United States Department of Agriculture
Animal and Plant Health Inspection Service
Plant Protection and Quarantine

# A Qualitative Pest Risk Analysis for the Importation of Fresh Unshu Orange Fruit (*Citrus reticulata* Blanco var. *unshu* Swingle) from the Republic of Korea into Alaska

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## Executive Summary

The export of fresh Unshu orange fruit (*Citrus reticulata* var. *unshui*), from the Republic of Korea (herein referred to as Korea) to the United States, was suspended in 2002 due to the increasing number of interceptions of *Xanthomonas axonopodis* pv. *citri* Vauterin *et al*. (Pseudomonadaceae), the causal agent of citrus canker. In late 2005, Korea made a request to APHIS to allow the shipment of Unshus to Alaska under different conditions. This pest risk analysis estimates the pest risk associated with importing fresh Unshu orange fruit from the Republic of Korea into the State of Alaska, including the risk associated with the possible unauthorized movement of some fruit from Alaska into other States.

A list of pests attacking Unshu oranges in Korea was compiled and a number of quarantine pests for the United States were identified. Two organisms, *Unaspis yanonensis* Kuwana (Homoptera: Diaspididae), and the bacterium, *Xanthomonas axonopodis* pv. *citri* Vauterin *et al*. (Pseudomonadaceae), causal organism of citrus canker, were determined to be quarantine pests with the potential to be introduced into the United States via fresh Unshu exports from Korea. *Unaspis yanonensis* is not known to occur in the United States. *Xanthomonas axonopodis* pv. *citri* is established in Florida but is under official control to prevent its spread to other areas of the United States[1].

The unmitigated Pest Risk Potential for *U. yanonensis*, and *X. axonopodis* pv. *citri*, was determined to be negligible for fruit imported into Alaska. Neither pest poses a threat to Alaska due to the inimical climate and the lack of host plants.

The unmitigated risk associated with the possible unauthorized movement of some fruit from Alaska to other areas of the United States was estimated to be slightly greater for both pests. There are small areas in the U.S. where the pests might establish (citrus growing regions), but the quantity of fruit that would move illegally into these areas would be expected to be quite small and the likelihood of establishment very low.

Korea has proposed to combine elements of the previous shipping program with the additional safeguard of limited movement to Alaska only. The proposed measures include: (1) the use of a field pest control program and cultural practices to reduce pests in the groves; (2) packing house selection (culling) to remove fruit with pests or disease symptoms; (3) a visual inspection of 2%

1 A recent APHIS risk analysis, "Evaluation of asymptomatic citrus fruit (*Citrus spp*.) as a pathway for the introduction of citrus canker disease (*Xanthomonas axonopodis* pv. *citri*)" (March 2006) concluded that asymptomatic, commercially produced citrus fruit that meets certain requirements described in the analysis is not epidemiologically significant as a pathway for the introduction of citrus canker. The analysis also concluded that even if infected fruit were to enter a canker-free area with susceptible hosts, the establishment of citrus canker via this pathway is highly unlikely. That analysis is being reviewed based on public comment and peer review, and additional analysis is ongoing to evaluate the potential movement of asymptomatic citrus to nonquarantined areas of the United States. Any regulatory action on that risk analysis is being handled independently of Korea's request to allow movement of Unshu oranges into Alaska.

of fruit in each shipment; (4) phytosanitary certification; (5) shipment safeguards (especially labeling); and (6) port of arrival inspection. The proposal does not include disinfectant wash which was included in the previous authorization for shipment to all States.

The measures proposed by Korea are designed to substantially reduce the likelihood of pests being present based on multiple visual inspections. APHIS has successfully operated similar programs of low risk for tropical fruit commodities into Alaska such as sand pears and apples from Japan, avocados from Mexico and sand pears from Korea.

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## I. Introduction

This risk assessment was conducted by the Plant Epidemiology and Risk Analysis Laboratory of the United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), to examine the risks associated with the importation of fresh Unshu orange fruit (*Citrus reticulata* Blanco var. *unshu* Swingle) from the Republic of Korea into Alaska, and the risk associated with the potential unauthorized movement of Unshu into other areas of the United States. Authority for APHIS to regulate the importation of citrus fruit from Korea is derived from the Plant Protection Act (2000) and Title 7 of the Code of Federal Regulations (CFR) Part 319, Subparts 28 and 56.

The International Plant Protection Convention (IPPC) provides standards for conducting pest risk analyses and the use of phytosanitary terms (IPPC, 2004a, b). The methods used to initiate, conduct, and report this analysis and the phytosanitary terms utilized are considered by APHIS to be consistent with these standards.

Pest risk analysis (PRA) includes risk assessment and risk management (IPPC, 2004b). PRA is the overall process of evaluating biological or other scientific and economic evidence in considering the regulatory status of a pest or regulated article, and the strength of any phytosanitary measures that may be implemented to reduce the risk (IPPC, 2004a, b).

Pest risk assessment evaluates the probability of the introduction and spread of a pest and the associated potential economic consequences (IPPC, 2004a, b). Pest risk management involves the process of identifying and evaluating options for reducing the risk of introduction of a quarantine pest (IPPC, 2004a, b) and is a key factor in decisionmaking regarding the import of a commodity or article which may provide a pathway for the introduction of harmful pests. In this document, the estimates of risk are expressed qualitatively (high, medium, or low), based on the criteria described in the document: Pathway-Initiated Pest Risk Assessment: Guidelines for Qualitative Assessments, Version 5.02 (PPQ, 2000).

## II. Risk Assessment

### A. Initiating Event

This commodity-based, pathway-initiated risk assessment evaluates the pest risks associated with the commercial importation of fresh Unshu orange fruit from Korea into Alaska and the potential unauthorized movement from Alaska into other areas of the United States. In 1994, PPQ assessed the risks posed by the proposed importation of fresh Unshu orange fruit from the Cheju Island production area of the Republic of Korea. After that review, the USDA approved the entry of fruit that met the requirements of 7 CFR § 319.28. Commercial shipments began in 1995. The U.S. market for Unshu oranges is small (around $1-2 million *per annum*).

### B. Current Status

During the Korean Unshu orange pre-clearance inspections of November, 2002, APHIS Preclearance Officers intercepted *Xanthomonas axonopodis* pv. *citri* Vauterin *et al*., causal organism of citrus canker, several times at various packinghouses in Korea. Each interception came from fruit that originated from different approved export groves. Due to these interceptions, monitoring activities were increased at the U.S. ports of entry. This increased

monitoring resulted in the detection of two additional citrus canker-infected fruit from different export groves.

In an effort to take the least trade restrictive action, a statistically-based sampling regime was implemented at the U.S. ports of entry as an emergency measure. When this measure was implemented, it was believed that the *X. axonopodis* pv. *citri* detections represented an isolated problem. Since the implementation of this inspection regime, infected fruit from at least two additional groves were intercepted. The National Plant Quarantine Service (NPQS) of Korea conducted investigations and concluded that some groves may have applied pest control treatments too late in the season. NPQS also acknowledged that some packinghouses commingled export fruit with fruit from non-approved groves. It became apparent that serious problems existed in the management of this program. Effective December 10, 2002, APHIS suspended the imports of Unshu oranges from Korea.

## C. Assessment of Weediness Potential

If the citrus species considered for import poses a risk as a weed pest (Table 1), then the pathway-initiated assessment is terminated and a pest-initiated assessment is conducted. The results of the weediness screening for *Citrus* spp. did not prompt a pest-initiated risk assessment.

**Table 1**. Weediness Potential of Korean unshu fruit.

| | |
|---|---|
| **Commodity:** *Citrus reticulata* Blanco var. *unshu* Swingle | |
| **Phase 1:** | Many species of *Citrus* are cultivated in the United States. |
| **Phase 2:** | The genus is not listed as a weed in: World's Worst Weeds (Holm *et al*., 1977), Geographical Atlas of World Weeds (Holm *et al*., 1979), World Weeds: Natural Histories and Distribution. (Holm *et al*., 1997), Report of the Technical Committee to Evaluate Noxious Weeds; Exotic Weeds for Federal Noxious Weed Act (Gunn and Ritchie, 1982), Economically Important Foreign Weeds (Reed, 1977), Weed Science Society of America list (WSSA, 1989). There are also no references indicating weediness in AGRICOLA, CAB, Biological Abstracts or AGRIS. |
| **Phase 3:** | *Citrus reticulata* var. *unshu* is prevalent in the United States and there is no indication of weediness, therefore the pathway risk assessment proceeds. |

## D. Pest Interceptions

The pest interceptions on *Citrus* spp. from the Republic of Korea from 1985 to 2006 are listed in Appendix A. During this time, there were 374 interceptions of quarantine pests on *Citrus* spp. from the Republic of Korea. These include: 170 interceptions of *X.axonopodis* pv. *citri* Vauterin *et al*. (= *X. campestris* pv. *citri* (Hasse) Dye) (Pseudomonadaceae); 46 interceptions of *Guignardia citricarpa* Kiely (Loculoascomycetes: Dothideales); 56 interceptions of *Parlatoria ziziphi* Lucas (Homoptera: Pseudococcidae); and 34 interceptions of *Unaspis yanonensis* Kuwana (Homoptera: Diaspididae).

## E. Prior Risk Assessments

In 1994, USDA approved entry of Unshu oranges from Korea, subject to the safeguards outlined in 7 CFR §319.28(b), into any area of the United States except: Arizona, California, Florida, Louisiana, Texas, American Samoa, Puerto Rico, Northern Mariana Islands and the United States Virgin Islands. The risk assessment conducted in support of this decision identified the following pests of quarantine significance: *U. yanonensis* Kuwana; *Conogethes punctiferalis* (Guenee); *Adoxophyes orana* Fischer von Roeslerstamm; *P. kraunhiae* Kuwana; *Frankliniella intonosa* Trybom; *Helicobasidium mompa* Tanaka; *Phyllosticta beltranii* Penz.; *X. campestris* pv. *citri* Dye [this is the older synonym of *X. axonopodis* pv. *citri*]; *Guignardia citricarpa* Kiely; *Haplothrips chinensis* Priesner; *Scirtothrips dorsalis* Hood; *Aculops pelekassi* (Keifer); and *Megalurothrips distalis* Karney. The 1994 assessment stated, "Permit entry of clean fruit subject to preclearance inspection and the safeguards [specified in an operational work plan]" Subsequent site visits by PPQ officials did not detect *G. citricarpa* on Cheju Island.

## F. Pests associated with *Citrus* spp. in the Republic of Korea

Pests associated with *Citrus* spp. in Korea are listed in Table 2. The list identifies: (1) the presence or absence of these pests in the United States, (2) the affected plant part or parts, (3) the quarantine status of the pests in the United States, (4) the likelihood of the pests following the import pathway and entering the United States and (5) pertinent citations for distributions and biologies of the pests. Based on the biological and geographic information, many organisms are eliminated from consideration as sources of phytosanitary risk on Korean Unshu oranges because they do not satisfy the geographic and regulatory criteria of a quarantine pest.

A quarantine pest is defined as, "A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled" (IPPC, 2004a). Reports of harmful organisms associated with the commodity plant species indicate the organism is a pest of potential economic importance. A pest is likely to be transported on Unshu oranges if it is present in Korea, is associated with Unshu oranges at the time of harvest, and is expected to remain alive and associated with the fruit throughout the harvesting, packing and shipping procedures. Quarantine pests likely to follow the pathway may be capable of establishment and spread within the United States if suitable ecological and climatic conditions and vectors exist (this includes protected areas such as greenhouses).

The pests in Table 2 include 193 arthropods, 3 bacteria, 29 fungi, 7 nematodes and 3 viruses; 45 of these pests were identified as having the potential to follow the pathway.

