Evidence-based, Pathway-Initiated Risk Assessment of the Importation of Fresh Longan, *Dimocarpus longan* Lour., from Taiwan into the United States

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Executive Summary

The Animal and Plant Health Inspection Service (APHIS) of the United States Department of Agriculture (USDA) prepared this pest risk assessment to examine plant pest risks associated with the importation of fresh longan (*Dimocarpus longan* Lour) fruit with stems into the United States from Taiwan. This is a qualitative risk assessment, as estimates of risk are expressed in qualitative terms (High, Medium, Low) rather than in numerical terms such as probabilities or frequencies. The details of the methodology and rating criteria used to analyze these pests are in the *Guidelines for Pathway-Initiated Pest Risk Assessment, version 5.02* (USDA, 2000). A list of pests reported in Taiwan and reported as attacking longan was developed based on the scientific literature, previous PPQ commodity risk assessments, and information provided by the Taiwanese government. Based on this list, 152 quarantine pests were identified; of those, 26 quarantine pests likely to follow the pathway were further analyzed. A pathway is any means that allows the entry and spread of a pest. Quarantine pests likely to follow the pathway and selected for further analysis include the following arthropods:

Acari
Eriophyidae
Aceria litchii
Diptera
Tephritidae
Bactrocera cucurbitae
Bactrocera dorsalis
Homoptera
Coccidae
Ceroplastes rubens
Coccus discrepans
Coccus formicarii
Coccus viridis
Drepanococcus chiton
Pulvinaria taiwana
Diaspidae
Aulacaspis tubercularis
Fiorinia pinicola
Pseudaonidia trilobitiformis
Thysanofiorinia nephelii
Kerridae
Kerria greeni
Kerria lacca
Margarodidae
Icerya seychellarum
Pseudococcidae
Maconellicoccus hirsutus
Nipaecoccus viridis
Planococcus lilacinus
Planococcus minor

<u>Lepidoptera</u>
Gracillariidae
Conopomorpha sinensis
Lycaenidae
Deudorix epijarbas
Pyralidae
Conogethes punctiferalis
Tortricidae
Adoxophyes orana
Cryptophlebia ombrodelta
<u>Thysanoptera</u>
Thripidae
Rhipiphorothrips cruentatus

All of these pests pose phytosanitary risks to American agriculture. The Pest Risk Potential was estimated to be High for *Bactrocera cucurbitae, Bactrocera dorsalis, Conogethes punctiferalis, Cryptophlebia ombrodelta,* and *Rhipiphorothrips cruentatus,* and Medium for all the other pests. The Pest Risk Potential is the summation of the ratings for the Consequences of Introduction and the Likelihood of Introduction. The Consequences of Introduction value was estimated by assessing the Climate/Host Interaction, the Host Range, the Dispersal Potential, the Economic Impact, and the Environmental Impact, which are based on the biology of the pests. The Likelihood of Introduction value was estimated by evaluating the proposed Quantity Imported Annually in combination with the Pest Survival Potential. The Pest Survival Potential evaluates the likelihood that the pests will survive post-harvest treatments and shipment, avoid detection at the port of arrival, are moved to a suitable habitat, and come into contact with suitable host material. Specific phytosanitary measures beyond port-of-entry inspection may be necessary for pests with a Pest Risk Potential of Medium. On the other hand, specific phytosanitary measures are strongly recommended for pests rated High, as port-of-entry inspection is not considered sufficient to provide phytosanitary security. Risk mitigation options for the quarantine pests of concern are provided in Appendix 2. The choice of appropriate measures to mitigate risks is part of Risk Management within APHIS and is not addressed within this risk assessment document.

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I. Introduction

This risk assessment was prepared by the Animal and Plant Health Inspection Service (APHIS) of the United States Department of Agriculture (USDA) to examine the plant pest risks associated with the importation of fresh longan (*Dimocarpus longan* Lour.) fruit with stems [The stems associated with commercial longan fruit for export are the 3-4 mm diameter fruit-bearing peduncles (PPQ, 1999)] from Taiwan into the United States (US). This risk assessment is qualitative, as risk is expressed in terms of High, Medium or Low, instead of probabilities or frequencies. The details of the methodology and rating criteria are in the *Pathway-Initiated Pest Risk Assessments: Guidelines for Qualitative Assessments, Version 5.02* (USDA, 2000).

Regional and international plant protection organizations such as the North American Plant Protection Organization (NAPPO) and the International Plant Protection Convention (IPPC) provide standards for conducting pest risk analyses (IPPC, 2004, 2006; NAPPO, 2004). The methods used to initiate, conduct, and report this assessment, as well as the use of biological and phytosanitary terms are based on these standards. The IPPC standards describe three stages of pest risk analysis: Stage 1, Initiation; Stage 2, Risk Assessment; and Stage 3, Risk Management. This document satisfies the requirements of IPPC Stages 1 and 3.

Longan is a member of the family Sapindaceae, which has about 140 genera and 2000 species distributed in temperate, tropical, pantropical and subtropical climates (Watson and Dallwitz, 1992 onward). The longan tree is a subtropical evergreen of Asian origin that grows up to 20 meters high and resembles the tree and fruit of litchi (Hill, 1983; NCSU CIPM, 2003; Yaacob and Subhadrabandhu, 1995). Longan fruits, however, are smaller and less succulent than those of litchi (Hill, 1983). A panicle on a healthy longan tree can carry up to 80 individual fruit, which vary in weight from 5 to 20 grams (Yaacob and Subhadrabandhu, 1995). Some cultivars will yield fruit at high altitudes in the tropics (Menzel and McConchie, 1998). Thailand, China, and Taiwan are considered major producers of longans (Agro Food Resources, 2003). Longan is not native to the US (USDA NRCS, 2003) but it is grown commercially in south Florida (NCSU CIPM, 2003) and in private gardens in southern California (Gaskell, 2003). Commercial acreage in the US increased 550 percent during the nineties, going from 72 to approximately 400 acres, and 1998 production was estimated at 1.4 million pounds worth 2.8 million dollars (NCSU CIPM, 2003).

II. Risk Assessment

A. Initiating Event: Proposed Action

This commodity-based, pathway-initiated pest risk assessment accompanies a request for USDA authorization to allow the importation of longan grown in Taiwan into the US, which is a potential pathway for the introduction of plant pests. The movement of fruits and vegetables from Taiwan into the US is regulated in 7 CFR §319.56/37. Currently, the entry of longan from Taiwan into the US is not authorized under 7 CFR §319.56/37, and the government of Taiwan seeks a change in this Federal Regulation to allow importation.

B. Assessment of the Weediness Potential of Longan

If the species considered for import poses a risk as a weed pest, then a "pest-initiated" risk assessment is conducted. The results of the weediness screening for longan do not prompt a pest-initiated risk assessment because the plant is already present in the US and it is not reported as a weed anywhere in the world (Table 1).

Table 1. Assessment of the Weediness Potential of Longan.
Commodity: Longan, *Dimocarpus longan* Lour. (Sapindaceae) Synonyms: *Euphoria longan* (Lour.) Steud., *Euphoria longana* Lam.; *Nephelium longana* (Lam.) Cambess.; *Nephelium longan* (Lour.) Hook. **Phase 1:** Longan is commercially grown in south Florida (NCSU CIPM, 2003) and in small private gardens in southern California (Gaskell, 2003). Longan does not occur naturally in the US (USDA NRCS, 2003). **Phase 2:** Is the species listed in: No Geographical Atlas of World Weeds (Holm *et al.*, 1979) No World's Worst Weeds (Holm *et al.*, 1977) or World Weeds: Natural Histories and Distribution (Holm *et al.*, 1997) No Report of the Technical Committee to Evaluate Noxious Weeds; Exotic Weeds for Federal Noxious Weed Act (Gunn and Ritchie, 1982) No *Economically Important Foreign Weeds* (Reed, 1977) No Weed Science Society of America list (WSSA, 1989) No Is there any literature reference indicating weediness, *e.*g., AGRICOLA, CAB, Biological Abstracts, AGRIS; search on "species name" combined with "weed". **Phase 3:** Longan is not listed as a common weed anywhere in the world and already occurs in the US; as a result, we can proceed with the Risk Assessment, according to the Guidelines (USDA, 2000).

C. Current Status and Pest Interceptions

Currently, 7 CFR §319.56 prohibits the entry of fresh longan fruit from Taiwan into the US. Decisions on previous requests for longan importation from the region are summarized below (Table 2):

Table 2. Decision History for Longan from Asia and the Pacific.

Country	Year	Decision
China (PRC)	1981	Disapproved because no acceptable treatment for *Dacus* and *Cryptophlebia*
Thailand	1983	Disapproved because no acceptable treatment for complex of fruit flies of the genus *Dacus*.
Hawaii	1997	Approved with irradiation for *Ceratitis capitata*, *Bactrocera cucurbitae*, and *B. dorsalis* (prohibited into FL).
China (PRC)	2002	Approved with cold treatment for *Bactrocera cucurbitae* and *B. dorsalis* (prohibited into FL).

Appendix 1 lists pest interceptions on longans from all countries since 1985 (PIN309 query May 7, 2003). If there are interceptions from Taiwan, they would be included under interceptions from China (Paul Courneya, NIS, personal communication, May 8, 2003).

D. Pest Categorization

Table 3 lists the pests associated with longan (in any country) that occur in Taiwan. This list identifies: (1) the presence or absence of these pests in the US, (2) the generally affected plant part or parts, (3) the quarantine status of the pest with respect to the US, (4) whether the pest is likely to follow the pathway and enter the US on commercially exported longan fruit with stem, and (5) pertinent citations for either the distribution or the biology of the pest. In light of pest biology and distribution, many organisms are eliminated from further consideration as sources of phytosanitary risk on longan from Taiwan because they do not satisfy the definition of a quarantine pest.

Of note: two pathogens [*Acerbia litchii (*Ascomycetes: Dothideales) and Longan Witches' Broom Disease (LWBD) virus] were not included on this pest list as they were determined to not be present in Taiwan. *Acerbia litchii* is reported in the literature as occuring on longan and litchi in Taiwan [(Farr *et al* 2003) citing (Anonymous 1979)]; however, the original source, Anonymous (1979), misspelled *Aceria litchii* (Acari: Eriophyidae), thereby erroneously listing *Acerbia litchii* (Chen, 2004). This mistake has been corrected in the newest edition of this original source, Anonymous (2002), which no longer lists *Acerbia litchii* in Taiwan on either host (or any other host). Furthermore, no other information in the literature was found reporting this pathogen on longan or in Taiwan. Symptoms of LWBD have been reported in Taiwan (Chen *et al.*, 2001; Waite and Hwang, 2002); however, according to Taiwan experts, the LWBD virus is not known to occur in Taiwan (Anonymous, 2000; Chen, 2004). Suspicious symptoms were once found in a restricted location of Taiwan (Wufeng, Taichung County), after which a study was conducted from 1998 to 1999 to clarify the causal agent (Anonymous, 2000). TEM observation revealed neither virus nor phytoplasma particles, and inoculation tests by grafting did not result in any symptoms in the grafted plants (Anonymous, 2000). Furthermore, no other LWBD symptoms were detected in Wufeng or in any other areas of Taiwan (Anonymous, 2000). It is believed that displayed symptoms were caused by boron deficiency (Anonymous, 2000; Chen, 2004).

Table 3. Pests reported on longan (*Dimocarpus longan*) (in any country) and present in Taiwan (on any host).

Scientific Name	Distribution[1]	Plant Part Affected[2]	Quarantine Pest	Likely to Follow Pathway	References
ARTHROPODS					
Acari					
Eriophyidae					
Aceria dimocarpi (Kuang)	TW	L	Yes	No	Waite and Hwang, 2002
Aceria litchii (Keifer) (synonym: *Eriophyes litchi* Keifer)	TW, US (HI)	L, F, S, I, Sh	Yes	Yes	Batten, 1986; China, 1997; Huang, 1967; Mathur and Tandon, 1974; PPQ, 1999; Taiwan, 2002
Cosella longana sp. nov.	TW	L	Yes	No	Huang *et al.*, 1996
Eriophyes dimocarpi Kuang	TW	L	Yes	No	Wen *et al.*, 2002
Tetranychidae					
Oligonychus biharensis Hirst	TW, US (HI)	L	No	No	Anonymous, 1994; Jeppson *et al.*, 1975; PPQ, 1999; Wongsiri, 1991
Oligonychus litchii Lo and Ho	TW	L	Yes	No	Bolland *et al.*, 1998; Hill, 1983; Wen *et al.*, 2002
Coleoptera					
Anthicidae					
Formicomus braminus La Ferte-Senectere	TW	I	Yes	No	Anonymous, 1965; Armstrong and Drummond, 1986; PPQ, 1999
Cerambycidae					
Anoplophora maculata (Thomson)	TW	R, S, W	Yes	No[3]	Hwang, 1988; Taiwan, 2002; Wen *et al.*, 2002

Table 3. Pests reported on longan (*Dimocarpus longan*) (in any country) and present in Taiwan (on any host).

Scientific Name	**Distribution**[1]	**Plant Part Affected**[2]	**Quarantine Pest**	**Likely to Follow Pathway**	**References**
Anoplophora malasiaca (Thompson)	TW	L, S, R	Yes	No[3]	CABI, 2002; Li-ying *et al.*, 1997; PPQ, 1999
Aristobia testudo (Voet)	TW	T, Br, W	Yes	No	Ho *et al.*, 1990; Li-ying *et al.*, 1997; PPQ, 1999
Chrysomelidae					
Aulacophora femoralis (Motschulsky)	TW	L	Yes	No	Anonymous, 1994, 2003
Phyllotreta striolata (Fabricius)	TW, US	L, I, R, F	No	No[3]	Anonymous, 2003; CABI, 2003
Taiwania obtusata Boheman	TW	L	Yes	No	Anonymous, 1994, 2003
Coccinellidae					
Henosepilachna vigintioctopunctata (Fabricius) [synonym: *Epilachna vigintioctopunctata* (Fabricius)]	TW	L, I, F	Yes	No[3]	Anonymous, 2003; CABI, 2003
Curculionidae					
Apoderus brachialis Voss	TW	L	Yes	No	Wen *et al.*, 2002
Hypomeces squamosus F.	TW	L	Yes	No	Anonymous, 1994; CABI, 2002; PPQ, 1999; Waterhouse, 1993; Wongsiri, 1991
Lyctidae					
Lyctus brunneus Stephens	TW, US (HI)	W	No	No	Borrer *et al.*, 1989; PPQ, 1999
Scarabaeidae					
Adoretus sinicus Burmeister	TW	L, I	Yes	No	Anonymous, 1965; Gordh and Headrick, 2001; Hill, 1983; Wen *et al.*, 2002
Adoretus tenuimaculatus Waterhouse	TW	L	Yes	No	Anonymous, 1994; Hill, 1983; PPQ, 1999

Table 3. Pests reported on longan (*Dimocarpus longan*) (in any country) and present in Taiwan (on any host).

Scientific Name	Distribution[1]	Plant Part Affected[2]	Quarantine Pest	Likely to Follow Pathway	References
Anomala anthusa Ohaus	TW	L, I, R	Yes	No	Anonymous, 1965; Arnett *et al.*, 2002
Anomala cupripes Hope	TW	L, R	Yes	No	Anonymous, 1965; PPQ, 1999; Talekar *et al.*, 1988; Wang and Liu, 1991; Wen *et al.*, 2002
Anomala cypryogastra Ohaus	TW	L, I, R	Yes	No[3]	Anonymous, 1965; Arnett *et al.*, 2002
Anomala expansa Bates	TW	L, R	Yes	No	Anonymous, 1965, 1994; PPQ, 1999; Talekar and Nurdin, 1991; Wen *et al.*, 2002; White, 1983
Anomala siniopyga Ohaus	TW	L, I, R	Yes	No[3]	Anonymous, 1965; Arnett *et al.*, 2002
Apogonia cribricollis Burmeister	TW	L, S, R	Yes	No[3]	Anonymous, 1994, 2003
Holotrichia sauteri Moser	TW	I	Yes	No	Anonymous, 1994; Huang and Lin, 1987; PPQ, 1999
Lepidiota nana Sharp	TW	L, F, I	Yes	No[3,5]	Anonymous, 1965; Borrer *et al.*, 1989; White, 1983
Popillia mutans Newman	TW	I, L, F, R	Yes	No[3]	Anonymous, 1994, 2003
Potosia brevitarsis Lewis	TW	l, F, R	Yes	No[3,5]	Anonymous, 1994; Borrer *et al.*, 1989; PPQ, 1999
Protaetia orientalis Gory and Perchelon	TW	F	Yes	No[3,5]	Wen *et al.*, 2002
Diptera					
Tephritidae					
Bactrocera cucurbitae (Coquillett)	TW, US (HI)	L, S, R, I, F	Yes	Yes[6]	Anonymous, 1994; CABI, 2002; PPQ, 1999; USDA, 1983; White and Elson-Harris, 1992

Table 3. Pests reported on longan (*Dimocarpus longan*) (in any country) and present in Taiwan (on any host).

Scientific Name	**Distribution**[1]	**Plant Part Affected**[2]	**Quarantine Pest**	**Likely to Follow Pathway**	**References**
Bactrocera dorsalis (Hendel)	TW, US (HI)	F	Yes	Yes	Anonymous, 1994; CABI, 2002; PPQ, 1999
Hemiptera					
Coreidae					
Cletus trigonus Thunberg	TW	L	Yes	No	Anonymous, 1994, 2003
Leptocorisa acuta Thunberg	TW	L, T	Yes	No	Anonymous, 2003; CABI, 2003
Riptortus linearis (Linnaeus)	TW	L	Yes	No	Anonymous, 1994, 2003; CABI, 2003
Pentatomidae					
Cantao ocellatus (Thunberg)	TW	L	Yes	No	Anonymous, 1994, 2003
Erthesina fullo (Thunberg)	TW	S, F	Yes	No[3]	Anonymous, 1965; China, 1997; Li-zhong, 2000; PPQ, 1999; Wen *et al.*, 2002
Eurydema cingulatus (F.)	TW	S	Yes	No[3]	Anonymous, 1965; PPQ, 1999
Plautia crossota (Dallas)	TW	S	Yes	No[3]	Anonymous, 1994; Li-zhong, 2000; PPQ, 1999
Rhynchocoris humeralis (Thunberg)	TW	F	Yes	No[3]	China, 1997; Li-zhong, 2000; PPQ, 1999
Tessaratoma papillosa Drury	TW	S, I, F	Yes	No[3]	CABI, 2002; PPQ, 1999; Wongsiri, 1991
Homoptera					
Aleyrodidae					
Aleurotuberculatus murrayae Singh	TW	L	Yes	No	Wen *et al.*, 2002
Aleurocanthus spiniferus Quaintance & Baker	TW, US (HI)	L, S	Yes	No[4]	Anonymous, 1994; CABI, 2002; China, 1997; PPQ, 1999
Aleurodicus dispersus Russell	TW, US (FL, HI)	L	[Yes][14]	No	CABI, 2003; Wen *et al.*, 2002

Table 3. Pests reported on longan (*Dimocarpus longan*) (in any country) and present in Taiwan (on any host).

Scientific Name	**Distribution**[1]	**Plant Part Affected**[2]	**Quarantine Pest**	**Likely to Follow Pathway**	**References**
Aleurotuberculatus psidii Singh	TW	L	Yes	No	Anonymous, 1965, 1994; David, 1978; PPQ, 1999; Wen *et al.*, 2002
Aphididae					
Aphis gossypii Glover	TW, US	L, S, I	No	No[4]	Anonymous, 1994; CABI, 2002; PPQ, 1999
Cervaphis quercus Takahashi	TW	L, I	Yes	No	Blackman and Eastop, 2000; Chou *et al.*, 1999; Wen *et al.*, 2002
Greenidea mangiferae Takahashi	TW	L, I	Yes	No	Anonymous, 1965; Blackman and Eastop, 2000; Chou *et al.*, 1999; Liao, 1978; Wen *et al.*, 2002
Cercopidae					
Cosmoscarta bispecularis White	TW	S	Yes	No[3]	Anonymous, 1994; Li-zhong, 2000; PPQ, 1999
Cicadellidae					
Empoasca flavescens (Fabricius)	TW	L	Yes	No	Anonymous, 1994; Hill, 1983; Li-zhong, 2000; PPQ, 1999
Idioscopus clypialis (Lethierry) (synonym: *Idiocerus clypealis* Leth)	TW	S, L, I	Yes	No[3]	Anonymous, 1965; Li-zhong, 2000; PPQ, 1999 Ahmed, 1983; Khan and Khan, 1994; Wen *et al.*, 2002
Tartessus ferrugineus (Walker)	TW	S	Yes	No[3]	Li-zhong, 2000; PPQ, 1999
Cicadidae					
Cryptotympana atrata (F.)	TW	S	Yes	No[3]	Anonymous, 1994; Li-zhong, 2000; PPQ, 1999
Huechys sanguinea (DeGeer)	TW	S	Yes	No[3]	Li-zhong, 2000; PPQ, 1999

Table 3. Pests reported on longan (*Dimocarpus longan*) (in any country) and present in Taiwan (on any host).

Scientific Name	Distribution[1]	Plant Part Affected[2]	Quarantine Pest	Likely to Follow Pathway	References
Coccidae					
Ceroplastes ceriferus (Fabricius)	TW, US	L, S, F	No	Yes	CABI, 2002; PPQ, 1999; ScaleNet, 2002; Wen *et al.*, 2002
Ceroplastes pseudoceriferus Green	TW	Sh, L, I, T	Yes	No	Ali, 1980; Ben-Dov, 1993; Coates *et al.*, 2003; ScaleNet, 2002
Ceroplastes rubens Maskell	TW, US (FL, HI)	L, S, F	[Yes][14]	Yes	CABI, 2002; Li-zhong, 2000; PPQ, 1999; ScaleNet, 2002; Tao, 1989; Wen *et al.*, 2002
Coccus discrepans Green	TW	L, S, F	Yes	Yes[7]	Anonymous, 1965; CABI, 2002; ScaleNet, 2002
Coccus elongatus Signoret [synonym: *Parthenolecanium persicae persicae* (Fabricius)]	TW, US	L	No	No	ScaleNet, 2002; Wen *et al.*, 2002
Coccus formicarii (Green)	TW	S	Yes	Yes	Li-zhong, 2000; PPQ, 1999; ScaleNet, 2002
Coccus hesperidum Linnaeus	TW, US	L, S	No	Yes	Anonymous, 1994; CABI, 2002; PPQ, 1999; ScaleNet, 2002; Wen *et al.*, 2002
Coccus kuravuensis Takahashi	TW	L	Yes	No	Wen *et al.*, 2002
Coccus viridis (Green)	TW, US (FL, HI)	L, S, F	[Yes][14]	Yes	CABI, 2002; ScaleNet, 2002
Drepanococcus chiton (Green)	TW	Sh, I, F	Yes	Yes	Ben-Dov, 1993; Coates *et al.*, 2003; Ibrahim, 1994; PIN309, 2003; ScaleNet, 2002
Eucalymnatus tessellatus (Signoret)	TW, US	S, L	No	Yes	Anonymous, 1965; PPQ, 1999; ScaleNet, 2002; Wen *et al.*, 2002

Table 3. Pests reported on longan (*Dimocarpus longan*) (in any country) and present in Taiwan (on any host).

Scientific Name	**Distribution[1]**	**Plant Part Affected[2]**	**Quarantine Pest**	**Likely to Follow Pathway**	**References**
Paracerostegia floridensis (Comstock) (synonym: *Ceroplastes floridensis* Comstock)	TW, US	S	No	Yes	ScaleNet, 2002; Wen *et al.*, 2002
Prococcus acutissimus (Green) [synonyms: *Coccus acutissima* (Green), *Coccus acutissimus* (Green)]	TW, US (HI, FL, TX)	L, S	No	Yes	Anonymous, 1965; Li-zhong, 2000; PPQ, 1999; ScaleNet, 2002; Wen *et al.*, 2002
Pulvinaria polygonata Cockerell (synonym: *Chloropulvinaria polygonata*)	TW	L, T	Yes	No	Anonymous, 1994; Ben-Dov, 1993; Ben-Dov and Hodgson, 1997b; PPQ, 1999
Pulvinaria psidii Maskell [synonym: *Chloropulvinaria psidii* (Maskell)]	TW, US	L, S, I, F	No	Yes	CABI, 2002; ScaleNet, 2002; Taiwan, 2002; Wen *et al.*, 2002
Pulvinaria taiwana Takahashi	TW	L, S	Yes	Yes	ScaleNet, 2002; Wen *et al.*, 2002
Saissetia coffeae (Walker) [synonym: *Saissetia hemisphaerica* (Targioni)]	TW, US	L, S, F	No	Yes	CABI, 2002, 2003; ScaleNet, 2002; Wen *et al.*, 2002
Saissetia oleae (Olivier)	TW, US	L, S	No	Yes	Anonymous, 1965, 1994; CABI, 2002; PPQ, 1999; ScaleNet, 2002; Wen *et al.*, 2002
Diaspidae					
Aulacaspis tubercularis Newstead	TW, US	L, S, F	Yes	Yes	CABI, 2002; ScaleNet, 2002; Tao, 1989
Fiorinia nephelis Maskell	TW	L	Yes	No	Wen *et al.*, 2002

Table 3. Pests reported on longan (*Dimocarpus longan*) (in any country) and present in Taiwan (on any host).					
Scientific Name	**Distribution[1]**	**Plant Part Affected[2]**	**Quarantine Pest**	**Likely to Follow Pathway**	**References**
Fiorinia pinicola Maskell	TW, US (Cumberland Island, GA; CA)	L, S	[Yes][14]	Yes	Anonymous, 1994; Dooley, 2004; Kosztarab, 1996; Nakahara, 1982; PPQ, 1999; ScaleNet, 2002
Fiorinia theae Green	TW, US	S	No	Yes	Anonymous, 1994; PPQ, 1999
Howardia biclavis (Comstock)	TW, US	B, S	No	Yes	PPQ, 1999; ScaleNet, 2002
Pseudaonidia trilobitiformis Green	TW, US (FL)	L, F, S	[Yes][14]	Yes	Anonymous, 1994; Coile and Dixon, 2000; Kosztarab, 1996; PIN309, 2003; PPQ, 1999; USDA, 1979
Rutherfordia major (Cockerell) (synonym: *Pseudaulacaspis major* Mamet)	TW, US (FL)	F, B	No	Yes	Ebeling, 1959; ScaleNet, 2002
Thysanofiorinia nephelii (Maskell)	TW, US (FL, HI)	S, F, L	[Yes][14]	Yes	Anonymous, 1965; Coile and Dixon, 2002a, 2002b; PIN309, 2003; PPQ, 1999; ScaleNet, 2002; Wen *et al.*, 2002
Flatidae					
Geisha distinctissima Walker	TW	S	Yes	No[3]	Anonymous, 1994; Li-zhong, 2000; PPQ, 1999
Lawana imitata Melichar	TW	L	Yes	No	Li-zhong, 2000; Wen *et al.*, 2002
Salurnis marginellus Guerin Meneville	TW	S, L	Yes	No[3]	Anonymous, 1994; China, 1997; Li-zhong, 2000; PPQ, 1999; Wen *et al.*, 2002

Table 3. Pests reported on longan (*Dimocarpus longan*) (in any country) and present in Taiwan (on any host).

Scientific Name	**Distribution**[1]	**Plant Part Affected**[2]	**Quarantine Pest**	**Likely to Follow Pathway**	**References**
Fulgoridae					
Pyrops candelaria (L.) (synonym: *Fulgora candelaria*)	TW	S	Yes	No[3]	Anonymous, 1994; China, 1997; Hill, 1983; Li-zhong, 2000; PPQ, 1999
Pyrops lathburii (Kirby) (synonym: *Fulgora lathburii* Kirby)	TW	S	Yes	No[3]	Anonymous, 1994; PPQ, 1999
Pyrops spinolae Westwood (synonym: *Fulgora spinolae* Westwood)	TW	S	Yes	No[3]	Anonymous, 1994; PPQ, 1999
Kerridae					
Kerria greeni (Chamberlin)	TW	S	Yes	Yes	Li-zhong, 2000; PPQ, 1999; ScaleNet, 2002
Kerria lacca Kerr	TW	S, Br	Yes	Yes	CABI, 2002; Chiu *et al.*, 1981; Hwang and Hsieh, 1981; PPQ, 1999; Taiwan, 2002; Waite and Hwang, 2002; Wen *et al.*, 2002
Margarodidae					
Icerya purchasi Maskell	TW, US	L, S	No	Yes	Anonymous, 1965; CABI, 2002; PPQ, 1999; Wen *et al.*, 2002
Icerya seychellarum Westwood	TW	L, F, S	Yes	Yes	Anonymous, 1994; CABI, 2002; China, 1997; Li-zhong, 2000; PPQ, 1999; Wen *et al.*, 2002
Pseudococcidae					
Maconellicoccus hirsutus (Green)	TW, US (CA, FL, HI)	L, S, I, F	[Yes][14]	Yes	CABI, 2002; Hoy *et al.*, 2003; Li-zhong, 2000; ScaleNet, 2002

Table 3. Pests reported on longan (*Dimocarpus longan*) (in any country) and present in Taiwan (on any host).

