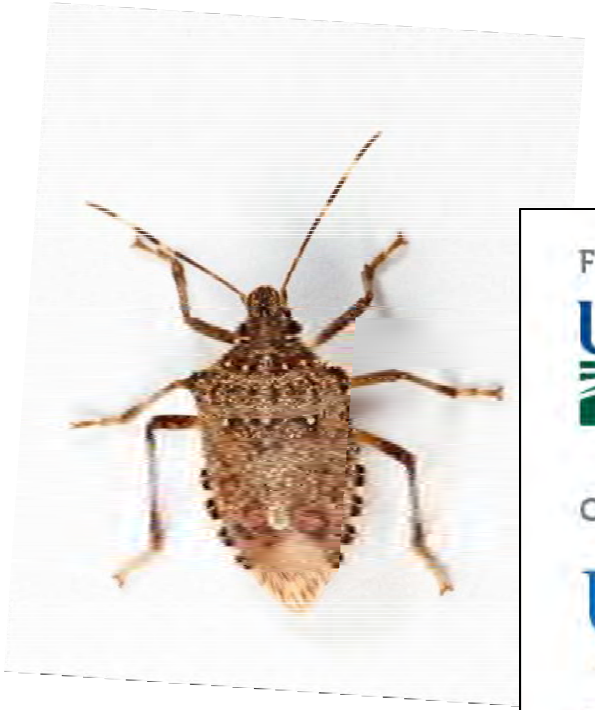
Objective 1.7 BMSB and Gut Symbionts



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Collaborating Institutions

University of Delaware

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Penn State

The State University of New Jersey Rutgers

Northeastern IPM Center

Washington State University

Cornell University

OSU Oregon State University

University of Maryland

VirginiaTech

NC State University

Stop BMSB .org

Introduction

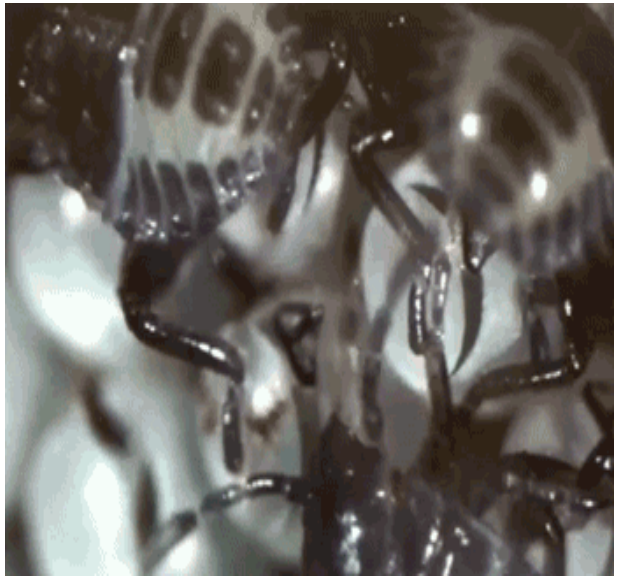
- Insect : microbe symbioses abound in nature
- Especially noted in insects with very specific yet nutrient poor diets (blood, sap, cellulose)
- Documented in all 3 suborders of Hemiptera
  - Auchenorrhyncha
  - Sternorrhyncha
  - Heteroptera



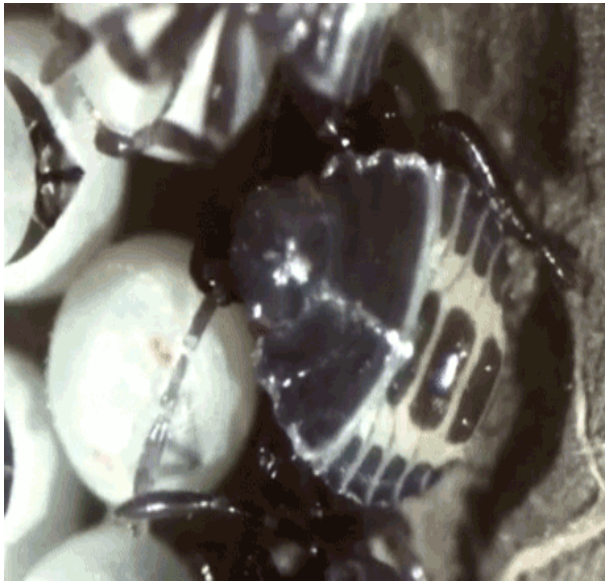



Introduction

- BMSB symbiont was identified as a species of *Pantoea* in 2013 (DeLay 2013, unpublished) and then described and given the proposed name *Candidatus* "Pantoea carbekii" in 2014 (Bansal, Michel and Sabree 2014)



Probing behavior ~1 hour after hatch



Sucking behavior, ~1 hour after hatch

Clustering behavior of 1st instars (M. Raupp)

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Review Article

Host-Symbiont Interactions for Potentially Managing Heteropteran Pests

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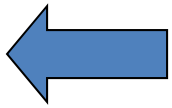
Insects in the suborder Heteroptera, the so-called true bugs, include over 40,000 species worldwide. This insect group includes many important agricultural pests and disease vectors, which often have bacterial symbionts associated with them. Some symbionts have coevolved with their hosts to the extent that host fitness is compromised with the removal or alteration of their symbiont. The first bug/microbial interactions were discovered over 50 years ago. Only recently, mainly due to advances in molecular techniques, has the nature of these associations become clearer. Some researchers have pursued the genetic modification (paratransgenesis) of symbionts for disease control or pest management. With the increasing interest and understanding of the bug/symbiont associations and their ecological and physiological features, it will only be a matter of time before pest/vector control programs utilize this information and technique. This paper will focus on recent discoveries of the major symbiotic systems in Heteroptera, highlighting how the understanding of the evolutionary and biological aspects of these relationships may lead to the development of alternative techniques for efficient heteropteran pest control and suppression of diseases vectored by Heteroptera.

Objectives

- Chapter 1: How reliant is BMSB on its egg mass smeared symbiont?