**Table 2.** Pests Associated with Citrus in Korea.

| Pest | Distribution | Plant part affected | Quarantine Pest | Follow Pathway | References |
|---|---|---|---|---|---|
| **ARTHROPODA** | | | | | |
| **ACARINA** | | | | | |
| **ERIOPHYIDAE** | | | | | |
| *Aculops pelekassi* (Keifer) | KR, US (FL) | Fruit, Leaf | No | Yes | Anon., 1990, 1998a; Denmark, 1962 |
| **TARSONEMIDAE** | | | | | |
| *Tarsonemus* sp. | KR | Fruit | Yes | Yes | PIN 309 |

| Pest | Distribution | Plant part affected | Quarantine Pest | Follow Pathway | References |
|---|---|---|---|---|---|
| **TETRANYCHIDAE** | | | | | |
| *Eotetranychus sexmaculatus* (Riley) | KR, US | Fruit, Leaf | No | Yes | Anon., 1998a; Baker and Tuttle, 1994 |
| *Panonychus citri* (McGregor) | KR, US | Fruit, Leaf, Stem/Trunk | No | Yes | Anon., 1990; CPC, 2001; Seizo, 1966 |
| *Tetranychus cinnabarinus* (Boisduval) | KR, US | Fruit, Leaf | No | Yes | Anon., 1990; Jeppson *et al*., 1975 |
| *Tetranychus hydrangea* Pritchard & Baker | KR, US | Fruit, Leaf, Stem/Trunk | No | Yes | Anon., 1998a; Navajas *et al*., 2001 |
| *Tetranychus urticae* (Koch) | KR, US | Fruit, Leaf, Stem/Trunk | No | Yes | Anon., 1994; CPC, 2001; Hill, 1983 |
| *Panonychus ulmi* (Koch) | KR, US | Fruit, Leaf | No | Yes | CPC, 2001; IIE, 1996 |
| **INSECTA** | | | | | |
| **COLEOPTERA** | | | | | |
| **ANTHRIBIDAE** | | | | | |
| *Araecerus fasciculatus* DeGeer | KR, US | Stem/Trunk | No | No | Anon., 1994; CPC, 2001; Shiraki, 1952 |
| **BUPRESTIDAE** | | | | | |
| *Chalcophora japonica* (Gory) | KR | Stem/Trunk | Yes | No | Lee *et al*., 1992 |
| *Chrysochroa fulgidissima* Schonherr | KR | Stem/Trunk | Yes | No | Anon., 1990; Shiraki, 1952 |
| **CANTHARIDAE** | | | | | |
| *Athemus suturellus* Motschulsky | KR | Flower | Yes | No | Anon., 1990; Shiraki, 1952 |
| **CERAMBYCIDAE** | | | | | |
| *Anoplophora chinensis* (Forster) | KR, US (HI) | Stem/Trunk | Yes | No | Duffy,1968 ; CPC, 1998 |
| *Anoplophora malasiaca* (Thompson) | KR | Stem/Trunk | Yes | No | Anon., 1990; CPC, 2001; Duffy 1968; EPPO, 1996; Seizo, 1966 |
| *Apriona germari* Hope | KR | Stem/Trunk | Yes | No | Anon., 1990; Duffy, 1968 |
| *Chlorophorus annularis* (F.) | KR | Stem/Trunk | Yes | No | Anon., 1990, 1997; Duffy, 1968; Shiraki, 1952 |
| *Mesosa myops* (Dalman) | KR | Stem/Trunk | Yes | No | Anon., 1990; Duffy, 1968 |
| *Pterolophia jugosa* (Bates) | KR | Stem/Trunk | Yes | No | Anon., 1986, 1997; Shiraki, 1952 |
| *Pterolophia zonata* Bates | KR | Stem/Trunk | Yes | No | Anon., 1986, 1997; Shiraki, 1952 |
| **CHRYSOMELIDAE** | | | | | |
| *Aulacophora femoralis* (Motschulsky) | KR | Leaf | Yes | No | Anon., 1990; Shiraki, 1952 |

| Pest | Distribution | Plant part affected | Quarantine Pest | Follow Pathway | References |
|---|---|---|---|---|---|
| *Aulacophora nigripennis* Motschulsky | KR | Leaf | Yes | No | Anon., 1990, 1997; Shiraki, 1952 |
| *Coptocephala flaviventre* (Motschulsky) | KR | Leaf | Yes | No | Anon., 1990 |
| *Longitarsus* sp. | KR | Fruit | Yes | Yes | PIN309 |
| *Physauchenia bifasciata* Jacoby | KR | Leaf | Yes | No | Anon., 1990 |
| **CURCULIONIDAE** | | | | | |
| *Mesalcidodes trifidus* (Pascoe) | KR | Root | Yes | No | Anon., 1998a; Anon., 1990; Shiraki, 1952 |
| *Scepticus insularis* Roelofs | KR | Leaf, Root | Yes | No | Anon., 1990, 1997, 1998b; Shiraki, 1952 |
| **DERMESTIDAE** | | | | | |
| *Anthrenus verbasi* (L.) | KR, US | Flower, Leaf | No | No | Anon., 1990; Metcalf and Metcalf, 1993 |
| **ELATERIDAE** | | | | | |
| *Agriotes sericeus* (Candeze) | KR | Root | Yes | No | Anon., 1997; ShirakI,1952 |
| *Agriotes sericeus* (Candeze) | KR | Root | Yes | No | Anon., 1997; ShirakI,1952 |
| *Cardiophorus vulgaris* Motschulsky | KR | Leaf, Root | Yes | No | Anon., 1997; Anon., 1990; Shiraki, 1952 |
| *Ectinus sericeus* Candeze | KR | Root | Yes | No | Anon., 1990 |
| *Melanotus annosus* Candeze | KR | Root | Yes | No | Anon., 1990, 1997; Shiraki, 1952 |
| *Melanotus legatus* Candeze | KR | Root | Yes | No | Anon., 1990 |
| *Paracardiophorus pullatus* (Candeze) | KR | Root | Yes | No | Anon., 1990 |
| **OEDEMERIDAE** | | | | | |
| *Xanthochroa waterhousei* Harold | KR | Flower, Leaf | Yes | No | Anon., 1990; Shiraki, 1952 |
| **SCARABAEIDAE** | | | | | |
| *Adoretus sinicus* Burmeister | KR | Flower, Leaf | Yes | No | Anon., 1990, 1997; Shiraki, 1952 |
| *Adoretus tenuimaculatus* Waterhouse | KR | Flower, Leaf | Yes | No | Anon., 1990, 1997 |
| *Anomala albopilosa* Hope | KR | Leaf, Root | Yes | No | Anon., 1990, 1997 |
| *Anomala cuprea* Hope | KR | Leaf, Root | Yes | No | Anon., 1990, 1997; Shiraki, 1952 |
| *Anomala daimiana* Harold | KR | Leaf, Root | Yes | No | Lee *et al*., 1992 |
| *Anomala orientalis* (Waterhouse) | KR, US | Leaf, Root | No | No | Anon., 1990; CPC, 2001 |
| *Anomala rufocuprea* Motschulsky | KR | Leaf, Root | Yes | No | Lee *et al*., 1992 |
| *Ectinohoplia obducta* Motschulsky | KR | Leaf, Root | Yes | No | Anon., 1990; Shiraki, 1952 |
| *Glycyphana fulvistemma* Motschulsky | KR | Leaf, Root | Yes | No | Anon., 1990, 1997; |

| Pest | Distribution | Plant part affected | Quarantine Pest | Follow Pathway | References |
|---|---|---|---|---|---|
| | | | | | Shiraki, 1952 |
| *Eucetonia pilifera* (Motschulsky) | KR | Leaf, Root | Yes | No | Anon., 1990 |
| *Maladera orientalis* Motschulsky | KR | Leaf, Root | Yes | No | Anon., 1997; Shiraki, 1952 |
| *Mimela flavilabris* Waterhouse | KR | Leaf, Root | Yes | No | Anon., 1990 |
| *Mimela testaceipes* Motschulsky | KR | Leaf, Root | Yes | No | Anon., 1990 |
| *Miridiva coreana* Mijima & Kinoshita | KR | Leaf, Root | Yes | No | Anon., 1990 |
| *Nipponovalgus angusticollis* Waterhouse | KR | Leaf, Root | Yes | No | Anon., 1990; Shiraki, 1952 |
| *Oxycetonia jucunda* Faldermann | KR | Leaf, Root | Yes | No | Anon., 1997; Clausen, 1931; Shiraki, 1952 |
| *Poecilophilides rusticola* (Burmeister) | KR | Leaf,Root | Yes | No | Lee *et al*., 1992 |
| *Protaetia brevitarsis* Lewis | KR | Leaf, Root | Yes | No | Anon., 1990; Shiraki, 1952 |
| *Protaetia orientalis* Gory & Percheron | KR | Leaf, Root | Yes | No | Anon., 1990 |
| **HETEROPTERA** | | | | | |
| **ALYDIDAE** | | | | | |
| *Megalotomus costalis* Stal | KR | Leaf | Yes | No | Anon., 1990, 1998a; Shiraki, 1952 |
| **COREIDAE** | | | | | |
| *Acanthocoris striicornis* (Scott) | KR | Fruit | Yes | No | Anon., 1998a |
| **PENTATOMIDAE** | | | | | |
| *Glaucias subpunctatus* Walker | KR | Fruit | Yes | No | Anon., 1998a; Anon., 1990 |
| *Halyomorpha halys* (Stal) | KR | Fruit | Yes | No | Anon., 1998a; Anon., 1997; Anon., 1990 |
| *Homalogonia obtusa* (Walker) | KR | Leaf | Yes | No | Lee *et al*., 1992 |
| *Nezara antennata* Scott | KR | Fruit | Yes | No | Anon., 1990, 1997, 1998a; PIN309; Shiraki, 1952 |
| *Nezara viridula* (L.) | KR, US | Fruit | No | No | Anon., 1990; Clausen, 1931; Henry and Froeschner, 1988 |
| *Plautia stali* Scott | KR | Fruit | Yes | No | Anon., 1990, 1997, 1998a; Shiraki, 1952 |
| **HOMOPTERA** | | | | | |
| **ADELGIDAE** | | | | | |
| *Adelges viridana* (Cholodkovsky) | KR | Leaf | Yes | No | Blackman and Eastop, 1994 |
| **ALEYRODIDAE** | | | | | |
| *Aleurocanthus spiniferus* (Quaintance) | KR, US (HI) | Leaf | Yes | No | Anon., 1990, 1997; PNKTO #14, 1982; Shiraki, 1952 |
| *Aleurolobus marlatti* Quaintance | KR | Leaf | Yes | No | PIN 309 |

| Pest | Distribution | Plant part affected | Quarantine Pest | Follow Pathway | References |
|---|---|---|---|---|---|
| *Dialeurodes citri* Ashmead | KR, US | Leaf | No | No | Anon., 1990; CPC, 2001; Syoziro *et al.*, 1965 |
| **APHIDIDAE** | | | | | |
| *Aphis craccivora* Koch | KR, US | Leaf | No | No | Anon., 1990; Stoetzel, 1994 |
| *Aphis citricola* van der Goot | KR, US | Leaf, Stem/Trunk | No | No | Anon., 1993; Blackman and Eastop, 1984; Metcalf and Metcalf, 1993 |
| *Aphis gossypii* Glover | KR, US | Leaf, Stem/Trunk | No | No | Anon., 1990; Blackman and Eastop, 1984 |
| *Aphis spiraecola* Patch | KR, US | Leaf, Stem/Trunk | No | No | Anon., 1990; Stoetzel, 1994 |
| *Aulacorthum magnoliae* Essi and Kuwana | KR | Leaf | Yes | No | Anon., 1990; Blackman and Eastop 1984; Syoziro *et al.*, 1965 |
| *Aulacorthum solani* (Kaltenbach) | KR, US | Leaf | No | No | Anon., 1990; Blackman and Eastop, 1984 |
| *Macrosiphum euphorbiae* (Thomas) | KR, US | Leaf | No | No | Anon., 1994; Blackman and Eastop, 1984; CIE, 1984; Stoetzel, 1994; Syoziro *et al*., 1965 |
| *Macrosiphum ibarae* Matsumura | KR | Leaf | Yes | No | Lee *et al*., 1992 |
| *Myzus persicae* (Sulzer) | KR, US | Leaf | No | No | Anon., 1990; Stoetzel, 1994 |
| *Tinocallis kahawaluckalami* (Kirkaldy) | KR, US | Leaf | No | No | Alverson and Allen, 1992; Anon., 1990 |
| *Tinocallis zelkowae* (Takahashi) | KR | Leaf | Yes | No | Anon., 1990 |
| *Toxoptera aurantii* (Boyer de Fonscolombe) | KR, US | Leaf, Stem/Trunk | No | No | Anon., 1994; CPC, 2001; Stoetzel, 1994 |
| *Toxoptera citricidus* Kirkaldy | KR, US (FL, PR) | Leaf, Stem/Trunk | Yes | No | Anon., 1990, 1997; Blackman and Eastop, 1984; CPC, 2001; Kranz *et al*., 1977; Stoetzel, 1994 |
| *Toxoptera odinae* van der Goot | KR | Leaf, Stem/Trunk | Yes | No | Anon., 1990, 1997; Blackman and Eastop, 1984 |
| **CERCOPIDAE** | | | | | |
| *Aphrophora intermedia* Uhler | KR | Leaf, Stem/Trunk | Yes | No | Anon., 1990, 1998b; Shiraki, 1952 |
| **CICADIDAE** | | | | | |
| *Chryptotympana dubia* (Haupt) | KR | Leaf | Yes | No | Anon., 1990 |

