Discovery and spread of *Eriococcus lagerstroemiae* Kuwana (Hemiptera: Eriococcidae), a new invasive pest of crape myrtle, *Lagerstroemia* spp.

Michael E. Merchant, Texas A&M University; Mengmeng Gu,Texas A&M University; Jim Robbins, University of Arkansas;
Erfan Vafaie, Texas A&M University; Norman Barr, USDA - APHIS; Amber D. Tripodi, USDA; Allen L. Szalanski, University of Arkansas;
John Hopkins, University of Arkansas; Gregory Evans, USDA - ARS

Introduction

During the summer of 2004, one of us (MEM) received a report of an unusual scale pest attacking crape myrtle trees in a commercial landscape in Richardson, TX (Dallas Co.) (Figure 1). Specimens were collected and tentatively identified using morphological keys as azalea bark scale, *Eriococcus azaleae* Comstock. The exact identity of the scale, however, remained uncertain given that *E. azaleae* had never previously been recorded as occurring on crape myrtle or related plants. In this poster we report morphological and genetic evidence that the scale discovered in 2004 is a previously unreported, invasive scale species from Asia, *Eriococcus lagerstroemiae* Kuwana, which we refer to as crape myrtle bark scale (CMBS). We also present findings concerning the identity of this scale, its geographic spread since its initial discovery in north Texas, and some preliminary notes about its phenology, varietal preferences, and control.

Figure 1. Initial site of discovery of CMBS in Richardson, TX. Abundant honeydew and sooty mold is common in infestations, as seen here by heavy coatings of black mold on middle and upper branches.

Genetic Evidence of a new scale

One hypothesis to explain the sudden appearance of our *Eriococcus* species on crape myrtle was that the scale had undergone a host-shift from its common hosts of *Rhododendron* spp. (Ericaceae) to *Lagerstroemia* spp. (Lythraceae). Another hypothesis was that the scale was a new species to the U.S., with the most likely candidate being *E. lagerstroemiae*, known from China, Korea, and Japan. Because existing scale taxonomic keys did not include *E. lagerstroemiae*, we employed molecular methods to test the host-shift hypothesis. To do this, we at the University of Arkansas (ADT, ALS) and the USDA/APHIS (NB) worked independently to confirm the scale identity. Procedures included the following:

- DNA sequences of portions of a mitochondrial (COI) and a nuclear (28S) marker were obtained for *Eriococcus* samples from the U.S., China, and South Korea.
- A Bayesian tree was constructed using 476 bp consensus region of COI for all samples using a GTR+I model (selected by AICc criteria in JModelTest1) within Mr. Bayes2.

Results. Both COI and 28S analysis showed a clear separation between *E. lagerstroemiae* and *E. azaleae*, rejecting the hypothesis that azalea bark scale had jumped to a new host.

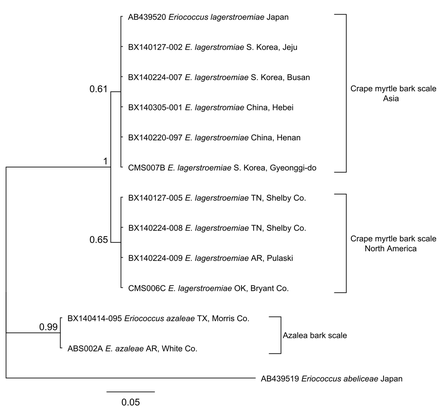

Figure 2. Bayesian tree of a 476 bp region of COI illustrating the distinctiveness of E. lagerstroemiae and E. azaleae. Numbers at nodes are posterior probabilities. Branch lengths are scaled by the number of nucleotide substitutions per site (scale bar). Data from Norman Barr, USDA-APHIS, Amber Tripodi, Allen Szalanski, University of Arkansas.

- The similarity between *E. lagerstroemiae* samples collected in Asia and in the U.S. provides supporting evidence that the new pest of crape myrtles is this exotic species.
- The distinctiveness of the U.S. samples compared to those in S. Korea and China suggests that the Asian source population has not yet been identified.

