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Marketing and Regulatory Programs

Animal and Plant Health Inspection Service

Proposed Release of a Parasitoid (*Tamarixia radiata* Waterston) for the Biological Control of Asian Citrus Psyllid (*Diaphorina citri* Kuwayama) in the Continental United States

Environmental Assessment
June 2010

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Environmental Assessment, June 2010

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I. Purpose and Need for the Proposed Action

The U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Plant Protection and Quarantine (PPQ) Permit Unit is proposing to issue permits for release of the insect *Tamarixia radiata* (*T. radiata*) (Waterston) (Hymenoptera: Eulophidae). The agent would be used for the biological control of the Asian citrus psyllid (ACP), *Diaphorina citri* Kuwayama (Hemiptera: Psyllidae), in the continental United States. Before permits are issued for release of *T. radiata*, APHIS needs to analyze the potential impacts of the release of this agent into the continental United States.

This environmental assessment[1] (EA) has been prepared, consistent with USDA–APHIS' National Environmental Policy Act of 1969 (NEPA) implementing procedures (Title 7 of the Code of Federal Regulations (CFR) part 372). It examines the potential effects on the quality of the human environment that may be associated with the release of *T. radiata* to control infestations of ACP within the continental United States. This EA considers a "no action" alternative and the potential effects of the proposed action.

The purpose for releasing *T. radiata* is to reduce the severity of infestations of ACP in the United States. ACP, a serious pest of citrus, was first discovered in Boynton Beach, Palm Beach County, Florida, in June 1998. By 2001, it had spread to 31 counties in Florida, primarily due to the movement of infested nursery plants. In 2001, ACP was accidentally introduced into Puerto Rico and the Rio Grande Valley of Texas. It was subsequently found in Hawaii in 2006, Guam in 2007, and in Alabama, Georgia, Louisiana, Mississippi, South Carolina, and California in 2008. ACP serves as a vector (disease transmitter) of Huanglongbing disease (HLB), also known as citrus greening disease, and is considered to be one of the most serious citrus diseases in the world. HLB is a bacterial disease caused by strains of the bacterial pathogen *Candidatus* Liberibacter asiaticus that attacks the vascular system of host plants. The pathogen is phloem-limited, inhibiting the food-conducting tissues of the host plant, and causes yellow shoots, blotchy mottling and chlorosis, reduced foliage, and tip dieback of citrus plants. HLB greatly reduces production, destroys the economic value of citrus fruit, and can kill trees. Once infected, there is no cure for a tree with HLB. In areas of

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[1] Regulations implementing the National Environmental Policy Act of 1969 (42 United States Code 4321 et seq.) provide that an environmental assessment "[shall include brief discussions of the need for the proposal, of alternatives as required by section 102(2)(E), of the environmental impacts of the proposed action and alternatives, and a listing of agencies and persons consulted" (40 CFR § 1508.9).

the world where HLB is established, citrus trees decline and die within a few years and may never produce usable fruit. HLB was first detected in the United States in Miami-Dade County, Florida, in 2005. Currently, in the United States, HLB is only known to be present in Florida, Louisiana, South Carolina, and Georgia.

In addition to transmitting *Candidatus* Liberibacter asiaticus, ACP can cause economic damage to citrus in groves and nurseries by direct feeding. Both adults and nymphs feed on young foliage, depleting the sap and causing galling or curling of leaves. High populations feeding on a citrus shoot can kill the growing tip.

In 1998, the proposed biological control organism *T. radiata* was imported from Taiwan and Vietnam into quarantine by Division of Plant Industry, Florida Department of Agriculture and Consumer Services. It was initially intentionally released into Florida in St. Lucie County on July 15, 1999, and Palm Beach County on August 17, 1999 and has become established in Florida. It also spread to Puerto Rico and Texas via accidental introductions. However, the APHIS–PPQ Permit Unit has received permit applications requesting to release *T. radiata* into additional States where ACP has spread, such as California, and has also received permit applications for importation and release of *T. radiata* from sources other than Taiwan and Vietnam (i.e., Punjab, Pakistan) because they may be more climatically adapted to new release locations.

The applicant has a need to include a host specific biological control agent as an additional tool for controlling ACP populations in the continental United States, especially in natural areas and neighborhoods where insecticide applications to control ACP are not always feasible.

II. Alternatives

This section will explain the two alternatives available to the PPQ Permit Unit—no action and issuance of permits for expanded environmental release of *T. radiata*. Although the PPQ Permit Unit's alternatives are limited to a decision on whether to issue permits for expanded release of *T. radiata*, other methods of control of ACP are described. These control methods are not decisions to be made by the PPQ Permit Unit, and their use will likely continue whether or not permits are issued for expanded environmental release of *T. radiata*. These are methods presently being used to control ACP by public and private concerns. For instance, the APHIS–PPQ, Citrus Health Response Program has undertaken measures to control the spread of ACP and HLB to uninfested areas of the United States since the introduction of HLB into the United States in 2005. This program was analyzed in an environmental assessment prepared by APHIS (USDA, APHIS, 2009) and it is incorporated by reference into this document.

A third alternative was considered, but will not be analyzed further. Under this third alternative, the PPQ Permit Unit would have issued permits for the field release of *T. radiata* but the permits would contain special provisions or requirements concerning release procedures or mitigating measures. No issues have been raised that would indicate that special provisions or requirements are necessary.

A. No Action

Under the no action alternative, the PPQ Permit Unit would not issue additional permits for the field release of *T. radiata* for the control of ACP—further release of this biological control agent outside of Florida would not take place and permits for release of new, more climatically-adapted strains would not be approved. Besides the APHIS–PPQ program, control measures could be taken by other Federal or non-Federal entities; those actions would not be under APHIS' control or funded by APHIS. Those additional methods of control are discussed in the "ACP Control Methods" section below and will likely continue even if permits are issued for expanded release of *T. radiata*.