| Pest | Distribution | Plant part affected | Quarantine Pest | Follow Pathway | References |
|---|---|---|---|---|---|
| *Cryptotympana dubia* (Haupt) | KR | Leaf | Yes | No | Anon., 1990, 1997; Shiraki, 1952 |
| *Graptopsaltria nigrofuscata* (Motschulsky) | KR | Leaf | Yes | No | Anon., 1990, 1997; Shiraki, 1952 |
| *Meimuna mongolica* (Distant) | KR | Leaf | Yes | No | Anon., 1990 |
| *Meimuna opalifera* (Walker) | KR | Leaf | Yes | No | An, 2000 |
| *Platypeura kaempferi* (F.) | KR | Leaf | Yes | No | Anon., 1990, 1997; Shiraki, 1952 |
| **CICADELLIDAE** | | | | | |
| *Bothrogonia japonica* Ishihara | KR | Leaf, Stem/Trunk | Yes | No | Anon., 1990, 1997, 1998a |
| *Cicadella viridis* (L.) | KR | Leaf, Stem/Trunk | Yes | No | Anon., 1997, 1998a; Shiraki, 1952 |
| *Dictyophara patruelis* (Stal) | KR | Leaf, Stem/Trunk | Yes | No | Anon., 1998a |
| *Empoasca vitis* (Gothe) | KR | Leaf | Yes | No | Anon., 1990, 1997, 1998a; CPC, 2001 |
| *Epiacanthus stramineus* (Motschulsky) | KR | Leaf | Yes | No | Anon., 1990, 1998a |
| *Hishimonus sellatus* Uhler | KR | Leaf | Yes | No | Anon., 1990, 1998a |
| *Kolla atramentaria* (Motschulsky) | KR | Leaf, Stem/Trunk | Yes | No | Anon., 1990, 1998a; Syoziro *et al.*, 1965 |
| *Ledra auditura* Walker | KR | Leaf, tem/Trunk | Yes | No | Anon., 1990, 1998a |
| *Nephotettix cinctceps* (Uhler) | KR | Leaf | Yes | No | Anon., 1990, 1998a |
| *Recilia dorsalis* (Motschulsky) | KR | Leaf | Yes | No | Anon., 1990, 1997, 1998a |
| *Stroggylocephalus agretis* (Fallen) | KR | Leaf | Yes | No | Anon., 1990, 1998a |
| **COCCIDAE** | | | | | |
| *Ceroplastes ceriferus* (Fabricius) | KR, US | Leaf, Stem/Trunk | No | No | CPC, 2001; An, 2000 |
| *Ceroplastes floridensis* (Comstock) | KR, US | Leaf, Stem/Trunk | No | No | CIE, 1982; CPC, 2001; Shiraki, 1952 |
| *Ceroplastes japonicus* Green | KR | Leaf, Stem/Trunk | Yes | No | Anon., 1990, 1997; CPC, 2001 |
| *Ceroplastes pseudoceriferus* Green | KR | Leaf, Stem/Trunk | Yes | No | Anon., 1990, 1997; Syoziro *et al*., 1965 |
| *Ceroplastes rubens* Maskell | KR, US (FL) | Leaf, Stem/Trunk | Yes | No | Anon., 1990, 1997; Shiraki, 1952; Syoziro et al., 1965 |
| *Coccus hesperidum* L. | KR, US | Leaf, Stem/Trunk | No | No | Anon., 1990; Gill, 1988; Hill, 1983; Syoziro *et al.*, 1965 |
| *Parasaissetia nigra* (Neitner) | KR, US | Leaf | No | No | Anon., 1990 |
| *Parthenolecanium corni* (Bouche) | KR, US | Leaf | No | No | Ben-Dov, 1993; CPC, 2001 |

| Pest | Distribution | Plant part affected | Quarantine Pest | Follow Pathway | References |
|---|---|---|---|---|---|
| *Saissetia coffeae* (Signoret) | KR, US | Leaf, Stem/Trunk | No | No | Anon., 1990 ;CPC, 2001; Hamon and Williams, 1984; Hill, 1983 |
| *Takahashia japonica* Cockerell | KR | Leaf, Stem/Trunk | Yes | No | Anon., 1990, 1998a |
| **DELPHACIDAE** | | | | | |
| *Sogatella furcifera* (Horvath) | KR | Leaf | Yes | No | Anon., 1990, 1998a; CIE, 1980 |
| **DIASPIDIDAE** | | | | | |
| *Aonidiella citrina* Coquillete | KR, US | Fruit, Leaf | No | Yes | Anon., 1990; CPC, 2001; EPPO, 1996; Metcalf and Metcalf, 1993; Nakahara, 1982 |
| *Aspidiotus destructor* Signoret | KR, US | Leaf | No | No | Anon., 1990; Nakahara, 1982 |
| *Chrysomphalus aonidum* L. | KR, US | Fruit, Leaf | No | Yes | CPC, 2001; Nakahara, 1982 |
| *Chrysomphalus bifasciculatus* Ferris | KR, US | Fruit, Leaf | No | Yes | Anon., 1990; Shiraki, 1952; Syoziro *et al.*, 1965 |
| *Chrysomphalus dictyospermi* (Morgan) | KR, US | Fruit, Leaf | No | Yes | Anon., 1990; Nakahara, 1982 |
| *Hemiberlesia lataniae* (Signoret) | KR, US | Fruit, Leaf | No | Yes | Anon., 1990; Nakahara, 1982 |
| *Lepidosaphes gloveri* (Packard) | KR, US | Fruit, Leaf | No | Yes | Anon., 1990; Nakahara, 1982 |
| *Lepidosaphes ulmi* (L.) | KR, US | Fruit, Leaf | No | Yes | Anon., 1990; Nakahara, 1982 |
| *Lopholeucaspis japonica* Cockerell | KR, US | Fruit, Leaf | No | Yes | Anon., 1990; CPC, 2001; EPPO, 1996; Nakahara, 1982 |
| *Parlatoria pergandii* Comstock | KR, US | Fruit, Leaf | No | No | Anon., 1990; Nakahara, 1982; Syorizo *et al.*, 1965 |
| *Parlatoria proteus* (Curtis) | KR, US | Fruit, Leaf | No | Yes | Anon., 1990; Nakahara, 1982; Syoziro *et al.*, 1965 |
| *Parlatoria theae* Cockerell | KR, US | Fruit, Leaf | No | Yes | Anon., 1990; Nakahara, 1982 |
| *Parlatoria ziziphi* Lucas | KR, US (FL) | Fruit, Leaf | No | Yes | Anon., 1998b; Deckle, 1976; PIN309 |
| *Pinnaspis aspidistrae* Signoret | KR, US | Leaf | No | No | Anon., 1990; Nakahara, 1982; Shiraki, 1952 |
| *Pseudaonidia duplex* (Cockerell) | KR, US | Leaf | No | No | Anon., 1990; Nakahara, 1982; Shiraki, 1952 |

| Pest | Distribution | Plant part affected | Quarantine Pest | Follow Pathway | References |
|---|---|---|---|---|---|
| *Pseudaulacaspis pentagona* (Targioni & Tozzetti) | KR, US | Leaf | No | No | Anon., 1990; Nakahara, 1982 |
| *Quadraspidiotus perniciosus* Comstock | KR, US | Leaf | No | No | Anon., 1990; Metcalf and Metcalf, 1993; Nakahara, 1982 |
| *Unaspis euonymi* Comstock | KR, US | Fruit, Leaf, Stem/Trunk | No | Yes | Anon., 1990; Nakahara, 1982 |
| *Unaspis yanonensis* Kuwana | KR | Fruit, Leaf, Stem/Trunk | Yes | Yes | Anon., 1990, 1997; PIN 309; PNKTO #45, 1984 |
| **FLATIDAE** | | | | | |
| *Geisha distinctissima* Walker | KR | Leaf, Stem/Trunk | Yes | No | Anon., 1990, 1998a |
| **MARGARODIDAE** | | | | | |
| *Drosicha corpulenta* (Kuwana) | KR | Fruit, Leaf , Stem/Trunk | Yes | No | Anon., 1997, 1998a; Shiraki, 1952 |
| *Drosicha howardi* (Kuwana) | KR | Leaf | Yes | No | Anon., 1990; Shiraki, 1952 |
| *Icerya purchasi* Maskell | KR, US | Fruit, Leaf, Stem/Trunk | No | No | Anon., 1990; CPC, 2001; Syoziro *et al.*, 1965 |
| **MEENOPLIDAE** | | | | | |
| *Nisia atrovenosa* (Leithierry) | KR | Leaf | Yes | No | Anon., 1990, 1998a |
| **MEMBRACIDAE** | | | | | |
| *Gargara genistae* F. | KR, US | Leaf | No | No | Anon., 1990, 1997, 1998a; Cave and Lightfield, 1994; Shiraki, 1952 |
| *Machaerotypus sibricus* (Lethierry) | KR | Leaf | Yes | No | Anon., 1990, 1998a |
| *Orthobelus flavipes* Uhler | KR | Leaf, Stem/Trunk | Yes | No | Anon., 1990, 1998a; Syoziro *et al.*, 1965 |
| **PENTHIMIIDAE** | | | | | |
| *Penthimia nitida* Walker | KR | Leaf | Yes | No | Anon., 1990, 1998a |
| **PSEUDOCOCCIDAE** | | | | | |
| *Antonia crawii* Cockerell | KR | Leaf | Yes | No | Anon., 1990, 1998a |
| *Nipaecoccus nipae* (Maskell) | KR, US | Leaf, Stem/Trunk | No | No | Anon., 1994; CPC, 2001 |
| *Phenacoccus pergandei* Cockerell | KR | Leaf | Yes | No | Lee *et al*., 1992 |
| *Planococcus citri* (Risso) | KR, US | Leaf, Fruit, Stem/Trunk | No | Yes | Cave and Lightfield, 1994; CPC, 2001 |
| *Planococcus kraunhiae* (Kuwana) | KR, US (CA) | Leaf, Stem/Trunk, Fruit | No | Yes | Anon., 1990, 1997, 1998a; Ben-Dov, 1993; Shiraki, 1952 |
| *Pseudococcus* sp. | KR | Leaf, Fruit, Stem/Trunk | Yes | Yes | Anon., 1997 |
| *Pseudococcus comstocki* Kuwana | KR, US | Leaf, Fruit, | No | Yes | Anon., 1990; Shiraki, |

| Pest | Distribution | Plant part affected | Quarantine Pest | Follow Pathway | References |
|---|---|---|---|---|---|
| | | Stem/Trunk | | | 1952 |
| **RICANIIDAE** | | | | | |
| *Ricania japonica* Melichar | KR | Leaf, Stem/Trunk | Yes | No | Anon., 1990, 1997, 1998a |
| **HYMENOPTERA** | | | | | |
| **FORMICIDAE** | | | | | |
| *Formica japonica* Motschulsky | KR | Stem/Trunk | Yes | No | Anon., 1990; Syoziro *et al.*, 1965 |
| **VESPIDAE** | | | | | |
| *Vespa crabro* Smith | KR, US | Fruit | No | No | Anon., 1990 |
| *Vespa mandarina* Smith | KR | Fruit | Yes | No | Anon., 1990 |
| **LEPIDOPTERA** | | | | | |
| **ARCTIIDAE** | | | | | |
| *Amsacta lactinea* (Cramer) | KR | Leaf | Yes | No | Anon., 1990, 1997; Clausen, 1931; CPC, 2001 |
| *Hyphantria cunea* (Drury) | KR, US | Leaf | Yes | No | Anon., 1990; Nagalingam, 1981 |
| *Utetheisa pulchella* L. | KR | Leaf | Yes | No | PIN 309 |
| **GEOMETRIDAE** | | | | | |
| *Apochima juglansiaria* (Graeser) | KR | Leaf | Yes | No | Anon., 1990 |
| *Ascotis selenaria* (Denis & Schiffermuller) | KR | Leaf | Yes | No | Anon., 1990, 1997; Shiraki, 1952 |
| *Chariaspilates formosaria* (Eversmann) | KR | Leaf | Yes | No | Anon., 1997; Anon., 199l |
| *Ectropis bistortata* (Goetze) | KR | Leaf | Yes | No | Anon., 1990 |
| *Ectropis excellens* (Butler) | KR | Leaf | Yes | No | Anon., 1990 |
| *Hemithia aestivaria* Hubner | KR | Leaf | Yes | No | Anon., 1990, 1997; Shiraki, 1952 |
| *Ophthalmitis irrorataria* Bremer & Grey | KR | Leaf | Yes | No | Anon., 1990; Shiraki, 1952 |
| *Pylargosceles steganioides* (Butler) | KR | Leaf | Yes | No | Anon., 1990 |
| **GRACILARIIDAE** | | | | | |
| *Phyllocnistis citrella* Stainton | KR, US (FL, LA, TX) | Leaf | Yes | No | Anon., 1990, 1997; CPC, 2001; INKTO #65, 1958; Shiraki, 1952 |
| **HEPIALIDAE** | | | | | |
| *Endoclita excrescens* Butler | KR | Stem/Trunk | Yes | No | Lee *et al*., 1992 |
| **HESPERIIDAE** | | | | | |
| *Parnara guttata* Bremer & Grey | KR | Leaf | Yes | No | Anon., 1990, 1997; CPC, 2001 |
| **LASIOCAMPIDAE** | | | | | |
| *Dendrolimus spectabilis* (Butler) | KR | Leaf | Yes | No | Anon., 1990 |

