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Matsucoccus alabamae Morrison, Alabama pine scale (Matsucoccidae: Coccomorpha: Hemiptera): a potential pest of Florida pines

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INTRODUCTION

Matsucoccus alabamae Morrison was first described from a pine species in Alabama, in 1902 (Morrison 1939). To date, there is no published record of its occurrence outside of Alabama. Pine trees play a vital role in Florida's ecosystems and economy (Proctor and Monroe 2016). In addition to benefitting wildlife and providing attractive landscapes in Florida, pines are also grown commercially, providing products such as paper, industrial chemicals and lumber. Due to the importance of pine production in Florida and the fact that several species of *Matsucoccus* cause considerable damage to pines worldwide, *M. alabamae* has the potential to be a pest in Florida (García et al. 2016).

The Cooperative Agricultural Pest Survey (CAPS) uses Lindgren funnel traps (LFT) as a part of an exotic wood borer survey. On June 19, 2017, a LFT sample collected on slash pine, *Pinus elliottii* Engelm. (Pinaceae), in Brevard County (FDACS-DPI sample# E2017-4204) yielded specimens of *M. alabamae*. This discovery and possible range extension raised interest in this species. A second find, *M. alabamae* (E2017-4454), was received June 28, 2017, on *Pinus* sp. in Volusia County as part of the CAPS exotic wood borer survey.

At the time, the only published record of a *Matsucoccus* species in Florida was of *M. gallicolus* Morrison. However, the unpublished dissertation of Dr. Charles Ray reported four additional records of *M. alabamae* from *P. elliottii* in Florida: Highlands County, collected April 28, 1975; Miami-Dade County, collected December 25, 1978; Okaloosa County, collected February 17, 1978; and Miami-Dade County, collected July 20, 1980 (Ray 1982).

Based on the 2017 collections and previous information as noted above, a survey was initiated to search for populations of *M. alabamae* in the panhandle region of Florida near the Alabama state boundary. Dead specimens were found under the outer layers of the bark of *Pinus* sp. in Franklin County (E2018-343), Lafayette County (E2018-0034) and Liberty County (E2018-0346). An additional survey was conducted in the Gainesville, Florida area on *P. elliottii* where the authors found several additional dead specimens of *M. alabamae* on September 6, 2018 (E2018-4724). Three more CAPS LFT trap samples yielded *M. alabamae* on *Pinus* sp. in Broward County collected April 26, 2018 (E2018-2743), Duval County collected November 1, 2017 (E2018-0609) and December 7, 2017 (E2018-1002). Upon reexamination of the specimens identified as "*Matsucoccus* sp." in the Florida State Collection of Arthropods, one record from 1997 (E1997-0195) on *P. palustris* from Leon County was confirmed as *M. alabamae*.

Two species of *Matsucoccus* are now known to occur in Florida: *M. alabamae* and *M. gallicolus*. The specimens of *M. gallicolus* from Florida are morphologically different from the specimens of *M. gallicolus* collected outside of Florida. Because of these differences, we are investigating the possibility that it is a unique species. Published records of *M. gallicolus* include a single collection taken from an herbarium specimen in the US National Herbarium, from Chattahoochee, Gadsden County, Florida, on *Pinus glabra*, by A.H. Curtiss, November (year not given) (Morrison 1936). However, the unpublished dissertation of Dr. Charles Ray includes one sample of *M. gallicolus* collected from *P. elliottii*: Columbia County, October 22, 1958 (Ray 1982).

GEOGRAPHICAL RANGE

Until now, *Matsucoccus alabamae* was officially known only from Alabama (García et al. 2016). Ray (1982) reported it from Florida, Georgia, South Carolina and Tennessee in his dissertation. An additional series was collected recently from Virginia (E2020-25). Surveys indicated that it is widespread with detections in 13 Florida counties: Alachua, Brevard, Broward, Duval, Franklin, Highlands, Lafayette, Leon, Liberty, Miami-Dade, Okaloosa, Palm Beach and Volusia.

