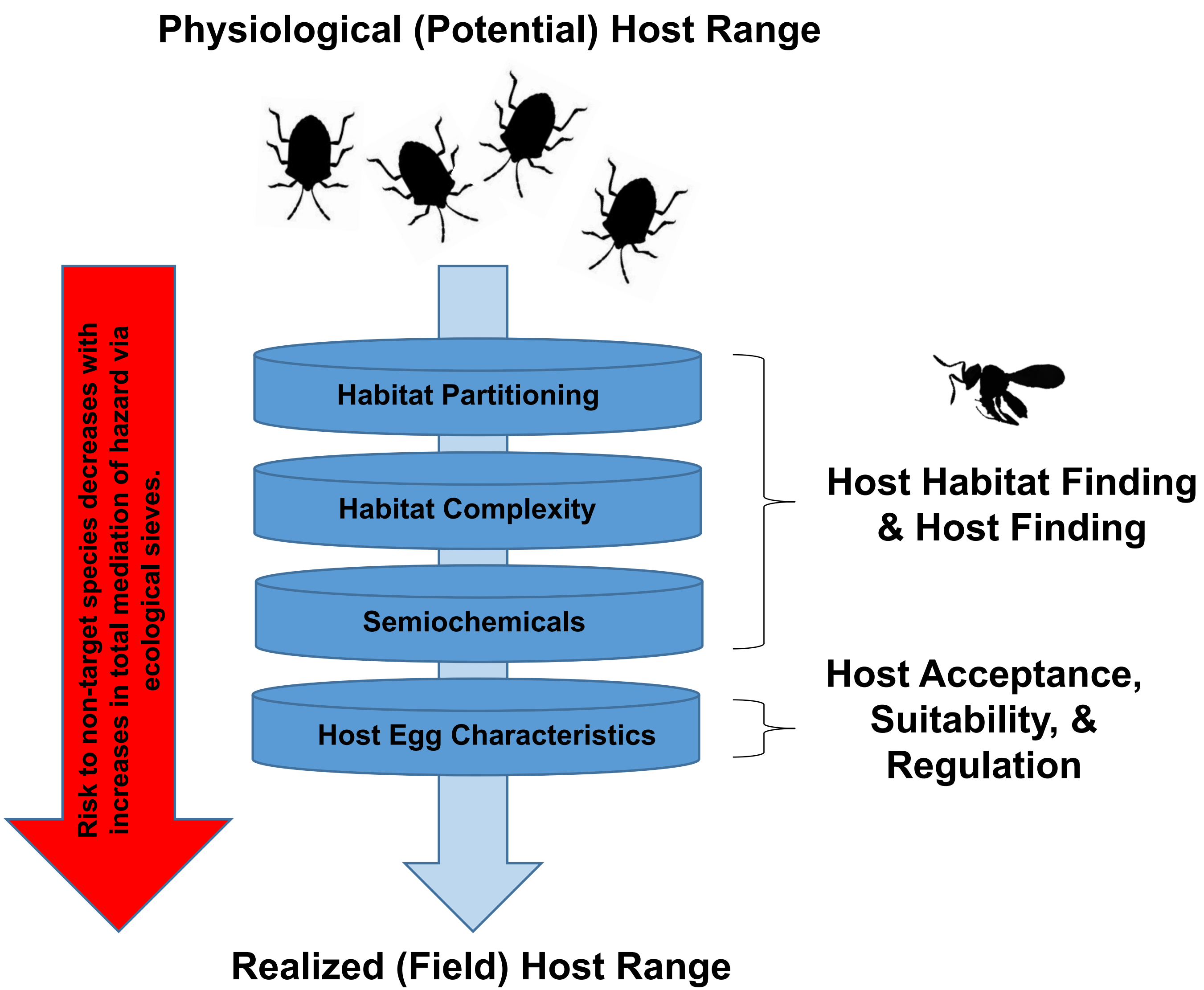
46 x 46 x 46 cm

1.5 x 1.5 x 2 m H

Habitat Complexity Experiments

		No. egg masses parasitized				
Test	No. reps	BMSB	*T.c. accerra*	*P. maculiventris*	X^2 statistic	p-value
Paired-choice	21	20	15	----	4.29	0.0384
	21	18	----	12	4.2	0.0404