Scientific Name	Distribution[1]	Plant Part Affected[2]	Quarantine Pest	Likely to Follow Pathway	References
Nipaecoccus viridis hirsutus (Newstead)	TW, US (HI)	F, S, L, Sh, I, Br, T, R	Yes	Yes	CABI, 2002; China, 1997; CIE, 1983; PPQ, 1999; ScaleNet, 2002
Planococcus citri (Risso)	TW, US	L, S, R, I, F	No	Yes	Anonymous, 1994; CABI, 2002; PPQ, 1999; Wen *et al.*, 2002
Planococcus lilacinus (Cockerell)	TW	F, S, L, I	Yes	Yes[11]	Anonymous, 1994; CABI, 2002; Li-zhong, 2000; PIN309, 2003; PPQ, 1999; Wen *et al.*, 2002
Planococcus minor (Maskell)	TW	Br, I, F	Yes	Yes[12]	Li-zhong, 2000; Ooi *et al.*, 2002; PIN309, 2003
Psyllidae					
Neophacopteron euphoriae Yang (synonym: *Cornegenapsylla sinica* Yang et Li)	TW	L	Yes	No	Li-zhong, 2000; Taiwan, 2002; Wen *et al.*, 2002; Wongsiri, 1991; Xu *et al.*, 2001; Yang Chung, 1984; Yang and Li, 1982
Ricaniidae					
Ricania speculum (Walker)	TW	L	Yes	No	Anonymous, 1994, 2003
Isoptera					
Rhinotermitidae					
Coptotermes formosanus Shiraki	TW, US	W	No	No	Anonymous, 1994; Gordh and Headrick, 2001; PPQ, 1999
Termitidae					
Odontotermes formosanus Sharaki	TW	W	Yes	No	Anonymous, 1965; Gordh and Headrick, 2001; PPQ, 1999; Wen *et al.*, 2002

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Scientific Name	**Distribution[1]**	**Plant Part Affected[2]**	**Quarantine Pest**	**Likely to Follow Pathway**	**References**
Lepidoptera					
Cossidae					
Zeuzera coffeae Nietner	TW	Br, T, B	Yes	No	Anonymous, 1965, 1994; CABI, 2002, 2003; PPQ, 1999; Waite and Hwang, 2002; Wen *et al.*, 2002; Wongsiri, 1991
Geometridae					
Ascotis selenaria (Denis and Schiffermuller)	TW	L, F	Yes	No[3]	China, 1997; Grout, 2003; Li-ying *et al.*, 1997; Ohtani *et al.*, 2001; PPQ, 1999; Zhang, 1994
Comostola laesaria Walker	TW	I	Yes	No	Heppner and Inoue, 1992; Wongsiri, 1991
Pingasa sngnaiuia Guenue	TW	L	Yes	No	Wen *et al.*, 2002
Sauris interruptata (Moore)	TW	L	Yes	No	Borrer *et al.*, 1989; China, 1997; Heppner and Inoue, 1992; PPQ, 1999
Thalassodes aucta Prout	TW	L	Yes	No	Holloway, 1996; Wen *et al.*, 2002
Thalassodes falsaria Prout	TW	L	Yes	No	Heppner and Inoue, 1992; Wongsiri, 1991
Thalassodes proquadraria Inoue	TW	L	Yes	No	Borrer *et al.*, 1989; China, 1997; Heppner and Inoue, 1992; PPQ, 1999
Thalassodes quadraria Guenee	TW	L	Yes	No	Heppner and Inoue, 1992; Wongsiri, 1991
Gracillariidae					
Conopomorpha litchiella Bradley	TW	Sh, L	Yes	No	Hwang and Hung, 1996; Waite and Hwang, 2002; Wen *et al.*, 2002; Wongsiri, 1991

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Scientific Name	Distribution[1]	Plant Part Affected[2]	Quarantine Pest	Likely to Follow Pathway	References
Conopomorpha sinensis Bradley	TW	F, Sh, S, Sd, L	Yes	Yes	CABI, 2002; China, 1997; Hung *et al.*, 2002; Hwang and Hung, 1996; Taiwan, 2002; Waite and Hwang, 2002; Wen *et al.*, 2002; Wongsiri, 1991
Limacodidae					
Setora sinensis Moore [synonym: *S. postornata* (Hamptson)]	TW	Br	Yes	No	Anonymous, 1994; China, 1997; Fang *et al.*, 2001; Heppner and Inoue, 1992; PPQ, 1999
Lycaenidae					
Deudorix epijarbas Moore	TW	F, I	Yes	Yes	Anonymous, 1965; China, 1997; Heppner and Inoue, 1992; PPQ, 1999; Verma, 1985; Wen *et al.*, 2002
Lymantriidae					
Dasychira mendosa (Hubner)	TW	L	Yes	No	Heppner and Inoue, 1992; Wongsiri, 1991; Zhang, 1994
Euproctis taiwana (Shiraki) (synonym: *Porthesia taiwana* Shiraki)	TW	L, I	Yes	No	Heppner and Inoue, 1992; Li-ying *et al.*, 1997; Liu and *et al*, 1998; PPQ, 1999; Wen *et al.*, 2002
Euproctis varians (Walker)	TW	L	Yes	No	Anonymous, 1994, 2003
Lymantria xylina Swinhoe	TW	L, Br	Yes	No	Anonymous, 1994; Chang *et al.*, 1991; Chao *et al.*, 1996; Heppner and Inoue, 1992; Li *et al.*, 1981; PPQ, 1999

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Scientific Name	**Distribution[1]**	**Plant Part Affected[2]**	**Quarantine Pest**	**Likely to Follow Pathway**	**References**
Orgyia postica (Walker) (synonym: *Notolophus australis posticus* Walker)	TW	L, I	Yes	No	Anonymous, 1965; CABI, 2002, 2003; PPQ, 1999; Wen *et al.*, 2002
Metarbelidae					
Indarbela dea Swinhoe	TW	B, Br, W	Yes	No	Anonymous, 1994; Butani, 1977; CABI, 2002; PPQ, 1999
Squamura discipuncta (Wileman)	TW	B[16]; S	Yes	No[4, 17]	Heppner and Inoue, 1992; Li-ying *et al.*, 1997; PPQ, 1999; Robinson *et al.*, 2001; Zhang, 1994
Noctuidae					
Eudocima fullonia (Clerck)	TW, US (HI)	F	Yes	No[3]	CABI, 2002; Hyde, 2000; Li-zhong, 2000; Menzel and McConchie, 1998; Wongsiri, 1991
Eudocima salaminia Cramer	TW	F	Yes	No[3]	Heppner and Inoue, 1992; Hyde, 2000; Menzel and McConchie, 1998; Zhang, 1994
Oxyodes scrobiculata Fabricius	TW	L	Yes	No	Li-zhong, 2000; PPQ, 1999; Wongsiri, 1991
Selepa celtis Moore	TW	L	Yes	No	Anonymous, 1994, 2003; Ranjeet *et al.*, 1996; Ranjeet *et al.*, 1997
Spodoptera litura (Fabricius) (synonym: *Prodenia litura* Fabricius)	TW, US (HI)	L	Yes	No	Anonymous, 1965; CABI, 2002; PPQ, 1999; Wen *et al.*, 2002

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Scientific Name	**Distribution**[1]	**Plant Part Affected**[2]	**Quarantine Pest**	**Likely to Follow Pathway**	**References**
Notodontidae					
Stauropus alternus Walker	TW	L	Yes	No	Anonymous, 1965; China, 1997; PPQ, 1999; Reddy *et al.*, 2001; Wen *et al.*, 2002
Psychidae					
Chalioides kondonis Matsumura	TW	Br, S, W	Yes	No[15]	Anonymous, 1994, 2003
Clania minuscula Butler (synonym: *Eumeta minuscula* Butler)	TW	L, Sh	Yes	No	Anonymous, 1994; PPQ, 1999; Simbolon and Yukawa, 1993
Clania variegata Snellen (synonyms: *Eumeta variegata* Snellen, *Clania pryeri* Leech)	TW	L	Yes	No	Anonymous, 1965, 1994; PPQ, 1999; Sun *et al.*, 1999 Borrer *et al.*, 1989; Heppner and Inoue, 1992; Hill, 1983; Wen *et al.*, 2002
Dappula tertia Templeton	TW	L	Yes	No	Anonymous, 1994; Gibb and Clifford, 2002; PPQ, 1999; Sankaran and Syed, 1972
Mahasena oolona Sonan	TW	L	Yes	No	Anonymous, 1994; Heppner and Inoue, 1992; PPQ, 1999; Shiao, 1981
Pyralidae					
Conogethes punctiferalis (Guenée) [synonym: *Dichocrocis punctiferalis* (Guenée)]	TW	L, S, F, I	Yes	Yes	CABI, 2002; CSIRO, 1991; Gupta and Arora, 2001; Huang *et al.*, 2000; Kim *et al.*, 1997; Ooi *et al.*, 2002; PIN309, 2003; Robinson *et al.*, 2001; USDA, 1957; Waterhouse, 1993; Wongsiri, 1991

Table 3. Pests reported on longan (*Dimocarpus longan*) (in any country) and present in Taiwan (on any host).					
Scientific Name	**Distribution**[1]	**Plant Part Affected**[2]	**Quarantine Pest**	**Likely to Follow Pathway**	**References**
Tortricidae					
Adoxophyes fasciculana (Walker) (synonym: *A. cyrtosema*)	TW	L	Yes	No	Anonymous, 1994; Heppner and Inoue, 1992; New Zealand, 1999; Pantoja *et al.*, 2002; PPQ, 1999
Adoxophyes orana Fischer von Roeslerstamm	TW	L, I, F	Yes	Yes	Anonymous, 1994; CABI, 2002; Carter, 1984; Heppner and Inoue, 1992; PPQ, 1999
Adoxophyes privatana Walker	TW	L	Yes	No	Taiwan, 2002; Zhang, 1994
Archips asiaticus Walsingham	TW	L	Yes	No	Anonymous, 1994; Hwang, 1974; PPQ, 1999
Cerace stipatana Walker	TW	L[16]	Yes	No[4]	Anonymous, 1994; Han and Shen, 1993; Heppner and Inoue, 1992; Meijerman and Ulenberg, 2004; PPQ, 1999; Robinson *et al.*, 2001
Cnesteboda celligera (Meyrick)	TW	L	Yes	No[4]	Anonymous, 1994; Heppner and Inoue, 1992; PPQ, 1999; Robinson *et al.*, 2001
Cryptophlebia ombrodelta (Lower)	TW, US (HI)	F	Yes	Yes	Batten, 1986; CABI, 2002; Chang, 1995; Hyde, 2000; McQuate *et al.*, 2000; Menzel and McConchie, 1998; PPQ, 1999; Waite and Hwang, 2002

Table 3. Pests reported on longan (*Dimocarpus longan*) (in any country) and present in Taiwan (on any host).

Scientific Name	Distribution[1]	Plant Part Affected[2]	Quarantine Pest	Likely to Follow Pathway	References
Dudua aprobola (Meyrick) (synonym: *Argyroploce aprobola* Mayrick)	TW	L, I	Yes	No	Abraham and Jayanthi, 1999; Anonymous, 1994; Heppner and Inoue, 1992; Mann and Singh, 1984; PPQ, 1999; Punnaiah and Devaprasad, 1996; Wen *et al.*, 2002
Eboda celligera Meyrick	TW	L	Yes	No	Heppner and Inoue, 1992; Wen *et al.*, 2002
Homona coffearia Nietner	TW	L	Yes	No	Anonymous, 1965, 1994; CABI, 2002; China, 1997; Heppner and Inoue, 1992; Hill, 1983; PPQ, 1999; Van Der Geest and Evenhuis, 1991
Olethreutes lencaspis Megrick	TW	L	Yes	No	Wen *et al.*, 2002
Statherotis discana (Felder & Rogenhofer)	TW	L	Yes	No	CABI, 2002; Waterhouse, 1993
Statherotis leucaspis Meyrick	TW	L	Yes	No	Heppner and Inoue, 1992; PPQ, 1999; Wongsiri, 1991
Orthoptera					
Acrididae					
Chondracis rosea (De Geer)	TW	L	Yes	No	Anonymous, 1994, 2003; CABI, 2003
Locusta migratoria manilensis (Meyton)	TW	L, F, I, S, B	Yes	No[3]	Anonymous, 1994, 2003; CABI, 2003
Tettigoniidae					
Holochlora japonica (Brunner von Wattenwyl)	TW, US (HI)	L, Sh, T[16]	Yes	No[4]	Anonymous, 1994; PPQ, 1999; Soetardi, 1949

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Scientific Name	Distribution[1]	Plant Part Affected[2]	Quarantine Pest	Likely to Follow Pathway	References
Thysanoptera					
Thripidae					
Rhipiphorothrips cruentatus Hood	TW	L, F	Yes	Yes	CABI, 2003; Gima *et al.*, 2001; Wen *et al.*, 2002
Scirtothrips dorsalis Hood	TW, US (FL, HI)	L, I	Yes	No	CABI, 2002; China, 1997; Li-zhong, 2000; PPQ, 1999; Thomas, 2000; Wen *et al.*, 2002
Selenothrips rubrocinctus (Giard)	TW, US (FL, HI)	L, I, F	No	Yes	Anonymous, 1994; CABI, 2002; PPQ, 1999; Wen *et al.*, 2002
Thrips coloratus Schmutz	TW	I	Yes	No	Li-zhong, 2000; Wongsiri, 1991
Thrips hawaiiensis (Morgan)	TW, US	L, F, I	No	Yes	CABI, 2003; Wen *et al.*, 2002
FUNGI					
Ascochyta sp. (Fungi Imperfecti)	TW	F, S, L	Yes	Yes	CABI, 2002; China, 1997; Farr *et al.*, 2003
Aspergillus niger (Fungi Imperfecti)	TW, US	F	No	Yes	CABI, 2002; Coates *et al.*, 2003; Farr *et al.*, 2003
Aspergillus sp. (Fungi Imperfecti)	TW	F	No[10]	Yes	China, 1997; Coates *et al.*, 2003; Farr *et al.*, 2003; PIN309, 2003
Asterina heliciae Yamam. (Ascomycetes: Dothideales)	TW	L	Yes	No	Anonymous, 1994; Farr *et al.*, 2003; PPQ, 1999
Beltrania rhombica Penz. (Fungi Imperfecti)	TW, US (FL, GA)	L, Sd, F	No	Yes	Aloj *et al.*, 1994; Farr *et al.*, 2003; Gusmao and Grandi, 1996; Heredia, 1993; Puppi, 1981

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Scientific Name	**Distribution**[1]	**Plant Part Affected**[2]	**Quarantine Pest**	**Likely to Follow Pathway**	**References**
Beltraniopsis esenbeckiae (Fungi Imperfecti)	TW	L	Yes	No	Farr *et al.*, 2003; Gusmao *et al.*, 2000; Gusmao and Grandi, 1996; Rambelli and Ciccarone, 1985
Botryosphaeria sp. (Ascomycetes: Dothideales)	TW	S	Yes	Yes	Coates *et al.*, 2003; Farr *et al.*, 2003
Chaetothyrium echinulatum Yamam. (synonym: *C. sawadai* Yamam.) (Ascomycetes: Dothideales)	TW	L, S, F	Yes	No[18]	Anonymous, 1994; Farr *et al.*, 2003; Taiwan, 2002
Cladosporium sp. (Fungi Imperfecti)	TW	F	Yes	Yes	Coates *et al.*, 2003; Farr *et al.*, 2003
Colletotrichum gloeosporioides Penzig. (Fungi Imperfecti)	TW, US	B, F, I, L, S, Sd	No	Yes	CABI, 2002; Farr *et al.*, 2003; Ploetz *et al.*, 1994; Tsai, 1991
Colletotrichum sp. (Fungi Imperfecti)	TW	F, S	Yes	Yes	CABI, 2002; China, 1997; PPQ, 1999
Fomes lamaoensis (Murr.) Sacc. et Trott (Basidiomycetes: Poriales)	TW	R	Yes	No	Barthakur, 1994; Farr *et al.*, 2003; Maiti and Chattopadhyay, 1986; Satyanarayana *et al.*, 1983; Satyanarayana *et al.*, 1987; Tsai, 1991
Fusarium solani (Mart.) (Fungi Imperfecti)	TW, US	S, R, W, B	No	Yes	CABI, 2002; China, 1997; Farr *et al.*, 2003
Fusarium sp. (Fungi Imperfecti)	TW	F	Yes	Yes	Coates *et al.*, 2003; Farr *et al.*, 2003
Geotrichum candidum Link (Ascomycetes: Saccharomycetales)	TW, US	F	No[10]	Yes	Farr *et al.*, 2003; Tsai and Hsieh, 1998

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Scientific Name	**Distribution**[1]	**Plant Part Affected**[2]	**Quarantine Pest**	**Likely to Follow Pathway**	**References**
Geotrichum ludwigii (Ascomycetes: Saccharomycetales)	TW	F	No[10]	No[9]	Tsai and Hsieh, 1998
Glomerella cingulata (Stonem.) Spauld. & Schr. (Ascomycetes, Phylochorales) [*Colletotrichum gloeosporioides* (Penz.) Sacc. (anamorph)]	TW, US	B, F, I, L, S, Sd	No	Yes	CABI, 2002; China, 1997
Hexagonia heteropora (Montogne) Lmazaki [synonym: *Coriolopsis caperata* (Berk.) Murr.] (Basidiomycetes: Aphyllophorales)	TW	Br, S	Yes	No[8]	Anonymous, 1994; Farr *et al.*, 2003; PPQ, 1999; Tsai, 1991
Meliola euphorbiae (Ascomycetes: Meliolales)	TW	L, R	No[10]	No	Cao *et al.*, 2002; Farr *et al.*, 2003; Katumoto, 1991; Luttrell, 1989; Mibey and Hawksworth, 1997; Mishra and Prakash, 1993; Nagaraja and Thite, 1995; PIN309, 2003; Saldana *et al.*, 1985
Meliola nepheliicola F. Stev. et Roldon (Ascomycetes: Meliolales)	TW	L	No[10]	No	Anonymous, 1994; Farr *et al.*, 2003; PIN309, 2003; PPQ, 1999; Tsai, 1991
Micropeltis sp. (Ascomycetes: Dothideales)	TW	L	Yes	No	Farr *et al.*, 2003; Hsieh *et al.*, 1995; PIN309, 2003
Neocapnodium tanakae (Shirai et Hara) Yamam. (Ascomycetes: Dothideales)	TW	F, S, L	Yes	No[18]	Anonymous, 1994; China, 1997; Farr *et al.*, 2003; PPQ, 1999

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Scientific Name	**Distribution**[1]	**Plant Part Affected**[2]	**Quarantine Pest**	**Likely to Follow Pathway**	**References**
Penicillium sp. (Fungi Imperfecti)	TW	F, I, L, S	No[10]	Yes	China, 1997; Farr *et al.*, 2003; PIN309, 2003
Pestalotia funerea Desm (Fungi Imperfecti)	TW, US	L, Br	No	No	Anonymous, 1994; China, 1997; Farr *et al.*, 2003; Luisi and Triggiani, 1977; Tuset Barrachina, 1972
Pestalotiopsis sp. (Fungi Imperfecti)	TW	F	Yes	Yes	Coates *et al.*, 2003; Lin and Tsai, 2001; Liu, 1995; Tsay, 1991
Phaeosaccardinula javanica (Zimm.) Yamam. (Ascomycetes: Hemisphaeriales)	TW	L, F	Yes	No[19]	Anonymous, 1994; China, 1997; Farr *et al.*, 2003; PPQ, 1999; Tsai, 1991
Phellinus noxius (Corner) G.H. Cunningham (synonym: *Fomes lamaensis* Sacc. et Trott) (Basidiomycetes: Hymenochaetales)	TW	L, R	Yes	No	Ann *et al.*, 1999; CABI, 2002; Farr *et al.*, 2003; Leu, 1997; Taiwan, 2002
Phellinus williamsii (Murr.) Pat. (Basidiomycetes: Hymenochaetales)	TW	Br, NS	Yes	No	Anonymous, 1994
Phomopsis sp. (Fungi Imperfecti)	TW	S	Yes	Yes	Coates *et al.*, 2003; Farr *et al.*, 2003
Phyllosticta sp. (Fungi Imperfecti)	TW	F, I, S, L	Yes	Yes	CABI, 2002; China, 1997; Farr *et al.*, 2003
Phytophthora capsici Leonian (Oomycetes: Pythiales)	TW, US	F, L, R, S	No	Yes	Anonymous, 2003; CABI, 2003; Farr *et al.*, 2004
Phytophthora palmivora Butler (Oomycetes: Pythiales)	TW, US (CA, FL, AZ, HI)	L, S, R, I, F	No	Yes	CABI, 2002; Coates *et al.*, 2003

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Scientific Name	**Distribution[1]**	**Plant Part Affected[2]**	**Quarantine Pest**	**Likely to Follow Pathway**	**References**
Triposporiopsis spinigera (Hoehn) Yamam. (Ascomycetes: Dothideales)	TW	F, S, L, Br	Yes	No[18]	Anonymous, 1994; China, 1997; Farr *et al.*, 2003; PPQ, 1999; Tsai, 1991
Uredo euphoriae Pat. (Basidiomycetes: Uredinales)	TW	L	Yes	No	Anonymous, 1994; Farr *et al.*, 2003
MOLLUSKS					
Achatinidae					
Achatina fulica Bowdich	TW, US (HI)	L, S, R, F	Yes	No[3,13]	CABI, 2003; Wen *et al.*, 2002
Eulotidae					
Bradybaena similaris (Ferussac)	TW, US	L	No	No	CABI, 2003; Wen *et al.*, 2002
NEMATODES					
Tylenchida					
Helicotylenchus crenacauda Sher	TW	R	Yes	No	Lin, 1970; Liu and Zhang, 1999; UC Davis, 2004
Pratylenchus coffeae (Zimmermann) Filipjev & Schuurmans Steckhoven	TW, US	R	No	No	CABI, 2003; Liu and Zhang, 1999
Tylenchorhynchus annulatus (Cassidy) Golden	TW, US	R	No	No	CABI, 2003; Liu and Zhang, 1999
Tylenchulus semipenetrans Cobb	TW, US	R	No	No	Anonymous, 1994; CABI, 2002; China, 1997; PPQ, 1999; Tsai, 1991
VIRIDIPLANTAE (ALGAE)					
Cephaleuros virescens Kunze	TW, US	L	No	No	PPQ, 1999; Taiwan, 2002; Tsai, 1991

[1]TW = Taiwan; US = United States; AZ = Arizona; CA = California; FL = Florida; GA = Georgia; HI = Hawaii; TX = Texas (Individual States are listed only if the pest is reported in less than five States within the continental US).
[2]F = Fruit (seed pod or capsule), I = Inflorescence, L = Leaves, R = Root, S = Stem, Sd = Seed, T=Twig, B=Bark, Br=Branch, NS=Nursery Stock, Sh=Shoots, W=Wood
[3]Because of its size, biology and/or mobility, this pest is not expected to stay on the commodity through harvest, standard handling and processing.

[4]Pest mainly associated with plant parts other than commodity (PPQ, 1999).
[5]Many scarabs feed on plant materials such as grasses, foliage, fruits, and flowers, and some are serious pests of various agricultural crops (Borrer *et al.*, 1989). It is assumed that only the adults attack the fruit, as the literature does not mention scarab larvae feeding on fruit (White, 1983).
[6]White and Elson-Harris (1992) include *Dimocarpus longan* in *Bactrocera cucurbitae*'s host range based on some old Hawaiian records that require confirmation. *B. cucurbitae* was included in the PPQ commodity risk assessments for longans from Hawaii and China; therefore, the present risk assessment considers longan a host of this fruit fly species for consistency.
[7]Related species (*e.g*., *Coccus viridis, Coccus hesperidum*) are reported to attack stems and/or fruit (CABI, 2002); therefore, it is assumed that this species could follow the pathway.
[8]*Hexagonia heteropora* is reported "on dead parts" (Tsai, 1991), and other species within the genus *Hexagonia* are reported as wood-decaying fungi (Dass and Teyegaga, 1996; Harsh *et al.*, 1997); therefore, this fungus is not expected to follow the pathway.
[9]*Geotrichum ludwigii* has only been reported causing fruit rot in longan in pathogenicity tests (Tsai and Hsieh, 1998); otherwise, the literature does not report this pathogen on longan. Therefore, this fungus is not expected to follow the pathway.
[10]Genus listed as a "nonreportable" pest in PIN309 (2003).
[11]*Planococcus lilacinus* has been intercepted 47 times on *Dimocarpus longan*, 32 of which were on fruit (PIN309 query November 21, 2003).
[12]*Planococcus minor* has been intercepted 46 times on *Dimocarpus longan*, all of which were on fruit (PIN309 query November 21, 2003).
[13]*Achatina fulica* has a preference for fallen and decaying fruit (CABI, 2003), making it unlikely to follow the pathway of commercial fruit for export.
[14]Quarantine significant species with limited distribution in the US (Dooley, 2004; NIS, 2004a, 2004b).
[15]The larvae and pupae in the family Psychidae are external pests that develop inside characteristic bags or cases made of silk and portions of leaves and twigs (Borrer *et al.*, 1989). These bags or cases are easily seen when leaves are absent (Borrer *et al.*, 1989). Because leaves will not accompany the imported longan fruits and stems, these insects are not expected to stay with the commodity through harvest and standard postharvest handling and processing.
[16]Based on information at the genus level
[17]*Squamura discipuncta* (synonym: *Indarbela baibarana*) (Zhang, 1994) is reported to bore into stems (Zhang, 1994). Because the literature mainly reports species in the genera *Squamura* and *Indarbela* as attacking wood and bark (*e.g*., Choudhary *et al.*, 2005; Kannan and Rao, 2007; Masarrat, 2007; Meshram, 2005; Rao and Prasad, 2004; Sangha and Makkar, 2005; Sasidharan and Varma, 2005; Sidhu and Poon, 1983; Waite and Hwang, 2002; Zhang, 1994), we assumed that *Squamura discipuncta* is mainly associated with stems or branches larger than the 3-4mm diameter stems associated with exported longan fruit. Consequently, we estimated this species would be unlikely to follow the commodity pathway.
[18]Because they are sooty molds, the fungi *Chaetothyrium echinulatum* (Ascomycetes: Dothideales), *Triposporiopsis spinigera* (Ascomycetes: Dothideales), and *Neocapnodium tanakae* (Ascomycetes: Dothideales) are unlikely to follow the commodity pathway. *Chaetothyrium echinulatum* is reported as a sooty mold (Tsai, 1991). No information could be found on the genus *Triposporiopsis*, but its synonym *Trichomerium* (Hawksworth *et al.*, 1995) is reported as a sooty mold (Kwee, 1988, 1989; Swai, 1988). Likewise, no information could be found on the genus *Neocapnodium*, but its synonym *Phragmocapnias* (Hawksworth *et al.*, 1995) is reported as a sooty mold (Kwee, 1988, 1989). Sooty molds are not parasitic but live off honeydew from certain insects, particularly aphids and scale insects (Agrios, 1997), and their presence is usually of minor importance to the health of the plant (Agrios, 1997). As long as honeydew-causing insects are controlled, these fungi are unlikely to be associated with the exported commodity.
[19]*Phaeosaccardinula javanica* is not expected to follow the pathway of commercial export quality longan fruit because it is in the Hemisphaeriales, which, generally, are not pathogens and, at most, may cause some cosmetic "problems" (Palm, 2003).

Quarantine pests that are reasonably likely to follow the pathway on commercial shipments of longan from Taiwan are further analyzed in this risk assessment and summarized in Table 4. Quarantine pests not included in this summary have the potential to be detrimental to US agriculture or ecosystems; however, they have not been subjected to further analysis because they are mainly associated with plant parts other than the commodity; they may be more reasonably associated with larger diameter stems or branches than with the 3-4 mm diameter stems associated with longan fruit; they may have a greater association with new stem or leaf growth rather than with mature fruit-bearing peduncles at harvest time; or they are unlikely to be associated with the fruit during transport or processing because of their inherent mobility.

Biological hazards associated with organisms not identified to the species level were not assessed because often there are many species within a genus, and it is not reasonable to assume that the biology of all organisms within a genus is identical. In this risk assessment, the above statement only applies to *Colletotrichum* sp. (Fungi Imperfecti). Lack of specific identification may indicate the limits of current taxonomic knowledge, the life stage or the quality of the specimen submitted for identification. By necessity, pest risk assessments focus on organisms for which biological information is available. Lack of specific identification does not rule out the possibility that a high risk quarantine pest was intercepted. Conversely, the development of detailed assessments for known pests that inhabit a variety of ecological niches, such as internal fruit feeders or foliage pests, allow effective mitigation measures to eliminate the known organisms as well as similar but incompletely identified organisms that inhabit the same niche. If pests identified to higher taxa are intercepted in the future, then a reevaluation of their risk may occur.

Table 4. Quarantine pests likely to be associated with longan imported from Taiwan and selected for further analysis
Arthropods
Acari **Eriophyidae** *Aceria litchii* **Diptera** **Tephritidae** *Bactrocera cucurbitae* *Bactrocera dorsalis* **Homoptera** **Coccidae** *Ceroplastes rubens* *Coccus discrepans* *Coccus formicarii* *Coccus viridis* *Drepanococcus chiton* *Pulvinaria taiwana* **Diaspidae** *Aulacaspis tubercularis* *Fiorinia pinicola* *Pseudaonidia trilobitiformis* *Thysanofiorinia nephelii* **Kerridae** *Kerria greeni* *Kerria lacca* **Margarodidae**

Table 4. Quarantine pests likely to be associated with longan imported from Taiwan and selected for further analysis
Icerya seychellarum
Pseudococcidae
Maconellicoccus hirsutus
Nipaecoccus viridis
Planococcus lilacinus
Planococcus minor
Lepidoptera
Gracillariidae
Conopomorpha sinensis
Lycaenidae
Deudorix epijarbas
Pyralidae
Conogethes punctiferalis
Tortricidae
Adoxophyes orana
Cryptophlebia ombrodelta
Thysanoptera
Thripidae
Rhipiphorothrips cruentatus

E. Analysis of Quarantine Pest

The undesirable consequences that may occur from the introduction of quarantine pests are assessed within this section. For each quarantine pest, the potential consequences of introduction are rated in five areas called "Risk Elements". The Risk Elements include: Climate-Host Interaction, Host Range, Dispersal Potential, Economic Impact and Environmental Impact. These Risk Elements reflect the biology, host range and climatic/geographic distribution of each pest and are supported by biological information on each of the analyzed pests summarized in this section. For each risk element, pests are assigned a rating of Low (1 point), Medium (2 points) or High (3 points). A cumulative risk value is then calculated by summing the ratings. The following scale is used to interpret this total: Low is 5-8 points, Medium is 9-12 points and High is 13-15 points. The ratings are summarized in Table 5. The ratings were determined using the criteria in the *Risk Assessment Guidelines, Version 5.02* (USDA, 2000).

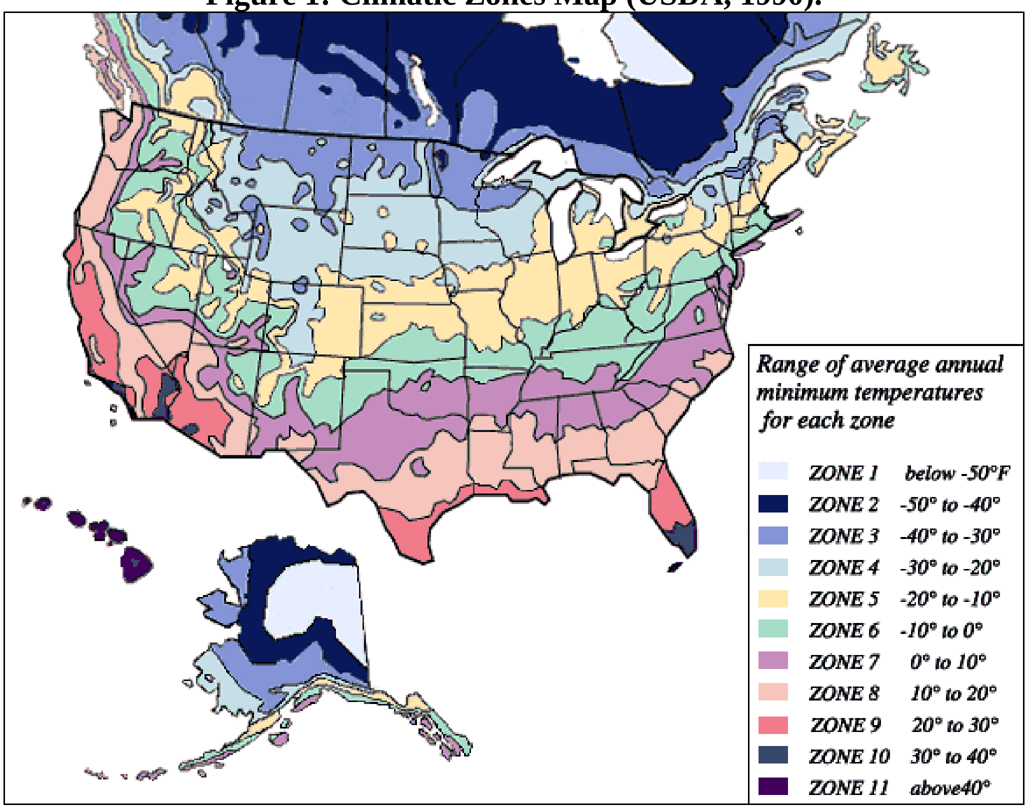
The major sources of uncertainty present in this risk assessment are similar to those in other risk assessments. They include the use of a developing or evolving process (Orr *et al.*, 1993; USDA, 2000), the approach used to combine risk elements (Bier, 1999; Morgan and Henrion, 1990), and the evaluation of risk by comparisons to lists of factors within the guidelines (Kaplan, 1992; Orr *et al.*, 1993). To address this last source of uncertainty, the lists of factors were interpreted as illustrative and not exhaustive. This implies that additional biological information, even if not explicitly part of the criteria, can be used when it is relevant to a rating. Other sources of uncertainty are the quality of the biological information and the amount of information available on the regional flora and fauna. Inherent biological variation within a population of organisms introduces uncertainty as well (Morgan and Henrion, 1990).

Consequences of Introduction—Economic/Environmental Importance

Potential consequences of introduction are rated using five risk elements: Climate-Host Interaction, Host Range, Dispersal Potential, Economic Impact, and Environmental Impact. These elements reflect the biology, host ranges and climatic/geographic distributions of the pests. For each risk element, pests are assigned a rating of Low (1 point), Medium (2 points) or High (3 points) (USDA, 2000). The following is a description of how each of these ratings are determined for each risk element (USDA, 2000):

Risk Element #1: Climate—Host Interaction
Estimates are based on availability of both host material and suitable climate conditions. To rate this Risk Element, the US "Plant Hardiness Zones" (USDA, 1990) are used (Figure 1). Due to the availability of both suitable host plants and suitable climate, the pest has potential to establish a breeding colony:
Low (1): In a single plant hardiness zone.
Medium (2): In two or three plant hardiness zones.
High (3): In four or more plant hardiness zones.

Figure 1: Climatic Zones Map (USDA, 1990).



Risk Element #2: Host Range
Risk is rated as a function of host range.
Low (1): Pest attacks a single species or multiple species within a single genus.
Medium (2): Pest attacks multiple species within a single plant family.

High (3): Pest attacks multiple species among multiple plant families.