| Pest | Distribution | Plant part affected | Quarantine Pest | Follow Pathway | References |
|---|---|---|---|---|---|
| **LIMACODIDAE** | | | | | |
| *Cnidocampa flavescens* Walker | KR, US | Leaf | No | No | Anon., 1990; Shiraki, 1952 |
| *Monema flavescens* Walker | KR | Leaf | Yes | No | Anon., 1990 |
| *Parasa consocia* (Walker) | KR | Leaf | Yes | No | Anon., 1990, 1997 |
| *Thosea sinensis coreana* Okano & Park | KR | Leaf | Yes | No | Anon., 1990, 1997; CPC, 2001 |
| **LYMANTRIIDAE** | | | | | |
| *Euproctis piperita* Oberthür | KR | Leaf | Yes | No | Lee *et al*., 1992 |
| *Euproctis pseudoconspersa* (Strand) | KR | Leaf | Yes | No | Anon., 1990 |
| *Euproctis pulverea* (Leech) | KR | Leaf | Yes | No | Anon., 1990, 1997; Shiraki, 1952 |
| *Euproctis similis* (Fuessly) | KR | Leaf | Yes | No | Anon., 1994, 1997; CIE, 1978 |
| *Latoia consocia* (Walker) | KR | Leaf | Yes | No | Lee *et al*., 1992 |
| *Latoia sinica* (Moore) | KR | Leaf | Yes | No | Lee *et al*., 1992 |
| *Lymantria dispar* L | KR, US | Leaf | Yes | No | Anon., 1994; Zhang, 1994 |
| **NOCTUIDAE** | | | | | |
| *Acronicta rumicis oriens* (Strand) | KR | Leaf | Yes | No | Anon., 1997 |
| *Agrotis segetum* (Schiffermuller) | KR | Leaf, Root, Stem/Trunk | Yes | No | Anon., 1994; IIE, 1987; INKTO #25, 1957 |
| *Agrypnus binodulus* Motschulsky | KR | Root | Yes | No | Anon., 1990, 1997; Shiraki, 1952 |
| *Agrotis ipsilon* (Hufnagel) | KR, US | Root, Stem/Trunk | No | No | Anon., 1994; Zhang, 1994 |
| *Amata germana* (Felder & Felder) | KR | Leaf | Yes | No | Anon., 1990, 1997; Shiraki, 1952 |
| *Anomis mesogona* (Walker) | KR | Fruit | Yes | No | Anon., 1990; Poole, 1989; Zhang, 1994 |
| *Apamea aquila* Donzel | KR | Leaf | Yes | No | Anon., 1990; Poole, 1989 |
| *Arcte coerulea* (Guenee) | KR | Fruit Piercing | Yes | No | Anon., 1990; Poole, 1989; Yoon and Lee 1974 |
| *Artena dotata* (F.) | KR | Fruit Piercing | Yes | No | Anon., 1990; Poole, 1989; Yoon and Lee, 1974 |
| *Autographa gamma* L. | KR | Leaf | Yes | No | Anon., 1997; PNKTO #75, 1986 |
| *Calyptera lata* (Butler) | KR | Fruit Piercing | Yes | No | Anon., 1990; Poole, 1989 |
| *Calyptera thalictri* (Borkhousen) | KR | Fruit Piercing | Yes | No | Anon., 1990; Poole, 1989 |
| *Chrysodeixis eriosoma* Doubleday | KR, US | Flower, | Yes | No | Anon., 1997 |

| Pest | Distribution | Plant part affected | Quarantine Pest | Follow Pathway | References |
|---|---|---|---|---|---|
| | (HI) | Leaf | | | |
| *Dysgonia arctotaenia* (Guenee) | KR | Fruit Piercing | Yes | No | Anon., 1990; Cave and Lightfield, 1994 |
| *Dysgonia maturata* (Walker) | KR | Fruit Piercing | Yes | No | Anon., 1990; Poole, 1989 |
| *Eudocema fullonia* (Clerck) | KR | Fruit | Yes | No | Anon., 1990, 1997; Poole, 1989; Shiraki, 1952 |
| *Eudocema tyrrannus* Guenee | KR | Fruit | Yes | No | Anon., 1990; Poole, 1989 |
| *Eudocima tyrannus amurensis* Staudinger | KR | Fruit Piercing | Yes | No | Anon., 1993; Zhang, 1994 |
| *Helicoverpa armigera* (Hubner) | KR | Fruit, Leaf | Yes | No | Anon., 1994, 1997; Avidov and Harpaz, 1969; CPC, 2001 |
| *Helicoverpa assulta assulta* Guenee | KR | Fruit, Leaf | Yes | No | Anon., 1997, 2000 |
| *Mamestra brassicae* L. | KR | Leaf | Yes | No | Anon., 1997 |
| *Ophiusa tirhaca* Cramer | KR | Fruit Piercing, Leaf, Stem/Trunk | Yes | No | CPC, 2001; Zhang, 1994 |
| *Oraesia emarginata* (F.) | KR | Fruit Piercing | Yes | No | Anon., 1990, 1997; CPC, 2001; Poole, 1989; Shiraki, 1952 |
| *Oraesia excavata* (Butler) | KR | Fruit Piercing | Yes | No | Anon., 1990, 1997; Clausen, 1931; CPC, 2001; Poole, 1989; Shiraki, 1952 |
| *Parallelia maturata* (Walker) | KR | Leaf | Yes | No | Anon., 1990, 1997 |
| *Parallelia arctotaenia* (Guenee) | KR | Leaf | Yes | No | Anon., 1990 |
| *Spodoptera exigua* (Hubner) | KR, US | Leaf | No | No | Anon., 1994; Kranz *et al*., 1977 |
| *Spodoptera litura* (F.) | KR | Leaf | Yes | No | Anon., 1990, 1997; CPC, 2001; PNKTO #24, 1982; Poole, 1989; Shiraki, 1952 |
| *Thyas juno* (Dalman) | KR | Fruit Piercing, Leaf | Yes | No | Anon., 1990; Clausen, 1931; Poole, 1989; Zhang, 1994 |
| *Xestia c-nigrum* (L.) | KR, US | Leaf | No | No | Anon., 1990; Poole, 1989 |
| **NOTODONTIDAE** | | | | | |
| *Phalera assimilis* Bremer & Grey | KR | Leaf | Yes | No | Lee *et al*., 1992 |
| **OECOPHORIDAE** | | | | | |
| *Psorosticha melanocrepida* Clarke | KR | Leaf | Yes | No | Anon., 1990, 1997, 1998a; Shiraki, 1952 |
| **PAPILIONIDAE** | | | | | |

| Pest | Distribution | Plant part affected | Quarantine Pest | Follow Pathway | References |
|---|---|---|---|---|---|
| *Papilio bianor* Cramer | KR | Leaf | Yes | No | Anon., 1990, 1997; Shiraki, 1952 |
| *Papilio maackii* Menetries | KR | Leaf | Yes | No | Anon., 1990, 1997; Shiraki, 1952 |
| *Papilio protenor* (Cramer) | KR | Leaf | Yes | No | Anon., 1990, 1997; Shiraki, 1952 |
| *Papilio xuthus* L. | KR | Leaf | Yes | No | Anon., 1990, 1997; CPC, 2001; Ebeling, 1959 |
| **PIERIDAE** | | | | | |
| *Aporia crataegi* L. | KR | Leaf | Yes | No | Anon., 1997; INKTO #149, 1962 |
| **PSYCHIDAE** | | | | | |
| *Bambalina* sp. | KR | Leaf | Yes | No | Lee *et al*., 1992 |
| **PYRALIDAE** | | | | | |
| *Cadra cautella* (Walker) | KR, US | Fruit, Leaf | No | No | Anon., 1994; Zhang,1994 |
| *Conogethes punctiferalis* (Guenee) | KR | Fruit | Yes | No | Anon., 1990, 1997, 1998a; INKTO #19, 1957 |
| *Glyphodes pyloalis* Walker | KR | Leaf | Yes | No | Anon., 1990, 1998a |
| **SATURNIIDAE** | | | | | |
| *Dictyoploca japonica* (Moore) | KR | Leaf | Yes | No | Lee *et al*., 1992 |
| *Samia cynthia walkeri* C & R Felder | KR | Leaf | Yes | No | Anon., 1990 |
| **SESIIDAE** | | | | | |
| *Synanthedon hector* Butler | KR | Leaf | Yes | No | Lee *et al*., 1992 |
| **TORTRICIDAE** | | | | | |
| *Adoxophyes orana* Fischer von Roeslerstamm | KR | Fruit, Leaf, Flower, Stem/Trunk | Yes | No | Anon., 19998a, 1990, 1997; Shiraki, 1952 |
| *Archips breviplicana* (Walsingham) | KR | Leaf | Yes | No | Anon., 1990, 1998a, 1997; Shiraki, 1952 |
| *Archips crataeganus* (Hubner) | KR | Leaf | Yes | No | Anon., 1990, 1998a |
| *Archips ingentana* Christopher | KR | Leaf | Yes | No | Anon., 1990, 1998a, 1997; Shiraki, 1952 |
| *Archips xylosteana* L. | KR | Leaf | Yes | No | Anon., 1990, 1997, 1998a; Shiraki, 1952 |
| *Homona magnanima* Diakonoff | KR | Leaf | Yes | No | Anon., 1998a; Anon., 1997; Anon., 1990 |
| **ORTHOPTE**RA | | | | | |
| **ACRIDIDAE** | | | | | |
| *Chondracris rosea* (De Geer) | KR | Leaf | Yes | No | Anon., 1994; CPC, 2001 |
| *Oxya chinensis formosana* Shiraki | KR | Leaf | Yes | No | Anon., 1990, 1997 |
| *Oxya japonica* Thunberg | KR | Leaf | Yes | No | Anon., 1990, 1997 |

| Pest | Distribution | Plant part affected | Quarantine Pest | Follow Pathway | References |
|---|---|---|---|---|---|
| **GRYLLOTALPIDAE** | | | | | |
| *Gryllotalpa africana* Palisot De Beauvois | KR | Leaf | Yes | No | Anon., 1997; CPC, 2001 |
| **PYROGOMORPHIDAE** | | | | | |
| *Atractomorpha bedeli* Bolivar | KR | Leaf | Yes | No | Anon., 1990, 1997; Shiraki, 1952; Syoziro *et al*., 1965 |
| **TETTIGONIIDAE** | | | | | |
| *Gampsocleis sedakovi abscura* Walker | KR | Leaf | Yes | No | Anon., 1993 |
| *Gompsocleis sedakovi obscura* (Walker) | KR | Leaf | Yes | No | Anon., 1990, 1998a |
| *Holochlora japonica* Brunner von Watten | KR | Leaf | Yes | No | Anon., 1990, 1997, 1998a; Shiraki, 1952 |
| **THYSANOPTERA** | | | | | |
| **PHLAEOTHRIPIDAE** | | | | | |
| *Haplothrips chinensis* Priesner | KR | Flower, Leaf, Stem/Trunk | Yes | No | Anon., 1998a; Anon., 1997; Anon., 1990; Shiraki, 1952 |
| **THRIPIDAE** | | | | | |
| *Frankliniella intonsa* Brybom | KR, US | Flower, Leaf | No | No | Anon., 1990, 1997; CPC, 2001 |
| *Heliothrips haemorrhoidalis* Bouche | KR, US | Leaf | No | No | Anon., 1990; Hill, 1983; Syoziro *et al.*, 1965 |
| *Megalurthrips distalis* Karny | KR | Flower, Leaf | Yes | No | Anon., 1990, 1997, 1998b |
| *Thrips hawaiiensis* (Morgan) | KR, US | Leaf | No | No | Anon., 1994; CPC, 2001 |
| *Thrips palmi* Karny | KR, US (FL, HI) | Fruit, Flower, Leaf | Yes | Yes | Anon., 1998b; CPC, 2001 |
| *Thrips setosus* Moultan | KR | Flower, Leaf | Yes | No | Anon., 1998b |
| **BACTERIA** | | | | | |
| *Rhizobium tumefaciens* (Smith & Townsend) Conn (Proteobacteria alpha subdivision: Rhizobiaceae) | KR, US | Whole Plant | No | No | Bradbury, 1986; Cave and Lightfield, 1994 |
| *Pseudomonas syringae* pv. *syringae* van Hall (Proteobacteria gamma subdivision: Pseudomonas group) | KR, US | Fruit, Leaf, Stem/Trunk | No | Yes | Bradbury, 1986; Cave and Lightfield, 1994 |
| *Xanthomonas axonopodis* pv. *citri* Vauterin *et al* (Proteobacteria gamma subdivision: Lysobacterales) | KR, US (FL) | Fruit, Leaf, Stem/Trunk | Yes | Yes | Anon., 1990, 1997, 1998b; PNKTO #27, 1983; PIN309 |
| **FUNGI** | | | | | |
| *Alternaria citri* Ellis & N. Pierce in Pierce[2] (Fungi Imperfecti: Hyphomycetes) | KR, US | Fruit | No | Yes | Anon., 1986, 1990, 1993, 1998b; Knorr, 1973; Reuther *et al.*, 1978; Timmer *et al.*, |

