Temperature and humidity interact to influence brown marmorated stink bug survival

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USDA United States Department of Agriculture National Institute of Food and Agriculture

Specialty Crop Research Initiative

Collaborating Institutions

ars · NC State University · PennState · OSU Oregon State · University of Maryland · University of Georgia · Washington State University · Northeastern IPM Center · Cornell University · Utah State University · Rutgers University · The Ohio State University · University of Kentucky · UC Davis · University of Minnesota · Virginia Tech · Berkeley · Michigan State University · UC Riverside

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BMSB in CA: Different landscape (less bordering forest and urban areas)

Central Valley California

Northeast

So far CA BMSB populations are lower than Northeast

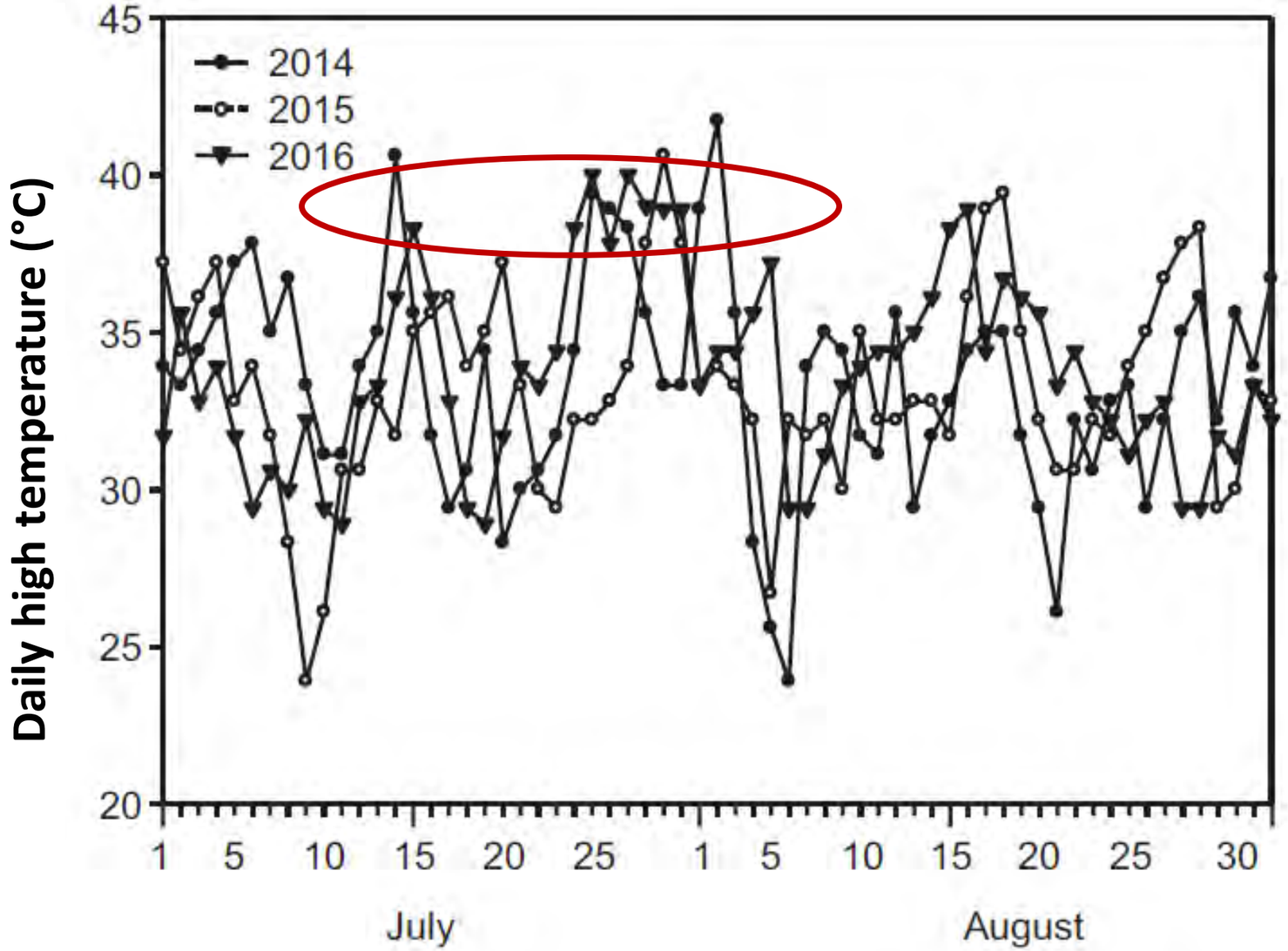
Due to high temperatures? Low humidity?

Central Valley California

Northeast

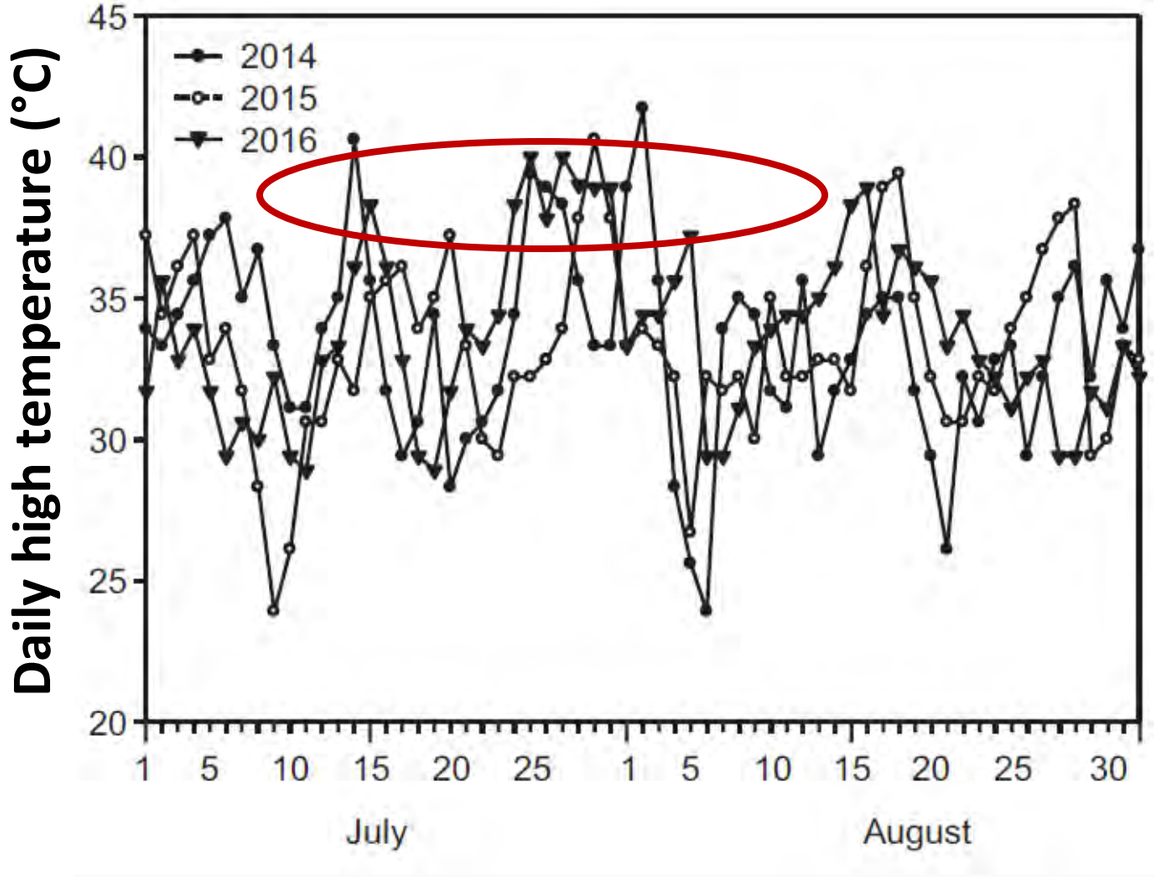

Tree in Sacramento CA 2015
Photo: Chuck Ingles

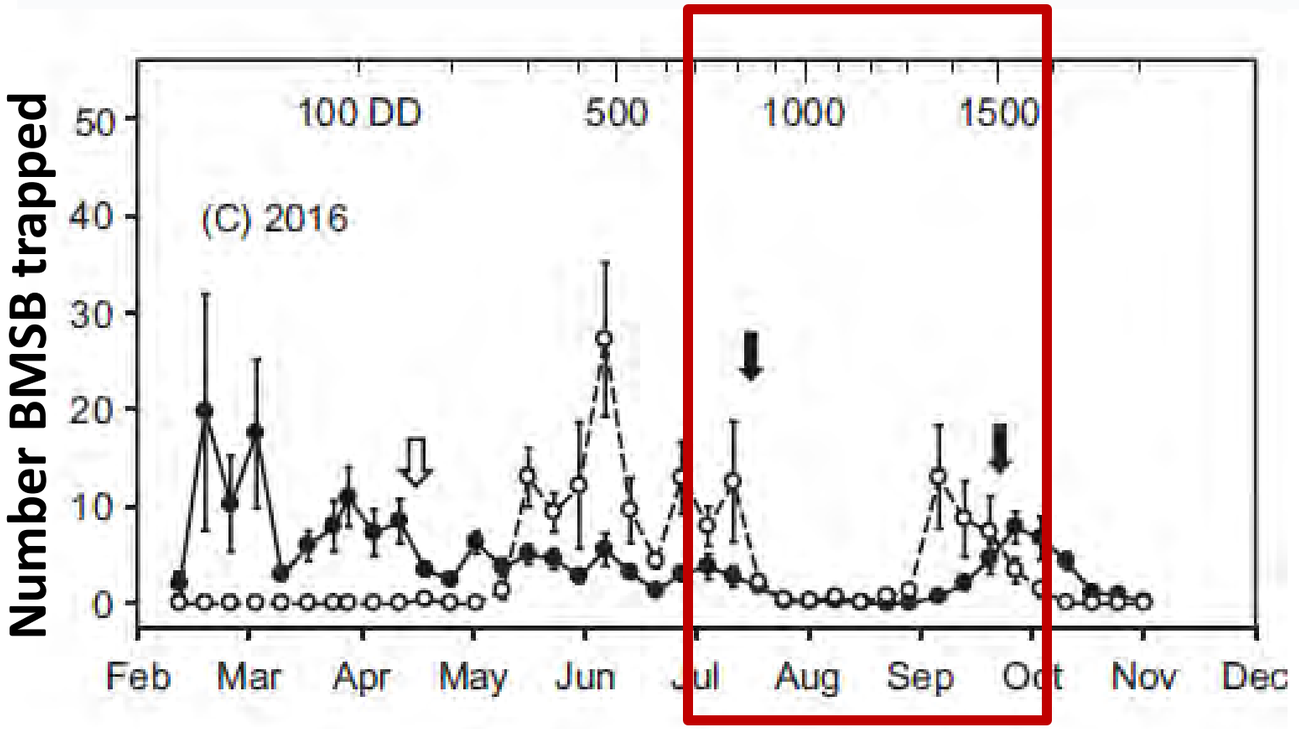
Unusual number of hot temp days in Jul + Aug 2016 (above 35°C and below 16% RH



Ingles and Daane, 2018 J. Econ. Entomol.

Unusual number of hot temp days in Jul + Aug 2016 (above 35°C and below 16% RH) followed by near zero trap counts





Ingles and Daane, 2018 J. Econ. Entomol.

Questions

- Do high temperatures kill BMSB?
- What about low humidity?
- How will temperature and low humidity impact different BMSB life stages?

