United States
Department of
Agriculture

Marketing and
Regulatory
Programs

Animal and
Plant Health
Inspection
Service

Field Release of *Encarsia diaspidicola* (Hymenoptera: Aphelinidae) for Biological Control of White Peach Scale, *Pseudaulacaspis pentagona* (Hemiptera: Diaspididae), in Hawai'i

Environmental Assessment, June 2011

Field Release of *Encarsia diaspidicola* (Hymenoptera: Aphelinidae) for Biological Control of White Peach Scale, *Pseudaulacaspis pentagona* (Hemiptera: Diaspididae), in Hawai'i

Environmental Assessment, June 2011

Agency Contact:

Shirley Wager-Page, Branch Chief
Pest Permitting
Plant Protection and Quarantine
Animal and Plant Health Inspection Service
U.S. Department of Agriculture
4700 River Road, Unit 133
Riverdale, MD 20737–1236

Table of Contents

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) Pest Permitting Branch (PPB) is proposing to issue permits for release of the insect *Encarsia diaspidicola* Silvestri (Hymenoptera: Aphelinidae). The agent would be used by the applicant for biological control of white peach scale, *Pseudaulacaspis pentagona* (Hemiptera: Diaspididae), in Hawaiʻi. Before permits are issued for release of *E. diaspidicola*, the APHIS–PPQ PPB needs to analyze the potential impacts of the release of this agent into Hawaiʻi.

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 *E. diaspidicola* to control white peach scale in Hawaiʻi. This EA considers a "no action" alternative and the potential effects of the proposed action.

The applicant's purpose for releasing *E. diaspidicola* is to reduce the severity of infestations of white peach scale (*P. pentagona*) on papaya in Hawaiʻi. White peach scale is a serious pest of papaya (*Carica papaya* L.) in Hawaiʻi. It was first collected in Hawaiʻi in 1997 on papaya and has spread to all production areas on the island of Hawaiʻi. The scale also occurs on the Hawaiian Islands of Oʻahu and Kauaʻi. White peach scale poses a serious threat to the Hawaiian papaya industry as a source of plant stress, fruit downgrading and culling, and quarantine restrictions. A number of predatory beetles in the insect family Coccinellidae and some parasitic insects attack white peach scale but do not suppress populations effectively (PMSP, 2008). There has been limited success in control of white peach scale in the field (Follett, 2000).

Existing white peach scale management options (discussed below) are ineffective, expensive, temporary, or have non-target impacts. For these reasons, the applicant has a need to identify an effective, host-specific biological control organism and release it into the environment of Hawaiʻi for the control of white peach scale.

[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).

II. Alternatives

This section will explain the two alternatives available to the APHIS–PPQ PPB—no action (no issuance of permits) and issuance of permits for environmental release of *E. diaspidicola* in Hawaiʻi. Although APHIS' alternatives are limited to a decision of whether to issue permits for release of *E. diaspidicola,* other methods available for control of white peach scale in Hawaiʻi are also described. These control methods are not decisions to be made by APHIS, and are likely to continue whether or not permits are issued for environmental release of *E. diaspidicola*. These are methods presently being used to control white peach scale by papaya growers in Hawaiʻi.

A third alternative was considered, but will not be analyzed further. Under this third alternative, the APHIS–PPQ PPB would have issued permits for the field release of *E. diaspidicola*, however, the permits would contain special provisions or requirements concerning release procedures or mitigating measures, such as limited release of *E. diaspidicola* in Hawaiʻi. No issues have been raised which would indicate that special provisions or requirements are necessary.

A. No Action

Under the no action alternative, the APHIS–PPQ PPB would not issue permits for the field release of *E. diaspidicola* for the control of white peach scale—the release of this biological control agent would not take place. The following methods are presently being used to control white peach scale on papaya in Hawaiʻi; these methods will continue under the "no action" alternative and are likely to continue even if permits are issued for release of *E. diaspidicola*. Presently, control of white peach scale in Hawai'i is limited to chemical, cultural, and post-harvest control methods.

1. Chemical Control

Control methods are often best directed at the larval or crawler stages which are the most vulnerable (Branscome, 2009). Traditional methods of control have included various insecticidal oils as well as a number of other insecticides. Where this insect is found in Hawaiʻi, it is a year-round pest and must be controlled throughout all stages of papaya growth and production. The following insecticides are used in Hawaiʻi by papaya growers to control white peach scale (PMSP, 2008):

- Azadirachtin
- Malathion
- Imidacloprid
- Potassium salts of fatty acids
- Pyriproxyfen
- Various petroleum distillate oils, solvents, or hydrocarbons, also

paraffinic hydrocarbons, aliphatic hydrocarbons, and paraffinic oil

2. Cultural Control

Leaves, wood, and fruit often provide pests with places to complete their development or to survive the winter. Field sanitation (removing and destroying dead, diseased and damaged wood and fruit) provides fair control of white peach scale (PMSP, 2008).