Risk Element #3: Dispersal Potential
A pest may disperse after introduction to a new area. The following items are considered: reproductive patterns of the pest (*e.g.*, voltinism, biotic potential), inherent powers of movement, factors facilitating dispersal (wind, water, presence of vectors, human, *etc*.).
Low (1): Pest has neither high reproductive potential nor rapid dispersal capability.
Medium (2): Pest has either high reproductive potential *OR* the species is capable of rapid dispersal.
High (3): Pest has high biotic potential, *e.g.*, many generations per year, many offspring per reproduction ("r-selected" species), *AND* evidence exists that the pest is capable of rapid dispersal, *e.g.*, over 10 km/year under its own power; via natural forces, wind, water, vectors, *etc*., or human-assistance.

Risk Element #4: Economic Impact
Introduced pests are capable of causing a variety of direct and indirect economic impacts. These impacts are divided into three primary categories (other types of impacts may occur): 1) Lower yield of the host crop, *e.g.*, by causing plant mortality, or by acting as a disease vector; 2) Lower value of the commodity, *e.g.*, by increasing costs of production, lowering market price, or a combination; 3) Loss of foreign or domestic markets due to presence of new quarantine pest.
Low (1): Pest causes any one or none of the above impacts.
Medium (2): Pest causes any two of the above impacts.
High (3): Pest causes all three of the above impacts.

Risk Element #5: Environmental Impact
The assessment of the potential of each pest to cause environmental damage proceeds by considering the following factors: 1) Introduction of the pest is expected to cause significant, direct environmental impacts, *e.g.*, ecological disruptions, reduced biodiversity. When used within the context of the National Environmental Policy Act (NEPA) (7CFR §372), the significance is qualitative and encompasses both the likelihood and severity of an environmental impact; 2) The pest is expected to have direct impacts on species listed by Federal Agencies as endangered or threatened (50CFR §17.11 and §17.12), by infesting/infecting a listed plant. If the pest attacks other species within the genus or other genera within the family, and preference/no preference tests have not been conducted with the listed plant and the pest, then the plant is assumed to be a host; 3) The pest is expected to have indirect impacts on species listed by Federal Agencies as endangered or threatened by disrupting sensitive, critical habitats; 4) Introduction of the pest would stimulate chemical or biological control programs.
Low (1): None of the above would occur; it is assumed that introduction of a nonindigenous pest will have some environmental impact (by definition, introduction of a nonindigenous species affects biodiversity).
Medium (2): One of the above would occur.
High (3): Two or more of the above would occur.
A Cumulative Risk Rating is then calculated by summing all risk element values. The values determined for the Consequences of Introduction for each pest are summarized in Table 5.

Consequences of Introduction: ***Aceria litchii*** **(Keifer) (Prostigmata: Eriophyidae)**	**Risk Value**
Risk Element #1: Climate-Host Interaction *Aceria litchii* is reported in China (He and He, 2001; Waite and Hwang, 2002); Taiwan (Huang, 1967; Taiwan, 2002; Waite and Hwang, 2002); India (Kumar K. K., 1992; Waite and Hwang, 2002); Hawaii; Pakistan (Jeppson *et al.*, 1975; Waite and Hwang, 2002); and Australia (Waite and Hwang, 2002). Based on the distribution and reported host range of this species, it is estimated that it could become established in the US Plant Hardiness Zones 9-11. Neither of its hosts, longan nor litchi, occur naturally in the US (USDA NRCS, 2003); however, longan is commercially grown in southern Florida (NCSU CIPM, 2003) and is grown in small back yard gardens in southern California (Gaskell, 2003). Similarly, litchi is commercially grown in southern Florida and Hawaii and largely grown as an ornamental in southern California (Erickson *et al.*, 1999).	Medium (2)
Risk Element #2: Host Range *Aceria litchii*'s host range includes *Dimocarpus longan* (Sapindaceae) (Huang, 1967; Taiwan, 2002) and *Litchi chinensis* (Sapindaceae) (Huang, 1967; Jeppson *et al.*, 1975).	Medium (2)
Risk Element #3: Dispersal Potential In India and China, 13-15 overlapping generations are produced each year (Waite and Hwang, 2002). A study in India, *A. litchii* completed its life cycle in 15-20 days and had 10-12 annual generations (Prasad and Singh, 1981). The reproductive rate of *A. litchii* is not reported in the literature, but a related species, *Aceria guerreronis*, is reported to have a high reproductive rate (CABI, 2003). This mite could easily be dispersed by human activity because it is minute, and it attacks young leaves, fruits, stems, shoots, and flower buds (Jeppson *et al.*, 1975; PPQ, 1999; Taiwan, 2002). Since 1985, the genus *Aceria* has been intercepted on 20 occasions by PPQ officers on various plant parts (fruit, leaf, plant, *etc.*), most of which were in cargo (PIN309 query July 28, 2003). In India, this mite moves with the importation of gootee plants from affected orchards (Prasad and Singh, 1981). In terms of natural dispersal ability, all stages are quite mobile and can move easily from old infested leaves to new leaves (Waite and Hwang, 2002). Erinose mites can be transported from tree to tree by phoresy (*e.g.*, on honeybees at flowering), human activity or other agents; however, wind currents are the most common method of movement (Waite and Hwang, 2002).	High (3)
Risk Element #4: Economic Impact *Aceria litchii* is a serious pest of litchi (Kumar K. K., 1992). It is ranked as the most important pest of litchi in Bihar, India (Mathur and Tandon, 1974; Prasad and Singh, 1981) and is also one of the most important pests in the Guangdong litchi producing areas of China (He and He, 2001). In Taiwan, *A. litchi* infests litchi and longan; it is reported to be a "serious" pest of litchi, damaging 20-83% of this commodity (Huang, 1967), and a pest of "major economic significance" to longan (Taiwan, 2002). In Bihar, India, both young and mature litchi trees are attacked and seriously damaged by *A. litchi*, causing losses as high as 80	High (3)

Consequences of Introduction: *Aceria litchii* (Keifer) (Prostigmata: Eriophyidae)	**Risk Value**
percent in severely infested orchards (Prasad and Singh, 1981). This mite is the most important pest of litchi in Hawaii and Pakistan (Jeppson *et al.*, 1975). Damage by this mite includes: causing a felt-like erineum on leaves and fruit, deformed terminals, leaf fall, and prevention of fruit set or malformed fruit (Waite and Hwang, 2002). When fruits are attacked, they may be unmarketable (Waite and Hwang, 2002). Additionally, introduction of this pest into the US could cause a loss of foreign and domestic markets.	
Risk Element #5: Environmental Impact The genera *Litchi* and *Dimocarpus* are not listed as Threatened or Endangered in 50 CFR §17.12. The Hawaiian species *Alectryon macrococcus* (Sapindaceae) is listed as Endangered, and preference tests with this plant species and *A. litchii* are not known; however, this mite is already present in Hawaii (see Risk Element #1). Although the introduction of *A. litchii* into the US does not present any foreseeable impacts on Threatened or Endangered plants, its establishment in the US would probably initiate chemical and/or biological control programs. Management of *A. litchii* in China includes the use of chemical pesticides (He and He, 2001). Phosphamidon, dimethoate phosalone (Kumar R., 1992), dicofol, monocrotophos (Kumar K. K., 1992), and malathion (Prasad and Singh, 1981) have been successfully used against this pest.	Medium (2)

Consequences of Introduction: *Adoxophyes orana* Fischer von Röeslerstamm (Lepidoptera: Tortricidae)	**Risk Value**
Risk Element #1: Climate-Host Interaction *Adoxophyes orana* is present throughout Western Europe, as far south as Spain and as far north as Finland, Sweden, and Norway (CABI, 2002). It is also present in Armenia, Azerbaijan, China (Hebei, Hong Kong, Sichuan), Georgia, Japan, Korea, Siberia and Taiwan (CABI, 2002). It is, therefore, conservatively estimated that this species could become established in US Plant Hardiness Zones 5-11. One or more of its potential hosts occurs in these zones (USDA NRCS, 2003).	High (3)
Risk Element #2: Host Range Primary hosts are reported to be in the families Rosaceae (*Malus pumila, Pyrus communis, Prunus domestica, Prunus avium, Prunus armeniaca, Prunus persica, Cydonia oblonga, Rubus idaeus, Rosa* sp.) and Grossulariaceae (*Ribes nigrum*) (CABI, 2002). This tortricid has wild hosts in other families, including Aceraceae (*e.g., Acer campestre*), Betulaceae (*e.g., Alnus, Betula*), and Malvaceae (*e.g., Gossypium herbaceum*) (CABI, 2002). In China, its host range includes longan (Sapindaceae) (Anonymous, 1994).	High (3)
Risk Element #3: Dispersal Potential Females can deposit more than 300 eggs each. There are usually two generations per year in north-western Europe, although in warm summers a partial third generation may occur (CABI, 2002). Migration is reported to be	Medium (2)

Consequences of Introduction: ***Adoxophyes orana*** **Fischer von Röeslerstamm (Lepidoptera: Tortricidae)**	**Risk Value**
rather limited, especially for females, with flying activity often restricted to the night; however, males have been found more than 400m from their initial location (CABI, 2002). Although dispersal by natural means may be limited, fruit and leaves are liable to carry the pest in trade (CABI, 2002). However, this genus has only been intercepted by PPQ on two occasions since 1985, once on cut flowers and once on fruit, both of which were in permit cargo (PIN309, query July 9, 2003). Therefore, the risk of dispersal by commercial trade appears to be limited. This may be due, in part, to the fact that fruit damage consists of large deep holes or several smaller holes (less than 5mm in diameter) adjacent to each other (CABI, 2002) that often do not penetrate deeper than the skin (USDA, 1985). These symptoms probably increase the chance of infested fruit being culled during harvest and post-harvest. Indeed, on apple, larval presence can be easily recognized by a large, shallow, irregular area of apple skin removed from the surface (USDA, 1985).	
Risk Element #4: Economic Impact *Adoxophyes orana* is the most important lepidopteran pest of pome fruit in Belgium (Bylemans, 2000). It is a long established fruit pest in continental Europe, and is now considered a potentially serious apple pest in Britain (Carter, 1984). It caused considerable damage to apples in an orchard in Hungary in 1996 to 2000 (Voigt *et al.*, 2001). Extensive damage to lilac buds and developing flowers has also occurred in the Netherlands (Carter, 1984). This tortricid is reported to damage more than 50% of orchard fruit, causing the fruit to dessicate or rot (CABI, 2002). Even superficial damage to the fruit will cause a downgrading in value (Meijerman and Ulenberg, 2000; Van Der Geest and Evenhuis, 1991). Introduction of this pest into the US could cause a loss of foreign and domestic markets.	High (3)
Risk Element #5: Environmental Impact Examples of potential hosts listed as Threatened or Endangered in 50 CFR §17.12 are: *Prunus geniculata*, *Betula uber*, *Ribes echinellum*. As this tortricid represents an important economic threat, its establishment in the US would probably trigger the initiation of chemical and/or biological control programs. Biocontrol agents have been developed and used against this pest (Andermatt *et al.*, 2000).	High (3)

Consequences of Introduction: ***Aulacaspis tubercularis*** **Newstead (Homoptera: Diaspididae)**	**Risk Value**
Risk Element #1: Climate-Host Interaction *Aulacaspis tubercularis* is widespread in the mango-growing areas of the world; it is present throughout Africa, in South and Southeast Asia, the Caribbean, and in northern South America, with disjunct populations in Europe (Italy) and the south Pacific (CABI, 2002). From this warm temperate to tropical distribution, it is estimated that this species would be able to survive in the warmer regions of the US corresponding to Plant Hardiness Zones 8-11. One or more of its potential hosts occurs in these zones (USDA NRCS, 2003).	High (3)

Consequences of Introduction: ***Aulacaspis tubercularis*** **Newstead (Homoptera: Diaspididae)**	**Risk Value**
Risk Element #2: Host Range *Aulacaspis tubercularis*' preferred host is *Mangifera indica* (Anacardiaceae) (CABI, 2002). Other hosts include *Cocos nucifera* (Arecaceae), *Citrus* spp. (Rutaceae), *Persea americana* (Lauraceae), *Zingiber officinale* (Zingiberaceae), *Cucurbita* spp. (Cucurbitaceae) (CABI, 2002), and *Dimocarpus longan* (Sapindaceae) (ScaleNet, 2002).	High (3)
Risk Element #3: Dispersal Potential Fecundity ranges as high as 80-200 eggs per female on mango, and there may be several generations per year (CABI, 2002). First-instar crawlers may be dispersed locally on wind currents, and long distance dispersal may be accomplished on infested plant materials (*e.g.*, the pest has spread to the south Pacific on infested plant material) (CABI, 2002).	High (3)
Risk Element #4: Economic Impact *Aulacaspis tubercularis* is reported to be a significant pest of mango in South Africa (CABI, 2002; Colyn and Schaffer, 1993). Infestation causes a conspicuous pink blemish on fruits, affecting their commercial value and export potential (CABI, 2002). In nurseries, severe early-stage infestation retards growth (CABI, 2002). Young trees are vulnerable to excessive leaf loss and twig death during hot, dry weather (CABI, 2002). Increased exports of mangoes from South Africa have made effective control of this scale insect essential (Labuschagne, 1991).	High (3)
Risk Element #5: Environmental Impact This pest has the potential to attack Endangered or Threatened plants in the US (*e.g.*, *Cucurbita okeechobeensis* ssp. *okeechobeensis*, a Florida cucurbit listed as Endangered in 50 CFR §17.12). Its introduction could stimulate chemical or biological control programs.	High (3)

Consequences of Introduction: ***Bactrocera cucurbitae*** **(Coquillett) (Diptera: Tephritidae)**	**Risk Value**
Risk Element #1: Climate-Host Interaction This species is present in subtropical and tropical Asia, Eastern and Western Africa, and the Pacific Islands, including Hawaii (CABI, 2002). It is estimated that it could become established in areas of the US corresponding to Plant Hardiness Zones 9-11. One or more of its potential hosts occurs in these zones (USDA NRCS, 2003).	Medium (2)
Risk Element #2: Host Range Primary hosts are from the family Cucurbitacaeae and include *Cucumis melo*, *Cucurbita maxima*, *Cucurbita pepo*, and *Trichosanthes cucumerina* (CABI, 2002). Secondary hosts from the Cucurbitaceae include *Benincasa hispida*, *Citrullus colocynthis* and *Cucumis anguria* (CABI, 2002). Additional secondary hosts occur in the families Rosaceae (*e.g.*, *Prunus persica*), Rutaceae (*e.g.*, *Citrus sinensis*), Fabaceae (*e.g.*, *Phaseolus vulgaris*), Loganiaceae (*Strychnos nux-vomica*), Malvaceae (*Abelmoschus moschatus*), Myrtaceae (*Psidium guajava*), Pandanaceae (*Pandanus odoratissimus*), Passifloraceae	High (3)

Consequences of Introduction: *Bactrocera cucurbitae* (Coquillett) (Diptera: Tephritidae)	**Risk Value**
(*Passiflora edulis*), Rhamnaceae (*e.g.*, *Ziziphus jujube*), Sapotaceae (*Manilkara zapota*), Solanaceae (*Lycopersicon esculentum*) (CABI, 2002), and Sapindaceae (*Dimocarpus longan*) (White and Elson-Harris, 1992).	
Risk Element #3: Dispersal Potential Females lay up to 40 eggs at a time and may lay more than 1000 eggs total in their lifetime (CABI, 2002; Weems, 1964). Reproduction is continuous, as adults occur throughout the year (CABI, 2002). Under warm summer conditions, the development from egg to adult requires from 12 to 28 days (Weems, 1964). This species can be dispersed via commercial trade as eggs and larvae present internally in fruit, as pupae in growing media accompanying plants, and in flowers (CABI, 2002). Additionally, this fruit fly can disperse naturally by adult flight. Fletcher (1989a) reports that many *Bactrocera* spp. can fly 50-100km.	High (3)
Risk Element #4: Economic Impact *Bactrocera cucurbitae* has been considered the most destructive pest of cucurbits in the Indo-Malayan region (USDA, 1983; Weems, 1964), and it has greatly reduced the production of melons, cucumbers, tomatoes, and similar vegetables in Hawaii (USDA, 1983; Weems, 1964). Around 1915, *B. cucurbitae* caused a loss of nearly $1 million annually in Hawaii, during which more than 95% of the pumpkin crop was destroyed (USDA, 1983). Damage levels up to 100% have been reported in unprotected fruit (CABI, 2002). Injury by this fruit fly can result in deformed fruit (USDA, 1983). Introduction of this pest into the US could cause a loss of foreign and domestic markets.	High (3)
Risk Element #5: Environmental Impact Examples of potential hosts listed as Threatened or Endangered in 50 CFR §17.12 are: *Cucurbita okeechobeensis* ssp. *okeechobeensis*, *Prunus geniculata*, and *Ziziphus celata*. As this fruit fly represents an important economic threat, its establishment in the US would probably trigger the initiation of chemical and/or biological control programs.	High (3)

Consequences of Introduction: *Bactrocera dorsalis* (Hendel) (Diptera: Tephritidae)	**Risk Value**
Risk Element #1: Climate-Host Interaction Except for adventive populations in Guam and Hawaii, *B. dorsalis* is restricted to subtropical and tropical Asia White and Elson-Harris, 1992. It is estimated that this species could become established in the continental US in areas corresponding to Plant Hardiness Zones 9-11. One or more of its potential hosts occurs in these zones (USDA-NRCS, 2002).	Medium (2)
Risk Element #2: Host Range This species is extremely polyphagous. Recorded hosts include *Coffea* sp. (Rubiaceae), *Ficus* sp. (Moraceae), *Prunus* spp. (Rosaceae), *Eugenia uniflora* (Myrtaceae), *Mangifera* spp. (Anacardiaceae), *Citrus* spp. (Rutaceae), *Areca catechu* (Arecaceae), *Chrysophyllum cainito* (Sapotaceae), *Cucumis* spp.	High (3)

Consequences of Introduction: *Bactrocera dorsalis* (Hendel) (Diptera: Tephritidae)	**Risk Value**
(Cucurbitaceae), *Dimocarpus longan* (Sapindaceae), *Diospyros kaki* (Ebenaceae), *Flacourtia indica* (Flacourtiaceae), *Punica granatum* (Punicaceae), *Ziziphus* spp. (Rhamnaceae), *Annona* spp. (Annonaceae), *Averrhoa carambola* (Oxalidaceae), *Carica papaya* (Caricaceae), *Malpighia glabra* (Malpighiaceae), *Muntingia calabura* (Elaeocarpaceae), *Persea americana* (Lauraceae), *Terminalia catappa* (Combretaceae), *Musa* x *paradisiaca* (Musaceae) (CABI, 2001); *Passiflora mollisima* (Passifloraceae), *Juglans hindsii* (Juglandaceae), *Quassia simarouba* (Simaroubaceae), *Solanum seaforthianum* (Solanaceae), and *Clausena lansium* (Rutaceae) (White and Elson-Harris, 1992).	
Risk Element #3: Dispersal Potential Females deposit 3-30 eggs per host fruit; total fecundity per female may exceed 1000 eggs (Fletcher, 1989a). There are several generations per year (CABI, 2002). Adult *B. dorsalis* are capable of flying up to 65km (Fletcher, 1989b), and transport of infested fruit is a major means of movement and dispersal to previously uninfested areas (CABI, 2001). Like other dacine tephritids, *B. dorsata* exhibits high reproductive and dispersal potentials.	High (3)
Risk Element #4: Economic Impact Economic losses include (Harris, 1989): 1) downgrading quality caused by oviposition "stings," which spoil the appearance of fruits, including those unfavorable for larval survival; 2) fruit spoilage caused by larval tunneling and the entry of organisms that cause decay; and 3) indirect damage in the form of lost markets resulting from the imposition of quarantine restrictions. In Hawaii, annual losses in major fruit crops caused by *B. dorsalis* may exceed 13%, or $3 million (Culliney, 2002).	High (3)
Risk Element #5: Environmental Impact Because of its extremely broad host range, *B. dorsalis* represents a potential threat to plants listed as Threatened or Endangered in 50 CFR §17.12 that are found in southern areas of the US (*e.g*., *Prunus geniculata*, *Ziziphus celata*). As the species is a pest of numerous economically significant crops in the continental US (*e.g*., apple, peach, pear, citrus), its entry and establishment could stimulate the initiation of chemical or biological control programs, as has occurred in Hawaii.	High (3)

Consequences of Introduction: *Ceroplastes rubens* Maskell (Homoptera: Coccidae)	**Risk Value**
Risk Element #1: Climate-Host Interaction *Ceroplastes rubens*' distribution extends from warm temperate zones to the tropics. It is found in East and South Asia, throughout Oceania, Australia, East Africa, and the West Indies (CABI, 2001). It is estimated that it could survive in US Plant Hardiness Zones 7-11. One or more of its potential hosts occurs in these zones (USDA NRCS, 2003).	High (3)
Risk Element #2: Host Range The species has been recorded on numerous wild and cultivated hosts, including *Citrus* spp. (Rutaceae), *Mangifera indica* (Anacardiaceae), *Artocarpus altilis*	High (3)

Consequences of Introduction: *Ceroplastes rubens* Maskell (Homoptera: Coccidae)	Risk Value
(Moraceae), *Cinnamomum verum* (Lauraceae), *Camellia sinensis* (Theaceae), *Litchi chinensis* (Sapindaceae), *Psidium guajava* (Myrtaceae), *Coffea* sp. (Rubiaceae), *Alpinia purpurata* (Zingiberaceae), *Myristica fragrans* (Myristicaceae), *Annona* sp. (Annonaceae), *Artemisia* sp. (Asteraceae), *Prunus* spp. (Rosaceae), *Pinus* spp. (Pinaceae), *Cocos nucifera* (Arecaceae) (CABI, 2001), and *Dimocarpus longan* (Sapindaceae) (Li-zhong, 2000; ScaleNet, 2002).	
Risk Element #3: Dispersal Potential Females may deposit over 1000 eggs, but mean fecundity is just below 300 (CABI, 2001). There are two generations per year (CABI, 2002). As with other scales, the species exhibits limited mobility under its own power. The main means of long-distance dispersal is on infested plant materials (CABI, 2002).	High (3)
Risk Element #4: Economic Impact *Ceroplastes rubens* is a widespread pest of *Citrus*, coffee, tea, *Cinnamomum*, mango, avocado and litchi (CABI, 2001). It is considered a major pest of citrus in Australia, Hawaii, Korea, China and Japan (CABI, 2002). Economic damage is caused directly through phloem feeding and indirectly through the promotion of sooty mold growth, which lowers the market value of fresh fruit and can reduce photosynthetic efficiency, causing reduced growth (CABI, 2002). Based on this evidence, if *C. rubens* should become more widely established in the US, there would likely be a lower yield of host crops, lower value of host crop commodities, and loss of foreign or domestic markets.	High (3)
Risk Element #5: Environmental Impact The extreme polyphagy of this species increases the probability of it attacking plants in the US listed as Threatened or Endangered. It has been recorded from species of *Euphorbia*, *Gardenia*, *Ilex*, *Lindera*, and *Rhus* (CABI, 2001), which have congeners (*E. haeleeleana*, *E. telephioides*, *G. brighamii*, *G. mannii*, *I. cookii*, *I. sintenisii*, *L. melissifolia*, and *R. michauxii*) listed in 50 CFR §17.12. As this species is a pest of citrus, the wider establishment of this pest in the US would likely result in the initiation of chemical and/or biological control programs.	High (3)

Consequences of Introduction: *Coccus discrepans* Green (Homoptera: Coccidae)	Risk Value
Risk Element #1: Climate-Host Interaction *Coccus discrepans* has a tropical/subtropical distribution, as it is reported in Singapore, India, Pakistan, Sri Lanka, Taiwan, and Japan (Ben-Dov, 1993; Graf, 1981). It is, therefore, estimated that this species could become established in the continental US in areas corresponding to Plant Hardiness Zones 9-11. One or more of its potential hosts occurs in these zones (USDA NRCS, 2003).	Medium (2)
Risk Element #2: Host Range *Coccus discrepans*' host range includes: *Carica papaya* (Caricaceae); *Glochidion callicarpa* (Euphorbiaceae); *Maesa pedicellata* (Myrsinaceae); *Areca oleracea*, *Cocos nucifera* (Palmae); *Citrus*, *Murraya calaxylon* (Rutaceae); *Thea*	High (3)

Consequences of Introduction: *Coccus discrepans* Green (Homoptera: Coccidae)	Risk Value
(Theaceae); and *Callicarpa formosana* (Verbenaceae) (Ben-Dov, 1993); plus *Mangifera indica, Mangifera odorata* (Anacardiaceae); *Musa*, *Musa paradisiaca* (Musaceae); *Ziziphus jujube* (Rhamnaceae); *Camellia sinensis* (Theaceae) (ScaleNet, 2002), and *Dimocarpus longan* (Sapindaceae) (Anonymous, 1965).	
Risk Element #3: Dispersal Potential No information could be found on the dispersal potential of this species. Because of a lack of information, its dispersal potential is assumed to be similar to that of *Coccus viridis*, and it is given a rating of High (3) for the Dispersal Potential Risk Element.	High (3)
Risk Element #4: Economic Impact No information could be found on the economic impact of this species. Because of a lack of information, its potential economic impact is assumed to be similar to that of *Coccus viridis*, and it is given a rating of High (3) for the Economic Impact Risk Element.	High (3)
Risk Element #5: Environmental Impact *Ziziphus celata* is a potential host of *C. discrepans* and is listed as Endangered in 50 CFR §17.12. As it is assumed this scale represents an important economic threat (see Risk Element #4), its establishment in the US would probably trigger the initiation of chemical and/or biological control programs.	High (3)

Consequences of Introduction: *Coccus formicarii* (Green) (Homoptera: Coccidae)	Risk Value
Risk Element #1: Climate-Host Interaction *Coccus formicarii* has a tropical/subtropical distribution, as it is reported in Madagascar, Hong Kong, India, Indonesia, Malaysia, Nepal, Sri Lanka, Taiwan, and Thailand (Ben-Dov, 1993; ScaleNet, 2002). Based on this distribution, it is estimated that this species could become established in the continental US in areas corresponding to Plant Hardiness Zones 9-11. One or more of its potential hosts occurs in these zones (Ben-Dov, 1993; ScaleNet, 2002; USDA NRCS, 2003).	Medium (2)
Risk Element #2: Host Range *Coccus formicarii*'s host range includes species in 31 plant families: Anacardiaceae, Araliaceae, Bischofiaceae, Bombacaceae, Buxaceae, Capparidaceae, Ebenaceae, Elaeocarpaceae, Ericaceae, Euphorbiaceae, Fagaceae, Guttiferae, Lauraceae, Leguminosae, Lythraceae, Magnoliaceae, Meliaceae, Moraceae, Myristicaceae, Myrsinaceae, Myrtaceae, Oleaceae, Palmae, Proteaceae, Rosaceae, Rubiaceae, Rutaceae, Salicaceae, Sapindaceae, Theaceae, and Verbenaceae (ScaleNet, 2002).	High (3)
Risk Element #3: Dispersal Potential No information could be found on the dispersal potential of this species. Because of a lack of information, its dispersal potential is assumed to be similar to that of *Coccus viridis*.	High (3)
Risk Element #4: Economic Impact No information could be found on the economic impact of this species.	High (3)

Consequences of Introduction: *Coccus formicarii* (Green) (Homoptera: Coccidae)	Risk Value
Because of a lack of information, its potential economic impact is assumed to be similar to that of *Coccus viridis*.	
Risk Element #5: Environmental Impact *Eugenia koolauensis, Prunus geniculata, Gardenia brighami, Gardenia mannii* are examples of potential hosts that are listed as Endangered in 50 CFR §17.12. As it is assumed this scale represents an important economic threat (see Risk Element #4), its establishment in the US would probably trigger the initiation of chemical and/or biological control programs.	High (3)

Consequences of Introduction: *Coccus viridis* (Green) (Homoptera: Coccidae)	Risk Value
Risk Element #1: Climate-Host Interaction This species is pantropical in distribution. It has been reported from India through Indo-China, Malaysia to the Philippines and Indonesia, throughout much of Oceania and sub-Saharan Africa south to South Africa (CABI, 2002). In the New World, it is present in Florida, and ranges from Central America to the northern part of South America and throughout the Caribbean. Its reported distribution corresponds to Plant Hardiness Zones 8-11 (BackyardGardner.com, 2003). It is estimated that this species could become established in areas of the US corresponding to Plant Hardiness Zones 9-11, which corresponds to its present distribution in the US. Zones 9-11 correspond to Florida, southern Texas, southern Arizona, much of California, and Hawaii (USDA, 1990). One or more hosts of *C. viridis* are present in these States (USDA NRCS, 2003). This estimate does not include Plant Hardiness Zone 8, as this zone only occurs in isolated areas of some of the countries (e.g., Andean regions of Bolivia and Peru, northern Mexico, isolated central area of South Africa) from which *C. viridis* is reported (BackyardGardner.com, 2003). Survival outside of these areas would be limited to greenhouse or other artificial situations.	Medium (2)
Risk Element #2: Host Range This species has a broad host range (CABI, 2002). Primary hosts are *Citrus* spp. (Rutaceae), *Coffea arabica* (Rubiaceae), *Artocarpus* sp. (Moraceae), *Camellia sinensis* (Theaceae), *Manihot esculenta* (Euphorbiaceae), *Mangifera indica* (Anacardiaceae), *Psidium guajava* (Myrtaceae), and *Theobroma cacao* (Sterculiaceae) (CABI, 2002). Other hosts include *Alpinia purpurata* (Zingiberaceae), *Chrysanthemum* sp. (Asteraceae), *Manilkara zapota* (Sapotaceae), *Nerium oleander* (Apocynaceae) (CABI, 2002), and *Dimocarpus longan* (Sapindaceae) (ScaleNet, 2002).	High (3)
Risk Element #3: Dispersal Potential *Coccus viridis* is parthenogenetic and oviparous (Dekle, 1976). Females may deposit up to 500 eggs (CABI, 2002). There may be several generations per year (Kosztarab, 1997). The rate of natural dispersal is inherently low (Tandon and Veeresh, 1988); however, since 1985, *C. viridis* has been intercepted 10,252 times by PPQ at ports of entry (PIN309 query August 7, 2003), which is strong evidence that this species can, and has, spread quickly and widely via the	High (3)

Consequences of Introduction: *Coccus viridis* (Green) (Homoptera: Coccidae)	Risk Value
transport of infested plant materials.	
Risk Element #4: Economic Impact Although its economic impact is usually minor, it can be extremely devastating depending on location and crop (CABI, 2002). *Coccus viridis* is a pest of coffee, citrus and other crops in several regions in the tropics, and it is reported as a major pest of citrus in Bolivia (Ben-Dov, 1993). *Coccus viridis* is a major pest of coffee in Haiti (Aitken Soux, 1985) and India (Narasimham, 1987). In Brazil, infestations of 50 scales per plant caused significant damage to coffee seedlings, reducing leaf area and plant growth rate (Silva and Parra, 1982). Of all the scale insects known on coffee in Papua New Guinea, *C. viridis* and one other scale species cause most of the yield loss (Williams, 1986). In India, citrus fruit quality was significantly lower on trees following *C. viridis* infestation and the sooty mold (*Capnodium citri*) contamination that accompanied it (Haleem, 1984). Based on this evidence, the wider establishment in the US of *C. viridis* would likely lead to lower yield of host crops, lower value of host crop commodities, and loss of foreign or domestic markets.	High (3)
Risk Element #5: Environmental Impact The extreme polyphagy of *C. viridis* predisposes it to attack vulnerable native plants in the US. The potential host *Manihot walkerae* (Euphorbiaceae), which is present in Texas, is listed as Endangered in 50 CFR §17.12. The wider establishment of this species could have a negative impact on the citrus industry in areas, such as Arizona and Texas, and stimulate the initiation of chemical or biological control programs.	High (3)