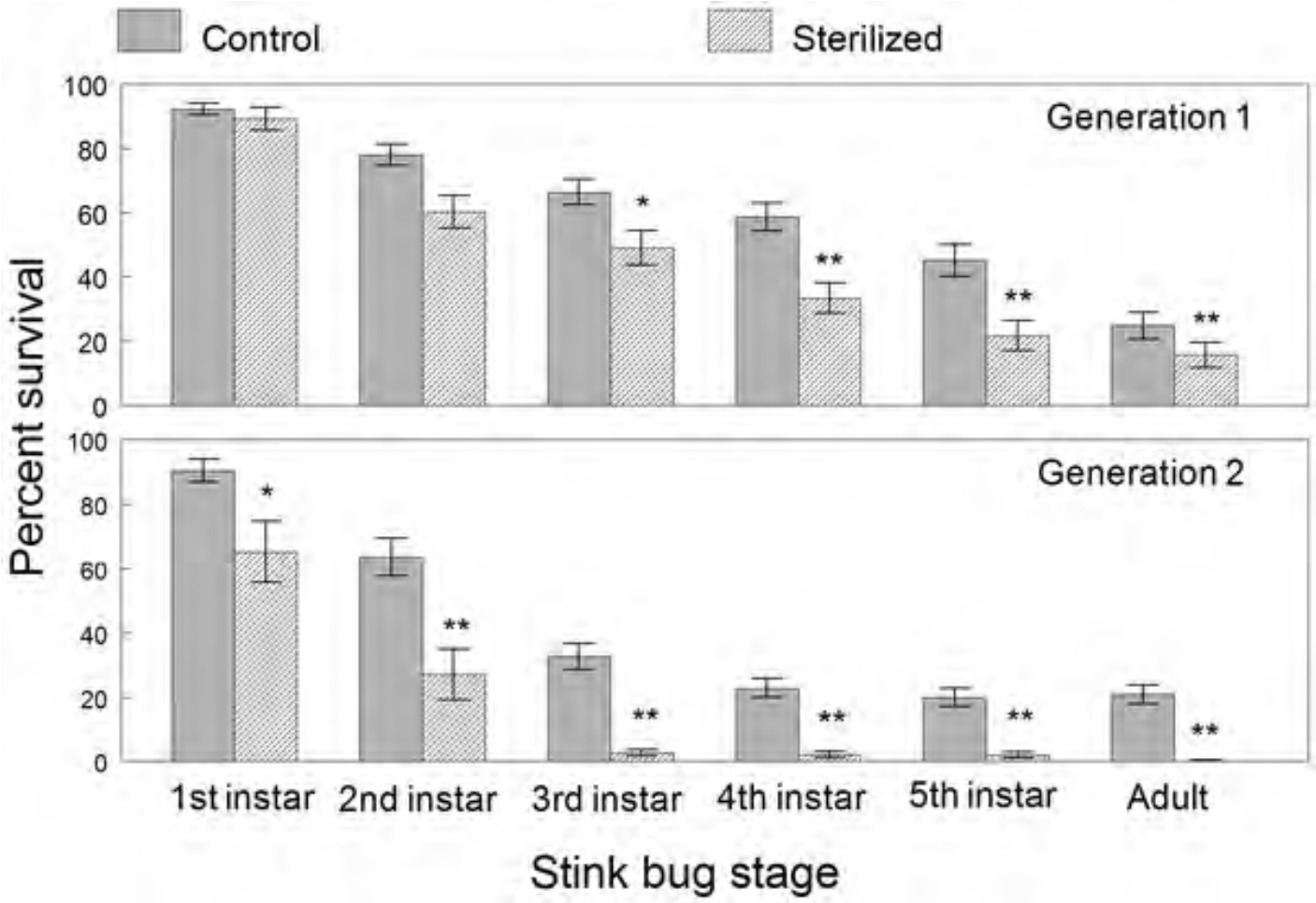
- Chapter 2: What environmental factors influence symbiont survival and transmission to BMSB?

- Chapter 3: Is removal of the symbionts via bactericidal foliar sprays a feasible management technique for BMSB?

Materials and Methods

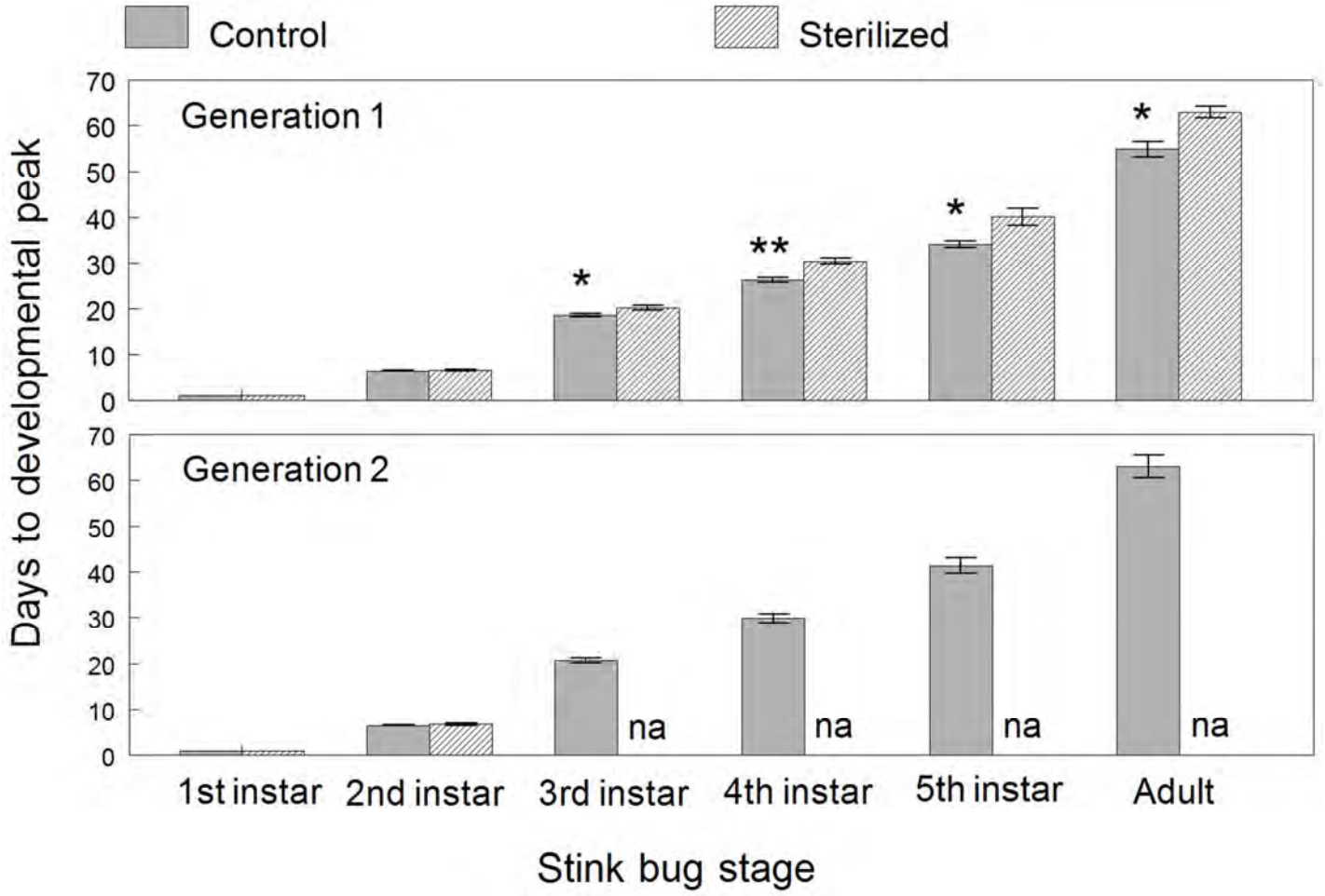
- Egg masses sterilized using techniques used in literature (ethanol and bleach baths)
- Reared in individual deli dishes
- Adults of control egg masses allowed to breed
- Adults of sterilized egg masses allowed to breed

Results: Survival



Percent survival from egg hatch to the peak density of each developmental stage of *H. halys* during two successive generations.

