

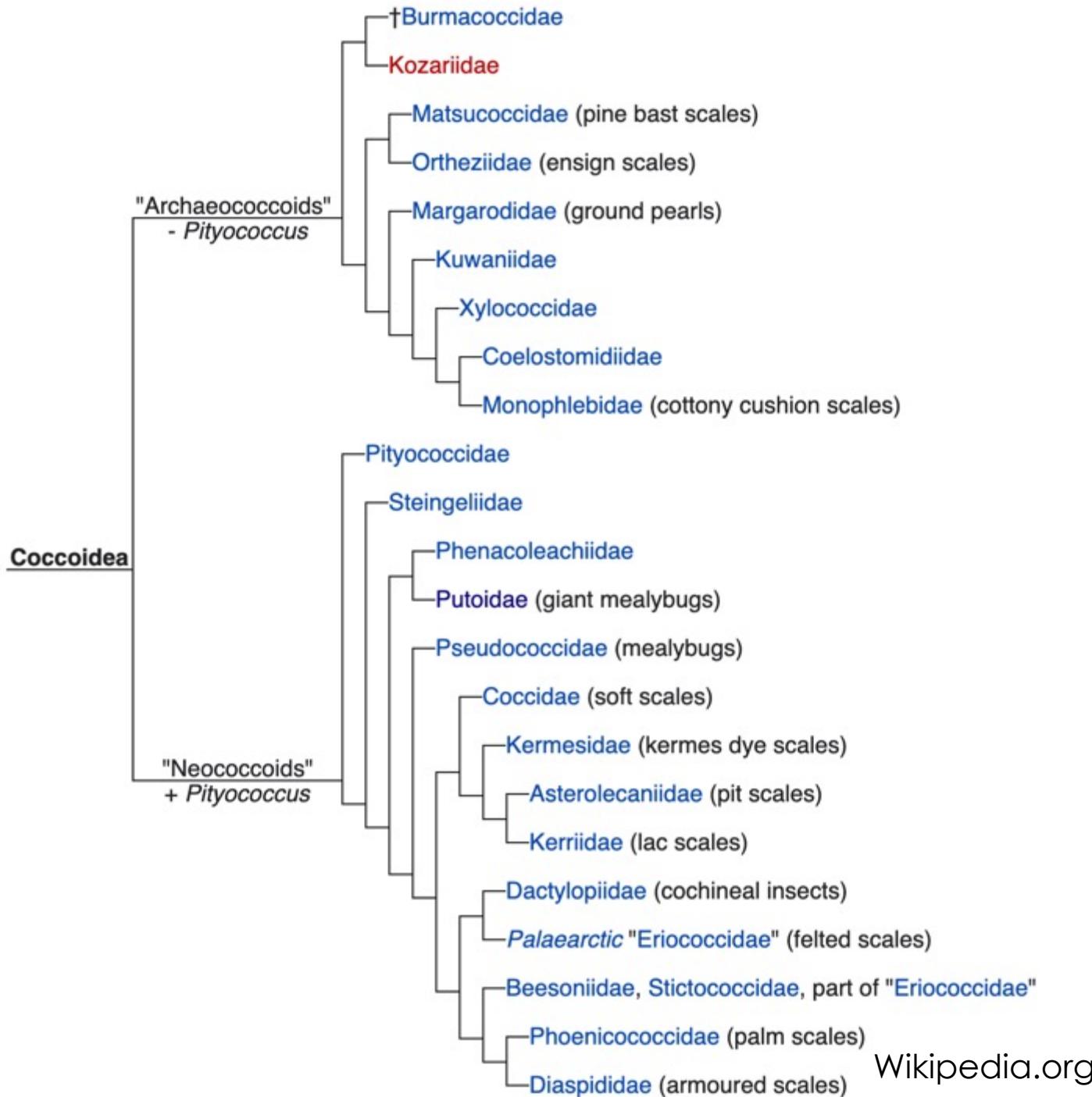
# Crape myrtle Bark Scale (and other scale) in the Landscape:

An integrated pest  
management approach

ERFAN VAFAIE, PHD

# Scale (Coccoidea) | What are they?

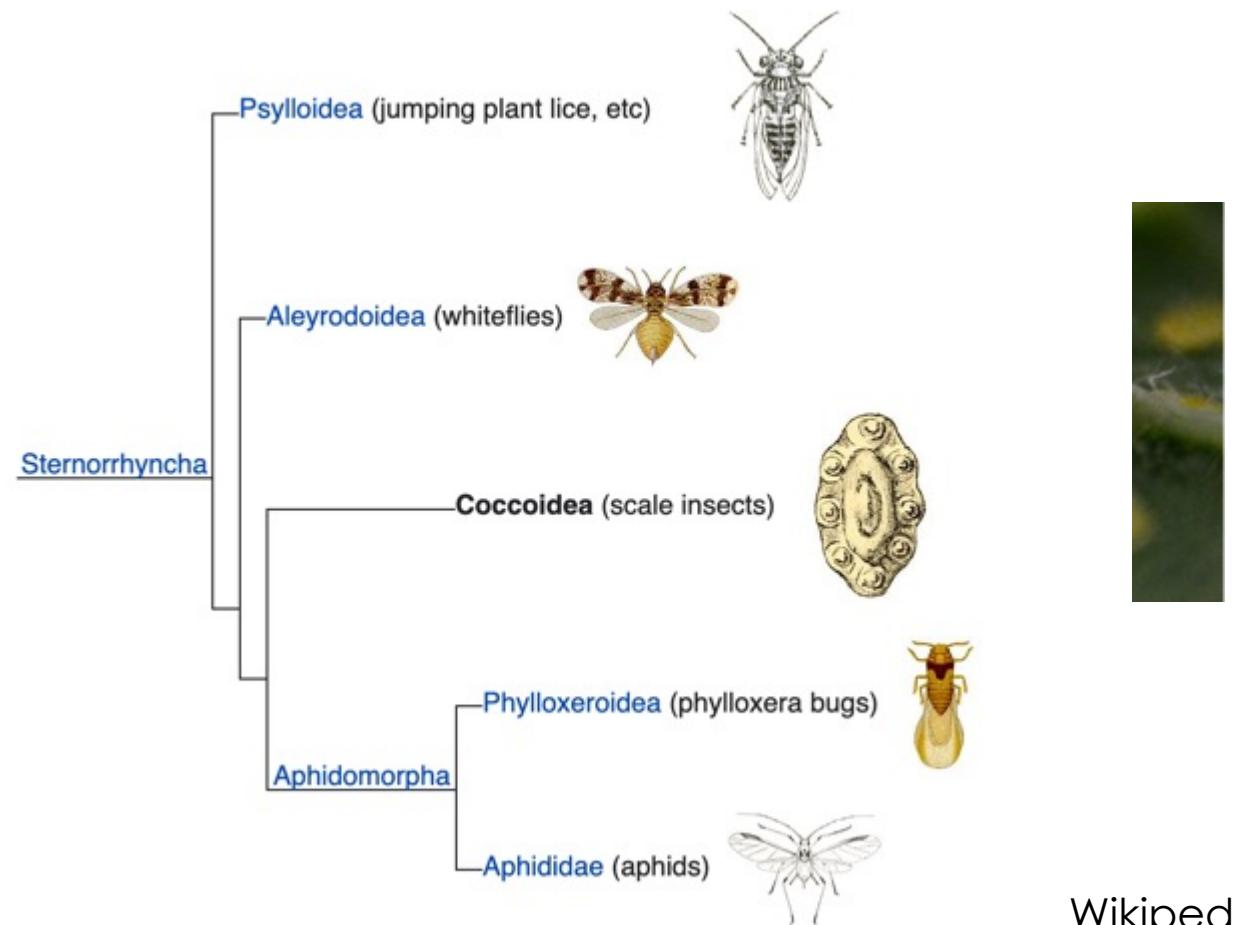
- Hemipterans (true bugs)
- Sucking mouthparts
- Produce honeydew\*
- Sexual dimorphism
- Produce waxy coat



\* Not all species

# Scale (Coccoidea) | What are they?

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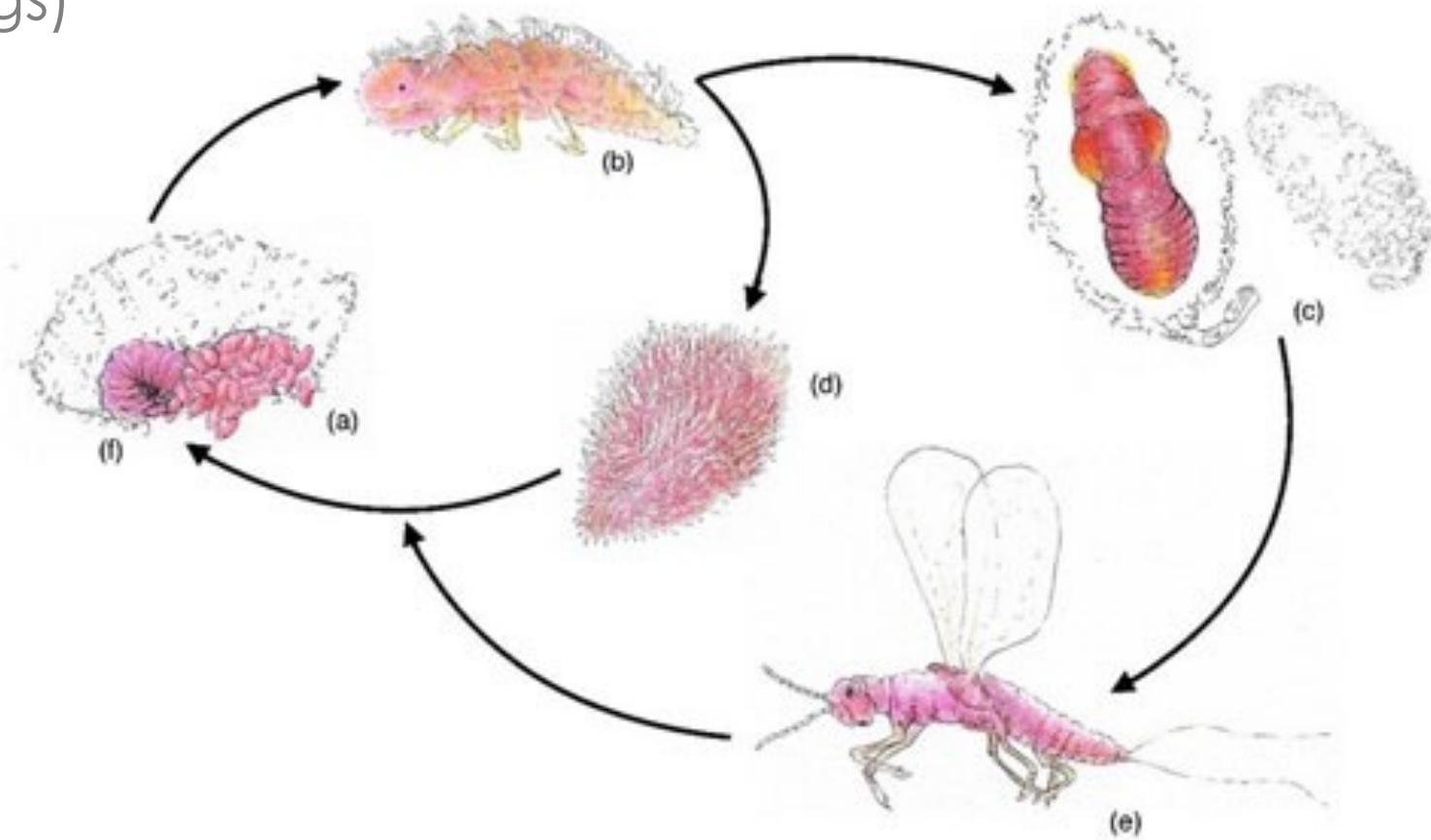
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\* Not all species

# Scale (Coccoidea) | All Bad?

- Dye
- Biological Control

Illustration of cochineal collection in José Antonio de Alzate y Ramírez, *Memoria sobre la naturaleza, cultivo, y beneficio de la grana...*, (Essay on the Nature, Cultivation, and Benefits of the Cochineal Insect), 1777, colored pigment on vellum  
(photo: [Newberry Digital Collections for the Classroom](#), Edward E. Ayer Manuscript Collection, VAULT Ayer MS 1031).