Ecological Sieves



Semiochemicals

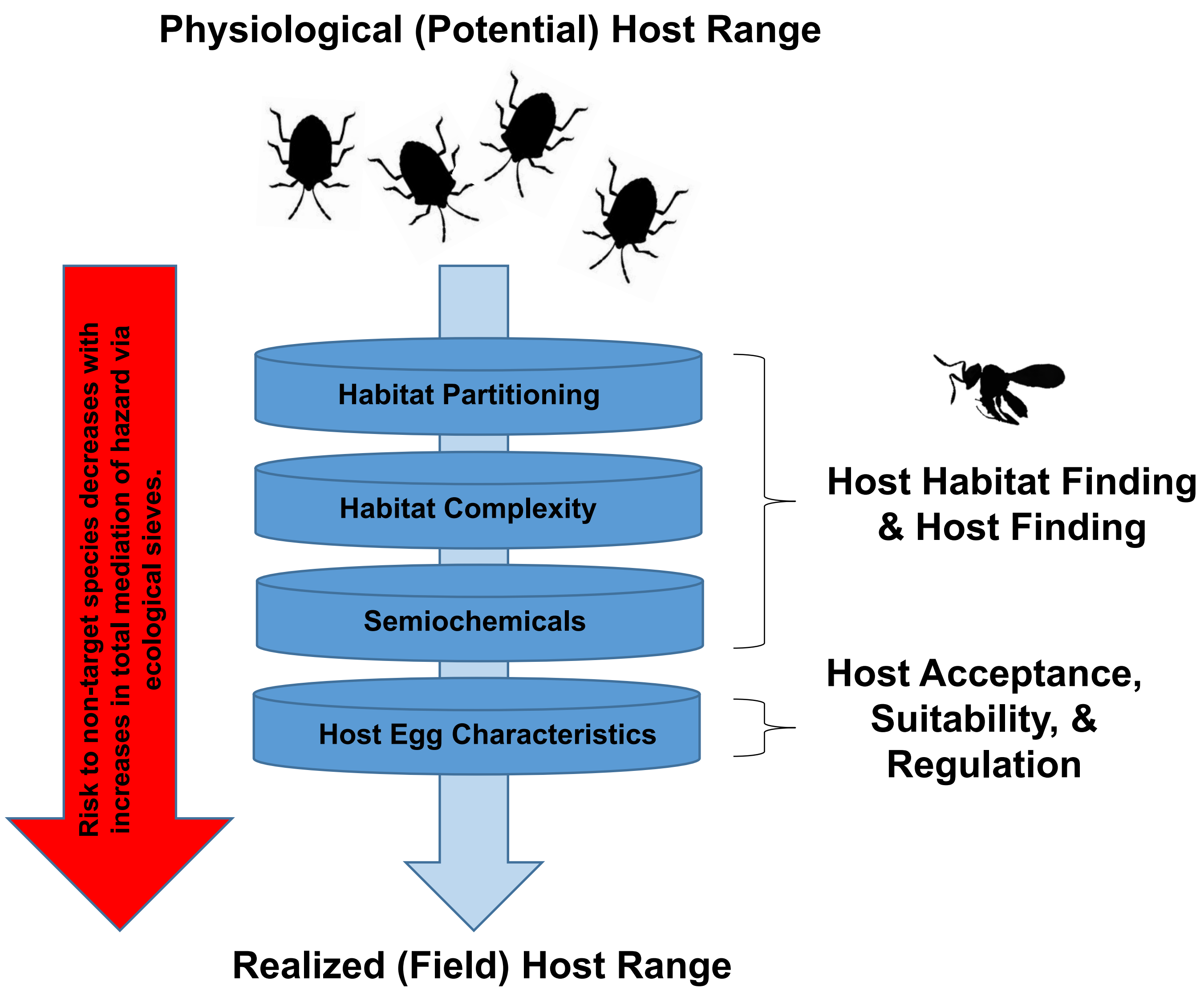
Host location by *Trissolcus basalis*:

- **Egg kairomones** (Bin *et al*. 1993).
- **Adult cuticular hydrocarbons** (Colazza *et al*. 2007).
- **Defensive secretions** (Laumann *et al*. 2009).
- **Chemical footprints on leaves** (Colazza *et al*. 2009).
- **Feeding and oviposition damage** (Colazza *et al*. 2004).

Semiochemicals

- Y-tube Olfactometer.
- Odor Sources.
  - ❖ Eggs.
  - ❖ Adult BMSB.
  - ❖ Chemical footprints.
  - ❖ Feeding damage.
- Under Continued Evaluation.