HOSTS PLANTS

This species is only known from the genus *Pinus,* including *P. elliottii* and *P. palustris*. Each species of *Matsucoccus* feeds on pines of a single subsection (group of related species) of *Pinus* (Ray and Williams 1991). For example, *M. alabamae* feeds on the trunks of pines in only the subsection *Australes* of the genus *Pinus.* There are at least six species of the subsection *Australes* in Florida: *P. echinata*, *P. elliottii*, *P. glabra*, *P. palustris*, *P. serotina* and *P. taeda*. The majority of available records for *M. alabamae* in Florida are from *P. elliottii,* a native and widespread pine species in Florida, and one of the most abundant trees in the landscape (Gilman et al. 2014, Proctor and Monroe 2016).

IDENTIFICATION

Adult females are light yellow or brown, wingless and have unusually large and characteristically shaped antennae (Figs 1 and 2). First instar nymphs resemble adult females but are much smaller (Fig. 3). First instars transform into an intermediate legless cyst resembling a brown pearl. Preadult males resemble females with large antennae but are smaller and slenderer. Adult males have one pair of obvious wings and a series of long crystalline rods at the rear of the body (Fig. 3).

Four species, including *M. banksianae* Ray & Williams from Minnesota, *M. californicus* Morrison from California, *M. oocarpae* Ray & Williams from Guatemala and *M. vexillorum* Morrison from Arizona, are morphologically similar to *M. alabamae* (Ray and Williams 1991). Adult females of these species all lack fleshy sensory setae on the fifth antennal segment, have well developed legs and antennae, possess multilocular disc pores at the apex of the abdomen and possess only one size of body setae, and each species feeds on pines of a single subsection (McKenzie 1943, Ray and Williams 1991). *Matsucoccus alabamae* differs from the others in that the adult female cicatrices are usually in four distinct bands, the anterior one is about half of the width of the other bands, the body setae are all about the same size in the adult and third-instar males, and they usually feed on pines of the subsection *Australes* (Ray and Williams 1984).

PEST SCOUTING

Use of Lindgren funnel traps are a reasonable method for detecting *M. alabamae* because they occasionally capture adult females. Detection can also occur by removing the outer flakes of pine tree bark to look for mummies and old ovisacs because infested trees will contain multiple generations of *M. alabamae.*

PEST DISPERSAL

Matsucoccus are naturally spread by wind, but may also hitchhike on birds, mammals, clothing, tree cutting machinery, or be transported on infested host material (Kanoti and Ostrofsky 2014).

BIOLOGY

The following information is based on observations Ray (1982) made in Auburn, Alabama from November 1978 to April 1981. *Matsucoccus alabamae* overwinters in the second-instar cyst beneath bark scales on the trunk of the host. In March, the third-instar males emerge from the cysts, settle, feed beneath bark and produce a waxy sac in which they molt to the fourth-instar pupa. Adult males emerge and begin to actively seek out females. Adult females emerge from the cyst, move to the outer surface of the tree trunk, or between the edges of bark scales, and extend the posterior end of their abdomen as far from the trunk as possible. Adult males run rapidly up and down the trunk and orient to the posterior apex of the female to copulate. After copulation is complete, adult females crawl beneath loose bark flakes, near a scar or at the base of a branch, before producing a waxy ovisac in which 501-860 eggs are laid. Copulation is necessary for oviposition; unmated females do not produce eggs. As females deposit eggs, their bodies contract and fold so that when all eggs are deposited, the females are reduced to less than a third of their original size (Fig. 3).

DAMAGE

It has not been demonstrated that *M. alabamae* causes economic damage to its host. However, 11 species of the genus have been shown to cause at least some economic damage, in some cases quite severe (see García et al. 2016 for detailed references)**.** Infestations of *Matsucoccus* sp. can cause foliage discoloration, the pine foliage color changes gradually from green to yellow to red, first on individual branches on the lower part of the crown of pine tree, then slowly over the entire tree crown (Anonymous 2012). Infestation of *Matsucoccus* species can lead to defoliation, dieback and mortality of both mature and young pine trees. *Matsucoccus gallicolus* was found to be responsible for the mortality of terminal leaders on more than 63 percent of *Pinus rigida* Mill trees in an experimental plot in Pennsylvania, and more than 50 percent in *P. rigida* stands in a similar plot in Massachusetts (Parr 1939). Weakened trees may also be attacked by bark beetles causing rapid tree mortality (Anonymous 2012). Masses of cottony white filaments become visible on the branches when infestations are heavy.