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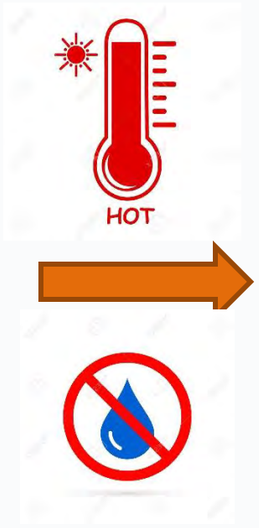

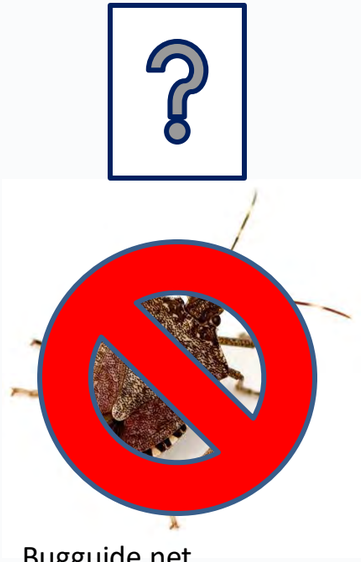

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Goal: Determine effect of field temperature and humidity on BMSB survival

Placed egg masses in different CA sites and adults in almond trees in Stanislaus

Community Garden
Sacramento County

Almond Trees
Stanislaus County

Tree of Heaven
Yolo County

Cherry Orchard
Solano County

- **Adults left in field for 1 week, Eggs for 2 days**
- **Recorded survival after exposure to summer temperatures**

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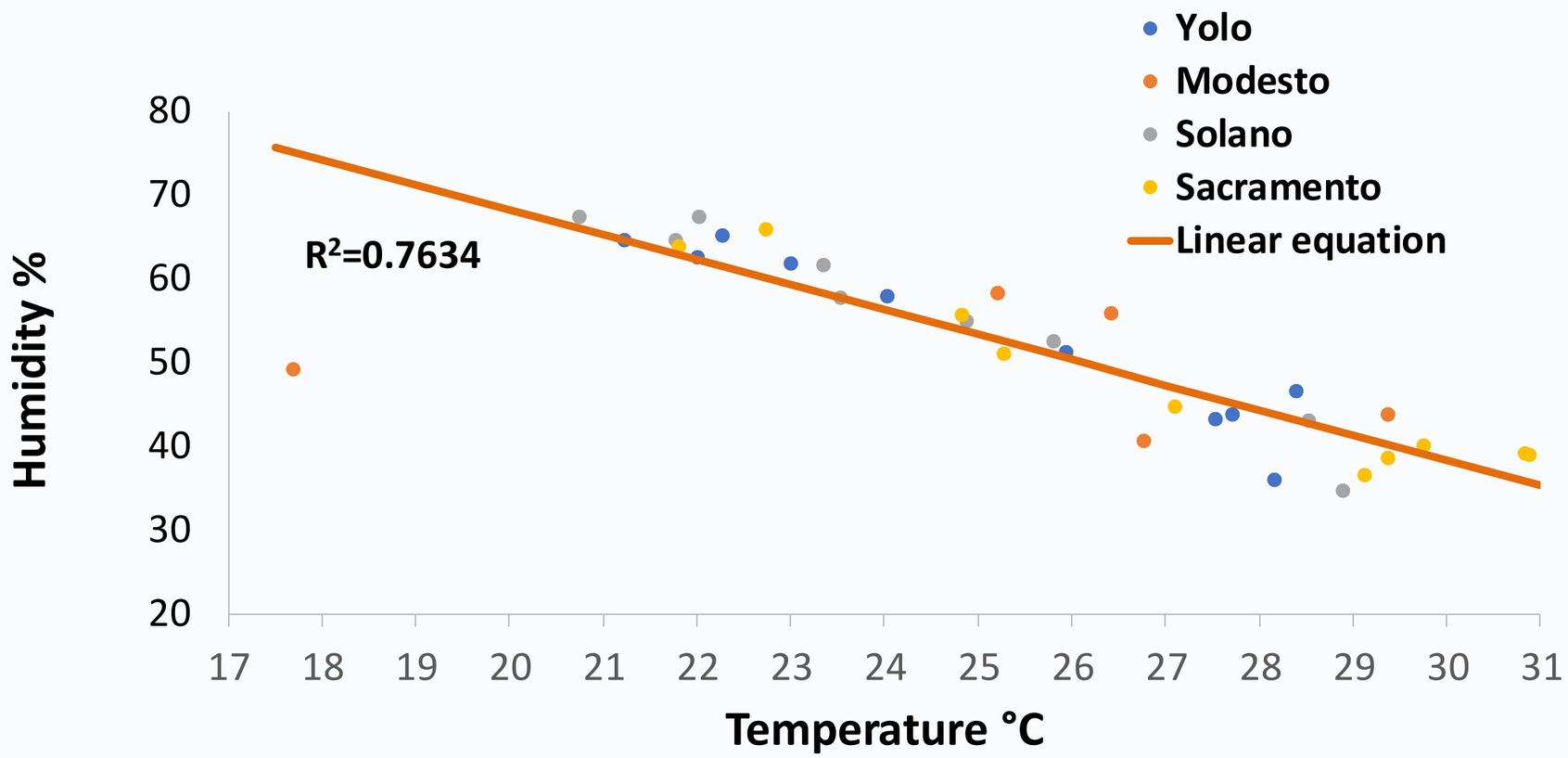
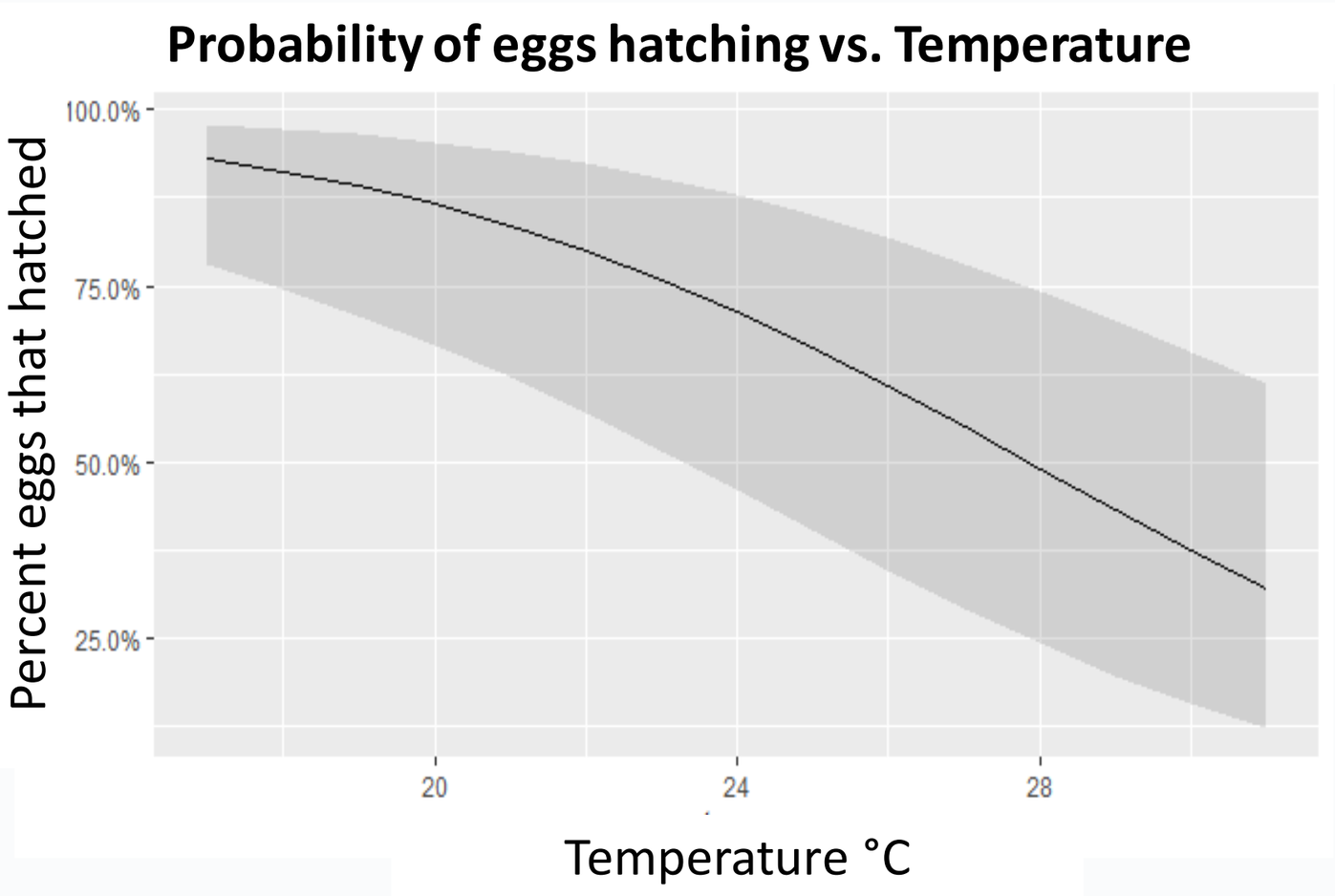
Temperature and Humidity at 4 sites Jul-Sept 2017

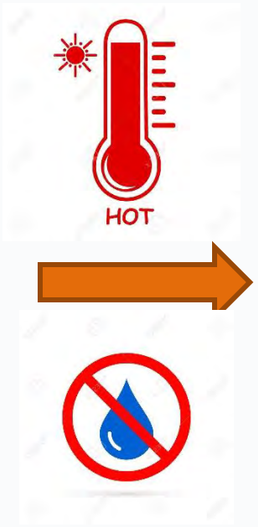


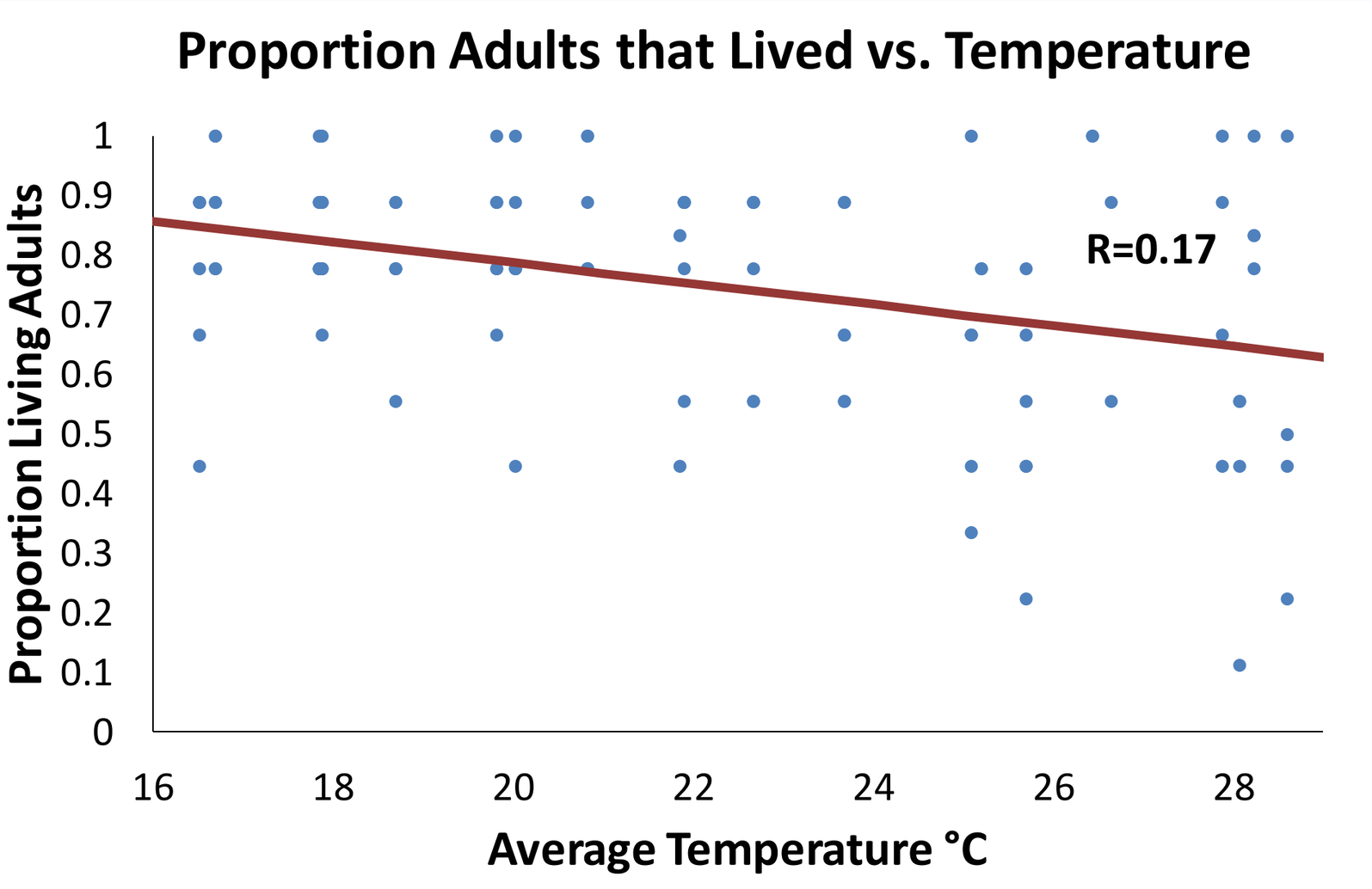
Strong linear relationship between temp and humidity in the field so can't determine individual effect of temp vs. humidity.