| Pest | Distribution | Plant part affected | Quarantine Pest | Follow Pathway | References |
|---|---|---|---|---|---|
| | | | | | 2000 |
| *Antennella citrina* Hara (Loculoascomycetes: Dothideales) | KR | Leaf | Yes | No | Anon., 1986 |
| *Ascochyta citri* Penz. (Fungi Imperfecti: Coelomycetes) | KR | Fruit, Leaf | Yes | Yes | PPQ Interception |
| *Ascochyta pisi* Lib. (Fungi Imperfecti: Coelomycetes) | KR, US | Fruit | No | Yes | CMI, 1985; Timmer *et al*., 2000 |
| *Aspergillus niger* Tiegh. (Fungi Imperfecti: Hyphomycetes) | KR, US | Fruit | No | Yes | Onions, 1966; Timmer *et al*., 2000 |
| *Botryosphaeria rhodina* (Cook) Arx (Loculoascomycetes: Dothideales) | KR, US | Fruit, Stem/Trunk | No | Yes | Anon., 1998b; Farr *et al*., 1989; Santacroce, 1993; Timmer *et al*., 2000 |
| *Botrytis cinerea* Pers. *ex* Fr. (Fungi Imperfecti: Hyphomycetes) | KR, US | Fruit | No | Yes | Anon., 1998b; Bai, 1977; Timmer *et al*., 2000 |
| *Capnodium tanakae* Shirai & Hara (Loculoascomycetes: Dothideales) | KR | Fruit, Leaf, Stem/Trunk | Yes | No | Anon., 1986, 1990 |
| *Capnophaeum fuliginodes* (Rehm) Yamamoto (Loculoascomycetes: Dothideales) | KR | Fruit | No | No | Anon., 1986; Cave and Lightfield, 1994 |
| *Chaetothyrium spinigerum* (Hohnel) Yamamoto (Loculoascomycetes: Dothideales) | KR | Leaf | Yes | No | Anon., 1986, 1990 |
| *Cladosporium* sp. (Fungi Imperfecti: Hyphomycetes) | KR | Fruit | Yes | Yes | PPQ Interception |
| *Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc. in Penz. (Fungi Imperfecti: Coelomycetes) | KR, US | Fruit | No | Yes | Anon., 1986, 1990, 1998b; Knorr, 1973; Timmer *et al*., 2000 |
| *Corticium rolfsii* Curzi (Basidiomycetes: Corticiaceae) | KR, US | Fruit | No | Yes | CMI, 1992; CMI, 1974 |
| *Diaporthe citri* F. A. Wolf (Pyrenomycetes: Diaporthales) | KR, US | Fruit | No | Yes | Anon., 1986, 1990, 1998b; Timmer *et al*., 2000 |
| *Elsinoë australis* Bit. & Jenkins (Loculoascomycetes: Dothideales) | KR | Fruit | Yes | Yes | PPQ Interception |
| *Elsinoë fawcetti* Bit. & Jenkins (Loculoascomycetes: Dothideales) | KR, US | Fruit | No | Yes | Anon., 1986, 1990, 1998b; CMI, 1986; Timmer *et al*., 2000 |
| *Elsinoë* sp. (Loculoascomycetes: Dothideales) | KR | Fruit | Yes | Yes | PIN309 |
| *Geotrichum citri-aurantii (*Feiraris) E. E. Butler (Fungi Imperfecti: Hyphomycetes) | KR, US | Fruit | No | Yes | Anon., 1998b; Farr *et al*., 1989 |
| *Guignardia citricarpa* Kiely (Loculoascomycetes: Dothideales) Anamorph: *Phoma citricarpa* McAlpine (Fungi Imperfecti: Coelomycetes) | KR | Fruit | Yes | Yes | CMI, 1990; CPC, 2001; PIN 309; Sutton and Waterston, 1966 |
| *Guignardia* sp. Anamorph: *Phoma citricarpa* McAlpine var. *mikan* Hara (Fungi Imperfecti: Coelomycetes) | KR, US | Fruit | No | Yes | Anon., 1990; CMI, 1990; CPC, 2001; PIN309 |

| Pest | Distribution | Plant part affected | Quarantine Pest | Follow Pathway | References |
|---|---|---|---|---|---|
| *Helicobasidium mompa* Tanaka (Basidiomycetes: Ceratobasidiaceae) | KR | Root, Stem/Trunk | Yes | No | Anon., 1986; Knorr, 1973 |
| *Macrophomina phaseolina* (Tassi) Goidanich (Fungi Imperfecti: Coelomycetes) | KR, US | Root | No | No | CPC, 2001; Farr *et al*., 1989; Knorr, 1973 |
| *Microsphaeropsis* sp. (Fungi Imperfecti: Coelomycetes) | KR | Fruit | Yes | Yes | PIN 309 |
| *Limacinia japonica* Hara (Loculoascomycetes: Dothideales) | KR | Fruit | Yes | No | Anon., 1990; Anon., 1986 |
| *Penicillium digitatum* Sacc. (Fungi Imperfecti: Hyphomycetes) | KR ,US | Fruit | No | Yes | Anon., 1998b |
| *Penicillium italicum* Wehmer (Fungi Imperfecti: Hyphomycetes) | KR, US | Fruit | No | Yes | Anon., 1998b; Bai, 1977; Hong *et al.*, 1991; Timmer *et al*., 2000 |
| *Phaeopeltis japonica* Yamamoto (Loculoascomycetes: Dothideales) | KR | Fruit | Yes | No | Anon., 1986, 1990 |
| *Phyllosticta beltranii* Penzig (Fungi Imperfecti: Coelomycetes) | KR | Leaf | Yes | No | Anon., 1986, 1990, 1998b; Knorr, 1973 |
| *Phyllosticta erratica* Ellis & Everh. (Fungi Imperfecti: Coelomycetes) | KR, US | Leaf | No | No | Anon., 1998b; Farr *et al*., 1989 |
| *Phytophthora citrophthora* (R.E. Sm. & E.H. Sm.) Leonian (Oomycetes: Pythiaceae) | KR, US | Fruit | No | Yes | Anon., 1986, 1990, 1998b; Timmer *et al*., 2000 |
| *Phytophthora nicotianae* Breda de Haan var. *parasitica* Dastur (G.M.Waterhouse) (Oomycetes: Pythiaceae ) | KR, US | Fruit | No | Yes | Anon., 1998b; Timmer *et al*., 2000 |
| *Rosellinia necatrix* Prill. (Ascomycetes: Xylariaceae) | KR, US | Root | No | No | CMI, 1987; Farr *et al*., 1989 |
| *Sclerotinia sclerotiorum* (Lib.) deBary (Ascomycetes: Sclerotiniaceae) | KR, US | Fruit | No | Yes | Bai, 1977; Reuther *et al*., 1978; Timmer *et al*., 2000 |
| **NEMATODA** | | | | | |
| **CRICONEMATIDAE** | | | | | |
| *Criconemoides informis* (Micoltzdy) | KR | Root | Yes | No | Anon., 1990; Anon., 1984 |
| *Hemicriconemoides mangiferae* Siddiqi | KR, US | Root | No | No | Anon., 1984; CPC, 2001 |
| **LONGIDORIDAE** | | | | | |
| *Xiphinema americanum* Cobb | KR, US | Root | No | No | Anon., 1984; CPC, 2001 |
| *Xiphinema insigne* Loos (Longidoridae) | KR | Root | Yes | No | CPC, 2001 |
| **PRATYLENCHIDAE** | | | | | |
| *Pratylenchus penetrans* (Cobb) Filipjev & Schuurmans Stekhoven | KR, US | Root | No | No | Anon., 1984; CPC, 2001 |
| **TRICHORDORIDAE** | | | | | |
| *Paratrichodorus porosus* (Allen) Siddiqi | KR, US | Root | No | No | Anon., 1984; CPC, 2001 |
| **TYLENCHIDAE** | | | | | |

| Pest | Distribution | Plant part affected | Quarantine Pest | Follow Pathway | References |
|---|---|---|---|---|---|
| *Tylenchulus semipenetrans* Cobb | KR, US | Root | No | No | Anon., 1990; Anon., 1984 |
| **VIRUSES** | | | | | |
| *Citrus tatter leaf virus* (Capillovirus) | KR, US (CA, FL) | Whole Plant | No | No | Brunt *et al.*, 1995; Cave and Lightfield, 1994; CPC, 2001; |
| *Citrus tristeza virus* (Closteroviridae: Closterovirus) | KR, US | Whole Plant | No | No | Anon., 1990; Brunt *et al*., 1995; CPC, 2001 |
| *Satsuma dwarf virus* (Bromoviridae: Nepovirus) | KR | Whole Plant | Yes | No | Anon., 1990; CPC, 2001 |
| **MOLLUSCA** | | | | | |
| **BRADYBAENIDAE** | | | | | |
| *Acusta despecta* (Grey) | KR | Whole Plant | Yes | No | An, 2000 |

[1]AZ-Arizona, CA-California, FL-Florida, HI-Hawaii, KR-Korea, PR-Puerto Rico, LA-Louisiana, TX-Texas, US-United States.

[2]*Alternaria* spp. cause four distinct diseases of citrus: Alternaria brown spot of mandarins, Alternaria leaf spot of rough lemon, post-harvest black rot of fruit, and mancha foliar de los citricos. The causal agent of Alternaria brown spot of mandarins, leaf spot of rough lemon and post-harvest rot was described originally as *A. citri* Ell. & Pierce. Recently, the pathogen that affects mandarins was designated *A. alternata* Fr. (Keissler) pv. *citri* Solel. And, ten new species were described among isolates pathogenic to mandarins and rough lemons. Timmer *et al.*, 2000.

## G. Quarantine Pests Likely to Follow the Pathway

The quarantine pests selected for further analysis are listed in Table 3.

**Table 3.** Quarantine Pests Selected for Further Analysis

| | |
|---|---|
| *Unaspis yanonensis* Kuwana | Homoptera: Diaspididae |
| *Xanthomonas axonopodis* pv. *citri* Vauterin *et al*. | Pseudomonadaceae |

Other quarantine pests not included in this listing have the potential to be harmful if introduced into the U.S. but are not likely to follow the import pathway. There were a variety of reasons for not subjecting them to further analysis, *e.g.*, the primary association of the pest may be with plant parts other than the part being exported; the pests may not be associated with the commodity during transport or processing because of their inherent mobility; sexually immature insect stages can be transported in a shipment but are unable to establish viable populations; the pests may be associated with the fruit as incidental contaminants but are not expected to be present in many shipments.

The biological hazard of organisms identified only to the order, family or the generic level is not often assessed because of the lack of biological information. Lack of species identification may indicate the limits of taxonomic or life-stage knowledge or the quality of the specimen submitted for identification. In this assessment, this applies to: *Cladosporium* sp.; *Elsinoë* sp.; *Longitarsus* sp.; *Microsphaeropsis* sp.; and *Tarsonemus* sp. (Appendix A).

By necessity, pest risk assessments focus mainly on the organisms for which biological information is available. The lack of biological information on any given pest insect, mite or

pathogen of a major crop suggests that this pest is of minor economic importance or does not present a high pest risk. Lack of information, however, cannot be taken as proof of this supposition. The lack of identification at the specific level does not rule out the possibility that a dangerous pest was intercepted or that it was not a quarantine pest. 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 be crafted that will eliminate the known organisms as well as similar, but incompletely identified organisms that mayinhabit the same niches.

Certain Noctuidae, (fruit piercing moths) attack fruit as adults (Banzinger, 1982). The following taxa of fruit piercing moths are not likely to follow the import pathway: *Anomis mesogona*, *Arcte coerulea*, *Artena dotata*, *Calyptera thalictri*, *Dysgonia arctotaenia*, *D. maturata*, *Eudocema tyrannus amurensis*, *Ophiusa tirhaca*, *Oraesia emarginata*, *O. excavata* and *Thyas juno*. A trip report (Redlin, 2002) stated that it was a standard practice to keep the packing house doors closed, and prohibit packing at night because the lights attract moths and other insects.

In addition, *Vespa mandarina*, (Hymenoptera: Vespidae), *Acanthocoris striicomis*, (Heteroptera: Coreidae) and *Glaucias subpunctatus*, *Halyomorpha halys* and *Plautia stali* (Heteroptera: Pentatomidae) will not remain with the fruit during harvest or packing and *Drosicha corpulenta* (Homoptera: Pseudococcidae) and *Helicoverpa assulta assulta* (Lepidoptera: Noctuidae) mainly attack parts other than the fruit.

There are no references to *C. reticulata* as a host for the yellow peach moth, *Conogethes punctiferalis*, (Lepidoptera: Pyralidae), however, *C. nobilis* is a secondary host (CPC, 2001; INKTO #19, 1957). The larvae of this moth are internal feeders in host fruit (CPC, 2001; INKTO #19, 1957; Sekiguchi, 1974) and have never been intercepted on *Citrus* spp. (PIN309). Other hosts include: *Averrhoa carambola*, *Carica papaya*, *Gossypium*, *Helianthus annuus*, *Macadamia ternifolia*, *Morus alba*, *Nephelium lappaceum*, *Prunus persica*, *Psidium guajava*, *Sorghum bicolor*, and *Zea mays* (CPC, 2001; INKTO #19, 1957). Based on the reported host range and the lack of interceptions on citrus, PPQ believes that it is unlikely that *C. punctiferalis* will follow the import pathway.

In 1995, one adult *Nezara antennata* (Heteroptera: Pentatomidae) was intercepted during a preclearance inspection (PIN309). The closely related *N. viridis* is controlled on fruit by normal packinghouse procedures (Dixon, 1995). So it is reasonable to assume that *N. antennata* would be controlled in a similar manner.

