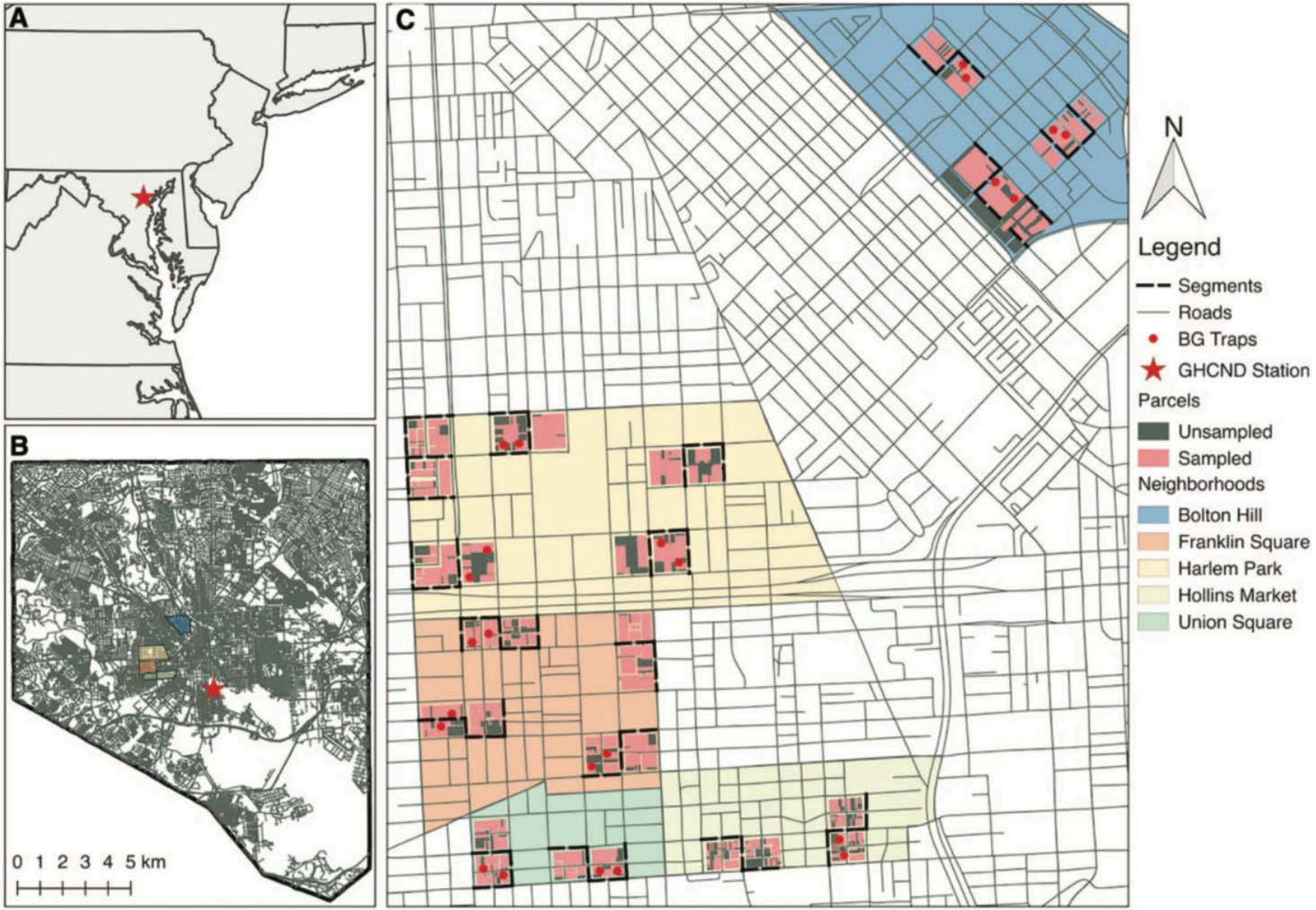
Ecology of urban mosquitoes along socio-economic gradients: Interesting insights from Baltimore, Maryland