3. Post Harvest Treatments

Post-harvest treatments, including forced hot air treatment, irradiation, brushing, and vapor heat treatment are used to eliminate white peach scale on fruit prior to shipment because presence of this insect on fruit surfaces can result in delays at the port of entry or rejection of the shipment.

B. Issue Permits for Environmental Release of *E. diaspidicola.*

Under this alternative, the APHIS–PPQ PPB would issue permits upon request and after evaluation of each application for the field release of *E. diaspidicola* for the control of white peach scale in Hawaiʻi. These permits would contain no special provisions or requirements concerning release procedures or mitigating measures.

a. Biological control organism information

1. Taxonomic Information

Insect Taxonomy

Order:	Hymenoptera
Family:	Aphelinidae
Genus:	*Encarsia*
Species:	*diaspidicola* (Silvestri)
Common name	none

Encarsia diaspidicola (Silvestri) (Hymenoptera: Aphelinidae) was identified on January 9, 2007 by Gregory Evans at the USDA-APHIS-PPQ National Identification Services (NIS) in Beltsville, Maryland. Voucher specimens were deposited at the NIS and at the USDA-Agricultural Research Service laboratory in Hilo, Hawaiʻi.

2. Description and Biology

Encarsia spp. are tiny (about 1 millimeter in length), stingless wasps. Like all parasitic wasps, the immature stages develop as parasites of arthropods. Many species of *Encarsia* have demonstrated their importance in the biological control of whiteflies (Aleyrodidae) and armored scale insects (Diaspididae) (Noyes, 2003).

Encarsia diaspidicola is a solitary, endoparasitic wasp. An endoparasite is a parasite that lives within another organism. It is thelytokous (produces only females from unfertilized eggs) (Neumann et al., 2010). Adult females deposit eggs singly in immature stages of white peach scale (Neumann et al., 2010). The development time of *E. diaspidicola* at 23°

Celsius (C) is 30–35 days (Neumann et al., 2010). The emerging adult wasps live for 3–6 days and spend most of their time searching for suitable hosts (Neumann et al., 2010).

3. Geographic Range

The range of *E. diaspidicola* includes South Africa (Silvestri, 1909), Brazil (Dozier, 1933), Haiti (Dozier, 1933), Puerto Rico and Vieques Island (Dozier, 1933), China, Fujian, and Guangdong (Huang and Polaszek, 1998). (As cited in Heraty et al., 2007)

4. Impact on White Peach Scale

Encarsia diaspidicola develops as an endoparasite of armored scales (Diaspididae). Adult wasps deposit eggs into immature stages of white peach scale. Eggs hatch inside the host scale and go through several juvenile (larval) stages, eventually consuming the host scale entirely and killing it. The wasp then goes through a pupal stage and when it emerges as an adult, it leaves the host scale by chewing a hole through the remaining scale cover.

Encarsia diaspidicola was released into Western Samoa for biological control of white peach scale on passion fruit vines (*Passiflora edulis* var. *flavicarpa*) and has been an effective biological control agent significantly lowering white peach scale populations (Liebregts et al., 1989). Because of its successful establishment and control of white peach scale populations in Samoa, which has a similar climate to Hawaiʻi, *E. diaspidicola* was selected as a biological agent and was imported into Hawaiʻi from Samoa in 2006 (Neumann et al., 2010).

III. Affected Environment

Although white peach scale can develop on many host plants, in Hawaiʻi it is only known as a crop pest in papaya. Infestation can rapidly increase to levels where large areas of the trunks of papaya trees are completely covered by white peach scales. Overcrowding causes spread up the trunk, and in heavily infested trees, scales move up onto the fruit. White peach scale on the fruit is a quarantine problem. Infested fruit shipments may be rejected in California, and Japan, a very important market for Hawaiʻi papayas, has zero tolerance for white peach scale. Infested fruits may be brushed, at considerable cost. Fields may be abandoned if white peach scale infestation is high. White peach scale can also decrease plant vigor and yield.