OTHER SPECIES

It is worth mentioning that *M. macrocicatrices* Richards has been collected in eastern North America from Canada to Georgia on *P. strobus* L. (Richards 1960, Mech et al. 2013). It can be distinguished from the other species in Florida by having enlarged setae on the last five antennal segments and cicatrices greater than 15 microns in diameter. Comparatively, *M. alabamae* and *M. gallicolus* have enlarged setae on the last four antennal segments and their cicatrices are less than 15 microns in diameter. Because *M. macrocicatrices* has only been reported on *P. strobus*, and because Florida is outside the natural range of this host, it is unlikely this *Matsucoccus* species will be found in Florida unless the tree is planted in an ornamental setting.

Matsucoccus matsumurae (Kuwana), the only exotic species of *Matsucoccus* occurring in the U.S., (Connecticut, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island) has not been reported in Florida. There are three species, *M. feytaudi* Ducasse from Africa and Europe, *M. josephi* Bodenheimer & Harpaz from the Mediterranean and *M. pini* (Green) from the Middle East and Europe, that are major pests but are not reported in the U.S.

MANAGEMENT

Although the two species currently established in Florida do not require management, a preventive plan would be beneficial to avoid the establishment of other *Matsucoccus* species in new areas of woodlands and landscapes in Florida. There are no effective chemical controls for woodlands and plantations. There is a low risk of spread during the winter months when the scale is overwintering and immobile. Therefore, work on infested trees should take place in the winter to prevent the spread of the scale (Anonymous 2012; Kanoti and Ostrofsky 2014). Landscapes with high tree diversity and a high density of non-host trees can inhibit any further spread of the scale after the pest becomes established (Rigot et al. 2014). Drenching trunk sprays against adults of *M. acalyptus* Herbert in spring showed effective results and might be the only effective method for pine trees in residential landscapes (Skelly and Christopherson 2003). Washing the trunks can also be effective, but only when the scales are in the egg stage before emerging into crawlers during the spring through early summer and might be effective in residential landscapes (Skelly and Christopherson 2003). Biological control is the only reliable option for managing *Matsucoccus* species due to the difficulty of environmental pollution resulting from chemical insecticides in woodlands. Natural enemies associated with *M. macrocicatrices* in North America are principally generalist predators including anthocorid bugs, cecidomyiid flies and coccinellids (Anonymous 2012). Several species of predators, including *Elatophilus pinophilus* Blatchley (pirate bugs), attacked *Matsucoccus* species, but they are not abundant enough for effective control (Mendel et al. 1991). Trials in Connecticut of introduced predators have remained ineffective (Anonymous 2012). Recently, entomopathogenic fungi were found to be promising biocontrol agents against invasive *M. matsumurae* in China (Liu et al. 2014). Two species of *Aspergillus* fungus have been found attacking *M. alabamae*, and infested adult females were unable to produce ovisacs (Ray 1982). Maintaining tree vigor may aid in slowing tree mortality caused by *Matsucoccus* species. The use of mass trapping and silvicultural interventions helped to reduce the population of *M. feytaudi* in Italy (Sciarretta et al. 2016).