In the last 20 years, *Thrips palmi* (Thysanoptera: Thripidae) has spread from tropical to temperate Asia and has been introduced into the southern coastal areas of Korea (including Cheju Island), Australia, the Caribbean, and the United States (Florida and Hawaii) (Cho *et al*., 2000; Layland *et al*., 1994; Nakahara, 1984; Tsai *et al*., 1995; Kajita *et al*., 1996; Banks *et al*., 1996; FAO, 1990). This pest affects ornamentals and vegetables, and hosts include asters, chrysanthemums, cucurbits, ficus, cotton, orchids, members of the Solanaceae and some weeds (EPPO, 1997; Kawai, 1990; Martin and Mau, 1992; Vierbergen, 1995). It is listed as a citrus pest on fruit and leaves in Florida, but is controlled on fruit by normal packinghouse procedures (Dixon, 1995). There were no interceptions on any fruit commodities from Korea (PIN309),

despite being identified as a citrus pest in Korea (NPQS, 1998; Thaw, 1997). Additionally, this pest was not observed during a three-year survey (1996-98) on Cheju Island (NPQS, 1998). Based on the preceding evidence, *T. palmi* is unlikely to follow the pathway on imported Unshu oranges produced on Cheju Island.

Sooty mold fungi are generally considered minor leaf pathogens that grow superficially on plant tissue (Agrios, 1997). The four sooty molds identified as citrus pests in Korea are quarantine pests because they are not present in the United States: *Antenella citrina* (synonym: *Scorias citrina*), *Capnodium tanakae*, *Limacinia japonica* and *Phaeopeltis japonica*. It is unlikely that any of these fungi will follow the pathway because these fungi are likely to be washed off in packing house procedures.

The inclusion of *Ascochyta citri* and *E. australis* (Appendix A) are based on single interceptions of these fungi on citrus fruit in passenger baggage from Korea. Additional interceptions are expected if these fungi are prevalent. Neither fungus is further analyzed because these lone interceptions are considered anomalies.

*Guignardia citricarpa*, the causal agent of citrus black spot disease, is a quarantine pest (Sutton and Waterston, 1966). But the report of *G. citricarpa* does not mean that citrus black spot disease and its causal fungus are present (Timmer *et al*., 2000). The genus *Guignardia* includes species that are morphologically similar to, but physiologically and pathogenically different from *G. citricarpa* (McOnie, 1964). The endophyte *Guignardia* sp. causes symptomless infections in many plant species (McOnie, 1964). The presence of *Guignardia* sp. in citrus producing regions where citrus black spot disease does not occur led to confusion in the literature regarding the true distribution of *G. citricarpa*. The pest risk assessment conducted by PPQ in 1994 noted that Korean officials were unable to detect citrus black spot disease during several years of survey in the citrus growing areas on Cheju Island.

A list of *Citrus* pests submitted by the Republic of Korea (Anon., 1990) included *Phoma citricarpa* McAlpine var. *mikan* Hara as a causal agent of storage rot of citrus. *Phoma citricarpa* McAlpine is an anamorph of *G. citricarpa* (EPPO, 1997). The same situation was described in Japan, where a low percentage of stored Unshu fruit developed a decay caused by *G. citricarpa* var. *mikan* (anamorph: *P. citricarpa* var. *mikan*) (McOnie, 1967, pers. comm.). McOnie (pers. comm.) concluded that *G. citricarpa* var. *mikan* was actually the nonpathogenic strain of *G. citricarpa*, that small irregular marking on fruit, thought to be caused by *G. citricarpa* were due to mechanical or insect injury, and that the *G. citricarpa* isolated from those fruit was the nonpathogenic *Guignardia* sp. Based on this information, PPQ believes that the *Guignardia* present in the Republic of Korea is nonpathogenic. This concurs with reports of *G. citricarpa* in the Republic of Korea as being either doubtful or reports of the non-pathogenic *Guignardia* sp. (CPC, 2001; CMI, 1990). The non-pathogenic *Guignardia* was reported in Florida (Alfieri *et al*., 1994) and Texas (Okamura and Davis, 1987) and is not considered a quarantine pest.

## H. Consequences of Introduction - Movement into Alaska

The undesirable consequences that may occur from the introduction of quarantine pests are assessed within this section. For each quarantine pest, the Pest Risk Potential is calculated by summing the values for the Consequences of Introduction and the Likelihood of Introduction.

The major sources of uncertainty in this risk assessment are similar to those in other risk assessments. They include 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). 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 informs a rating. Sources of uncertainty in this analysis stem from the quality of the available biological information (Gallegos and Bonano, 1993), and the inherent, natural biological variation within a population of organisms (Morgan and Henrion, 1990).

The potential consequences are evaluated using the following five Risk Elements: Climate-Host Interaction, Host Range, Dispersal Potential, Economic Impact, and Environmental Impact. These risk elements reflect the biology, host range and climatic and geographic distribution of each pest, and are supported by biological information on each of the analyzed pests. For each risk element, pests are assigned a rating of Low (1 point), Medium (2 points), or High (3 points). The summation of the points for each risk rating is the cumulative value for the Consequences of Introduction (Table 4). A cumulative value of 5 to 8 points is considered Low risk, 9 to 12 points is Medium, and 13 to 15 points is considered High.

**Risk Element 1: Climate-Host Interaction**

This risk element considers ecological zonation and the interactions of quarantine pests with their biotic and abiotic environments. When introduced into new areas, pests are expected to behave as they do in their native areas if the potential host plants are present and the climates are similar. Broad availability of suitable climates and a wide distribution of suitable hosts are assumed to increase the impact of a pest introduction. The ratings for this risk element are based on the relative number of United States Plant Hardiness Zones (USDA, 1990) where the pest could establish.

**Risk Element 2: Host Range**

The risk posed by a plant pest depends on its ability to establish a viable, reproductive population and its potential to cause plant damage. This risk element assumes that the consequences of pest introduction are positively correlated with the pest's host range. Aggressiveness, virulence and pathogenicity also may be factors. The consequences are rated as a function of host range and consider the ability of a pest can attack a single species, multiple species within a genus, a single plant family, or multiple families.

**Risk Element 3: Dispersal**

After introduction, pests may disperse into new areas. The dispersal potential, expressed by aspects of the pest's reproductive potential, inherent mobility and dispersal facilitation, indicates the rapidity and range of the pest's potential economic and environmental impact. Criteria for rating the dispersal potential include: the presence of multiple generations per year or growing season, the relative number of offspring or propagules per generation, inherent capabilities for rapid movement, the presence of natural barriers or enemies, and dissemination enhanced by wind, water, vectors, or human assistance.

**Risk Element 4: Economic Impact**

Introduced pests cause a variety of direct and indirect economic impacts such as reduced yield,

reduced commodity value, loss of foreign or domestic markets, and non-crop impacts. Factors considered during the ranking process included: affect on fruit yield or quality, ability to cause plant mortality, ability to act as a disease vector, increased costs of production and pest control, ability to lower market prices, affect on market availability, increased research or extension costs and potential reduction in recreational land use or aesthetic value.

**Risk Element 5: Environmental Impact**
The ratings for this Element were based on three aspects: the potential interaction with species that are listed as Threatened or Endangered (50 CFR §§ 17.11-12); the potential for disrupting native plants based on the pest's habits within its current geographic range; and the initiation of chemical or biological control programs. The importation of these oranges is as a commodity for consumption. In the marketplace, commodities for consumption are often separated from ecosystems and generally the fruit is unlikely to be in contact with non-agroecosystems.

## *Unaspis yanonensis* Kuwana (Homoptera: Diaspididae)

**Risk Element 1: Climate-Host Interaction**
This predominately Asian species prefers warm temperate, Mediterranean, and tropical climates (CPC, 2001) which correspond to at least four Plant Hardiness Zones (NASS, 1997; NPQS, 1998; NRCS, 2001). However, due to the absence of suitable climates, *U. yanonensis* will be unable to establish in Alaska. Therefore, the rating for this Risk Element is Low (1).

**Risk Element 2: Host Range**
This insect is associated primarily with *Citrus*, *Fortunella* and *Poncirus* (Rutaceae), *Damnacanthus* (Rubiaceae) (PNKTO #45, 1984), *Camellia* (Theaceae) and *Dimocarpus* (Sapindaceae) (Li-zhong, 2000). However, none of these plants occur in Alaska. For this reason, the rating for the host range risk element is Low (1).

**Risk Element 3: Dispersal**
Due to the absence of suitable climates and lack of host material, this insect will be unable to establish in Alaska. Because of this lack of dispersal potential, the rating for this Risk Element is Low (1).

**Risk Element 4: Economic Impact**
Due to the absence of suitable climates and lack of host material, this insect will be unable to establish in Alaska and cause any negative economic impact. Therefore the rating for this Risk Element is Low (1).

**Risk Element 5: Environmental Impact**
None of the hosts for *U. yanonensis* corresponded to any genera on the Endangered Species List. Therefore, the rating for this Risk Element is Low (1).

## *Xanthomonas axonopodis* pv. *citri* Vauterin *et al.* (Proteobacteria: Lysobacterales)

**Risk Element 1: Climate-Host Interaction**
Citrus canker disease occurs in Asia, Africa, Central America, the Caribbean, South America, Oceania, and only the D-strain was reported in Mexico. In the United States, *X. axonopodis* pv. *citri* has the potential to establish in USDA Plant Hardiness Zones 8 to10 (USDA, 1990).

However, due to the lack of suitable climates, this bacterium will be unable to establish in Alaska. Therefore, the rating for this Risk Element is Low (1).

**Risk Element 2: Host Range**
Primary hosts of *X. axonopodis* pv. *citri* include: *Casimiroa*, *Citrus*, *Poncirus*, *Eremocitrus* and *Limonia* (Rutaceae) (CPC, 2001). Secondary hosts include: *Fortunella* (Rutaceae)(CPC, 2001). The following plants were also reported to be susceptible to *X. axonopodis* pv. *citri*, however, the original descriptions either were not confirmed or contradict those of other authors: *Aegle*, *Balsamocitrus*, *Feroniella*, *Toddalia* (Rutaceae) and *Matthiola* (Brassicaceae) (CPC, 2001). None of these plants occur in Alaska. Therefore, the rating for this Risk Element is Low (1).

**Risk Element 3: Dispersal**
Due to the absence of suitable climates and lack of host material, this bacterium sect will be unable to establish in Alaska. Because of this lack of dispersal potential, the rating for this Risk Element is Low (1).

**Risk Element 4: Economic Impact**
Due to the absence of suitable climates and lack of host material, this bacterium will be unable to establish in Alaska and and cause any negative economic impact. Therefore the rating for this Risk Element is Low (1).

**Risk Element 5: Environmental Impact**
None of the hosts for *X. axonopodis* pv. *citri* corresponded to any genera on the Endangered Species List. Therefore, the rating for this Risk Element is Low (1).

**Table 4:** Risk Ratings for the Consequences of Introduction.

| Pest | Climate/ Host | Host Range | Dispersal Potential | Economic Impact | Environmental Impact | Consequences of Introduction |
|---|---|---|---|---|---|---|
| *Unaspis yanonensis* | Low (1) | Low (1) | Low (1) | Low (1) | Low (1) | Low (5) |
| *Xanthomonas axonopodis* pv. *citri* | Low (1) | Low (1) | Low (1) | Low (1) | Low (1) | Low (5) |

## I. Likelihood of Introduction - Movement into Alaska.

The Likelihood of Introduction for a pest is rated relative to six factors (USDA, 2000). The assessment rates five of these areas based on the biological features exhibited by the pest's interaction with the commodity. These areas represent a series of independent events that must all take place before a pest outbreak occurs. The value for the Likelihood of Introduction is the sum of the ratings for the Quantity Imported Annually and these biologically based areas (Table 6). The scale is used to interpret this total is: Low (6-9 points), Medium (10-14 points) and High (15-18 points).

### Quantity Imported Annually

Korea's export of Unshu oranges to the United States began in 1995 and ended in 2002 (Table 5). The number of 40' containers fell within the range of 10 to 100 containers per year The rating would be Medium (2) for both of the pests based on the assumption that a similar volume would be exported to Alaska.

**Table 5.** Shipping Volumes of Korean Unshu fruit, 1995 - 2002.

| Year | Volume (metric tons) | Approx. no. of 40' containers |
|---|---|---|
| 1995 | 50 | 2.5 |
| 1996 | 220 | 11 |
| 1997 | 1,190 | 59.5 |
| 1998 | 40 | 2 |
| 1999 | 380 | 19 |
| 2000 | 240 | 12 |
| 2001 | 1,434 | 71.7 |
| 2002 | 1,601 | 80 |

### Survive Postharvest Treatment

Standard postharvest treatments include culling and washing. It is doubtful that these practices directly kill *U. yanonensis* or *X. axonopodis* pv. *citri*. Based on these practices, the rating for both pests is High (3).

### Survive Shipment

This sub-element evaluates the mortality of the pest population during shipment of the commodity. Shipments of Unshus are likely to be refrigerated and spend less than 20 days in transit to the United States (Jennifer Lemly, pers. comm.). *Unaspis yanonensis* can survive refrigeration, but may be killed by exposure to sub-freezing temperatures if they exceed a specie specific duration (CPC, 2001; Lee and Denlinger, 1991; McKenzie, 1967; PNKTO #44, 1984; PNKTO #45, 1984; Rosen, 1990). , *Unaspis yanonensis* was intercepted 23 times on citrus from Korea between 1985 and 2006. These interceptions came from passenger baggage and ship's quarters, not from cargo (PIN309). Based on this evidence, it is likely that some insects on fruit may survive shipment and thus the rating for this Risk Element is Medium (2).

