Objective 2. Develop monitoring and management tools for BMSB

2.2.5. Screen Asian natural enemies of BMSB for potential release in North America

Funding

USDA United States Department of Agriculture

National Institute of Food and Agriculture

Specialty Crop Research Initiative

Grant #2011-01413-30937

Collaborating Institutions

University of Delaware

ars

Penn State

The State University of New Jersey Rutgers

Northeastern IPM Center

Washington State University

Cornell University

University of Maryland

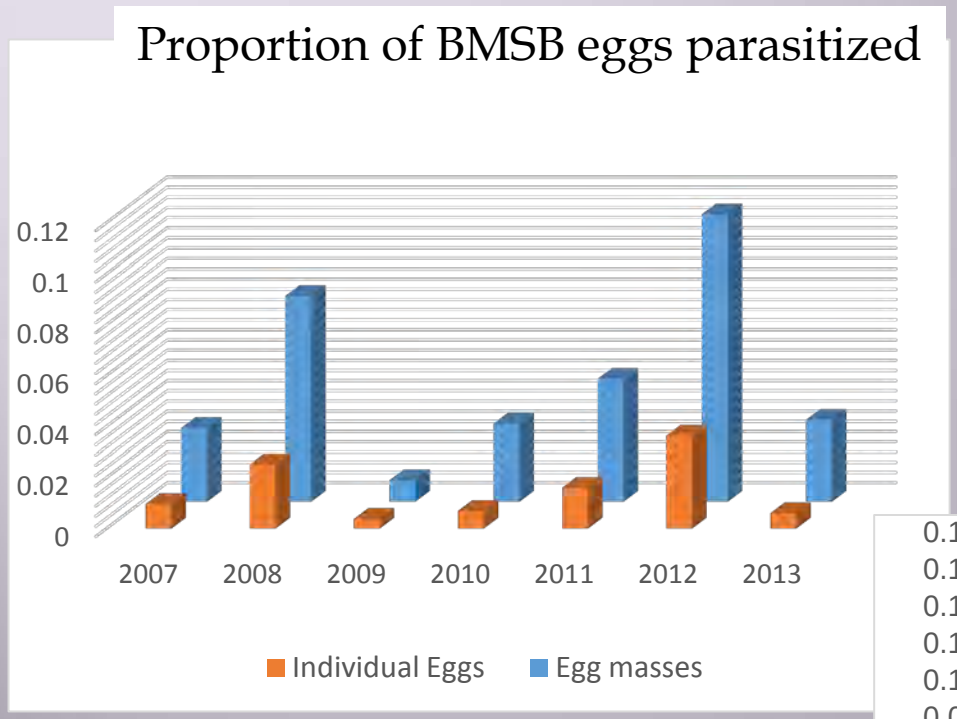
VirginiaTech

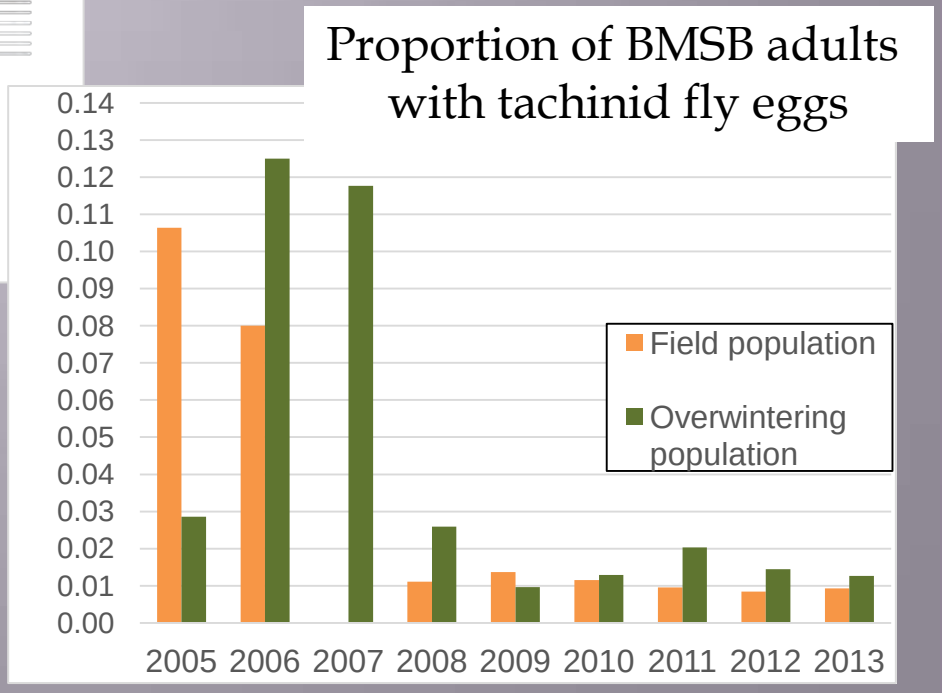
OSU Oregon State University

NC State University

StopBMSB.org

Native parasitism of BMSB in landscape hosts





Asian *Trissolcus spp.*

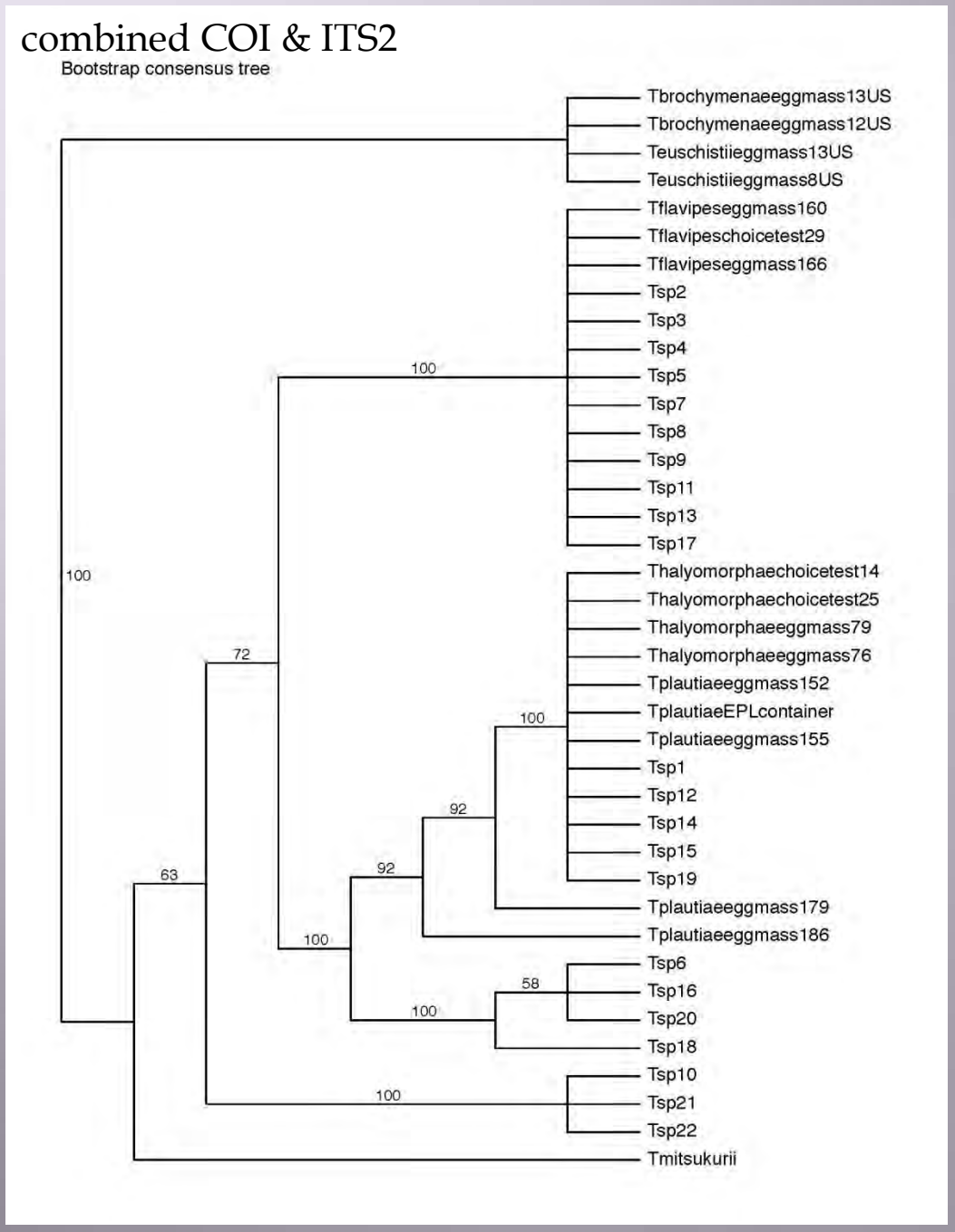
30+ parasitoid populations at ARS BIIR
maintained for host range and efficacy testing