Results: Development

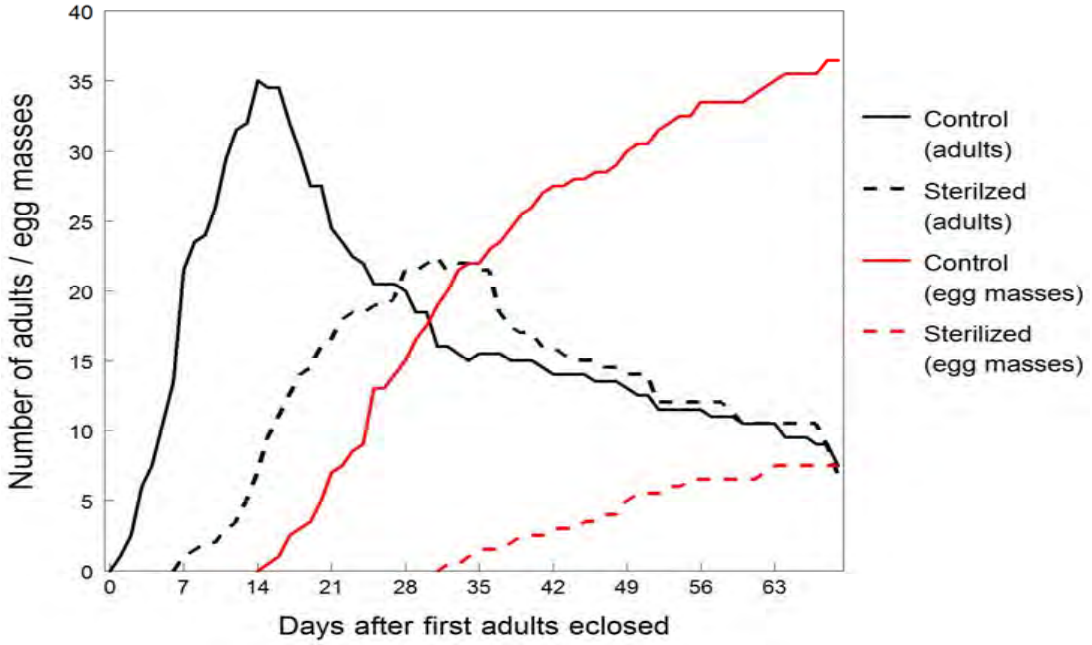


Development time expressed as the number of days from egg hatch required to reach peak density of each stage of *H. halys*.

Results: Fecundity

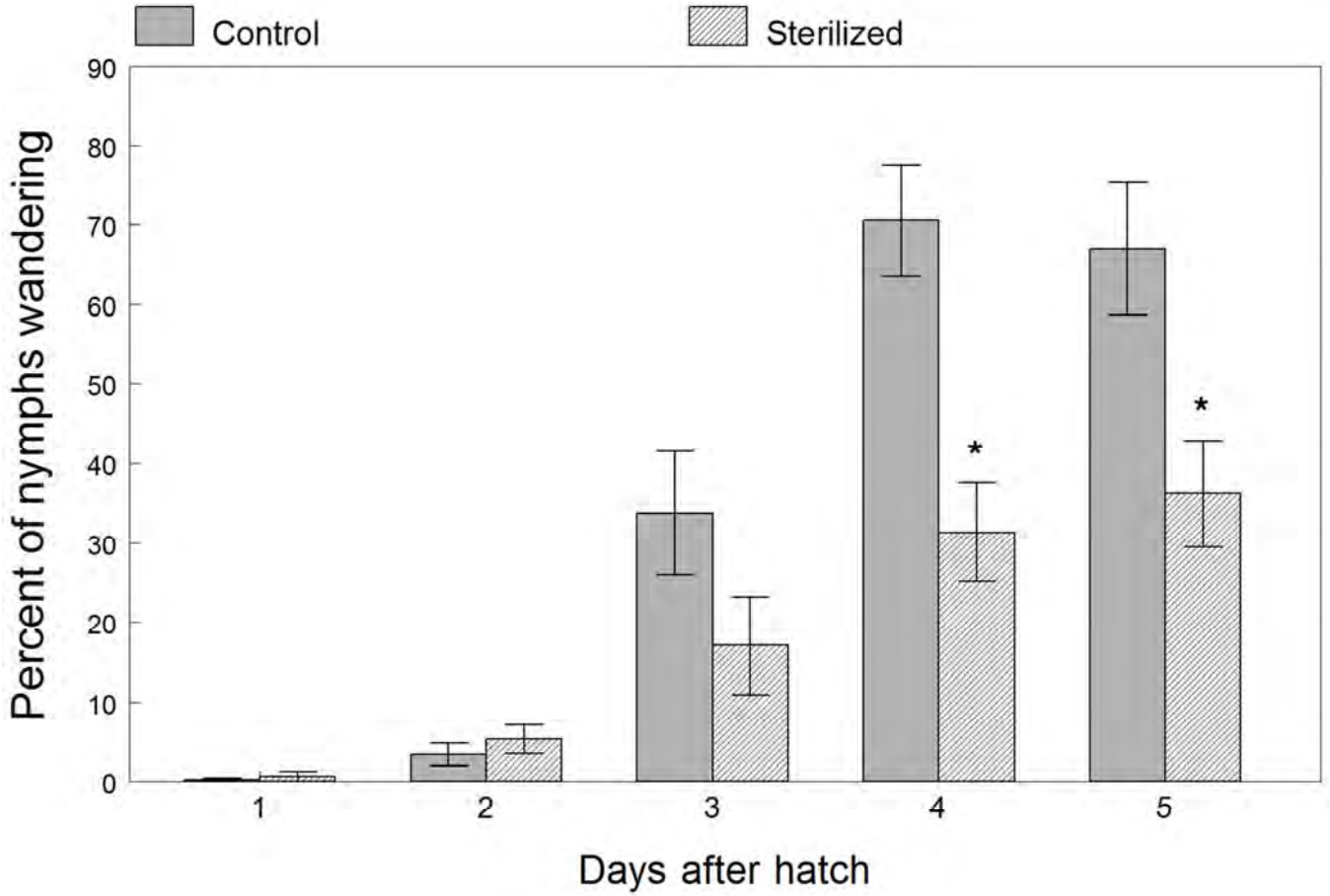
Parameter	*Control*	*Sterile*	*df*	*F*	*P*
Time to first egg mass (days)	15.5±1.5	25±0	-	-	-
Mean #egg masses/female	1.58±0.011	0.473±0.098	-	-	-
Mean # eggs/mass	27.77±0.01	17.13±2.05	1, 85.3	129.52	<.0001
Mean % hatch	94.43±1.30	64.95±9.46	1, 85	33.44	<.0001
Mean development time (days)	6.42±0.08	6.50±0.11	1, 83	0.18	0.6735