The pathogen, *X. axonopodis* pv. *citri*, is a relatively labile bacterium (Civerolo, 1995). It is generally believed that bacterial populations decline rapidly even within lesions of infected fruit after harvest (Civerolo, 1981; USDA, 1985). The extended drying period during shipping causes mortality of superficial populations of the bacterium, thus, the epidemiological significance of the surviving bacteria is questionable (Schubert *et al*., 1998). Viable bacteria have been re-isolated from infected citrus tissues even after several months under dry conditions (Graham *et al*., 1987; Koziumi, 1972). However, Timmer *et al.* (1996) found that although epiphytic *X. axonopodis* pv. *citri* were detected on asymptomatic plants, the occurrence of epiphytic populations was not related to subsequent appearance of symptoms, and evidence indicates that this organism is highly unlikely to persist on hosts or non-hosts in the absence of symptoms for long periods.

Although an occasional fruit with symptoms of citrus canker may escape detection, normal industry practices for commercial exports would exclude fruit with blemishes, including citrus canker lesions. This substantially reduces the potential for survival of the pathogen since epiphytic contamination is short-lived. Due to these reasons, the rating is Low (1).

**Not Detected at the Port of Arrival**

*U. yanonensis* is rated Medium (2) because careful inspection for the mobile stages of this insect can detect it despite its small size (Rosen, 1990). The high number of interceptions of this pest from many countries and commodities confirms that inspectors can find them. *Unaspis yanonensis* was detected in surveys by the [Korean] National Institute of Agricultural Science and Technology during 1996–1998, but was categorized as a “very minor pest” in commercial Unshu orange groves and only partially occurs in groves that are “not managed” (An, 2000).

Trained inspectors can readily detect symptomatic canker diseased fruit by the necrotic lesions on the rind (EPPO, 1997; Schubert *et al.*, 2001; Timmer *et al*., 2000). These bacteria may remain viable in citrus tissue after several months under dry conditions (Graham *et al*., 1987; Koziumi, 1972). Shorter-lived epiphytic bacterial populations however cannot be detected by visual examination. This pathogen was intercepted numerous times on citrus fruit, (Appendix A). For these reasons, the rating is Medium (2).

**Moved to a Suitable Habitat**

This sub-element considers the geographic location of likely markets and the chance of the commodity moving to locations suitable for the pest’s survival. Fruit that arrives in the United States does not normally arrive at a single port, but is distributed according to market demand. Restricting the distribution of commodities reduces the likelihood that any associated pests can reach a suitable habitat. Since 1995, an estimated 24 million Korean Unshu oranges have been shipped to the United States. In that time, there was only one PPQ interception of an Unshu orange shipment from Korea being sent into a citrus producing State (Schwartz, 2002). This was an accidental redirection of an air shipment; resolved by re-exportation to a non-citrus producing state (Schwartz, 2002). The proposed export program would move the fruit only into Alaska, an unsuitable habitat for either organism to survive. For this reason, the rating for *U. yanonensis* and *X. axonopodis* pv. *citri* is Low (1).

### Contact with Host Material

The proposed export program would restrict the distribution of fruit to Alaska. Lack of suitable hosts and climates restricts the opportunities for pests to establish populations. While passive factors such as wind, water, or animals may aid in the dispersal of certain stages of pests (Kosztarab and Kozar, 1988; Rosen, 1990), the opportunity for these mechanisms of dispersal is decreased by the proposed program because of the absence of host plants and inimical climate. In addition, fruit exposed to, but asymptomatic for *X. axonopodis* pv. *citri*, is unlikely to have sufficient level(s) of viable bacteria to cause infection (Civerolo, 2002). For these reasons, the ratings for both pests is Low (1).

**Table 6.** Ratings for the Likelihood of Introduction for Movement into Alaska.

| Pest | Quantity Imported Annually | Pest Survival Potential | | | | | Likelihood of Introduction |
|---|---|---|---|---|---|---|---|
| | | Survive Postharvest Treatment | Survive Shipment | Not Detected at the Port of Entry | Move to Suitable Habitat | Contact with Host Material | |
| *Unaspis yanonensis* | Medium (2) | High (3) | Medium (2) | Medium (2) | Low (1) | Low (1) | Medium (11) |
| *Xanthomonas axonopodis* pv. *citri* | Medium (2) | High (3) | Low (1) | Medium (2) | Low (1) | Low (1) | Medium (10) |

## J. Pest Risk Potential for Movement into Alaska

The sum of the values for the Consequences of Introduction and the Likelihood of Introduction produce the Baseline Pest Risk Potential (PRP) value. This cumulative total expresses the risk on the following scale: Low (11-18 points), Medium (19-26 points), and High (27-33 points). The Baseline PRP for each quarantine pest is summarized in Table 7.

Pests with a Low Baseline PRP value typically do not require mitigation measures other than port of arrival inspection, while a value within the Medium or High ranges indicates that specific phytosanitary measures, supplemental to port of arrival inspection, are necessary. The Baseline PRP values for *U. yanonensis* and *X. axonopodis* pv. *citri* are Low.

**Table 7.** Pest Risk Potential for Movement into Alaska

| Pest | Consequences of Introduction | Likelihood of Introduction | Pest Risk Potential |
|---|---|---|---|
| *Unaspis yanonensis* | Low (5) | Medium (10) | Low (15) |
| *Xanthomonas axonopodis* pv. *citri* | Low (5) | Medium (10) | Low (15) |

In this case, the pests of concern are clearly not a risk to Alaska because the climate and lack of suitable hosts make it impossible for them to establish even if introduced. The Low rating is more appropriately characterized as negligible.

## K. Consequences of Introduction - Movement from Alaska into other Areas of the U.S.

If shipments of Korean Unshus are imported into Alaska, there is a potential for some of these fruit to move out of Alaska via smuggling, passenger baggage, *etc*. APHIS, PPQ has had good results with similar programs limiting the importation of fruits from tropical regions of Asia and Mexico to Alaska for consumption. None of these programs has ever been linked to the outbreak of a quarantine pest (Cave and Lightfield, 1994). Because the potential exists for movement of Unshus out of Alaska, the two pests of concern were analyzed for their potential to become introduced in other areas of the United States. The summation of the points for each risk rating for the Consequences of Introduction is summarized in Table 8.

## *Unaspis yanonensis* Kuwana (Homoptera: Diaspididae)

**Risk Element 1: Climate-Host Interaction**
This species prefers warm temperate, Mediterranean, and tropical climates (CPC, 2001) which correspond to at least four Plant Hardiness Zones (NASS, 1997; NPQS, 1998; NRCS, 2001). Host plants grow in North America, in Plant Hardiness Zones 5 to 10 (USDA, 1990). For these reasons, the rating is High (3).

**Risk Element 2: Host Range**
This insect is associated primarily with *Citrus*, *Fortunella* and *Poncirus* (Rutaceae), *Damnacanthus* (Rubiaceae) (PNKTO #45, 1984), *Camellia* (Theaceae) and *Dimocarpus* (Sapindaceae) (Li-zhong, 2000). The host range of this pest suggests that establishment in non-agronomic ecosystems may be limited if this pest is introduced into the continental United States (Li-zhong, 2000; PNKTO #45, 1984). However, the host plants of this insect are economically important in the U.S. For this reason, the rating for the host range risk element is High (3).

**Risk Element 3: Dispersal**
This pest has up to three generations per year in Japan (Clausen, 1931; PNKTO #45, 1984) and females may lay up to 200 eggs (Miller, 1985). First instar crawlers may settle on the host shortly after hatching (PNKTO #45, 1984), or disperse by wind or other means (Rosen, 1990; Stehr, 1991). Because of this high reproductive rate and wind-aided dispersal, this pest is rated High (3).

**Risk Element 4: Economic Impact**
Feeding by this pest can severely distort the fruit resulting in rejection of the fruit from markets, inhibit plant growth which causes the death of small trees (Clausen, 1927; CPC, 2001; PNKTO #45, 1984), can lower the yield and value of agricultural commodities and cause damage serious enough to require the use of pesticides for control (PNKTO #45, 1984). During 2004-2005, the value of commercial citrus production in the four largest citrus producing States as was follows: Arizona ($38,276,000), California ($1,131,851,000), Florida ($1,130,444,000) and Texas ($88,684,000) (NASS, 2005). Because of the potentially large negative economic impact that could be caused by this insect, the rating for this Risk Element is High (3).

**Risk Element 5: Environmental Impact**
None of the hosts for *Unaspis yanonensis* corresponded to any genera on the Endangered Species List. Therefore, the rating for this Risk Element is Low (1).

## *Xanthomonas axonopodis* pv. *citri* Vauterin *et al.* (Proteobacteria: Lysobacterales)

**Risk Element 1: Climate-Host Interaction**

*Xanthomonas axonopodis* pv. *citri* occurs in Asia, Africa, Central America, the Caribbean, South America, Oceania, and only the D-strain was reported in Mexico. In the United States, *X. axonopodis* pv. *citri* has the potential to establish in Plant Hardiness Zones 8 to10 (USDA, 1990). This bacterium naturally infects green citrus tissues (stems, fruit, and leaves) in the later stages of growth or tissue expansion, and wounds from mechanical damage and insect feeding can cause mature tissues to become infected (Schubert *et al*., 2001). Additionally, in Florida, a well managed citrus tree will undergo three to five growth flushes every growing season, each accompanied by a period of susceptibility (Schubert *et al*., 2001). This combination of naturally susceptible tissue and wounded tissue means that canker infection can occur year-round. For these reasons, the rating is Medium (2).

**Risk Element 2: Host Range**

Primary hosts of *X. axonopodis* pv. *citri* include: *Casimiroa edulis*, *Citrus aurantium*, *C. maxima*, *C. hystrix*, *C. limetta*, *C. limon*, *C. medica*, *C. madurensis*, *C. natsudaidai*, *Citrus x paradisi*, *C. reticulata*, *C. reticulata x Poncirus trifoliata*, *C. sinensis*, *C. sunki*, *C. unshiu*, *Eremocitrus glauca*, *Limonia acidissima*, *Poncirus trifoliata*, *C. aurantiifolia*, *C. tankan*, *C. junos* and *C. reshni* (CPC, 2001). Secondary hosts include: *Fortunella japonica* and *F. margarita* (CPC, 2001). There are no native members of these genera within the continental United States (NRCS, 2001; Wunderlin, 2001). The following plants were also reported to be susceptible to *X. axonopodis* pv. *citri*, however, the original descriptions either were not confirmed or contradict those of other authors: *Aegle malmelos*, *Balsamocitrus paniculata*, *Feroniella obligata*, *Matthiola incana* var. *annua*, and *Toddalia asiatica* (CPC, 2001), and only the possibility of an extension of a host range may be inferred (Cave, 2000). However, the confirmed hosts of *X. axonopodis* pv. *citri* are members of a single plant family (Mabberly, 1998). For these reasons, the rating is Medium (2).

**Risk Element 3: Dispersal**

The documented evidence indicates that the primary modes for long distance dispersal of *X. axonopodis* pv. *citri* are the movement of infected or infested plant material, movement of inoculum on personnel, clothing or equipment and weather events such as thunderstorms and tropical storms (Gottwald *et al*., 2001; Schubert *et al*., 1998). The latter are responsible for dispersal of the bacteria from a few hundred meters to several miles (Stall *et al*., 1980; Civerolo, 1981; Gottwald *et al*. 1992, 1997). Outbreaks of citrus canker have never been directly attributed to infested commercial shipments of citrus fruit (EPPO, 1997; Timmer *et al*., 2000).

Within a tree, this bacterium is disseminated by rainwater running over the surfaces of lesions and splashing onto uninfected, unprotected shoots. The concentration of bacteria is largely dependent on the age of the lesions with a maximum of 100 million–1000 million cells/drop (CPC, 2001) or about $10^5$ to $10^6$ colony forming units (cfu) per ml in rainwater (Stall, 1980). The effective inoculum dose is estimated at somewhere between $10^2$ and $10^3$ cfu per ml (Schubert *et al*., 1998). Based on this evidence, the rating for this pest is High (3).

**Risk Element 4: Economic Impact**

Citrus canker, under favorable conditions, causes defoliation, shoot dieback, and fruit drop (Timmer *et al*., 2000). Development and maturity may be delayed by several years in severely infected, young trees (CPC, 2001). Although the internal quality of maturing fruit is not affected, fresh fruit with lesions is reduced in market value (EPPO, 1997; Timmer *et al*., 2000). The disease is most serious in areas with temperatures between 14-38 C and rainfall greater than 1,000 mm per year) (EPPO, 1997). This bacterium is considered a quarantine pest by EPPO, NAPPO and most citrus producing countries (EPPO, 1997). The costs associated with eradication or management of the disease combined with the loss of export markets due to domestic and international quarantine would be expected to have a substantial economic impact. Based on this, the rating for this Risk Element is High (3).

**Risk Element 5: Environmental Impact**
None of the hosts for *X. axonopodis* pv. *citri* corresponded to any genera on the Endangered Species List. Therefore, the rating for this Risk Element is Low (1).