Morphological Evidence of new scale

Specimens collected on crape myrtle from Texas were initially sent to the USDA/ARS Systematics Identification Lab in 2004 for identification. Upon initial examination by Douglass Miller (USDA/ARS ret.), they were determined to be an eriococcid scale (Hemiptera: Coccoidea: Eriococcidae). Using taxonomic keys by Miller & Miller (1992; 1993), he determined that the specimens were most similar to *E. azaleae*, a widespread pest of azaleas (*Rhododendron* spp.) in the United States and Europe.

Type specimens from Pergande's 1881 collection of *E. azaleae* deposited in the USNM and other specimens of this species collected in various states on azalea and other hosts were subsequently examined by one of us (GE) and compared with specimens of *E. lagerstroemiae* collected on crape myrtle in Japan (the country and host from which the species was described), China and Korea, and also with the specimens collected on crape myrtle from Texas, Arkansas, Tennessee, and Virginia.

Both species were found to have 5 setae on the tibia of the forelegs, 4 setae on the tibia of the hind legs, and large setae with acute and/or truncate apices forming transverse bands across the body segments. However, the following *differences* were also found (Figures 3 & 4):

- **Number and length of dorsal setae**: *E. azaleae* has many more and longer dorsal setae than *E. lagerstroemiae*, which overlap each other . Although there is some intraspecific variation in the number and length of these setae, *E. lagerstroemiae* has much shorter and fewer dorsal setae that do not overlap. *Eriococcus azaleae* has a cluster of dorsal setae just above the mouthparts in all of the specimens that I observed, which is not present in *E. lagerstroemiae*.

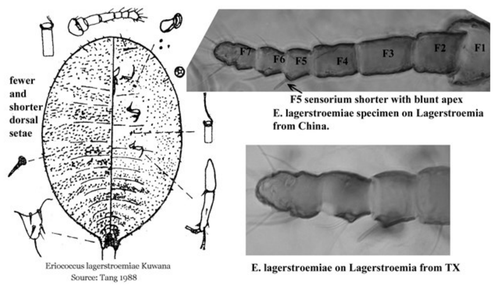

Figure 3. Illustration of Eriococcus lagerstroemiae from Tang, 1988 (l). Note shorter sensorium with blunt apex on Lagerstroemia specimens from China and Texas (upper and lower right). Images USDA/ARS, Greg Evans .

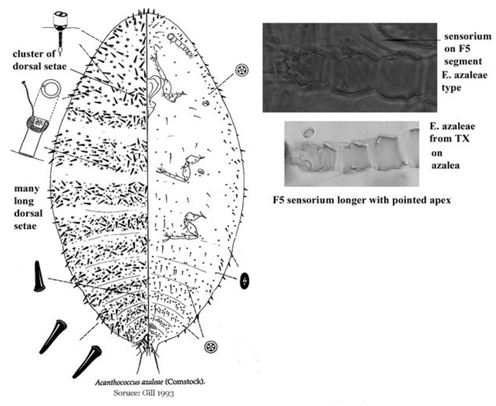

Figure 4. Illustration of Eriococcus (=Acanthococcus) azaleae from Gill 1993. Note the more numerous and longer setae, and the longer sensorium on F5, compared to E. lagerstroemiae. Images USDA/ARS, Greg Evans .

- **Antennal sensillum on the 5th antennal segment (F5)**: In *E. azaleae*, this sensillum is long and slender with pointed apex which extends beyond the base of the F6 sensillum; whereas in *E. lagerstroemiae*, it is shorter, thicker with rounded apex which does not extend beyond the base of the F6 sensillum.
- **Relative length of hind tarsus (III)**: The hind tarsi of *E. azaleae* are relatively longer than those of *E. lagerstroemiae*. *E. azaleae* has a tarsus III/tibia III ratio ranging from 1.3-1.5 with that of most specimens 1.4 and a tarsus/femur III ratio of 1.1-1.2 (tarsus longer than femur in most specimens). *E. lagerstroemiae* has shorter tarsi with a tarsus III/tibia III ratio ranging from 1.0-1.4, with that of most specimens between 1.1-1.3 and a tarsus III/femur III ratio of < 1 in most specimens (tarsus shorter than femur in most specimens).