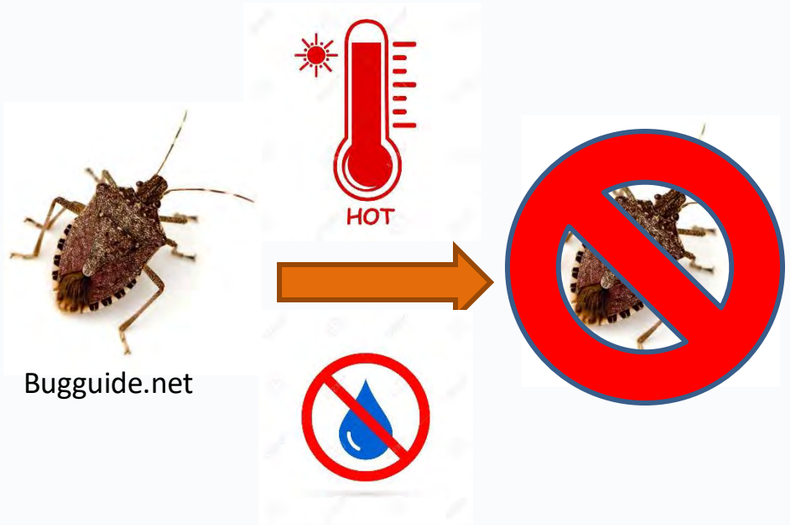
Temperature and humidity (are highly correlated) influenced hatch rate

High temp (low RH) decreases hatch rate





High temperatures and low humidity decreased adult survival



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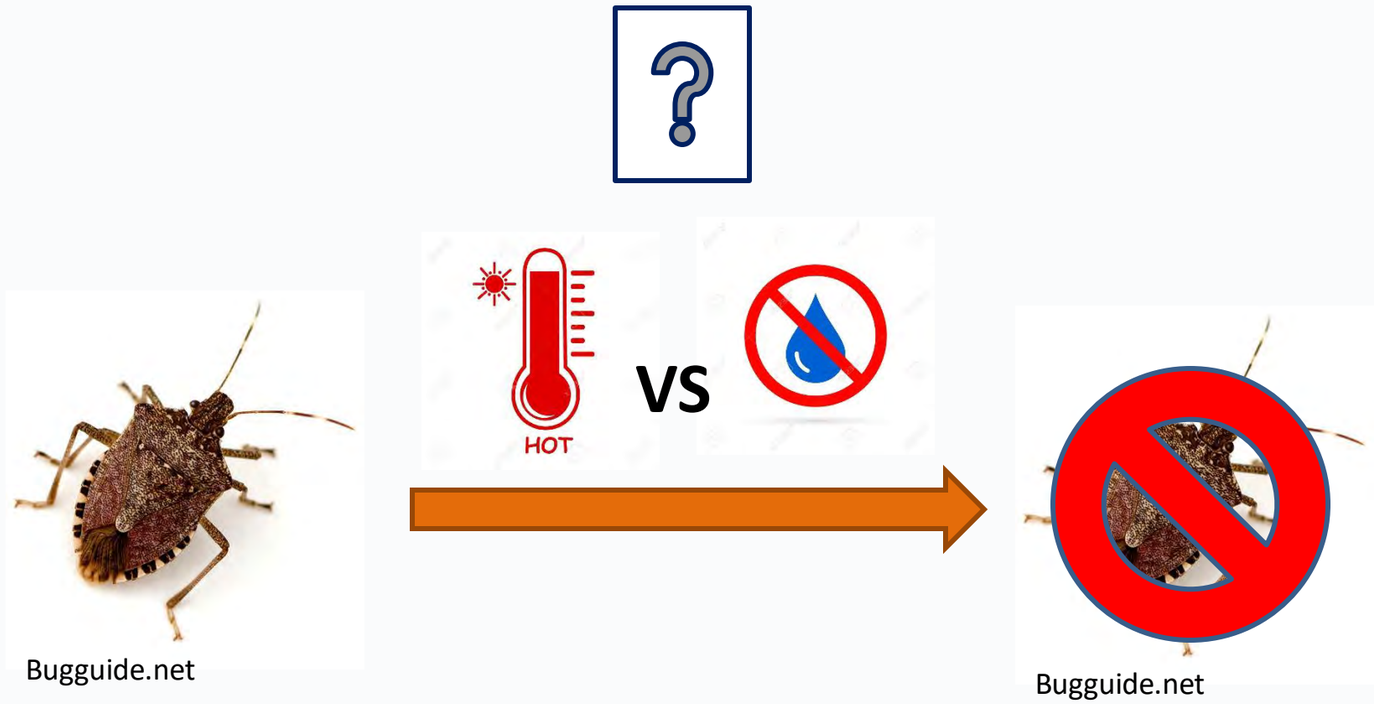
What we learned from the field study

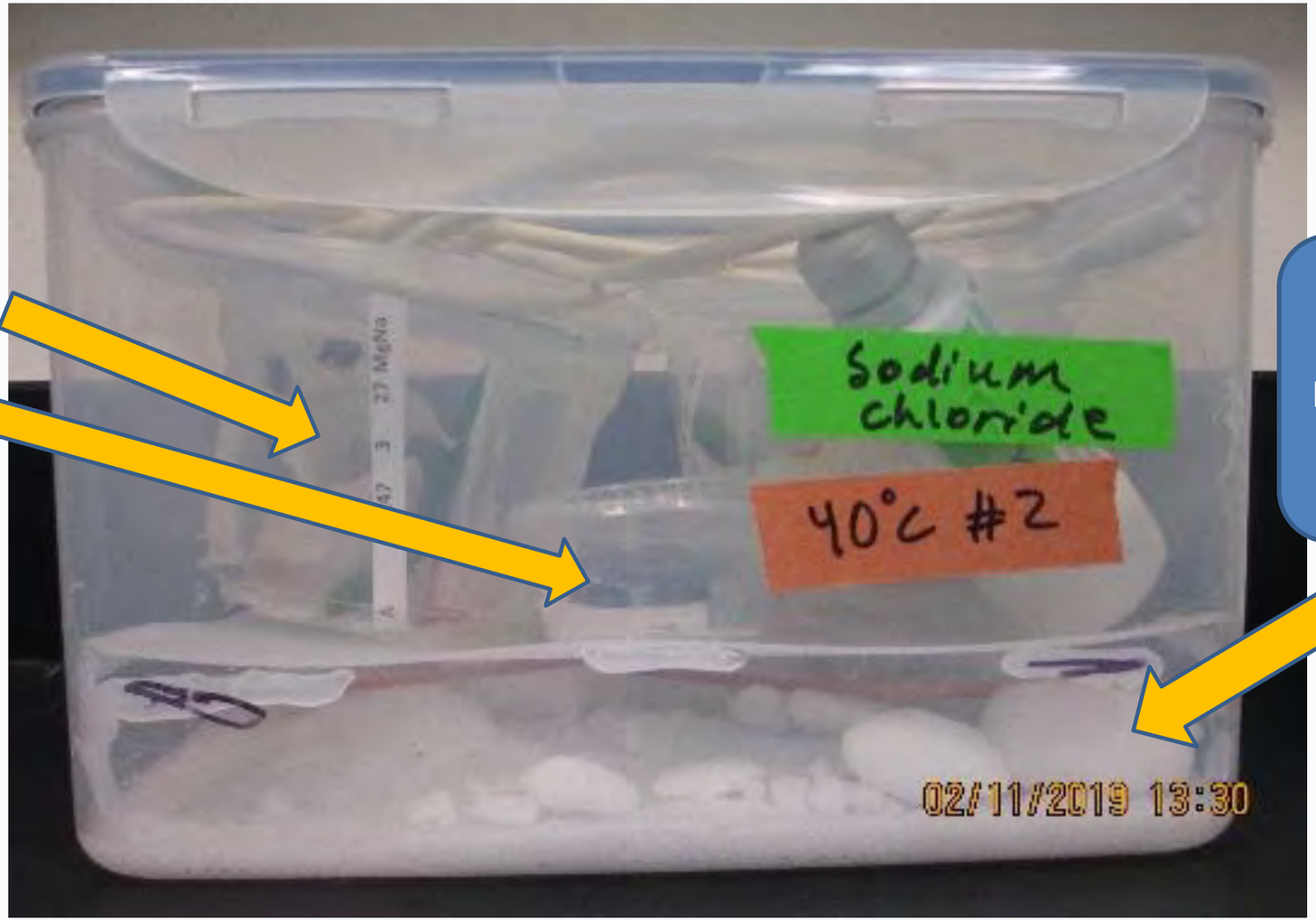
Temperature and humidity are highly correlated

Observed BMSB population declines in the field are at least partly the result of high temperature and low humidity events

Is Temperature or Humidity more Important for Predicting BMSB Mortality?