Consequences of Introduction: *Conogethes punctiferalis* (Guenée) (Lepidoptera: Pyralidae)	Risk Value
Risk Element #1: Climate-Host Interaction The distribution of *C. punctiferalis* extends from warm temperate regions to the tropics of South and East Asia (CABI, 2002). The species also occurs in Australia and Papua New Guinea (CABI, 2001). It is estimated that this species could become established in parts of the US corresponding to Plant Hardiness Zones 6-11. One or more of its potential hosts occurs in these zones (USDA NRCS, 2003).	High (3)
Risk Element #2: Host Range This moth has a broad host range, including *Carica papaya* (Caricaceae), *Macadamia integrifolia* (Proteaceae), *Morus alba* (Moraceae), *Prunus persica* (Rosaceae), *Psidium guajava* (Myrtaceae), *Gossypium herbaceum* (Malvaceae), *Zea mays* (Poaceae), *Averrhoa carambola* (Oxalidaceae), *Nephelium lappaceum* (Sapindaceae), *Helianthus annuus* (Asteraceae), *Curcuma longa* (Zingiberaceae), *Punica granatum* (Punicaceae), *Ricinus communis* (Euphorbiaceae), *Castanea mollissima* (Fagaceae), *Citrus nobilis* (Rutaceae), *Cryptomeria japonica* (Taxodiaceae), *Piper nigrum* (Piperaceae) (CABI, 2001), and *Dimocarpus longan* (Sapindaceae) (Waterhouse, 1993).	High (3)

Consequences of Introduction: *Conogethes punctiferalis* (Guenée) (Lepidoptera: Pyralidae)	**Risk Value**
Risk Element #3: Dispersal Potential Each female lays a total of 20-30 eggs; these are laid on the surface of fruits or on the ear silk and tassels of maize (CABI, 2001). Five generations per year have been reported (Wang and Cai, 1997). Larvae are internal fruit feeders (CABI, 2002; CSIRO, 1991; Gupta and Arora, 2001; Huang *et al.*, 2000; Wongsiri, 1991), with the potential to be spread long distances in infested fruit. Since 1985, the genus *Conogethes* has been intercepted by PPQ 654 times, including 330 times on fruit and 292 times on seed (PIN309 query June 8, 2004).	Medium (2)
Risk Element #4: Economic Impact *Conogethes punctiferalis* is an important pest of peaches and apples in China, and infestations result in the stunting, scorching and falling of fruit (CABI, 2001). It is one of the most destructive pests of peaches in China and of cotton in Australia (USDA, 1957). In recent years in China, *C. punctiferalis* has been found more commonly on longan, causing important economic damage to this crop (Huang *et al.*, 2000). Waterhouse (1993) includes *C. punctiferalis* as one of the major arthropod pests on longan in Southeast Asia. In longan, a single larva can cause damage on multiple fruit (Huang *et al.*, 2000). In India, this species has caused severe infestation of guavas (Gupta and Arora, 2001), and it is considered a major pest of sorghum in some areas of India (Kishore and Jotwani, 1982). In maize and sorghum, pollination is reduced due to the damage done to the plant by *C. punctiferalis* feeding on tassels and maize ear silk (CABI, 2002). Stems bored by the moth are easily broken by wind and farming practices, which decreases yield (CABI, 2002). Yield losses can be as high as 63% in castor bean (Kapadia, 1996) and 48% in plum (Wang and Cai, 1997). The moth's excretions, which cover the fruit's surface and have a high sugar content, attract other insect pests and diseases that can damage fruit (CABI, 2002). In China, insecticides and the bagging of fruit are two control measures employed against this insect pest (CABI, 2002). Introduction of this pest into the US would likely result in a loss of foreign and domestic markets.	High (3)
Risk Element #5: Environmental Impact Because of its broad host range, this pest is expected to have direct, negative impacts on vulnerable native plants. For example, *C. punctiferalis* is an important pest of *Quercus* spp. (oaks) in Korea (Park *et al.*, 1998) and, thus, has the potential to attack *Q. hinckleyi*, a Texas tree listed as Threatened in 50 CFR §17.12. Introduction of this pest into the US would likely result in initiation of chemical and/or biological control programs.	High (3)

Consequences of Introduction: *Conopomorpha sinensis* Bradley (Lepidoptera: Gracillariidae)	**Risk Value**
Risk Element #1: Climate-Host Interaction *Conopomorpha sinensis* has been reported in the Fujian, Guangdong, Hainan, and Guangxi provinces of China (Waite and Hwang, 2002), Taiwan (Hung *et al.*, 2002; Hwang and Hung, 1996; Waite and Hwang, 2002) and Thailand (Wongsiri,	Medium (2)

Consequences of Introduction: *Conopomorpha sinensis* Bradley (Lepidoptera: Gracillariidae)	**Risk Value**
1991). The hosts of *C. sinensis*, longan and litchi, occur in south Florida and in southern California (Gaskell, 2003; NCSU CIPM, 2003). Litchi is also commercially grown in Hawaii (Erickson *et al.*, 1999). Based on this information, it is estimated that this species could become established in areas of the US corresponding to Plant Hardiness Zones 9-11.	
Risk Element #2: Host Range *Conopomorpha sinensis* is reported on *Litchi chinensis* and *Dimocarpus longan* (Sapindaceae) (Anonymous, 1994; Hung *et al.*, 2002; Hwang and Hung, 1996; Waite and Hwang, 2002). Zhang (Zhang, 1994) lists cocoa as a host for this species; however, Hwang and Hung (Hwang and Hung, 1996) and Yao and Liu (Yao and Liu, 1990) state that *C. sinensis* has long been confused with the cocoa pest, *C. cramerella*; therefore, it is assumed that Zhang (1994) is referring to *C. cramerella* and not *C. sinensis.*	Medium (2)
Risk Element #3: Dispersal Potential More than one egg may be laid on a fruit, but only one larva survives per fruit (Waite and Hwang, 2002). Information on the fecundity of *C. sinensis* was not found, but the related species, *C. cramerella*, normally produce 50-100 eggs during their lifetime CABI, 2002. *Conopomorpha sinensis* may complete 4-5 generations during the litchi and longan fruiting seasons in Taiwan (Waite and Hwang, 2002). This insect could easily be dispersed by commercial trade, because females lay eggs on fruit, and larvae penetrate the fruit, leaf, or shoot while feeding (Waite and Hwang, 2002). Since 1985, this genus has been intercepted by PPQ 14 times on fruit, one time in permit cargo and 13 times in baggage (PIN309 query, July 22, 2003). The majority (11) of these interceptions was on litchi. One or more of these interceptions could potentially have been *C. sinensis*, but they were not identified to the species level. This species was assigned a High (3) risk rating because of uncertainty in reproductive potential.	High (3)
Risk Element #4: Economic Impact *Conopomorpha sinensis* damages the fruit and shoots of litchi and longan (Hwang and Hung, 1996); it is considered a key pest of these plants in Taiwan (Hung *et al.*, 2002; Wen *et al.*, 2002), China (He and He 2001) and Thailand (Waite and Hwang, 2002). Larval feeding causes premature fruit drop (Waite and Hwang, 2002); 87.9-99.0% of fallen fruit in sprayed orchards and 96.1-100% in unsprayed orchards were reported as damaged by *C. sinensis* in the Chia Nan district of Taiwan (Huang *et al.*, 1994). Fruit that remained on the tree in this district were also infested, with damage reported as 16.0-86.5% in sprayed orchards and 41.5-96.7% in unsprayed orchards (Huang *et al.*, 1994). Such extensive damage is likely to stimulate chemical and/or biological control programs that would lower the value of the commodity by increasing production costs, and establishment of this pest in the US would likely cause a loss of foreign and domestic markets.	High (3)
Risk Element #5: Environmental Impact The hosts of *C. sinensis* (longan and litchi) are not listed as Threatened or	High (3)

Consequences of Introduction: *Conopomorpha sinensis* Bradley (Lepidoptera: Gracillariidae)	**Risk Value**
Endangered in 50 CFR §17.12. On the other hand, the Hawaiian species *Alectryon macrococcus* (Sapindaceae) is listed as Endangered, and preference tests with this plant and *C. sinensis* are unknown; therefore, it is assumed that *C. sinensis* would be able to use this plant as a host. Because it represents an economic threat (see Risk Element #4), the establishment of *C. sinensis* in the US would probably initiate chemical and/or biological control programs. In the Guangdong litchi producing areas of China, integrated pest management of *C. sinensis* and other pests include the release of natural enemies and chemical control (He and He, 2001). In Taiwan, the egg parasitoid, *Trichogrammatoidea bactrae fumata*, has been introduced to control *C. sinensis* (Waite and Hwang, 2002); cypermethrin, deltamethrin, carbofuran, and fenthion are recommended during early fruit set to prevent damage by this insect (Waite and Hwang, 2002); and parathion is a popular insecticide used to control *C. sinensis* (Hwang and Hung, 1993). In Thailand, permethrin is applied at weekly intervals to control *C. sinensis* (Waite and Hwang, 2002). Numerous other insecticides have been successfully tested to control *C. sinensis* (*e.g.*, carbofuran, chlorpyrifos, fenthion, fenitrothion, dimethoate, Deltamethrin, cypermethrin, and mevinphos) (Hung and Hwang, 1995).	

Consequences of Introduction: *Cryptophlebia ombrodelta* (Lower) (Lepidoptera: Tortricidae)	**Risk Value**
Risk Element #1: Climate-Host Interaction *Cryptophlebia ombrodelta* is reported in Bangladesh, Cambodia, China (Beijing, Fujan, Guangdon, Guizhou, Heibei, Inner-Mongolia, Shanxi, Sichuan and Yunna), India, Indonesia, Japan, Laos, the Philippines, Sri Lanka, Thailand, Taiwan, Vietnam, and Oceania (Australia, the Northern Mariana Islands, Papua New Guinea, the Solomon Islands, and Vanuatu) (CABI, 2002). This species also occurs in Hawaii (Chang, 1995; Waite and Hwang, 2002) and is widely distributed in Africa (Van Der Geest and Evenhuis, 1991). Based on this distribution, it is estimated that this species could become established in areas of the US corresponding to Plant Hardiness Zones 8-11. One or more of its potential hosts occurs in these zones (USDA NRCS, 2003).	High (3)
Risk Element #2: Host Range *Cryptophlebia ombrodelta* is reported on *Acacia* (Fabaceae), *Cassia* (Fabaceae), *Macadamia* (Proteaceae), *Litchi chinensis* (Sapindaceae) (Zhang, 1994), *Dimocarpus longan* (Sapindaceae) (Anonymous, 1994), *Macadamia integrifolia* (Proteaceae), *Tamarindus indica* (Fabaceae), *Averrhoa carambola* (Oxalidaceae), *Bauhinia* (Fabaceae), *Glycine max* (Fabaceae), *Lablab purpureus* (Fabaceae), *Phaseolus lunatus* (Fabaceae), *Phaseolus vulgaris* (Fabaceae), *Parkia* (Fabaceae), and *Vigna unguiculata* (Fabaceae) (CABI, 2002).	High (3)
Risk Element #3: Dispersal Potential Eggs of *C. ombrodelta* are laid on fruit singly or in groups; females may lay up	High (3)

Consequences of Introduction: *Cryptophlebia ombrodelta* (Lower) (Lepidoptera: Tortricidae)	**Risk Value**
to 250 eggs during their life (Waite and Hwang, 2002). No information was found on the number of generations per year in the field, but in a laboratory study *C. ombrodelta* completed 3-4 generations per year (Lingappa and Siddappaji, 1981). *Cryptophlebia ombrodelta* is an internal fruit feeder that tunnels towards the seed (Waite and Hwang, 2002); it is, therefore, assumed that this pest could easily be transported over long distances in shipments of infested fruit. Since 1985, it has been intercepted 115 times by PPQ officers, of which 98 were with fruit (PIN309 query July 23, 2003). Members of the genus *Cryptophlebia* (including *C. ombrodelta*) have been intercepted 12 times in commercial cargo (PIN309 query July 23, 2003), which is evidence that *C. ombrodelta* can be dispersed by commercial trade.	
Risk Element #4: Economic Impact This tortricid is regarded as a significant pest of litchi and longan in Hawaii and Australia (Waite and Hwang, 2002). It is considered to be one of the most important pests of macadamia in China (Zhan, 1998). One larva can damage up to three immature litchi or longan, although they prefer mature fruit (Waite and Hwang, 2002). Larval damage renders litchi and longan fruit unmarketable; neighboring fruit may also be unmarketable if they are stained by the juice that exudes from the attacked fruit (Waite and Hwang, 2002). The economic importance of *C. ombrodelta* is evident from the fact that studies have been undertaken to determine whether irradiation is an acceptable treatment for disinfestation of sapindaceous fruit (Follett and Lower, 2000). Establishment of this pest in the continental US is likely to cause a loss of foreign and domestic markets and to stimulate chemical and/or biological control programs, which would lower the value of the commodity by increasing production costs.	High (3)
Risk Element #5: Environmental Impact *Vigna o-wahuensis*, a potential host of *C. ombrodelta*, is listed as Endangered in 50 CFR §17.12; however, this plant is only reported in Hawaii (USDA NRCS, 2003), where *C. ombrodelta* is already present. Plants in the family Fabaceae that are listed as Threatened or Endangered (*e.g.*, *Amorpha crenulata*, *Apios priceana*) are also potential hosts, and preference tests with these plants and *C. ombrodelta* are unknown; therefore, it is assumed that *C. ombrodelta* would be able to use one or more of these plants as hosts. As this species represents an economic threat (see Risk Element #4), its establishment in the US would probably initiate chemical and/or biological control programs.	High (3)

Consequences of Introduction: *Deudorix epijarbas* Moore (Lepidoptera: Lycaenidae)	**Risk Value**
Risk Element #1: Climate-Host Interaction *Deudorix epijarbas* has a tropical/subtropical distribution, as it is reported in India (Jammu, Kashmir, Uttar, and Pradesh), the Philippines, China	Medium (2)

Consequences of Introduction: *Deudorix epijarbas* Moore (Lepidoptera: Lycaenidae)	**Risk Value**
(Guangdong), Australia (Queensland) (Zhang, 1994), and Taiwan (Anonymous, 1965; Heppner and Inoue, 1992). Based on this distribution, it is estimated that this species could become established in US Plant Hardiness Zones 9-11. One or more of its potential hosts occurs in these zones (USDA NRCS, 2003).	
Risk Element #2: Host Range *Deudorix epijarbas* is reported on *Nephelium* (Sapindaceae), *Litchi chinensis* (Sapindaceae), *Macadamia* (Proteaceae), *Aesculus indica* (Hippocastanaceae) (Zhang, 1994), *Dimocarpus longan* (Sapindaceae) (Anonymous, 1965), *Punica granatum* (Punicaceae) (Verma, 1985), and *Aesculus indicus* (Hippocastanaceae) (Verma, 1985).	High (3)
Risk Element #3: Dispersal Potential Three to four generations have been reported on pomegranate (*Punica granatum*) in India under laboratory and field conditions (Verma, 1985). The females of this species usually lay up to four eggs on a pomegranate fruit, usually inside the calyx cup (Zaka ur Rab, 1980). Adult butterflies are able to migrate to their alternate host, horse chestnut (*Aesculus indicus*) (Verma, 1985); however, no other specific information on its natural ability to disperse was found. Likewise, no evidence was found of this insect's ability to disperse easily via human-mediated means. Since 1985, this genus has never been intercepted by PPQ at ports of entry (PIN309 query, July 25, 2003). On the other hand, the larvae of this insect bore into fruit (Verma, 1985; Waite and Hwang, 2002) and eggs are laid on flowers and fruit (Verma, 1985), which would seem to make it easily dispersed via commercial trade. However, its limited host range (see Risk Element #2) and its reported pest status only on minor crops for the US (see Risk Element #4) would likely lower its probability of being dispersed via commercial trade of plant products in the US. Based on this evidence, *D. epijarbas* is given a rating of Medium (2) for this risk element.	Medium (2)
Risk Element #4: Economic Impact *Deudorix epijarbas* is a serious pest of pomegranate (*Punica granatum*) in India (Dubey *et al.*, 1993; Verma, 1985; Zaka ur Rab, 1980) and a minor pest of litchi and longan in China, India and Thailand (Waite and Hwang, 2002). A closely related species, *D. diovis* is a minor pest of litchi, longan and macadamia in Australia (Ironside, 1979). Females of both species lay eggs singly on fruit; larvae then bore into fruit soon upon hatching and completely destroy the flesh and seed; a single larva can damage up to four fruits (Verma, 1985). Larval feeding can cause immature fruit to drop from the tree, and those fruits that do not drop are rendered unfit for consumption (Thakur *et al.*, 1995). *Deudorix epijarbas* reportedly damaged an average of 25.33% of pomegranate (*Punica*) fruit in the Jammu region of India (Thakur *et al.*, 1995). Chemical control of this insect is often ineffective, and biological control is being studied (Thakur *et al.*, 1995). Establishment of this pest in the US could potentially cause a loss of foreign and domestic markets and stimulate chemical and/or biological control programs, which would lower the value of the commodity by increasing production costs. However, because this species is only reported as an	Medium (2)

Consequences of Introduction: ***Deudorix epijarbas*** **Moore (Lepidoptera: Lycaenidae)**	**Risk Value**
important pest on pomegranate, a minor crop in the US, and a minor pest on litchi and longan, it is given a Medium (2) rating for this risk element.	
Risk Element #5: Environmental Impact The genera in *D. epijarbas*' reported host range are not listed as Threatened or Endangered in 50 CFR §17.12. The Hawaiian species *Alectryon macrococcus* (Sapindaceae) is listed as Endangered, and preference tests with this plant and *D. epijarbas* are not known; therefore, it is assumed that *D. epijarbas* would be able to use this plant as a host. As this species represents a potential economic threat (see Risk Element #4), its establishment in the US could trigger the initiation of chemical and/or biological control programs. Inundative releases of *Trichogramma* spp. have been made against this pest in India (Rawat and Pawar, 1991; Thakur *et al.*, 1991; Thakur *et al.*, 1995). Although it is stated that chemical control of this insect is often ineffective (Thakur *et al.*, 1995), foliar application of cypermethrin, permethrin, fenvalerate, and decamethrin have been used to effectively control this fruit borer (Kakar *et al.*, 1987); the chemical pesticides endosulfan, cypermethrin, methyl parathion, and quinalphos have been tested against this pest (Dubey *et al.*, 1993).	High (3)

Consequences of Introduction: ***Drepanococcus chiton*** **(Green) (Homoptera: Coccidae)**	**Risk Value**
Risk Element #1: Climate-Host Interaction The distribution of *Drepanococcus chiton* includes: Malaysia, Papua New Guinea, Solomon Islands, Andaman Islands, India, Sri Lanka, Taiwan, Thailand, and Vietnam (Ben-Dov, 1993). Based on this distribution, it is estimated that this species could become established in areas of the US corresponding to Plant Hardiness Zones 9-11. One or more of its potential hosts occurs in these zones (USDA NRCS, 2003).	Medium (2)
Risk Element #2: Host Range The host range of *D. chiton* includes: *Semecarpus magnifica* (Anacardiaceae), *Annona muricata* (Annonaceae), *Carica papaya* (Caricaceae), *Calophyllum inophyllum* (Clusiaceae), *Aleurites moluccana* (Euphorbiaceae), *Coleus* (Labiatae), *Litsea* (Lauraceae), *Bauhinia*, *Cajanus indicus*, *Canavalia*, *Cassia*, *Dalbergia*, *Gliricidia septum* (Leguminosae), *Thespesia propulnea* (Malvaceae), *Ficus* (Moraceae), *Grevillea papuana* (Proteaceae), *Colubrina* (Rhamnaceae), *Citrus aurantifolia* (Rutaceae), *Solanum melongena* (Solanaceae), *Theobroma cacao* (Sterculiaceae) (Ben-Dov, 1993), *Dimocarpus longan* (Sapindaceae) (Coates *et al.*, 2003), *Ziziphus mauritiana* (Rhamnaceae), *Psidium guajava* (Myrtaceae) (Jothi and Tandon, 1995; Mani and Krishnamoorthy, 1997), and *Averrhoa carambola* (Oxalidaceae) (Ibrahim, 1994).	High (3)
Risk Element #3: Dispersal Potential *Drepanoccus chiton* females are reported to produce an average of 1081.9 ± 256.0 eggs; however, only 2.5% of these eggs reach adult maturity in the field	Medium (2)

Consequences of Introduction: *Drepanococcus chiton* (Green) (Homoptera: Coccidae)	**Risk Value**
(Ibrahim, 1994). As with other scales, this species has limited mobility under its own power but could probably disperse over long distances with the movement of host materials. Since 1985, this genus has been intercepted 17 times by PPQ at ports of entry (PIN309 query September 3, 2003).	
Risk Element #4: Economic Impact *Drepanoccus chiton* is a serious pest of the fruit crops ber (*Ziziphus mauritiana*) and guava (*Psidium guajava*) (Jothi and Tandon, 1995; Mani and Krishnamoorthy, 1997). Damage to these crops is reportedly severe in India (Mani, 1995). It is also a minor pest of carambola (*Averrhoa carambola*) in Malaysia, causing drying of shoots and flower stalks (Ibrahim, 1994). Establishment of this pest in the US could potentially cause a loss of foreign or domestic markets and is likely to stimulate chemical and/or biological control programs, which would lower the value of the commodity by increasing production costs.	High (3)
Risk Element #5: Environmental Impact Potential hosts listed as Threatened or Endangered in 50 CFR §17.12 include the Hawaiian species: *Canavalia molokaiensis, Colubrina oppositifolia, Solanum incompletum, S. sandwicense*, as well as the Floridian species *Ziziphus celata*. Threatened and Endangered plants in the families Annonaceae, Anacardiaceae, Euphorbiaceae, and Lauraceae are also potential hosts, and preference tests with these plant species and *D. chiton* are unknown. It is, therefore, assumed that *D. chiton* would be able to use one or more of these plants as hosts. Introduction of this pest into the US could stimulate chemical and/or biological control programs.	High (3)

Consequences of Introduction: *Fiorinia pinicola* Maskell (Homoptera: Diaspidae)	**Risk Value**
Risk Element #1: Climate-Host Interaction *Fiorinia pinicola*'s distribution includes: Montserrat, China (Guangdong, Guangxi, Hainan, Hunan, Yunnan, Zhejiang; Hong Kong), Taiwan, Japan, (Honshu, Kyushu, Shikoku), and Portugal (ScaleNet, 2002), as well as the US (Cumberland Island, Georgia) (Nakahara, 1982). *Fiorinia pinicola* has also been reported in California (ScaleNet, 2002); however, Nakahara (1982) reports that it was eradicated from this State. On the other hand, more recently this scale was reported to have a limited distribution in California (Dooley, 2004). Based on this distribution, it is estimated that this species could become established in areas of the US corresponding to Plant Hardiness Zones 9-11. One or more of its potential hosts occurs in these Zones (USDA NRCS, 2003).	Medium (2)
Risk Element #2: Host Range *Fiorinia pinicola*'s host range includes: *Dimocarpus longan* (Sapindaceae) (Anonymous, 1994); *Aucuba japonica* (Aucubaceae), *Cephalotaxus* sp. (Cephalotaxaceae), *Quercus schottkyana* (Fagaceae), *Magnolia sp.* (Magnoliaceae), *Ficus foveolata* (Moraceae), *Ficus foveolata nipponica* (Moraceae), *Ficus pumila* (Moraceae), *Myrica rubra* (Myricaceae), *Cupressus*	High (3)

Consequences of Introduction: *Fiorinia pinicola* Maskell (Homoptera: Diaspidae)	**Risk Value**
juniperus (Pinaceae), *Pinus docarpus* (Pinaceae), *Pinus latteri* (Pinaceae), *Pinus macrophylus* (Pinaceae), *Pinus massoniana* (Pinaceae), *Pinus sinensis* (Pinaceae), *Pittosporum* sp. (Pittosporaceae), *Pittosporum tobira* (Pittosporaceae), *Cephalotaxus drupacea* (Taxaceae), *Cephalotaxus drupacea koraiana* (Taxaceae), *Podocarpus macrophylla* (Taxaceae), *Podocarpus macrophylla maki* (Taxaceae), *Podocarpus nagi* (Taxaceae), *Podocarpus neriifolia* (Taxaceae), *Podocarpus* sp. (Taxaceae), *Torreya nucifera* (Taxaceae), *Sciadopitys verticillata* (Taxodiaceae), *Camellia japonica* (Theaceae), *Eurya japonica* (Theaceae), and *Thea japonica* (Theaceae) (ScaleNet, 2002).	
Risk Element #3: Dispersal Potential No information was found on the fecundity or dispersal potential of *F. pinicola*. Other species within this genus are able to disseminate locally on wind currents, especially the mobile 1st-instar (McClure, 1977, 1979, 1989). Wind is reported to have accelerated the spread *F. externa*, a serious forest pest that was introduced into the US from Asia (McClure, 1989). *Fiorinia* spp. are found on leaves, stems, and bark (Kosztarab, 1996); it is, therefore, assumed that *F. pinicola* could be dispersed over long distances by trade. A related species, *F. japonica*, was recently introduced into France from Taiwan on ornamental bonsai (Matile-Ferrero, 1990). Because of uncertainty in dispersal potential, *F. pinicola* is given a rating of High (3) for this risk element.	High (3)
Risk Element #4: Economic Impact This species is listed as a pest by (Miller and Davidson 1990). No other information on its economic importance could be found. Other species within this genus, however, are reported as pests (*e.g.*, *F. fiorinia*, *F. externa*) (Canales Canales and Valdivieso Jara, 1999; McClure, 1989). The related species, *F. externa*, which was accidentally introduced into the US from Asia, has become a serious pests of 2 important forest trees in the northeastern USA (McClure, 1989). Because of uncertainty surrounding the potential economic impact of *F. pinicola*, it is rated High (3) for the Economic Impact risk element.	High (3)
Risk Element #5: Environmental Impact Potential hosts listed as Threatened or Endangered in 50 CFR §17.12 include: *Quercus hinckleyi*, *Cupressus abramsiana*, and *Torreya taxifolia*. Its introduction into the US could stimulate chemical or biological control programs, assuming it has economic impacts.	High (3)

Consequences of Introduction: *Icerya seychellarum* (Homoptera: Margarodidae)	**Risk Value**
Risk Element #1: Climate-Host Interaction *Icerya seychellarum* is distributed in Southeast Asia, Eastern and Southern Africa, Australia and Oceania (CABI, 2002). It is estimated that in the US it could establish in Plant Hardiness Zones 8-11. One or more of its potential hosts occurs in these zones (USDA NRCS, 2003).	High (3)

Consequences of Introduction: *Icerya seychellarum* (Homoptera: Margarodidae)	**Risk Value**
Risk Element #2: Host Range *Icerya seychellarum* has a wide variety of hosts, especially woody plants. The extensive host list includes, but is not limited to: *Persea Americana* (Lauraceae), *Cocos nucifera* (Arecaceae), *Psidium guajava* (Myrtaceae), *Rosa* spp. (Rosaceae), *Pyrus* spp. (Rosaceae), *Camellia sinensis* (Theaceae), *Coffea* spp. (Rubiaceae), *Dioscorea* spp. (Dioscoreaceae), *Ipomea batatas* (Convolvulaceae), *Lycopersicum esculentum* (Solanaceae), *Vitis vinifera* (Vitaceae), *Mangifera indica* (Anacardiaceae) (CABI, 2002), and *Dimocarpus longan* (Sapindaceae) (Anonymous, 1994; China, 1997).	High (3)
Risk Element #3: Dispersal Potential Development usually takes three months (CABI, 2002). In Japan and South Africa there is one generation per year (CABI, 2002; USDA, 1982); elsewhere (Aldabra Island) more generations per year are documented (USDA, 1982). Males are rare and are not necessary for reproduction (CABI, 2002). The only mobile stage is the first instar crawler, which can be transported by wind up to one hundred kilometers per day (Greathead, 1997). Data on fecundity of this species is not available, but *I. aegyptiaca* may produce 70 - 140 eggs and complete 2 -3 generations per year in Northern Africa (Azab *et al.*, 1969).	Medium (2)
Risk Element #4: Economic Impact *Icerya seychellarum* has the potential to impact many economically important tropical tree species, attacking leaves, twigs, smaller branches, fruits and flowers (USDA, 1982). Feeding decreases plant vigor, reducing leaf production as much as 36% (Newbery, 1980). Honeydew excreted by the scale provides a medium for molds to grow, thereby reducing photosynthesis (USDA, 1982). This has been demonstrated in the Pacific Islands, where *I. seychellarum* has been recorded killing trees (CABI, 2002). *Icerya seychellarum* is a pest of guava (*Psidium guajava*), citrus (*Citrus* spp.), breadfruit (*Artocarpus altilis*), avocado (*Persea americana*), jackfruit (*Artocarpus heterophyllus*), various genera of palms, and rose (*Rosa* spp.) (CABI, 2002). Hill (1983) considers the scale to be a minor pest of various crops (*e.g*., coconut, jackfruit, breadfruit, citrus, *etc*.). The scale is considered a minor pest of citrus in India, Japan, and South Africa (USDA, 1982). Establishment of this pest in the US could potentially cause a loss of foreign or domestic markets and would likely stimulate chemical and/or biological control programs, which would lower the value of the commodity by increasing production costs.	High (3)
Risk Element #5: Environmental Impact As the species is polyphagous**,** it is likely to affect Endangered and Threatened species, particularly from the genera *Caesalpinia*, *Crotalaria*, *Eugenia*, *Euphorbia*, *Hibiscus*, *Solanum*, *Prunus* and *Scaevola.* Chemical and/or biological control is likely to be implemented upon introduction of this pest.	High (3)

Consequences of Introduction: *Kerria lacca* (Kerr) (Homoptera: Kerridae)	Risk Value
Risk Element #1: Climate-Host Interaction *Kerria lacca* is reported to occur in: Bangladesh, China (Guangdong, Yunnan), India, Indonesia (CABI, 2002), and Taiwan (Chiu *et al.*, 1981; Taiwan, 2002; Waite and Hwang, 2002). ScaleNet (2002) reports the following distributions for subspecies of this species: *K. lacca lacca* (Kerr) is reported in Guyana, Bangladesh, Burma, China (Hunan), India, Malaysia, Nepal, Pakistan, Sri Lanka, Azerbaijan, and Georgia; *K. lacca ambigua* (Misra) is reported in India; *K. lacca mysorensis* (Mahdihassan) is reported in India; *K. lacca takahashii* Varshney is reported in Thailand. Based on this distribution and its host range, it is estimated that *K. lacca* could become established in areas of the US corresponding to Plant Hardiness Zones 9-11. One or more of its potential hosts occurs in these zones (USDA NRCS, 2003).	Medium (2)
Risk Element #2: Host Range The host range of *K. lacca* includes: *Acacia auriculiformis*, *Acacia nilotica* (Fabaceae), *Dimocarpus longan* (Sapindaceae), *Mangifera indica* (Anacardiaceae), and *Ziziphus mauritiana* (Rhamnaceae) (CABI, 2002). Scalenet (2002) reports the following hosts for subspecies of this species: *K. lacca lacca* (Kerr) is reported on species within the families Anacardiaceae, Annonaceae, Corylaceae, Cucurbitaceae, Dipterocarpaceae, Ebenaceae, Erythroxylaceae, Euphorbiaceae, Juglandaceae, Leguminosae, Malvaceae, Meliaceae, Moraceae, Proteaceae, Punicaceae, Rhamnaceae, Rosaceae, Rutaceae, Sapindaceae, Tiliaceae, and Vitaceae; *K. lacca ambigua* (Misra) is reported on "jheolia" (scientific name unknown); and *K. lacca mysorensis* (Mahdihassan) is reported on *Shorea roxburghii* and *Shorea talura* (Dipterocarpaceae).	High (3)
Risk Element #3: Dispersal Potential *Kerria lacca* has two generations per year in Taiwan, and the females can be ovoviviparous or will produce eggs (Waite and Hwang, 2002). In Taiwan, the number of progeny produced by a single female was 681.3 for the summer generation and 438.6 for the winter generation (Hwang and Hsieh, 1981). *Kerria lacca* can be dispersed by crawling (in the 1st instar stage) or by wind, birds or other animals (Hwang and Hsieh, 1981). It is assumed, like other scale insects, that this species could disperse over long distances via the trade of plants and plant parts.	High (3)
Risk Element #4: Economic Impact *Kerria lacca* is a serious pest of fruit trees, including longan, litchi, sugar apple and fig in Taiwan (Chiu *et al.*, 1981; Wen *et al.*, 2002). Hwang (1990) states that, in Taiwan, "since the 1960s, it has been considered a serious pest of 66 crop species, especially fruit trees." Taiwan (2002) reports this insect as having major economic significance on longans. Heavy infestations can cause twigs to wilt and die, which affects flowering and fruiting. In India, *K. lacca* is among the main coccids that cause dieback and lower fruit set of *Santalum album* L. in nurseries and plantations (Remadevi *et al.*, 1998). Additionally, honeydew produced by it can encourage the growth of sooty mold (Waite and Hwang, 2002). Establishment of this pest in the US could potentially cause the loss of	High (3)