Ecological Sieves



Multiple-Species Choice Tests

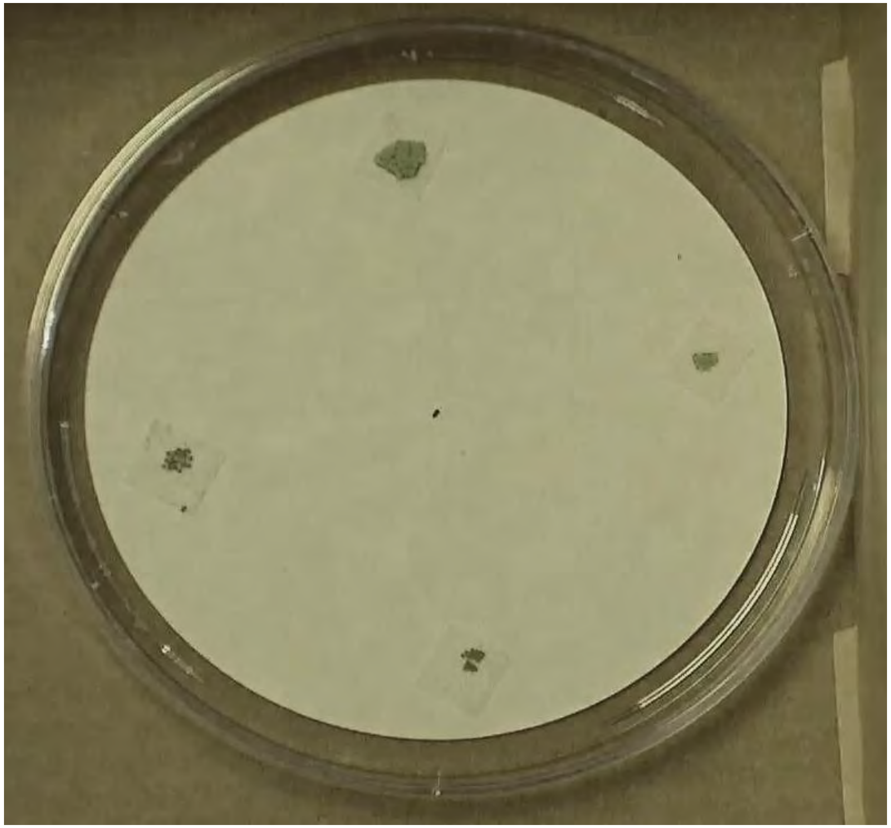
- One, 24-h-old mated, naïve female *T. japonicus* placed in middle of arena.

- Scored behaviors:
  - Encounter with eggs;
  - Inspection of eggs by circling and antennal drumming;
  - Egg rejection (abandoning); and
  - Egg acceptance (oviposition).

- After 24-h, Petri dishes moved to an environmental chamber at 25°C; 60-80% RH; 16:8 L:D.

- Wasp removed from the arena after 24-h.

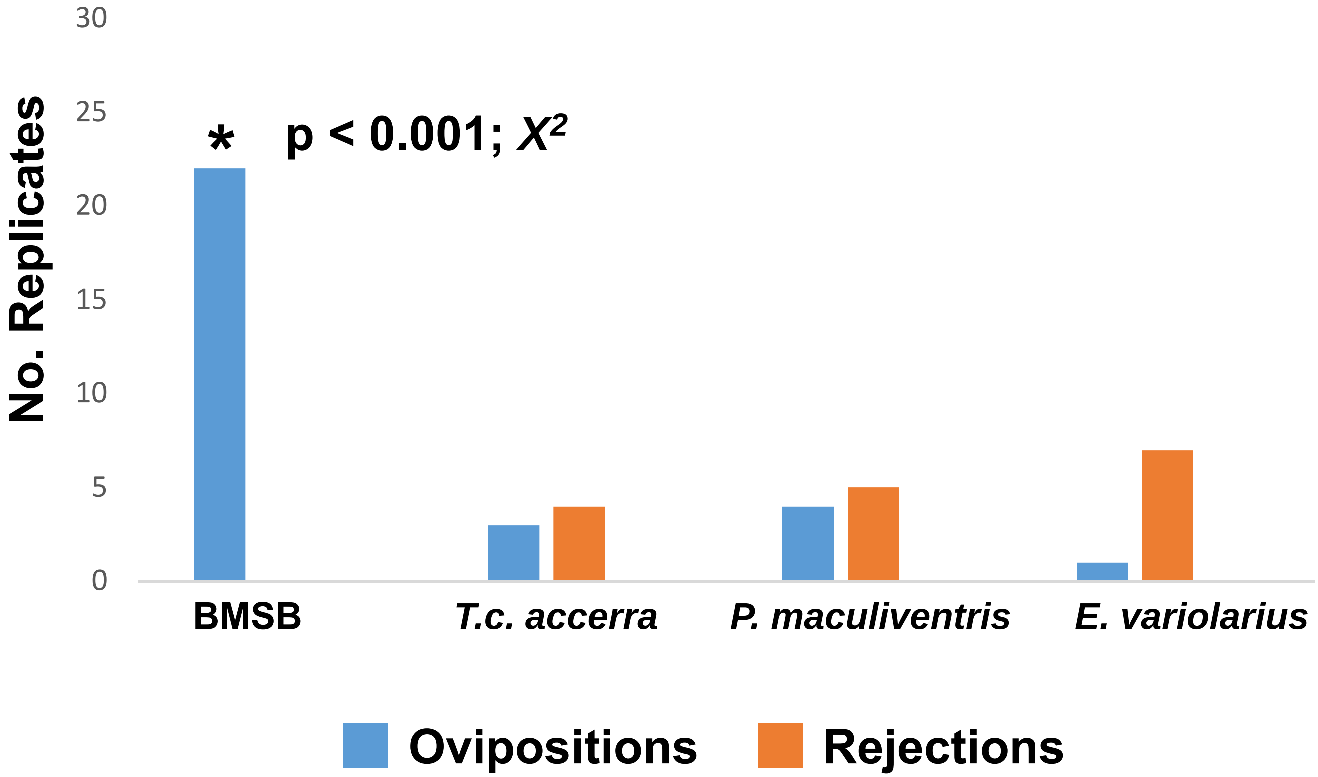
- Egg masses held separately until wasp or nymph emergence.