Paul T. Leisnham


A
B
0 1 2 3 4 5 km
C
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Legend
Segments
Roads
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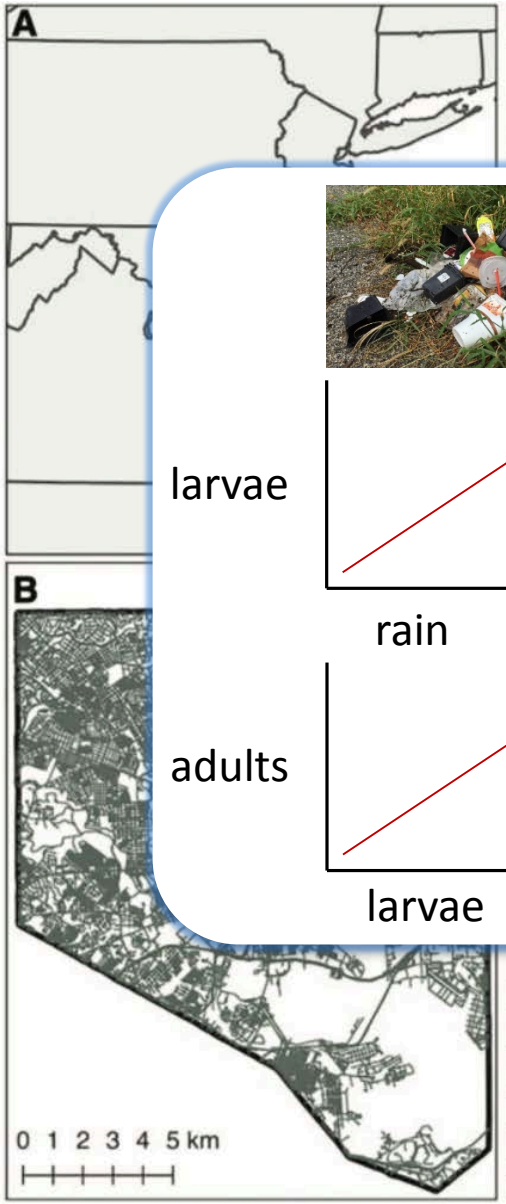
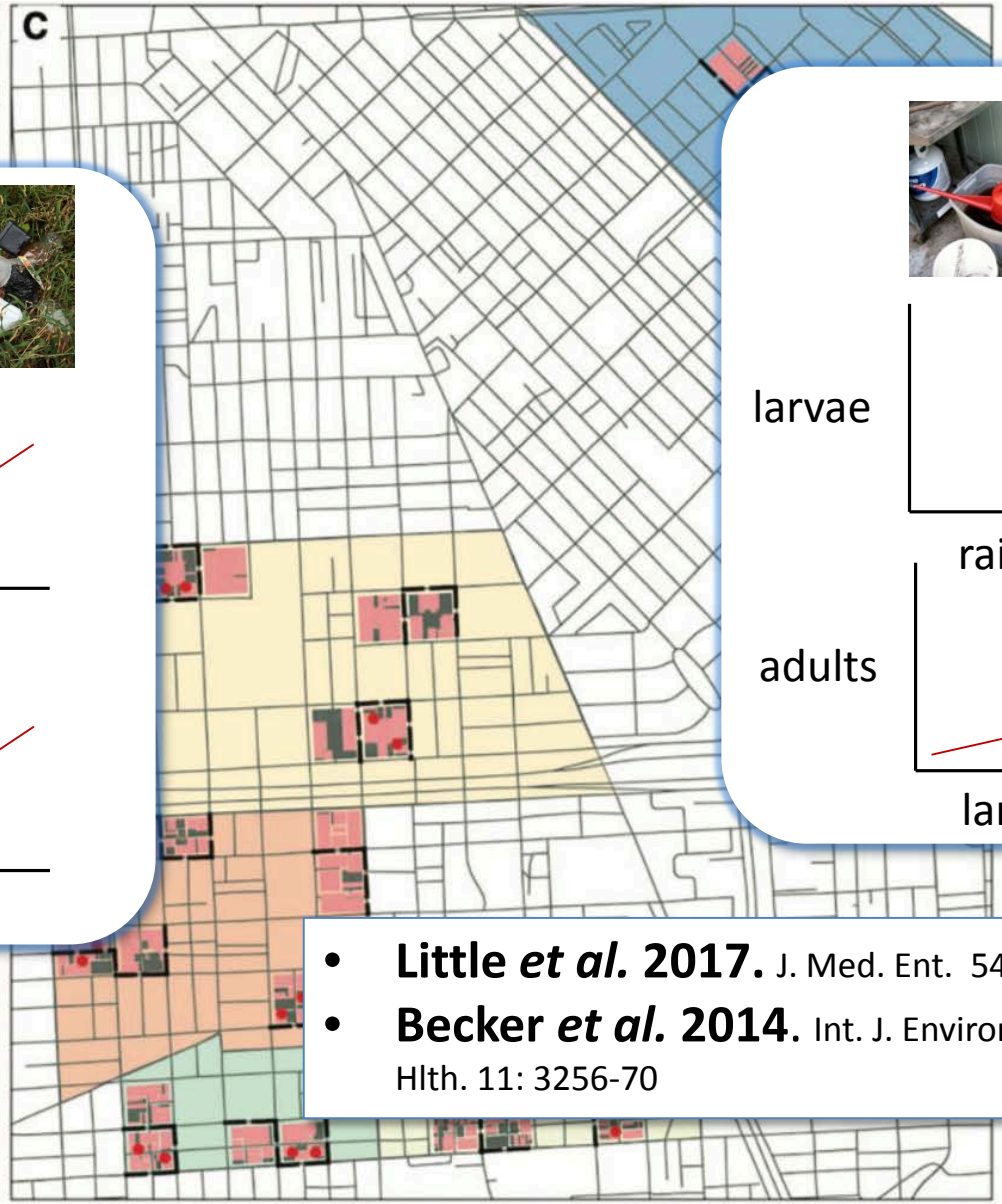
Neighborhoods
Bolton Hill
Franklin Square
Harlem Park
Hollins Market
Union Square