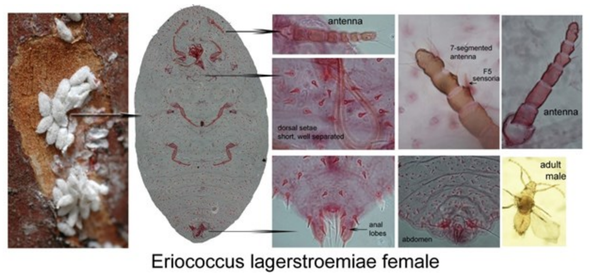

Figure 5. Key characters of *Eriococcus lagerstroemiae*, female and adult male (lower right). Images USDA/ARS, Greg Evans .

Phenology of CMBS

Seasonal occurrence of CMBS crawlers was determined from a naturally infested 'Natchez' crape myrtle (approximately 19.1 feet in height) located in Little Rock, AR (JDH, JR). Counts were initiated on 21 March 2014 and continued on a weekly basis through 29 October 2014. Scotch® Removable Double Sided Tape (0.75 inch wide) was used to trap crawlers. Five traps labeled 1 through 5 were placed at an average height of 6.6 feet around main stems and replaced weekly (+ or - 1 day). The total number of CMBS crawlers adhering to the sticky tape traps was counted using a Nikon SMX-1 stereo microscope and the average count per rating date converted to crawlers per square inch.

Results. Scale crawler counts imply three generations per season with initial crawler emergence occurring in late March to early April (Figure 6). A second crawler emergence occurred in late May through early July, and a third emergence occurred in August. Double-sided sticky tape was a time efficient method for assessing crawler numbers and may assist in timing of insecticide sprays to control the smallest and most insecticide-sensitive scale life stage.

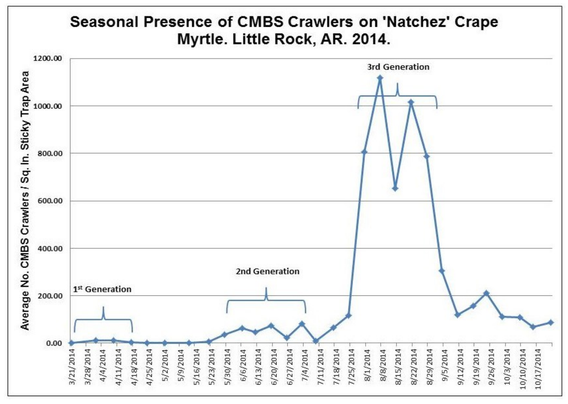

Figure 6. Counts of CMBS crawlers from sticky trap over time. Crape myrtle variety 'Natchez', Little Rock, AR.

Varietal Preferences

Initial evaluations of varietal preferences were assessed on 24 and 25 June 2014 in McKinney, TX. The Parks Department of the City of McKinney has assembled a world collection of crape myrtle varieties planted along city roadways and in parks . We (MG, MEM, EF) selected five trees from 22 varieties to evaluate possible differences in scale preference or survival. We assigned each tree a subjective rating of 0 to 10 for four characters: (1) scale density on upper branches; (2) scale density on trunks; (3) overall presence of sooty mold on branches and trunks; and (4) overall assessment of plant vigor. In addition, we clipped three randomly chosen branches, at least 30 cm length, for estimating scale density. Branches were placed in plastic bags and returned to the laboratory for counting under a microscope.

Results. There was a significant (ANOVA, $F_{21,93}$=6.63, P<0.001) difference in scale numbers over the 22 varieties we tested (Figure 7). Highest scale numbers and damage assessments were seen on the varieties 'Tuscarora', 'Lipan', and 'Pink Ruffles'. The lowest numbers of scales and lowest damage ratings were seen on varieties 'Biloxi', 'Miami', 'Sarahs Favorite' , 'Twilight', and 'Natchez'. Subjective scale ratings on upper branches and sooty mold ratings correlated best with scale branch counts (r^2=0.65 and r^2=0.47); however there were some inconsistencies in rankings between the methods (e.g., cf. ratings for 'Sarahs Favorite'). For this reason, actual scale counts from branches remain the most accurate measurement for assessing varietal differences and for evaluating insecticide trials.