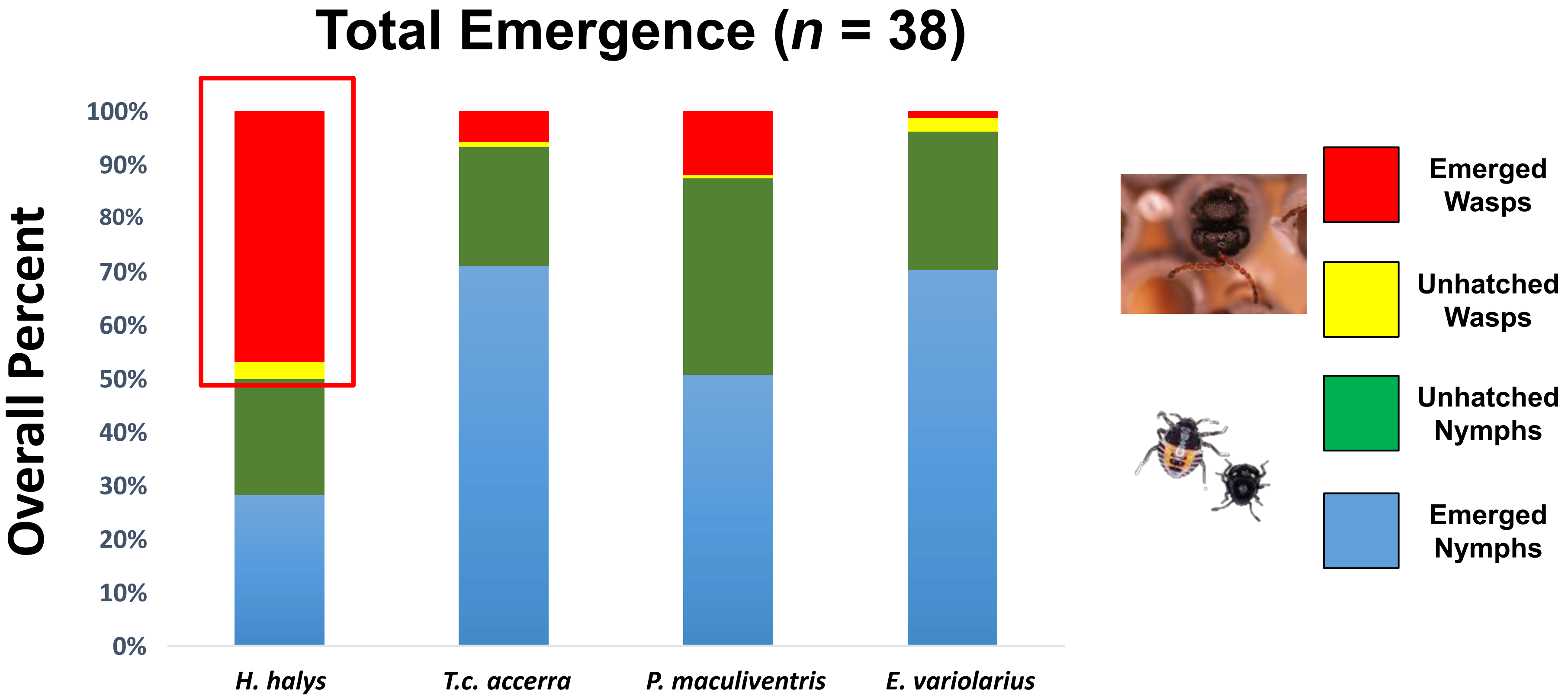
150 x 15 mm Petri dish arenas.