- **Little *et al.* 2017.** J. Med. Ent. 54(5): 1183-92
- **Becker *et al.* 2014.** Int. J. Environ. Res. Pub. Hlth. 11: 3256-70

Print education

Youth summer camps

- Workshops
- Citizen science

Trash removal

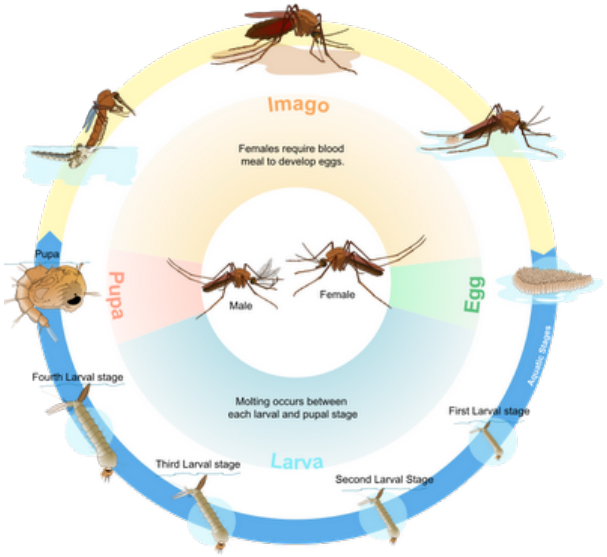
- Controlled
- Evaluated

Novel attractants

- Tire ecology
- Spatial & temporal

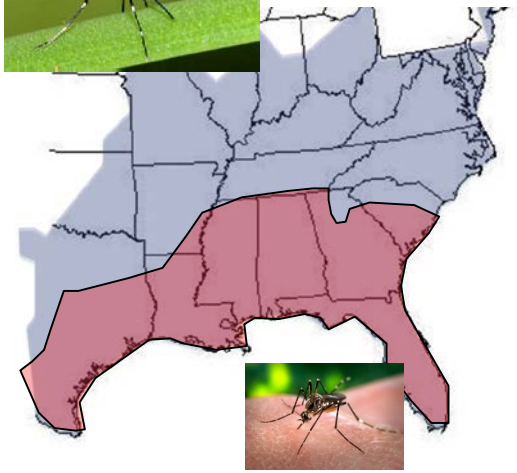
Urban Container Mosquito Communities

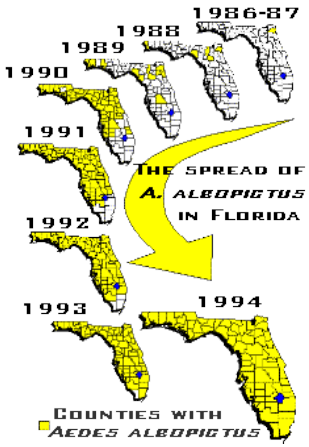
- Resource limited
- Ephemeral & lack vertebrate predators



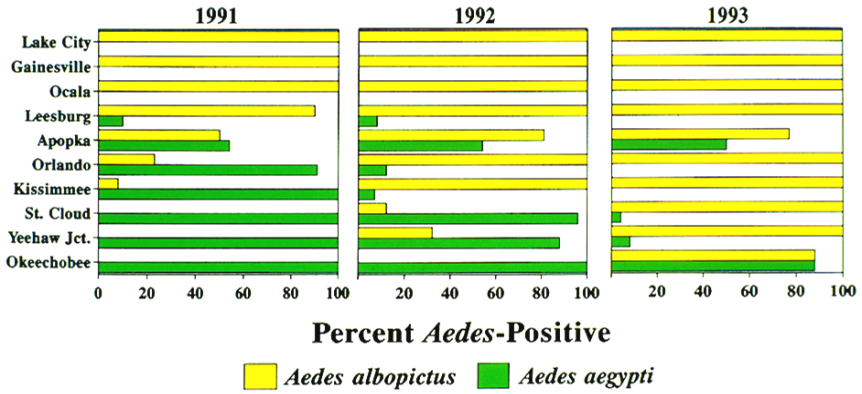
- Well documented effects of competition structuring communities (reviewed by Juliano 2009)

Aedes albopictus Invasion



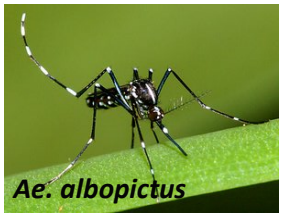


- Rapid spread since mid-1980s
- Declines of resident species
  - Competitive exclusion
  - Superior resource competitor