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)

combined COI & ITS2



native *Trissolcus*

Trissolcus 'near' *flavipes*

Trissolcus japonicus

Trissolcus "sp" ??

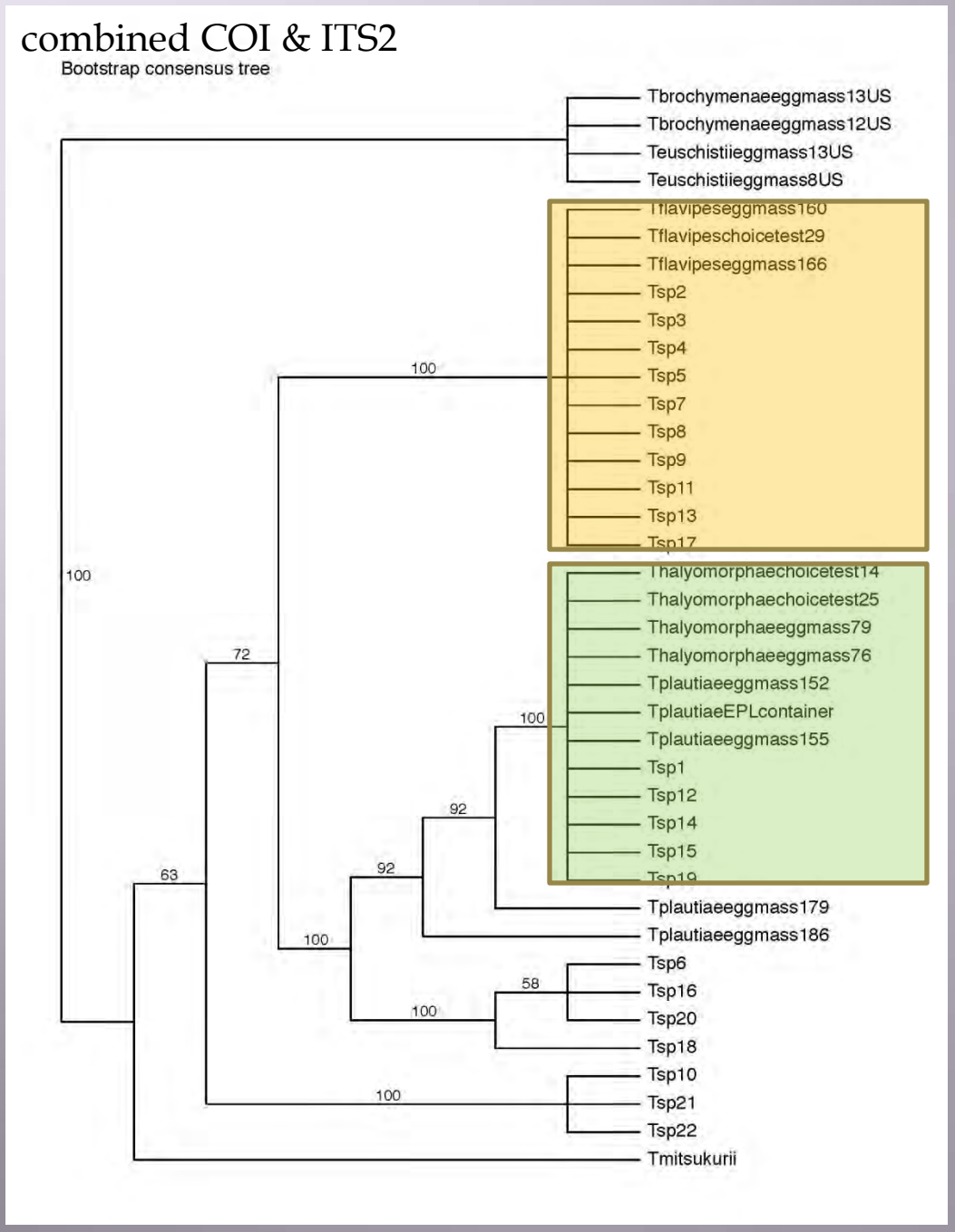
Trissolcus "sp" ??

