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EENY-033

Asian Citrus Psyllid, *Diaphorina citri* Kuwayama (Insecta: Hemiptera: Psyllidae)[1]

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Introduction

The Asian citrus psyllid, *Diaphorina citri* Kuwayama, is widely distributed in southern Asia. It is an important pest of citrus in several countries as it is a vector of a serious citrus disease called greening disease or Huanglongbing. This disease is responsible for the destruction of several citrus industries in Asia and Africa (Manjunath 2008). Until recently. the Asian citrus psyllid did not occur in North America or Hawaii, but was reported in Brazil, by Costa Lima (1942) and Catling (1970).

In June 1998, the insect was detected on the east coast of Florida, from Broward to St. Lucie counties, and was apparently limited to dooryard host plantings at the time of its discovery. By September 2000, this pest had spread to 31 Florida counties (Halbert 2001).

Diaphorina citri is often referred to as 'citrus psylla,' but this is the same common name sometimes applied to *Trioza erytreae* (Del Guercio), the psyllid pest of citrus in Africa. To avoid confusion, *T. erytreae* should be referred to as the 'African citrus psyllid' or the 'two-spotted citrus psyllid' (the latter name in reference to a pair of spots on the base of the abdomen in late stage nymphs). These two psyllids are the only known vectors of the etiologic agent of citrus greening disease (Huanglongbing), and are the only economic psyllid species on citrus in the world. Six other species of *Diaphorina* are reported on citrus, but these are non-vector species of relatively little importance (Halbert and Manjunath 2004).

Figure 1. **Adult Asian citrus psyllid, *Diaphorina citri* Kuwayama. Credits: Douglas L. Caldwell, University of Florida**

Distribution

Diaphorina citri ranges primarily in tropical and subtropical Asia and is reported from the following geographical areas: Afghanistan, Caribbean (Bahamas, the Cayman Islands,

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Jamaica, Dominican Republic, Cuba, Puerto Rico, plus interceptions from St. Thomas and Belize), Central America (Guadaloupe), China, Hong Kong, India, Indonesia, Malaysia, Mauritius, Mexico, Myanmar, Nepal, Pakistan, Philippine Islands, Reunion Island, Ryukyu Islands, Saudi Arabia, Sri Lanka, South America (Argentia, Brazil, Venezuela), Taiwan, Thailand, the United States and some of its territories (Halbert and Núñez 2004a).

The discovery of *D. citri* in Saudi Arabia (Wooler et al. 1974) was the first record from the Near East. *Trioza erytreae* also occurs in Saudi Arabia, preferring the eastern and highland areas where the extremes of climate are present, whereas *D. citri* is widespread in the western, more equitable coastal areas.

In the U.S. and its territories, this species is present in Alabama, Arizona, California, Florida, Georgia, Guam, Hawaii, Louisiana, Mississippi, Puerto Rico, South Carolina, Texas, and the U.S. Virgin Islands. In late May 2008, specimens were discovered in Jefferson and Orleans Parishes, Louisiana. On September 2, 2008, the psyllid was first detected in San Diego County, California. On October 27, 2009, the psyllid was discovered in Yuma county, Arizona. On April 21, 2010, surveys determined that the psyllid was present in the U.S. Virgin Islands (USDA 2010b).

As of June 2010, the following U.S. areas are quarantined due to the presence of the Asian citrus psyllid (USDA 2010c):

- Alabama: entire state
- Arizona: portion of Yuma County (USDA 2010b)
- California: southern areas (USDA 2010a)
- Florida: entire state
- Georgia: entire state
- Guam: entire Territory
- Hawaii: entire state
- Louisiana: entire state
- Mississippi: entire state
- Puerto Rico: entire Commonwealth.
- South Carolina: southeastern area
- Texas: entire state
- Virgin Islands - entire Territory (USDA 2010b)

Description and Identification

Adults

The adults are 3 to 4 mm long with a mottled brown body. The head is light brown, whereas *T. erytreae* has black head. The forewing is broadest in the apical half, mottled, and with a brown band extending around periphery of the outer half of the wing. This band is slightly interrupted near the apex (in *T. erytreae*, band is broadest at middle, unspotted and transparent). The antennae have black tips with two small, light brown spots on the middle segments (in *T. erytreae*, antennae are nearly all black). A living *D. citri* is covered with whitish, waxy secretion, making it appear dusty.