Female white peach scales deposit all their eggs (approximately 100–150 total/female) in about a week. Eggs hatch in 3-4 days and the young scales (“crawlers”) settle on the host plants within two days after hatching. Crawlers do not actively disperse far from the point of hatching but can be spread by the wind. Crawlers settle and begin feeding within two days and complete development in about a week. Once they settle they remain attached to the host plant throughout their lives. Two subsequent molts requiring about three weeks time produce adult females. Females complete development in about three weeks. During their development, they form a slightly oval waxy cover over their bodies. Second instar males form an oblong cover, and after three molts, emerge as adults 19 to 22 days later. Adult males are winged and immediately start mating with females. Egg laying by females begins 14 to 16 days after mating. A generation is completed in 36 to 40 days at 25 °C (Miller and Davidson, 2005).

A. Areas Affected by White Peach Scale

1. Native and Worldwide Distribution

White peach scale is native to eastern Asia (Miller and Davidson, 2005) and is now a cosmopolitan pest.

2. Present Distribution in the United States

In the United States, white peach scale is found primarily in the southeast, although it has been reported as far west as Texas and in northern states up to Maine (Branscome, 2009). White peach scale was first found in Hawaiʻi in 1997 on papaya. It is distributed throughout the papaya production areas of the island of Hawaiʻi and it is known to occur on Oahʻu and Kauaiʻi. This insect is an important economic pest of peach trees as well as woody ornamentals in the southeastern United States (Branscome, 2009).

3. Hosts

Hosts of white peach scale have been reported from 108 genera in 55 families (Borchsenius, 1966 *in litt.*). Dekle (1977 *in litt.*) reports it from 115 genera in Florida with *Callicarpa, Diospyros, Melia,* and *Prunus* as the most frequently reported (Miller and Davidson, 2005).

4. Habitat

In Hawaiʻi, papayas are the main host of white peach scale although the scale has many other potential hosts. Papaya is a tropical crop that cannot tolerate freezing temperatures and does best at sea level to 500 feet elevation in Hawaiʻi (PMSP, 2005), although temperatures above 90–95°F may induce female sterility (Nishina et al., 2000). Commercial papaya production is limited to low-elevation areas where the minimum temperature is above 60° F (Nishina et al., 2000). A minimum monthly rainfall of 4 inches and an average relative humidity of 66 percent are considered ideal for papaya growth and production (Nishina et al., 2000). Good soil drainage, adequate air movement, and protection from wind are also important factors for papaya growth (Nishina et al., 2000). Of Hawaiʻi's total papaya production acreage, 92 percent occurs on the island of Hawaiʻi, 6 percent on Oʻahu, Molokaʻi and Maui, and 2 percent on Kauaʻi (PMSP, 2005). The main production region on the island of Hawaiʻi in the Puna District, located on the east side of the island (PMSP, 2005).

B. Insects Related to White Peach Scale in Hawaiʻi

1. Insects Taxonomically Related to White Peach Scale in Hawaiʻi

Information regarding insects taxonomically related to white peach scale is included because insect species which are closely related to it have the most potential to be attacked by *E. diaspidicola*.

There are no native diaspidid scales in Hawaiʻi, but three endemic palm scales have been described in the family Halimococcidae (Neumann et al., 2010), earlier classified as members of Diaspididae (Beardsley, 1963). All three are species endemic to the Hawaiian Islands, and are associated with *Pritchardia* sp. *Colobopyga pritchardiae*, is reported on the islands of Hawaiʻi, Oahʻu, and Molokaʻi; *Colobopyga browni* has been reported from Oahʻu; *Platycoccus tylocephalus* is known to occur on Oahʻu and Nihoa (Neumann et al., 2007).

IV. Environmental Consequences

A. No Action

1. Impact of White Peach Scale on the Environment

a. Effect of white peach scale on host plants

White peach scale is one of the most polyphagous armored scale insects in the world (Miller and Davidson, 2005). It is a pest of peach and other stone fruits but feeds on many other plants of economic and ornamental value. Some of the most frequently infested ornamentals are chinaberry, flowering peach, French mulberry, and persimmon; but other hosts include catalpa, lilac, privet, and walnut. The white peach scale feeds on the bark, fruit, or leaves of the host plant. Its feeding can cause stunting, leaf drop, and death of entire branches. Fruit size may be reduced and premature drop is likely to occur.