T. radiata was introduced into Florida in 1998 (Hoy and Nguyen, 2001). It was also detected in Texas, Mexico, and Puerto Rico where purposeful releases were not made. The insect may have moved to these locations on infested orange jasmine *Murraya paniculata* (L). Although *T. radiata* is already established in Florida, Puerto Rico, and Texas, under this alternative, the APHIS–PPQ Permit Unit would not issue permits for movement of *T. radiata* into new States and would not issue permits to release new strains of *T. radiata* into the United States that were collected from new sources in Asia. However, since *T. radiata* is established in Florida, Puerto Rico, and Texas, it will continue to be used in those areas. It is possible that *T. radiata* will naturally spread from Florida and Texas into other States.

ACP Control Methods

1. Chemical Control

Chemical control of ACP includes the use of foliar and/or systemic applications of the following insecticides: imidacloprid, thiamethoxam, dinotefuran, acetamiprid, aldicarb, abamectin, chlorpyrifos, deltamethrin, fenpropathrin, bifenthrin, cyfluthrin, carbaryl, dimethoate, phosmet, spinetoram, formetanate, diflubenzuron, and spirotetramat, kaolin, petroleum and horticultural mineral oils (UC IPM, 2009; Rogers et al., 2009a; Rogers et al., 2009b). There are no chemical controls for HLB.

2. Biological Control

In addition to *T. radiata*, another parasitoid used for biological control of ACP is an encyrtid wasp, *Diaphorencyrtus aligarhensis* (*D. aligarhensis*). A parasitoid is an organism that spends a significant portion of its life history within a single host organism which it ultimately kills (and often consumes) in the process. *T. radiata* is more efficient at parasitizing ACP than *D. aligarhensis* (Tang, 1989). Both *T. radiata* and *D. aligarhensis* were released into Florida (McFarland and Hoy, 2001) but with mixed results (Halbert and Manjunath, 2004). Only *T. radiata* has established in Florida (Michaud, 2002) but has exhibited a very low rate of parasitism of ACP (approximately 1 percent) (Michaud, 2004). However, more recent studies by Qureshi et al. (2009a; 2009b) found that rates of parasitism of ACP by *T. radiata* in Florida were variable, and averaged less than 20 percent during spring and summer, but 39 percent in September and 56 percent in November in the central and southwest regions of Florida, respectively. These rates are lower than those observed on Reunion Island, Guadeloupe, or Puerto Rico, where significant suppression of ACP populations has been reported (Aubert and Quilici, 1984; Étienne et al. 2001; Torres et al., 2006; Pluke et al., 2008).

Native predators, such as spiders, coccinellids (lady beetles), lace wings, syrphids, and minute pirate bugs attack ACP (Quereshi et al., 2009b; UC IPM, 2009). Coccinellids are important predators of ACP in Florida (Michaud, 2002; 2004).

B. Issue permits for expanded release of *T. radiata*

Under this alternative, the PPQ Permit Unit would issue permits for the expanded field release of *T. radiata*, including permits for new, more climatically-adapted or better performing strains, for the control of ACP wherever it occurs in the continental United States. These permits would contain no special provisions or requirements concerning release procedures or mitigating measures.

1. Description of *T. radiata*

T. radiata (Hymenoptera: Chalcidoidae: Eulophidae) is a small, stingless wasp ectoparasite (an external parasitic organism). It was described as *Tetrastichus radiata* by Waterston (1922) from host materials—*Diaphorina citri*—on lemon leaves collected in Lyallpur, Punjab (Pakistan).

2. Life History of *T. radiata*

The biology of *T. radiata w*as studied in detail by Chu and Chien (1991), Chien et al. (1989), and Chien (1995). Females deposit eggs between the thorax and abdomen of immature ACP. The newly hatched *T. radiata* larva sucks fluid from the site where it is attached externally to the ACP host, eventually killing it. By the time the *T. radiata* larva has matured, it has sucked out the contents of the ACP, and the psyllid becomes 'mummified' and turns a dark brown color. The adult *T. radiata* parasitoid emerges from the top of the mummified ACP thorax, leaving a distinctive emergence hole. Under laboratory conditions, *T. radiata* females deposit 166 to 300 eggs during their life span of 14 to 24 days. The development time from egg to adult is 12 days under a 25 °C and 14 hours of light:10 hours of dark regime. *T. radiata* completes development at temperatures varying from 15 to 32 °C, with an optimum of 25 °C. The lowest developmental threshold is estimated to be 11 °C for all stages, from egg to adult.

Adult *T. radiata* females also kill psyllids by host feeding. Females insert their ovipositor (egg-laying organ) into the ACP, producing a hole, and then suck up the liquid that oozes out. Host feeding provides a source of protein that helps the female parasitoid produce more eggs. *T. radiata* females also feed on honeydew (sticky waste product excreted by nymphs and adult psyllids after digesting phloem) excreted by the psyllids. A single *T. radiata* female is able to kill over 500 psyllids through the combination of host feeding and parasitism (Nguyen, 2009).

3. Native Range of *T. radiata*

The native range of *T. radiata* includes Africa: Saudi Arabia (Bove, 1986), and Asia: India (Husain and Nath, 1927), China (Jiangxi and Fujian Provinces) (Tang, 1998; Tang and Aubert, 1990), Japan (Ryukyu Archipelago) (Kohno et al., 2002), Nepal (Lama et al., 1988), Pakistan (Waterson, 1922), Thailand (Morakote and Nanta, 1995), and Vietnam (Hoy et al., 1999).