Trissolcus "sp"

Trissolcus "sp" ??

Trissolcus itoi

Trissolcus mitsukurii


combined COI & ITS2
Bootstrap consensus tree
Tbrochymenaeeggmass13US
Tbrochymenaeeggmass12US
Teuschistiieggmass13US
Teuschistiieggmass8US
Tflavipeseggmass160
Tflavipeschoicetest29
Tflavipeseggmass166
Tsp2
Tsp3
Tsp4
Tsp5
Tsp7
Tsp8
Tsp9
Tsp11
Tsp13
Tsp17
Thalyomorphaechoicetest14
Thalyomorphaechoicetest25
Thalyomorphaeeggmass79
Thalyomorphaeeggmass76
Tplautiaeeggmass152
TplautiaeEPLcontainer
Tplautiaeeggmass155
Tsp1
Tsp12
Tsp14
Tsp15
Tsp19
Tplautiaeeggmass179
Tplautiaeeggmass186
Tsp6
Tsp16
Tsp20
Tsp18
Tsp10
Tsp21
Tsp22
Tmitsukurii
100
72
100
63
92
92
100
58
100
100
native U.S. Trissolcus
Trissolcus 'near' flavipes
Trissolcus japonicus
Trissolcus "sp" ??
Trissolcus "sp" ??
Trissolcus "sp"
Trissolcus "sp" ??
Trissolcus itoi
Trissolcus mitsukurii

Petitioning for release of exotic biocontrol agents

- USDA-APHIS-PPQ regulates releases of new agents under Plant Protection Act
  - Receives petitions for new candidates
  - APHIS is required (by the Environmental Protection Act) to regulate based on risk (NOT cost:benefit)
  - Consults with NAPPO Working Group on Biological Control for opinion
    - NAPPO sends petitions to outside reviewers
    - Based on reviews, NAPPO makes a recommendation
    - APHIS generally follows NAPPO recommendations

    (but is not required to do so)

NAPPO Guidelines for Petitions for First Release of Arthropod Pest Biological Control Agents

General Requirements

1. Proposed Action
2. Target Pest Information
3. Biological Control Agent Information
4. Host-Specificity Testing
5. Environmental and Economic Impacts of Proposed Release
6. Post-Release Monitoring

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Types of data used to demonstrate host-specificity

- Selection of test host species: subspecies, species, genera, and other related groups of insects recorded as hosts in literature and other records (museum specimens, etc.), other insects found in the same habitat, rare and endangered species, ecologically and economically useful species.

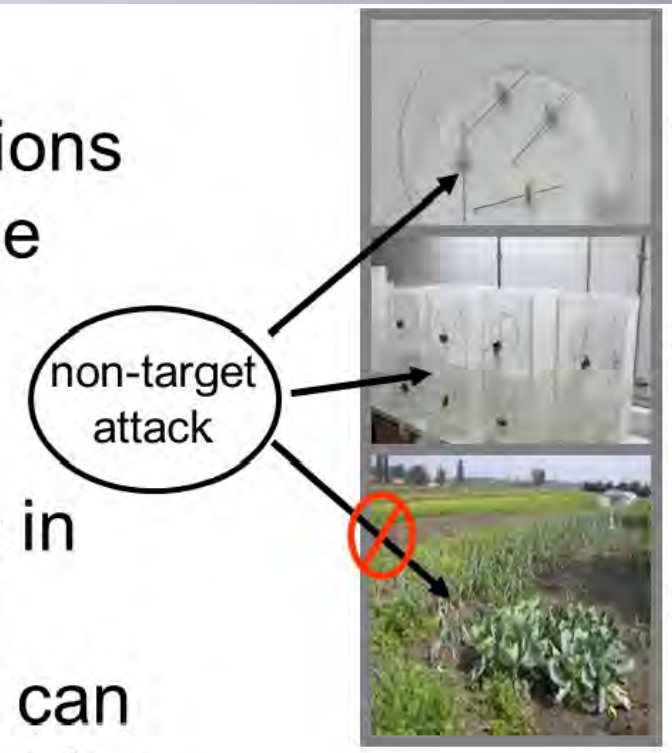
- Laboratory tests (choice and no-choice feeding tests, developmental success, fitness of offspring…)