Our preliminary data suggest that some varieties might be more desirable for areas where the scale has invaded. We have, however, received multiple reports of unacceptable scale numbers on 'Natchez', our least infested variety in this study. More replications, especially over a wider geographical area, will be necessary to confirm the results of varietal trials and determine if varietal differences are enough to warrant extension recommendations of some varieties over others.

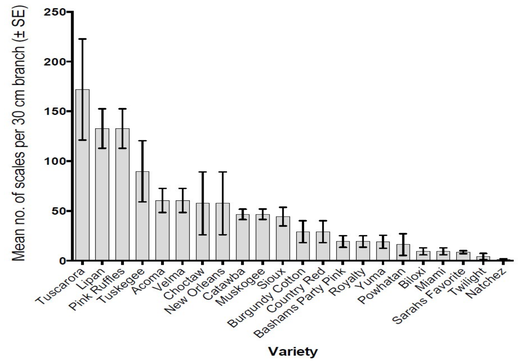

Figure 7. Mean number of crape myrtle bark scales (crawlers/nymphs/adults on 3 branches per tree) for 22 varieties of crape myrtles (ANOVA; $F_{21,93}$=6.63, P<0.001, n=5 trees per variety). McKinney, TX. June 24-25, 2014.

Monitoring the Spread of CMBS

2004: Initial discovery of CMBS in Dallas County, TX. Relatively slow spread through Dallas/Fort Worth metroplex.
2008: Infestations found throughout crape myrtle plantings in McKinney (TX), approximately 16 km from original discovery site.
2010: First report outside Texas, in Ardmore, OK (Figure 8).
2013: Noticed by horticulturalists in Louisiana and Arkansas, unconfirmed report from Georgia.
2014: Spot infestations of CMBS reported as far south in TX as Houston, west to Albuquerque, NM, and east to Alabama, Georgia, and Chesapeake, VA.

Human-assisted spread, via the nursery industry, is the most likely mechanism for this long-distance transport. Based on the rate of dispersal in the Dallas/Fort Worth metropolitan area, once established, the scale may spread locally at the approximate rate of 5 to 10 miles per year.
A website is currently under construction, with the partnership of the University of Georgia's Center for Invasive Species and Ecosystem Health. The site provides basic information about the scale and its control, and will allow Extension professionals and the public to report and track the spread of CMBS. The site can be accessed at:

http://www.eddmaps.org/cmbs/

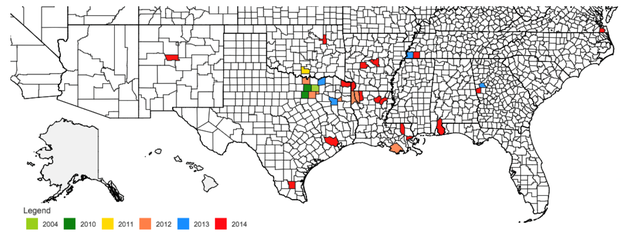

Figure 8. Geographic distribution of confirmed reports of CMBS in the southeastern U.S., November 2014. From http://www.eddmaps.org/cmbs/

Summary:

An exotic scale pest of crape myrtle was discovered in 2004, and its identity confirmed in 2014. Both genetic and morphological evidence support that the new crape myrtle pest is *Eriococcus lagerstroemiae*, a felt scale previously known only from China, Korea, and Japan. Initial observations indicate that the scale has three generations per year in Arkansas. The Dallas/Fort Worth area remains the epicenter of the infestation; however infested plants have been observed from New Mexico to Virginia. The USDA/APHIS considers the scale to be widely established and does not have plans to impose a quarantine on nurseries growing and distributing crape myrtle trees (USDA/APHIS 2014). There do appear to be varietal differences in levels of infestation; however this factor needs further investigation to determine whether these differences are consistent throughout the range of crape myrtle plantings in the U.S. For more information and Extension recommendations for control of the scale, see Gu et al. (2014) and Robbins et al. (2014).

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