doi:10.1371/journal.pone.0090312.t004



Results: Behavior

- Significantly more nymphs wandering in control egg masses on days 4 and 5

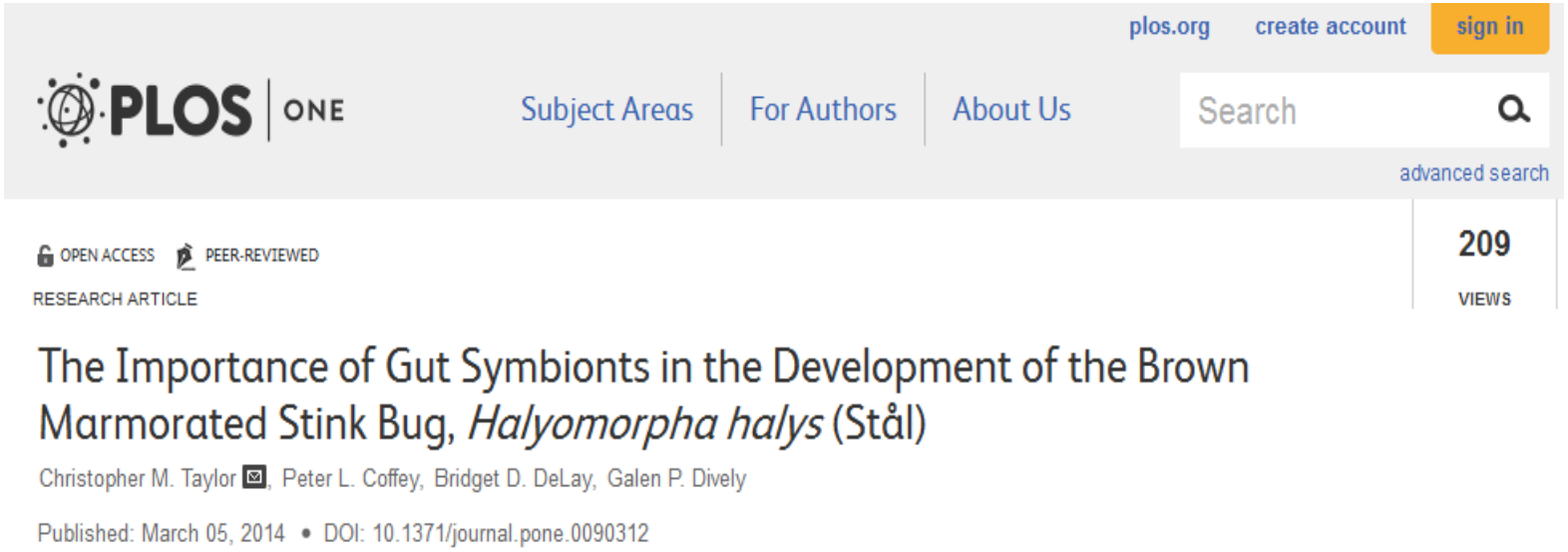


Conclusions

- BMSB is HEAVILY reliant on its symbiont for survival
  - Impacts survival, development, fecundity, and even behavior!

- Symbiont is exposed on egg mass surface until hatch/ acquisition by nymphs

- NEXT STEP: are there any environmental conditions that may impact symbiont survival and by extension BMSB?
  - Range limiting perhaps?



Objectives

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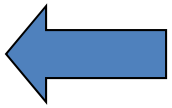
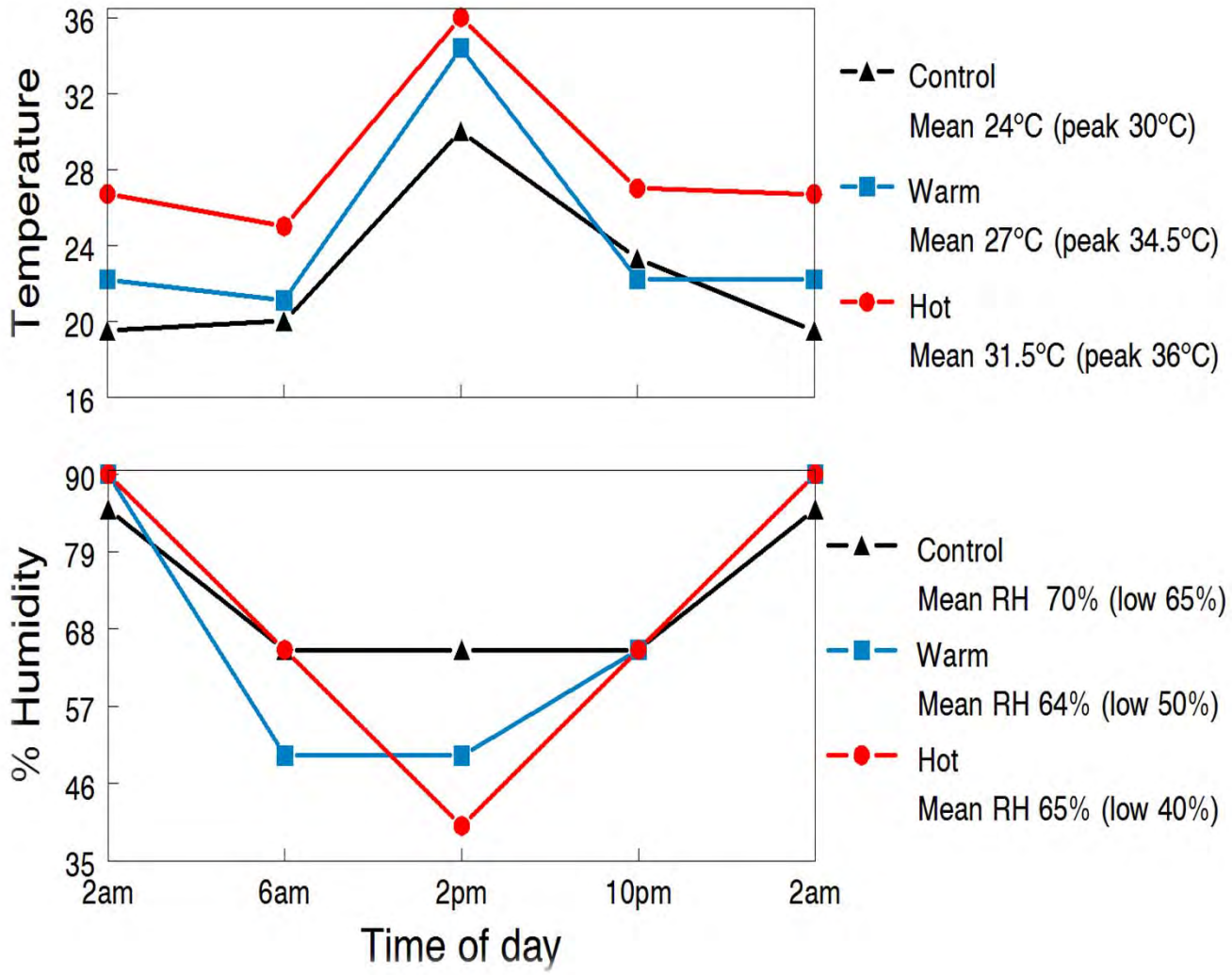
- Chapter 2: What environmental factors influence symbiont survival and transmission to BMSB?