# Scale (Coccoidea) | All Bad?

- Dye
- Biological Control

*Dactylopius coccus* on prickly pear  
Used by American Indians to make  
crimson dye to paint missionary  
buildings, particularly in the San  
Antonio area



# Scale (Coccoidea) | All Bad?

- Dye
- Biological Control



Rembrandt van Rijn, Portrait of a couple as Isaac and Rebecca, known as *The Jewish Bride*, about 1665–69, oil on canvas, 121.5 × w 166.5 cm (Rijksmuseum, Amsterdam)

# Scale (Coccoidea) | All Bad?

- Dye
- Biological Control

*Dactylopius opuntiae* on  
opuntia; biological  
control in Kenya



Vahe Martirosyan, Flickr, [Some rights reserved](#)

# Scale (Coccoidea) | Main Categories

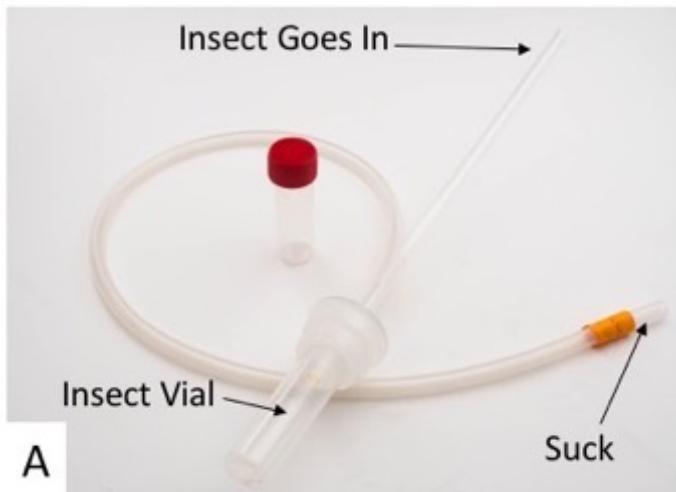
## Soft/Felt Scale

- produce thin, waxy/powdery outer layer
  - cannot be separated from rest of the body
- produce honeydew

## Hard/Armored Scale

- hard shield-like cover
  - not attached to body of the insect
- do *not* produce honeydew

# Monitoring | Tools of the Trade



# Monitoring | Tools of the Trade

“Headband magnifier”



\$17 on Amazon

# Monitoring | Tools of the Trade

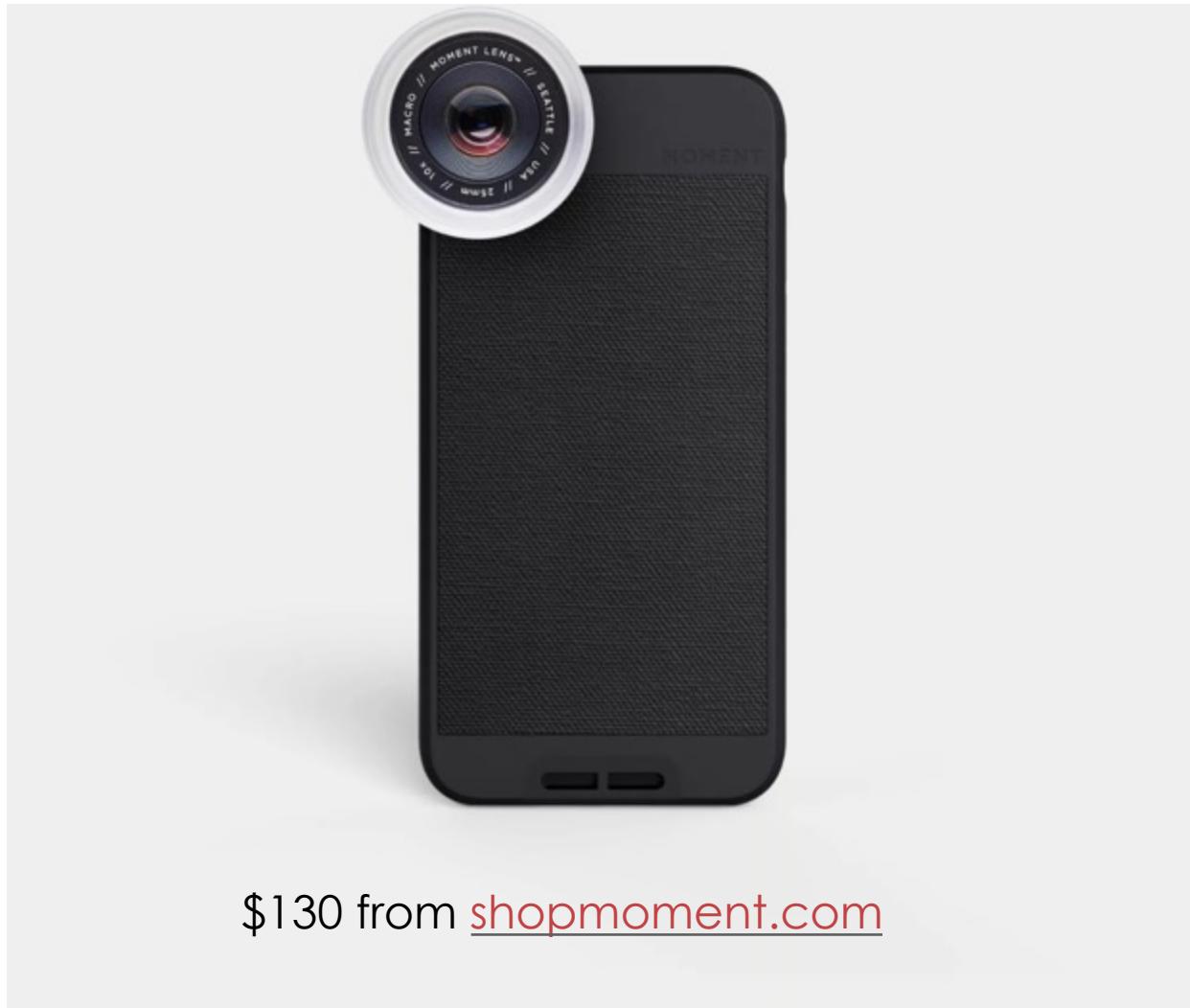
Macro Lens kit for Phone



Shot with Xenvo Clarus 15x Macro Lens

# Monitoring | Tools of the Trade

Macro Lens kit for Phone



\$130 from [shopmoment.com](http://shopmoment.com)



# Monitoring | Tools of the Trade



Roll over image to zoom in

# Monitoring | Tools of the Trade

Double-sided sticky tape



# Monitoring | Tools of the Trade

Double-sided sticky tape



# Common Landscape Scale Insects of Texas

- Crapemyrtle bark scale
- Cycad aulacaspis scale
- Tea scale
- False oleander scale
- Euonymous scale
- Obscure scale
- Oystershell scale
- Wax scales
- Cottony cushion scale
- Brown soft scale
- San jose scale

[Detailed view](#) | [Field-Guide view](#)



# Crapemyrtle bark scale

North Amer. First sighting:  
2004, Northern Texas

Now found in:  
TX, OK, LA, AR, NM, TN, GA,  
AL, MS, NC, SC, VA, and WA

Originally from:  
Asia  
[*Acanthococcus lagerstroemiae*  
(Hemiptera: Eriococcidae)]

# Crapemyrtle

*The Call*



Richardson, TX (2004)

Photo: Mike Merchant



Acanthococcus azaleae ?

Photo: Mike Merchant

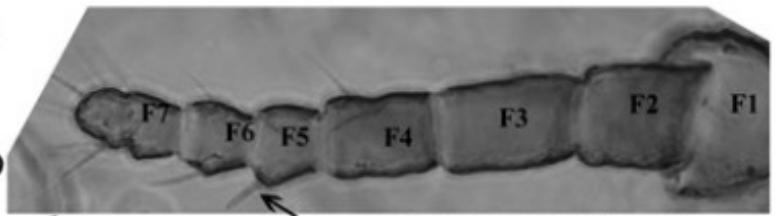
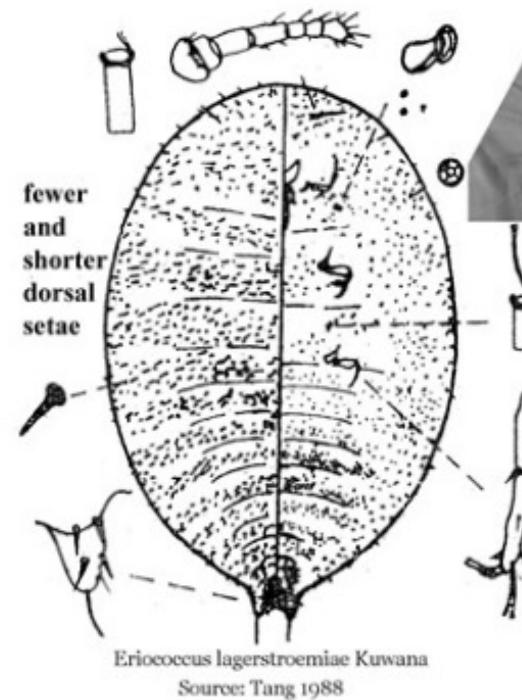
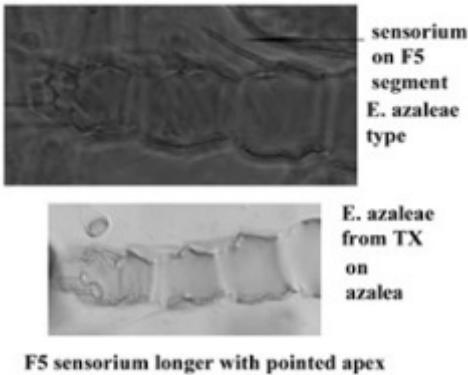
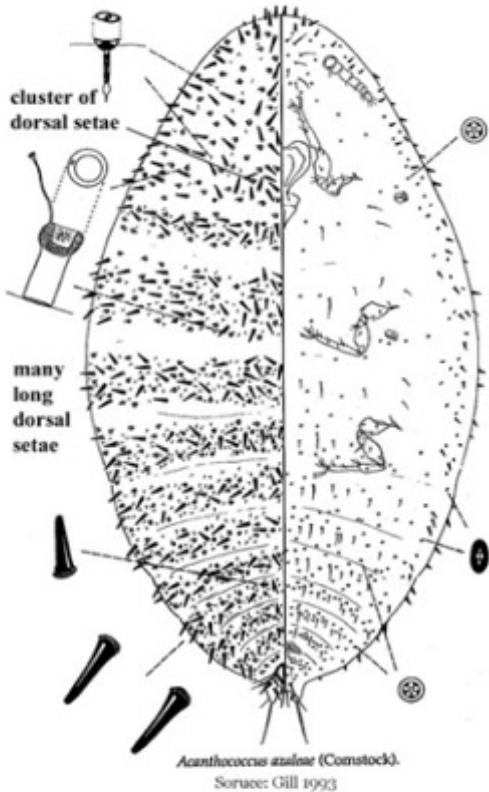
*Acanthococcus (=Eriococcus) lagerstroemiae* Kuwana 1907  
Distribution: Inner Mongolia, China & Japan



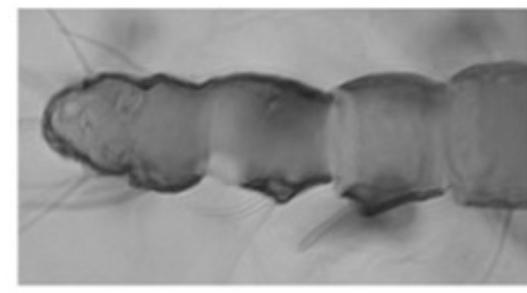


Beijing Botanical Garden November, 2013

# *Acanthococcus lagerstroemiae* ?



*E. lagerstroemiae* specimen on *Lagerstroemia* from China.



*E. lagerstroemiae* on *Lagerstroemia* from TX

Figure 4. Illustration of *Eriococcus* (=*Acanthococcus*) *azaleae* from Gill 1993. Note the more numerous and longer setae, and the longer sensorium on F5, compared to *E. lagerstroemiae*. Images USDA/ARS, Greg Evans .

Figure 3. Illustration of *Eriococcus lagerstroemiae* from Tang, 1988 (I). Note shorter sensorium with blunt apex on *Lagerstroemia* specimens from China and Texas (upper and lower right). Images USDA/ARS, Greg Evans .



NEWS

WEATHER

SPORTS

FEATURES

GOOD DAY TULSA

STATION

CIRCA

WATCH



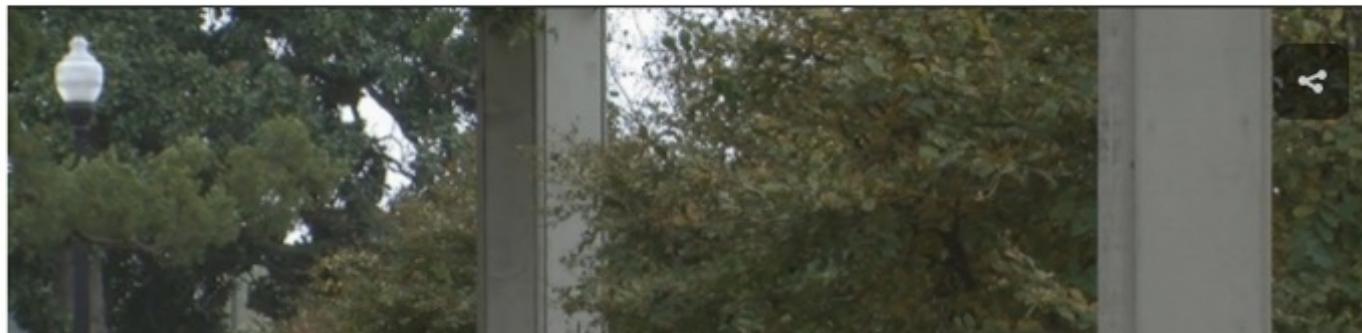
## Left Behind: Stories of heroism

The stories behind the items left at the Vietnam Veterans Memorial wall.