Back to the lab! Experiment Set-up



Insects

Saturated salt solution maintains a specific relative humidity

Insect life stages

Eggs

1st instars

3rd-4th instars

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Adults

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X

Avg. Humidity

17%

39%

56%

79%

X

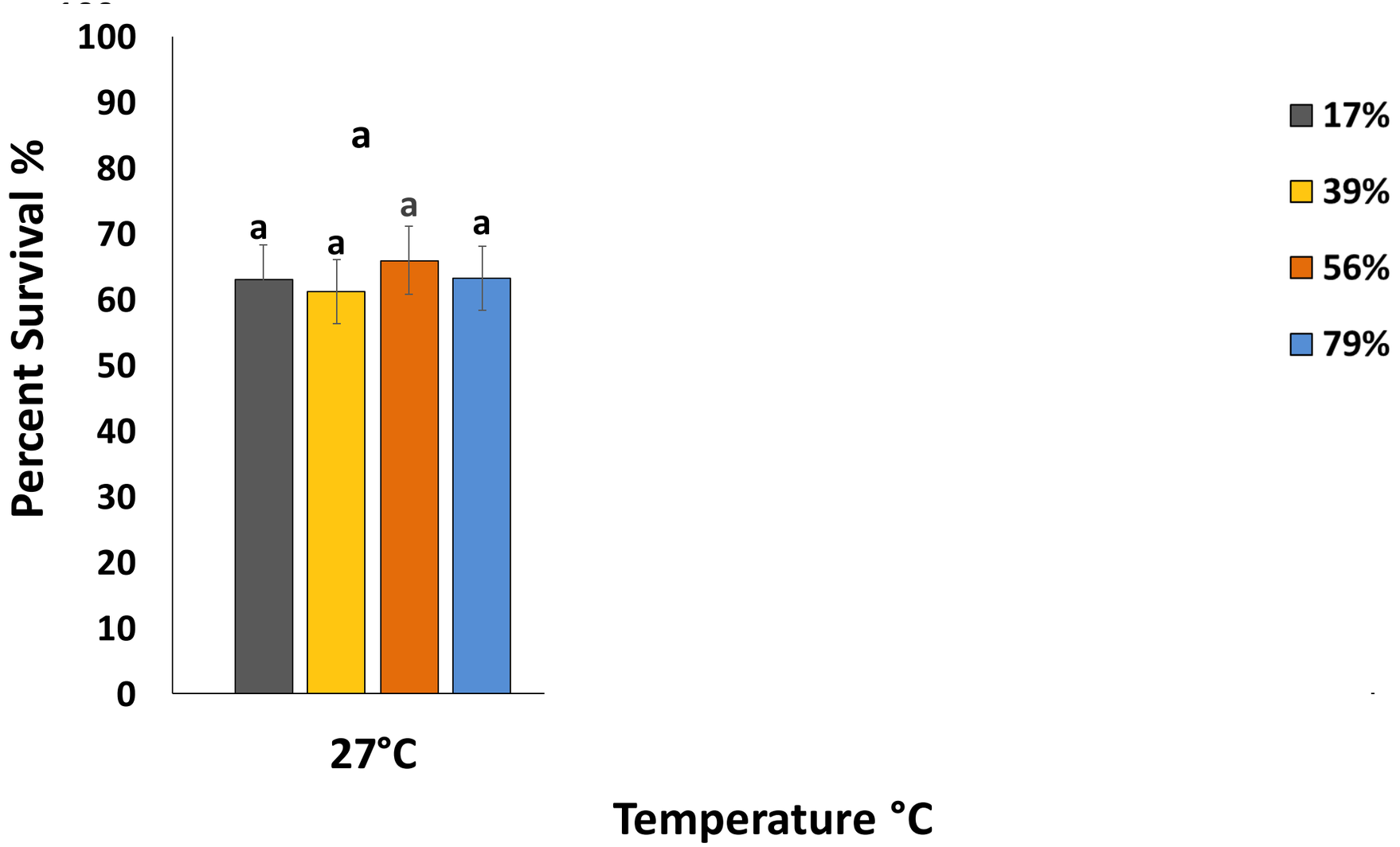
2 day high temp exposure

Ambient: 27°C const

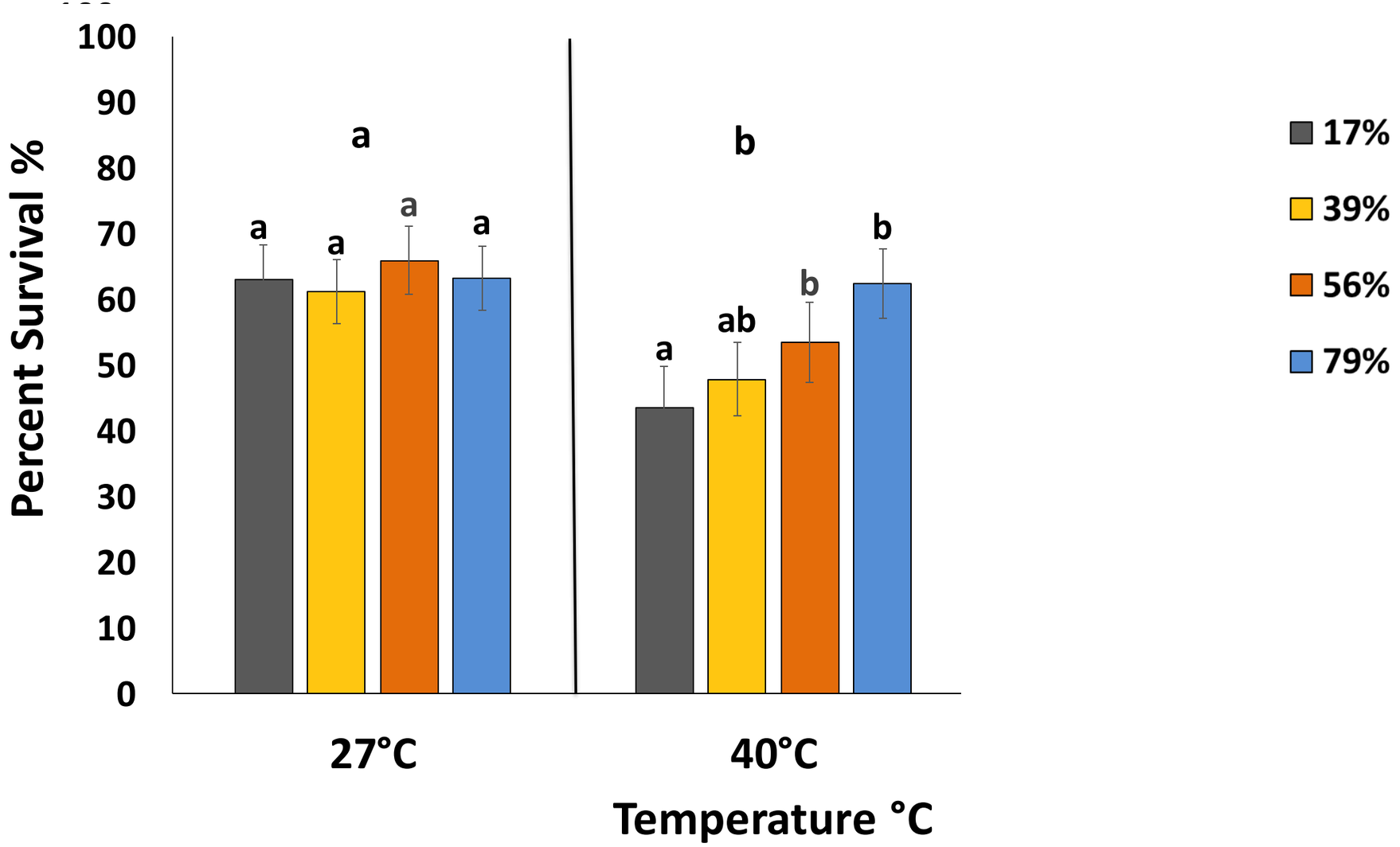
High temp: 39° C 3.75hr.

Very high temp: 42° C 3.75hr.

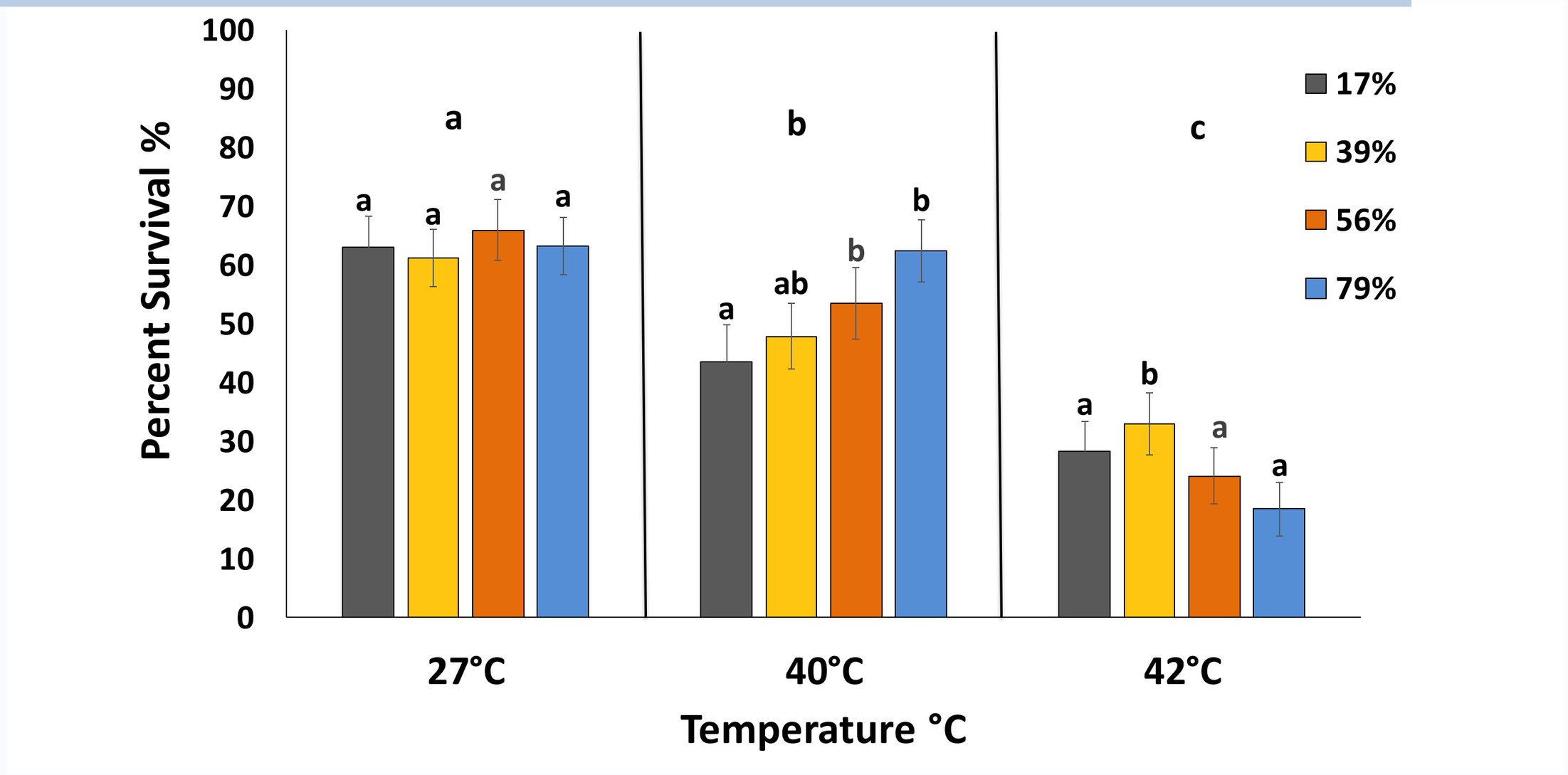
- **No effect of humidity on BMSB survival at low temperatures**