- Chapter 3: Is removal of the symbionts via bactericidal foliar sprays a feasible management technique for BMSB?

Materials and Methods: 3 Growth Chamber Programs



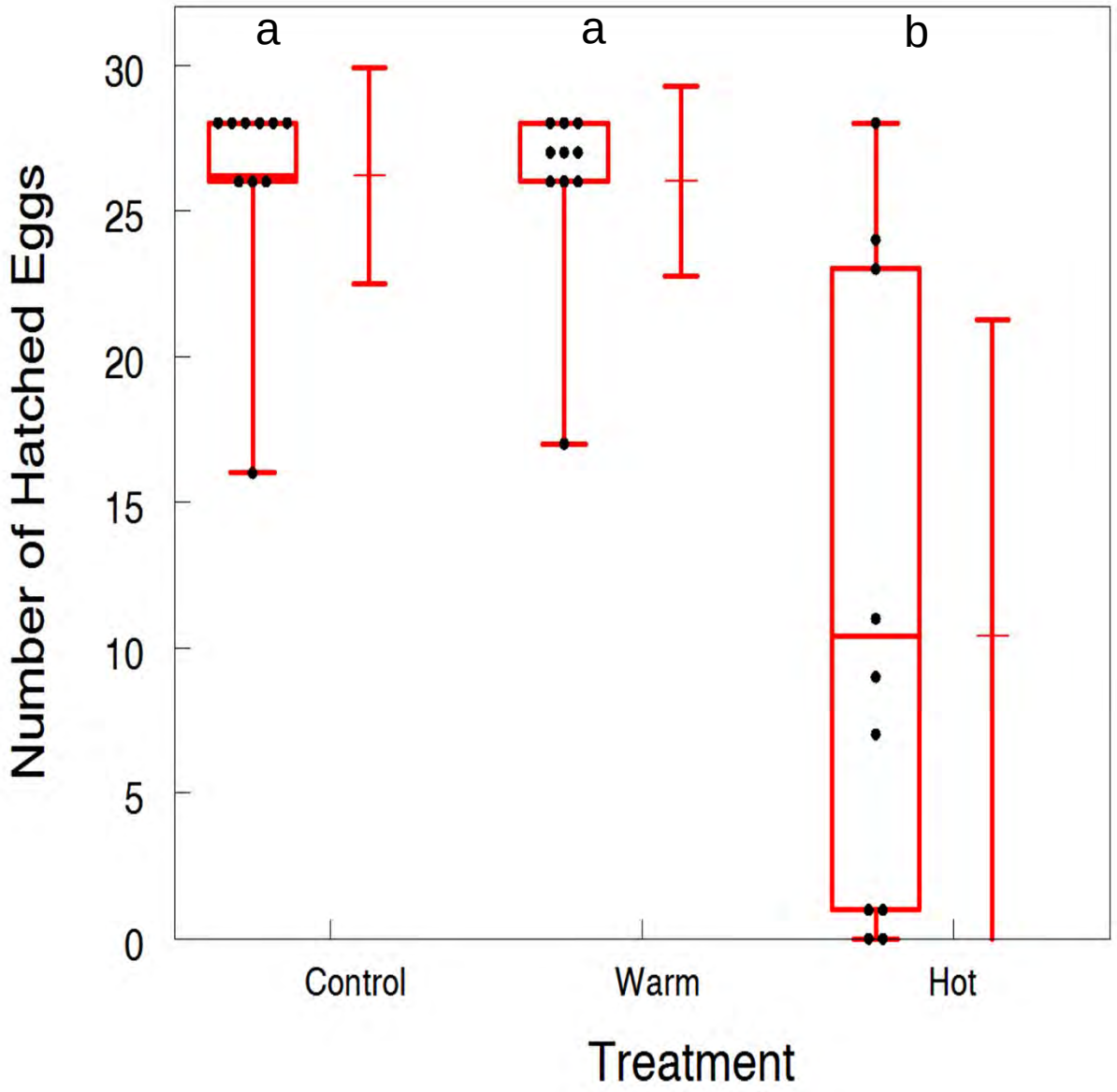
Materials and Methods: Exposure Protocol