[FULL VIDEO](#) | [Gallery:Items left behind](#) | [A means to heal](#)

# Invasive species killing Crepe Myrtles in Green Country

by Tyler Butler | Tuesday, November 7th 2017



## TRENDING

- 1  6 HOURS AGO  
Police focusing on cellphones in brutal rape, murder of 10-year-old Albuquerque girl
- 2  A DAY AGO  
KFC rewards man who noticed they only follow '11 herbs and spices' on Twitter
- 3  AN HOUR AGO  
Standoff ends with apparent suicide in Osage County
- 4  A DAY AGO  
Muskogee Police identify victim shot to death in

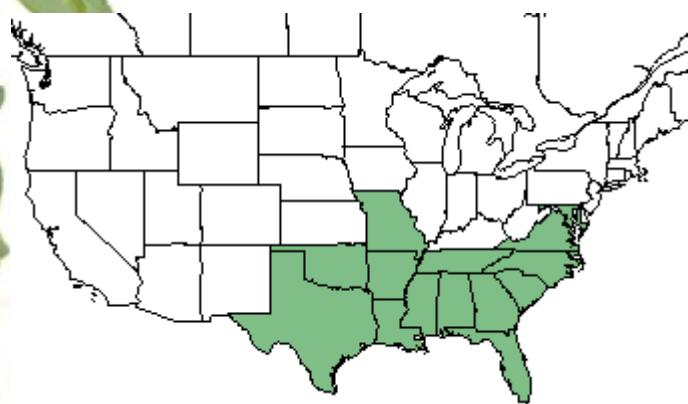
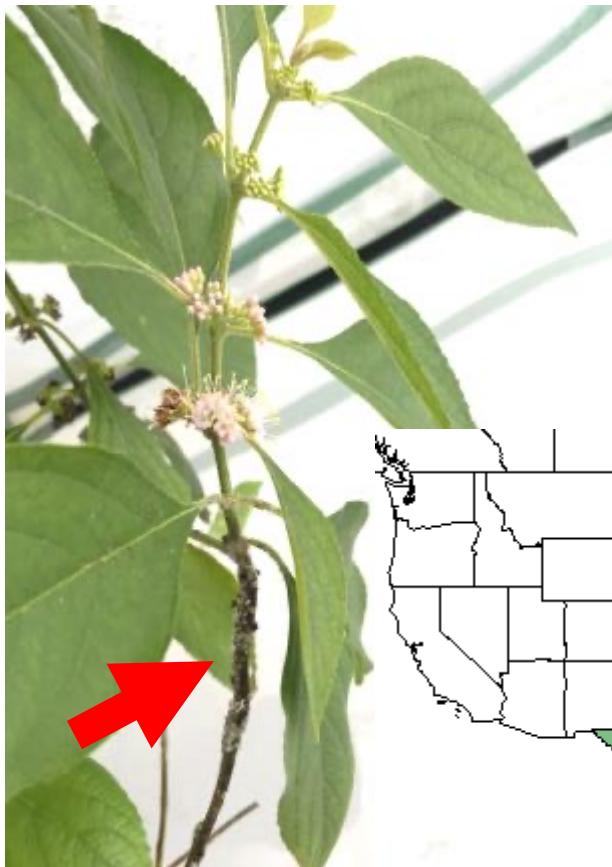
# Crapemyrtle bark scale | Beautyberry



# Five plant species confirmed to be hosts

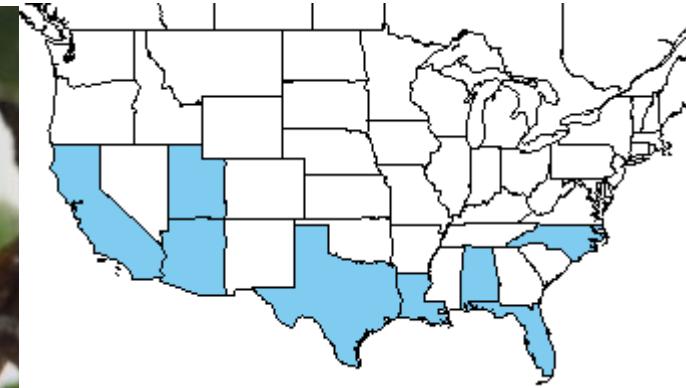
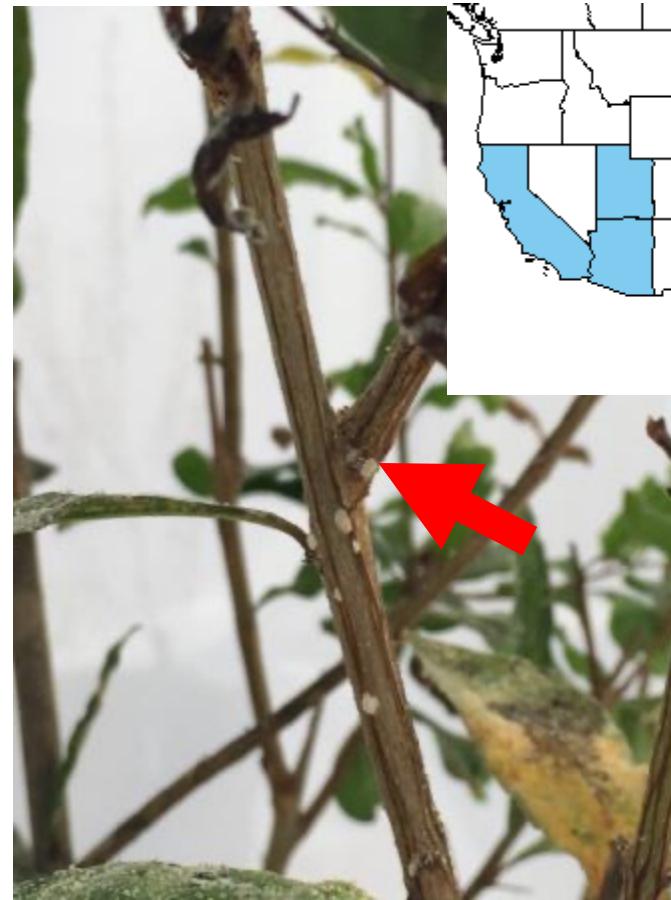
American beautyberry

*Callicarpa americana* L. (Lamiales: Lamiaceae)



Pomegranate

*Punica granatum* L. (Myrtales: Lythraceae)



Henna

*Lawsonia inermis* L.

(Myrtales: Lythraceae)



Heimia

*Heimia salicifolia* Link

(Myrtales: Lythraceae)



Winged loosestrife

*Lythrum alatum* Pursh

(Myrtales: Lythraceae)



We also have other loosestrifes!

Purple loosestrife

*Lythrum salicaria L.*

Exotic invasive



European wand  
loosestrife

*Lythrum virgatum L.*



California loosestrife

*Lythrum californicum L.*





# Crapemyrtle bark scale



# Crapemyrtle bark scale



# Crapemyrtle bark scale



# Crapemyrtle bark scale | Nymph (2nd instar)

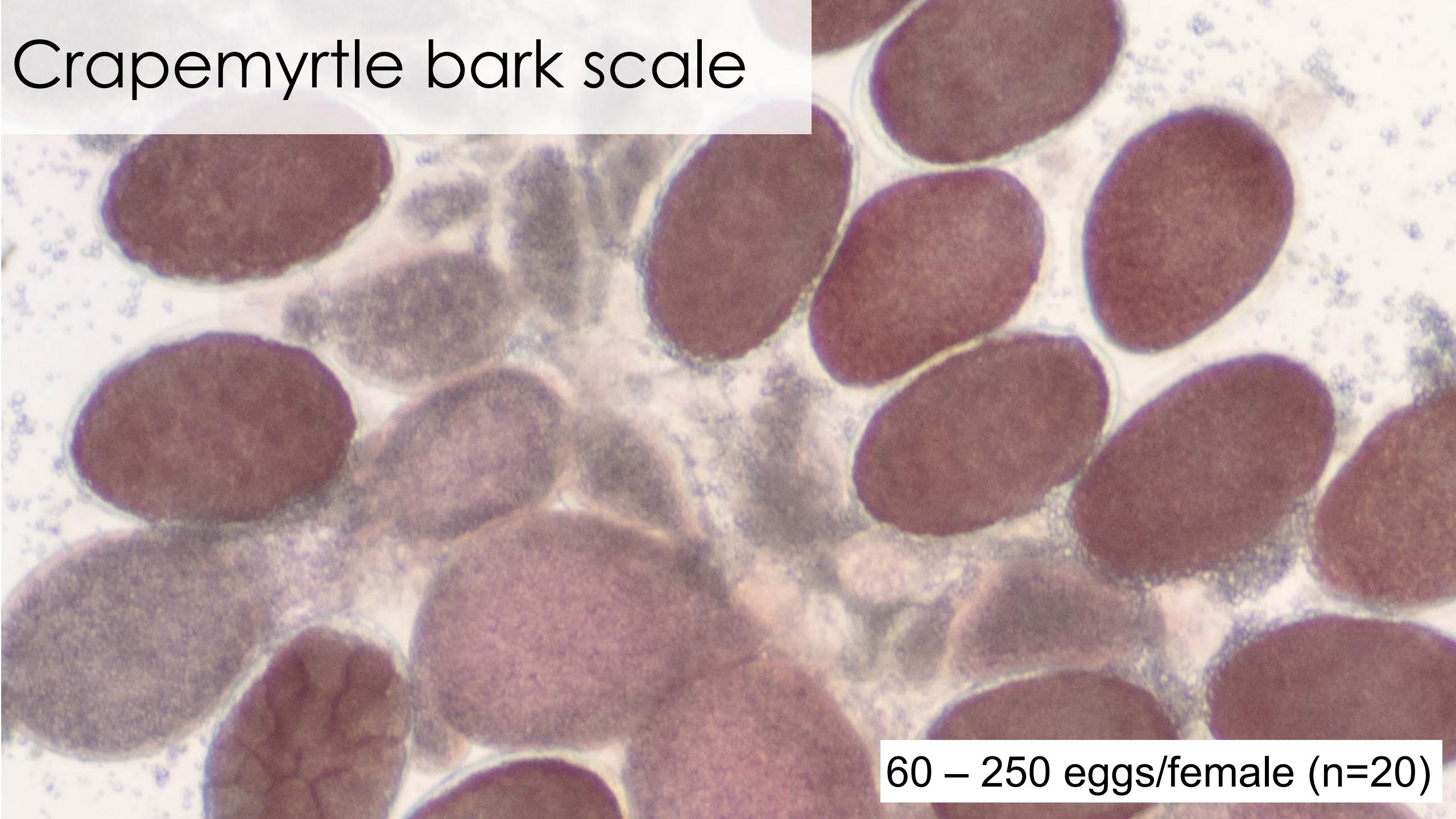


Photo courtesy of Zinan Wang et al., LSU

# Crapemyrtle bark scale



# Crapemyrtle bark scale



60 – 250 eggs/female (n=20)

# Crapemyrtle bark scale | Male adult

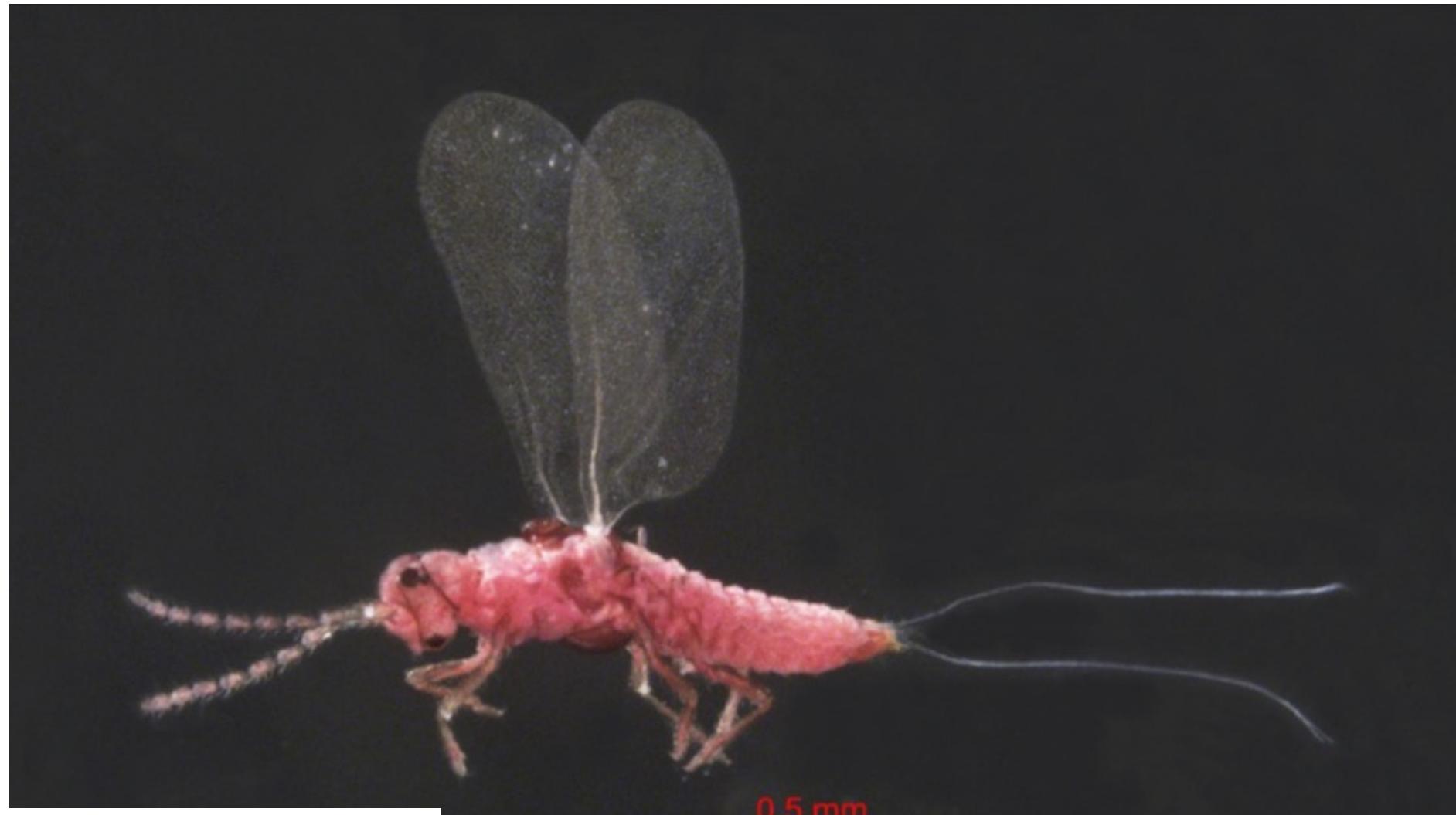


Photo courtesy of Zinan Wang et al., LSU

## Report an Invasive Species Occurrence

Red fields are required.

### Species

Pest (?) :

Acanthococcus lagerstroemiae (crapemyrtle bark scale)

Host:

Lagerstroemia indica (crapemyrtle)

Observation Date(?):

11/12/2017

### Location

State:

Select State

County:

Select County

Latitude (?:

Longitude (?:

Must be expressed in Decimal Degrees  
(00.0000),and DATUM NAD83/WGS84.

Must be expressed in Decimal Degrees  
(00.0000),and DATUM NAD83/WGS84.