Multiple-Species Choice Tests

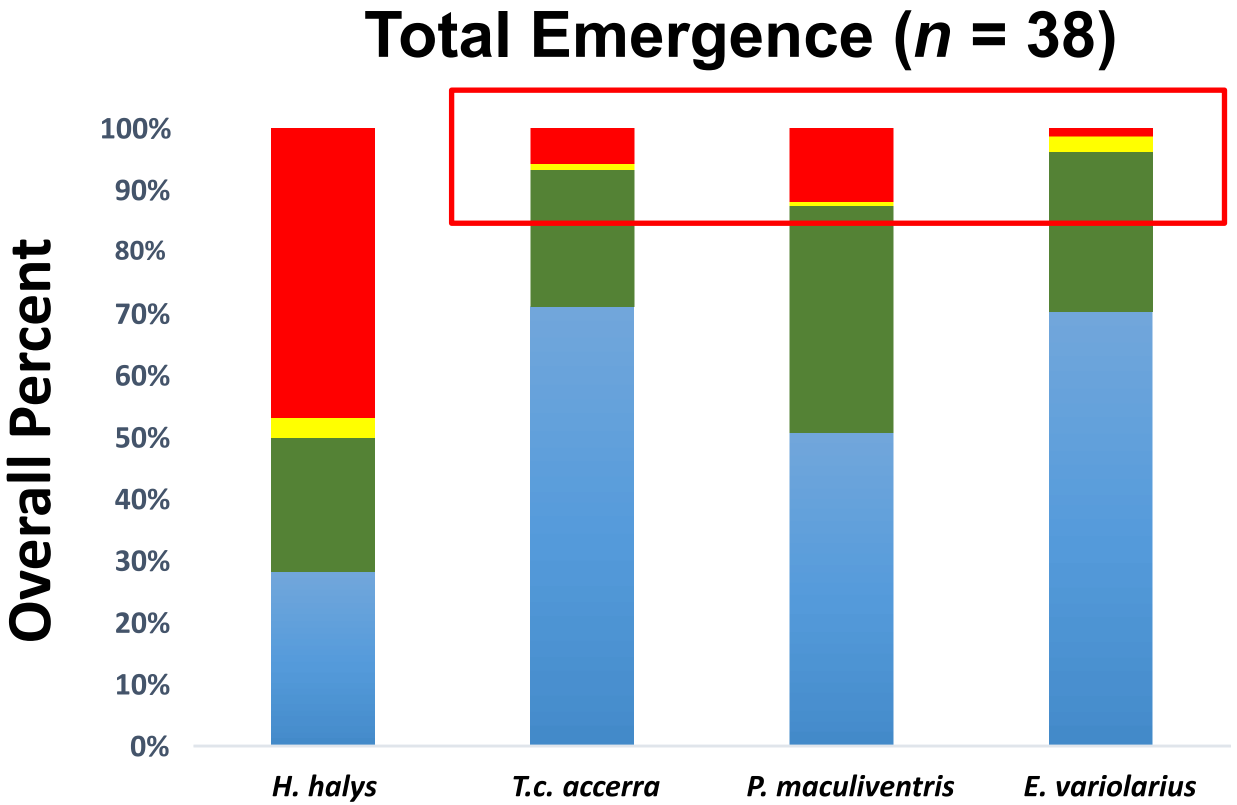
No. replicates in which eggs were accepted (blue) or rejected (orange) (*n* = 30)