Aedes albopictus vs. *Culex pipiens*

- Superior larval competitor to *Cx. pipiens*
  - Costanzo *et al.*, 2011; Costanzo *et al.* 2005; Carrieri *et al.* 2003
- *Cx. pipiens* persists in urban areas
- Little research on interspecific competition using resources and densities typical of different urban containers



Hypotheses & Predictions

- Interspecific competition between *Ae. albopictus* and *Cx. pipiens* important in urban containers
  - Co-occurrence in Baltimore containers
  - Detect competition at field densities

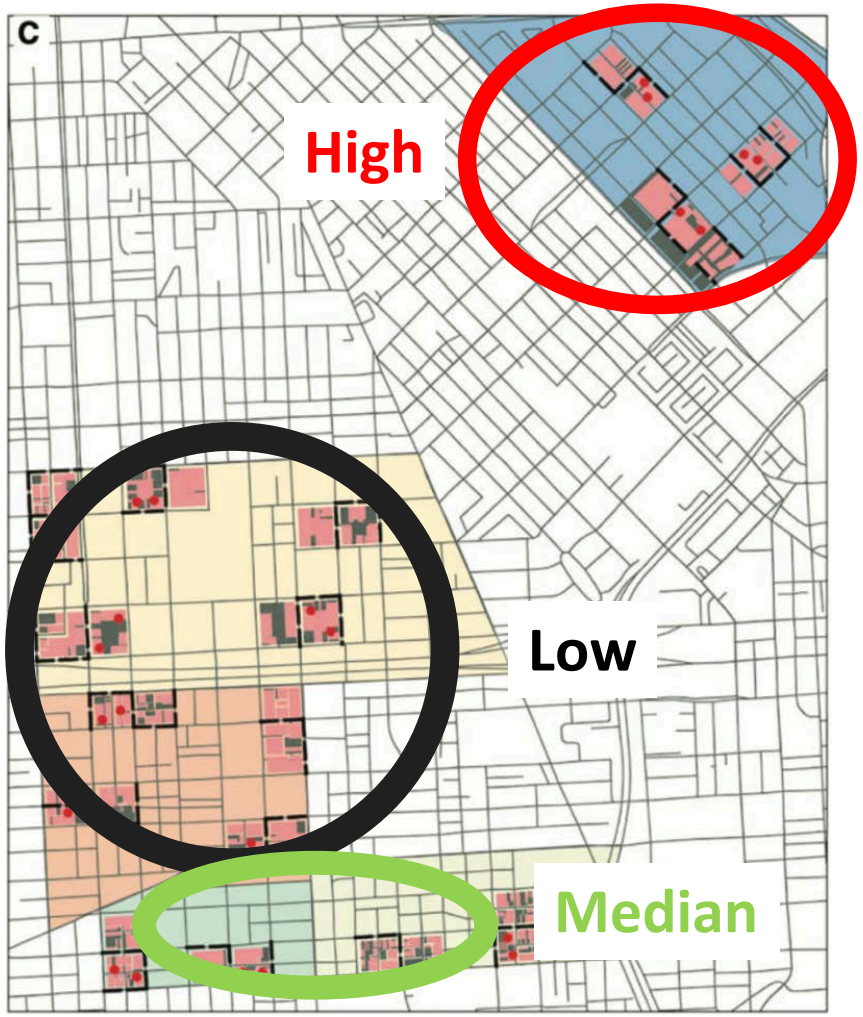
- Persistence of *Cx. pipiens* occurs in some containers because conditions alter competition
  - Proportion *Cx. pipiens* varies among field containers
  - Competition varies among container conditions

Methods: Field Data

- Sampled container habitat in 2015
  - May, July-Aug., Sept.

➢ 608 water-filled containers

➢ Mean density: 0.33 larva per mL
  - ➢ Baseline field density



Methods: Field Survey

- 3 most common trash & functional/structural container types

Trash

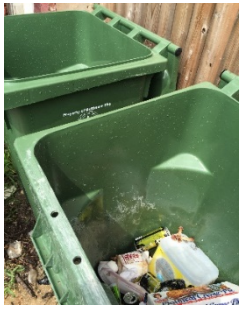
Plastic trash

Styrofoam trash

Dumped tire

Functional/Structural

Bucket



Trash can

Fence pole

- Calculate proportion containers with mixed species & proportion total larvae that are *Cx. pipiens*

Methods: Competition Trial

Late May 2016: ~300 mL homogenized sample from four randomly selected containers from each container type (24 total containers)