Figure 2. **Adult Asian citrus psyllid, *Diaphorina citri* Kuwayama. Credits: Jeffrey Lotz, FDACS-Division of Plant Industry**

Nymphs

D. citri nymphs are 0.25 mm long during the 1st instar, 1.5 to 1.7 mm in last (5th) instar. Their color is generally yellowish-orange. There are no abdominal spots, whereas in *T. erytreae*, advanced nymphs have two basal dark abdominal spots. The wing pads in *D. citri* are massive, while *T. erytreae* has small pads. In *D. citri*, large filaments are confined to the apical plate of the abdomen (in *T. erytreae*, there is a fringe of fine white filaments around the whole body, including head).

Figure 3. **Nymphal stages of the Asian citrus psyllid, *Diaphorina citri* Kuwayama.**
Credits: David Hall, USDA

Figure 4. **The white waxy excretions of the nymphs are an indicator of the Asian citrus psyllid, *Diaphorina citri* Kuwayama.**
Credits: Douglas L. Caldwell, University of Florida

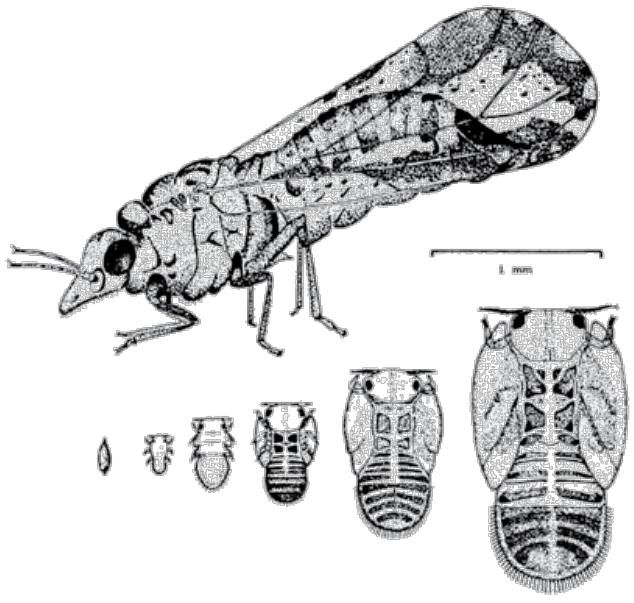

Figure 5. **Adult female and nymphal instars of Asian citrus psyllid.**

Eggs

The eggs of *D. citri* are approximately 0.3 mm long, elongate, almond-shaped, thicker at base, and tapering toward the distal end. Newly laid eggs are pale, but then turn yellow and finally orange before hatching. The eggs are placed on plant tissue with long axis vertical to surface. *T. erytreae* eggs are laid with the long axis horizontal to surface.

Figure 6. **Eggs of the Asian citrus psyllid, *Diaphorina citri* Kuwayama.**
Credits: Douglas L. Caldwell, University of Florida

Identifications having regulatory significance should be made by taxonomists with adequate reference materials. Psyllids as a group are most likely to be confused with aphids as these latter insects are common on tender citrus leaves. But while adult psyllids are active jumping insects, aphids are sluggish. In addition, aphids usually have four- to six-segmented antennae, while psyllid antennae usually have 10 segements. Most aphids have cornicles on the abdomen, while psyllids lack cornicles.