Consequences of Introduction: *Kerria lacca* (Kerr) (Homoptera: Kerridae)	Risk Value
foreign or domestic markets and would likely stimulate chemical and/or biological control programs, which would lower the value of the commodity by increasing production costs.	
Risk Element #5: Environmental Impact Potential hosts listed as Threatened or Endangered in 50 CFR §17.12 include *Hibiscus* spp. and *Ziziphus celata*. As this species represents a potential economic threat (see Risk Element #4), its establishment in the US could initiate chemical and/or biological control programs. Dimethoate and fenthion have been used to control this pest in Taiwan (Waite and Hwang, 2002).	High (3)

Consequences of Introduction: *Kerria greeni* (Chamberlin) (Homoptera: Kerridae)	Risk Value
Risk Element #1: Climate-Host Interaction *Kerria greeni*'s distribution includes the Philippines, Thailand (ScaleNet, 2002), Taiwan (Li-zhong, 2000; ScaleNet, 2002), and China (Fujian, Guangxi) (Li-zhong, 2000). Based on this distribution, it is estimated that *K. lacca* could become established in areas of the US corresponding to Plant Hardiness Zones 9-11. One or more of its potential hosts occurs in these zones (USDA NRCS, 2003).	Medium (2)
Risk Element #2: Host Range Reported hosts of *K. greeni* include: *Dimocarpus longan* (Sapindaceae), *Litchi chinensis* (Sapindaceae) (Li-zhong, 2000), *Mangifera indica* (Anacardiaceae), *Terminalia catappa* (Combretaceae), *Euphorbia longan* (Euphorbiaceae), *Machilus* (Lauraceae), *Calliandra haematocephala* (Leguminosae), *Ficus bengalensis* (Moraceae), *Ficus ulmifolia* (Moraceae), *Ficus wightiana* (Moraceae), *Rhodomyrtus tomentosa* (Myrtaceae), *Averrhoa carambola* (Oxalidaceae), *Platanus orientalis* (Platanaceae), *Palaquium formosanum* (Sapotaceae), and *Heritiera littoralis* (Sterculiaceae) (ScaleNet, 2002).	High (3)
Risk Element #3: Dispersal Potential No information could be found on the fecundity and dispersal potential of *K. greeni*. Because of the uncertainty surrounding this species, as well as the dispersal potential of the related species *K. lacca* (see Consequences of Introduction analysis for *K. lacca* in this document), *K. greeni* is given a High (3) rating for the Dispersal Potential risk element.	High (3)
Risk Element #4: Economic Impact In southern China, *K. greeni* mainly attacks litchi and longan; it is reported as an unimportant pest in Fujian (Li-ying *et al.*, 1997). In Taiwan, this scale is reported as an important pest only locally or only in some years (Li-ying *et al.*, 1997). No other information on the economic importance of this species could be found. Because of the uncertainty surrounding this species, as well as the economic importance of the related species *K. lacca* (see Consequences of Introduction analysis for *K. lacca* in this document), *K. greeni* is given a High (3) rating for the Economic Impact risk element.	High (3)

Consequences of Introduction: *Kerria greeni* (Chamberlin) (Homoptera: Kerridae)	Risk Value
Risk Element #5: Environmental Impact Potential hosts listed as Threatened or Endangered in 50 CFR §17.12 include *Euphorbia haeleeleana* and *Euphorbia telephioides*. As this species represents a potential economic threat (see Risk Element #4), its establishment in the US could trigger chemical and/or biological control programs.	High (3)

Consequences of Introduction of *Maconellicoccus hirsutus* (Homoptera: Pseudococcidae)	Risk Value
Risk Element #1: Climate-Host Interaction This species is reported in Northern Africa, parts of sub-Saharan Africa, the Middle East, South and-Southeast Asia, the Far East, the Caribbean, Central America, Australia and Oceania (CABI, 2002). It currently has a limited distribution in the US, occurring only in Hawaii, California (CABI, 2002), and Florida (Hoy *et al.*, 2003). It is estimated that *M. hirsutus* could potentially establish in US Plant Hardiness Zones 9 - 11. One or more of its potential hosts occurs in these zones (USDA NRCS, 2003).	Medium (2)
Risk Element #2: Host Range *Maconellicoccus hirsutus* is very polyphagous. It has been recorded feeding on plants from 73 plant families and over 200 plant genera; it shows some preference for hosts in the families Malvaceae, Leguminosae and Moraceae (CABI, 2002).	High (3)
Risk Element #3: Dispersal Potential Local movement of this species is accomplished by the first instar (crawler) (CABI, 2002). Crawlers are very small and light and are able to survive a day or so without feeding (CABI, 2002). They are unable to walk far; however, they are ideally suited for transport by water, wind and animal agents, including domestic animals and humans (CABI, 2002). Accidental introductions into new countries can occur via infested plant material (CABI, 2002). Each adult female lays 150-600 eggs over a one week period (CABI, 2002). A generation is completed in five weeks under warm conditions, and the species can survive cold conditions as eggs or other stages on the host plant or in the soil (CABI, 2002). There can be up to 15 generations per year (CABI, 2002).	High (3)
Risk Element #4: Economic Impact Estimated annual losses in Grenada due to *M. hirsutus* are $3.5 million (CABI, 2002). Feeding by this scale can cause severe stunting, crinkling of leaves, thickening of stems and a bunchy-top appearance of shoots (CABI, 2002). Honeydew excreted by *M. hirsutus* often leads to sooty mold contamination of fruit, which reduces the value of the fruit (CABI, 2002). Crops that are/were reported as seriously damaged by this scale include: cotton in Egypt (growth can be arrested); tree cotton in India (yield is reduced); the fiber crops *Hibiscus sabdariffa var. altissima* (roselle), *H. cannabinus* (mesta), and *Boehemeria*	High (3)

Consequences of Introduction of *Maconellicoccus hirsutus* (Homoptera: Pseudococcidae)	**Risk Value**
nivea in India and Bangladesh (roselle fiber yield reduced by 21.4% - 40%); and grapes in India (up to 90% of bunches destroyed or so heavily infested that they are unfit for consumption) (CABI, 2002). Establishment of this pest in the US beyond where it is already reported could potentially cause a loss of foreign or domestic markets and would likely stimulate chemical and/or biological control programs, which would lower the value of the commodity by increasing production costs.	
Risk Element #5: Environmental Impact If *M. hirsutus* is introduced into the US beyond where it is already present, it is likely to affect Threatened and Endangered plants and stimulate chemical and/or biological control programs. These results are predicted because *M. hirsutus* is extremely polyphagous and several economically important plants are potential hosts (*e.g.* cotton, grapes).	High (3)

Consequences of Introduction: *Nipaecoccus viridis* (Newstead) (Homoptera: Pseudococcidae)	**Risk Value**
Risk Element #1: Climate-Host Interaction This species is widespread in tropical and subtropical Asia, Africa and in parts of Oceania (CABI, 2002). It occurs in North America, but its distribution is limited to California and Hawaii (CABI, 2002). It should only be able to survive in the warmer, southern parts of the US (Plant Hardiness Zones 9-11). One or more of its potential hosts occur in these zones (USDA NRCS, 2003).	Medium (2)
Risk Element #2: Host Range *Nipaecoccus viridis* has been recorded on hosts distributed among 18 different plant families (CABI, 2002). Primary hosts are species of *Citrus* (Rutaceae), *Coffea* (Rubiaceae), and *Gossypium* (Malvaceae). Other hosts include, among others, *Leucaena leucocephala* (Fabaceae), *Nerium oleander* (Apocynaceae), *Punica granatum* (Punicaceae), *Artocarpus heterophyllus* (Moraceae), *Corchorus capsularis* (Tiliaceae), *Asparagus officinalis* (Liliaceae), *Euphorbia hirta* (Euphorbiaceae), *Mangifera indica* (Anacardiaceae), *Jacaranda mimosifolia* (Bignoniaceae), *Vitis vinifera* (Vitaceae), *Clerodendrum infortunatum* (Verbenaceae), *Solanum tuberosum* (Solanaceae) (CABI, 2002), and *Dimocarpus longan* (Sapindaceae) (China, 1997).	High (3)
Risk Element #3: Dispersal Potential Fecundity ranges from 90 to 138 eggs per female, and there are as many as three generations per year (CABI, 2002). Local dispersal is accomplished by crawlers, which often settle in protected areas (*e.g.*, under the sepals of fruitlets); this behavior predisposes them to dissemination on exported plants or plant products (CABI, 2002).	High (3)
Risk Element #4: Economic Impact This insect causes bulbous outgrowths on young twigs, and heavy infestations by this insect may severely stunt growth of young trees (CABI, 2002). Infested fruits	High (3)

Consequences of Introduction: *Nipaecoccus viridis* (Newstead) (Homoptera: Pseudococcidae)	Risk Value
often become yellow and then partly black around the stem, eventually dropping off the tree, and infested citrus fruit can develop "lumpy outgrowths or raised shoulders" near the stem end (CABI, 2002). Copious quantities of honeydew may contaminate fruit and other plant parts, which can serve as a medium for the growth of sooty molds (CABI, 2002). This mealybug was responsible for losses up to 5% in vineyards in India (CABI, 2002). Losses in citrus orchards are due firstly to fruit drop caused by large infestations of mealybugs; in South Africa, 50% or more of the navel orange crop has been lost in this way (CABI, 2002). Secondly, fruits with deformities caused by mealybug feeding are culled in the packinghouse, resulting in the further loss of production (CABI, 2002). Based on this evidence, the establishment of this insect in the US would likely cause a loss of foreign and domestic markets and would likely stimulate chemical and/or biological control programs, which would lower the value of the commodity by increasing production costs.	
Risk Element #5: Environmental Impact This pest represents a potential threat to plants listed as Threatened and Endangered in 50 CFR § 17.12. (*e.g.*, *Euphorbia*). The widespread establishment of *N. viridis* in the US is likely to stimulate chemical and/or biological control programs because it is a pest of the economically important citrus crop.	High (3)

Consequences of Introduction of *Planococcus lilacinus* (Cockerell) (Homoptera: Pseudococcidae)	Risk Value
Risk Element #1: Climate-Host Interaction This species ranges from south Asia (*i.e.*, Bangladesh, Cambodia, India, Laos, Myanmar, Taiwan, Vietnam and Yemen) through the islands of the South Pacific (*i.e.*, Indonesia, Java, Malaysia, the Philippines and Paupa New Guinea) (CABI, 2002). It also occurs in East Africa, Central America, and northern South America (CABI, 2002). Based on this distribution, it is estimated that *P. lilacinus* could establish in US Plant Hardiness Zones 9-11. One or more of its potential hosts occurs in these zones (USDA NRCS, 2003).	Medium (2)
Risk Element #2: Host Range The host range of *P. lilacinus* is extremely broad, comprising species in at least 35 plant families (Ben-Dov, 1994). Included are several economically important crops, such as *Citrus* spp. (Rutaceae), *Mangifera indica* (Anacardiaceae), *Coffea* spp. (Rubiaceae), *Theobroma cacao* (Sterculiaceae), *Vitis* spp. (Vitaceae), *Cocos nucifera* (Arecaceae), *Bambusa vulgaris* (Poaceae), *Dioscorea* sp. (Dioscoreaceae), *Tamarindus indica* (Caesalpiniaceae), *Annona* spp. (Annonaceae), and guava (Myrtaceae) (CABI, 2002). The only evidence of *Dimocarpus longan* being a host of *P. lilacinus* is it being intercepted on this plant species by PPQ 47 times since 1985 (PIN309 query November 21, 2003).	High (3)
Risk Element #3: Dispersal Potential Fecundity per female on *Brassica oleracea* (Brassicaceae) is 55-152 eggs (Loganathan and Suresh, 2001). There are two or three generations per year (IPM	High (3)

Consequences of Introduction of *Planococcus lilacinus* (Cockerell) (Homoptera: Pseudococcidae)	**Risk Value**
DANIDA, 2003). As with other mealybugs, long-distance dispersal is accomplished on infested plant materials.	
Risk Element #4: Economic Impact Throughout the orient and the South Pacific, *P. lilacinus* is a pest of cacao, on which it causes severe damage to young trees by killing the tips of branches (CABI, 2002). It is also considered a major pest of tamarind in India (Hill, 1983) and causes damage to a wide range of other economically important crops, such as coffee, custard apple (*Annona reticulata*), coconut, citrus, grape, guava, and mango (CABI, 2002). The prevalence of this scale has increased and spread to most coffee-growing areas, where it attacks the roots and shoots and causes serious damage to the plant (CABI, 2002). In India, it has been necessary to mount chemical and biological control programs against this pest in cacao, coffee, custard apple, and mandarin orange (CABI, 2002). However, the species is considered only a minor pest of avocado in the Philippines (Waite and Martinez, 2002). Based on this evidence, establishment of this insect in the US could possibly cause a loss of foreign and domestic markets and would likely stimulate chemical and/or biological control programs, which would lower the value of the commodity by increasing production costs.	High (3)
Risk Element #5: Environmental Impact Because of its extremely broad host range, this species has the potential to attack plants that are listed as Threatened or Endangered (*e.g.*, *Amaranthus*, *Solanum*) in 50 CFR §17.12 [The host range of this species includes plants in the genera *Amaranthus* and *Solanum* (CABI, 2002)]. Introduction of *P. lilacinus* into the US is likely to initiate chemical or biological control programs, because it is a serious pest of economically important crops (*e.g.*, citrus and coffee).	High (3)

Consequences of Introduction: *Planococcus minor* (Maskell) (Homoptera: Pseudococcidae)	**Risk Value**
Risk Element #1: Climate-Host Interaction *Planococcus minor* is reported in south Asia (Bangladesh; Brit. Indian Ocean Terr.; Burma; India; Indonesia, Kalimantan; Sumatra; Malaysia; Philippines; Singapore; Taiwan; Thailand), Australia and islands of the South Pacific (American Samoa; Cook Islands; Fiji; French Polynesia; Kiribati; New Caledonia; Niue; Papua New Guinea; Solomon Islands; Tokelau; Tonga; Vanuatu; Western Samoa), Africa (Madagascar; Rodriques Island; Seychelles), tropical areas of the New World [Antigua and Barbuda; Argentina (Buenos Aires, Entre Rios, Tucuman); Bermuda; Brazil; Colombia; Costa Rica; Cuba; Dominica; Galapagos Islands; Grenada; Guadeloupe; Guatemala; Guyana; Haiti; Honduras; Jamaica; Saint Lucia; Suriname; Trinidad and Tobago; U.S. Virgin Islands; Uruguay], and Mexico (ScaleNet, 2004). It is reported in only tropical areas of Mexico (Ben-Dov, 1994). Based on this geographical distribution, it is estimated that this species could establish in US Plant Hardiness Zones 9-11. One or more of its potential hosts occurs in these zones	Medium (2)

Consequences of Introduction: *Planococcus minor* (Maskell) (Homoptera: Pseudococcidae)	**Risk Value**
(USDA NRCS, 2003).	
Risk Element #2: Host Range This species is extremely polyphagous, having been recorded on hosts in at least 65 plant families (Ben-Dov, 1994). Hosts include *Colocasia esculenta* (Araceae), *Solanum* spp. (Solanaceae), *Theobroma cacao* (Sterculiaceae), *Citrus* spp. (Rutaceae), *Coffea* spp. (Rubiaceae), *Mangifera indica* (Anacardiaceae), *Musa* spp. (Musaceae), *Eugenia* spp. (Myrtaceae), *Vitis vinifera* (Vitaceae), *Ziziphus* sp. (Rhamnaceae), *Amaranthus* sp. (Amaranthaceae), *Annona* spp. (Annonaceae), *Helianthus* sp. (Asteraceae), *Euphorbia* spp. (Euphorbiaceae), *Persea americana* (Lauraceae), *Ipomoea* spp. (Convolvulaceae), *Brassica* spp. (Brassicaceae), *Cucumis* spp. (Cucurbitaceae), *Zea mays* (Poaceae), *Arachis hypogaea* (Fabaceae), *Artocarpus* spp. (Moraceae), *Cocos nucifera* (Arecaceae), *Pandanus* spp. (Pandanaceae), *Pyrus pyrifolia* (Rosaceae), and *Asparagus plumosus* (Liliaceae) (Ben-Dov, 1994; CABI, 2002). The only evidence of *Dimocarpus longan* being a host of *P. minor* is it being intercepted on this plant species by PPQ 43 times since 1985 (PIN309 query July 28, 2003).	High (3)
Risk Element #3: Dispersal Potential Reported fecundity ranges from about 200 to over 400 eggs per female, depending on host plant (Maity *et al.*, 1998; Martinez and Suris, 1998; Sahoo *et al.*, 1999). There may be as many as 10 generations per year (Sahoo *et al.*, 1999). This insect can be transported long distances in shipments of fruit (Sugimoto, 1994).	High (3)
Risk Element #4: Economic Impact This species is an important pest of coffee in India (Reddy *et al.*, 1997). Severe outbreaks (originally attributed to *P. citri* [Risso]) have been reported on coffee and sugarcane in New Guinea (CABI, 2002). Introduction of this mealybug into the US could cause the loss of domestic or foreign markets for a number of commodities.	High (3)
Risk Element #5: Environmental Impact The extreme polyphagy of this species predisposes it to attack native plants listed as Threatened or Endangered in 50 CFR §17.12 (*e.g.*, *Amaranthus*, *Cucurbita*, *Solanum*, *Helianthus*, *Abutilon*, *Eugenia*, *Euphorbia*). It represents a potentially serious threat to economically valuable crops in the US (*e.g.*, avocado, citrus, cucurbits), so its introduction could stimulate chemical or biological control programs.	High (3)

Consequences of Introduction: *Pseudaonidia trilobitiformis* (Green) (Homoptera: Diaspididae)	**Risk Value**
Risk Element #1: Climate-Host Interaction *Pseudaonidia trilobitiformis* has been reported in Taiwan (Anonymous, 1994), Mexico, Venezuela, the Caribbean (CABI, 2002), East Africa, New Caledonia in the South Pacific (Fabres, 1974), and Florida (Coile and Dixon, 2000; USDA, 1979). Suitable climatic conditions for this species should be available in the southern US (Plant Hardiness Zones 9-11). One or more of its potential hosts	Medium (2)

Consequences of Introduction: *Pseudaonidia trilobitiformis* (Green) (Homoptera: Diaspididae)	**Risk Value**
occurs in these zones (USDA NRCS, 2003).	
Risk Element #2: Host Range Hosts recorded for this species include *Mangifera indica* and *Anacardium occidentale* (Anacardiaceae), *Citrus* spp. (Rutaceae), *Anthurium andreanum* (Araceae), *Persea americana* (Lauraceae), *Zingiber officinale* (Zingiberaceae), *Theobroma cacao* (Sterculiaceae), *Coffea* spp. (Rubiaceae), *Cocos nucifera* (Arecaceae) (CABI, 2002), *Passiflora* spp. (Passifloraceae) (Hill, 1983), and *Dimocarpus longan* (Sapindaceae) (Anonymous, 1994).	High (3)
Risk Element #3: Dispersal Potential No information is available on the biology of this species, but two related species that occur in the southern US exhibit multivoltinism and high fecundity. *Pseudaonidia duplex* (Cockerell) has three generations per year in Louisiana, and *P. paeoniae* (Cockerell) produce 30-50 eggs per female (Kosztarab, 1996). Long-distance dispersal of *P. trilobitiformis* is likely accomplished by transport on infested plant material. Because of the lack of information regarding the dispersal potential of *P. trilobitiformis*, this element is given a risk value of High (3).	High (3)
Risk Element #4: Economic Impact *Pseudaonidia trilobitiformis* is regarded as a minor pest of avocado, cacao, citrus, coconut, coffee, mango, and passion fruit (Hill, 1983). In Brazil, however, it is a pest of cashew that requires chemical control (Silva *et al.*, 1977). Wider establishment of this insect in the US could stimulate chemical and/or biological control programs and cause a loss of domestic and foreign markets for commodities, such as citrus.	Medium (2)
Risk Element #5: Environmental Impact Potential hosts listed as Threatened or Endangered in 50 CFR §17.12 include, among others: *Zanthoxylum dipetalum* var. *tomentosum* (Rutaceae), *Melicope* spp. (Rutaceae), *Lindera melissifolia* (Lauraceae), and *Ayenia limitaris* (Sterculiaceae). These plants are present in *P. trilobitiformis*' predicted climatic range in the US outside of Florida (*e.g.*, Texas, Louisiana, California, Hawaii) and are classified in plant families within this scale's host range. As no host preference tests with *P. trilobitiformis* and these plants are known, it is assumed these plants could be used as hosts. Because *P. trilobitiformis* represents a potential threat to citrus and possibly other economically important crops, wider establishment of this species in the US could stimulate chemical or biological control programs.	High (3)

Consequences of Introduction: *Pulvinaria taiwana* Takahashi (Homoptera: Coccidae)	**Risk Value**
Risk Element #1: Climate-Host Interaction *Pulvinaria taiwana* is only reported in Taiwan (Ben-Dov, 1993; ScaleNet, 2002). Based on this distribution, it is estimated that this species could become established in areas of the US corresponding to Plant Hardiness Zones 9-11. Both of its reported hosts occur in these Zones (Gaskell, 2003; NCSU CIPM, 2003; USDA NRCS, 2003).	Medium (2)

Consequences of Introduction: *Pulvinaria taiwana* Takahashi (Homoptera: Coccidae)	**Risk Value**
Risk Element #2: Host Range *Pulvinaria taiwana* is reported on *Mangifera indica* (Anacardiaceae) (Ben-Dov, 1993; ScaleNet, 2002) and *Dimocarpus longan* (Sapindaceae) (Wen *et al.*, 2002).	High (3)
Risk Element #3: Dispersal Potential No information could be found on the reproductive or dispersal capabilities of this species. As with other scales, this species has limited mobility under its own power but could probably be dispersed over long distances with the movement of host materials. Since 1985, *Pulvinaria* spp. has been intercepted 132 times by PPQ officers at ports of entry on plant materials (PIN309 query Dec. 16, 2003). Because of the uncertainty surrounding the dispersal potential of this scale and considering the ability of this genus to be dispersed long distances with plant material, it is given a High (3) rating for this risk element.	High (3)
Risk Element #4: Economic Impact No information could be found on the economic impact of this species. *Pulvinaria* spp. are reported as minor pests of various crops, such as citrus and jujube (*Zizyphus mauritiana*), by infesting foliage (Hill, 1983). On the other hand, *P. psidii* is reported as a serious pest of guava, litchi, *Calocarpum sapota*, as well as a pest on other crops, such as of mango and citrus (CABI, 2003). Because of the uncertainty in its economic impact and the fact that at least one species in this genus (*i.e.*, *P. psidii*) is reported as a serious pest of economically important crops, *P. taiwana* was assigned a High (3) risk rating for this risk element.	High (3)
Risk Element #5: Environmental Impact The genera *Mangifera* and *Dimocarpus* are not listed as Threatened or Endangered in 50 CFR §17.12. *Alectryon macrococcus* (Sapindaceae), which is present in Hawaii (USDA NRCS, 2003), and *Rhus michauxii* (Anacardiaceae), which is reported in southeastern States, including Florida (USDA NRCS, 2003), are listed as Endangered. Preference tests involving these plant species and *P. taiwana* are not known; therefore, it is assumed that *P. taiwana* would be able to use these plants as hosts. As it is assumed this scale could have economic impacts (see Risk Element #4), it is assumed as well that its establishment in the US could trigger the initiation of chemical and/or biological control programs.	High (3)

Consequences of Introduction: *Rhipiphorothrips cruentatus* Hood (Thysanoptera: Thripidae)	**Risk Value**
Risk Element #1: Climate-Host Interaction *Rhipiphorothrips cruentatus* is reported as widespread in India and Sri Lanka and also present in Afghanistan, Bangladesh, China (Guangdong, Hainan), Taiwan, Myanmar, Oman, Pakistan, and Thailand (CABI, 2003). Based on this distribution, it is estimated that this species could become established in the continental US in areas corresponding to Plant Hardiness Zones 8-11. One or more of its potential hosts occurs in these zones (USDA NRCS, 2002).	High (3)

Consequences of Introduction: *Rhipiphorothrips cruentatus* Hood (Thysanoptera: Thripidae)	**Risk Value**
Risk Element #2: Host Range *Rhipiphorothrips cruentatus* is considered polyphagous, its primary hosts being *Anacardium occidentale* (Anacardiaceae), *Annona squamosa* (Annonaceae), *Mangifera indica* (Anacardiaceae), *Psidium guajava* (Myrtaceae), *Punica granatum* (Punicaceae), *Rosa rugosa* (Rosaceae), *Syzygium cumini* (Myrtaceae), *Syzygium samarangense* (Myrtaceae), *Terminalia catappa* (Combretaceae), and *Vitis vinifera* (Vitaceae) (CABI, 2003). *Dimocarpus longan* (Sapindaceae) is also recorded as a host (Wen *et al.*, 2002).	High (3)
Risk Element #3: Dispersal Potential *Rhipiphorothrips cruentatus* can reproduce sexually or by parthenogenesis (CABI, 2003; Chiu, 1984). The fecundity and longevity of this species depends on temperature (CABI, 2003). In field and laboratory studies on wax apple in Taiwan, females laid approximately 13 eggs, which hatched in 13 days, and nymphs reached adulthood in 12.5 days (Chiu, 1984). Five to eight generations occur each year in India, and overwintering pupae emerge from the soil as adults in March (Butani, 1979). In contrast, *R. cruentatus* reproduces throughout the year in Taiwan without a diapause (CABI, 2003). Adults are capable of flight and their small size and fringed wings allow long distance dispersal via wind or as passengers in commercial commodities (Lewis, 1997).	High (3)
Risk Element #4: Economic Impact *Rhipiphorothrips cruentatus* is reported as one of the major thrips pests in Taiwan (Chang *et al.*, 1995). It is reported as an important pest of grapes, roses (CABI, 2003) and guava (Harmit *et al.*, 2001) in India and wax apple (*Syzygium samarangense*) (CABI, 2003) and roses (Wang and Wang, 1997) in Taiwan. In Taiwan, *R. cruentatus* also damages other crops such as mango and guava, causing yield reductions and loss of market value (CABI, 2003). Attack by this thrips causes the host's leaves to turn brown and to fall prematurely (CABI, 2003). It can also cause fruit damage (CABI, 2003; Gima *et al.*, 2001). For example, in India, damage to guava fruit was reported to range from 9.64 to 56.92 percent (Gima *et al.*, 2001). Introduction of this pest into the US could cause a loss of foreign and domestic markets.	High (3)
Risk Element #5: Environmental Impact None of the genera containing primary hosts of *R. cruentatus* are listed as Threatened or Endangered in 50 CFR §17.12. However, plants in families containing primary hosts of *R. cruentatus* (*e.g.*, Anacardiaceae, Annonaceae, and Rosaceae) are listed as Threatened or Endangered (*e.g.*, *Rhus michauxii, Asimina tetramera*, and *Potentilla hickmanii*). As preference tests with these plants and *R. cruentatus* are not known, it is assumed that *R. cruentatus* would be able to use one or more of these plants as hosts. Because this thrips could have economic impacts (see Risk Element #4), its establishment in the US would likely trigger the initiation of chemical and/or biological control programs. Various chemical pesticides (*e.g.*, carbaryl, dimethoate, deltamethrin, cyhalothrin, deltamethrin, carbosulfan, methamidophos, carbosulfan, permethrin) have been used for the control of this thrips in India, Pakistan, and Taiwan (CABI, 2003; Chiu, 1984).	High (3)

Consequences of Introduction: *Thysanofiorinia nephelii* (Maskell) (Homoptera: Diaspidae)	**Risk Value**
Risk Element #1: Climate-Host Interaction *Thysanofiorinia nephelii*'s distribution includes Australia (New South Wales, Queensland), Hawaii, Northern Mariana Islands, Brazil, Cuba, Burma, China (Fujian, Guangdong, Guangxi, Zhejiang), Hong Kong, India (Karnataka, West Bengal), Taiwan, Thailand, Algeria, Japan (ScaleNet, 2002), and Florida (Coile and Dixon, 2002a, 2002b). Based on this tropical to warm temperate distribution and the host range of *T. nephelii*, it is estimated that this species could become established in areas of the US corresponding to US Plant Hardiness Zones 8-11.	High (3)
Risk Element #2: Host Range *Thysanofiorinia nephelii*'s host range includes: *Kentia* sp. (Arecaceae), *Euphorbia longana* (Euphorbiaceae), *Indigofera* sp. (Fabaceae), *Dimocarpus longan* (Sapindaceae), *Litchi chinensis* (Sapindaceae), *Nephelium longanum* (Sapindaceae), and *Nephelium* sp. (Sapindaceae) (ScaleNet, 2002).	High (3)
Risk Element #3: Dispersal Potential No information could be found on the fecundity and natural dispersal ability of this species or genus. Since 1985, *T. nephelii* has been intercepted by PPQ at ports of entry on plant materials, primarily on fruit (PIN309, 2003), which indicates that this scale, like other scales, could be dispersed long distances via commercial trade. Because of the uncertainty surrounding the dispersal potential of this scale and considering its ability to be dispersed long distances with plant material, it is given a High (3) rating for this risk element.	High (3)
Risk Element #4: Economic Impact *Thysanofiorinia nephelii* is listed among the principal scale pests of litchi and longan in Florida (Mossler and Nesheim, 2003). Since 1996, when *T. nephelii* was introduced into Florida (Thomas, 2000), slight to moderate infestations have been reported on longans in the State (Coile and Dixon, 2002a, 2002b; Garland and Dixon, 2002). No other information on the economic impact of this species could be found. Considering its narrow host range and the fact that it has not become a severe pest in Florida despite its introduction since 1996, this scale is given a Medium (2) rating for this risk element.	Medium (2)
Risk Element #5: Environmental Impact The potential Hawaiian host *Euphorbia haeleeleana* is listed as Endangered in 50 CFR §17.12; however, *T. nephelii* is already present in Hawaii (ScaleNet, 2002). On the other hand, species not present in Hawaii or Florida and in the families Euphorbiaceae (*Chamaesyce hooveri*, *Manihot walkerae*) and Fabaceae (*e.g.*, *Dalea foliosa*) are listed as Threatened or Endangered in 50 CFR §17.12. No preference tests among these plant species and *T. nephelii* are known; therefore, it is assumed that they could be potential hosts for this scale. In the event that this scale is discovered attacking a Threatened or Endangered plant, a chemical or biological control program would likely ensue.	High (3)

Table 5. Summary of the Risk Ratings and the Value for the Consequences of Introduction

Pest	**Climate / Host**	**Host Range**	**Dispersal Potential**	**Economic Impact**	**Environ-mental Impact**	**Consequen-ces of Introduction value**[1]
Aceria litchii	Medium (2)	Medium (2)	High (3)	High (3)	Medium (2)	Medium (12)
Adoxophyes orana	High (3)	High (3)	Medium (2)	High (3)	High (3)	High (14)
Aulacaspis tubercularis	High (3)	High (3)	High (3)	High (3)	High (3)	High (15)
Bactrocera cucrubitae	Medium (2)	High (3)	High (3)	High (3)	High (3)	High (14)
Bactrocera dorsalis	Medium (2)	High (3)	High (3)	High (3)	High (3)	High (14)
Ceroplastes rubens	High (3)	High (3)	High (3)	High (3)	High (3)	High (15)
Coccus discrepans	Medium (2)	High (3)	High (3)	High (3)	High (3)	High (14)
Coccus formicarii	Medium (2)	High (3)	High (3)	High (3)	High (3)	High (14)
Coccus viridis	Medium (2)	High (3)	High (3)	High (3)	High (3)	High (14)
Conogethes punctiferalis	High (3)	High (3)	Medium (2)	High (3)	High (3)	High (14)
Conopomorpha sinensis	Medium (2)	Medium (2)	High (3)	High (3)	High (3)	High (13)
Cryptophlebia ombrodelta	High (3)	High (3)	High (3)	High (3)	High (3)	High (15)
Deudorix epijarbas	Medium (2)	High (3)	Medium (2)	Medium (2)	High (3)	Medium (12)
Drepanococcus chiton	Medium (2)	High (3)	Medium (2)	High (3)	High (3)	High (13)
Fiorinia pinicola	Medium (2)	High (3)	High (3)	High (3)	High (3)	High (14)
Icerya seychellarum	High (3)	High (3)	Medium (2)	High (3)	High (3)	High (14)
Kerria lacca	Medium (2)	High (3)	High (3)	High (3)	High (3)	High (14)

Table 5. Summary of the Risk Ratings and the Value for the Consequences of Introduction						
Pest	**Climate / Host**	**Host Range**	**Dispersal Potential**	**Economic Impact**	**Environ-mental Impact**	**Consequen-ces of Introduction value[1]**
Kerria greeni	Medium (2)	High (3)	High (3)	High (3)	High (3)	High (14)
Maconellicoccus hirsutus	Medium (2)	High (3)	High (3)	High (3)	High (3)	High (14)
Nipaecoccus viridis	Medium (2)	High (3)	High (3)	High (3)	High (3)	High (14)
Planococcus lilacinus	Medium (2)	High (3)	High (3)	High (3)	High (3)	High (14)
Planococcus minor	Medium (2)	High (3)	High (3)	High (3)	High (3)	High (14)
Pseudaonidia trilobitiformis	Medium (2)	High (3)	High (3)	Medium (2)	High (3)	High (13)
Pulvinaria taiwana	Medium (2)	High (3)	High (3)	High (3)	High (3)	High (14)
Rhipiphorothrips cruentatus	High (3)	High (3)	High (3)	High (3)	High (3)	High (15)
Thysanofiorinia nephelii	High (3)	High (3)	High (3)	Medium (2)	High (3)	High (14)

[1] Low is 5-8 points, Medium is 9-12 points and High is 13-15 points

Likelihood of Introduction—Quantity Imported and Pest Opportunity

Likelihood of introduction is a function of the quantity of the commodity imported annually and pest opportunity, which consists of five criteria that consider the potential for pest survival along the pathway (USDA, 2000) (Table 6). The following scale is used to interpret this total: Low is 6-9 points, Medium is 10-14 points, and High is 15-18 points.