4. Impact of *T. radiata* on Asian Citrus Psyllid

According to Étienne and Aubert (1980), the biological control project using *T. radiata* in Reunion Island started in 1978. Reunion Island is located in the Indian Ocean, east of Madagascar, about 120 miles south west of Mauritius. Approximately 5,000 *T. radiata* adults originating from Punjab, Pakistan, were released in the field in 13 locations on Reunion Island. The population of ACP started to decrease significantly in 1980, and in 1982, *T. radiata* parasitism rates increased drastically to such levels that ACP disappeared from the citrus groves and maintained just a few residual populations on the ornamental *Murraya paniculata*, one of its preferred hosts (Aubert and Quilici, 1984; Étienne et al., 2001). From surveys made on Reunion Island, it was determined that *T. radiata* attacked 60 to 70 percent of ACP nymphs (Aubert, 1987). More than 25 years after release of *T. radiata* on Reunion Island, Aubert et al. (1996) concluded that the effort to control HLB was very successful. This was achieved by a combined effort of supplying certified disease-free trees and the highly successful biological control of ACP, the main vector of HLB. A similar program was also launched in Mauritius with the same success. While success on Reunion Island has been very high, use of the agent in Southeast Asia has been less successful, possibly because of the presence of hyperparasites (in this case, a parasite that attacks *T. radiata*) causing mortality of *T. radiata* (Supriyanto and Whittle, 1991).

T. radiata is established in Florida (Hoy and Nguyen, 2001) but parasitism rates reported in Florida (Tsai et al., 2002; Michaud, 2004; Qureshi et al., 2009) have been lower than generally reported in Reunion Island, Guadeloupe, and Puerto Rico (Aubert and Quilici, 1984; Étienne et al. 2001; Torres et al., 2006; Pluke et al., 2008).

III. Affected Environment

A. Asian Citrus Psyllid

ACP is an insect in the family Psyllidae. It is a pest of citrus and close relatives of citrus, and is the target of *T. radiata*. Psyllids resemble miniature cicadas and are sometimes called jumping plantlice. ACP damages plants through its feeding activities. New shoot growth that is heavily infested by ACP does not expand or develop normally, and is more susceptible to breaking off. While direct damage is serious, there is even greater concern as ACP is an efficient vector of the bacterium that causes HLB.

ACP is found in tropical and subtropical Asia, Afghanistan, Saudi Arabia, Réunion, Mauritius, parts of South and Central America, Mexico, and the Caribbean. In the United States and its territories, this species is present in all or parts of Alabama, California, Florida, Georgia, Guam, Hawaii, Louisiana, Mississippi, Puerto Rico, South Carolina, and Texas.

ACP is known to develop only on members of the plant family Rutaceae including the genera *Aegle, Aelopsis, Afraegle, Atalantia, Balsamocitrus, Citropsis, Citrus, Clausena, Eretmocitrus, Fortunella, Limonia, Merrillia, Microcitrus, Murraya, Naringi, Pampurus, Poncirus, Severina, Swinglea, Toddalia, Vepris,* and *Zanthoxylum*. *Murraya paniculata* (L.) Jack (orange jasmine) and *Citrus* spp. are the preferred hosts of ACP (Aubert, 1987; Halbert and Manjunath, 2004; Yang et al., 2006).

B. North American Psyllid Species

Over 100 psyllid species occur on both native and introduced landscape plants in the United States. Several psyllid species are pests of crops such as pear, potato, and tomato. Each kind of psyllid feeds on only one plant species or closely related group of plants. Most psyllids native to the United States are relatively uncommon and rarely become pests. Psyllid species in North America could possibly be attacked by *T. radiata*;

however, reports from the literature and host-specificity tests have indicated that *T. radiata* is specific to ACP (see discussion under chapter 4, Environmental Consequences).

C. Citrus Resources in North America

Citrus resources in the United States are at risk from ACP and HLB. Production of citrus in the United States includes oranges, tangelos, tangerines, grapefruit, lemons, and limes mainly in the States of Florida, California, Texas, and Arizona. The United States was forecast to produce 11.7 million tons of citrus in 2008–09, down from the 13-million ton crop produced in 2007–08 (USDA–ERS, 2009). The United States is one of the top citrus exporters in the world ranking first in grapefruit, third in oranges, fourth in lemons, and seventh in tangerines (USDA–FAS, 2009). In 2006–07, the United States exported 851,000 tons of citrus with 74 percent of the exports going to Japan, Canada, and Korea (USDA–FAS, 2008). Florida, the leading citrus-producing State, has 576,577 total acres (bearing and nonbearing) devoted to commercial citrus production (FASS, 2009a; FDOC, 2009). There were 271,281 total acres (bearing and nonbearing) of citrus in California in 2008 (USDA–NASS, 2008a). In the Lower Rio Grande Valley of Texas, there are roughly 27,300 bearing acres of citrus and, in Arizona, approximately 21,800 bearing acres devoted to commercial citrus production (FASS, 2009b; USDA–NASS, 2008b).

Nursery operations that produce citrus trees, orange jasmine, curryleaf, and other ACP host plants will be adversely affected by ACP and HLB. For example, according to the 2007 Census of Agriculture, there were 3,549 greenhouse, nursery, and floriculture operations in California, (USDA–NASS, 2009). In Hawaii, there were 1,393 greenhouse, nursery, and floriculture operations within the State (USDA–NASS, 2009). Eighteen commercial citrus operations accounted for 95 percent of the citrus nursery plants produced in Texas in 2008. Many more greenhouse, nursery, and floriculture operations occur in other States that are or could become infested with ACP and HLB. Many of these operations are identified by the Small Business Administration as small businesses.