Location Description/Nearest Address:

[Jump to Point](#)

[Lat/Lng Conversion Tools](#)



# STOPCMBS.COM

### Images

Image 1:

  
.jpg

Choose file

Image 2:

  
.jpg

Choose file

Caption:

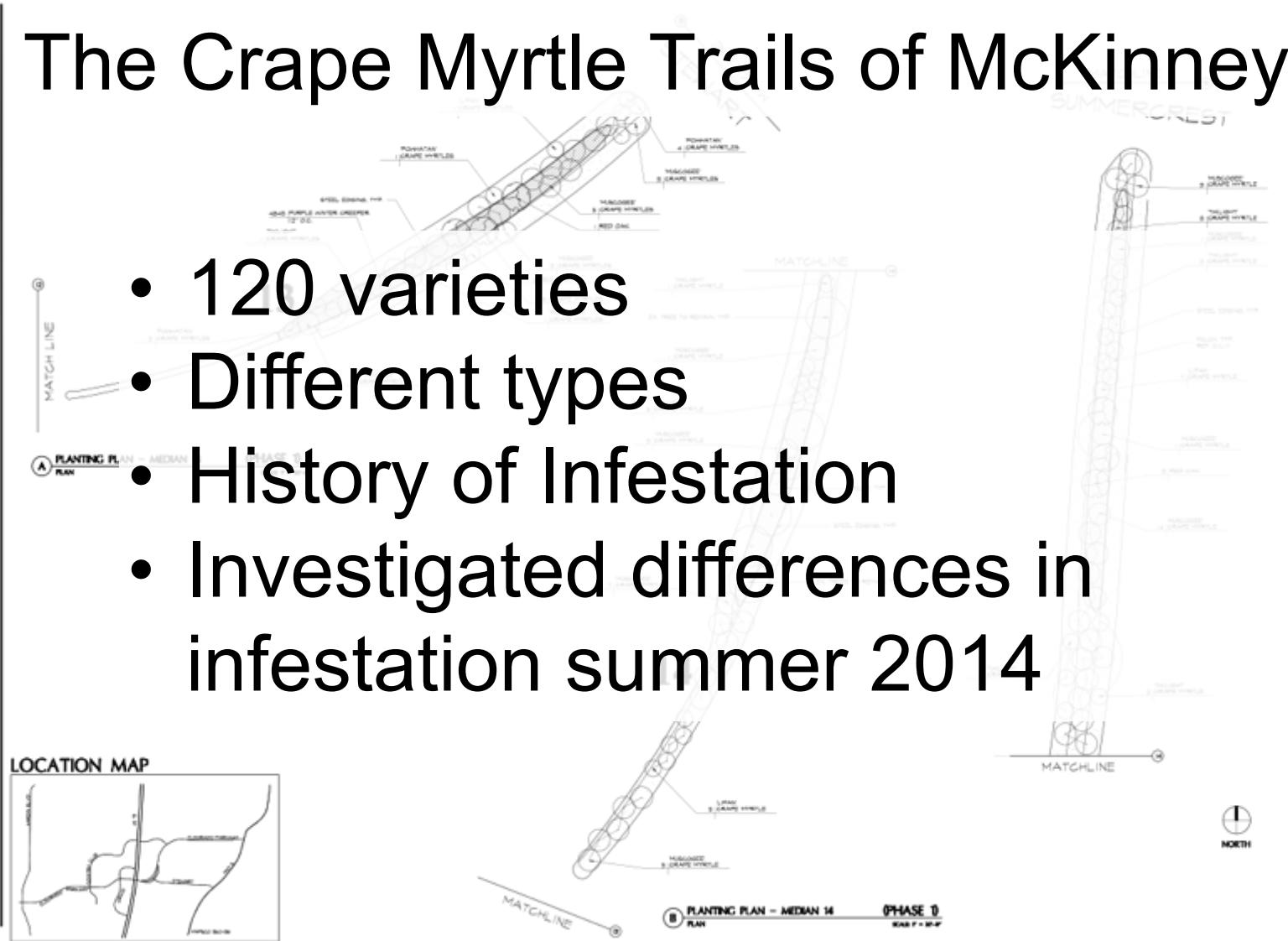
# Objectives

1. Cultivar resistance
2. Population dynamics
3. Population control
4. Role of natural enemies
5. Non-chemical control
6. Host Plant Tests
7. Insecticide Residue Analysis
8. Consumer preference surveys

# Objectives 1. Cultivar susceptibility

## The Crape Myrtle Trails of McKinney

- 120 varieties
- Different types
- History of Infestation
- Investigated differences in infestation summer 2014



Newman Jackson Builders  
Landscaping Architecture

1000 Main Street, Suite 200  
McKinney, Texas 75069  
(972) 248-2000  
(800) 248-2000  
www.njb.com

PRELIMINARY  
NOT FOR  
CONSTRUCTION

**McKinney Crapemyrtle Trails**  
City of McKinney  
P.O. Box 517  
McKinney, Texas 75069

Revised  
No Date

Date: 10-May-2008

Street:

Lot:

Project No:

Sheet Title:

El Dorado  
Median

Scale: 1" = 50'-0"  
Drawing No:

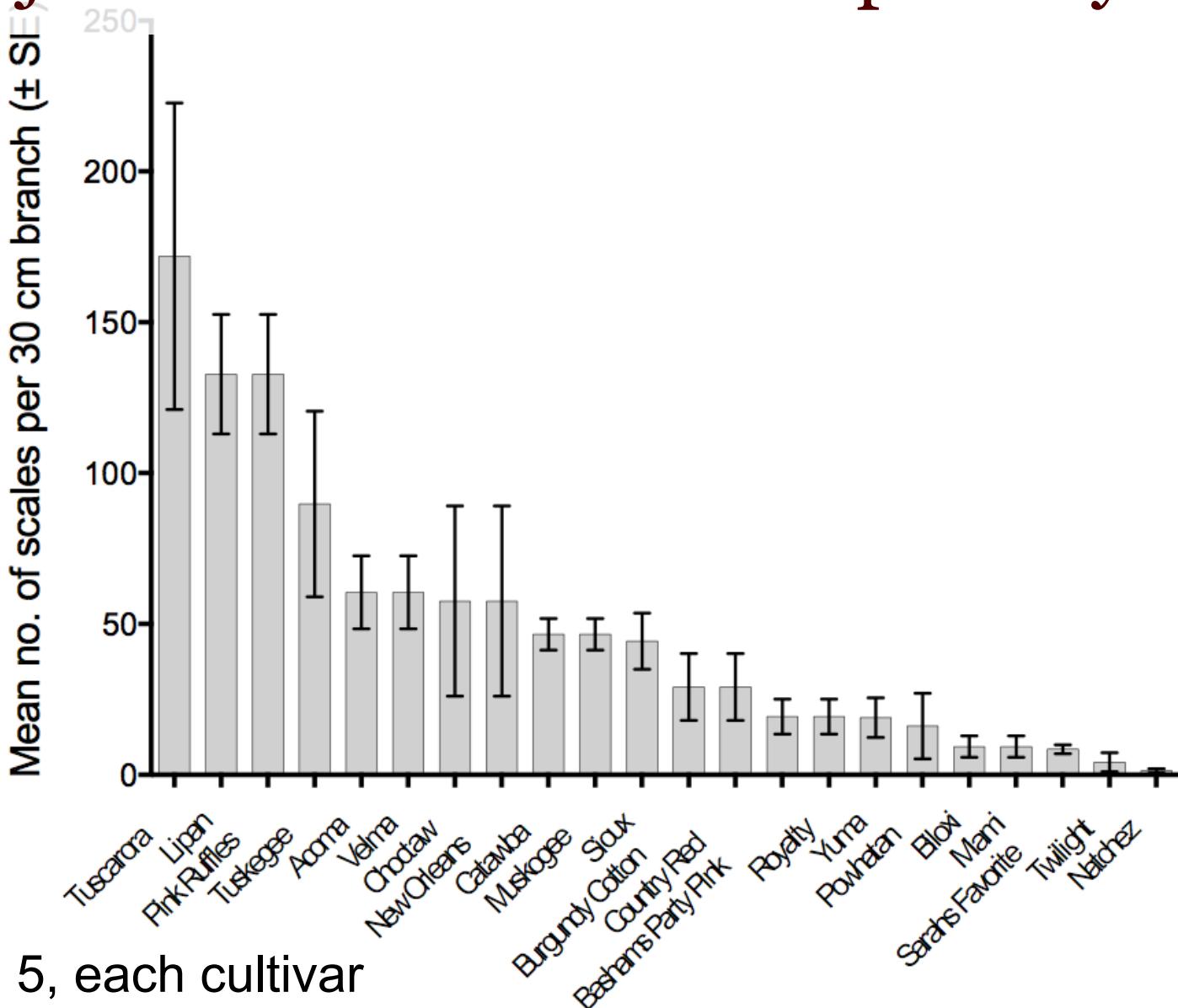
L-6

# Objectives 1. Cultivar susceptibility



n = 5, each cultivar

# Objectives 1. Cultivar susceptibility



# Objectives 1. Cultivar susceptibility

Mean no. of scales per 30 cm branch ( $\pm$  SE)