Quantity imported annually

The Taiwanese government estimates that longan exports to the US would total 180 metric tons per year (Ball, 2003). This translates to a predicted volume of approximately 9 standard 40-foot shipping containers annually, based on a conversion factor of 20 metric tons per 40-foot shipping container (Cargo Systems, 2001). The quantity of commodity is estimated to fall below 10 containers per year; therefore, the Quantity Imported Annually is rated Low (1) for all pests.

Survive postharvest treatment

This risk element evaluates the efficacy of postharvest treatments in terms of the mortality of pests exposed to the treatments. Among the arthropod pests, the tephritid fruit flies (*Bactrocera cucurbitae* and *B. dorsalis*) and Lepidoptera (*Conopomorpha sinensis, Deudorix epijarbas,* *Conogethes punctiferalis,* and *Cryptophlebia ombrodelta*), as internal feeders, would be expected to survive these postharvest treatments, especially if infestation of the fruit was not of such great age to make damage obvious. The Lepidoptera *Adoxophyes orana*, the scale insects [*Aulacaspis tubercularis* (Diaspidae), *Ceroplastes rubens* (Coccidae), *Coccus discrepans* (Coccidae), *Coccus formicarii* (Coccidae), *Coccus viridis* (Coccidae), *Drepanococcus chiton* (Coccidae), *Fiorinia pinicola* (Diaspidae), *Icerya seychellarum* (Margarodidae), *Kerria lacca* (Kerridae), *Kerria greeni* (Kerridae), *Maconellicoccus hirsutus* (Pseudococcidae), *Nipaecoccus viridis* (Pseudococcidae), *Planococcus lilacinus* (Pseudococcidae), *Planococcus minor* (Pseudococcidae), *Pseudaonidia trilobitiformis* (Diaspidae), *Pulvinaria taiwana* (Coccidae), *Thysanofiorinia nephelii* (Diaspidae)], the thrips (*Rhipiphorothrips cruentatus*), and the mite (*Aceria litchi*i) are external feeders and would have a less of a probability of surviving post-harvest treatments than internal feeders; however, depending on their stage (egg, larva, adult) or instar, these arthropods might find shelter on fruit, particularly at the stem end, or in packing materials. Scale insects have sessile stages that live firmly pressed to plant surfaces. Their cryptic behavior, small size [most scales are less than 5 mm long (Gullan and Kosztarab, 1997)], water-repellent, waxy coverings, and firm attachment to the substrate could make them difficult to see or dislodge, especially if sheltered at the stem end of the fruit. For example, many scales prefer tight, protected areas, such as cracks and crevices (Kosztarab, 1996). Adult mites of *Aceria litchii* are very small and are said to escape notice unless their outbreak is manifested on leaves (Mathur and Tandon, 1974). On the other hand, fruits infested by *A. orana* show obvious symptoms (CABI, 2002; Carter, 1984; USDA, 1985) and are relatively easy to identify (USDA, 1985). *Rhipiphorothrips cruentatus* adults are dark brown and, therefore, easy to detect on leaves and fruit (CABI, 2003); however, the larvae and eggs of *R. cruentatus* would be more difficult to detect. Consequently, the tephritid fruit flies and the Lepidoptera pests, except *A. orana*, are rated High (3); the scales, *R. cruentatus*, and *Aceria litchii* are rated Medium (2); and *A. orana* is rated Low (1) for **Survive postharvest treatment.**

Survive shipment

To maintain the quality of longan fruits, the recommended temperature and relative humidity for the transport and storage are 1.5 ^{o}C (35 ^{o}F) and 90-95% (McGregor, 1987). If properly packaged and held close to the recommended storage temperature and relative humidity, the time available for transit and storage is estimated to be three to five weeks (McGregor, 1987). These environmental conditions and time frames are estimated to be insufficient to reduce population levels of the quarantine pests of concern. Therefore, the unmitigated (*i.e.*, absence of any specific quarantine treatment during shipment) risk for **Survive Shipment** is estimated to be High (3) for all of the pests.

Not detected at port-of-entry

The larvae of the tephritid fruit flies (*Bactrocera cucurbitae*, *B. dorsalis*) and the Lepidoptera pests, except *A. orana*, are internal pests. The fruit flies deposit their eggs under the surface of the fruit. The early stages of larval development inside the fruit are only adequately detected by destructive sampling. Depending on the age of infestation, these pests could have a high probability of escaping detection. In fact, fruit fly-infested fruits often go unrecognized (White and Elson-Harris, 1992).

The lepidopteran pests deposit their eggs on the surface of plant parts, mainly leaves. Larvae enter fruit by chewing through the surface, creating an opening that may have frass associated with it. The injury also makes the fruit more susceptible to rots and secondary pests. The entry holes of second instar and larger larvae will generally be visually obvious. The entry hole and injury associated with first instar larvae may be difficult to detect on some fruit, especially when hidden by the calyx or stem, however such small injuries are more easily detected on the round, smooth, tan colored longan fruit.

As external pests, *A. orana*, all the scales, the thrips, *R. cruentatus*, and the mite, *Aceria litchii*, would be easier to detect; however, because of the small size of the scales and the mite and the sessile nature of the scales, low population densities of these arthropods may escape detection, particularly if concealed at the stem end of fruits or in packing materials. In contrast, fruit infested by *A. orana* show obvious symptoms (CABI, 2002; Carter, 1984; USDA, 1985) that are relatively easy to identify (USDA, 1985) and would be easily detected by officers at ports of entry. Similarly, *R. cruentatus* adults are dark brown and, therefore, would be easy to detect during quarantine inspections (CABI, 2003). The larvae and eggs of *R. cruentatus*, however, would be more difficult to detect. Consequently, the tephritid fruit flies are rated High (3); the Lepidoptera pests, (except *A. orana*), scales, *R. cruentatus*, and *Aceria litchii* are rated Medium (2); and *A. orana* is rated Low (1) for **Not detected at port-of-entry.**

Moved to suitable habitat

This sub-element considers the geographic location of likely markets and the chance that the commodity will be moved to locations suitable for pest survival. Fruit imported into the US typically arrives at multiple ports and is distributed according to market demand. Demographics derived from US Census data may be useful in predicting the distribution of imported longan fruit by indicating population centers where demand may be greatest. Three of the four most heavily populated States in the US, Florida, Texas, and California, have climates that closely resemble the native climates of the pests analyzed (U.S. Census, 2000); these three States account for approximately 25 percent of the total US population (U.S. Census, 2000). As longan is an Asian fruit, the demand may be concentrated in Asian American populations, which mostly occur on the West Coast, but also have sizable populations in the Northeast, Chicago (IL), and Florida (Snell, 2003). Taiwan expects to export longan to the West coast, particularly Los Angeles (Ball, 2003). Because Asian American populations occur in other areas of the US, it is assumed that exports could expand to include other areas. As establishment is unlikely in the Northeast and Chicago, areas suitable for pest establishment that are likely to receive imported longan comprise less than 15% of the US; therefore, all pests are rated Medium (2) for **Moved to suitable habitat.**

Contact with host material

Even if the final destination of infested commodities is suitable for pest survival, suitable hosts must be available in order for the pest to survive. This sub-element considers the likelihood that the pest species can come in contact with host material for reproduction. The complete host range of the pest was considered. According to the IPPC standard for pest risk analysis (IPPC, 2003), other factors that may be considered are:

- Dispersal mechanisms, including vectors to allow movement from the pathway to a suitable host
- Whether the imported commodity is to be sent to a few or many destinations in the PRA area

- Proximity of entry, transit and destination points to suitable hosts
- Time of year at which import takes place
- Intended use of the commodity (*e.g.*, for planting, processing or consumption)
- Risks from by-products and waste

Availability of hosts varies among the arthropods in their potential geographic range within the US. Hosts of the extremely polyphagous species (*Adoxophyes orana, Aulacaspis tubercularis, Bactrocera cucurbitae, Bactrocera dorsalis, Ceroplastes rubens, Coccus formicarii, Conogethes punctiferalis, Cryptophlebia ombrodelta, Fiorinia pinicola, Icerya seychellarum, Kerria lacca, Maconellicoccus hirsutus, Nipaecoccus viridis, Planococcus lilacinus, P. minor,* and *Rhipiphorothrips cruentatus*) include temperate-zone or widely cultivated plants (USDA NRCS, 2003) that should be available throughout their potential US range. Hosts of the monophagous or oligophagous pests (*Aceria litchii, Coccus discrepans, Coccus viridis, Conopomorpha sinensis, Deudorix epijarbas, Drepanococcus chiton, Kerria greeni, Pseudaonidia trilobitiformis, Pulvinaria taiwana,* and *Thysanofiorinia nephelii*), especially of *Aceria litchii* and *Conopomorpha sinensis*, are of more limited distribution in the US (USDA NRCS, 2003) and are less likely to be encountered and colonized compared to hosts of the polyphagous species listed above. Taiwan harvests longan from June to October (Ball, 2003), and it is therefore assumed that longan fruit would be shipped to the US during these months. Suitable hosts would be available throughout the shipping season in the southern States and would be available during most of the shipping season in the rest of the US.

Even if hosts are available for colonization, biological attributes of the organisms influence the probability of finding these hosts and successfully establishing in the US. The sessile nature of scale insects would severely limit their chances of coming into contact with hosts (Gullan and Kosztarab, 1997; Miller *et al.*, 1985). Successful establishment of these insects in a new environment can occur only when mobile forms (*i.e.*, crawlers) are present on the imported fruit and these fruit are placed in close proximity to a susceptible host. As these circumstances are highly unlikely to co-occur (Miller *et al.*, 1985), scale insects have a low probability of establishment. On the other hand, all of the Lepidoptera, the thrips, *Rhipiphorothrips cruentatus*, and the mite, *Aceria litchii*, have some natural ability to disperse, although probably limited. *Bactrocera* spp. have excellent dispersal capabilities, and many of them can fly 50-100km during their life (Fletcher, 1989b).

Based on this evidence (host ranges and biological attributes), the scales, *Aceria litchii*, and *Conopomorpha sinensis* are rated Low (1); *Deudorix epijarbas* is rated Medium (2); and *Adoxophyes orana, Bactrocera cucurbitae, Bactrocera dorsalis, Conogethes punctiferalis, Cryptophlebia ombrodelta*, and *Rhipiphorothrips cruentatus* are rated High (3) for **Contact with host material.**

Table 6. Summary of the ratings for the Quantity Imported Annually, Pest Opportunity, and the value for the Likelihood of Introduction.

Pest	Quantity Imported Annually	Ratings for Pest Opportunity					Likelihood of Introduction value[1]
		Survive Post-harvest Treatment	Survive Ship-ment	Not detected at the Port-of-Entry	Moved to a Suitable Habitat	Contact with Host Material	
Aceria litchii	Low (1)	Medium (2)	High (3)	Medium (2)	Medium (2)	Low (1)	Medium (11)
Adoxophyes orana	Low (1)	Low (1)	High (3)	Low (1)	Medium (2)	High (3)	Medium (11)
Aulacaspis tubercularis	Low (1)	Medium (2)	High (3)	Medium (2)	Medium (2)	Low (1)	Medium (11)
Bactrocera cucrubitae	Low (1)	High (3)	High (3)	High (3)	Medium (2)	High (3)	High (15)
Bactrocera dorsalis	Low (1)	High (3)	High (3)	High (3)	Medium (2)	High (3)	High (15)
Ceroplastes rubens	Low (1)	Medium (2)	High (3)	Medium (2)	Medium (2)	Low (1)	Medium (11)
Coccus discrepans	Low (1)	Medium (2)	High (3)	Medium (2)	Medium (2)	Low (1)	Medium (11)
Coccus formicarii	Low (1)	Medium (2)	High (3)	Medium (2)	Medium (2)	Low (1)	Medium (11)
Coccus viridis	Low (1)	Medium (2)	High (3)	Medium (2)	Medium (2)	Low (1)	Medium (11)
Conogethes punctiferalis	Low (1)	High (3)	High (3)	Medium (2)	Medium (2)	High (3)	Medium (14)
Conopomorpha sinensis	Low (1)	High (3)	High (3)	Medium (2)	Medium (2)	Low (1)	Medium (12)
Cryptophlebia ombrodelta	Low (1)	High (3)	High (3)	High (3)	Medium (2)	High (3)	High (15)
Deudorix epijarbas	Low (1)	High (3)	High (3)	High (3)	Medium (2)	Medium (2)	Medium (14)
Drepanococcus chiton	Low (1)	Medium (2)	High (3)	Medium (2)	Medium (2)	Low (1)	Medium (11)
Fiorinia pinicola	Low (1)	Medium (2)	High (3)	Medium (2)	Medium (2)	Low (1)	Medium (11)
Icerya seychellarum	Low (1)	Medium (2)	High (3)	Medium (2)	Medium (2)	Low (1)	Medium (11)
Kerria lacca	Low (1)	Medium (2)	High (3)	Medium (2)	Medium (2)	Low (1)	Medium (11)

Table 6. Summary of the ratings for the Quantity Imported Annually, Pest Opportunity, and the value for the Likelihood of Introduction.

Pest	Quantity Imported Annually	Ratings for Pest Opportunity					Likelihood of Introduction value[1]
		Survive Post-harvest Treatment	Survive Ship-ment	Not detected at the Port-of-Entry	Moved to a Suitable Habitat	Contact with Host Material	
Kerria greeni	Low (1)	Medium (2)	High (3)	Medium (2)	Medium (2)	Low (1)	Medium (11)
Maconellicoccus hirsutus	Low (1)	Medium (2)	High (3)	Medium (2)	Medium (2)	Low (1)	Medium (11)
Nipaecoccus viridis	Low (1)	Medium (2)	High (3)	Medium (2)	Medium (2)	Low (1)	Medium (11)
Planococcus lilacinus	Low (1)	Medium (2)	High (3)	Medium (2)	Medium (2)	Low (1)	Medium (11)
Planococcus minor	Low (1)	Medium (2)	High (3)	Medium (2)	Medium (2)	Low (1)	Medium (11)
Pseudaonidia trilobitiformis	Low (1)	Medium (2)	High (3)	Medium (2)	Medium (2)	Low (1)	Medium (11)
Pulvinaria taiwana	Low (1)	Medium (2)	High (3)	Medium (2)	Medium (2)	Low (1)	Medium (11)
Rhipiphorothrips cruentatus	Low (1)	Medium (2)	High (3)	Medium (2)	Medium (2)	High (3)	Medium (13)
Thysanofiorinia nephelii	Low (1)	Medium (2)	High (3)	Medium (2)	Medium (2)	Low (1)	Medium (11)

[1]Low is 6-9 points, Medium is 10-14 points, and High is 15-18 points

F. Conclusion: Pest Risk Potential

Summation of the Consequences of Introduction and the Likelihood of Introduction values produce the Pest Risk Potential (Table 7). The following scale is used to interpret the Pest Risk Potential: Low is 11-18 points, Medium is 19-26 points and High is 27-33 points. Pest Risk Potential is a baseline estimate of the risks associated with importation of the commodity in the absence of mitigation measures.

Table 7. Pest Risk Potential

Pest	Consequences of Introduction	Likelihood of Introduction	Pest Risk Potential
Aceria litchii	Medium (12)	Medium (11)	Medium (23)
Adoxophyes orana	High (14)	Medium (11)	Medium (25)
Aulacaspis tubercularis	High (15)	Medium (11)	Medium (26)
Bactrocera cucrubitae	High (14)	High (15)	High (29)
Bactrocera dorsalis	High (14)	High (15)	High (29)
Ceroplastes rubens	High (15)	Medium (11)	Medium (26)
Coccus discrepans	High (14)	Medium (11)	Medium (25)
Coccus formicarii	High (14)	Medium (11)	Medium (25)
Coccus viridis	High (14)	Medium (11)	Medium (25)
Conogethes punctiferalis	High (14)	Medium (14)	High (28)
Conopomorpha sinensis	High (13)	Medium (12)	Medium (25)
Cryptophlebia ombrodelta	High (15)	High (15)	High (30)
Deudorix epijarbas	Medium (12)	Medium (14)	Medium (26)
Drepanococcus chiton	High (13)	Medium (11)	Medium (24)
Fiorinia pinicola	High (14)	Medium (11)	Medium (25)
Icerya seychellarum	High (14)	Medium (11)	Medium (25)
Kerria lacca	High (14)	Medium (11)	Medium (25)
Kerria greeni	High (14)	Medium (11)	Medium (25)
Maconellicoccus hirsutus	High (14)	Medium (11)	Medium (25)

Table 7. Pest Risk Potential

Pest	Consequences of Introduction	Likelihood of Introduction	Pest Risk Potential
Nipaecoccus viridis	High (14)	Medium (11)	Medium (25)
Planococcus lilacinus	High (14)	Medium (11)	Medium (25)
Planococcus minor	High (14)	Medium (11)	Medium (25)
Pseudaonidia trilobitiformis	High (13)	Medium (11)	Medium (24)
Pulvinaria taiwana	High (14)	Medium (11)	Medium (25)
Rhipiphorothrips cruentatus	High (15)	Medium (13)	High (28)
Thysanofiorinia nephelii	High (14)	Medium (11)	Medium (25)

Specific phytosanitary measures beyond port-of-entry inspection may be necessary for pests with a Pest Risk Potential of Medium. On the other hand, specific phytosanitary measures are strongly recommended for pests rated High (*i.e.*, *Bactrocera cucurbitae*, *Bactrocera dorsalis*, *Conogethes punctiferalis*, *Cryptophlebia ombrodelta*, and *Rhipiphorothrips cruentatus*), as port-of-entry inspection is not considered sufficient to provide phytosanitary security.

Risk mitigation options for the quarantine pests of concern are provided in Appendix 2. The choice of appropriate measures to mitigate risks is part of Risk Management within APHIS and is not addressed within this risk assessment document.

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Appendix 1. Interceptions on Longan (*Dimocarpus longan*)

Interceptions on longan (*Dimocarpus longan*) from all countries as reported in the PIN309 database from 1985-2003 (PIN309 query May 7, 2003). If there are interceptions from Taiwan, they are included under interceptions from China (Paul Courneya, NIS, personal communication, May 8, 2003).

Pest	Origin	Where	Plant Part	Number
AEOLOTHRIPIDAE, SPECIES OF	THAILAND	Baggage	Fruit	1
AEOLOTHRIPIDAE, SPECIES OF	UNKNOWN	Quarter	Fruit	1
ALEUROCANTHUS SP. (ALEYRODIDAE)	THAILAND	Baggage	Plant	1
ALEURODICUS DISPERSUS RUSSELL (ALEYRODIDAE)	HAWAII	Baggage	Plant	1
ALEYRODIDAE, SPECIES OF	VIETNAM	Baggage	Fruit	1
APHIDIDAE, SPECIES OF	ASIA	Baggage	Fruit	1
AULACASPIS SP. (DIASPIDIDAE)	CHINA	Baggage	Plant	1
AULACASPIS SP. (DIASPIDIDAE)	MALAYSIA	Baggage	Stem	1
BACTROCERA DORSALIS (HENDEL) (TEPHRITIDAE)	HAWAII	Mail	Fruit	1
BACTROCERA SP. (TEPHRITIDAE)	ASIA	Baggage	Fruit	122
BACTROCERA SP. (TEPHRITIDAE)	ASIA	GenCarg	Fruit	5
BACTROCERA SP. (TEPHRITIDAE)	ASIA	PerCarg	Fruit	2
BACTROCERA SP. (TEPHRITIDAE)	CAMBODIA	Baggage	Fruit	2
BACTROCERA SP. (TEPHRITIDAE)	CHINA	Baggage	Fruit	2
BACTROCERA SP. (TEPHRITIDAE)	HONG KONG	Baggage	Fruit	2
BACTROCERA SP. (TEPHRITIDAE)	INDIA	Baggage	Fruit	1
BACTROCERA SP. (TEPHRITIDAE)	PHILIPPINES	Baggage	Fruit	1
BACTROCERA SP. (TEPHRITIDAE)	CHINA	Baggage	Fruit	7
BACTROCERA SP. (TEPHRITIDAE)	THAILAND	Baggage	Fruit	7
BACTROCERA SP. (TEPHRITIDAE)	UNKNOWN	Baggage	Fruit	8
BACTROCERA SP. (TEPHRITIDAE)	UNKNOWN	PerCarg	Fruit	1
BACTROCERA SP. (TEPHRITIDAE)	VIETNAM	Baggage	Fruit	35
BACTROCERA SP. (TEPHRITIDAE)	VIETNAM	Quarter	Fruit	1
CARPOSINIDAE, SPECIES OF	VIETNAM	Baggage	Fruit	1
CATAENOCOCCUS HISPIDUS (MORRISON) (PSEUDOCOCCIDAE)	PHILIPPINES	Baggage	Fruit	3
CATAENOCOCCUS HISPIDUS (MORRISON) (PSEUDOCOCCIDAE)	THAILAND	Baggage	Fruit	1
CATAENOCOCCUS HISPIDUS (MORRISON) (PSEUDOCOCCIDAE)	VIETNAM	Baggage	Fruit	1
CATAENOCOCCUS SP. (PSEUDOCOCCIDAE)	PHILIPPINES	Baggage	Fruit	1
CECIDOMYIIDAE, SPECIES OF	HONG KONG	Baggage	Fruit	1
CECIDOMYIIDAE, SPECIES OF	HONG KONG	Baggage	Leaf	1
CECIDOMYIIDAE, SPECIES OF	PHILIPPINES	Baggage	Fruit	1
CEPHALEUROS SP.	THAILAND	Baggage	Fruit	6
CEPHALEUROS SP.	UNKNOWN	Baggage	Fruit	1
CEPHALEUROS SP.	UNKNOWN	Baggage	Leaf	2
CERATITINI, SPECIES OF	UNKNOWN	Baggage	Fruit	1
CEROPLASTES RUBENS MASKELL (COCCIDAE)	THAILAND	GenCarg	Leaf	1
CICADELLIDAE, SPECIES OF	UNKNOWN	Baggage	Fruit	1
CLADOSPORIUM SP.	CHINA	GenCarg	Leaf	1
CLADOSPORIUM SP.	VIETNAM	PerCarg	Leaf	1
COCCIDAE, SPECIES OF	ASIA	Baggage	Fruit	25
COCCIDAE, SPECIES OF	HONG KONG	Baggage	Fruit	2
COCCIDAE, SPECIES OF	INDONESIA	Baggage	Fruit	1
COCCIDAE, SPECIES OF	CHINA	Baggage	Fruit	1
COCCIDAE, SPECIES OF	THAILAND	Baggage	Fruit	1
COCCIDAE, SPECIES OF	UNKNOWN	Baggage	Fruit	3
COCCIDAE, SPECIES OF	VIETNAM	Baggage	Fruit	1

Pest	Origin	Where	Plant Part	Number
COCCUS FORMICARII (GREEN) (COCCIDAE)	CAMBODIA	Baggage	Fruit	1
CONOGETHES PUNCTIFERALIS (GUENEE) (PYRALIDAE)	MALAYSIA	Baggage	Fruit	1
CONOGETHES SP. (PYRALIDAE)	ASIA	Baggage	Fruit	2
CONOGETHES SP. (PYRALIDAE)	CAMBODIA	Baggage	Fruit	2
CONOGETHES SP. (PYRALIDAE)	CHINA	Baggage	Fruit	1
CONOGETHES SP. (PYRALIDAE)	MALAYSIA	Quarter	Fruit	1
CONOGETHES SP. (PYRALIDAE)	PHILIPPINES	Baggage	Fruit	1
CONOGETHES SP. (PYRALIDAE)	CHINA	Baggage	Fruit	2
CONOGETHES SP. (PYRALIDAE)	SINGAPORE	Baggage	Fruit	1
CONOGETHES SP. (PYRALIDAE)	THAILAND	Baggage	Fruit	2
CONOGETHES SP. (PYRALIDAE)	THAILAND	Baggage	Leaf	1
CONOGETHES SP. (PYRALIDAE)	VIETNAM	Baggage	Fruit	17
COREIDAE, SPECIES OF	UNKNOWN	Baggage	Fruit	1
COSSIDAE, SPECIES OF	PHILIPPINES	Baggage	Fruit	1
COSSIDAE, SPECIES OF	PHILIPPINES	Baggage	Stem	1
CRAMBIDAE, SPECIES OF	KOREA	Baggage	Fruit	1
CRAMBUS SP. (PYRALIDAE)	PHILIPPINES	Baggage	Fruit	1
CRYPTOBLABES GNIDIELLA (MILLIERE) (PYRALIDAE)	HAWAII	Mail	Fruit	1
CRYPTOPHLEBIA OMBRODELTA (LOWER) (TORTRICIDAE)	VIETNAM	Baggage	Fruit	2
CRYPTOPHLEBIA SP. (TORTRICIDAE)	ASIA	Baggage	Fruit	1
CRYPTOPHLEBIA SP. (TORTRICIDAE)	CHINA	Baggage	Fruit	1
CRYPTOPHLEBIA SP. (TORTRICIDAE)	VIETNAM	Baggage	Fruit	9
CURCULIONIDAE, SPECIES OF	UNKNOWN	Baggage	Fruit	1
CYDIA SP. (TORTRICIDAE)	VIETNAM	Baggage	Fruit	1
DACUS SP. (TEPHRITIDAE)	PHILIPPINES	Baggage	Fruit	1
DACUS SP. (TEPHRITIDAE)	THAILAND	Baggage	Fruit	1
DIASPIDIDAE, SPECIES OF	ASIA	Baggage	Fruit	2
DIASPIDIDAE, SPECIES OF	CAMBODIA	Baggage	Fruit	1
DIASPIDIDAE, SPECIES OF	CANADA(?)	Baggage	Fruit	1
DIASPIDIDAE, SPECIES OF	CHINA	Baggage	Fruit	1
DIASPIDIDAE, SPECIES OF	HONG KONG	Baggage	Fruit	1
DIASPIDIDAE, SPECIES OF	CHINA	Baggage	Fruit	2
DIASPIDIDAE, SPECIES OF	CHINA(?)	Baggage	Fruit	1
DIASPIDIDAE, SPECIES OF	SINGAPORE	Baggage	Fruit	1
DIASPIDIDAE, SPECIES OF	THAILAND	Baggage	Fruit	1
DIASPIDIDAE, SPECIES OF	THAILAND	Baggage	Leaf	1
DIASPIDIDAE, SPECIES OF	UNKNOWN	Baggage	Fruit	6
DIASPIDIDAE, SPECIES OF	VIETNAM	Baggage	Fruit	2
DIPLODIA SP.	UNKNOWN	Misc	Fruit	1
DIPTERA, SPECIES OF	ASIA	Baggage	Fruit	9
DIPTERA, SPECIES OF	HAWAII	Baggage	Fruit	1
DIPTERA, SPECIES OF	JAPAN	Baggage	Fruit	1
DIPTERA, SPECIES OF	THAILAND	Baggage	Fruit	1
DIPTERA, SPECIES OF	THAILAND(?)	Baggage	Fruit	1
DIPTERA, SPECIES OF	UNKNOWN	Baggage	Fruit	3
DREPANOCOCCUS SP. (COCCIDAE)	CHINA	Baggage	Fruit	1
DREPANOCOCCUS SP. (COCCIDAE)	SOUTH KOREA	Baggage	Fruit	1
DREPANOCOCCUS SP. (COCCIDAE)	VIETNAM	Baggage	Fruit	2
DROSICHA SP. (MARGARODIDAE)	THAILAND	Baggage	Fruit	1
DYSMICOCCUS NEOBREVIPES BEARDSLEY (PSEUDOCOCCIDAE)	ASIA	Quarter	Fruit	1
DYSMICOCCUS NEOBREVIPES BEARDSLEY (PSEUDOCOCCIDAE)	BANGLADESH	Baggage	Fruit	1
DYSMICOCCUS NEOBREVIPES BEARDSLEY (PSEUDOCOCCIDAE)	CAMBODIA	Baggage	Fruit	4
DYSMICOCCUS NEOBREVIPES BEARDSLEY (PSEUDOCOCCIDAE)	CHINA	Baggage	Fruit	1