25°C
75% RH

Control,
Warm or
Hot
Chamber

25°C
75% RH

Results: Hatch Rate



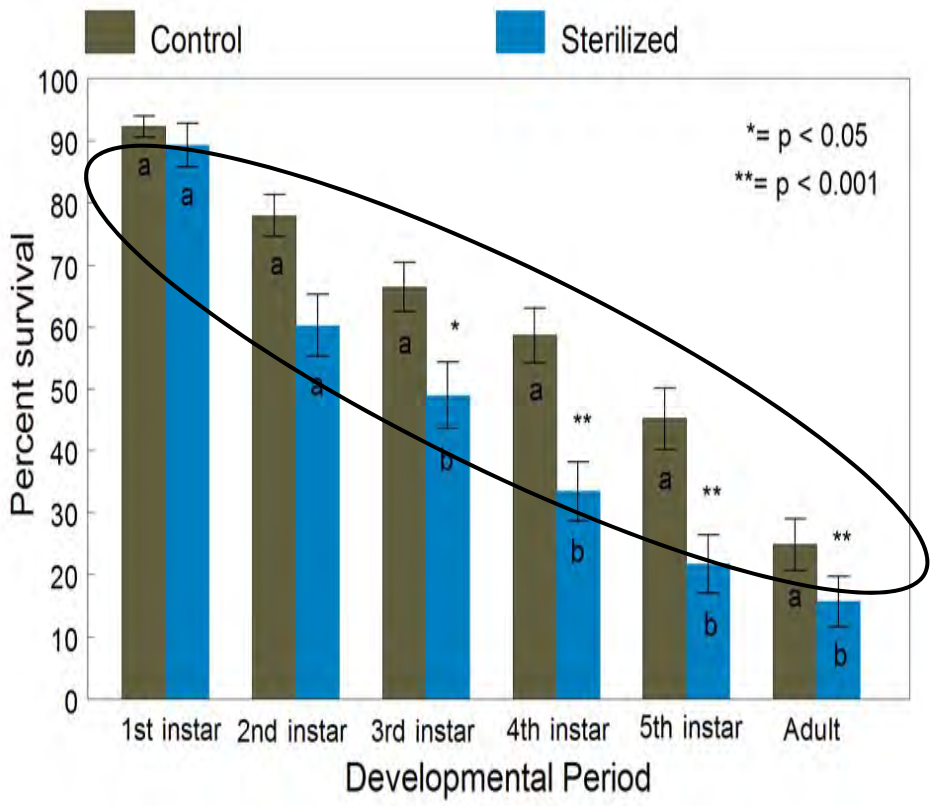
HATCH RATE:

Control: 96.7%

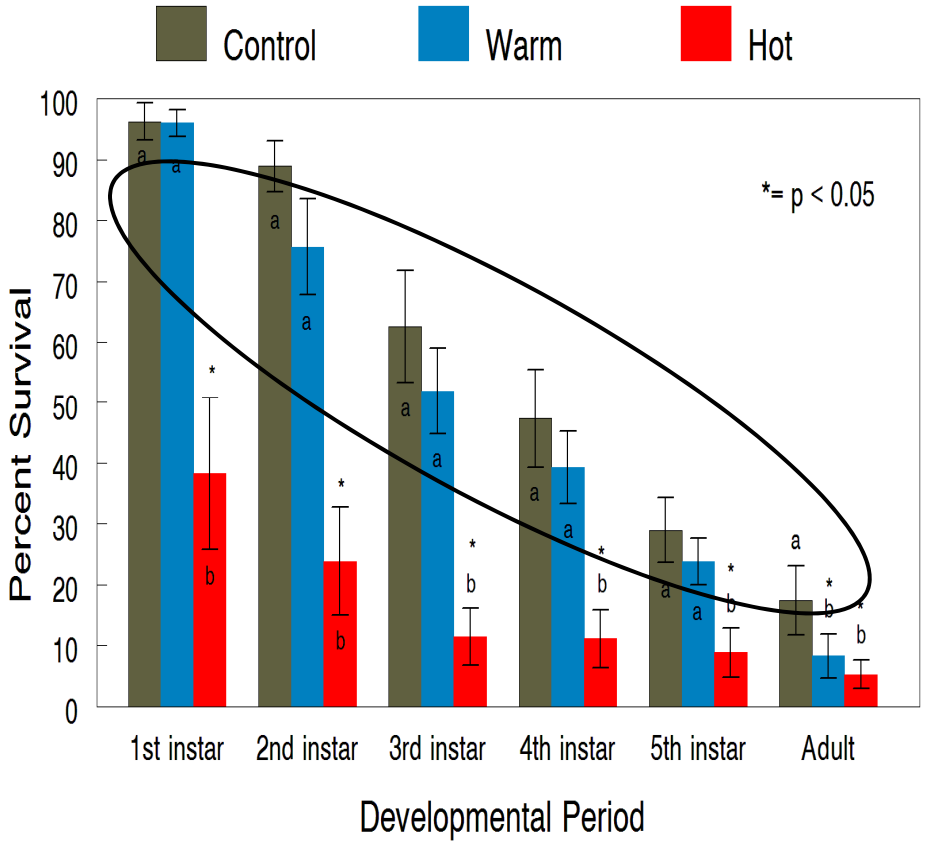
Warm: 96.3%

Hot: 40%

Results: Percent Survival by Stage

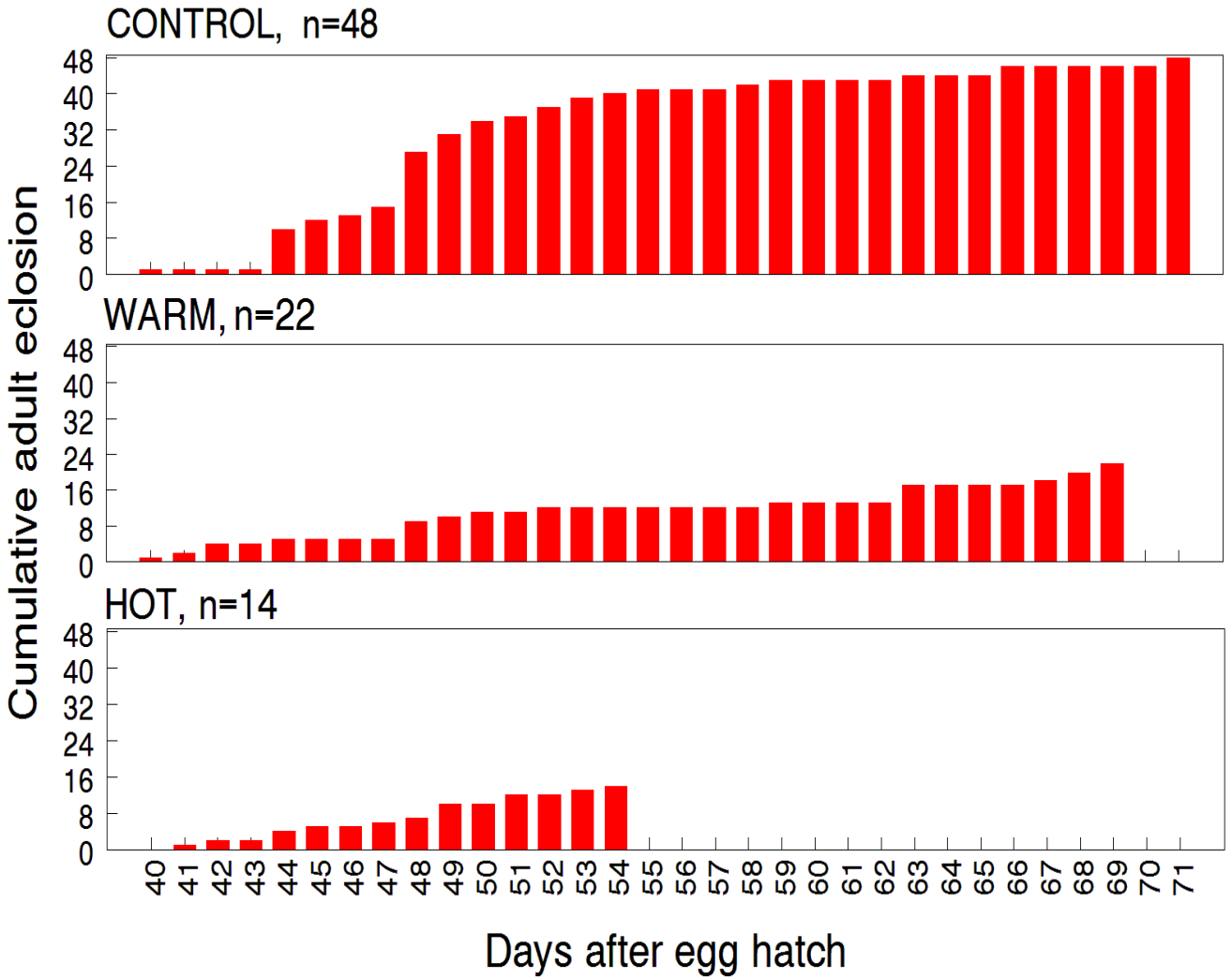


Chemical Sterilization Study (Taylor et al. 2014)