Applied one of three density treatments to each microcosm from each container

Divided sample into three 90 mL microcosms

REDUCED: 15 *Cx. pipiens*

CONTROL: 15 *Cx. pipiens* + 15 *Ae. albopictus*
Baseline field density

INCREASED: 15 *Cx. pipiens* + 30 *Ae. albopictus*

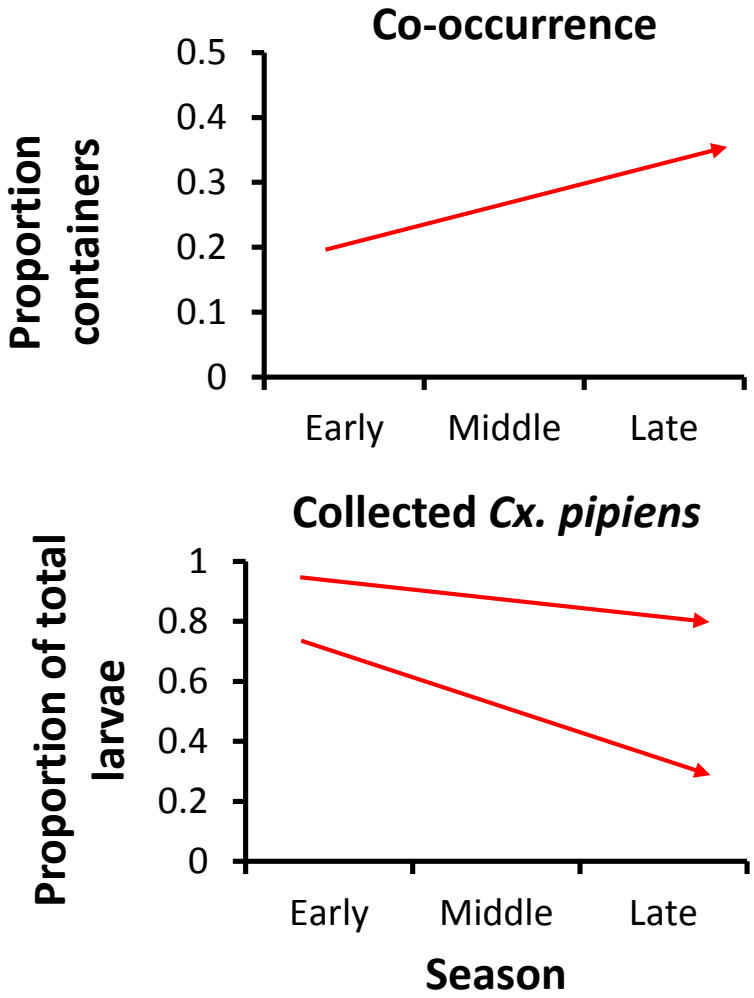
106-µm sieved to remove larvae and large detritus

Additive experimental design

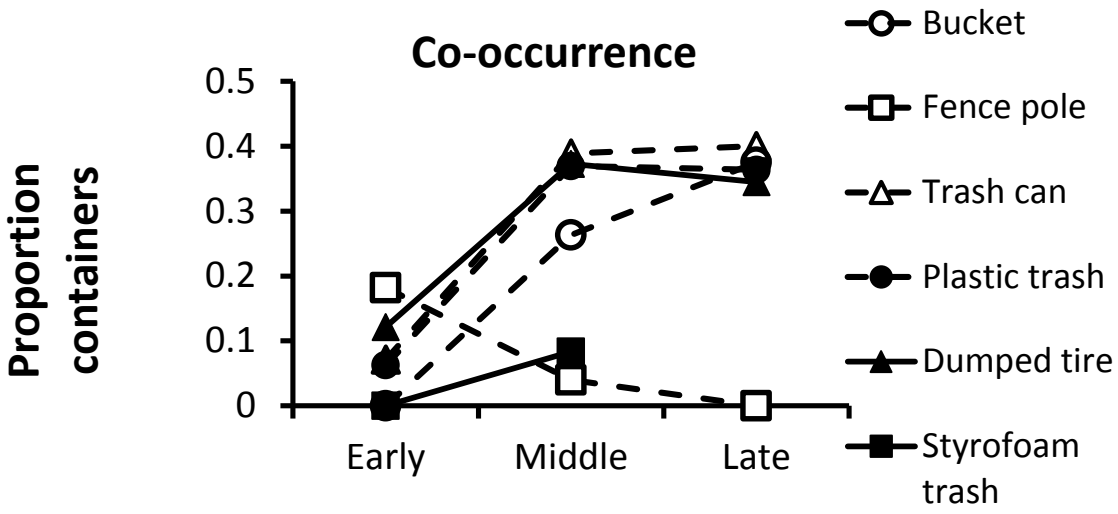
Methods: Competition Trial

- 72 total microcosms (6 types x 3 density treatments X 4 reps)
- Incubator set at 24˚C @ 18:10 L:D
  - Isolate effects from container contents
- Proportion survival and instar of *Cx. pipiens* after 6 days
  - Retain field conditions/competition is most impt.
- Data analyzed with linear mixed models