2. Impact from the Use of Other Control Methods

The continued use of chemical and cultural controls and post harvest treatments at current levels would result if the “no action” alternative is chosen, and may continue even if permits are issued for environmental release of *E. diaspidicola.*

a. Chemical Control

Control of white peach scale with available chemical insecticides is not effective (Follett, 2000). In addition, insecticide treatments are expensive to apply and are not specific to white peach scales.

b. Mechanical Control

Field sanitation (removing and destroying dead, diseased and damaged wood and fruit) provides only fair control of white peach scale (PMSP, 2008).

c. Post harvest treatments

Post harvest treatments are effective in eliminating white peach scale from harvested fruit prior to shipment but do not reduce white peach scale populations in the environment.

These environmental consequences may occur even with the implementation of the biological control alternative, depending on the efficacy of *E. diaspidicola* to reduce white peach scale infestations in Hawaiʻi.

B. Issue Permits for Environmental Release of *E. diaspidicola*

1. Impact of *E. diaspidicola* on Non-target Insects

Scientific Literature

In the scientific literature, *E. diaspidicola* is reported only from white peach scale (Huang and Polaszek, 1998) and *Quadraspidiotus pernicious*, San Jose scale (Peck, 1963). As there have been no reports since of *E. diaspidicola* attacking San Jose scale, this second record may be erroneous (Neumann et al,. 2010).

Host Specificity Testing

No-choice host specificity studies were conducted at Hawaiʻi Volcanoes National Park Quarantine Facility (Neumann et al., 2010, Appendix 1). In no choice, limited time exposure experiments, white peach scale, false oleander scale, coconut scale, and cycad scale insects were exposed to 20 *E. diaspidicola* wasps for 72 hours. No wasps emerged from non-target scales. In no-choice experiments where white peach scale, false oleander scale, coconut scale, cycad scale, greenhouse whitefly, green scale, and long-tailed mealybug were exposed to 20 *E. diaspidicola* wasps for the entire lifespan of the wasps, no wasps emerged from the non-target species. No-choice host specificity studies also included *Colobopyga pritchardiae* as a representative of the halimococcids endemic to Hawaiʻi and molecular methods were used to determine whether *E. diaspidicola* would parasitize it on its natural palm host, *Pritchardia* sp. The molecular data showed that *C. pritchardiae* is not parasitized by *E. diaspidicola* (Neumann et al., 2010, Appendix 1).

No-choice host specificity studies provided evidence that *E. diaspidicola* is highly host specific, even within the family Diaspididae (armored scales). *Encarsia diaspidicola* did not parasitize any of the species tested, including the white peach scale congener false oleander scale, *Pseudalaucaspis cockerelli* (Neumann et al., 2010, Appendix 1). There are no native diaspidid scales in Hawaiʻi, but three endemic palm scales have been described in the insect family Halimococcidae, earlier classified as members of Diaspididae (Beardsley, 1963). Host-specificity studies indicated that *E. diaspidicola* did not parasitize *C. pritchardiae* (Neumann et al., 2010, Appendix 1). .

2. Uncertainties Regarding the Environmental Release of *E. diaspidicola.*

Once a biological control agent such as *E. diaspidicola* is released into the environment and becomes established, there is a slight possibility it could move from the target insect (white peach scale) to attack nontarget insects, such as native scale species. Native species that are closely related to the target species are the most likely to be attacked (Louda et al., 2003). If other scale species were to be attacked by *E. diaspidicola*, the resulting effects could be environmental impacts that may not be easily reversed. Biological control agents such as *E. diaspidicola* 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.

In addition, these agents may not be successful in reducing white peach scale populations in Hawaiʻi. 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 white peach scale populations by *E. diaspidicola* 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 *E. diaspidicola* to reduce white peach scale populations in Hawaiʻi.

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).

In Hawaiʻi, papaya is attacked by a complex of pests and diseases that impact plant health, reduce yields, and pose phytosanitary risks (PMSP, 2008). Some of these pests include white peach scale, papaya mealybug, papaya ringspot virus, nematodes, snails and slugs, weeds, and anthracnose fruit rots. A variety of techniques are used to combat these pests, such as genetic engineering, pesticides, trapping and baiting, field sanitation, and biological control (PMSP, 2008).

Several biological control organisms are used for control of various papaya arthropod pests in Hawaiʻi. Papaya mealybug biological control is being implemented through mass rearing of *Anagyrus loecki* (Hymenoptera: Encyrtidae) at the University of Hawaiʻi and redistribution of the wasps to various locations (PMSP, 2008). *Stethorus* species beetles and other predatory mites and thrips are used for the biological control of spider mites (PMSP, 2008). Several species of parasitoid wasps have been released to control aphid pests of papaya (PMSP, 2008).