- Field tests to document host range in the region of origin

What petition issues raise concerns?

- What if the agent is an undescribed species?
- What non-target species should be tested?
- Can host range be predicted objectively?
- What if populations of the agent from different source locations behave differently in testing?
- What if post-release monitoring shows non-target impact?
- What is impact?

- Laboratory conditions are artificial & false positives likely
- Field experiments in area of origin and behaviour studies can provide the context for interpretation



1. No-choice test (Petri dish)
2. Choice test (Petri dish) (cage)
3. Choice test (field)

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

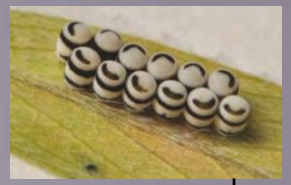
MSU – Michigan State University – Department of Entomology

Oregon Department of Agriculture

Oregon State University – Department of Horticulture

USDA-ARS Stoneville & Mississippi State University, MS

No-choice screening



Single egg mass of non-target species:

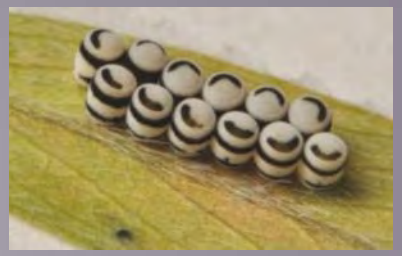
Followed by a BMSB control for an additional 24 hours:

no attack of non-target

no further testing required

Genus	Species
Alcaeorhynchus	*grandis*
Coenus	*delius*
Cosmopepla	*lintneriana*
Euschistus	*conspersus*
Euschistus	*quadrator*
Euschistus	*servus*
Euschistus	*tristigmus*
Euschistus	*variolarius*
Loxa	*viridis*
Megacopta	*cribraria*
Mormidea	*pama*
Murgantia	*histrionica*
Nezara	*viridula*
Oebalus	*pugnax*
Perillus	*strigipes*
Piezodorus	*guildinii*
Proxys	*punctulatus*
Sehirus	*cinctus*
Stiretrus	*anchorago*

Host Choice Screening



When attack of non-target hosts observed

One egg mass each of target and non-target species together

Genus	Species
Banasa	*dimiata*
Chinavia	*hilaris*
Chinavia	*marginata*
Chlorochroa	*ligata*
Euthyrhynchus	*floridanus*
Holcostethus	*limbolarius*
Loxa	*flavicollis*
Orsilochides	*guttata*
Perillus	*bioculatus*
Podisus	*maculiventris*
Thyanta	*custator*

What is the impact of attack on non-target species?

- Egg kill from stinging, but without oviposition
- Egg kill due to partial, unsuccessful development of parasitoid
- Egg kill from successful development and emergence of adult parasitoid
- Reproductive females produced, vs. mostly males
- Could Asian *Trissolcus* displace native *Trissolcus*?