Pest	Origin	Where	Plant Part	Number
DYSMICOCCUS NEOBREVIPES BEARDSLEY (PSEUDOCOCCIDAE)	INDONESIA	Baggage	Fruit	1
DYSMICOCCUS NEOBREVIPES BEARDSLEY (PSEUDOCOCCIDAE)	PHILIPPINES	Baggage	Fruit	4
DYSMICOCCUS NEOBREVIPES BEARDSLEY (PSEUDOCOCCIDAE)	PHILIPPINES	Baggage	Stem	1
DYSMICOCCUS NEOBREVIPES BEARDSLEY (PSEUDOCOCCIDAE)	CHINA	Baggage	Fruit	4
DYSMICOCCUS NEOBREVIPES BEARDSLEY (PSEUDOCOCCIDAE)	THAILAND	Baggage	Fruit	2
DYSMICOCCUS NEOBREVIPES BEARDSLEY (PSEUDOCOCCIDAE)	UNKNOWN	Baggage	Fruit	1
DYSMICOCCUS NEOBREVIPES BEARDSLEY (PSEUDOCOCCIDAE)	VIETNAM	Baggage	Fruit	36
DYSMICOCCUS SP. (PSEUDOCOCCIDAE)	CAMBODIA	Baggage	Fruit	1
DYSMICOCCUS SP. (PSEUDOCOCCIDAE)	PHILIPPINES	Baggage	Fruit	2
DYSMICOCCUS SP. (PSEUDOCOCCIDAE)	UNKNOWN	Misc	Fruit	1
DYSMICOCCUS SP. (PSEUDOCOCCIDAE)	VIETNAM	Baggage	Fruit	13
ERIOCOCCIDAE, SPECIES OF	VIETNAM	Baggage	Fruit	1
FIORINIA SP. (DIASPIDIDAE)	CAMBODIA	Baggage	Fruit	1
FIORINIA SP. (DIASPIDIDAE)	VIETNAM	Baggage	Fruit	1
FULGORIDAE, SPECIES OF	VIETNAM	Baggage	Fruit	1
GELECHIIDAE, SPECIES OF	ASIA	Baggage	Fruit	4
GELECHIIDAE, SPECIES OF	ASIA	Baggage	Stem	9
GELECHIIDAE, SPECIES OF	ASIA	GenCarg	Stem	2
GELECHIIDAE, SPECIES OF	CHINA	GenCarg	Stem	1
GELECHIIDAE, SPECIES OF	HONG KONG	Baggage	Fruit	1
GELECHIIDAE, SPECIES OF	HONG KONG	Baggage	Stem	1
GELECHIIDAE, SPECIES OF	CHINA	Baggage	Fruit	1
GELECHIIDAE, SPECIES OF	CHINA	Baggage	Stem	1
GELECHIIDAE, SPECIES OF	THAILAND	Baggage	Stem	1
GELECHIIDAE, SPECIES OF	UNKNOWN	Baggage	Fruit	2
GELECHIIDAE, SPECIES OF	UNKNOWN	PerCarg	Stem	1
GELECHIIDAE, SPECIES OF	UNKNOWN	Quarter	Stem	1
GELECHIIDAE, SPECIES OF	VIETNAM	Baggage	Fruit	1
GRACILLARIIDAE, SPECIES OF	ASIA	Baggage	Fruit	196
GRACILLARIIDAE, SPECIES OF	ASIA	Baggage	Leaf	1
GRACILLARIIDAE, SPECIES OF	ASIA	Baggage	Stem	1
GRACILLARIIDAE, SPECIES OF	ASIA	GenCarg	Fruit	4
GRACILLARIIDAE, SPECIES OF	ASIA	Holds	Fruit	2
GRACILLARIIDAE, SPECIES OF	ASIA	Misc	Fruit	1
GRACILLARIIDAE, SPECIES OF	ASIA	PerCarg	Fruit	1
GRACILLARIIDAE, SPECIES OF	ASIA	Quarter	Fruit	1
GRACILLARIIDAE, SPECIES OF	CAMBODIA	Baggage	Fruit	7
GRACILLARIIDAE, SPECIES OF	CANADA	Mail	Fruit	3
GRACILLARIIDAE, SPECIES OF	CANADA	PerCarg	Fruit	1
GRACILLARIIDAE, SPECIES OF	CHINA	Baggage	Fruit	18
GRACILLARIIDAE, SPECIES OF	HONG KONG	Baggage	Fruit	13
GRACILLARIIDAE, SPECIES OF	HONG KONG	PerCarg	Fruit	1
GRACILLARIIDAE, SPECIES OF	HONG KONG(?)	Baggage	Fruit	1
GRACILLARIIDAE, SPECIES OF	JAPAN	Baggage	Fruit	1
GRACILLARIIDAE, SPECIES OF	KOREA	Baggage	Fruit	3
GRACILLARIIDAE, SPECIES OF	LAOS	Baggage	Fruit	2
GRACILLARIIDAE, SPECIES OF	MALAYSIA	Baggage	Fruit	2
GRACILLARIIDAE, SPECIES OF	CHINA	Baggage	Fruit	8
GRACILLARIIDAE, SPECIES OF	PHILIPPINES	Baggage	Fruit	16
GRACILLARIIDAE, SPECIES OF	CHINA	Baggage	Fruit	35
GRACILLARIIDAE, SPECIES OF	CHINA	Baggage	Leaf	1
GRACILLARIIDAE, SPECIES OF	CHINA	GenCarg	Fruit	4
GRACILLARIIDAE, SPECIES OF	CHINA	Quarter	Fruit	1

Pest	Origin	Where	Plant Part	Number
GRACILLARIIDAE, SPECIES OF	CHINA(?)	GenCarg	Fruit	1
GRACILLARIIDAE, SPECIES OF	SINGAPORE	Baggage	Fruit	4
GRACILLARIIDAE, SPECIES OF	SINGAPORE	Quarter	Fruit	1
GRACILLARIIDAE, SPECIES OF	THAILAND	Baggage	Fruit	46
GRACILLARIIDAE, SPECIES OF	THAILAND	Baggage	Leaf	2
GRACILLARIIDAE, SPECIES OF	THAILAND	GenCarg	Fruit	1
GRACILLARIIDAE, SPECIES OF	THAILAND	PerCarg	Fruit	5
GRACILLARIIDAE, SPECIES OF	THAILAND	Stores	Leaf	1
GRACILLARIIDAE, SPECIES OF	THAILAND(?)	Baggage	Fruit	1
GRACILLARIIDAE, SPECIES OF	UNKNOWN	Baggage	Fruit	41
GRACILLARIIDAE, SPECIES OF	UNKNOWN	Misc	Fruit	3
GRACILLARIIDAE, SPECIES OF	UNKNOWN	PerCarg	Fruit	2
GRACILLARIIDAE, SPECIES OF	UNKNOWN	Quarter	Fruit	2
GRACILLARIIDAE, SPECIES OF	VIETNAM	Baggage	Fruit	424
GRACILLARIIDAE, SPECIES OF	VIETNAM	Baggage	Leaf	3
GRACILLARIIDAE, SPECIES OF	VIETNAM	GenCarg	Fruit	3
GRACILLARIIDAE, SPECIES OF	VIETNAM	Mail	Leaf	1
GRACILLARIIDAE, SPECIES OF	VIETNAM	PerCarg	Fruit	4
HOMOPTERA, SPECIES OF	VIETNAM	Baggage	Fruit	1
HYPOTHENEMUS SP. (SCOLYTIDAE)	CHINA	Baggage	Fruit	1
HYPOTHENEMUS SP. (SCOLYTIDAE)	THAILAND	Misc	Fruit	1
ICERYA SEYCHELLARUM (WESTWOOD) (MARGARODIDAE)	CAMBODIA	Baggage	Fruit	1
ICERYA SP. (MARGARODIDAE)	PHILIPPINES	Baggage	Stem	1
IMPERATA CYLINDRICA (LINNAEUS) BEAUVOIS (POACEAE)	ASIA	Baggage	Fruit	1
IMPERATA CYLINDRICA (LINNAEUS) BEAUVOIS (POACEAE)	THAILAND	PerCarg	Fruit	1
LEPIDOPTERA, SPECIES OF	CHINA	Baggage	Fruit	1
LEPIDOPTERA, SPECIES OF	THAILAND	Baggage	Fruit	1
LEPIDOPTERA, SPECIES OF	THAILAND	Baggage	Stem	1
LEPIDOPTERA, SPECIES OF	THAILAND	Stores	Fruit	1
LINDINGASPIS FERRISI MCKENZIE (DIASPIDIDAE)	CHINA	Baggage	Plant	1
LYCAENIDAE, SPECIES OF	ASIA	Baggage	Fruit	1
LYCAENIDAE, SPECIES OF	THAILAND	Baggage	Fruit	1
MACONELLICOCCUS HIRSUTUS (GREEN) (PSEUDOCOCCIDAE)	ASIA	Baggage	Fruit	1
MACONELLICOCCUS HIRSUTUS (GREEN) (PSEUDOCOCCIDAE)	CAMBODIA	Baggage	Fruit	1
MACONELLICOCCUS HIRSUTUS (GREEN) (PSEUDOCOCCIDAE)	CHINA	Baggage	Fruit	3
MACONELLICOCCUS HIRSUTUS (GREEN) (PSEUDOCOCCIDAE)	INDONESIA	Baggage	Fruit	1
MACONELLICOCCUS HIRSUTUS (GREEN) (PSEUDOCOCCIDAE)	MALAYSIA	Baggage	Fruit	1
MACONELLICOCCUS HIRSUTUS (GREEN) (PSEUDOCOCCIDAE)	CHINA	Baggage	Fruit	1
MACONELLICOCCUS HIRSUTUS (GREEN) (PSEUDOCOCCIDAE)	PHILIPPINES	Baggage	Fruit	1
MACONELLICOCCUS HIRSUTUS (GREEN) (PSEUDOCOCCIDAE)	CHINA	Baggage	Fruit	1
MACONELLICOCCUS HIRSUTUS (GREEN) (PSEUDOCOCCIDAE)	THAILAND	Baggage	Fruit	1
MACONELLICOCCUS HIRSUTUS (GREEN) (PSEUDOCOCCIDAE)	UNKNOWN	Baggage	Fruit	4
MACONELLICOCCUS HIRSUTUS (GREEN) (PSEUDOCOCCIDAE)	VIETNAM	Baggage	Fruit	20
MACONELLICOCCUS SP. (PSEUDOCOCCIDAE)	CAMBODIA	Baggage	Fruit	1
MACONELLICOCCUS SP. (PSEUDOCOCCIDAE)	UNKNOWN	Baggage	Fruit	3
MACONELLICOCCUS SP. (PSEUDOCOCCIDAE)	VIETNAM	Baggage	Fruit	2
MARGARODIDAE, SPECIES OF	INDIA	Baggage	Fruit	1
MARGARODIDAE, SPECIES OF	THAILAND	Baggage	Fruit	1
MARGARODIDAE, SPECIES OF	UNITED KINGDOM	Baggage	Stem	1
MARGARODIDAE, SPECIES OF	UNKNOWN	Misc	Fruit	1
MICROSPHAEROPSIS SP.	THAILAND	GenCarg	Fruit	1
MIRIDAE, SPECIES OF	CHINA	Baggage	Fruit	1
MYCOSPHAERELLA SP.	THAILAND	GenCarg	Fruit	1

Pest	Origin	Where	Plant Part	Number
NIPAECOCCUS SP. (PSEUDOCOCCIDAE)	ASIA	Baggage	Fruit	3
NIPAECOCCUS VIRIDIS (NEWSTEAD) (PSEUDOCOCCIDAE)	CHINA	Baggage	Fruit	1
NOCTUIDAE, SPECIES OF	THAILAND	Baggage	Fruit	1
OECOPHORIDAE, SPECIES OF	VIETNAM	Baggage	Fruit	1
OLETHREUTINAE, SPECIES OF (TORTRICIDAE)	CAMBODIA	Baggage	Fruit	2
OLETHREUTINAE, SPECIES OF (TORTRICIDAE)	CANADA	PerCarg	Fruit	1
OLETHREUTINAE, SPECIES OF (TORTRICIDAE)	LAOS	Baggage	Fruit	1
OLETHREUTINAE, SPECIES OF (TORTRICIDAE)	PHILIPPINES	Baggage	Fruit	2
OLETHREUTINAE, SPECIES OF (TORTRICIDAE)	CHINA	Baggage	Fruit	2
OLETHREUTINAE, SPECIES OF (TORTRICIDAE)	THAILAND	Baggage	Fruit	2
OLETHREUTINAE, SPECIES OF (TORTRICIDAE)	VIETNAM	Baggage	Fruit	41
ORTHEZIIDAE, SPECIES OF	VIETNAM	Baggage	Fruit	1
PARACOCCUS BURNERAE (BRAIN) (PSEUDOCOCCIDAE)	VIETNAM	Baggage	Fruit	1
PARACOCCUS SP. (PSEUDOCOCCIDAE)	PHILIPPINES	Baggage	Fruit	1
PARACOCCUS SP. (PSEUDOCOCCIDAE)	VIETNAM	Baggage	Fruit	2
PARLATORIA ZIZIPHI (LUCAS) (DIASPIDIDAE)	THAILAND	Baggage	Leaf	1
PENTATOMOIDEA, SPECIES OF	PHILIPPINES	Baggage	Fruit	1
PESTALOTIOPSIS SP.	THAILAND	Baggage	Fruit	1
PESTALOTIOPSIS SP.	VIETNAM	Baggage	Leaf	1
PHAEOSPHAERIA SP.	THAILAND	GenCarg	Fruit	1
PHEIDOLE SP. (FORMICIDAE)	PHILIPPINES	Baggage	Fruit	1
PHLAEOTHRIPIDAE, SPECIES OF	ASIA	Baggage	Fruit	1
PHLAEOTHRIPIDAE, SPECIES OF	ASIA	GenCarg	Fruit	1
PHLAEOTHRIPIDAE, SPECIES OF	HONG KONG	Baggage	Fruit	1
PHOMOPSIS SP.	PHILIPPINES	Baggage	Fruit	1
PHYCITINAE, SPECIES OF (PYRALIDAE)	PHILIPPINES	Baggage	Fruit	1
PHYCITINAE, SPECIES OF (PYRALIDAE)	CHINA	Baggage	Fruit	1
PHYCITINAE, SPECIES OF (PYRALIDAE)	VIETNAM	Baggage	Fruit	2
PLANOCOCCUS LILACINUS (COCKERELL) (PSEUDOCOCCIDAE)	ASIA	Baggage	Fruit	1
PLANOCOCCUS LILACINUS (COCKERELL) (PSEUDOCOCCIDAE)	ASIA	PerCarg	Fruit	1
PLANOCOCCUS LILACINUS (COCKERELL) (PSEUDOCOCCIDAE)	ASIA	Quarter	Fruit	1
PLANOCOCCUS LILACINUS (COCKERELL) (PSEUDOCOCCIDAE)	CAMBODIA	Baggage	Fruit	2
PLANOCOCCUS LILACINUS (COCKERELL) (PSEUDOCOCCIDAE)	INDONESIA	Baggage	Fruit	1
PLANOCOCCUS LILACINUS (COCKERELL) (PSEUDOCOCCIDAE)	JAPAN	Baggage	Fruit	1
PLANOCOCCUS LILACINUS (COCKERELL) (PSEUDOCOCCIDAE)	KOREA	Baggage	Fruit	1
PLANOCOCCUS LILACINUS (COCKERELL) (PSEUDOCOCCIDAE)	KOREA	Quarter	Fruit	1
PLANOCOCCUS LILACINUS (COCKERELL) (PSEUDOCOCCIDAE)	PHILIPPINES	Baggage	Fruit	14
PLANOCOCCUS LILACINUS (COCKERELL) (PSEUDOCOCCIDAE)	CHINA	Baggage	Fruit	2
PLANOCOCCUS LILACINUS (COCKERELL) (PSEUDOCOCCIDAE)	THAILAND	Baggage	Fruit	2
PLANOCOCCUS LILACINUS (COCKERELL) (PSEUDOCOCCIDAE)	THAILAND	Baggage	Stem	1
PLANOCOCCUS LILACINUS (COCKERELL) (PSEUDOCOCCIDAE)	VIETNAM	Baggage	Fruit	12
PLANOCOCCUS LILACINUS (COCKERELL) (PSEUDOCOCCIDAE)	VIETNAM	Baggage	Leaf	1
PLANOCOCCUS LITCHI COX (PSEUDOCOCCIDAE)	THAILAND	Baggage	Cutti	1
PLANOCOCCUS MINOR (MASKELL) (PSEUDOCOCCIDAE)	ASIA	Baggage	Fruit	2
PLANOCOCCUS MINOR (MASKELL) (PSEUDOCOCCIDAE)	AUSTRALIA	Baggage	Fruit	1
PLANOCOCCUS MINOR (MASKELL) (PSEUDOCOCCIDAE)	CAMBODIA	Baggage	Fruit	2
PLANOCOCCUS MINOR (MASKELL) (PSEUDOCOCCIDAE)	KOREA	Baggage	Fruit	1
PLANOCOCCUS MINOR (MASKELL) (PSEUDOCOCCIDAE)	MALAYSIA	Baggage	Fruit	1
PLANOCOCCUS MINOR (MASKELL) (PSEUDOCOCCIDAE)	CHINA	Baggage	Fruit	1
PLANOCOCCUS MINOR (MASKELL) (PSEUDOCOCCIDAE)	PHILIPPINES	Baggage	Fruit	1
PLANOCOCCUS MINOR (MASKELL) (PSEUDOCOCCIDAE)	CHINA	Baggage	Fruit	2
PLANOCOCCUS MINOR (MASKELL) (PSEUDOCOCCIDAE)	THAILAND	Baggage	Fruit	3
PLANOCOCCUS MINOR (MASKELL) (PSEUDOCOCCIDAE)	UNKNOWN	Baggage	Fruit	3

Pest	Origin	Where	Plant Part	Number
PLANOCOCCUS MINOR (MASKELL) (PSEUDOCOCCIDAE)	VIETNAM	Baggage	Fruit	24
PLANOCOCCUS MORRISONI (EZZAT & MCONNELL) (PSEUDOCOCCIDAE)	PHILIPPINES	Baggage	Fruit	2
PLANOCOCCUS SP. (PSEUDOCOCCIDAE)	ASIA	Baggage	Fruit	1
PLANOCOCCUS SP. (PSEUDOCOCCIDAE)	CAMBODIA	Baggage	Fruit	1
PLANOCOCCUS SP. (PSEUDOCOCCIDAE)	CHINA	Baggage	Fruit	2
PLANOCOCCUS SP. (PSEUDOCOCCIDAE)	LAOS	Baggage	Fruit	1
PLANOCOCCUS SP. (PSEUDOCOCCIDAE)	MALAYSIA	Baggage	Fruit	1
PLANOCOCCUS SP. (PSEUDOCOCCIDAE)	PHILIPPINES	Baggage	Fruit	1
PLANOCOCCUS SP. (PSEUDOCOCCIDAE)	CHINA	Baggage	Fruit	3
PLANOCOCCUS SP. (PSEUDOCOCCIDAE)	SINGAPORE	Baggage	Fruit	2
PLANOCOCCUS SP. (PSEUDOCOCCIDAE)	THAILAND	Baggage	Fruit	2
PLANOCOCCUS SP. (PSEUDOCOCCIDAE)	THAILAND	Quarter	Fruit	5
PLANOCOCCUS SP. (PSEUDOCOCCIDAE)	UNKNOWN	Baggage	Fruit	2
PLANOCOCCUS SP. (PSEUDOCOCCIDAE)	VIETNAM	Baggage	Fruit	20
PLANOCOCCUS SP. (PSEUDOCOCCIDAE)	VIETNAM	Baggage	Leaf	1
PRAIRIANA BIFURCATA DELONG (CICADELLIDAE)	THAILAND	Baggage	Fruit	1
PSEUDAONIDIA TRILOBITIFORMIS (GREEN) (DIASPIDIDAE)	ASIA	Baggage	Fruit	1
PSEUDAONIDIA TRILOBITIFORMIS (GREEN) (DIASPIDIDAE)	THAILAND	Stores	Leaf	1
PSEUDAONIDIA TRILOBITIFORMIS (GREEN) (DIASPIDIDAE)	VIETNAM	Baggage	Fruit	1
PSEUDAULACASPIS SP. (DIASPIDIDAE)	THAILAND	Misc	Fruit	1
PSEUDOCOCCIDAE, SPECIES OF	ASIA	Baggage		1
PSEUDOCOCCIDAE, SPECIES OF	ASIA	Baggage	Fruit	38
PSEUDOCOCCIDAE, SPECIES OF	ASIA	Baggage	Stem	1
PSEUDOCOCCIDAE, SPECIES OF	ASIA	Mail	Fruit	3
PSEUDOCOCCIDAE, SPECIES OF	ASIA	Stores	Fruit	2
PSEUDOCOCCIDAE, SPECIES OF	CAMBODIA	Baggage	Fruit	7
PSEUDOCOCCIDAE, SPECIES OF	CANADA	Baggage	Fruit	1
PSEUDOCOCCIDAE, SPECIES OF	CHINA	Baggage	Fruit	5
PSEUDOCOCCIDAE, SPECIES OF	DOMINICAN REPUB	PerCarg	Stem	1
PSEUDOCOCCIDAE, SPECIES OF	HAWAII	Baggage	Fruit	1
PSEUDOCOCCIDAE, SPECIES OF	HAWAII	GenCarg	Fruit	1
PSEUDOCOCCIDAE, SPECIES OF	HAWAII	Mail	Fruit	3
PSEUDOCOCCIDAE, SPECIES OF	HONG KONG	Baggage	Fruit	5
PSEUDOCOCCIDAE, SPECIES OF	INDONESIA	Baggage	Fruit	2
PSEUDOCOCCIDAE, SPECIES OF	JORDAN	Baggage	Fruit	1
PSEUDOCOCCIDAE, SPECIES OF	KOREA	Baggage	Fruit	1
PSEUDOCOCCIDAE, SPECIES OF	MALAYSIA	Baggage	Fruit	3
PSEUDOCOCCIDAE, SPECIES OF	CHINA	Baggage	Fruit	6
PSEUDOCOCCIDAE, SPECIES OF	CHINA	Quarter	Fruit	1
PSEUDOCOCCIDAE, SPECIES OF	PHILIPPINES	Baggage	Fruit	15
PSEUDOCOCCIDAE, SPECIES OF	PHILIPPINES	Baggage	Stem	1
PSEUDOCOCCIDAE, SPECIES OF	CHINA	Baggage	Fruit	21
PSEUDOCOCCIDAE, SPECIES OF	SINGAPORE	Baggage	Fruit	5
PSEUDOCOCCIDAE, SPECIES OF	SOUTH KOREA	Baggage	Fruit	1
PSEUDOCOCCIDAE, SPECIES OF	THAILAND	Baggage	Fruit	22
PSEUDOCOCCIDAE, SPECIES OF	THAILAND	Baggage	Leaf	1
PSEUDOCOCCIDAE, SPECIES OF	THAILAND	GenCarg	Fruit	2
PSEUDOCOCCIDAE, SPECIES OF	THAILAND	Mail	Fruit	1
PSEUDOCOCCIDAE, SPECIES OF	THAILAND	Quarter	Fruit	1
PSEUDOCOCCIDAE, SPECIES OF	UNKNOWN	Baggage	Fruit	26
PSEUDOCOCCIDAE, SPECIES OF	UNKNOWN	Quarter	Fruit	2
PSEUDOCOCCIDAE, SPECIES OF	VIETNAM	Baggage	Fruit	77

Pest	Origin	Where	Plant Part	Number
PSEUDOCOCCIDAE, SPECIES OF	VIETNAM	Baggage	Leaf	1
PSEUDOCOCCIDAE, SPECIES OF	VIETNAM	Baggage	Stem	2
PSEUDOCOCCUS CRYPTUS HEMPEL (PSEUDOCOCCIDAE)	CHINA	Baggage	Fruit	1
PSEUDOCOCCUS CRYPTUS HEMPEL (PSEUDOCOCCIDAE)	VIETNAM	Baggage	Fruit	1
PSEUDOCOCCUS SP. (PSEUDOCOCCIDAE)	CAMBODIA	GenCarg	Fruit	1
PSEUDOCOCCUS SP. (PSEUDOCOCCIDAE)	CHINA	Baggage	Fruit	3
PSEUDOCOCCUS SP. (PSEUDOCOCCIDAE)	JAPAN	Baggage	Fruit	1
PSEUDOCOCCUS SP. (PSEUDOCOCCIDAE)	PHILIPPINES	Baggage	Fruit	1
PSEUDOCOCCUS SP. (PSEUDOCOCCIDAE)	CHINA	Baggage	Fruit	2
PSEUDOCOCCUS SP. (PSEUDOCOCCIDAE)	UNKNOWN	Baggage	Fruit	4
PSEUDOCOCCUS SP. (PSEUDOCOCCIDAE)	VIETNAM	Baggage	Fruit	7
PYRALIDAE, SPECIES OF	JAPAN	Baggage	Seed	1
PYRALIDAE, SPECIES OF	KOREA	Baggage	Fruit	1
PYRALIDAE, SPECIES OF	PHILIPPINES	Baggage	Fruit	1
PYRALIDAE, SPECIES OF	UNKNOWN	PerCarg	Fruit	1
PYRALIDAE, SPECIES OF	VIETNAM	Baggage	Fruit	3
PYRAUSTINAE, SPECIES OF (CRAMBIDAE)	ASIA	Baggage	Fruit	3
PYRAUSTINAE, SPECIES OF (CRAMBIDAE)	ASIA	Baggage	Stem	3
PYRAUSTINAE, SPECIES OF (CRAMBIDAE)	CAMBODIA	Baggage	Fruit	1
PYRAUSTINAE, SPECIES OF (CRAMBIDAE)	HONG KONG	Baggage	Fruit	1
PYRAUSTINAE, SPECIES OF (CRAMBIDAE)	PHILIPPINES	Baggage	Fruit	1
PYRAUSTINAE, SPECIES OF (CRAMBIDAE)	VIETNAM	Baggage	Fruit	4
RASTROCOCCUS SP. (PSEUDOCOCCIDAE)	PHILIPPINES	Baggage	Fruit	1
SCIRTOTHRIPS SP. (THRIPIDAE)	ASIA	Baggage	Fruit	1
SCYTHRIDIDAE, SPECIES OF	VIETNAM	Baggage	Fruit	1
TARSONEMUS SP. (TARSONEMIDAE)	ASIA	Baggage	Fruit	2
TARSONEMUS SP. (TARSONEMIDAE)	CAMBODIA	Baggage	Fruit	2
TARSONEMUS SP. (TARSONEMIDAE)	ISRAEL	Baggage	Cutti	1
TARSONEMUS SP. (TARSONEMIDAE)	PHILIPPINES	Baggage	Fruit	1
TARSONEMUS SP. (TARSONEMIDAE)	VIETNAM	Baggage	Fruit	2
TEPHRITIDAE, SPECIES OF	ASIA	Baggage	Fruit	130
TEPHRITIDAE, SPECIES OF	ASIA	Misc	Fruit	1
TEPHRITIDAE, SPECIES OF	CANADA	Baggage	Fruit	1
TEPHRITIDAE, SPECIES OF	INDONESIA	Baggage	Fruit	1
TEPHRITIDAE, SPECIES OF	KOREA	Baggage	Fruit	1
TEPHRITIDAE, SPECIES OF	CHINA	Baggage	Fruit	3
TEPHRITIDAE, SPECIES OF	THAILAND	Baggage	Fruit	9
TEPHRITIDAE, SPECIES OF	THAILAND	PerCarg	Fruit	1
TEPHRITIDAE, SPECIES OF	UNKNOWN	Baggage	Fruit	34
TEPHRITIDAE, SPECIES OF	UNKNOWN	PerCarg	Fruit	3
TEPHRITIDAE, SPECIES OF	VIETNAM	Baggage	Fruit	4
TETRANYCHIDAE, SPECIES OF	AUSTRALIA	PerCarg	Plant	1
THRIPIDAE, SPECIES OF	ASIA	Baggage	Fruit	3
THRIPIDAE, SPECIES OF	MALAYSIA	Baggage	Fruit	1
THRIPIDAE, SPECIES OF	CHINA	Baggage	Fruit	1
THRIPIDAE, SPECIES OF	SINGAPORE	Baggage	Fruit	1
THRIPIDAE, SPECIES OF	THAILAND	Baggage		1
THRIPIDAE, SPECIES OF	THAILAND	Baggage	Fruit	1
THYSANOFIORINIA NEPHELII (MASKELL) (DIASPIDIDAE)	UNKNOWN	Baggage	Fruit	4
THYSANOFIORINIA NEPHELII (MASKELL) (DIASPIDIDAE)	UNKNOWN	Baggage	Leaf	2
THYSANOFIORINIA NEPHELII (MASKELL) (DIASPIDIDAE)	UNKNOWN	Mail	Fruit	1
TINEIDAE, SPECIES OF	CAMBODIA	Baggage	Fruit	1
TINEIDAE, SPECIES OF	VIETNAM	Baggage	Fruit	1

Pest	Origin	Where	Plant Part	Number
TISCHERIIDAE, SPECIES OF	ASIA	Baggage	Fruit	1
TORTRICIDAE, SPECIES OF	ASIA	Baggage	Fruit	1
TORTRICIDAE, SPECIES OF	DOMINICAN REPUB	Baggage	Fruit	1
TORTRICIDAE, SPECIES OF	CHINA	Quarter	Fruit	1
TORTRICIDAE, SPECIES OF	UNKNOWN	Baggage	Fruit	1
TORTRICIDAE, SPECIES OF	VIETNAM	Baggage	Fruit	8
TORTRICINAE, SPECIES OF (TORTRICIDAE)	PHILIPPINES	Baggage	Fruit	1
TORTRICINAE, SPECIES OF (TORTRICIDAE)	THAILAND	PerCarg	Fruit	1
TORTRICINAE, SPECIES OF (TORTRICIDAE)	VIETNAM	Baggage	Fruit	1
TRIOZIDAE, SPECIES OF	THAILAND	Mail	Plant	1
TUCKERELLA EQUALIS CHAUDHRI (TUCKERELLIDAE)	CHINA	Baggage	Fruit	1
XYLEBORUS SP. (SCOLYTIDAE)	UNKNOWN	Baggage	Fruit	1

Appendix 2. Risk Mitigation Options for the Importation of Fresh Longan, *Dimocarpus longan* Lour. from Taiwan into the United States

I. Introduction

The government of Taiwan requested permission to export fresh longan, *Dimocarpus longan* Lour., fruit with stems into the United States. The movement of fruits and vegetables into the United States is regulated in 7 CFR §319.56. The entry of longan from Taiwan is not currently authorized under 7 CFR §319.56. Consequently, the Animal and Plant Health Inspection Service (APHIS) Plant Protection and Quarantine (PPQ) of the United States Department of Agriculture (USDA) prepared the present pest risk assessment to examine unmitigated pest risks associated with the importation of fresh longan fruit with stems from Taiwan. This pest risk assessment identified 26 quarantine pests (one mite and twenty-five insects), of which introduction into the United States is possible via Taiwan longan imports. The pest risks of these organisms were estimated based on the USDA *Guidelines for Pathway-Initiated Pest Risk Assessment, version 5.02* (USDA, 2000).

The pest risk assessment identified the following pests as having High unmitigated risk potential:
Bactrocera cucurbitae (Diptera: Tephritidae) (melon fly)
Bactrocera dorsalis (Diptera: Tephritidae) (Oriental fruit fly)
Conogethes punctiferalis (Lepidoptera: Pyralidae) (yellow peach moth)
Cryptophlebia ombrodelta (Lepidoptera: Tortricidae) (litchi fruit moth)
Rhipiphorothrips cruentatus (Thysanoptera: Thripidae) (grapevine thrips)

The assessment identified the following pests as having a Medium unmitigated risk potential:
Aceria litchii (synonym: *Eriophyes litchii*) (Prostigmata: Eriophyidae) (litchi mite)
Adoxophyes orana (Lepidoptera: Tortricidae) (summer fruit tortrix)
Aulacaspis tubercularis (Hemiptera: Diaspididae)
Ceroplastes rubens (Hemiptera: Coccidae)
Coccus discrepans (Hemiptera: Coccidae)
Coccus formicarii (Hemiptera: Coccidae)
Coccus viridis (Hemiptera: Coccidae)
Conopomorpha sinensis (Lepidoptera: Gracillariidae) (litchi fruit borer)
Deudorix epijarbas (Lepidoptera: Lycaenidae) (anar fruit butterfly)
Drepanococcus chiton (Hemiptera: Coccidae)
Fiorinia pinicola (Hemiptera: Diaspididae)
Icerya seychellarum (Hemiptera: Margarodidae)
Kerria lacca (Hemiptera: Kerridae)
Kerria greeni (Hemiptera: Kerridae)
Maconellicoccus hirsutus (Hemiptera: Pseudococcidae)
Nipaecoccus viridis (Hemiptera: Pseudococcidae)
Planococcus lilacinus (Hemiptera: Pseudococcidae)
Planococcus minor (Hemiptera: Pseudococcidae)
Pseudaonidia trilobitiformis (Hemiptera: Diaspididae)
Pulvinaria taiwana (Hemiptera: Coccidae)
Thysanofiorinia nephelii (Hemiptera: Diaspididae)

Of the twenty-six quarantine pests identified, no pest had a low unmitigated risk potential, based on the USDA *Guidelines*.

Note: Although the armored scales (*Aulacaspis tubercularis, Fiorinia pinicola, Pseudaonidia trilobitiformis, Thysanofiorinia nephelii*) scored a Medium rating, they have a low likelihood of introduction and establishment that could not be addressed using the current USDA *Guidelines* (APHIS, 2000). Even if the armored scales were able to follow the pathway of longan fruit from Taiwan, these scales would be highly unlikely to establish in the United States. This low likelihood of establishment is an important consideration when developing risk mitigations. This estimate of low likelihood is based on the fact that armored scale insects on fruit for consumption are highly unlikely to come into contact with host material and, therefore, to establish in the United States (Appendix 3).

According to USDA *Guidelines* (2000), pests with a Low Pest Risk Potential do not typically require mitigation measures, other than port-of-entry inspection. A value within the Medium range indicates that specific phytosanitary measures may be necessary. A rating in the High range indicates that specific phytosanitary measures, supplemental to port-of-entry inspection, are strongly recommended.

The aim of this document is to assist PPQ Risk Management decision makers. This document presents available phytosanitary measures that can provide, or potentially provide, an appropriate level of protection against the quarantine pests of concern.