Life History

Eggs are laid on tips of growing shoots on and between unfurling leaves. Females may lay more than 800 eggs during their lives. Nymphs pass through five instars. Total life cycle requires from 15 to 47 days, depending upon the season. Adults may live for several months. There is no diapause, but populations are low in winter (the dry season). There are nine to 10 generations a year; however, 16 have been observed in field cages. There are numerous papers containing life history information, among them the following: Atwal et al. (1970), Capoor et al. (1974), Catling (1970), Husain & Nath (1927), Mangat (1961), Mathur (1975), Pande (1971), USDA-ARS (1959), and Wooler et al. (1974).

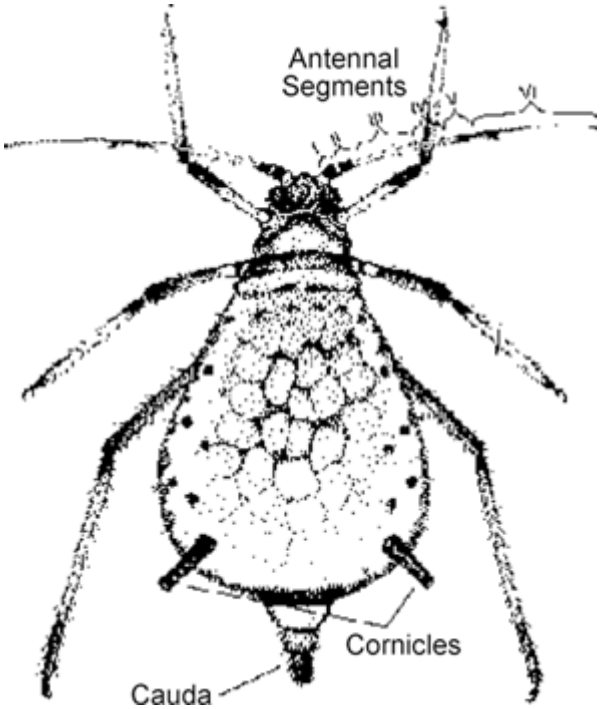

Figure 7. **Brown citrus aphid - adult wingless form.**
Credits: University of Florida

Damage

Injury caused by psyllids results from the withdrawal of large quantities of sap from the foliage, and transmission of the organisms that cause Huanglongbing (greening disease). Plant dieback has multiple causes but primarily is due to Huanglongbing. Greening disease has been called citrus chlorosis in Java, leaf-mottling and leaf-mottle yellows in the Philippines, likubin (rapid decline) in Taiwan, and Huanglongbing ('yellow dragon disease', often translated as 'yellow shoot disease') in China.

Figure 8. **Feeding damage caused by the Asian citrus psyllid, *Diaphorina citri* Kuwayama, to citrus foliage.**
Credits: University of Florida

Figure 9. **Huanglongbing or greening disease damage to a sweet orange tree.**
Credits: Florida Department of Agriculture and Consumer Services

Host Plants

Mainly *Citrus* spp., at least two species of *Murraya*, and at least three other genera, all in the family Rutaceae.

Survey and Detection

Nymphs

The nymphs are always found on new growth, and move in a slow, steady manner when disturbed.

Adults

The adults leap when disturbed and may fly a short distance. They are usually found in large numbers on the lower sides of the leaves with heads almost touching the surface and the body raised almost to a 30° angle. The period of greatest activity of the psyllid corresponds with the periods of new growth of citrus. There are no galls or pits formed on the leaves as caused by many other kinds of psyllids. The nymphs are completely exposed, while the nymphs of *T. erytreae* are partially enclosed in a pit. Citrus trees in advanced stages of decline are somewhat similar to those affected by tristeza. Field recognition of greening disease in Asia from symptoms alone is often difficult. Very similar leaf symptoms may be caused by a wide variety of factors varying from nutritional disorders to the presence of other diseases such as root rots and gummosis, tristeza, and exocortis.