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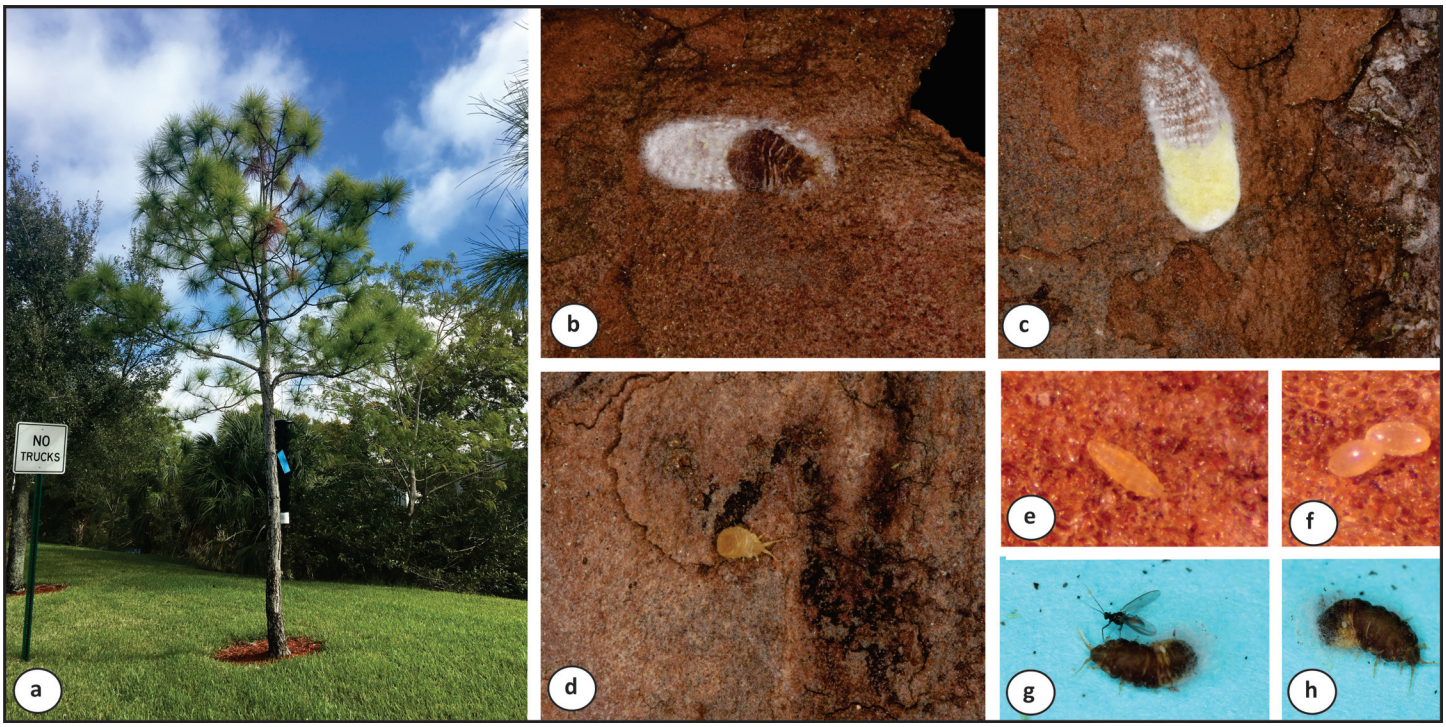

Figure. 1. (a) Lindgren funnel trap (E2019-0139) in Broward County on *Pinus* sp. (b-h) Different life stages of *Matsucoccus alabamae* . (b) Old female with egg sacs. (c) Egg sac. (d) Young female. (e) First instar. (f) Close-up of eggs. (g) Adult male and female. (h) Gravid female. Photos by Charles Ray, Auburn University, Jake M. Farnum, CAPS and Muhammad Z. 'Zee' Ahmed, FDACS-DPI.