Labybird beetles, or ladybugs, (Coccinellidae) (i.e., *Lindorus lophanthae* (Blaisdell) and *Telsimia nitida* (Chapin)) have been introduced and become established in Hawaiʻi to control armored scales (Tenbrink and Hara, 1992). These beetle adults and larvae are carnivorous, eating soft-bodied insects. In Hawaiʻi at least three wasp species, *Arrhenophagus albipes* (Encyrtidae), *Aspidiotiphagus citrinus* (Aphelinidae), and *Aphytis chrysomphali* (Aphelinidae) are known to parasitize armored scales (Tenbrink and Hara, 1992). *Arrhenophagus albitibiae* (Girault) is a white peach scale parasitoid already present in Hawaiʻi. Competition or superparasitism (host is attacked more than once by its parasitoids) could occur between *E. diaspidicola* and *A. albitibiae* but there are currently no studies that have investigated interspecific interactions between them (Neumann et al., 2010, Appendix 1).

Release of *E. diaspidicola* is not expected to have any negative cumulative impacts in Hawai'i because of its host specificity to white peach scale. Effective biological control of white peach scale will have beneficial effects for papaya growers in Hawaiʻi, and may result in a long-term, non-damaging method to assist in the control of white peach scale without adversely impacting other methods of papaya pest control.

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 *E. diaspidicola,* there will be no effect on any listed insect species or designated critical habitat in Hawaiʻi. In host specificity testing, *E. diaspidicola* survived only on white peach scale. No federally listed threatened or endangered insects belong to the armored scale family Diaspididae (USFWS, TESS, 2011). No federally listed species are known to depend on or utilize white peach scale.

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 anticipated from the field release of *E. diaspidicola* and its 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, no disproportionate effects on children are anticipated as a consequence of the field release of *E. diaspidicola*.

VI. Agencies, Organizations, and Individuals Consulted

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

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
4700 River Road, Unit 133
Riverdale, MD 20737

Dr. Peter A Follett
Research Entomologist
U.S. Department of Agriculture
Agricultural Research Service

Tropical Crop and Commodity Protection Research
64 Nowelo Street
Hilo, HI, 96720

VII. References

Beardsley, J. W. 1963. Notes on Hawaiian Phoenicoccinae, with description of a new species. Pac. Insects. 5: 59–64.

Borchsenius, N.S. 1966. Bases of classification of armored scales. Entomologicheskoe Obozrenie. 44: 326–376.

Branscome, D. 2009. White Peach Scale, *Pseudaulacaspis pentagona* (Targioni) (Insecta: Hemiptera: Diaspididae). University of Florida, IFAS Extension, EENY-076. 4 pp.

Dekle, G.W. 1977. Florida Armored Scale Insects. Arthropods of Florida and Neighboring Land Areas, Vol. 3, 345 pp.

Dozier, H.L. 1933. Miscellaneous notes and descriptions of Chalcidoid parasites (Hym). Proceedings of the Entomological Society of Washington. 35: 85−100.

Follett, P.A. 2000. Arthropod pests of papaya in Hawaii. Chronica Horticulturae. 40: 7–10.

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.

Heraty, J., J. Wooley, and A. Polaszek. 2007. Catalog of the *Encarsia* of the World. http://cache.ucr.edu/~heraty/Encarsia.cat.pdf *last accessed* February 17, 2011.

Huang, J. and Polaszek, A. 1998. A revision of the Chinese species of *Encarsia* Foerster (Hymenoptera: Aphelinidae): parasitoids of whiteflies, scale insects and aphids (Hemiptera: Aleyrodidae, Diaspididae, Aphidoidea). Journal of Natural History. 32: 1825−1966.

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.

Liebregts, W.J.M.M., D.P.A. Sands, and A.S. Bourne. 1989. Population studies and biological control of *Pseudaulacaspis pentagona* (Targiona-Tozetti) (Hemiptera: Diaspididae) on passion fruit in Western Samoa. Bulletin of Entomological Research. 79: 163–171.

Louda, S.M., R.W. Pemberton, M.T. Johnson, and P.A. Follett. 2003. Nontarget effects—the Achilles' heel of biological control. Retrospective analyses to reduce risk associated with biological control introductions.

Annual Rev. Entomol. 48: 365–396.

Miller, D.R., and J.A. Davidson. 2005. Armored Scale Insect Pests of Trees and Shrubs. Cornell University Press.

Neumann, G., P.A.Follett, R.G. Hollingsworth, and J.H. de León. 2010. High host specificity in *Encarsia diaspidicola* (Hymenoptera: Aphelinidae), a biological control candidate against the white peach scale in Hawaii. Biological Control. 54: 107–113.