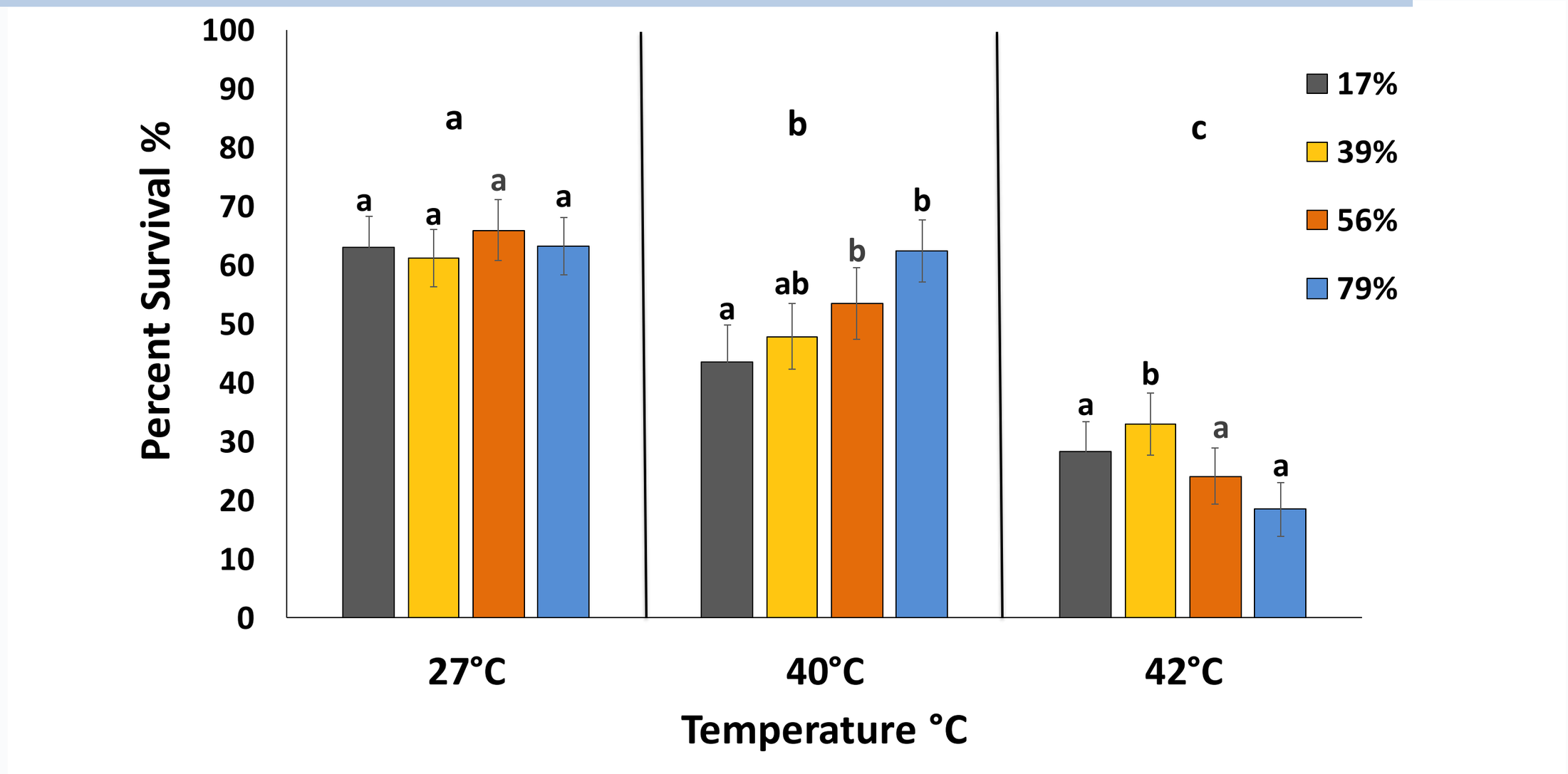
- **At 40°C exposure to 17% humidity decreased BMSB survival**



- **At 42°C BMSB have slightly higher survival if exposed to 39% humidity**



- **High temperature exposure significantly decreased BMSB survival of all BMSB lifestages**



High temperatures reduced the number of eggs that developed to the 1st instar and the number of 1st instars that developed into 3rd instars

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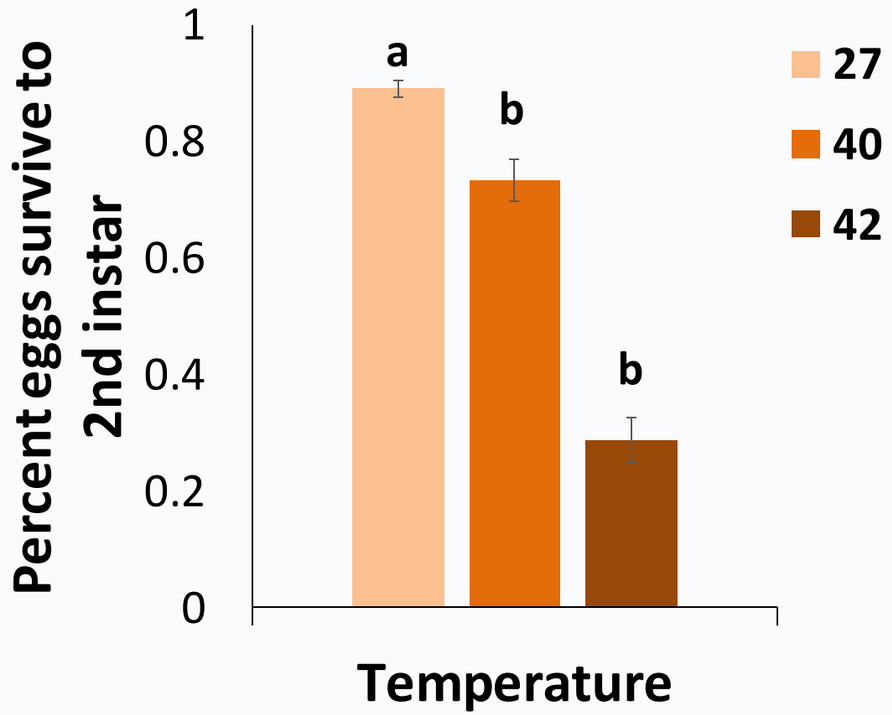

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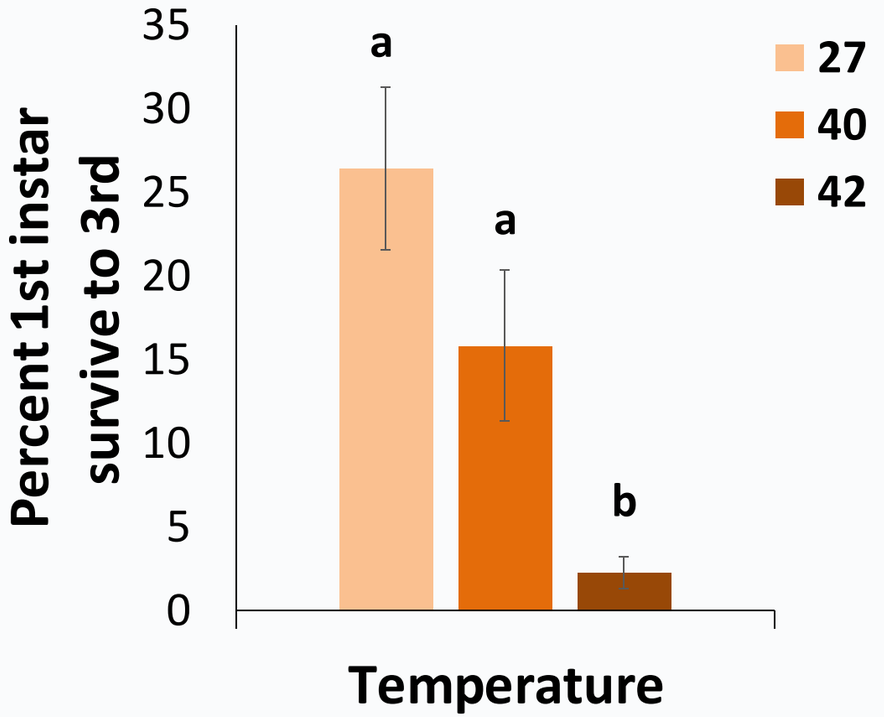
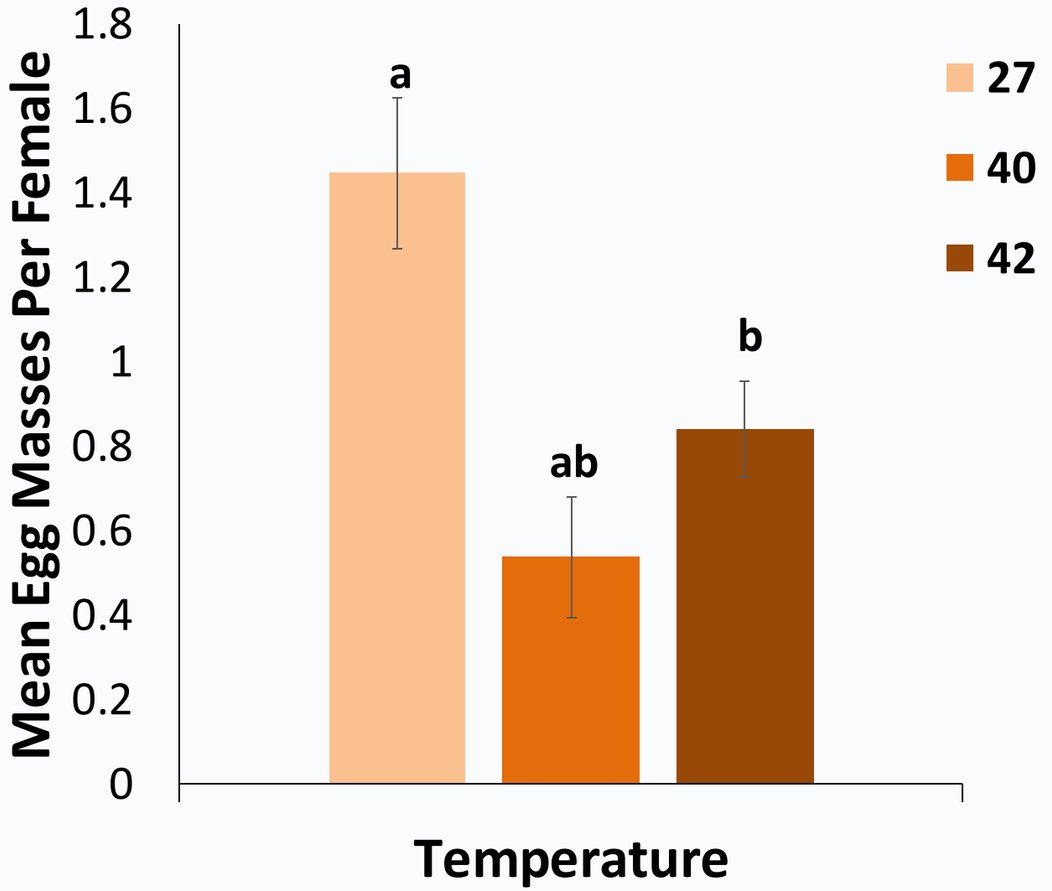
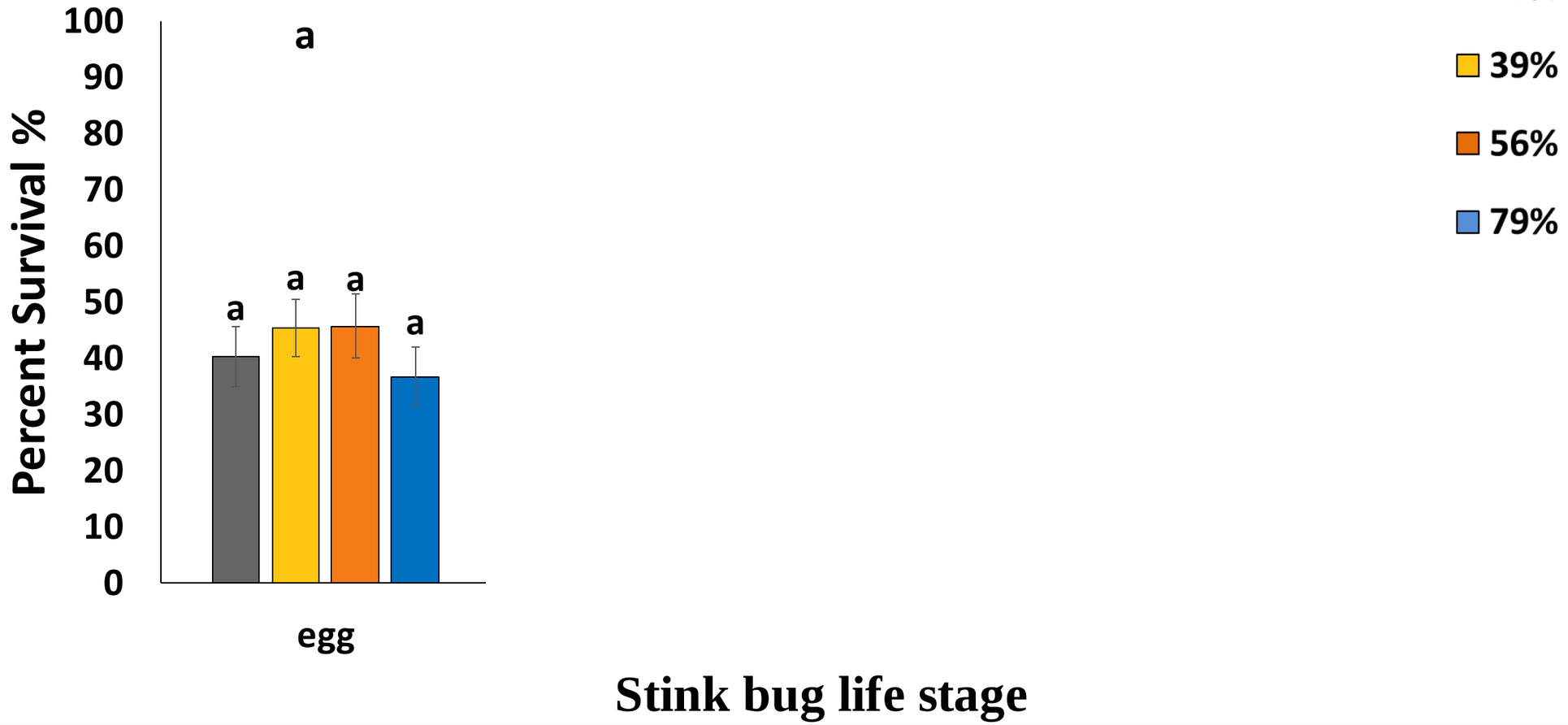