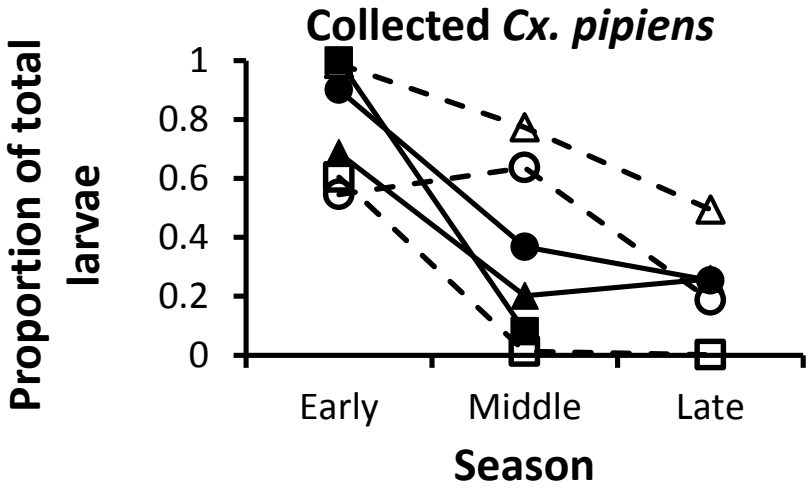
Results: Field Survey



Results: Field Survey

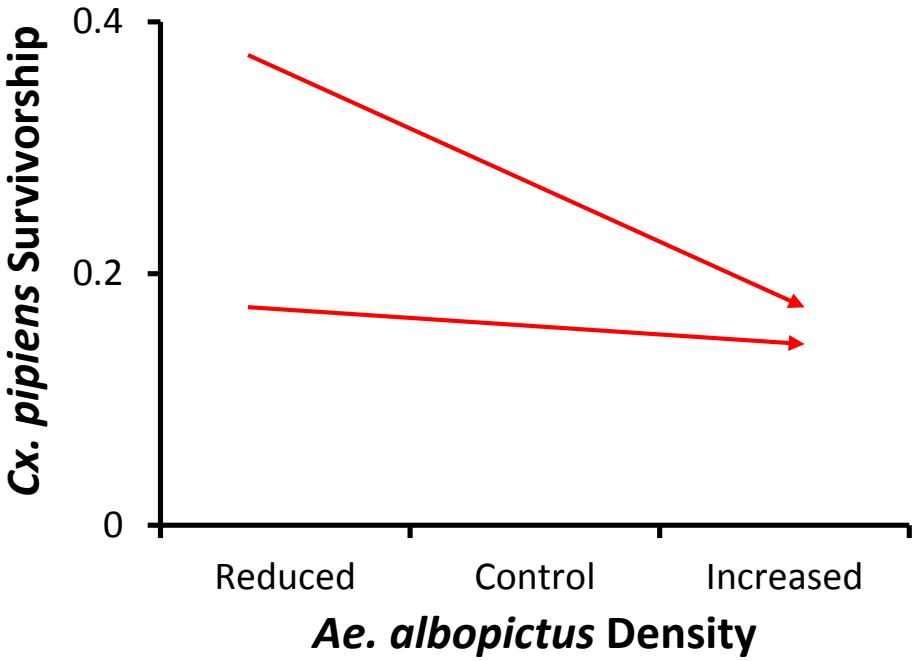


Co-occurrence was common within 2/3 trash and 2/3 functional container types

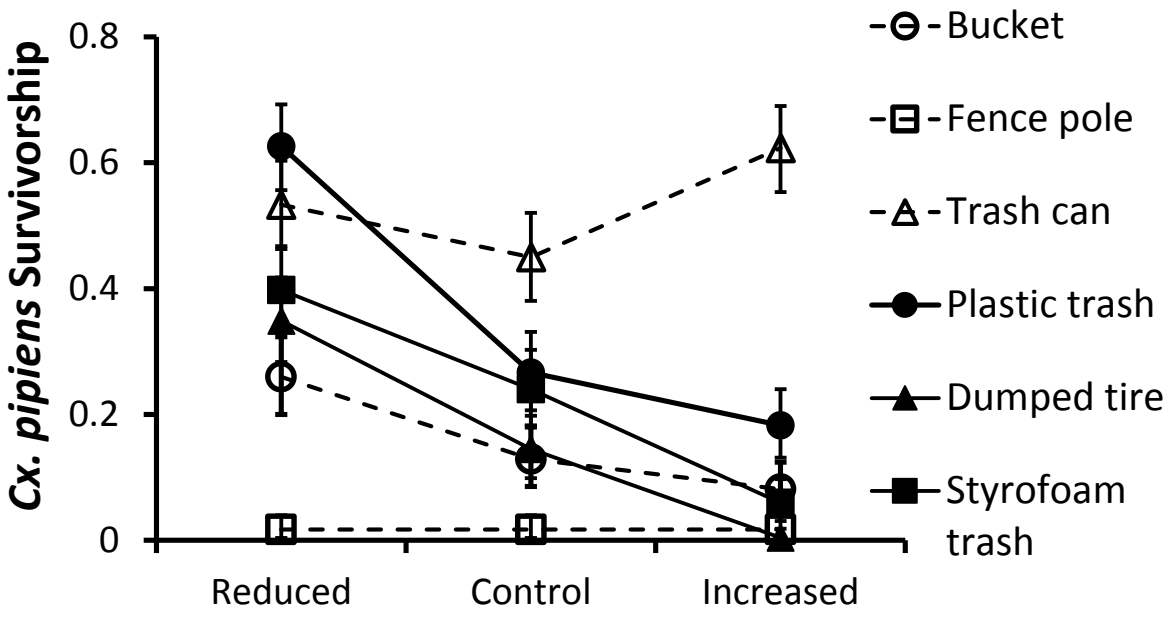


Milder decreases of *Cx. pipiens* from early to late season in 2/3 functional container types