IV. Environmental Consequences

A. No Action

1. Impact of Spread of ACP and HLB on Hosts of ACP and Citrus Resources

ACP damages citrus by feeding on young foliage, depleting the sap, and causing galling or curling of leaves. High populations feeding on a citrus shoot can kill the growing tip. ACP also causes damage by excreting honeydew that coats plant leaves, allowing the growth of sooty mold that reduces or inhibits sunlight penetration (Chien and Chu, 1996). However, the worst threat is that ACP is an efficient vector of the bacterium which causes HLB. This is the most serious disease of citrus in the world, causing reduced production of fruit and eventual death of the trees. HLB-infected trees show a blotchy, mottled condition of the leaves which results in the development of yellow shoots, the characteristic symptom of the disease. Trees are stunted, decline, and bear very few lop-sided, poor quality fruit. The fruit produced by infected trees is not suitable for either the fresh market or juice processing due to the significant increase in acidity and bitter taste. The lack of effective control measures to prevent the spread of HLB from sites of infestation to other areas and counties could lead to higher production costs and an increase in shortages of citrus fruits and plants to the general economy. This would potentially result in increased costs for survey, detection, and treatment for the control of ACP and HLB as they spread to other areas and counties.

Commercial acreage of citrus in Florida has dropped to 576,577, the lowest level since USDA began tracking citrus acreage in 1966 (FLCM, 2008). Commercial citrus acreage in Florida peaked in 1970 at more than 941,000 acres (FLCM, 2008). As the industry commits millions of dollars to new research to find a cure for HLB, costs to growers are soaring because they are spending more on fertilizer, insecticides, and inspection to limit crop losses and further spread (FLCM, 2008).

Pesticide usage to control ACP has increased significantly in Florida, since the introduction of HLB, with 6 or more applications per year. Application and spray material costs have risen dramatically, as well, from pre-HLB levels of $100 and $80 per acre, up to $140 and $240 per acre post-HLB (Irey, 2008). Prior to this, ACP was considered a minor pest. However, growers must apply both systemic soil drench treatments along with multiple foliar sprays (especially to protect newly planted and young (4 to 8-year old) trees that are more vulnerable to ACP attack because they flush more frequently. This pattern is similar to what has occurred in Brazil, South Africa, and other countries where HLB has been introduced. In Brazil, foliar applications of insecticides have steadily increased from 12 up to 24 per year, and soil treatments from 2 up to 4 per year. In an effort to reduce costs, pesticides with longer residual effects are being substituted. Pesticides also are being applied aerially over large areas to achieve greater control of ACP. There are no effective alternatives that can be used for organic citrus production.

For nurseries in the United States that produce citrus trees, orange jasmine, and curryleaf, the effects of ACP and HLB will be adverse. For areas quarantined for HLB, nursery operations will suffer a complete loss of domestic market access. For areas quarantined only for ACP but not for HLB, nursery operations will incur costs associated with treatment prior to interstate movement of the articles, as well as the loss of market access to other citrus-producing States not currently affected with ACP. As an example of ACP quarantine costs, the Texas State entomologist has estimated the cost of treatments with soil drenches and foliar sprays due to the quarantine in Texas to be approximately $0.24 per plant.

2. Impact from the Use of Other Control Methods

The continued use of chemical controls and previously released biological control agents at current levels would result if the no action alternative is chosen, and may continue even if permits are issued for expanded environmental release of *T. radiata*.

a. Chemical Control

The environmental consequences of many of the insecticides used for control of ACP were analyzed by APHIS (USDA–APHIS, 2009) and will not be discussed further in this document. However, an additional environmental consequence of the use of insecticides for control of ACP is a reduction in occurrence of natural predators of ACP, such as lady beetles, syrphids, and spiders. Following the discovery of HLB in Florida, many growers adopted intensive insecticide programs to control the psyllid (Rogers, 2008; Rogers et al., 2008). Most of the materials used to control ACP are broad-spectrum insecticides which disrupt not only native predators of ACP but also of other citrus pests. Research indicates that *T. radiata* is sensitive to a number of chemicals used in citrus (Hall and Nguyen, unpublished).

b. Biological Control

Native predators and previously released biological control agents will remain in the environment and exert some level of control over ACP. However, these are not adequate to control ACP populations in the United States.

B. Issue permits for expanded release of *T. radiata*

1. Impact of *T. radiata* on Nontarget Psyllids

Host specificity of *T. radiata* to ACP has been demonstrated through field observations and host specificity testing. Other nontarget psyllids are not expected to be attacked by *T. radiata.*

a. Scientific Literature

In scientific literature, the host records of *T. radiata* are listed in the Universal Chalcidoidea Database (http://www.nhm.ac.uk/research-curation/research/projects/chalcidoids/ *last accessed* July 9, 2009), and include *Euphalerus citri, Psylla hyalina, Trioza erytreae* and *Trioza* sp. *E. citri* is a synonym of *D. citri*. It is thought that *Psylla hyalina* and *Trioza erytreae*, as hosts of *T. radiata*, are likely mistaken reports (McDaniel and Morgan, 1972; Nguyen, unpublished data).

b. Host Specificity Testing

Researchers conducted host specificity testing using five native psyllid species—*Glycaspis brimblecombei*, *Ceropsylla sideroxyli*, *Trioza magnoliae*, *Hereropsylla cubana*, and *Pachypsylla* sp. (Nguyen et al., 2009). Each cage that contained either the native psyllids or ACP was inoculated with four females and two males of *T. radiata* from three different source colonies—Northern Vietnam, Southern China, and Pakistan. Three to six replications (cages) per each *T. radiata* colony were used for the test. In the tests, *T. radiata* did not parasitize any of the native psyllid species, only ACP. In addition, an Australian psyllid released into Florida for the biological control of melaleuca (*Boreiolycaspis melaleuca*) was tested but was not parasitized by *T. radiata*. The researchers concluded that *T. radiata* is specific to ACP (Nguyen et al., 2009).