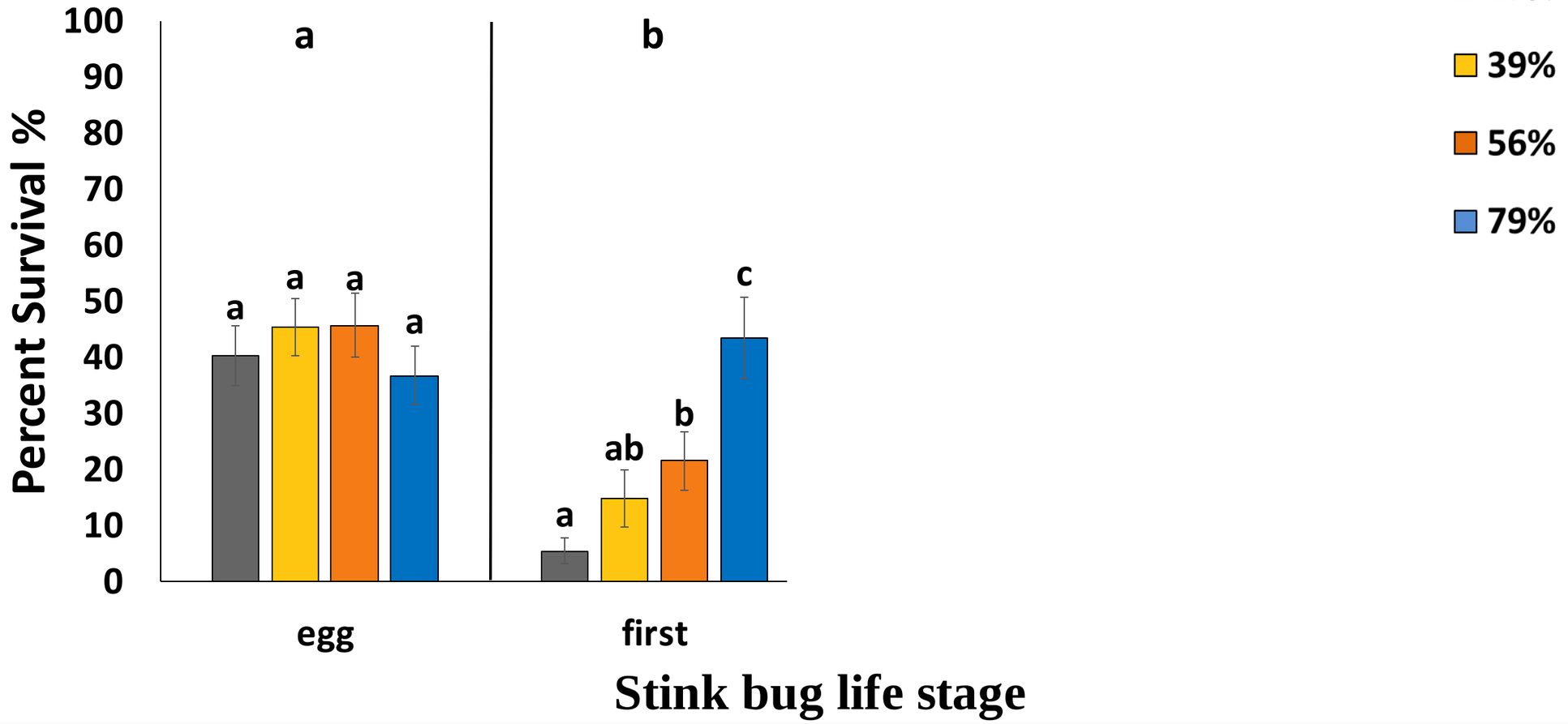
Fewer eggs were laid upon adult exposure to 42°C



- **Humidity does not matter for egg hatch**



- 1st instar nymphs die when exposed to low humidity



- **High humidity slightly decreases 3rd -4th instar survival**

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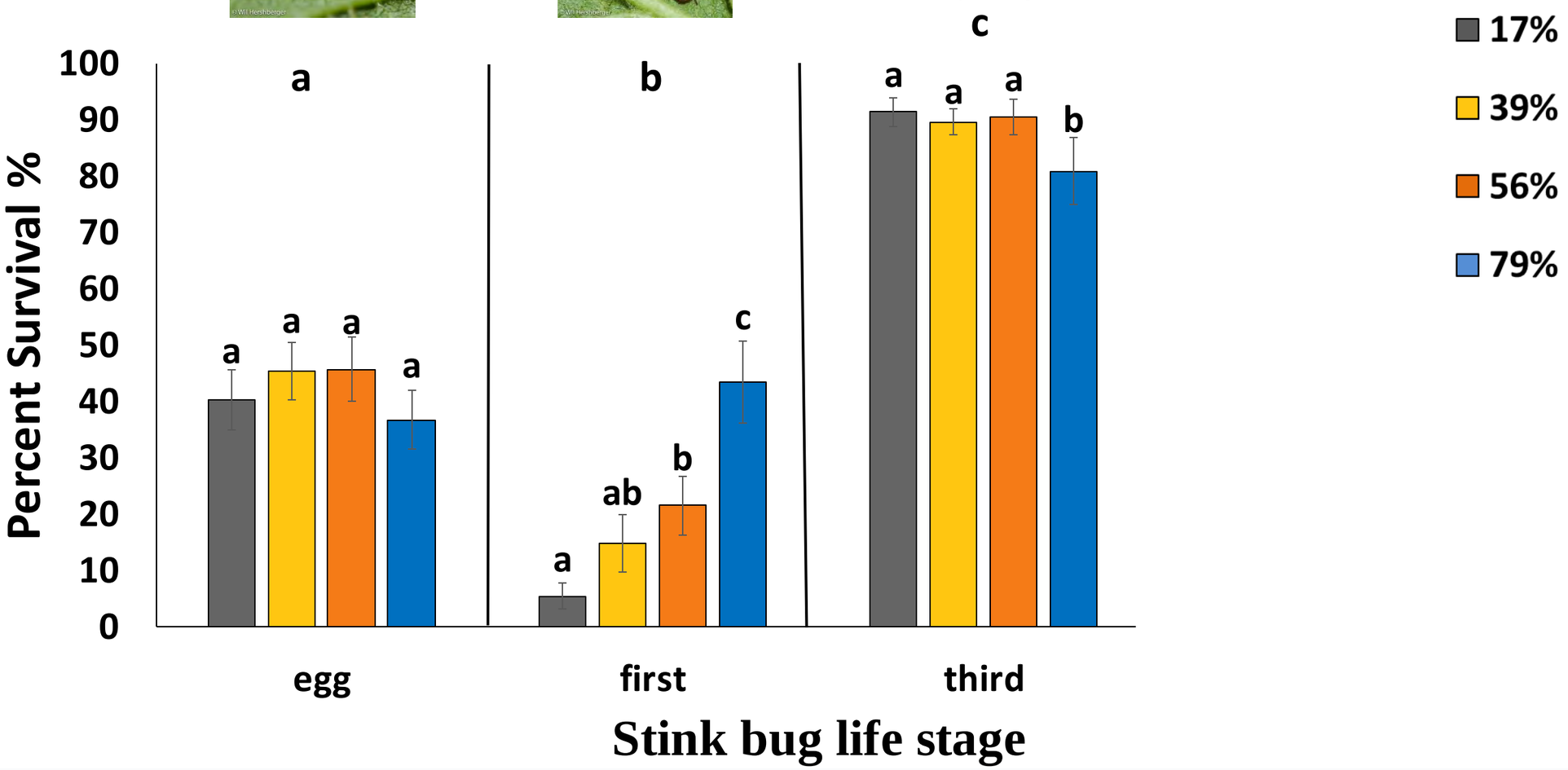
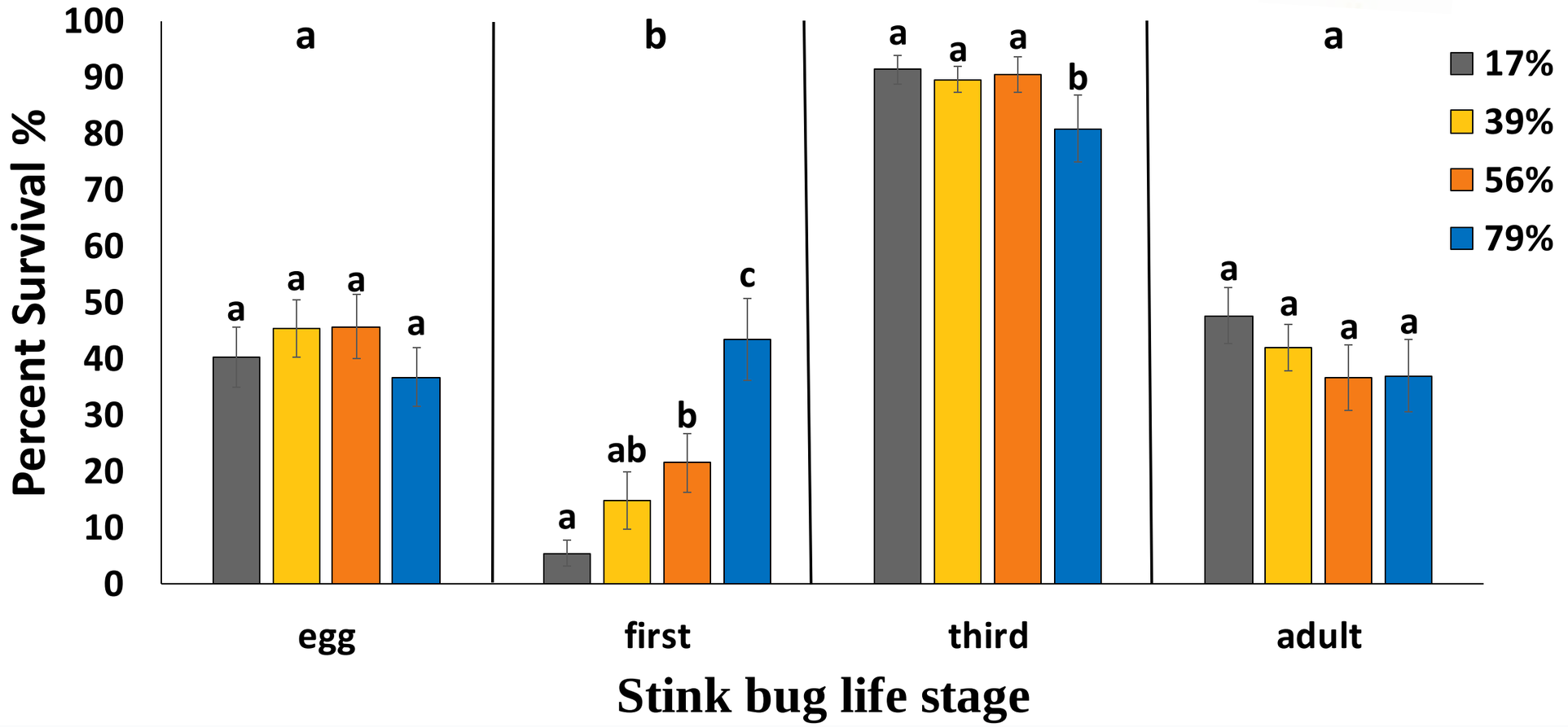