Capoor et al. (1974) described greening symptoms of citrus as trees showing stunted growth, sparsely foliated branches, unseasonal bloom, leaf and fruit drop, and twig dieback. Young leaves are chlorotic, with green banding along the major veins. Mature leaves have yellowish-green patches between veins, and midribs are yellow. In severe cases, leaves become chlorotic and have scattered spots of green. Fruits on greened trees are small, generally lopsided, underdeveloped, unevenly colored, hard, and poor in juice. The columella (the internal, central columnlike structure found in citrus and other fruits) was found to be almost always curved in sweet orange fruits and apparently is the most reliable diagnostic symptom of greening. Most seeds in diseased fruits are small and dark colored.

Figure 10. **Twig dieback caused by Huanglongbing or greening disease to a Murcott tree.**
Credits: Florida Department of Agriculture and Consumer Services

Schwarz et al. (1974) listed four reasons why the symptoms of greening in Southeast Asia were often different from those in South Africa. These reasons included the more tropical climate of Asia keeping mature fruit green, citrus variety differences, differences in the heat tolerance of the vectors leading to different disease distribution in the grove, and differences in the virulence of the strains of the pathogen.

Disease Transmission

Huanglongbing (HLB) is caused by a phloem-limited bacterium that has a true cell wall. There are at least three forms or species: *Candidatus* L. africanus causing African HLB; *Candidatus* L. asiaticus causing Asian HLB; and a new varient found in Brazil, tentatively called *Candidatus* L. americanus. Asian HLB is the bacterium found in Florida (Chung and Brlansky 2009). Capoor et al. (1974) reported

Figure 11. **Grapefruit damage caused by Huanglongbing or greening disease. Lopsided fruit are a symptom of greening disease. Note the extreme distortion of the columella, the central columnlike structure found in citrus and other fruits.**
Credits: Florida Department of Agriculture and Consumer Services

a high percentage of transmission by tissue grafts. They found that 4th and 5th instar nymphs and adults could effect transmission. *Diaphorina citri* requires an incubation period of about 21 days in which to transmit the pathogen, which it retains for life following a short access feeding (15 to 30 minutes) on a diseased plant. It is unnecessary for adult psyllids arising from infectious nymphs to have access feeding on diseased shoots in order to become vectors. Adult psyllids were able to transmit greening in a minimum infection feeding of 15 minutes but the percentage of transmission was low. One hundred percent infection was obtained when the psyllids fed for one hour or more. Capoor et al. (1974) strongly indicated that the pathogen multiplied in the body of the psyllid and that there was an absence of transovarial transmission. They summarized differences between *D. citri* and *Trioza erytreae* in various aspects of greening transmission.

Management

Workers in India reported that *D. citri* can be controlled effectively with a wide range of modern insecticides. Bindra et al. (1974) reported that for overall effectiveness against nymphs and adults at different intervals after spraying several chemicals were effective. Injection of trees with tetracycline antibiotics to control greening disease was effective where the vector can be kept under control. In countries where greening spread over long distances, it

Figure 12. **Symptoms of greening disease, Liberobacter spp, on citrus.**
Credits: **University of Florida**

occurred because of the movement of infected and infested nursery stock. **Only clean and healthy plants should be transported.** In areas with low incidence of greening disease, the relatively few infected trees should be removed to prevent them from being reservoirs of the pathogen.

Natural enemies of *D. citri* include syrphids, chrysopids, at least 12 species of coccinellids, and several species of parasitic wasps, the most important of which is *Tamarixia radiata* (Waterston). *T. radiata* was introduced in Florida (intentionally) and the Rio Grande Valley of Texas (accidentally) (Michaud, personal communication).

Figure 13. **Nymphs of the Asian citrus psyllid, *Diaphorina citri* Kuwayama, killed by the ectoparasitoid wasp *Tamarixia radiata*. Credits: University of Florida**

In the United States and its territories, areas with *D. citri* are under quarantine (USDA 2010b). International quarantines, enacted by other countries, may also be placed on countries or areas with *D. citri*.

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