2. Uncertainties Regarding the Environmental Release of *T. radiata*

Once a biological control agent such as *T. radiata* is released into the environment and becomes established, there is a slight possibility it could move from the target insect (ACP) to attack nontarget insects, such as native psyllid species. Native species that are closely related to the target species are the most likely to be attacked (Louda et al., 2003). If other psyllid species were to be attacked by *T. radiata*, the resulting effects could be environmental impacts that may not be easily reversed. Biological control agents such as *T. radiata* generally spread without intervention by man. In principle, therefore, release of these parasitoids at even one site should be considered equivalent to release over the entire area in which potential hosts occur and in which the climate is suitable for reproduction and survival. For example, although not purposely released in Puerto Rico and Texas, *T. radiata* has been found there.

In addition, these agents may not be successful in reducing ACP populations in the continental United States. Approximately 12 percent of all parasitoid introductions have led to significant sustained control of the target pests, but the majority of introductions have failed to provide control of the pest (Greathead and Greathead, 1992) either because introduction did not lead to establishment or establishment did not lead to control (Lane et al., 1999). Actual impacts on ACP populations by *T. radiata* will not be known until after release occurs and post-release monitoring has been conducted. The environmental consequences discussed under the no action alternative may occur even with the implementation of the biological control alternative, depending on the efficacy of *T. radiata* to reduce ACP populations in the continental United States.

3. Cumulative Impacts

"Cumulative impacts are defined as the impact on the environment which results from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions regardless of what agencies or person undertakes such other actions" (40 CFR 1508.7).

USDA–APHIS has undertaken measures to control the artificial spread of ACP and HLB to uninfested areas of the United States since the introduction of HLB in 2005. On September 16, 2005, APHIS issued a Federal Order designating all or parts of 10 affected counties in Florida as quarantined areas, and imposed restrictions on the interstate movement of all ACP and HLB host material from these areas. Since then, it has been necessary to update the restrictions and expand the ACP and/or HLB quarantine areas with subsequent Federal Orders due to the continuing spread of both ACP and HLB. APHIS has issued a total of 12 Federal Orders to impose restrictions on the interstate movement of ACP and HLB host plant material from quarantined areas. APHIS is developing an interim rule that would replace the most recent Federal Order for ACP and HLB. It would codify some of the provisions of the Order, clarify others, and add provisions that APHIS has determined to be necessary since the issuance of the last Federal Order so as to prevent the spread of ACP and HLB to uninfested areas of the United States.

California Department of Food and Agriculture (CDFA) is working to eradicate ACP from the two infested counties in that State and prevent spread into new counties. Since August 28, 2008, CDFA has detected populations of ACP in portions of San Diego, Imperial, Orange, and Los Angeles Counties, and has implemented an aggressive control and quarantine program to protect California from this invasive pest, including survey activities for the pest.

Release of *T. radiata* is not expected to have any negative cumulative impacts in the continental United States because of its host specificity to ACP. Effective biological control of ACP would have beneficial effects for ACP and HLB management programs, and may result in a long-term, non-damaging method to assist in the control of ACP and HLB, and prevent their spread into other areas potentially at risk from invasion.

4. Endangered Species Act

Section 7 of the Endangered Species Act (ESA) and ESA's implementing regulations require Federal agencies to ensure that their actions are not likely to jeopardize the continued existence of federally listed threatened and endangered species, or result in the destruction or adverse modification of critical habitat.

APHIS has determined that, based on the host specificity of *T. radiata*, there will be no effect on any listed insect in the continental United States. In host specificity testing, the biological control organism attacked only ACP. No federally listed threatened or endangered insects belong to the family Psyllidae (FWS–TESS, 2009). In addition, no listed species is dependent on ACP as a food source. Although certain federally listed plants occur in the family Rutaceae and may serve as hosts of ACP, release of *T. radiata* will not benefit any of these species because all occur outside of the continental United States. *T. radiata* will only be released within the continental United States.

V. Other Issues

Consistent with Executive Order (EO) 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations," APHIS considered the potential for disproportionately high and adverse human health or environmental effects on any minority populations and low-income populations. There are no adverse environmental or human health effects from the field release of *T. radiata*, and their release will not have disproportionate adverse effects to any minority or low-income populations.

Consistent with EO 13045, "Protection of Children From Environmental Health Risks and Safety Risks," APHIS considered the potential for disproportionately high and adverse environmental health and safety risks to children. No circumstances that would trigger the need for special environmental reviews are involved in implementing the preferred alternative. Therefore, it is expected that no disproportionate effects on children are anticipated as a consequence of the field release of *T. radiata*.

EO 13175, "Consultation and Coordination with Indian Tribal Governments," was issued to ensure that there would be "meaningful consultation and collaboration with tribal officials in the development of Federal policies that have tribal implications…."
Consistent with EO 13175, APHIS sent letters of notification and requests for comment and consultation on the proposed action to tribes in California, Arizona, and Texas. APHIS will continue to consult and collaborate with Indian tribal officials to ensure that they are well-informed and represented in policy and program decisions that may impact their agricultural interests, in accordance with EO 13175.

VI. Agencies and Organizations Consulted

This EA was prepared and reviewed by APHIS. The addresses of participating APHIS units, cooperators, and consultants (as applicable) follow.

Florida Department of Agriculture and Consumer Services
Division of Plant Industry
P.O. Box 147100
Gainesville, FL 32601

U.S. Department of Agriculture
Animal and Plant Health Inspection Service
Policy and Program Development
Environmental and Risk Analysis Services
4700 River Road, Unit 149
Riverdale, MD 20737

U.S. Department of Agriculture
Animal and Plant Health Inspection Service
Plant Protection and Quarantine
Registrations, Identification, Permits, and Plant Safeguarding
River Road, Unit 133
Riverdale, MD 20737

VII. References

Aubert, B., 1987. Le greening une maladie infectieuse des agrumes, d'origine bactéreenne, transmise pardes homoptéres. Stratégie de lutte développée l'île de la Réunion. Circumstances epidemiologiques en Afrique/Asie et modakitésd'intervention. IRFA/CIAD-B. 97455 Saint Pierre Cedex.