Multiple-Species Choice Tests



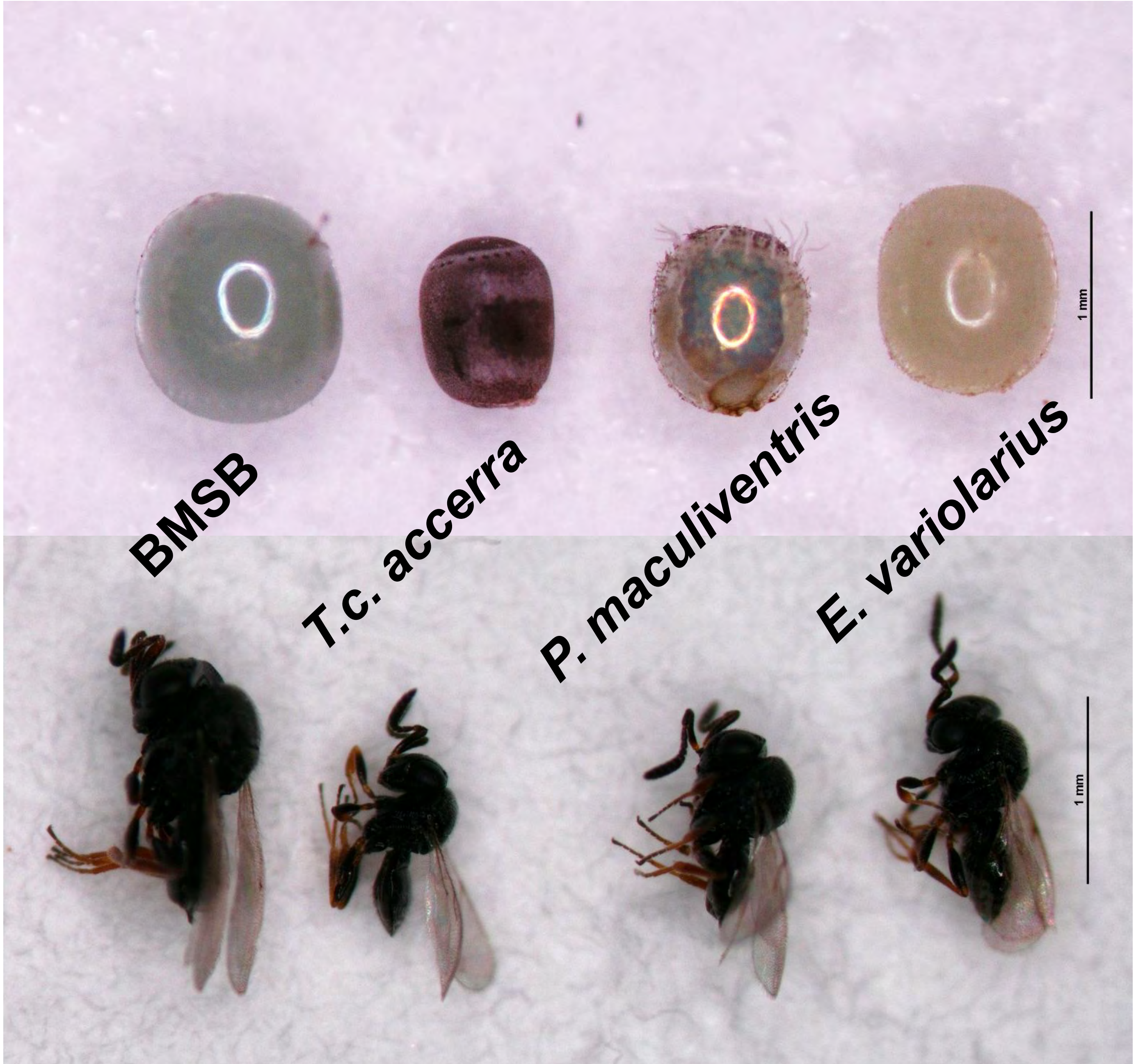
Multiple-Species Choice Tests



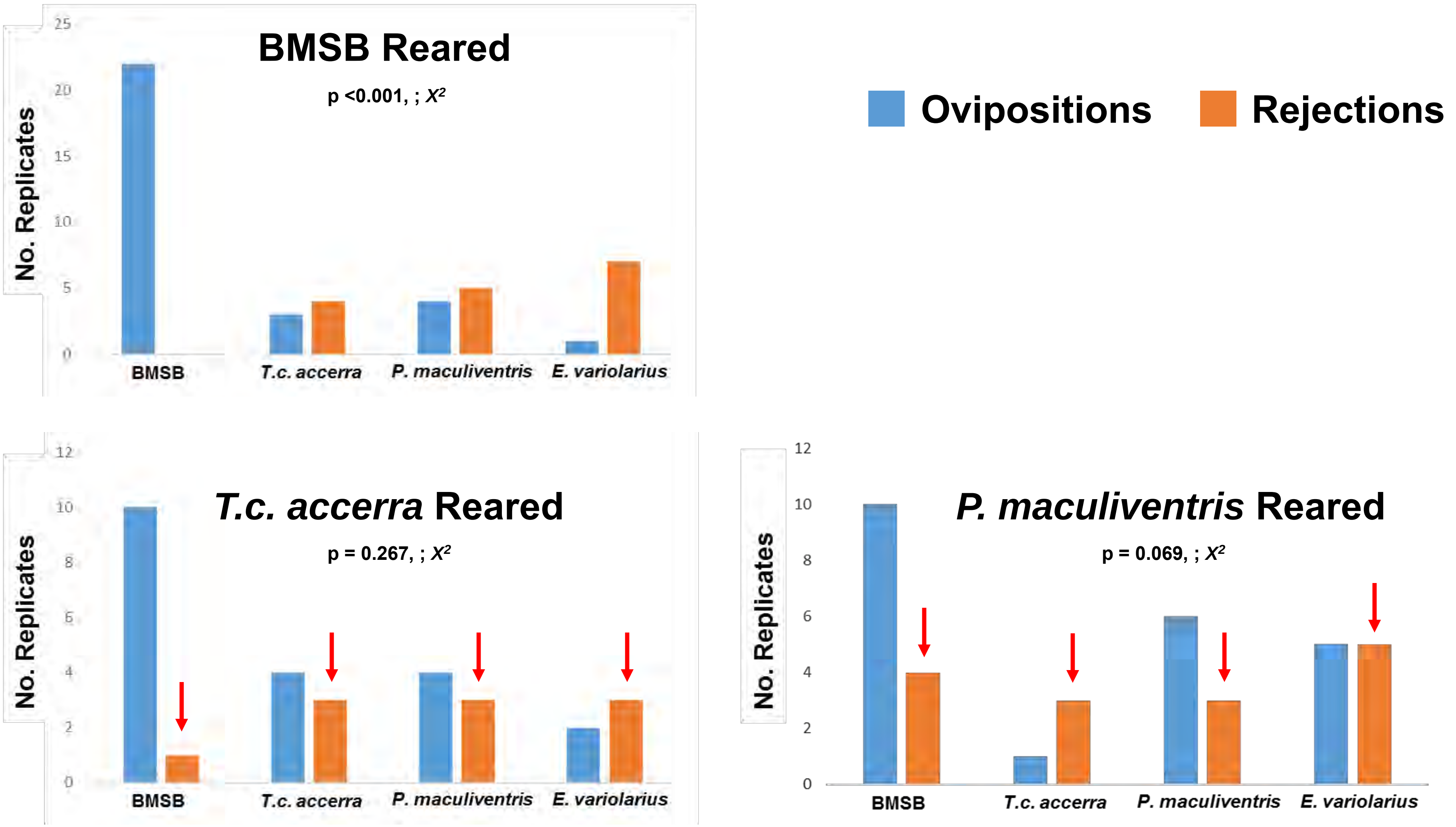
Development on Non-Target Hosts

- **Does specificity differ?**
  - **Do compounds on eggs train wasps for preference?**
  - **Genetic inclination?**
    - **Tumlinson *et al*. 1993. How parasitic wasps find their hosts. *Scientific American*. March: 100-106.**

- **Does fecundity differ?**
  - **Effects of phenotypic variation.**
    - **Arakawa *et al*. 2004. Effects of host species on body size, fecundity, and longevity of *Trissolcus mitsukurii* (Hymentoptera: Scelionidae), a solitary egg parasitoid of stink bugs. *Appl. Entomol. Zool*. 39:177-181.**
    - **Abram *et al*. 2015. Size-induced phenotypic reaction norms in a parasitoid wasp: an examination of life-history and behavioural traits. *Biological Journal of the Linnean Society*. (*In Press*).**