- **Humidity does not matter for adult survival**



The impact of humidity on BMSB survival depends on the insect life stage

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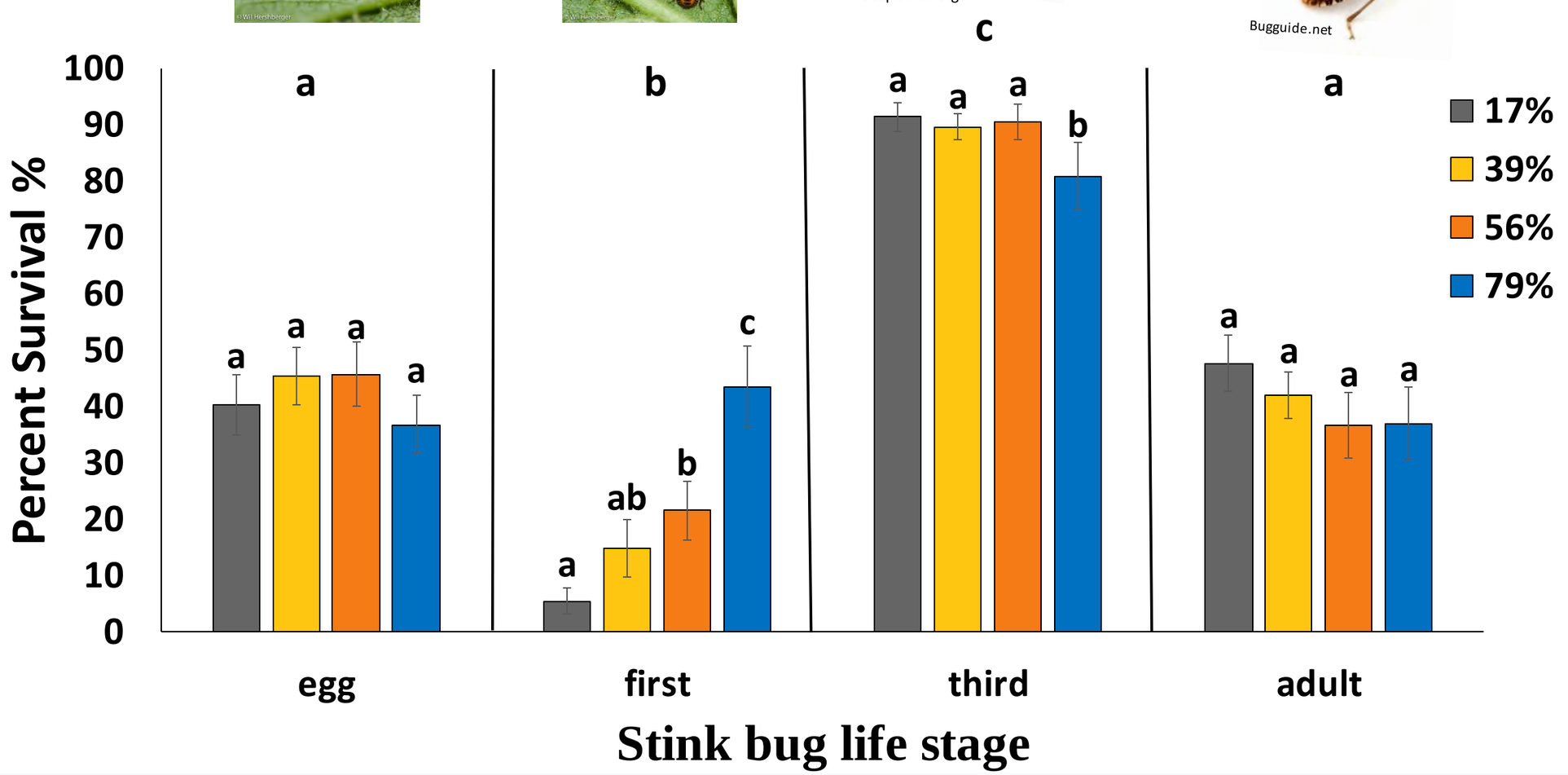
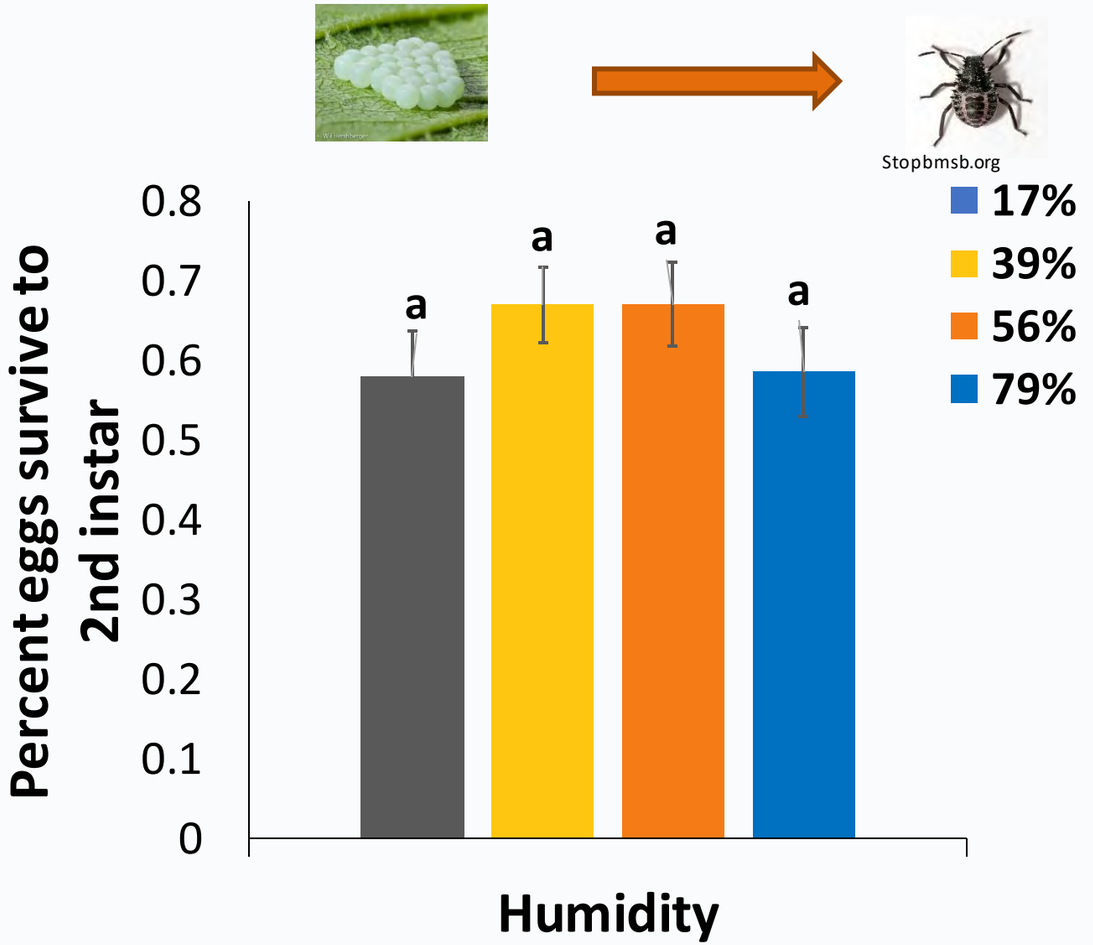
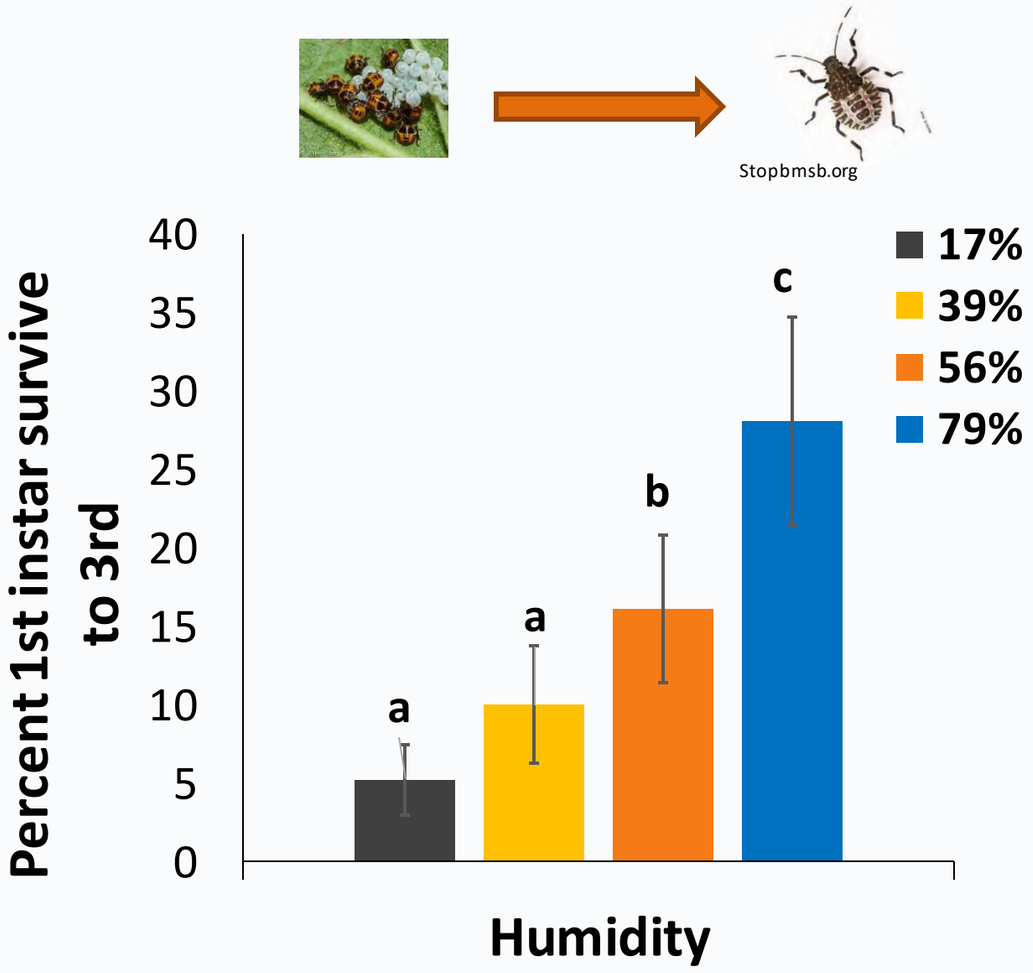
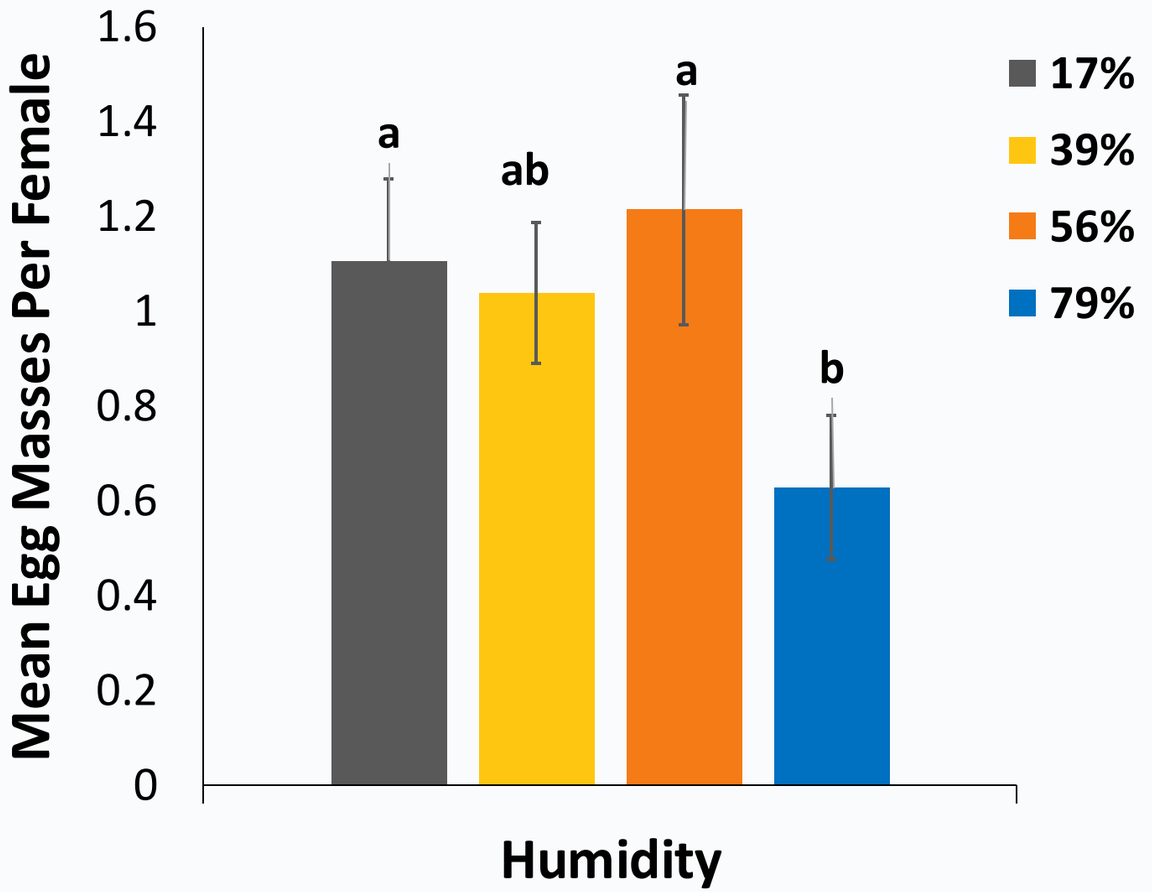