Aubert, B., Grisoni, M., Villemin, M., and Rossolin, G., 1996. A case study of huanglongbing (greening) control in Réunion. *In:* Proc. 13th IOCV Conf., Riverside, California. pp. 276−278.

Aubert, B., and Quilici, S., 1984. Biological control of the African and Asian citrus psyllids (Homoptera: Psylloidea), through eulophid and encyrtid parasites (Hymenoptera: Chalcidoidea) in Reunion Island. pp. 100−108. *In:* S.M. Garnsey, L.W. Timmer, and J.A. Dodds [eds.] Proceedings, 9th Conference of the International Organization of Citrus Virologists, 9−13 November 1983, Argentina. University of California, Riverside, CA.

Bove, J.M., 1986. Greening in the Arabian Peninsula: Toward new techniques for its detection and control. FAO Plant Prot. Bull. 34(1): 7−14.

Chien, C.C., 1995. The role of parasitoids in the pest management of citrus psyllid. Proc. Symp. Res. Develop. Citrus in Taiwan. Pp. 245−261 (in Chinese).

Chien, C.C., and Chu, Y.I., 1996. Biological control of citrus psyllid, *Diaphorina citri*, in Taiwan. Biological pest control in systems of integrated pest management. Fr: FFTC Book Series. No. 47: 93−105.

Chu, Y.I. and Chien, C.C., 1991. Utilization of natural enemies to control psyllid vectors transmitting citrus greening. *In:* K. Kiritana, H.J. Su and Y.I. Chu [eds.], Integrated Control of Plant Virus Diseases. Food and Fertilizer Center for the Asian and Pacific Region. Suppl. No. 1: 135−145.

Chien, C.C, Chiu, S.C., and Ku, S.C., 1989. Biological control of *Diaphorina citri* in Taiwan. Fruits. 44(7−8): 401−407.

Chien, C.C, Chiu, S.C., and Ku, S.C., 2001. Mass rearing and field release of an eulophid wasp, *Tamarixia radiata* (Waters). FFTC Technical Notes No. 2001–5. [Online.] Available: http://www.agnet.org/library/tn/2001005/. [2009, August 5.]

Étienne, J., and Aubert, B., 1980. Biological control of psyllid vectors of greening disease on Reunion Island. *In*: Proc. 8th Conf. IOCV. Pp. 118−121.

Étienne, J., Quilici, S., Marival, D., and Franck, A., 2001. Biological control of *Diaphorina citri* (Hemiptera: Psyllidae) in Guadeloupe by imported *Tamarixia radiata* (Eulophidae). Fruits. 56: 307−315.

FASS—See Florida Agricultural Statistics Service

FDOC—See Florida Department of Citrus

FLCM—See Florida Citrus Mutual

Florida Agricultural Statistics Service, 2009a. Commercial citrus inventory 2008. April 2009. 57 pp.

Florida Agricultural Statistics Service, 2009b. Citrus summary 2007–08. Published March 2009. 55 pp.

Florida Citrus Mutual, 2008. Mutual Board Member Larry Black Discusses Citrus Greening. December 21, 2008. [Online.] Available: http://www.flcitrusmutual.com/news/tbo_larryblack_122108.aspx. [2009, July 10.]

Florida Department of Citrus, 2009. Citrus reference book. May 2009. 102 pp.

FWS—See U.S. Fish and Wildlife Service.

Grafton-Cardwell, E., 2009. Asian citrus psyllid. University of California, Riverside, Center for Invasive Species Research. [Online.] Available: http://cisr.ucr.edu/asian_citrus_psyllid.html. (2009, July 13.)

Greathead, D., and Greathead, A.H., 1992. Biological control of insect pests by parasitoids and predators: the BIOCAT database. Biocontrol News and Information. 13: 61N−68N.

Halbert, S.E., and Manjunath, K.L., 2004. Asian citrus psyllids (Sternorrhyncha: Psyllidae) and greening disease of citrus: a literature review and assessment of risk in Florida. Florida Entomologist. 87: 330−353.

Hoy, M.A., Nguyen, R., and Jeyaprakash, A., 1999. Classical biological control of Asian citrus psylla – release of *Tamarixia radiata*. Citrus Industry. 80: 20−22.

Hoy, M.A., and Nguyen, R., 2001. Classical biological control of Asian citrus psylla. Citrus Industry. 82: 48−50.

Husain, M.A., and Nath, D., 1927. The citrus psylla (*Diaphorina citri*, Kuw.) (Psyllidae: .... Homoptera). Memoir Dept. Agric. India (Entomol. Series). 10: 5−27.

Irey, M.S., Gast, T., and Snively, J., 2008. Economic impact of managing huanglongbing in groves at Southern Gardens Citrus. Presentation 12. *In:* Proceedings, NAPPO International Workshop on HLB and ACP. Hermosillo, Sonora, Mexico, May 2008.

Kohno, K., Takahashi, K., Nakata, T., and Konoshi, K., 2002. Occurrence of the Asian citrus psylla and its parasitic natural enemies in the Ryukyu Archipelago, Japan. Acta Horticulturae. No. 575 (Vol 2): 503−508.

Lama, T.K., Regmi, C., and Aubert, A., 1988. Distribution of the citrus greening disease vector (*Diaphorina citri* Kuw.) in Nepal and attempts to establish biological control. Proc. 10th Conference IOCV 1988. Pp. 255−227.