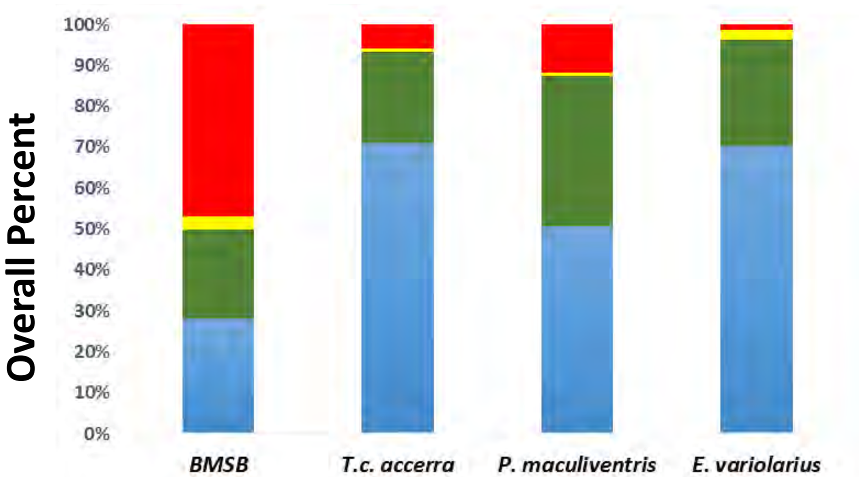

BMSB
T.c. accerra
P. maculiventris
E. variolarius
1 mm
1 mm

Multiple-Species Choice Tests



Multiple-Species Choice Tests

BMSB Reared



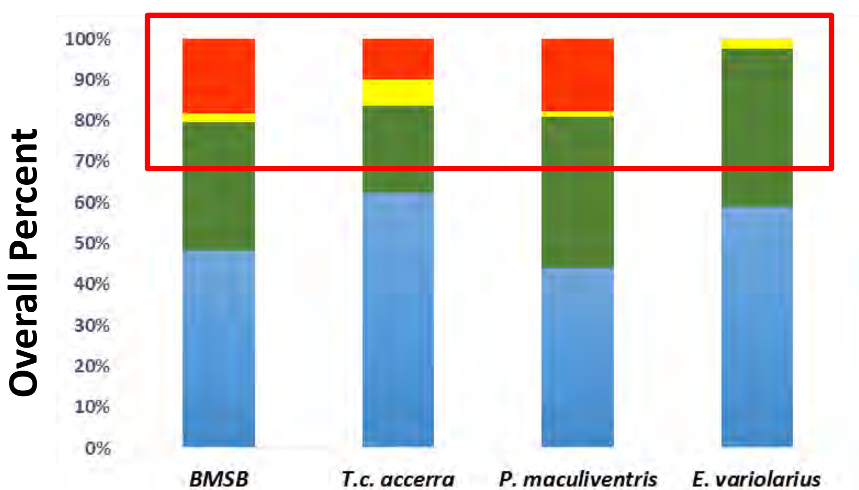
Emerged Wasps

Unhatched Wasps

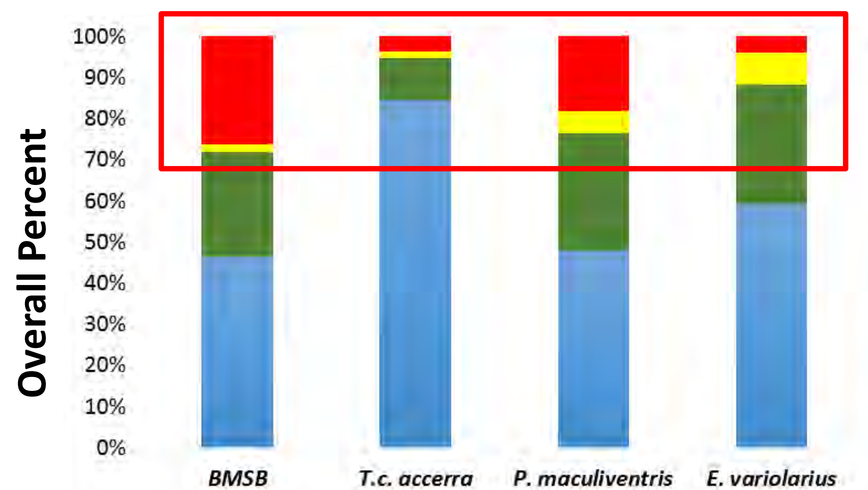
Unhatched Nymphs

Emerged Nymphs

T.c. accerra Reared



P. maculiventris Reared



Conclusions and Future Work

1. **Risk = Hazard x Exposure, = "Can-Do" x "Will Do."**
   - **Hazard is the innate capacity of a biological control agent to attack a non-target species and is determined in PHST; and**
   - **Exposure is determined by ecological sieves that may mediate the hazard.**
   - **A high hazard and a low exposure can mean that a potential biological control agent is "safe" to release.**
2. **The hazard analysis following PHST shows that *T. japonicus* can attack at least 11 genera of native Pentatomoidea.**
3. **The exposure analysis shows that there are some ecological sieves (habitat partitioning and host egg characteristics) that can mediate the potential hazard.**
4. **In the absence of mediating ecological sieves, we feel that the potential host range of *T. japonicus* is too broad, and it should not be approved for release.**
5. **However, since adventive populations of *T. japonicus* have been found in eastern and western U.S., this is a moot point, and efforts to identify ecological sieves and evaluate damage to native Pentatomoidea should be the focus of future research.**

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