Non-target attack: no-choice vs. choice

Host species	No-choice			Choice		
	Proportion of eggs parasitized	Proportion of live parasitoid emergence	Sex ratio (proportion of males)	Proportion of Eggs parasitized	Proportion of live parasitoid emergence	Sex ratio (proportion of males)
Murgantia histrionica	0.12	0.0	-	0.0	0.0	-
Podisus maculiventris	0.39	0.31	0.11	0.22	0.172	0.50
Thyanta custator	0.10	0.0	0.09	0.01	0.01	-

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Pitfalls encountered in 2013

- Progress of host testing is slowed by difficulty of collecting native species, maintaining cultures and obtaining eggs of NT stink bugs for tests
- *Trissolcus japonicus* (Beijing population) attacks and develops successfully in some non-target stink bugs in laboratory choice tests

Follow-up Studies

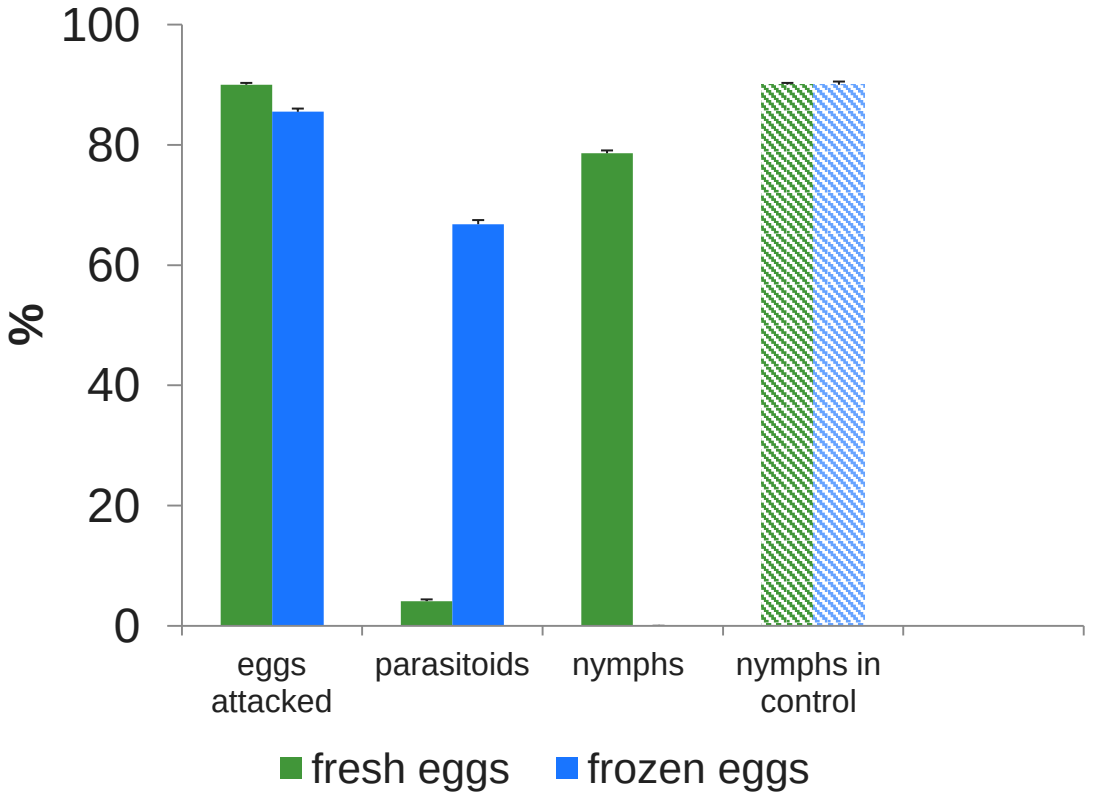
- Continue host testing with additional populations/species of *Trissolcus*
- *Trissolcus* host range studies in Asia
- Vary lab exposure conditions (when non-target hosts are attacked in choice tests) to better represent natural situations
- Further taxonomic and molecular studies by ARS-SEL & EBCL to clarify identities of Asian species

Tests with *Trissolcus flavipes*

- Egg masses of 10 were exposed to *Trissolcus flavipes*
- Eggs were frozen or fresh
- Parasitoid emergence very poor from fresh eggs, but high from frozen eggs

(Unpublished data, Tim Haye, CABI Switzerland)

N = 29 fresh; 28 frozen



- Fresh eggs frequently attacked but little emergence
- Emergence from frozen eggs shows that oviposition occurred
- BMSB id dead end for native parasitoids

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