Lane, S.D., Mills, N.J., and Getz, W.M., 1999. The effects of parasitoid fecundity and host taxon on the biological control of insect pests: the relationship between theory and data. Ecological Entomol. 24:181−190.

Louda, S.M., Pemberton, R.W., Johnson, M.T., and Follett, P.A., 2003. Nontarget effects—the achilles' heel of biological control? Retrospective analyses to reduce risk associated with biological control introductions. Ann. Rev. of Entomol. 48: 365–396.

McDaniel, J.R., and Moran, V.C., 1972. The parasitoid complex of the citrus psylla *Trioza erytreae* (Del. Guercio) (Homoptera: Psyllidae). Entomophaga. 17: 297−317.

McFarland, C.D., and Hoy, M.A., 2001. Survival of *Diaphorina citri* (Homoptera: Psyllidae), and its two parasitoids, *Tamarixia radiata* (Hymenoptera: Eulophidae) and *Diaphorencyrtus aligarhensis* (Homoptera: Encyrtidae), under different relative humidities and temperature regimes. Florida Entomologist. 84: 227−233.

Michaud, J.P., 2002. Biological control of Asian citrus psyllid, *Diaphorina citri* (Hemiptera: Psyllidae) in central Florida: a preliminary report. Entomological News. 113: 216−222.

Michaud, J.P., 2004. Natural mortality of Asian citrus psyllid (Homoptera: Psyllidae) in central Florida. Biological Control. 29: 260−269.

Morakote, R., and Nanta, P., 1995. Current status of biological control research on citrus leafminer, *Phyllocnistis citrella* and Asian citrus psyllid, *Diaphorina citri* Kuwayama in Thailand. *In:* Proc. Semi-Annual Workshop of Integrated Pest Management in Selected Fruit Trees. Pp. 83−87.

Nguyen, R., 2009. Proposed released of *Tamarixia radiata* (Waterston) (Hymenoptera: Eulophidae) into Florida to control *Diaphorina citri* Kuwayama (Hemiptera: Psyllidae). NAPPO petition submitted to USDA–APHIS. 37 pp.

Nguyen, R., Hall, D.G., and Stansly, P.A., 2009. *Tamarixia radiata* host range test, June 1, 2009. Unpublished report submitted to USDA–APHIS, 10 pp.

Pluke, R.W.H., Qureshi, J.A., and Stansly, P.A., 2008. Citrus flushing patterns, *Diaphorina citri* (Homoptera: Psyllidae) populations and parasitism by *Tamarixia radiata* (Hymenoptera: Eulophidae) in Puerto Rico. Florida Entomologist. 91: 36−42.

Qureshi, J.A., and Stansly, P.A., 2009b. Exclusion techniques reveal significant biotic mortality suffered by Asian citrus psyllid *Diaphorina citri* (Hemiptera: Psyllidae) populations in Florida citrus. Biological Control. 50: 129–136.

Rogers, M.E., 2008. General pest management considerations. Citrus Industry. 89: 12−17.

Rogers, M.E., Stansly, P.A., and Stenlinski, L.L., 2009a. Florida citrus pest management guide: Asian citrus psyllid and citrus leafminer. Entomol. Nematol. Dept., Fla. Coop. Ext. Serv., Inst. Food Agri. Sci., Univer. Fla., ENY-734. [Online.] Available: http://edis.ifas.ufl.edu/pdffiles/IN/IN68600.pdf. (2009, July 21.)

Rogers, M.E., Dewdney, M.M., and Futch, S.H., 2009b. Florida citrus pest management guide: pesticides registered for use on Florida citrus. Entomol. Nematol. Dept., Fla. Coop. Ext. Serv., Inst. Food Agri. Sci., Univer. Fla., ENY601. [Online.] Available: http://edis.ifas.ufl.edu/CG017. (2009, July 21.)

Supriyanto, A., and Whittle, A.M., 1991. Citrus rehabilitation in Indonesia. *In:* Proc. 11th Conference IOCV, 1991. Pp. 409−413.

Tang, Y.-Q., 1989. A preliminary survey on the parasite complex of *Diaphorina citri* Kuwayama (Homoptera: Psyllidae) in Fujan. Pp. 10−16. *In:* B. Aubert, K. Chung, and C. Gonzalez [eds.]. Proceedings of the 2nd FAO-UNDP Regional Workshop on the Asian-Pacific Citrus Greening Disease.

Tang, Y.-Q., 1998. A preliminary survey on the parasite complex of *Diaphorina citri* .... Kuwayama (Homoptera: Psyllidae) in Fujian. *In:* B. Aubert, C. Ke, and C. .....Gonzales [eds.], Proc. 2nd Asian/Pacific regional Workshop on citrus greening, Lipa, Philippines, 20−26 November 1988. ROME: UNDP–FAO. Pp. 10−15.

Tang, Y.-Q., and Aubert, B., 1990. An illustrated guide to the identification of parasitic wasps associated with *Diaphorina citr*i Kuwayama in the Asian-Pacific region. Proc. 4th International Asia Pacific Conf. on Citrus Rehabilitation, Chiang Mai, Thailand 1990. Pp. 228−238.

Torres, M.L., Nava, D.E., Gravena, S., Costa, V.A., and Parra, J.R.P., 2006. Registro de *Tamarixia radiata* (Waterston) (Hymenoptera: Eulophidae) em *Diaphorina citri* Kuwayama (Hemiptera: Psyllidae) em São Paulo, Brasil. Rev. de Agricultura, Piracicaba-SP. 81: 112−117.

Tsai, J.H., Wang, J.J., and Liu, Y.H., 2002. Seasonal abundance of the Asian citrus psyllid, *Diaphorina citri* (Homoptera: Psyllidae) in southern Florida. Florida Entomologist. 85: 446−451.