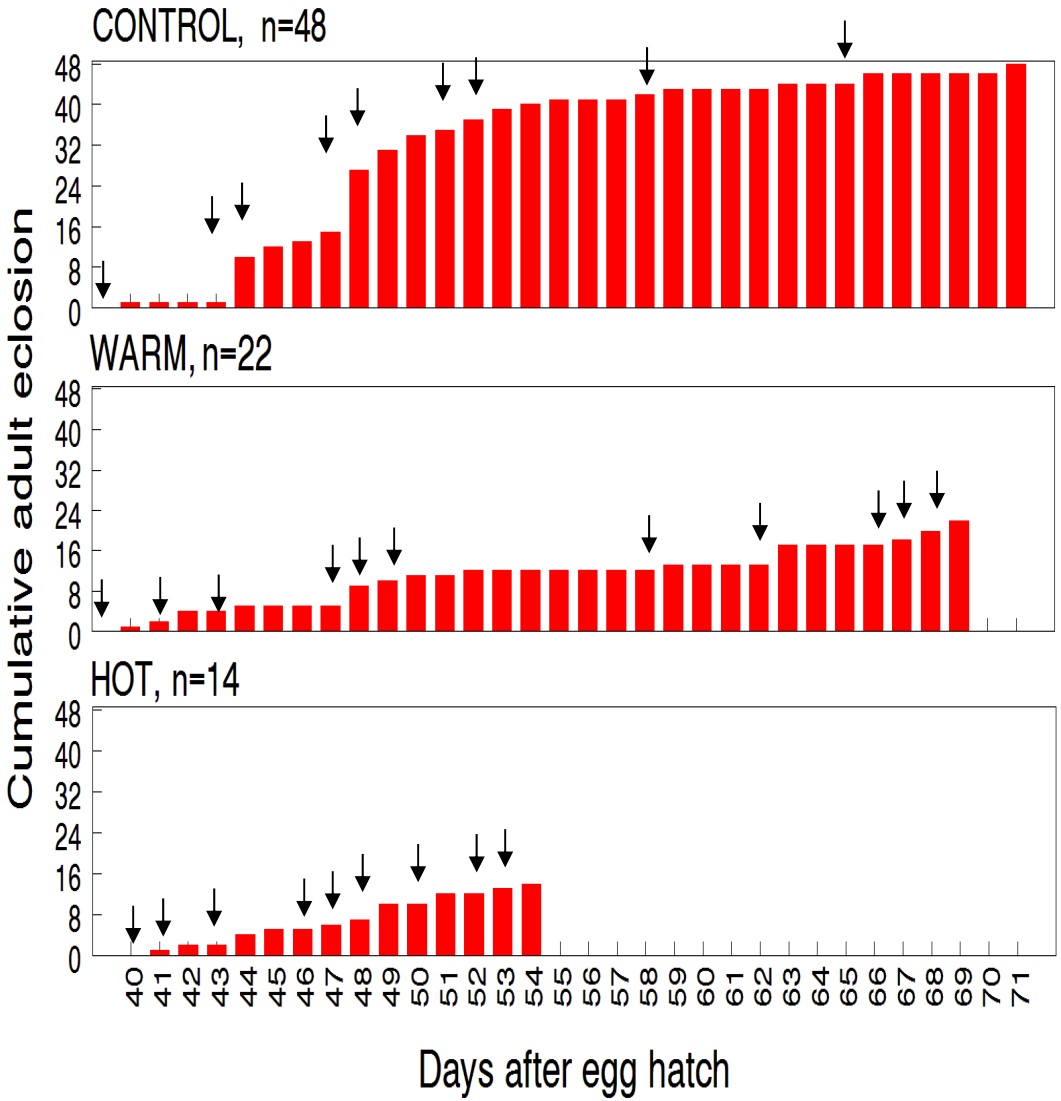


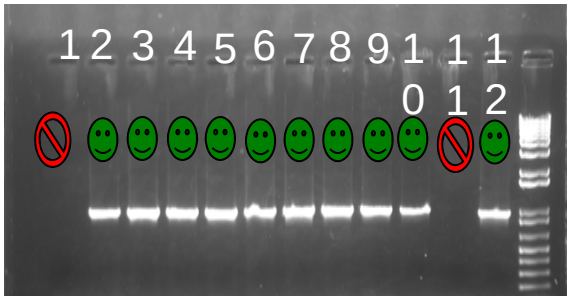
Abiotic Factors Study

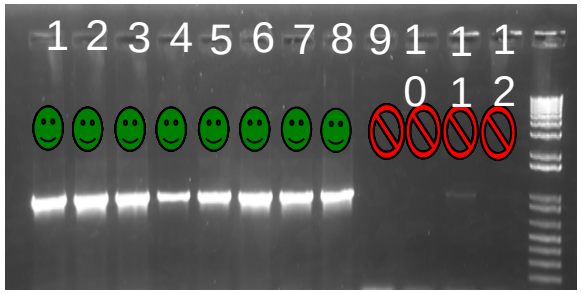
Results: Cumulative Adult Eclosion

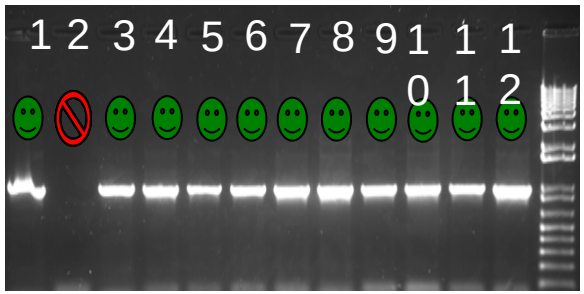


Results: BMSB Cumulative adult eclosion w/ PCR results









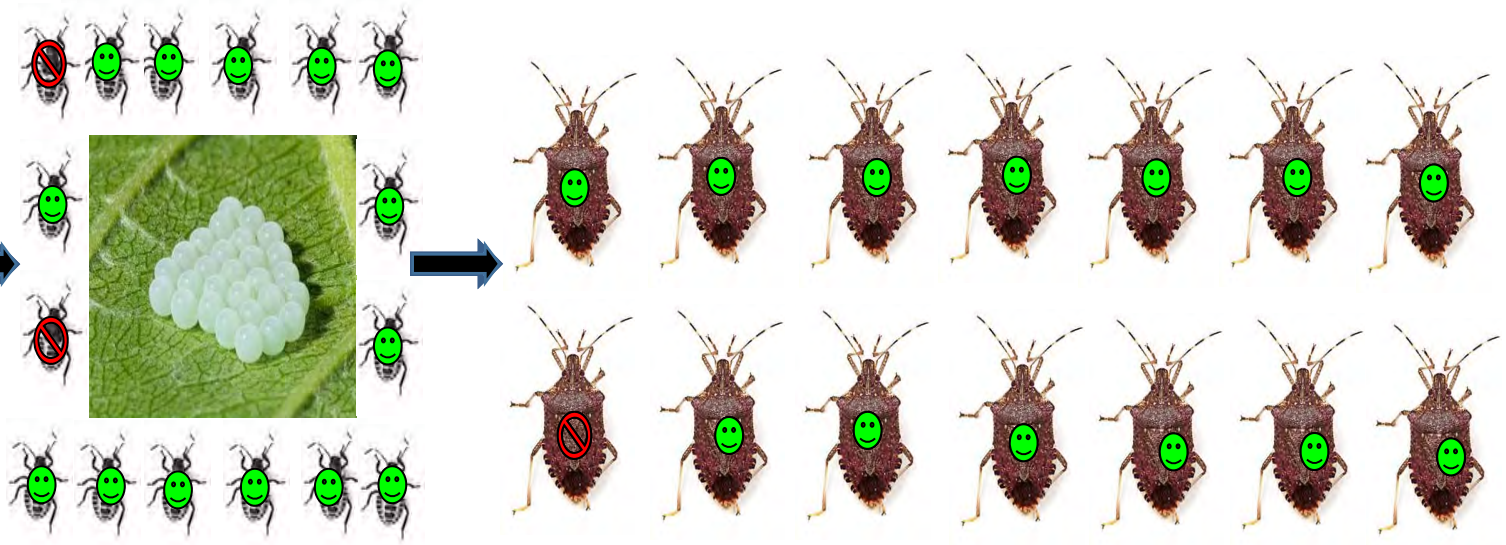
Conclusions

Total # adults different by treatment

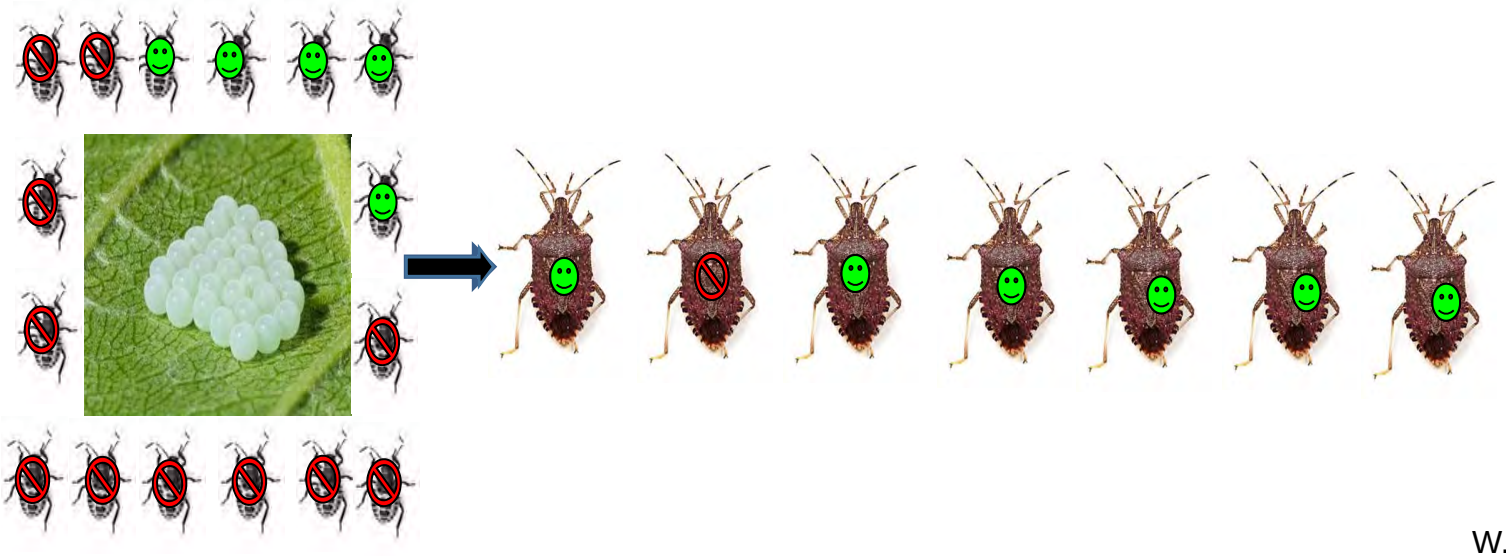
Initial inoculation ratio different?

But inoculation occurred across treatments

CONTROL



WARM



W. Hershberger

Objectives

- How reliant is BMSB on its egg mass smeared symbiont?
- What environmental factors influence symbiont survival and transmission to BMSB?
- Is removal of the symbionts via bactericidal foliar sprays a feasible management technique for BMSB?

Introduction

- Because of the exposed nature of the symbiont on BMSB egg masses, can we treat it like a ‘disease’ and use foliar applications of bactericidal agents to sterilize the egg masses to control BMSB?

Materials/ Methods

- Determine if any bactericidal products are useful in sterilization of the symbiont on BMSB egg masses:

Category	**Product**	**Active ingredient(s)**
Surfactant	Naiad	Monoethanolaminedodecylbenzene
Horticultural Oil	EcoTec	Rosemary, clove and thyme oil
Oxidizer	OxiDate 2	Hydrogen dioxide, peroxyacetic acid
*IGR	AzaGuard	Azadiractin
Antimicrobial	Agri-Mycin 17	Streptomycin sulfate
Copper Based Antimicrobial	Liquid Copper Fungicide	Copper Ammonium Complex

Questions?