- Humidity did not influence the number of eggs that developed to the1st instar
- Low humidity reduced the number of 1st instars that developed to the 3rd instars





Fewer eggs were laid upon adult exposure to 79% rh



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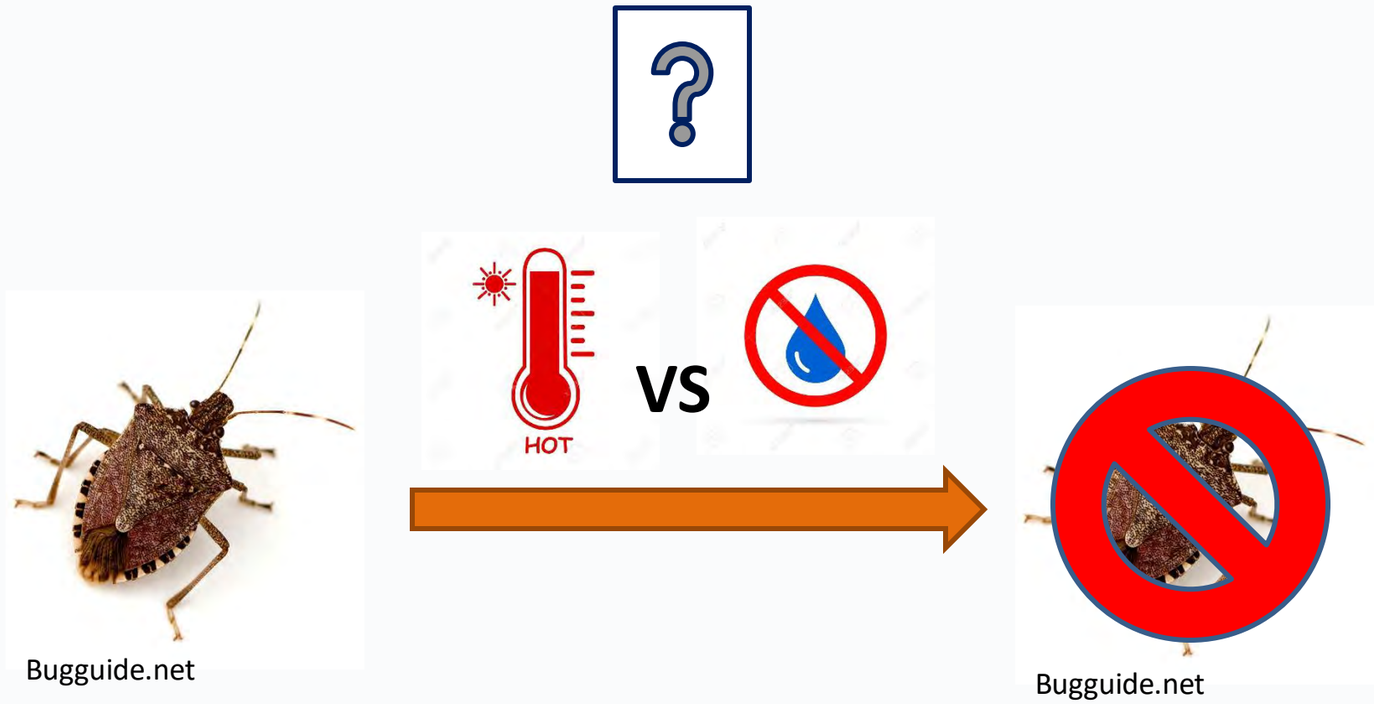


Both matter!

High temperatures decreases the survival of all BMSB life stages

Humidity had no effect on adults or eggs but low humidity killed 1st instars,

High humidity reduced older nymph survival

Depends…

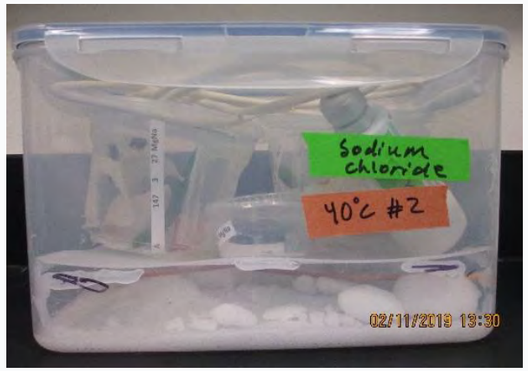
Overall findings:

High temperature and low humidity seem to be factors in the observed decline of BMSB populations in CA following high temperature events

Why it matters

- Could see lower populations in hot and dry areas/ hot and dry years.

- This data can be used to help predict the ability of BMSB to spread into new areas and how climate and high temperature events will impact BMSB population levels.



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- **Chuck Ingels**
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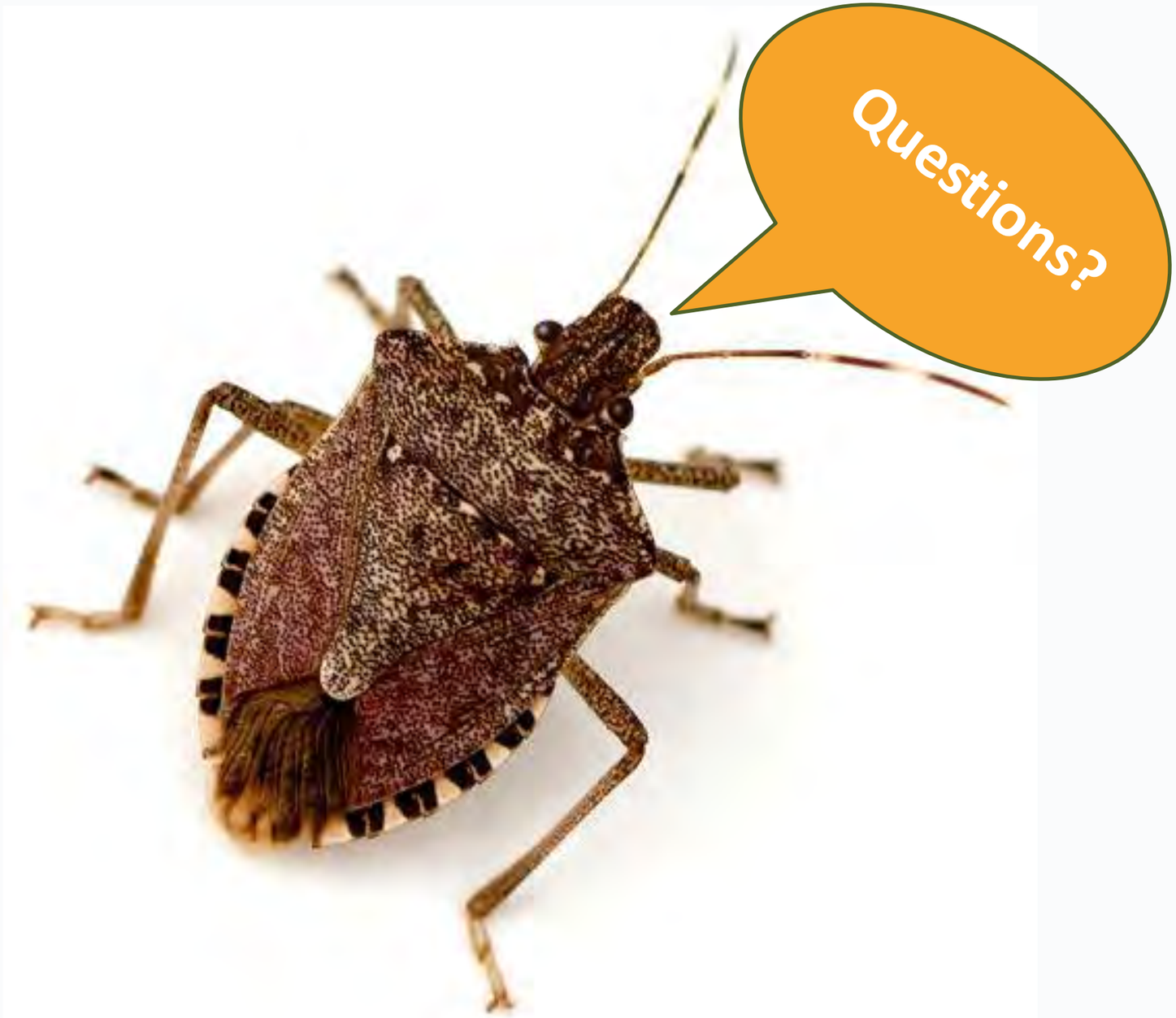

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