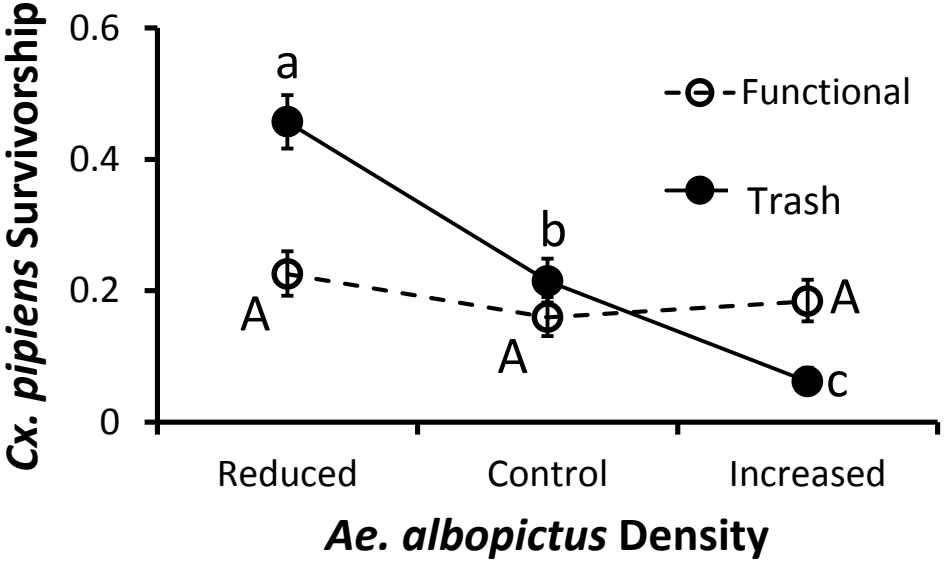
Results: Competition Trial



Results: Competition Trial - Survival

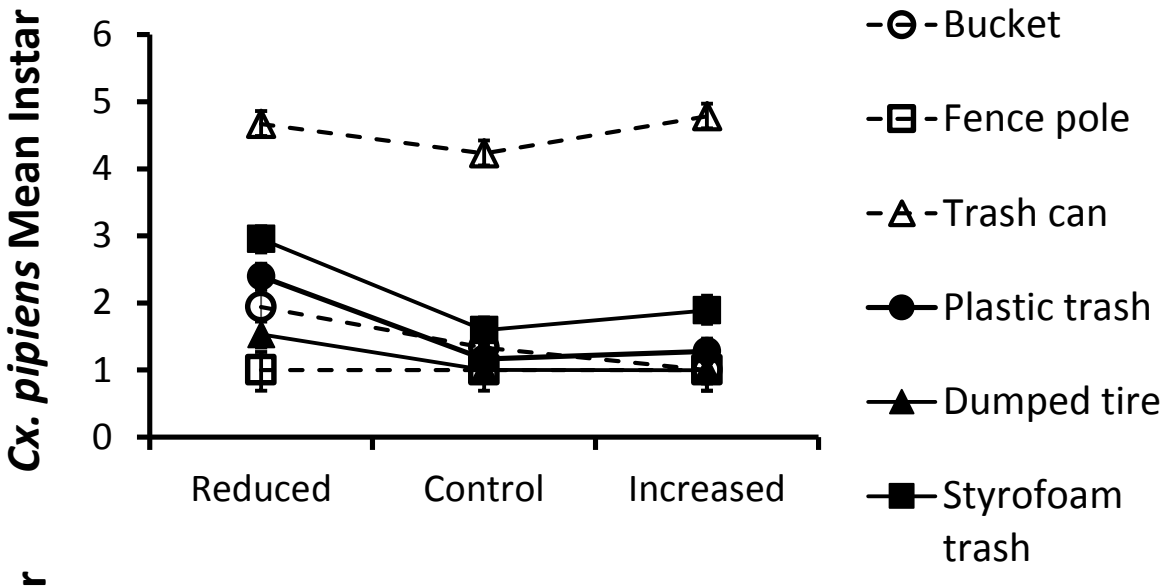


Lower survival in Increased vs. Decreased treatments for Trash container types

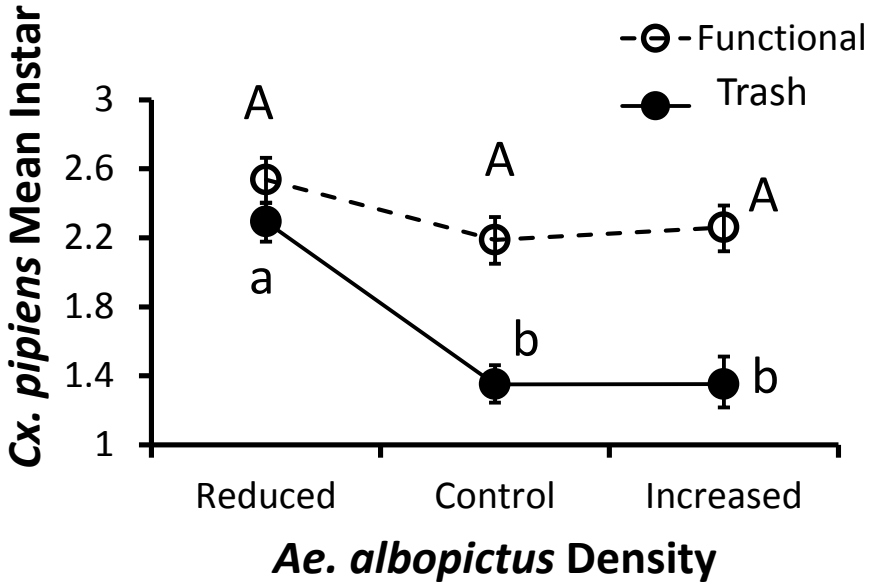


Stronger effects of *Ae. albopictus* competition in Trash containers

Results: Competition Trial - Development Time



Slower development in Increased vs. Decreased treatments for Plastic and Styrofoam Trash & Buckets



Strong effects of *Ae. albopictus* competition in Trash containers

Results Summary

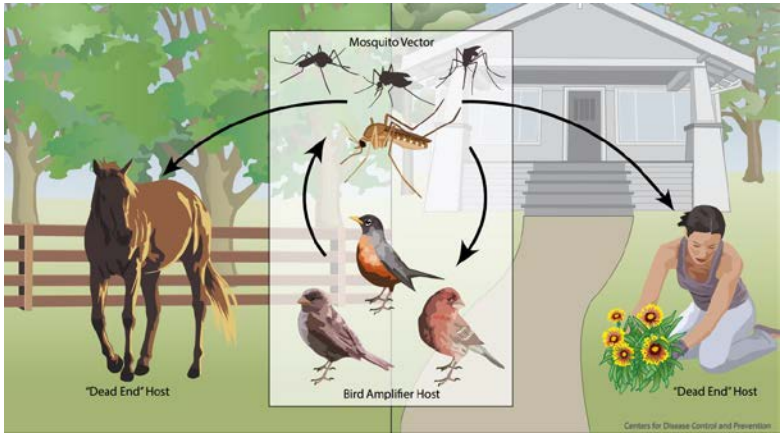
- Negative competitive effects of *Ae. albopictus* on *Cx. pipiens* at field densities
- Less evidence of competitive impacts in Functional containers
  - Likely due to greater FPOM, nutrient & microbial resources
- Regional persistence of *Cx. pipiens* after *Ae. albopictus* invasion in urban container conditions
- Competition important in structuring *Ae. albopictus-Cx. pipiens* communities
  - In addition to other ecological processes

Implications

- *Cx. pipiens* coexistence with *Ae. albopictus* may increase transmission risk
  - Simultaneous zoonotic and bridge transmission of WNV

- Functional Trash Cans good habitat for *Cx. pipiens*
  - Unlike “typical” functional containers
  - Control requires resident-based behavior change

- May be one of few container habitats where larvicidal control works (e.g., Bti dunks)



Collaborators

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Citizen Science:
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Environmental Justice:
Dawn Biehler (UMBC) & Sacoby Wilson (UMD)

Community Partners:
Guy Hager (Parks and People Foundation)

- NSF-Couple Natural Human Systems Program (DEB-1211797)
- USDA-NIFA and the Northeastern Integrated Pest Management Center (MD-2011-00540)
- NSF-LTER Program (Baltimore Ecosystem Study)

National Science Foundation
WHERE DISCOVERIES BEGIN

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

Graduate students:
Numerous graduate and undergraduate students

End Slides

Results: Competition Trial

	Survival			***Development Time***		
Source	dfs	*F*	*P*	dfs	*F*	*P*
Container Type	5,18	27.54	**<0.0001**	5,17.9	124.29	**<0.0001**
Treatment	2,36	25.60	**<0.0001**	2,33.7	15.49	**<0.0001**
Container Type x Treatment	10,36	4.57	**0.0003**	10,31.5	2.80	**0.0134**

Container (Container Type) included as a random variable

Development Time could not be calculated in 11 microcosms that had no survivorship