Neumann, G., R.G. Hollingsworth, and P.A. Follett. 2007. First record of the endemic Hawaiian scale *Colobopyga pritchardiae* (Hemiptera: Halimococcidae) on the Island of Hawaii. Proceedings of the Hawaiian Entomological Society. 39: 39–41.

Nishina, M., F. Zee, R. Ebesu, A. Arakaki, R. Hamasaki, S. Fukada, N. Nagata, C.L. Chia, W. Nishijima, R. Mau, and R. Uchida. 2000. Papaya Production in Hawaii. Cooperative Extension Service, College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa. F&N-3, June 2000. 8 pp.

Noyes, J.S. 2003. Universal Chalcidoidea Database. The Natural History Museum, London. http://www.nhm.ac.uk/research-curation/research/projects/chalcidoids/introduction.html *last accessed* March 14, 2011.

Peck, O. 1963. A catalogue of the Nearctic Chalcidoidea (Insecta: Hymenoptera). Canadian Entomologist, Supplement 30: 1092 pp.

Pemberton, R.W., 2000. Predictable risk to native plants in weed biological control. Oecologia. 125: 489–494.

Pest Management Strategic Plan for Papaya Production in Hawaii (PMSP). 2008. L.N. Constantinides and J.J. McHugh [eds.]. http://www.ipmcenters.org/pmsp/pdf/HIPapayaPMSP.pdf *last accessed* March 21, 2011.

Silvestri, F. 1909. Notizie e descrizioni preliminari di insetti parssiti della *Diaspis pentagona*. II-III. Nouva specie di Aphelininae (Hymenoptera Chalcidoidea) del Giapponme *Archemonus orientalis* sp. n. *rendiconti*. Accad. Nazionale dei Lincei (Ser. 5). 18: 564–565.

Tenbrink, V. and A.H. Hara. *Aspidiotus nerii* (Bouche). Crop Knowledge Master. http://www.extento.hawaii.edu/kbase/crop/type/a_nerii.htm *last accessed* March 16, 2011.

Appendix 1. Host specificity tests for *Encarsia diaspidicola* (Neumann et al., 2010).

Appendix 2. Response to comments.

One comment was submitted on the draft environmental assessment for release of *E. diaspidicola* for biological control of white peach scale in Hawaiʻi. The issues raised are indicated in bold text and the response follows.

1. If the other methods of pest control will be used when the wasp is released, such as pesticides, will that not impact the wasps? If there are impacts, why are there no pesticide restrictions being put in place? Given the variety of other pests and diseases that attack papaya, it is reasonable to assume that pesticides will continue to be used. There will also still need to be post harvest treatment for these other problems. What, then, is the benefit of releasing the wasp when it will not likely result in reduced chemical use, and the chemical use may kill the wasps?

Insecticides are generally harmful to natural enemies, and this is likely the case for *Encarsia diaspidicola*. Pesticides (insecticides, fungicides and herbicides) are normally used in conventional papaya production in Hawaiʻi, but *E. diaspidicola* should be able to establish and persist, because it spends most of its life cycle protected inside the scale, and because it will attack scales in abandoned and organic orchards where pesticide are not used. White peach scale is an economic pest causing plants stress, and a quarantine pest that can cause rejection of fruit by importers (mainly California and Japan) or culling of fruit. Pesticide use is likewise affected by economics, and because of cost, pesticides are often not used until pest levels exceed certain thresholds. There are many examples in agriculture over the decades where successful classical biological control controlled a pest that previously received frequent pesticide applications. For example, the California red scale, a serious citrus pests in California for many years, was effectively brought under control by a parasite. Growers who withheld DDT applications and allowed the parasite to build up on the scale saw the scale infestations drop well below even those levels on sprayed trees (Huffaker, 1971). Once the *E. diaspidicola* is released, the permittee can encourage farmers to stop directing sprays at white peach scale.

2. Without knowing how the pesticides used in growing papaya will impact the wasp, you do not know how effective the wasps might be in commercial papaya fields. It seems this is important to know, since the primary rationale for this release is to reduce which peach scale on the papaya, and the wasp will to some unknown degree be reduced in numbers and effectiveness in sprayed fields. In addition, it seems that the big problem with this scale, as well as other pests such as fruit flies, is that the papaya fields are abandoned with the living papaya. Clearly, these abandoned fields are a reservoir of pests, and it would be beneficial to cut down the papaya when production is over. This should be easy to do with a machete and some manual labor. It seems that this cause of the pest problem is not being addressed, and should be addressed in this EA as an alternative to the proposed action. If these papaya trees in abandoned fields are routinely destroyed by the farmers, the reduction in white peach scale could be significant, and could obviate the need for this release, which, as in all biocontrol releases, entails some risk. It would also reduce fruit fly problems and other papaya diseases made worse by these abandoned fields.