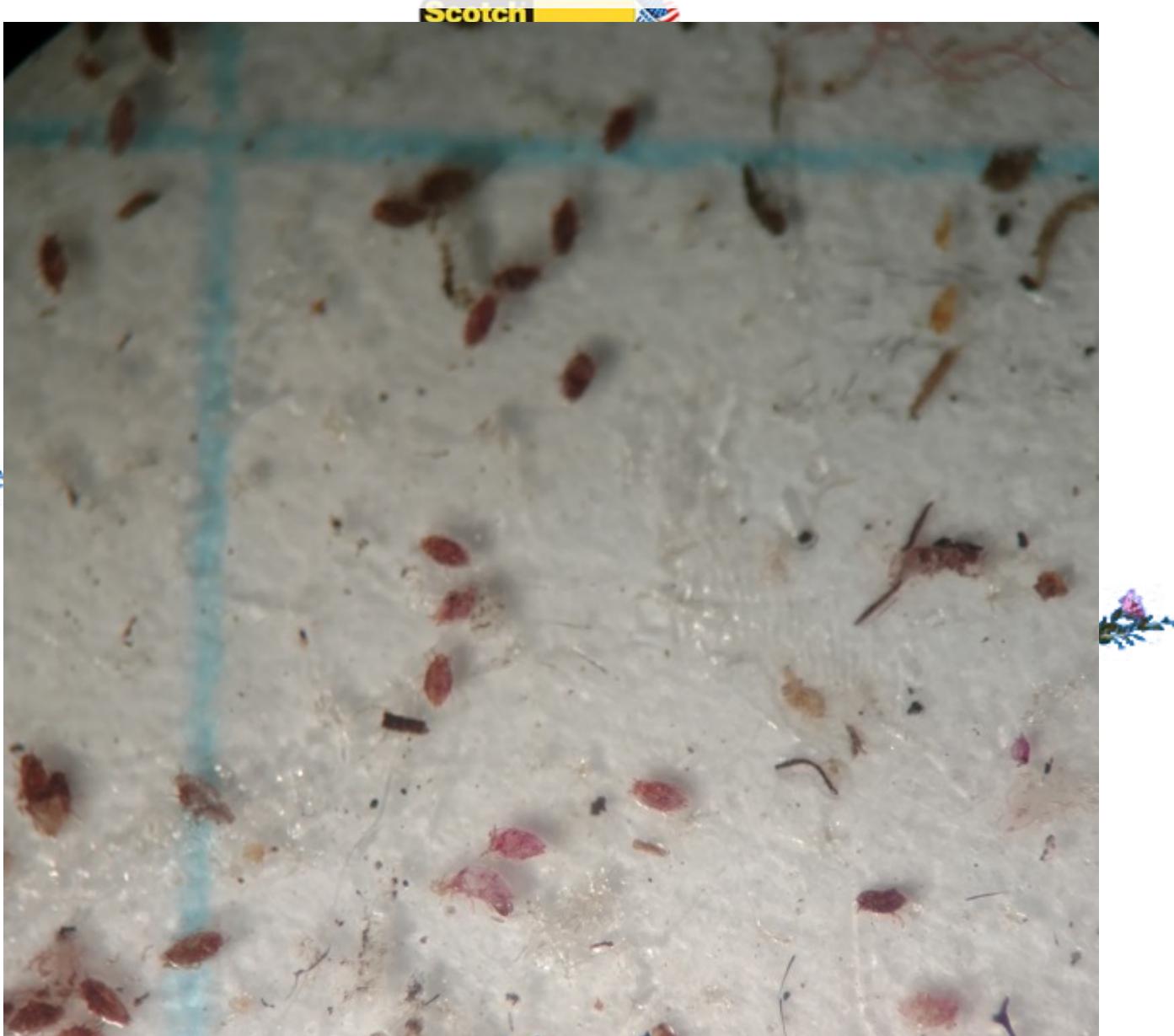
n = 5, €



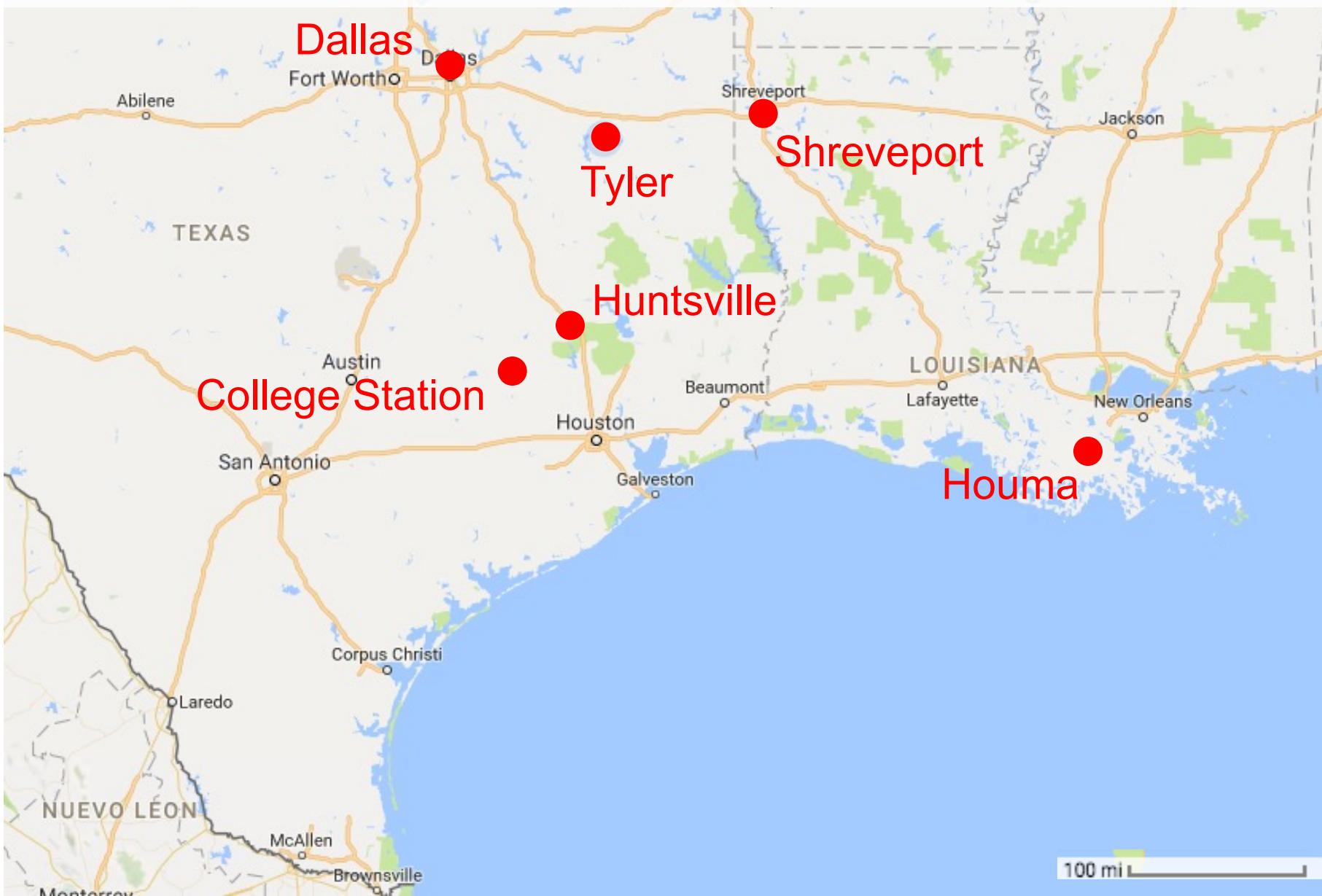
Lowe's

240  
± 10

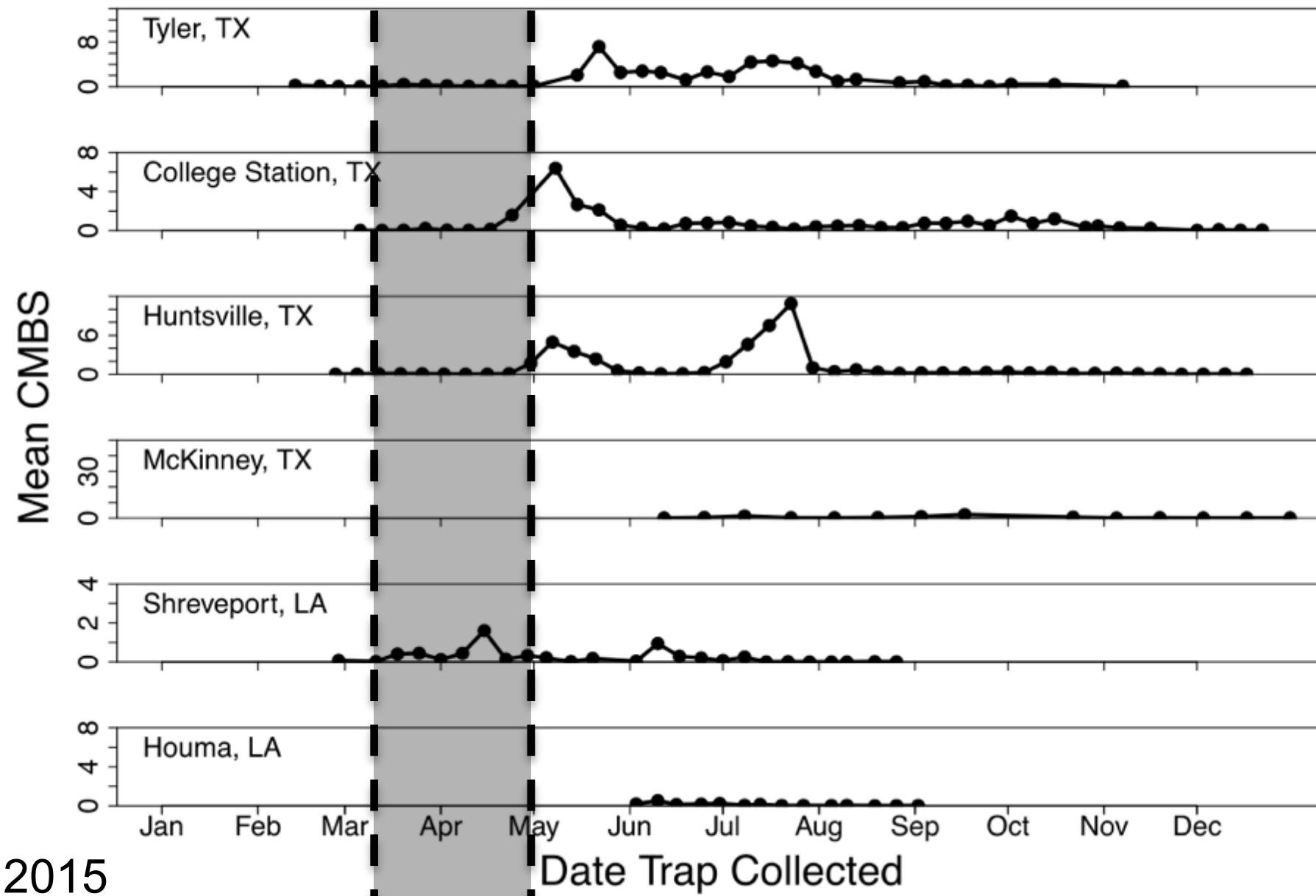
## Objectives 2. Population Dynamics



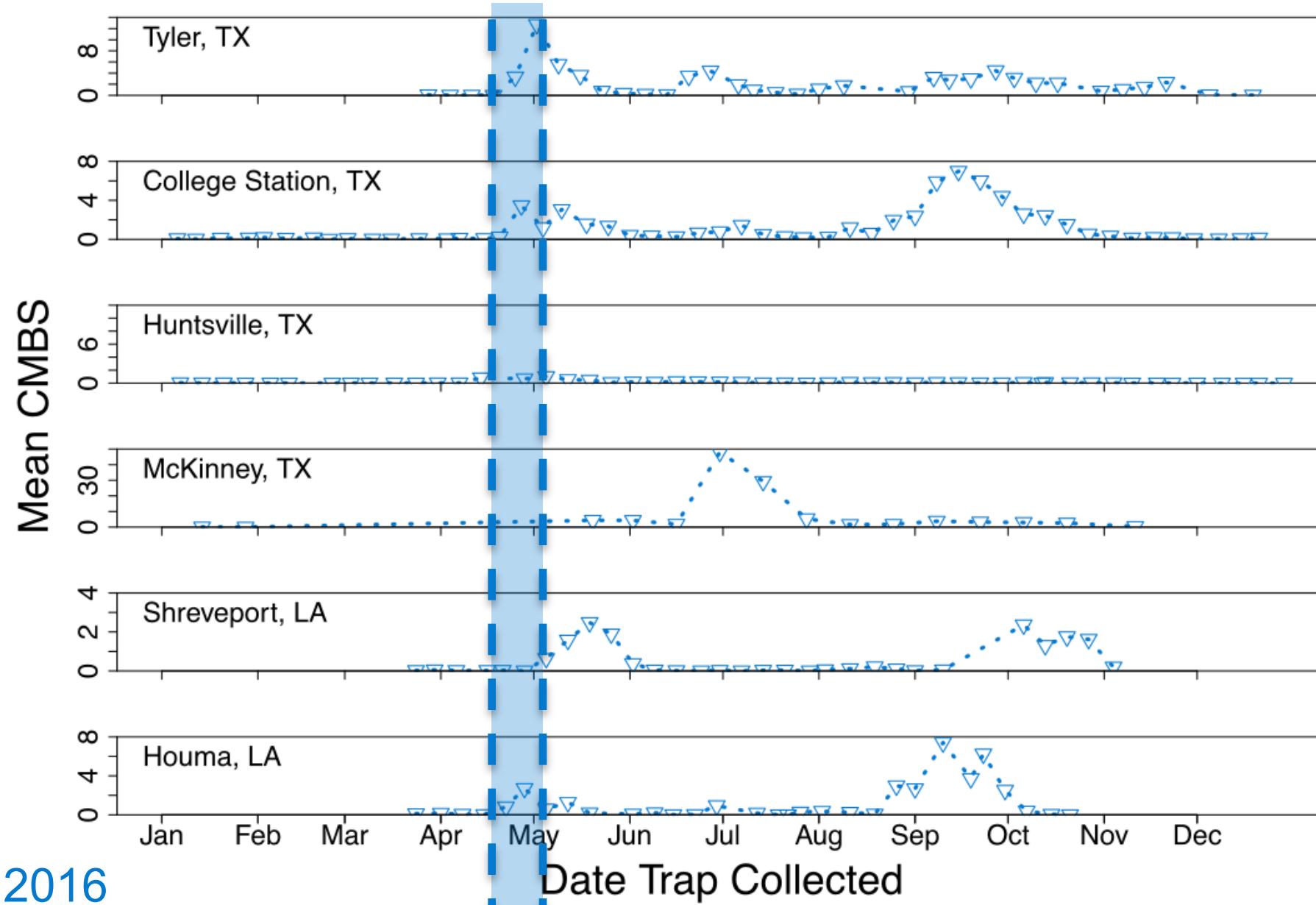
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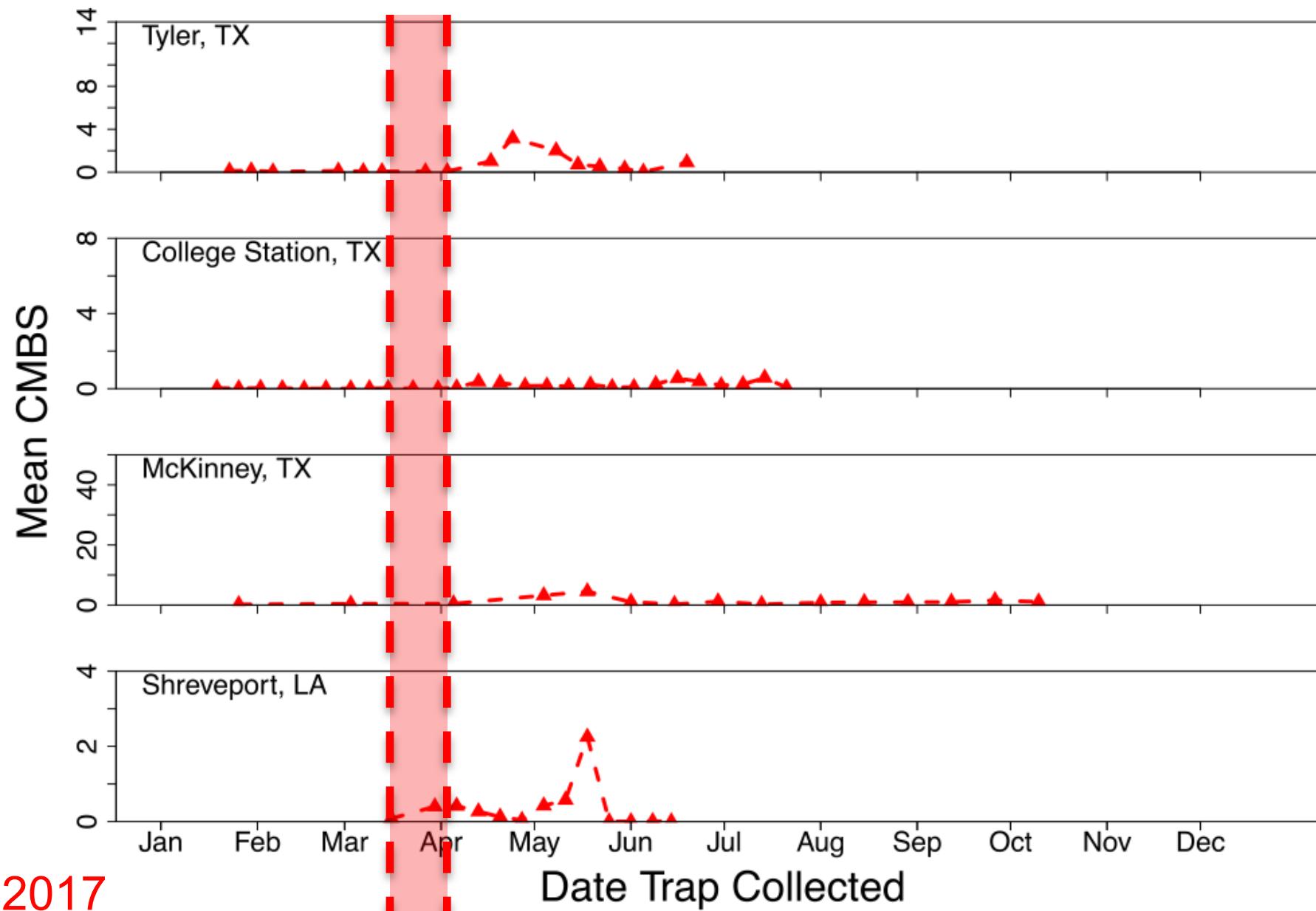
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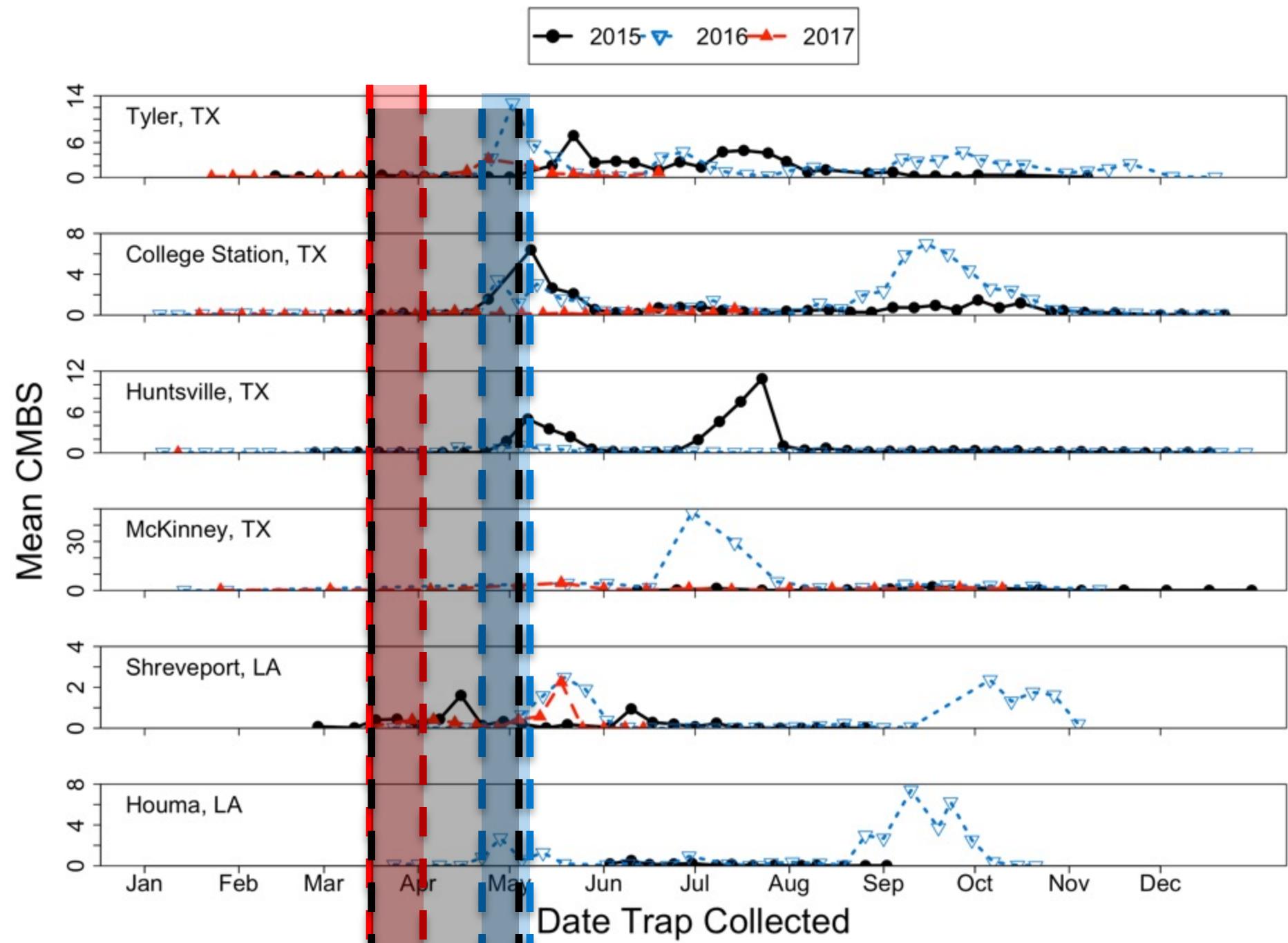