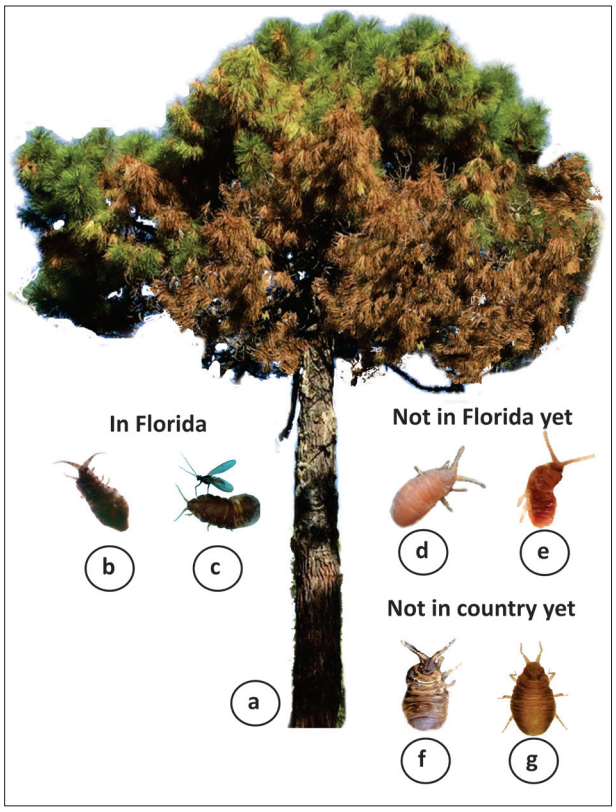

Figure 2. (a) Damaged pine tree. (b) *Matsucoccu gallicolus*. (c) *Matsucoccus alabamae*. (d) *Matsucoccus matsumurae*. (e) *Matsucoccus macrocicatrices*. (f) *Matsucoccus feytaudi*. (g) *Matsucoccus josephi*. Photo by Muhammad Z. 'Zee' Ahmed, FDACS-DPI, Charles Ray, Auburn University, Protasov AN (Shutterstock Image# 435340348), Mech et al. (2013), and Anonymous (2015).

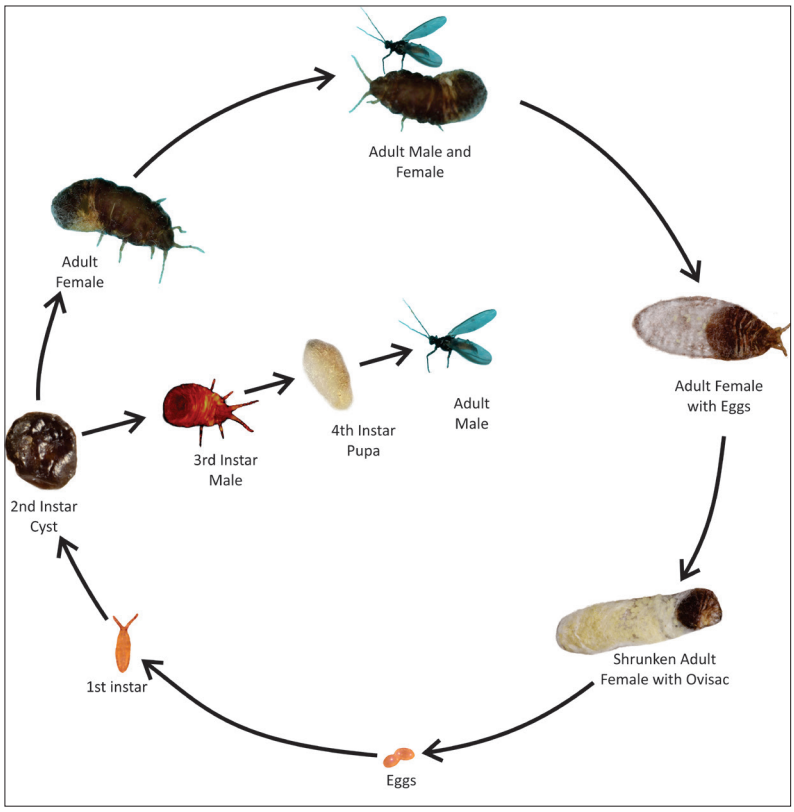

Figure 3. Life cycle of *Matsucoccus alabamae* with two exceptions; cyst is of *Matsucoccu gallicolus* and fourth instar pupa is of *Matsucoccus josephi*. Photos by Charles Ray, Auburn University, Protasov AN (Shutterstock Image#435340348) and Muhammad Z. 'Zee' Ahmed, FDACS-DPI.