Good sanitation is assists in management of white peach scale, and it is useful to remove trees and fruit after harvesting is done, but this is a labor decision for the farmer. Abandoned orchards are not the source of the white peach scale problem as they are only a small fraction of the planted area of papaya. Many times more white peach scales are found in managed papaya orchards than abandoned orchards.

The consideration of removal of papaya trees from abandoned orchards is beyond the authority of the PPQ-Pest Permitting Branch, does not meet the need of the permit applicant, and is beyond the scope of this environmental assessment, and thus will not be considered further as an alternative to the proposed action in this document.

3. The specificity tests did not include hosts other than scale insects. Some *Encarsia* wasps attack lepidopteran eggs. I also know that some past biocontrol parasitoids are attacking the Kamehameha butterfly larvae, and the larvae of the mamane moths that feed the palila bird. Why were these and other species of lepidopterans not tested as potential hosts of the proposed parasitoid? To test for the potential for rapid evolution, in which these wasps can adapt or evolve to attack new hosts, there should be multi-generational studies. I realize this is currently not done as part of the testing protocol, however, it should be. You will not see a mutational or adaptational change without studying the insect over time and over dozens of generations. When considering nontarget impacts, this potential for a change in parasitoid preferences should be addressed, and this requires temporal studies.

Some *Encarsia* spp. will attack lepidopteran species. However, within the subgroup of *Encarsia* to which *E. diaspidicola* belongs, no attack of lepidopteran species has been reported. Therefore, the applicant focused host specificity studies on the close relatives (armored scales, soft scales, whitefly) of white peach scale, including native Hawaiian scales, as these would be the most likely non-target species to be attacked by *E. diaspidicola*.

E. diaspidicola has followed a path of increased host specialization, to the point where it appears to be monophagous (a type of specialized feeding in animals, in which the diet consists of a single food) on white peach scale. Although hosts shifts may occur, they are uncommon.

4. The EA did not mention what species in Hawaiʻi may be using the white peach scale as a food source, apart from saying no protected species uses them. Does anything? Could reducing the population of these scales have secondary impacts on another species that uses them for food?

Only one other parasitic wasp attacks white peach scale as well as two small ladybeetles that feed on many insects.

5. The EA does not mention any potential human health impacts from exposure to these wasps. What do you expect could be their population density in areas of Puna near papaya fields? As tiny flying insects, could these wasps become a nuisance to people or animals? Are they allergenic? Are they attracted to light? (Speaking of the adult, emergent stage. I realize the other stages are inside the scale.). Could humans have an allergenic response to

swarms of these insects? Could humans with respiratory issues (i.e., asthma) be affected by these insects? Will this insect become a nuisance?

Encarsia diaspidicola is a minute stingless wasp. It has an ovipositor to lay eggs in the host but does not "sting" humans. The adult wasp is very tiny (about the size of two of the periods at the end of this sentence) and very difficult to see without magnification. It is unlikely that anyone will ever see this parasitic wasp due to its exceedingly small size. One wasp typically emerges from one scale, thus, the number of wasps will never exceed the number of scales. Furthermore, in classical biological control, typically the parasite population gradually builds up generation by generation, year by year, on the pest population. The population level of the pest consequently subsides as numbers are lost to parasitism. Thus, the peak pest population is not all parasitized at once, but gradually reduced. Eventually, as the pest population is reduced over time, not only are fewer parasites produced, but locating hosts becomes less efficient for the parasites, and parasitism rates begin to drop. Swarms are not expected to occur. The parasitic wasp is highly specialized to attack the scale and is not expected to pose a threat to public health. No reports of human health or nuisance effects have been reported from Western Samoa where it has been released.

6. What controls these wasps, apart from limited food supply? For what species are these wasps a food source?

Encarsia diaspidicola is extremely small and would not likely become a food source to any other organism.

7. Please explain what mitigation measures will be taken if this wasp does become a public health nuisance? How will you stop it? What will you spray? The EA should address mitigation measures.