# Objectives 2. Population Dynamics

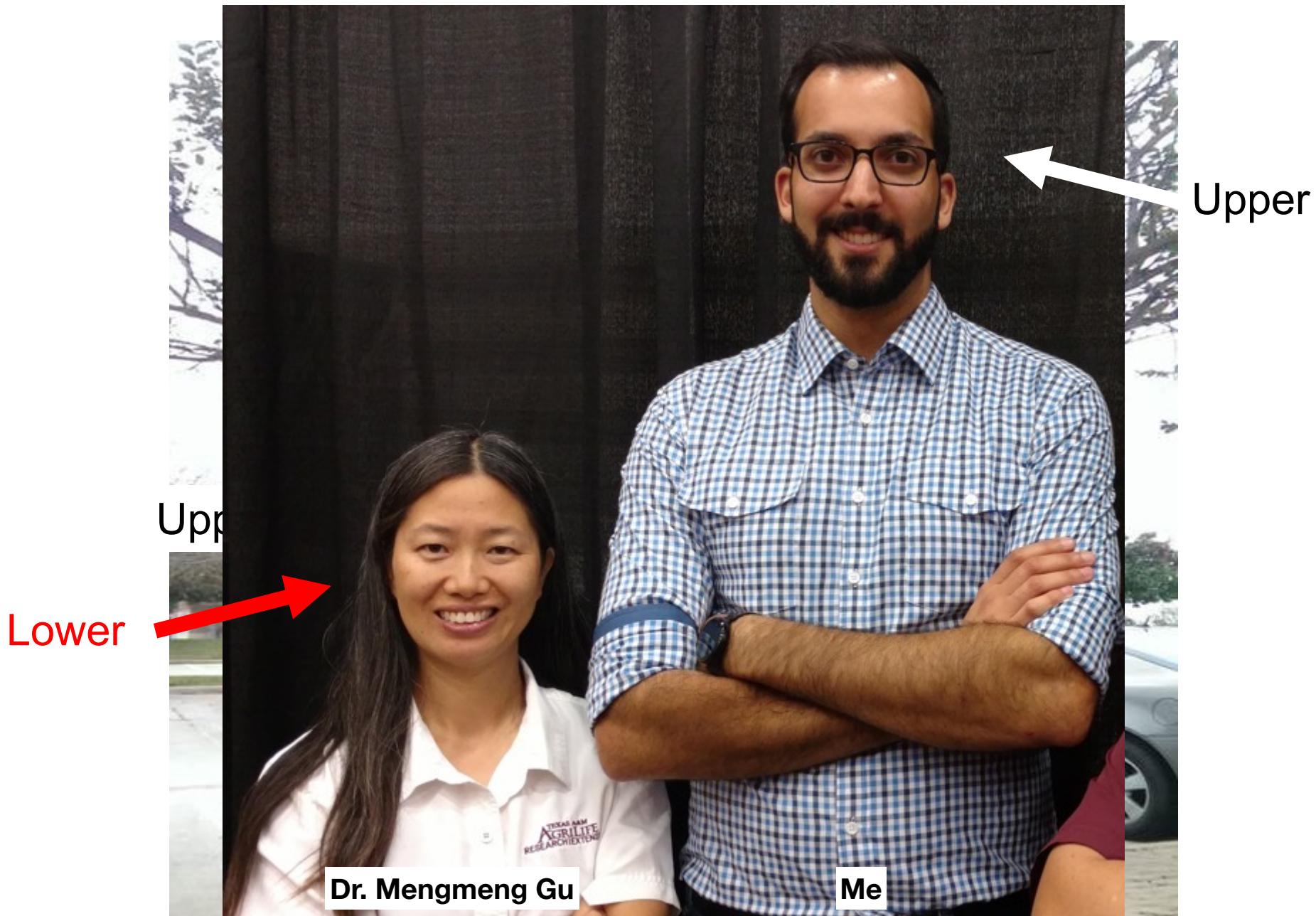


# Objectives 2. Population Dynamics

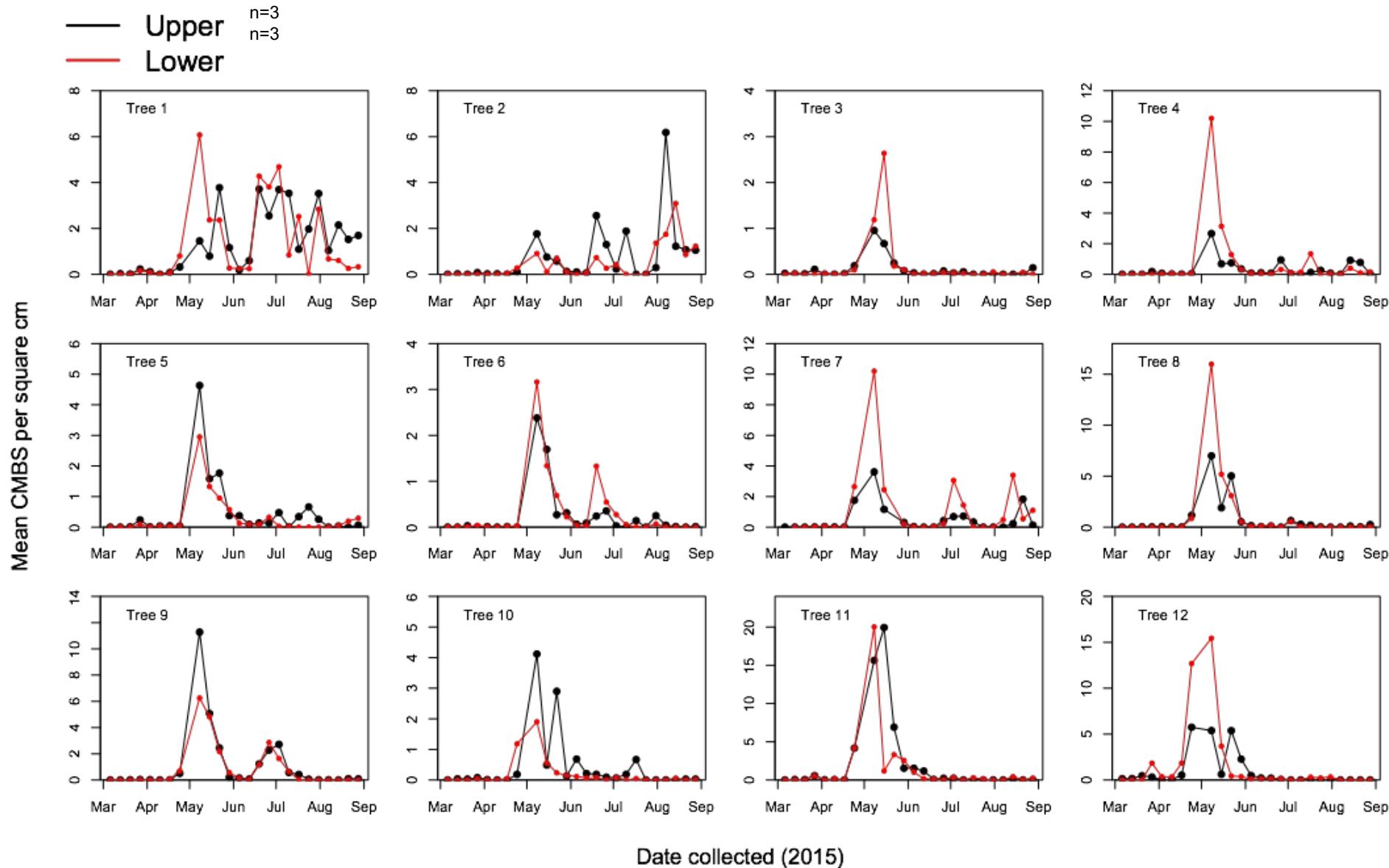




# Objectives 2. Population Dynamics



# Objectives 2. Population Phenology | 2015



# Objectives 3. Management | Landscape

2016

n = 7 per treatment, n = 6 for control/water



# Objectives 3. Management | Potted

## 2017



# Crapemyrtle bark scale | Summary

Product	a.i.	Application Method	Frequency	Efficacy
Safari	Dinotefuran	Drench	1	Great
Talstar + Safari	Bithentrin + Dinotefuran	Bark Spray + Drench	2 & 1	Great
Safari	Dinotefuran	Bark Spray	1	Good
Fulcrum	Pyriproxyfen	Bark Spray	2	Good
Talus	Buprofezin	Bark Spray	2	Good
Altus	Flupyradifurone	Bark Spray	2	Moderate
Mainspring	Cyantraniliprole	Drench	1	Moderate
Mallet	Imidacloprid	Drench	1	Moderate - Good
Grandevote & Venerate	Chromobacterium subtsugae strain PRAA4-1 & Burkholderia spp. strain A396	Bark Spray	2 & 2	Poor
Acelepyrn	Chlorantraniliprole	Bark Spray	2	Poor
AzaGuard	Azadirachtin	Bark Spray	2	Poor
Acephate	Acephate	Bark Spray	2	Poor
SuffOil-X + Molt-X	Mineral oil + Azadirachtin	Bark Spray	2	Poor
Ventigra	Afidopyropen	Bark Spray	2	Inconclusive
Pradia	Cyclaniliprole + Flonicamid	Bark Spray	2	Inconclusive
Sarisa	Cyclaniliprole	Bark Spray	2	Inconclusive