UC IPM—See University of California

USDA–APHIS—See U.S. Department of Agriculture, Animal and Plant Health Inspection Service.

USDA–ERS—See U.S. Department of Agriculture, Economic Research Service.

USDA–FAS—See U.S. Department of Agriculture, Foreign Agricultural Service

USDA–NASS—See U.S. Department of Agriculture, National Agricultural Statistics Service.

U.S. Department of Agriculture, Animal and Plant Health Inspection Service, 2009. Quarantine and interstate movement of citrus greening and Asian citrus psyllid, environmental assessment. June 2009.

U.S. Department of Agriculture, Economic Research Service, 2009. Fruit and tree nuts outlook. 44 pp. [Online.] Available: http://www.ers.usda.gov/Publications/FTS/2009/FTS336.pdf. (2009, July 10.)

U.S. Department of Agriculture, Foreign Agricultural Service, Office of Global Analysis, 2009. World markets and trade: citrus. February 2009. 15 pp.

U.S. Department of Agriculture, National Agricultural Statistics Service, 2009. United States: summary and State data, volume 1, 2007. Census of Agriculture, issued February 2009.

U.S. Department of Agriculture, National Agricultural Statistics Service, 2008a. 2008 California citrus acreage report. [Online.] Available: http://www.nass.usda.gov/Statistics_by_State/California/Publications/Citrus/200811citac.pdf. (2009, July 10.)

U.S. Department of Agriculture, National Agricultural Statistics Service, 2008b. Citrus fruits—2008 Summary. Publication No. Fr Nt 3-1 (08). 53 pp.

University of California, 2009. UC IPM Online. Statewide integrated pest management program. [Online.] Available: http://www.ipm.ucdavis.edu/EXOTIC/diaphorinacitri.html. (2009, July 10.)

U.S. Fish and Wildlife Service, 2009. Threatened and endangered species system. [Online.] Available: http://ecos.fws.gov/tess_public/. (2009, July 14.)

Waterston, J., 1922. On the chalcidoid parasites of psyllids (Hemiptera, Homoptera). Bull. of Entomol. Res. 13: 41−58.

Yang, Y., Huang, M., Beattie, G.A.C., and Xia, Y., 2006. Distribution, biology, ecology and control of the psyllid *Diaphorina citri* Kuwayama, a major pest of citrus: a status report from China. Intl. J. of Pest Mgmt. 52: 342−352.

Decision and Finding of No Significant Impact
for
Proposed Release of a Parasitoid (*Tamarixia radiata* Waterston)
for the Biological Control of Asian Citrus Psyllid (*Diaphorina citri* Kuwayama) in the Continental United States
June 2010

The U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Plant Protection and Quarantine (PPQ) Permit Unit, is proposing to issue permits for release of an insect, *Tamarixia radiata* Waterston (Hymenoptera: Eulophidae) in the continental United States. The agent would be used by the applicant for the biological control of Asian citrus psyllid, *Diaphorina citri* Kuwayama (Hemiptera: Psyllidae). Before permits are issued for release of *T. radiata*, APHIS must analyze the potential impacts of the release of this organism into the continental United States. APHIS has prepared an environmental assessment (EA) that analyzes the potential environmental consequences of this action. The EA is available from:

U.S. Department of Agriculture
Animal and Plant Health inspection Service
Plant Protection and Quarantine
Registrations, Identification, Permits, and Plant Safeguarding
4700 River Road, Unit 133
Riverdale, MD 20737
http://www.aphis.usda.gov/plant_health/ea/index.shtml

The EA analyzed the following two alternatives in response to a request for permits authorizing environmental release of *T. radiata*: (1) no action, and (2) issue permits for the release of *T. radiata* for biological control of Asian citrus psyllid. A third alternative, to issue permits with special provisions or requirements concerning release procedures or mitigating measures, was considered. However, this alternative was dismissed because no issues were raised that indicated that special provisions or requirements were necessary. The No Action alternative, as described in the EA, would likely result in the continued use at the current level of chemical and biological control methods for the management of Asian citrus psyllid. These control methods described are not alternatives for decisions to be made by the Permit Unit, but are presently being used to control Asian citrus psyllid in the United States and may continue regardless of permit issuance for field release of *T. radiata*. Notice of the EA was made available in the Federal Register on May 20, 2010 for a 30-day public comment period. Four comments were received on the EA, all in favor of the release of *T. radiata*.

I have decided to authorize the APHIS–PPQ Permit Unit to issue permits for the environmental release of *T. radiata*. The reasons for my decision are:

- This biological control agent is sufficiently host specific and poses little, if any, threat to the biological resources, including non-target psyllid species, of the continental United States.

- The release will have no effect on federally listed threatened and endangered species or their habitats in the continental United States.

- *T. radiata* poses no threat to the health of humans or wild or domestic animals.

- No negative cumulative impacts are expected from release of *T. radiata.*

- There are no disproportionate adverse effects to minorities, low-income populations, or children in accordance with Executive Order 12898 "Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations" and Executive Order 13045, "Protection of Children from Environmental Health Risks and Safety Risks."

- While there is not total assurance that the release of *T. radiata* into the environment will be reversible, there is no evidence that this organism will cause any adverse environmental effects.

An environmental impact statement (EIS) must be prepared if implementation of the proposed action may significantly affect the quality of the human environment. I have determined that there would be no significant impact to the human environment from the implementation of any of the action alternatives and, therefore, no EIS needs to be prepared.

M. J. Firko — 06/22/2010

Dr. Michael J. Firko
Director
Registrations, Identification, Permits, and Plant Safeguarding
Plant Health Programs
APHIS, Plant Protection and Quarantine

Date