The wasp will first be released in one unsprayed field to determine whether it establishes before releasing it more widely in East Hawaii. The wasp is extremely small and difficult to see with the naked eye. Although *E. diaspidicola* is not expected to become a nuisance, insecticides could be applied to papaya fields infested with the white peach scale to attempt to eliminate the host, thus eliminating the wasp.

7. Does Samoa grow papaya, and if so, does the white peach scale attack their papaya? What impact did the wasps have on their papaya?

There is papaya in Samoa but it is grown mainly as backyard trees rather than for commercial production (P. Follett, pers. comm.). White peach scale almost certainly attacks papaya there but was considered a serious problem only on passion fruit, which is grown commercially in Samoa (P. Follett, pers. comm.).

8. The white peach scale has a broad host range, and yet, in Hawaiʻi, it is only attacking papaya. What do you think is the cause of this exclusive preference for papaya in Hawaii? Does the white peach scale attack all papaya in Hawaii, or only certain weak papaya or certain papaya strains? Does it attack organically grown papaya as frequently?

White peach scale can be found on many hosts in Hawaiʿi, including several crop hosts (e.g. mango). It is not clear why it thrives on papaya and not on the other hosts in Hawaiʿi. It is present in organic papaya orchards and the highest populations are typically found in unsprayed, abandoned papaya orchards (P. Follett, pers. comm.).

9. Instead of treating the problem of the scale with a new wasp introduction, it seems that looking at the cause of the problem may be more beneficial. Insects usually attack weak or stressed plants. Perhaps by improving agricultural techniques we can reduce scale infestation by increasing plant health and resistance. This could reduce agricultural costs and prevent the potential negative impacts of nontarget parasitism by the introduced wasp.

In Hawaiian papaya orchards, white peach scale can be found on many of papaya trees, whether the plants are healthy or not (P. Follett, pers. comm.). Based on host specificity testing and scientific literature presented in this EA, *E. diaspidicola* appears to be host specific to white peach scale. Improvement of agricultural techniques to manage white peach scale is beyond the scope of this EA.

Reference:

Huffaker, C. B., editor. 1971. *Biological Control*. Plenum Press, New York, New York. 511 pp.

Decision and Finding of No Significant Impact
for
Field Release of *Encarsia diaspidicola* (Hymenoptera: Aphelinidae) for Biological Control of White Peach Scale, *Pseudaulacaspis pentagona* (Hemiptera: Diaspididae), in Hawai'i
June 2011

The U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Plant Protection and Quarantine (PPQ) Pest Permitting Branch (PPB), is proposing to issue permits for release of an insect, *Encarsia diaspidicola* (Hymenoptera: Aphelinidae), in Hawai'i. The agent would be used by the applicant for the biological control of white peach scale, *Pseudaulacaspis pentagona* (Hemiptera: Diaspididae). The issuance by APHIS of a permit for release of this organism into the environment in Hawai'i is subject to USDA APHIS National Environmental Policy Act implementing regulations (7 Code of Federal Regulations (CFR) Part 372). Because *E. diaspidicola* is neither native nor established in Hawai'i, APHIS has prepared an environmental assessment (EA) that analyzes the potential environmental consequences of this proposed action in accordance with 7 CFR 372.5 (b) (ii) (4). This 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 *E. diaspidicola*: (1) no action, and (2) issue permits for the release of *E. diaspidicola* for biological control of white peach scale. 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 mechanical control methods and post-harvest treatments for the management of white peach scale. These control methods described are not alternatives for decisions to be made by the PPB, but are presently being used to control white peach scale in Hawai'i and may continue regardless of permit issuance for field release of *E. diaspidicola*. Legal notice of the EA was made available in the Hawaii Tribune Herald and the Hawaii Star-Advertiser on May 8, 2011 for a 30-day public comment period. In addition, notice was published in The Environmental Notice (published by the Hawai'i Office of Environmental Quality Control) on May 8, 2011. One comment was received on the EA. The comment was summarized and addressed in appendix 2 of the final EA.

I have decided to authorize the PPB to issue permits for the environmental release of *E. diaspidicola*. 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 insect species of Hawai'i.
- The release will have no effect on federally listed threatened and endangered species or their habitats in Hawai'i.
- *E. diaspidicola* poses no threat to the health of humans.
- No negative cumulative impacts are expected from release of *E. diaspidicola.*
- 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 *E. diaspidicola* into the environment will be reversible, there is no evidence that this organism will cause any adverse environmental effects.

I have determined that there would be no significant impact to the human environment from the implementation of the preferred alternative (issuance of permits for the release of *E. diaspidicola in* Hawai'i).

[signature] 6/24/2011

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

Date