# Objectives 3. Management | Landscape

## Spray Application

2016



Applied Twice – 2 week interval

Bifenthrin  
Pyriproxyfen  
Buprofezin

# Objectives 3. Management | Landscape

Drenches





## Objectives 3. Management | Potted



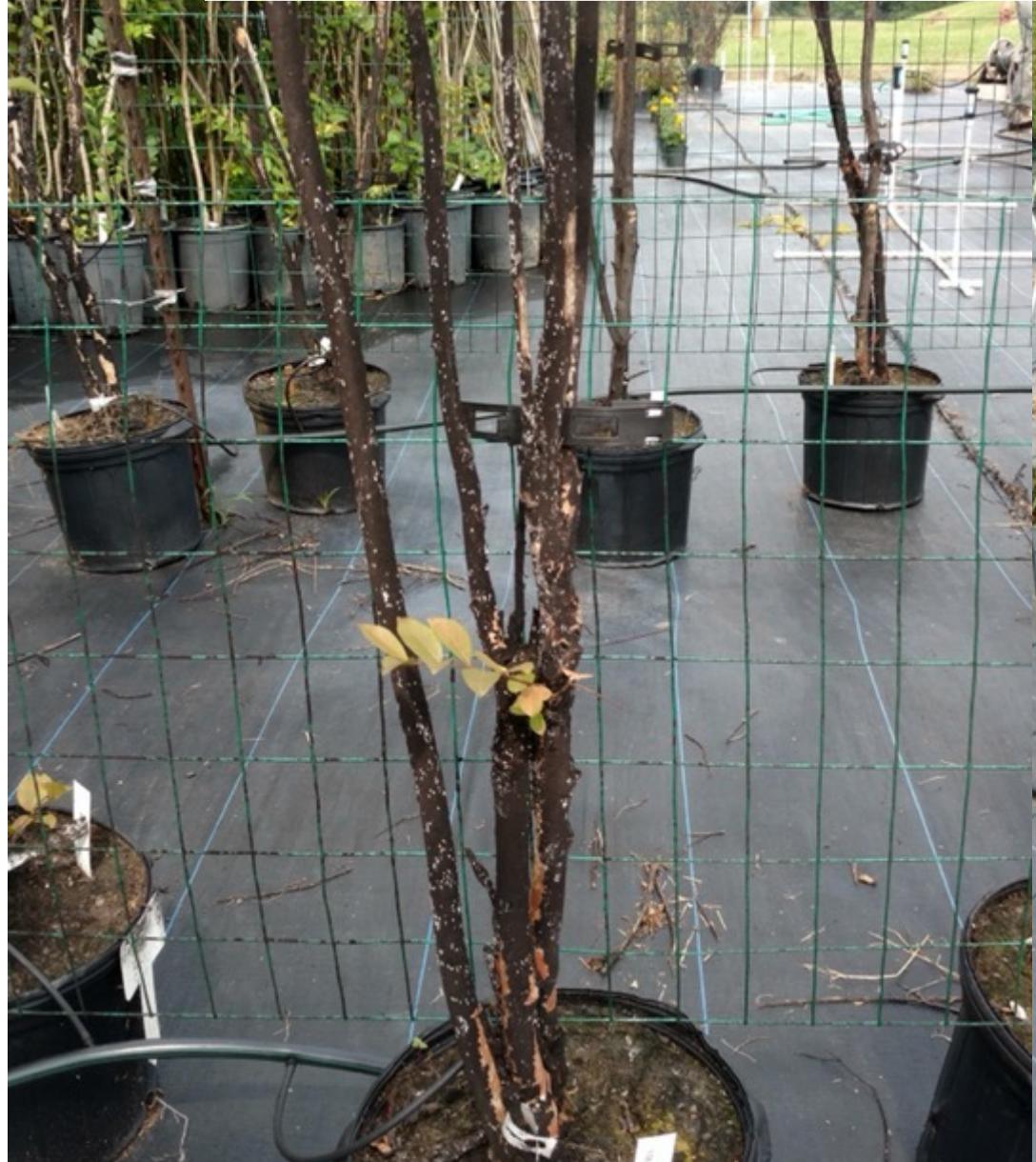
# Objetivo



# Crapemyrtle bark scale | Queens Lace

#	Tradename(s)	Treatname	active ingredients	rates	Method		Date(s)	
1	Water	UTC	-					
2	Safari	Nukem	Dinotefuran	4 fl. oz. of dilute solution (24 ounces/100 gal) in 20 fl. oz. of water	Drench	27-Mar		
2	Talus		Buprofezin	14 oz. 100 gal.	Bark Spray	15-Apr	29-Apr	
4	Xpire	Xpire_high	Sulfoxaflor & Spinetoram	3.5 oz / 100 gal	Bark/Foliar Spray	15-Apr	29-Apr	
5	Xpire	Xpire_2x	Sulfoxaflor & Spinetoram	14 oz (first app), then 7 oz. / 100 gal., 20 fl. oz. per pot	Bark/Foliar Spray	6-Apr	23-Apr	
6	Altus	altus	Flupyradifurone	3.7 fl oz / 100 gal,	Drench	16-Apr		
7	Merit	merit	Imidacloprid	1.5 fl oz / 100 gal, 0.5 L per pot	Drench	6-Apr		
8	Ventigra + CapSil	VC	Afidopyropen	7 oz / 100 gal + 6 oz / 100 gal.	Spray	15-Apr	29-Apr	
9	Velifer	VEL	B. bassiana PPRI 5339	13 oz. / 100 gal.		15-Apr	23-Apr	29-Apr 6-May
10	UltraPure Oil	ultVC	Horticultural Oil	2 gal / 100 gal		15-Apr		29-Apr
10	Ventigra + CapSil		Afidopyropen	7 oz / 100 gal + 6 oz / 100 gal.			23-Apr	6-May
11	UltraPure Oil	ultVCVEL	Horticultural Oil	2 gal / 100 gal		15-Apr		
11	Ventigra + CapSil		Afidopyropen	7 oz / 100 gal + 6 oz / 100 gal.			23-Apr	
11	Velifer		B. bassiana PPRI 5339	13 oz / 100 gal			29-Apr	6-May
12	Talus	Talus-early	Buprofezin	14 oz. / 100 gal.		7-Apr	23-Apr	

# Objectives 3. Management | Potted







## Objectives 4. Natural Enemies



# CMBS NATURAL ENEMIES

2cm = ~1mm

Coccine lIids



*H. bigeminata*



*H. lateralis*



*L. Cacti*



*A. plagiatum  
var. texanum*



*chrysopa  
rufilabris*

*ois lateralis*

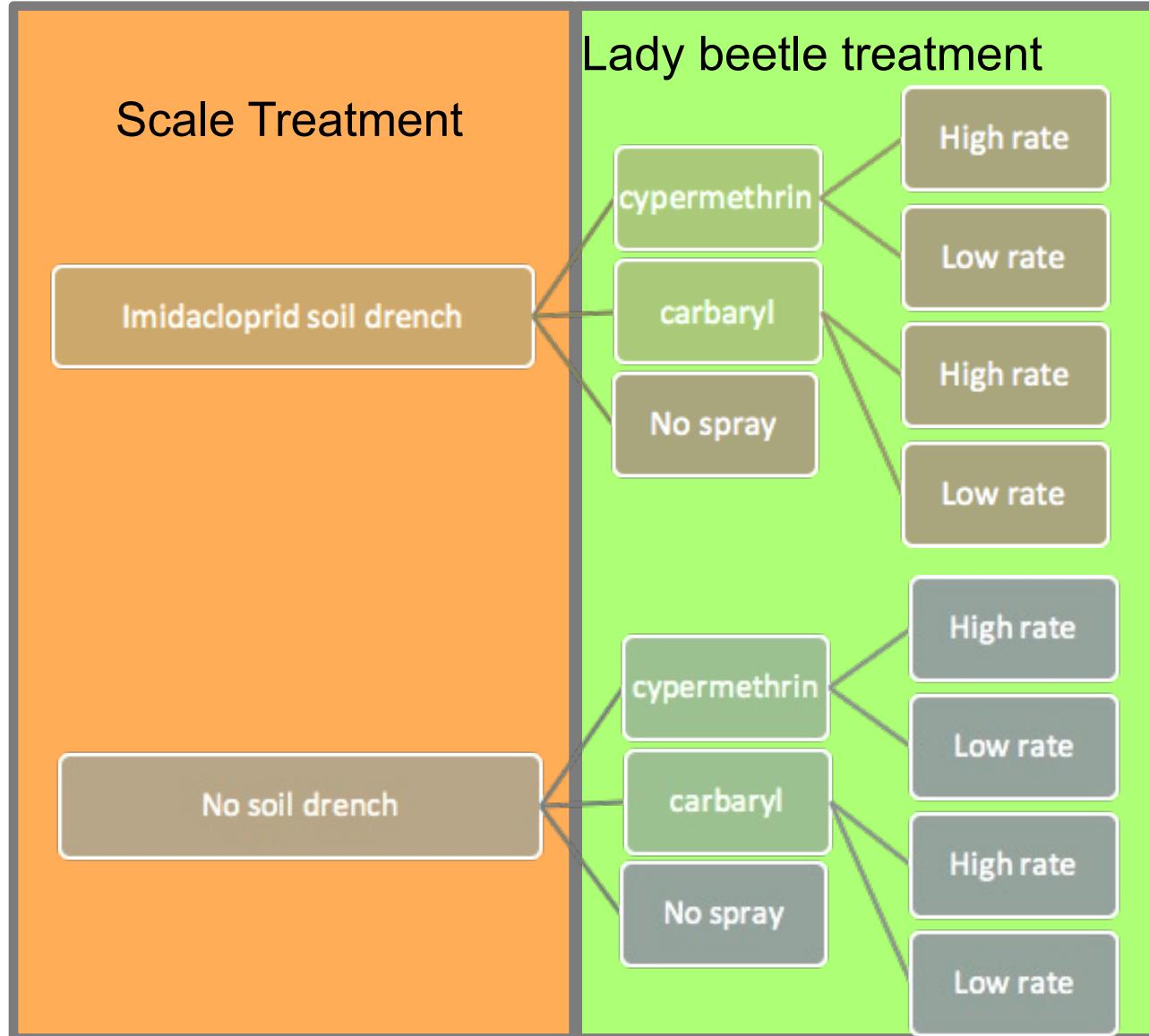
Kyle Gilder, Texas A&M

# Objectives 4. Natural Enemies

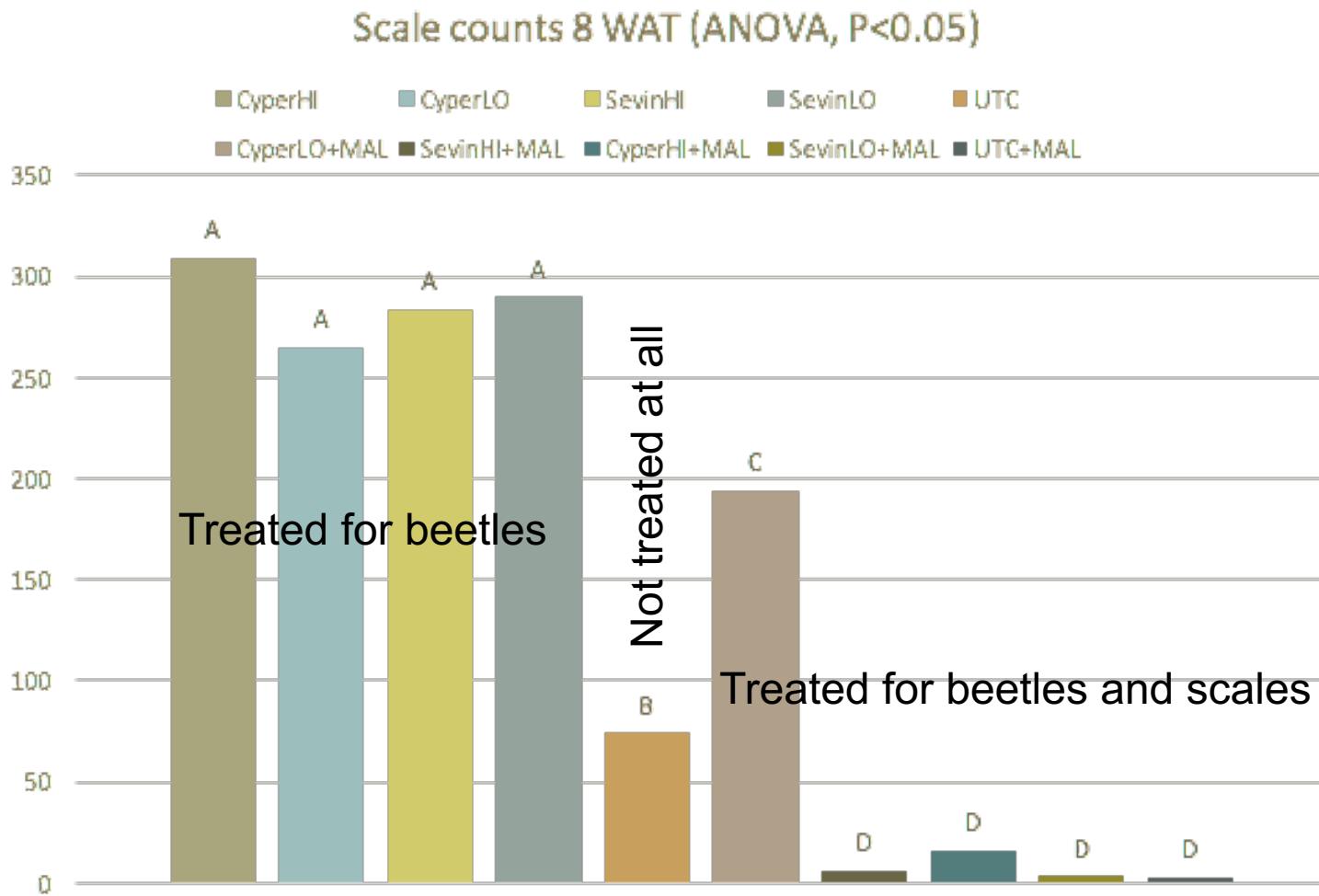


Genus and species	Family	Order
<b>Scale natural enemies</b>		
<i>Hyperaspis bigeminata</i>	Coccinellidae	Coleoptera
<i>Hyperaspis lateralis</i>	Coccinellidae	Coleoptera
<i>Microweisea</i> sp.	Coccinellidae	Coleoptera
<i>Harmonia axyridis</i>	Coccinellidae	Coleoptera
<i>Chilocorus cacti</i>	Coccinellidae	Coleoptera
<i>Axion plagiatum</i> var. <i>texanum</i>	Coccinellidae	Coleoptera
<i>Cybocephalus</i> sp.	Cybocephalidae	Coleoptera
<i>Chrysoperla rufilabris</i>	Chrysopidae	Neuroptera
<i>Sympherobius barberi</i>	Hemerobiidae	Neuroptera
<i>Leucopis</i> sp.	Chamaemyiidae	Diptera
<b><i>Hyperaspis lateralis</i> pupal parasitoid</b>		
<i>Homalotylus</i> sp.	Encyrtidae	Hymenoptera
<b><i>Leucopis</i> sp. parasitoid</b>		
<i>Pachyneuron</i> sp.	Pteromalidae	Hymenoptera

# Objectives 4. Natural Enemies



# Objectives 4. Natural Enemies



\* Percent control calculated with Henderson's method

Merchant 2016

# Crapemyrtle bark scale | Summary

## Phenology

Crawler populations appear most active around beginning of May.