The appropriate level of protection may be achieved through the application of a single phytosanitary measure, such as inspection or a quarantine treatment, or a combination of measures. A "systems approach" combines different measures and is defined as "the integration of different pest risk management measures, at least two of which act independently, and which cumulatively achieve the appropriate level of phytosanitary protection" (IPPC, 2002a). Combining specific mitigation measures in a way that provides overlapping or sequential safeguards is distinctly different from applying single mitigation methodologies, such as fumigation or inspection. Specific measures may be selected from a range of pre-harvest and post-harvest measures (*e.g.*, surveys, inspections, sanitation, chemical treatments, maintaining the integrity of lots, requiring pest-proof packaging, screening packing areas, designated harvest or shipping periods,
limited distribution at the destination, *etc*.), and include mitigation measures to compensate for uncertainty. PPQ uses systems approach for the importation of many commodities, including Unshu oranges from Japan (7 CFR § 319.28, U.S. Federal Register, 1997); tomatoes from Spain, France, Morocco, and Western Sahara (7 CFR § 319.56-2dd, U.S. Federal Register, 1997); and peppers from Israel (7 CFR § 319.56-2u U.S. Federal Register, 1997). These programs are successful examples of the systems approach.

II. Risk Mitigation Options

2.1 Establishment of Pest-free Areas

As a sole mitigative measure, the establishment of pest-free areas, or pest-free places of production, may be effective in satisfying an importing country's appropriate level of phytosanitary protection (IPPC, 1996, 1999). The establishment and maintenance of pest-free areas or production sites should be in compliance with international standards (IPPC, 1996, 1999).

2.2 Establishment of Areas of Low Pest Prevalence / Pest Suppression

According to the IPPC (2005), an area of low pest prevalence is "an area, whether all of a country, part of a country, or all or parts of several countries, as identified by the competent authorities, in which a specific pest occurs at low levels and which is subject to effective surveillance, control or eradication measures." Procedures for the establishment and maintenance of areas of low pest prevalence need to comply with international standards (IPPC, 2005). For example, elements of an operational plan for the establishment and maintenance of areas might include: a geographic description to delimit the area; specification of an upper limit to pest densities; means to document and verify all necessary procedures and maintain records; specification of phytosanitary procedures (*e.g.*, survey, pest control); and movement controls to prevent pest entry or re-entry into the area. IPPC (2005) recommends that the exporting country consults with the importing country in the early stages of implementation to ensure meeting the importing country's requirements. In particular, target or threshold population densities defining an area of low pest prevalence need to be established in consultation with the importing country.

Note: Any protocol for establishing and maintaining a pest-free area, or an area of low pest prevalence, also needs to include a pest-reporting procedure and emergency action plan to address target pest detections that could possibly occur in the pest-free or low-prevalence zones (IPPC, 1999, 2005).

Cultural, chemical, or mechanical means (*e.g.*, orchard sanitation, pruning of dead and diseased branches, pre-harvest application of pesticides, fruit bagging) may be used to suppress pest populations or prevent fruit infestation in orchards. Sanitation and pesticide applications are essential components of best management practices and mainstays of commercial fruit production (PPQ, 2005a). For instance, to control fruit flies, PPQ guidelines (PPQ, 2003) could be consulted for development of a systems approach; as part of this systems approach, prophylactic measures, such as sterile insect release and other control methods, are used in response to pest detection, or when fruit fly detections reach a specified level.

2.3 Phytosanitary Certification Inspections and Monitoring

Each longan shipment needs to be accompanied by a phytosanitary certificate issued by Taiwan's National Plant Protection Organization (NPPO). The certificate should contain additional declarations stating the longan fruits were treated and/or grown in accordance with any phytosanitary measures required by APHIS. Production areas also may be subject to periodic, unannounced inspections by certified inspectors from PPQ and/or Taiwan's NPPO to ensure that they meet stipulated requirements for the issuance of a phytosanitary certificate. This measure is useful for detecting pests present in the field that may be more difficult to detect post-harvest; however, it must be combined with other measures to ensure the absence of pests of concern.

2.4 Post-harvest Safeguards and Packinghouse Procedures

Screens, plastic tarpaulins, and other pest-proof covers are necessary to protect harvested fruit in transit and fruit awaiting packaging. Packinghouses should be pest exclusionary, and transportation should occur in a timely manner (*e.g.*, within three hours of harvest). Packinghouse standards help ensure adequate pest exclusion. When packing longan fruit for export to the United States, the packinghouse should only accept longans from registered and approved production sites. Packinghouse procedures should include fruit inspection and culling; this practice will remove damaged and deformed fruit from shipment containers. External pests should be removed by mechanical brushing and cleansing of the fruit using compressed air or other treatment, followed by immersion in a water bath containing a surfactant, and then air-drying. Scientists have evaluated the efficacy of dipping longan fruit in fungicidal solution and waxing; there are no conclusive results at this time (Yaacob and Subhadrabandhu, 1995). Finally, the fruits need to be packed in pest-proof containers and transported in sealed vehicles.

More details regarding post-harvest safeguards for the specific pests of concern are detailed below.

2.4.1 Internal Pests (fruit flies, Lepidoptera pests)

The larvae of fruit flies and lepidopteran insects may be difficult to detect during post-harvest inspection. The fruit flies of concern deposit their eggs under the surface of the fruit. The early stages of larval development inside the fruit are unlikely to be detected without dissecting the fruit. However, even with dissection, they may still fail to detect infested fruits. Inspectors cutting different types of fruit failed to detect larvae of *Anastrepha suspensa*, a fruit fly in the same family as *Bactrocera* and *Ceratitis*, on average from 16.5% of the time for carambolas to 82.1% of the time for green guavas (Gould, 1995).

The lepidopteran pests of concern deposit their eggs on the surface of plant parts, mainly leaves. To enter fruit, the larvae must chew through the surface. This feeding creates an entry hole that may exhibit frass and allows for the introduction of rots and other secondary pests. As a result, the entry of second instar and larger larvae will generally be visually obvious. The first instar larvae, which create smaller holes and are more difficult to detect, will feed closer to the surface and are therefore be more susceptible to treatment.

2.4.2 External Pests (thrips, scales, mites, *Adoxophyes orana*)

Culling for damage and insect infestation should reduce the probability of insect pests in the pathway, especially the external pests, *Rhipiphorothrips cruentatus*, *Aceria litchii*, the scale species, and *Adoxophes orana*. *Rhipiphorothrips cruentatus* adults are dark brown and easy to detect on fruit; the larvae can readily be found in association with the adults (CABI, 2004). Thrips that feed on fruit cause visible symptoms, including silvering that gradually turns the fruit's surface brown and rough (CABI, 2004). Adult mites of *A. litchii* are very small and may not be noticed. The PPQ Treatment Manual (PPQ, 2006a) states (regarding litchi from Hawaii) that "*Eriophyes litchii* [*Aceria litchii*] cannot be effectively detected by inspection;" however, feeding damage by this mite causes projections of light brown color on the fruit skin (Mathur and Tandon, 1974), making detection possible at least on some infested fruits.

Fruits infested by *A. orana* display obvious symptoms (CABI, 2002; Carter, 1984; USDA, 1985), such as large deep holes, or several smaller, adjacent holes (less than 5 mm in diameter) (CABI, 2002) that often do not penetrate deeper than the skin (USDA, 1985). These visual symptoms increase the chance of infested fruit being culled during harvest and post-harvest. Indeed, on apple, larval presence can be easily recognized by a large, shallow, irregular area of apple skin removed from the surface (USDA, 1985).

To reduce the likelihood of the external insect pests being in the pathway, mechanical brushing and cleansing with compressed air (or other treatment) methods can be utilized. The removal and reduction of external insect pests, like aphids, mites, mealybugs, and thrips, is possible by using a brisk water spray (Townsend, 1994).

Surfactants, such as common dishwashing detergent, may show a high degree of insecticidal activity, with a minimal risk of phytotoxicity. For example, Liu and Stansly (2000) achieved mortalities of 95-99% in leaf-infesting populations of silverleaf whitefly (*Bemisia argentifolii*) treated with detergent-water solutions ranging in concentration from 2 to 30 ml L^{-1}. Washing with detergent-water solutions (1 teaspoon detergent/1 gallon water) is effective in removing or killing scales, aphids, mealybugs, or other small insects on plants (Townsend, 1994).

2.5 Quarantine Treatments

2.5.1 Generic Dose Irradiation

Recently, APHIS published a final rule establishing "a minimum generic dose of 150 Gy for all fruit flies of the family Tephritidae," and "a minimum generic dose of 400 Gy for all plant pests of the class Insecta other than pupae and adults of the order Lepidoptera" for "all regulated articles (*i.e.*, fruits**,** vegetables**,** cut flowers, and foliage)" (Shea, 2006). There are two exceptions to these generic doses: 1) "lower minimum doses for certain fruit flies," and 2) "new approved minimum doses for 10 plant pests" (Shea, 2006). Of all the quarantine pests of concern on longan from Taiwan, only *Cryptophlebia ombrodelta* (Lepidoptera: Tortricidae) is specifically listed in the rule. According to the rule (Shea, 2006), for all regulated plant articles, an irradiation dose of 250 Gy is approved for *C. ombrodelta*. This final rule does not mention a generic irradiation dose for mites; therefore, this rule does not apply to *Aceria litchii*.

To summarize, based on a recent final rule (Shea, 2006), **irradiation is approved for all insect pests of concern on Taiwan longan** at the following doses:

- *Bactrocera cucurbitae, B. dorsalis* (Diptera: Tephritidae): 150 Gy
- *Cryptophlebia ombrodelta* (Lepidoptera: Tortricidae): 250 Gy
- All the other insects in the order Lepidoptera (except for pupae and adults), all the scale insects (Hemiptera: Coccoidea), and the one thrips species, *Rhipiphorothrips cruentatus*: 400 Gy

2.5.2 Internal Pests (fruit flies, lepidopteran insects)

2.5.2.1 Fruit flies

PPQ recognizes hot water immersion, irradiation, and cold treatment as quarantine treatments for *Bactrocera cucurbitae* and *B. dorsalis* in longans (PPQ, 2006b).

- T102-d-1 hot water immersion for *Ceratitis capitata* and *B. dorsalis* in longan fruit from Hawaii: 20 minutes at a minimum temperature of 120.2°F (49°C).
- T105-a-6 irradiation for *C. capitata*, *B. dorsalis*, and *B. cucurbitae* in longan fruit from Hawaii: the minimum absorbed dose of gamma irradiation shall be 250 Gy (25 krad), but shall not exceed 1000 Gy (100 krad).
- T107-h cold treatment for *B. dorsalis*, *B. cucurbitae*, and *Conopomorpha sinensis* in longans: 33.8°F (0.99°C) or below for 17 days, or 34.5°F (1.38°C) or below for 20 days.
- T107-j cold treatment for *B. dorsalis* in longans: 33.8°F (0.99°C) or below for 15 days or 34.5°F (1.38°C) or below for 18 days.

PPQ recognizes the following quarantine treatments for *B. cucurbitae* and *B. dorsalis* in "fruits and vegetables":

- T105-b-1 irradiation for *B. dorsalis*: same dosage as for T105-a-6 (see above)
- T105-b-3 irradiation for *B. cucurbitae*: the minimum absorbed dose of gamma irradiation shall be 210 Gy (21 krad), but shall not exceed 1000 Gy (100 krad).

The above hot water immersion treatment for *B. dorsalis* in longan (T102-d-1) would likely mitigate *B. cucurbitae*; however, efficacy needs to be confirmed. Armstrong (1982) found that a 15-minute hot water treatment at 50^{o}C (122^{o}F) disinfested bananas of *B. cucurbitae*. Additional studies have shown the lethal effects of hot water immersion on eggs of *B. cucurbitae* in papaya (Liquido, 1990). PPQ recognizes heat treatments to mitigate this fruit fly species in other fruits and vegetables (*e.g*, high temperature forced air in citrus and papayas; vapor heat in pepper, eggplant, mango, papaya, and pineapple) (PPQ, 2006a); this provides further evidence of the fruit fly's susceptibility to high temperatures.

Methyl bromide fumigation, high temperature forced air, and vapor heat represent are possible options for research in mitigating *B. dorsalis* and *B. cucurbitae* in longan fruit. PPQ recognizes all three types of quarantine treatments for the control of these fruit fly species in other host commodities. PPQ recognizes fumigation with methyl bromide for the control of these fruit flies in avocado from Hawaii, Israel, and the Philippines (T101-c-1) (PPQ, 2006a). Examples of commodities for which PPQ recognizes high temperature forced air for the control of *B. dorsalis* include citrus, mountain papaya, papaya, and rambutan (PPQ, 2006a). Examples of commodities for which PPQ recognizes vapor heat for the control of *B. dorsalis* include bell pepper, eggplant, litchi, and rambutan (PPQ, 2006a).

2.5.2.2 Lepidopteran Insects

The internal lepidopteran species of concern are *Conogethes punctiferalis* (Lepidoptera: Pyralidae), *Cryptophlebia ombrodelta* (Lepidoptera: Tortricidae), *Deudorix epijarbas* (Lepidoptera: Lycaenidae), and *Conopomorpha sinensis* (Lepidoptera: Gracillariidae).

PPQ recognizes cold treatment (T107-h) as an effective quarantine treatment for *Conopomorpha* *sinensis* in longan. Additional research is necessary to confirm efficacy of any other type of quarantine treatment for *C. sinensis*.

PPQ does not have an approved quarantine treatments for the other lepidopteran insects in longan. Research is necessary to confirm the efficacy of quarantine treatments for these pest species. Cold treatment, methyl bromide, and hot water immersion represent possible options for research for at least some of the species. Cold treatment might be effective against *Cryptophlebia ombrodelta* in longans. Although PPQ does not list any approved quarantine treatments for this species, PPQ recognizes cold treatment (T107-e) for the related species, *Cryptophlebia leucotreta*, on apricot, citrus, nectarine, peach, and plum (PPQ, 2006a). PPQ also recognizes methyl bromide treatment (T203-k) for the related species, *Cryptophlebia illepida*, on Macadamia nuts (as seeds) (PPQ, 2006a). Follet and Sanxter (2001) report that hot water immersion quarantine treatment for fruit flies (49°C water for 20 minutes) should effectively disinfest longans of *C. ombrodelta*. PPQ recognizes cold treatment followed by methyl bromide (T109a) as a quarantine treatment for *Conogethes punctiferalis* on 'Fuji' apple from Japan and Korea (PPQ, 2005b).

There are no reports in the scientific literature of quarantine treatments for *Deudorix epijarbas* (or the genus *Deudorix*) on any host plant; as a result, research is necessary to determine an effective quarantine treatment or treatments for this species.

2.5.3 External Pests (thrips, scales, mites, *Adoxophyes orana*)

According to the PPQ Treatment Manual (PPQ, 2006a), PPQ does not recognize any quarantine treatments aimed at the specific external species of concern; however, PPQ does recognize methyl bromide as a quarantine treatment for surface pests, such as scale insects, thrips, and spider mites on "various commodities" (T104-a-1, T104-a-2) (PPQ, 2006a). For plant material not tolerant to fumigation, PPQ recognizes treatment T201-p-2, which involves hand removal of pests plus a malathion-carbaryl chemical dip (PPQ, 2006a). Also, as PPQ recognizes hot water immersion (T102-e) for mealybugs and other surface pests on limes (PPQ, 2006a), hot water immersion represents a research option for the external pests on longans.

See the following paragraphs for further information regarding possible areas of research for quarantine treatments.

2.5.3.1 Thrips: *Rhipiphorothrips cruentatus* (Thysanoptera: Thripidae)

The PPQ Treatment Manual (PPQ, 2006a) and various scientific literature do not indicate any specific quarantine treatments for the genus *Rhipiphorothrips*; however, based on data for other thrips species, possible areas of research for mitigating *R. cruentatus* include fumigation (methyl bromide or other pesticides), irradiation (below 400 Gy), hot water immersion, forced-air heat treatment, insecticidal dips, and ultrasound bath treatment.

As noted, PPQ recognizes methyl bromide treatment (T104-a-1) for surface pests, such as thrips, on various commodities (PPQ, 2005b). Multiple applications of 0.8% or 2.4% ethyl formate result in "complete control" of the western flower thrips (*Frankliniella occidentalis*) on strawberries (Simpson *et al.*, 2004). Preliminary data indicate that different post-harvest insecticidal controlled-atmosphere treatments provide significant control of *F. occidentalis* on grapes (Ahumada *et al.*, 1996). Malaren (1987) found that a post-harvest malathion dip of peaches and nectarines in New Zealand resulted in survival of less than 48 adult thrips per million adults, and only 21 live larvae per million fruit at harvest. Recommendations indicate that the use of methamidophos 60% SC at 1.5 g a.i./ha (as a post-harvest treatment) will positively control *F. occidentalis* on peaches, nectarines and table grapes in Chile (Gonzalez, 1995). Another recommendation indicated the use of acetaldehyde as a potential fumigant for post-harvest control of *F. occidentalis* on strawberries (Aharoni *et al.*, 1979).

In terms of irradiation, in one study, although *T. palmi* 2nd-instar larvae survived at a dose of 100 Gy, they were completely sterilized (Dohino *et al.*, 1996). Other studies show negative effects of irradiation below 300 Gy on thrips species. Pupation of the thrips species, *Frankliniella pallida*, was inhibited at a dose of 10 krad (Wit and Vrie, 1985). In another study with the yellow flower thrips, *Frankliniella schultzei*, an irradiation dose of 250 Gy caused non-emergence of eggs and pupae, failure of larval development, and sterility of adults (Yalemar *et al.*, 2001).

Jacqua and Etienne (1987) found that post-harvest treatment with hot water for 2 or 3 minutes at 50^{o}C, or for 7 minutes at 45^{o}C, eliminated *T. palmi* from under the calyx of eggplant fruit. Hot water immersion (49^{o}C for 20 minutes) of *Citrus latifolia* resulted in no surviving mealybugs or other arthropods, including thrips found externally or under the calyx (Gould and McGuire, 2000). Lay-Yee and Rose (1993) report that forced-air heat treatment for 10 hour-equivalents at 42^{o}C “controls” thrips on nectarines.

Finally, the ultrasound bath treatment can potentially serve as a post-harvest phytosanitation treatment against external pests, including thrips, on apples (Hansen, 2001).

2.5.3.2 Scale Insects

Scale insects of concern include *Aulacaspis tubercularis* (Hemiptera: Diaspididae), *Ceroplastes rubens* (Hemiptera: Coccidae), *Coccus discrepans* (Hemiptera: Coccidae), *Coccus formicarii* (Hemiptera: Coccidae), *Coccus viridis* (Hemiptera: Coccidae), *Drepanococcus chiton* (Hemiptera: Coccidae), *Fiorinia pinicola* (Hemiptera: Diaspididae), *Icerya seychellarum* (Hemiptera: Margarodidae), *Kerria lacca* (Hemiptera: Kerridae), *Kerria greeni* (Hemiptera: Kerridae), *Maconellicoccus hirsutus* (Hemiptera: Pseudococcidae), *Nipaecoccus viridis* (Hemiptera: Pseudococcidae), *Planococcus lilacinus* (Hemiptera: Pseudococcidae), *Planococcus minor* (Hemiptera: Pseudococcidae), *Pseudaonidia trilobitiformis* (Hemiptera: Diaspididae), *Pulvinaria taiwana* (Hemiptera: Coccidae), and *Thysanofiorinia nephelii* (Hemiptera: Diaspididae).

As noted, there are no PPQ-recognized quarantine treatments specifically aimed at these scale species or related species within these pest genera. Possible future research options for the mitigation of these scale insects include fumigation with methyl bromide, irradiation below 400 Gy, and hot water immersion.

PPQ recognizes the use of methyl bromide quarantine treatment for surface pests, such as scale insects on “various commodities” (T104-a-1, T104-a-2) (PPQ, 2006a). Additionally, PPQ recognizes methyl bromide treatment (T101-b-1-1) for mealybugs (Pseudococcidae) on litchi

(PPQ, 2006a).

Research suggests irradiation at a dose of 250 Gy can effectively control *Coccus viridis* (Hara *et al.*, 2002). The reported minimum dose of irradiation needed to ensure quarantine security against *M. hirsutus* is between 100 and 250 Gy (Jacobsen and Hara, 2003). After exposure to 100 Gy and 250 Gy, adults, the most resistant stage of *M. hirsutus*, produced eggs with 1.2% and 0% viability rates, respectively (Jacobsen and Hara, 2003). No information was found in the literature regarding the effect of irradiation on the other scale species of concern; however, adult species of *Planococcus citri*, which is in the same genus as *Planococcus minor*, irradiated with 40 Gy or higher, produced no offspring (Arthur and Wiendl, 1996). Other reports depict irradiation as being detrimental to other scale genera. For instance, irradiation at 200 Gy or higher sterilized twelve-day-old eggs and third-instar nymphs of *Pseudococcus comstocki* (Dohino *et al.*, 1997).

On propagative cuttings of *Gardenia jasminoides*, hot water immersion at 49°C for 10 minutes was 99.9% effective against *C. viridis* adults and crawlers, and 99.7% effective against nymphs (Hara *et al.*, 1994). Hara *et al.* (1994) concluded that hot water immersion can be used in a systems approach to obtain quarantine security for *C. viridis* on cape jasmine. Evidence suggests that hot water immersion might also mitigate other scale species of concern. In one study, hot water immersion of *Citrus latifolia* at 49^{o}C for 20 minutes resulted in no surviving mealybugs (or other arthropods) (Gould and McGuire, 2000). Hot water immersion is a potentially useful control method for the scale species, *Pseudococcus longispinus,* on persimmons (Lester *et al.*, 1995).

2.5.3.3 Mite: *Aceria litchii* (Prostigmata: Eriophyidae)
The PPQ Treatment Manual (PPQ, 2006a) and the scientific literature do not indicate any specific quarantine treatments for the genus *Aceria* (nor *Eriophyes*, which is the genus of *Aceria litchii*'s synonym, *Eriophyes litchii*).

Evidence indicates that possible research options for this mite include fumigation with methyl bromide, irradiation, and, less likely, hot water immersion. Methyl bromide treatment for 24 hours at 12.9, 9.0 and 7.7 mg/liter at 10, 20 and 30^{o}C, respectively, gave 100% mortality of the related species, *Aceria mangiferae*, on mango twigs (Nakhla *et al.*, 1991, 1993). Lammerink (1990) recommends methyl bromide fumigation at 32 g/m^3 for two hours at 21^{o}C to control the related species, *Aceria tulipae,* in stored garlic. As for irradiation, multiple authors have reported sterility in other mite species (*Tetranychus urticae*, *Tyrophagus putrescentiae, Rhyizoglyphus echinopus*) exposed to irradiation ranging from 260 to 350 Gy (Burditt, 1994). A 20-minute 49^{o}C hot water immersion treatment is effective against mealybugs and other arthropods, including mites, on *Citrus latifolia* (Gould and McGuire, 2000). However, the PPQ Treatment Manual (PPQ, 2006a) states that, for litchi from Hawaii, *Eriophyes litchii* [*Aceria litchii*] "would not be effectively eliminated by hot water immersion."

2.5.3.4 Lepidoptera: *Adoxophyes orana* (Lepidoptera: Tortricidae)
The PPQ Treatment Manual (PPQ, 2006a) and the scientific literature do not indicate any specific quarantine treatments for *Adoxophyes orana* (or the genus *Adoxophyes*) on any host plant. If a quarantine treatment is necessary for this pest species, research needs to be conducted

to determine an effective treatment or treatments.

Note: If using the irradiation treatment, as the objective is sterilization and not necessarily mortality, documentation of the dosage must accompany all irradiated shipments.

Note: The probit-9-level security afforded by a quarantine treatment may be overwhelmed by a large volume of infested fruit (Powell, 2003). For this reason, adoption of a particular quarantine treatment should be in conjunction with efforts to maintain pest populations in production zones below specified densities (*e.g.,* 0.01 fruit flies per trap per day; DeHaven, 2005), as would satisfy requirements for the establishment of areas of low pest prevalence (IPPC, 2005).

2.6 Port-of-entry Sampling and Inspection

Upon arrival in the United States, federal agricultural specialists should inspect consignments as provided in CFR319.56-6, with particular attention given to paperwork and seals on vehicles; this process helps ascertain that the chain of custody remained intact during shipment.

2.7 Limits on Distribution and Transit within the United States

In some instances, the importation of commodities that could harbor exotic pests may be authorized for shipment to certain locations (*e.g.,* Alaska or North Atlantic ports) or during a specific season (usually the one with the coldest temperatures). These additional measures limit the risk of exotic pest establishment. Taiwan harvests longan from June to October (Ball, 2003); therefore, longan fruit would probably be shipped to the United States during these months. Shortening the importation season could increase the level of protection.

III. Monitoring and Traceability

We recommend that operational arrangements include provisions for the following:

- Inspection, treatment, and other prescribed phytosanitary procedures performed in the field and/or packinghouse be subject to direct monitoring by APHIS personnel and qualified personnel of the Taiwanese NPPO to identify shortcomings or opportunities for program modifications, and ensure conformity with program requirements (IPPC, 2002b).
- A program for the formal recognition of approved production sites, including the specification of conditions for revoking approved status.
- Labeling requirements that identify the approved production site.

IV. Conclusions

There are multiple options available for mitigating quarantine pests of concern on Taiwanese longans. A combination of measures is more likely to prevent the pests from entering the United States than the use of a single measure. These combined measures include: orchard monitoring and management programs to achieve and maintain area pest freedom or low pest prevalence; packinghouse inspection and treatments; phytosanitary certification; quarantine treatments; maintenance of consignment security and traceability in transit; and port-of-entry inspection. Table 1 summarizes options for risk mitigation.

Table 1. Summary of Risk Mitigation Options for Longan, *Dimocarpus longan*, from Taiwan		
Measure(s)	**Pests**	**Efficacy**
Pest-free areas or places of production	All	Satisfies requirements for appropriate level of protection
Area of Low Pest Prevalence/Pest Suppression	All	Target or threshold population densities need to be established in consultation with APHIS; may not necessarily satisfy requirements for appropriate level of protection if used alone
Post-harvest and packinghouse procedures	External pests (*Rhipiphorothrips cruentatus*, scale insects, *Aceria litchii*, *Adoxophyes orana*)	Likely to substantially lower population levels, but research required to demonstrate efficacy
Irradiation combined with low pest prevalence	*Bactrocera dorsalis, B. cucurbitae*	**PPQ-recognized** quarantine treatment for longan (250 Gy); **PPQ-recognized** quarantine treatment (150 Gy) for all life stages on all regulated plant articles
	Cryptophlebia ombrodelta (except pupae and adults)	**PPQ-recognized** quarantine treatment (250 Gy) on all regulated plant articles
	All lepidopteran insects (except pupae and adults), all scale insects, *Rhipiphorothrips cruentatus*	**PPQ-recognized** generic dose (400 Gy) quarantine treatment on all regulated plant articles for all insect pests except for lepidopteran pupae and adults
	Aceria litchii	Research required to demonstrate efficacy
Cold treatment combined with low pest prevalence	*Bactrocera dorsalis, B. cucurbitae, Conopomorpha sinensis*	**PPQ-recognized** quarantine treatment for longan
	All other pests	Research required to demonstrate efficacy
Cold treatment followed by methyl bromide fumigation combined with low pest prevalence	All	Research required to demonstrate efficacy
Vapor heat treatment combined with low pest prevalence	All	Research required to demonstrate efficacy
Hot water immersion combined with low pest prevalence	*Bactrocera dorsalis*	**PPQ-recognized** quarantine treatment for longan
	All other pests	Research required to demonstrate efficacy

Table 1. Summary of Risk Mitigation Options for Longan, *Dimocarpus longan*, from Taiwan		
Measure(s)	**Pests**	**Efficacy**
High temperature forced air combined with low pest prevalence	All	Research required to demonstrate efficacy
Methyl bromide fumigation combined with low pest prevalence	External pests (scale insects, *Aceria litchii*, *Rhipiphorothrips cruentatus*)	**PPQ-recognized** quarantine treatment for various commodities
	All other pests	Research required to demonstrate efficacy
Hand removal plus a malathion-cabaryl chemical dip combined with low prevalence	External pests (scale insects, *Aceria litchii*, *Rhipiphorothrips cruentatus*)	**PPQ-recognized** quarantine treatment for various commodities not tolerant to fumigation
Other fumigation combined with low pest prevalence	All	Research required to demonstrate efficacy
Insecticidal dip combined with low pest prevalence	All	Research required to demonstrate efficacy
Ultrasound bath combined with low pest prevalence	All	Research required to demonstrate efficacy

This document does not purport to establish specific work plans or to evaluate the quality of a specific program or systems approach. It provides information regarding known mitigation measures. The specification and implementation of measures, as would be present in an operational work plan, is beyond the scope of this document.

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Appendix 3: Pest Risk of Armored Scale Insects (Hemiptera: Diaspididae)

Although the armored scales (*Aulacaspis tubercularis*, *Fiorinia pinicola*, *Pseudaonidia trilobitiformis*, *Thysanofiorinia nephelii*) scored a Medium rating, they have a low likelihood of introduction and establishment that could not be addressed using the current USDA *Guidelines* (APHIS, 2000). Even if the armored scales were able to follow the pathway of longan fruit from Taiwan, these scales would be highly unlikely to come in contact with host material and, therefore, to establish in the United States. This low likelihood of introduction and establishment is an important consideration when developing risk mitigations. The evidence to support our estimate of low likelihood follows.

- Scale insects (Coccoidea), including armored scales, may disperse great distances by wind (Greathead, 1990; Greathead, 1997; Gullan and Kosztarab, 1997). They do not have the capability for directed dispersal in this way, so long range dispersal would depend on the dispersal of large numbers of insects so that some may find suitable hosts. Insects arriving with commercial quality fruit represent such small populations that dispersal by air to a host would be very unlikely.

- The newly emerged first instar nymphs ("crawlers") of scale insects are capable of dispersing long distances by wind (Gullan and Kosztarab, 1997). For armored scales, "only crawlers and perhaps gravid females could contribute to dispersal of the species and to the colonization of new host plants" (Greathead, 1990). The crawler stage is the primary stage where upon dispersal is possible, because this is the only mobile stage besides the adult male (Greathead, 1990; Koteja, 1990). Although adult males are mobile, they cannot start new infestations by themselves (Greathead, 1990; Koteja, 1990). Based on this evidence, the spread of armored scales from infested plant materials for consumption can only occur if crawlers or adult females with eggs are present (Burger and Ulenberg, 1990), and spread from the gravid females likely would occur only if crawlers hatched from the females' eggs.

- Although crawlers may disperse long distances by wind (as explained above), and can theoretically walk a distance of up to 150 m, they "usually settle within several dozen cm of their birth site" (Koteja, 1990).

- The crawler stage of armored scale insects occurs for a relatively short time (Koteja, 1990); this stage is divided into four periods: 1) postnatal torpidity, which lasts a few minutes to several hours, depending on ecological factors; 2) dispersal phase; 3) feeding period; and 4) morphogenetic period (Koteja, 1990). Crawlers are mobile only during the dispersal phase, which lasts in general several hours to several days (Koteja, 1990). For example, in one study, the wandering time of *Aonidiella aurantii* lasted from 174 to 206 minutes (approximately 3 to 3.5 hours) (Greathead, 1990). Studies with *A. aurantii*, as well as other armored scale species, show that most crawlers will terminate wandering and settle on a host within 24 hours of emergence (Greathead, 1990). Due to the brevity of the crawler stage, the stage most capable of dispersal (as described above), the likelihood of establishment of armored scales via imported fruit for consumption further decreases.

- A USDA Agricultural Research Service expert working group assessed the risk of armored scales on fruit for consumption (Miller *et al.*, 1985). These authors concluded that, for several reasons, the probability of armored scales' establishment in a new region, by way of commercially shipped fruit for consumption, is relatively remote. These authors state that fruits are not the preferred feeding sites for most armored scales; therefore, these insects would be less likely to survive on fruits compared to leaves or twigs. Secondly, the sessile nature of armored scales and their inability to disperse long distances under their own powers severely limit their ability of coming into contact with potential hosts. Furthermore, for armored scales on imported commercial fruit to establish in a new area, many conditions must co-occur, which is highly unlikely. These conditions include 1) survival through harvest and post-harvest handling and transport; 2) survival of the rigors of the marketplace, as well as consumer storage, handling, and consumption; 3) presence of a susceptible host near infested fruit discarded by the consumer; 4) presence of crawlers on the discarded fruit (or the fruit stays viable long enough for crawlers to develop from a gravid female); and 5) successful colonization of the new host by the crawlers (Miller *et al.*, 1985).