## Natural Predators

Mostly lady beetles (*Symnus*, *Hyperaspis*, and *H. axyridis*)

Can provide about 75% suppression in the landscape

## Management

Bifenthrin, Imidacloprid, Dinotefuran, Buprofezin and Pyriproxyfen show most promise.



United States Department of Agriculture  
National Institute of Food and Agriculture



# Cycad aulacaspis scale

aka. Asian cycad scale

*Aulacaspis yasumatsui*

- 1996: found on cycads in Florida
- First described on cycads in Thailand in 1972 (Takagi 1977)
- Infest any part above ground and roots down to depth of 60 cm (~24 inches)



F.W. Howard, University of Florida, Bugwood.org

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OFFICE of the SECRETARY of STATE

## Texas Administrative Code

[TITLE 4](#)

AGRICULTURE

[PART 1](#)

TEXAS DEPARTMENT OF AGRICULTURE

[CHAPTER 19](#)

QUARANTINES AND NOXIOUS AND INVASIVE PLANTS

[SUBCHAPTER S](#)

ASIAN CYCAD SCALE QUARANTINE

## Rules

[§19.200](#) Quarantined Pest

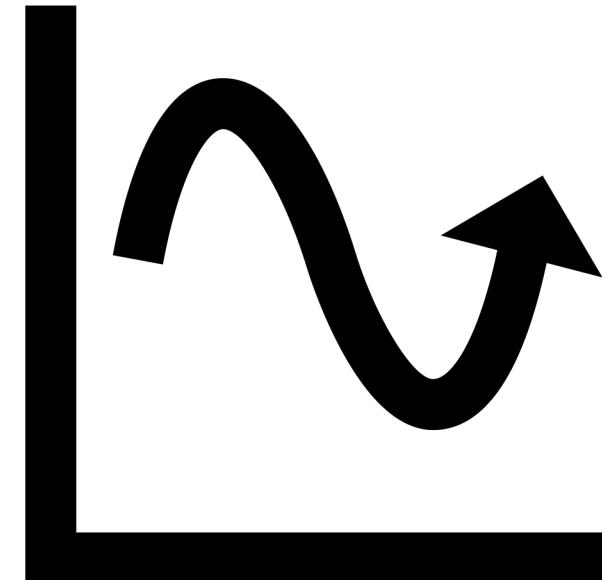
[§19.201](#) Quarantined areas

[§19.202](#) Quarantined Articles

[§19.203](#) Restrictions

# Cycad aulacaspis scale | Life cycle

- ▶ 7 – 15 days: egg development
- ▶ 4 – 18 days: 1<sup>st</sup> instar development
- ▶ 9 – 19 days: 2<sup>nd</sup> instar development
- ▶ 8 – 14 days: pre-ovipositional period  
(i.e. before females lay eggs)
- ▶ Lowest developmental temperature threshold: 8 – 12 C (46 – 54 F) (Cave et al. 2009)



# Cycad aulacaspis scale

Plant hosts & damage



Florida Division of Plant Industry, Florida Department of Agriculture and Consumer Services, Bugwood.org

# Cycad aulacaspis scale

Plant hosts & damage



Jeffrey W. Lotz, Florida Department of Agriculture  
and Consumer Services, Bugwood.org

# Cycad aulacaspis scale

Plant hosts &  
damage



Jeffrey W. Lotz, Florida Department of Agriculture and  
Consumer Services, Bugwood.org

# Cycad aulacaspis scale

## Prevention



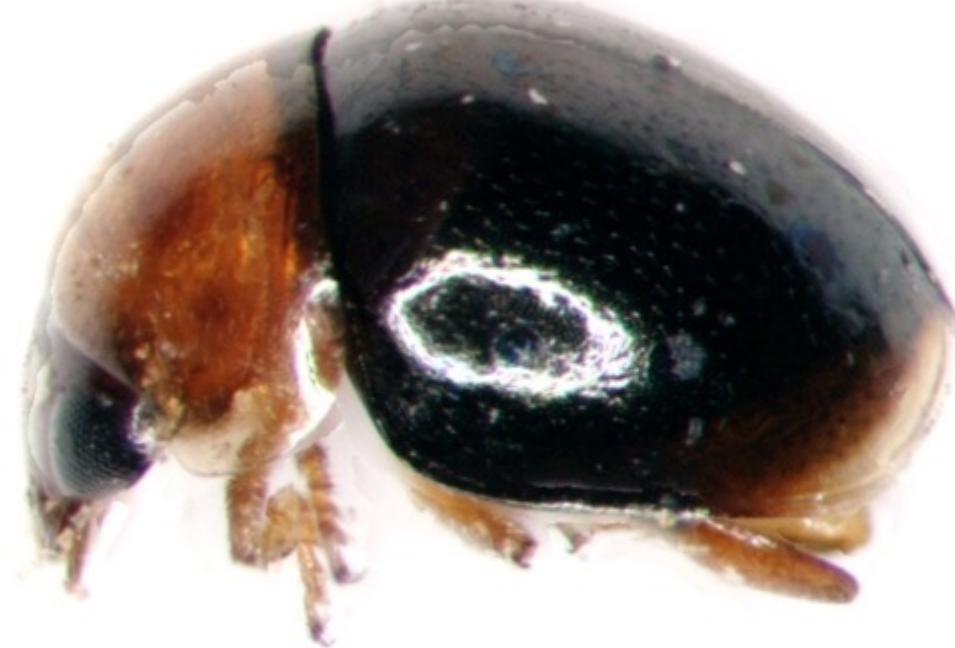
- Inspect new plant materials
- Near base of the fronds
- Prevent movement of infested materials
  - Bag and trash (do not compost)

# Cycad aulacaspis scale | Biological Control

*Coccobius fulvus*



*Cybocephalus nipponicus*



# Cycad aulacaspis scale

## Insecticidal control

Contact Insecticides: multiple applications with good coverage

- Insecticidal oils (i.e. petroleum-based horticultural oil)
- Insecticidal soaps

Systemics:

- Dinotefuran (drench)
- Frequent hosing with water to remove old/dead scale

# Cycad aulacaspis scale

## Insecticidal control

Table 1.

Treatment/ formulation	Gal product/ 100 gal	% mortality in foliar treatments (7 DAT)			
		Adult females		2nd instars	
		Upper surface	Under surface	Upper surface	Under surface
Organocide	1.56	46b	8b	79ab	21cd
Ortho Hort. Oil	2	84a	19ab	100a	47b
Safer Insecticidal Soap	2	12c	1b	---	5d
Cygon 2E	0.52	71ab	35a	88a	85a
Check	---	1c	5b	54b	23c

Means within columns, followed by the same letter, are not significantly different ( $P = 0.05$ , DNMRT).

# Common Landscape Scale Insects of Texas

- Crapemyrtle bark scale
- Cycad aulacaspis scale
- Tea scale
- False oleander scale
- Euonymous scale
- Obscure scale
- Oystershell scale
- Wax scales
- Cottony cushion scale
- Brown soft scale
- San jose scale

[Detailed view](#) | [Field-Guide view](#)

# Tea scale

## General Description

- Armored scale
- Indigenous to Asia; introduced ~1908
- ~1.5 mm in length; female egg sac dark, males light

## Host Plants

- Chinese and yaupon **holly**, **camellias**, dogwood, ferns, figs, Satsuma orange, and tea plant

## Significance

- Aesthetic damage
- Unacceptable in tea or ornamental production

## Management

- Sticker spreader + good timing + good coverage (underside of leaves) + oils or soaps
- Dinotefuran\* drench
- Pyriproxyfen, bifenthrin, or spinetoram + sulfoxaflor spray

*Fiorinia theae*



Clemson University - USDA Cooperative Extension Slide Series,  
Bugwood.org

\*Neonicotinoid; pollinator impact hazard

# False oleander scale

*Pseudaulacaspis cockerelli*

## General Description

- Armored scale
- Pear-shaped and 2 – 3 mm long (female egg sacs)
- Resemble the cycad aulacaspis scale in appearance

## Host Plants

- Over 100 plant species hosts; magnolia, sweetbay, bird-of-paradise, flowering dogwood, oleander, banana shrub, and palmetto.

## Significance

- Aesthetic; problematic in ornamental production

## Management

- Horticultural oil + Spreader/sticker + good coverage + good timing
- Thiamethoxam spray\*



Jeffrey W. Lotz, Florida Department of Agriculture and Consumer Services, Bugwood.org

\*Neonicotinoid; pollinator impact hazard

Resource(s): [IFAS-FC](#) | [AMT](#)

# Euonymus scale

## General Description

- Armored scale
- Females ~1.6 mm in length
- Female egg sacs brown (oyster-shaped); male pupae are white

## Host Plants

- Euonymus, celastrus, camellia, eugenia, hollies, pachysandra and twinberry

## Significance

- Whole branch or even whole plant can die of heavy infestation

## Management

- *Chilocorus kuwanae* (lady beetle; black with red dots) released to suppress populations
- Dinotefuran\* drench
- Bifenthrin + Clothianidin\*, Pyriproxyfen, or neem oil

*Unaspis euonymi*



\*Neonicotinoid; pollinator impact hazard

Resource(s): [AgriLife](#) | [Cornell](#) | [AMT](#)

John .A. Davidson, Univ. Md, College Pk,  
[Buckwood.org](#)

# Obscure scale

## General Description

- Armored scale
- Female egg sacs about 3 mm long
- Blend in extremely well with the bark (hence the name “obscure”)

## Host Plants

- Dogwood, beech, hackberry, hickory, maple, and oak

## Significance

- Can cause premature leaf drop and branch dieback
- Seldom kills, but can increase susceptibility to other pests

## Management

- Lady beetles and parasitic wasps
- Horticultural oil (growing season) or dormant oil during the winter

*Melanapsis obscura*



James Solomon, USDA Forest Service, Bugwood.org

# Oystershell scale

## General Description

- Armored scale
- Males and females about 2.5 mm long and resemble oystershell

## Host Plants

- More than 100 plant species; e.g. lilac, ash, poplar, dogwood, maple, and willow.

## Significance

- Heavy infestations can kill twigs and branches
- Very heavy infestations can result in cytospora canker

## Management

- Research and resources scarce
- Similar to other armored scale

*Lepidosaphes ulmi*



Whitney Cranshaw, Colorado State University, Bugwood.org

# Wax scales

## General Description

- Soft scale, produce honeydew and result in sooty mold
- Up to 6.4 mm in diameter (barnacle scale)
- Coated with heavy layer of wet beige, pinkish, whitish, or grey wax

## Host Plants

- Ficus, gardenia, hawthorne, holly, crapemyrtle, ornamental pear, pyracantha and other landscape trees and shrubs.

## Significance

- Leaf discoloration and branch dieback. Tree mortality possible with high densities.
- Mainly problematic in ornamental production

## Management

- Naturally occurring parasitic wasps
- Thiamethoxam\*, Acetamiprid\*, Dinotefuran\*, buprofezin, bifenthrin

*Ceroplastes* sp.



Joseph LaForest, University of Georgia, Bugwood.org

\*Neonicotinoid; pollinator impact hazard

# Cottony cushion scale

## General Description

- Introduced through California in 1860s
- Copious amounts of honeydew & sooty mold
- ~1,000 round eggs per egg sac

## Host Plants

- Citrus, apple, Boston ivy, boxwood, cypress, hackberry, locust, maple, oaks, peaches and plums (*Prunus*), pecan, pears, pine, pittosporum, pomegranate, quince, rose, verbena, walnut, willow and other woody ornamentals.

## Significance

- Decreased tree vitality, fruit drop, and defoliation
- Most problematic in fruit and ornamental production

## Management

- Vedalia beetle; Classical biological control poster-child
- Acetamiprid\*, Orthene TTO

*Icerya purchasi*



Will Hudson, University of Georgia, Bugwood.org

\*Neonicotinoid; pollinator impact hazard

# Brown soft scale

## General Description

- Soft scale, produces honeydew = sooty mold
- Adults slightly convex reddish-brown, with brown or black spots/patterns

## Host Plants

- Recorded feeding on 346 plant genera from 121 plant families; e.g. citrus, ferns, ficus

## Significance

- Problematic in young plantings; high reproductive potential

## Management

- Naturally occurring parasitic wasps (*Metaphycus* spp); avoid use of broad-spectrum insecticides
- Similar to crapemyrtle bark scale

*Coccus hesperidum*



John .A. Davidson, Univ. Md, College Pk, Bugwood.org

# San Jose Scale

*Quadraspidiotus perniciosus*

## General Description

- Armored scale
- Females under grey circular wax covering; males under smaller white oval covering with raised dot near one end.

## Host Plants

- Apple, pear, peach, plums, Osage orange, other fruit trees, shrubs and shade trees.

## Significance

- Considered major pest of citrus and stone fruits in Texas

## Management

- Mostly focused on management in fruit orchards



United States National Collection of Scale Insects Photographs , USDA  
Agricultural Research Service, Bugwood.org

# Crape myrtle Bark Scale (and other scale) in the Landscape:

An integrated pest  
management approach

ERFAN VAFAIE, PHD