**Table 8**. Risk Ratings for the Consequences of Introduction - Movement From Alaska

| Pest | Climate/ Host | Host Range | Dispersal Potential | Economic Impact | Environmental Impact | Consequences of Introduction |
|---|---|---|---|---|---|---|
| *Unaspis yanonensis* | High (3) | High (3) | High (3) | High (3) | Low (1) | High (13) |
| *Xanthomonas axonopodis pv. citri* | Medium (2) | Medium (2) | High (3) | High (3) | Low (1) | Medium (11) |

## L. Likelihood of Introduction - Movement from Alaska into Other Areas of the U.S.

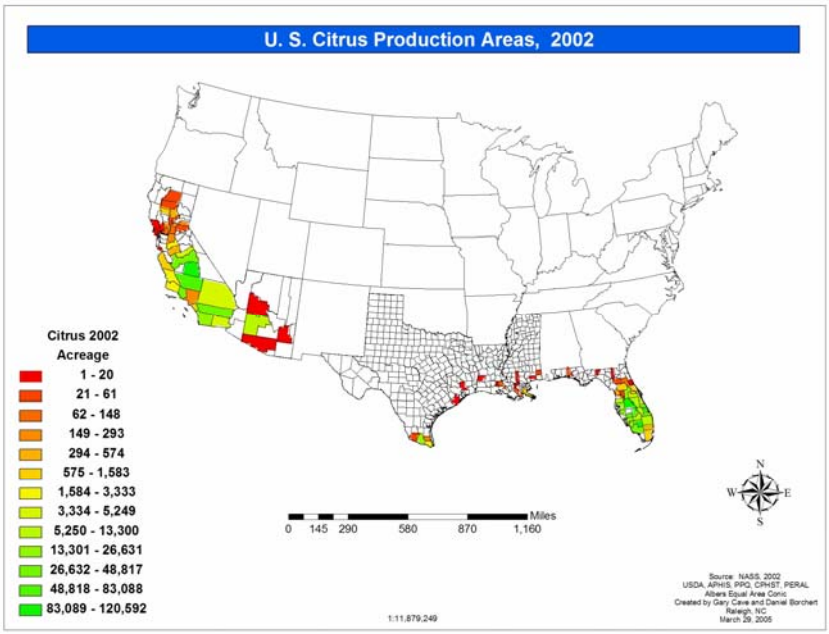
The analysis of factors to be considered for estimating the likelihood of introduction into States other than Alaska is substantially different than what is described above for import into Alaska only. The key difference is that movement is not via authorized imports but rather through the accidental misdirection of shipments or smuggling.

Since 1995, an estimated 24 million Korean Unshu oranges have been shipped to the United States. In that time, one air shipment of Unshu oranges from Korea was mistakenly redirected into a citrus producing State and was immediately re-exportated to a non-citrus producing State (Schwartz, 2002). The proposed export program into Alaska will prohibit the movement of fruit directly into States with suitable habitats for the introduction of the pests of concern, so it it not expected that whole shipments would be shipped to and distributed in citrus growing areas of the United States. Based on APHIS' past experience with similar programs for limited distribution, it is highly unlikely that whole shipments or containers of Korean Unshus would move from Alaska into other areas of the U.S. What is more likely is that a few fruit may move in passenger baggage or a few boxes may move as illegal cargo. This represents a tiny proportion of the total quantity imported.

It is estimated that under the current proposal, 10-100 40' containers would be shipped to Alaska each year (Table 5). By allowing imports to Alaska, the likelihood of fruit moving into other States with suitable habitats for pest establishment is increased. However, the distribution of host plants is limited (Fig. 1) and the likelihood that significant numbers of *U. yanonensis* and *X. axonopodis* pv. *citri* infested/infected fruit would be present in shipments and then move from Alaska to one of these areas is small. The small proportion of fruit that might move illegally from Alaska to a suitable habitat in the U.S. would need to have sufficient inoculum to be

infective and be in the vicinity of (or in contact with) host material at the right time and under the right combination of circumstances for the pests to establish.

**Figure 1.** U.S. Citrus Production Areas




Considering the very small number of fruit that might move to suitable habitats and the unlikely set of circumstances required for the establishment of the pests of concern, the likelihood for introduction via fruit misdirected from Alaska is very low.

### M. Pest Risk Potential - Movement from Alaska into Other Areas of the U.S.

Although the likelihood of introduction for either pest is very low, the consequences are significant enough to justify measures to reduce the probability that the unauthorized movement of fruit would be a pathway for introduction.

## III. Pest Risk Management

Pest risk management is the process used to identify and evaluate options for mitigating the risk of introduction of a quarantine pest (IPPC 2004a, b). The reduction of phytosanitary risk occurs through the use of mitigation measures that eliminate, reduce, or prevent the presence of pest populations within shipments of commodities primarily in the country of origin. In this case, the pest risk management aspect of the analysis is to evaluate measures proposed by Korea.

The risk mitigation measures proposed by Korea are: (1) the use of a field pest control program and cultural practices to reduce pests in the groves; (2) packing house selection (culling) to remove fruit with pests (including fruit with symptoms or damage that could harbor disease); (3) a visual inspection of 2% of fruit in each shipment; (4) phytosanitary certification; (5) shipment safeguards (especially labeling); and (6) port of arrival inspection.

Boxes will be stamped with “distribution limited to Alaska”, and shipments will be accompanied by a phytosanitary certificate that includes an additional declaration stating that the shipment

was inspected and found free of citrus canker. As a general requirement, imported fruit must also be free of leaves and soil and the origin of the fruit identified by stamps or labels on individual shipping boxes.

The effect of phytosanitary measures proposed by Korea is to substantially reduce the likelihood that the pests of concern will be associated with shipments to Alaska. As discussed above, the pests of concern pose no threat to Alaska. However, account is also taken of the potential for the unauthorized movement of fruit from Alaska into other States. This possibility increases the likelihood that the pests of concern can move into suitable habitats for establishment. The proposal by Korea includes a range of mitigation measures designed to reduce this likelihood by substantially reducing the likelihood that fruit will carry the pests of concern.

A key element of this approach is the combination of inspections designed to remove fruit that are infested with insects or have symptoms or injuries that could harbor citrus canker and ensure that only the highest quality fruit is shipped. Although any program based on inspection cannot be 100% effective, these measures can be expected to greatly reduce the potential for the pests of concern to be present in shipments to Alaska, thereby substantially reducing the already low risk associated with the potential for unauthorized movement of some fruit to other States.

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**Appendix A. Pest Interceptions on *Citrus* spp. from the Republic of Korea as reported in the PPQ Pest Interception Database from 1985 to 2001.**

| PEST | HOST | WHERE | TOTAL |
|---|---|---|---|
| Acarina | *Citrus reticulata* | Permit cargo | 1 |
| *Aleurolobus marlatti* | *Citrus* sp. (Leaf) | Baggage | 1 |
| *Ascochyta citri* | *Citrus sinensis* (Fruit) | Baggage | 1 |
| *Aulacaspis tubercularis* | *Citrus aurantifolia* (Fruit) | Baggage | 1 |
| Bradybaenidae sp. | *Citrus reticulata* | Permit cargo | 1 |
| *Chrysomphalus pinnulifer* | *Citrus reticulata* | Stores | 1 |
| *Cladosporium* sp. | *Citrus* sp. (Fruit) | Baggage | 2 |
| Coccidae, species of | *Citrus* sp. | Baggage | 1 |
| *Colletotrichum* sp. | *Citrus* sp. | Baggage | 1 |
| Diaspididae, species of | *Citrus sinensis* (Fruit) | Baggage | 1 |
| Diaspididae, species of | *Citrus reticulata* (Fruit) | Baggage | 1 |
| Diaspididae, species of | *Citrus* sp. (Fruit) | Stores | 3 |
| *Elsinoë australis* | *Citrus reticulata*. (Fruit) | Baggage | 1 |
| *Elsinoë australis* | *Citrus* sp. (Fruit) | Baggage | 1 |
| *Elsinoë* sp. | *Citrus reticulata* (Fruit) | Baggage | 1 |
| *Elsinoë* sp. | *Citrus* sp. (Fruit) | Baggage | 1 |
| *Guignardia citricarpa* | *Citrus limon* (Fruit) | Stores | 1 |
| *Guignardia citricarpa* | *Citrus paradisi* (Fruit) | Stores | 1 |
| *Guignardia citricarpa* | *Citrus reticulata* (Fruit) | Baggage | 5 |
| *Guignardia citricarpa* | *Citrus sinensis* (Dried Fruit) | Baggage | 2 |
| *Guignardia citricarpa* | *Citrus sinensis* (Fruit) | Baggage | 6 |
| *Guignardia citricarpa* | *Citrus sinensis* (Fruit) | Stores | 4 |
| *Guignardia citricarpa* | *Citrus* sp. (Dried Fruit) | Baggage | 2 |
| *Guignardia citricarpa* | *Citrus* sp. (Dried Fruit) | Mail | 1 |
| *Guignardia citricarpa* | *Citrus* sp. (Fruit) | Baggage | 29 |
| *Guignardia citricarpa* | *Citrus* sp. (Fruit) | Quarters | 1 |
| *Guignardia citricarpa* | *Citrus* sp. (Leaf) | Baggage | 3 |
| *Guignardia citricarpa* | *Citrus* sp. (Seed) | Mail | 1 |
| Insecta, species of | *Citrus aurantifolia* | Permit cargo | 1 |
| Insecta, species of | *Citrus reticulata* | Permit cargo | 1 |
| *Longitarsus* sp. | *Citrus reticulata* | Permit cargo | 1 |
| *Microsphaeropsis* sp. | *Citrus* sp. (Leaf) | Baggage | 1 |
| *Nezara antennata* | *Citrus reticulata* (Fruit) | Permit cargo | 1 |
| *Parlatoria citri* | *Citrus amblycarpa* | Baggage | 1 |
| *Parlatoria ziziphi* | *Citrus aurantifolia* (Fruit) | Baggage | 2 |
| *Parlatoria ziziphi* | *Citrus aurantifolia* (Leaf) | Baggage | 1 |
| *Parlatoria ziziphi* | *Citrus limon* (Fruit) | Baggage | 2 |
| *Parlatoria ziziphi* | *Citrus paradisi* (Fruit) | Baggage | 2 |
| *Parlatoria ziziphi* | *Citrus reticulata* | Baggage | 1 |

| PEST | HOST | WHERE | TOTAL |
|---|---|---|---|
| *Parlatoria ziziphi* | *Citrus reticulata* (Fruit) | Baggage | 4 |
| *Parlatoria ziziphi* | *Citrus reticulata* (Fruit) | Quarters | 2 |
| *Parlatoria ziziphi* | *Citrus sinensis* (Fruit) | Baggage | 3 |
| *Parlatoria ziziphi* | *Citrus sinensis* (Leaf) | Baggage | 1 |
| *Parlatoria ziziphi* | *Citrus sinensis* | Baggage | 1 |
| *Parlatoria ziziphi* | *Citrus* sp. (Fruit) | Baggage | 12 |
| *Parlatoria ziziphi* | *Citrus* sp. (Fruit) | Stores | 1 |
| *Parlatoria ziziphi* | *Citrus* sp. (Leaf) | Baggage | 20 |
| *Parlatoria ziziphi* | *Citrus* sp. | Baggage | 4 |
| *Phyllosticta citricarpa* | *Citrus aurantium* | Baggage | 1 |
| *Phyllosticta citricarpa* | *Citrus* sp. (Dried Fruit) | Mail | 1 |
| *Phyllosticta citricarpa* | *Citrus* sp. (Fruit) | Baggage | 14 |
| *Phyllosticta citricarpa* | *Citrus* sp. (Fruit) | Mail | 3 |
| *Phyllosticta citricarpa* | *Citrus reticulata* (Fruit) | Baggage | 2 |
| *Pseudaonidia trilobitiformis* | *Citrus paradisi* (Fruit) | Baggage | 1 |
| Pseudococcidae, species of | *Citrus reticulata* | Permit cargo | 1 |
| Pseudococcidae, species of | *Citrus sinensis* (Fruit) | Baggage | 1 |
| Pseudococcidae, species of | *Citrus* sp. (Fruit) | Baggage | 2 |
| Pseudococcidae, species of | *Citrus* sp. (Fruit) | Cargo | 1 |
| Pseudococcidae, species of | *Citrus* sp. | Baggage | 2 |
| Pyraustinae, species of | *Citrus* sp. (Fruit) | Baggage | 1 |
| *Tarsonemus* sp. | *Citrus reticulata* (Fruit) | Permit cargo | 2 |
| *Unaspis yanonensis* | *Citrus maxima* (Fruit) | Baggage | 1 |
| *Unaspis yanonensis* | *Citrus paradisi* (Fruit) | Baggage | 1 |
| *Unaspis yanonensis* | *Citrus reticulata* (Fruit) | Baggage | 6 |
| *Unaspis yanonensis* | *Citrus reticulata* (Fruit) | Quarters | 2 |
| *Unaspis yanonensis* | *Citrus reticulata* | Baggage | 1 |
| *Unaspis yanonensis* | *Citrus sinensis* (Fruit) | Baggage | 2 |
| *Unaspis yanonensis* | *Citrus* sp. (Fruit) | Baggage | 20 |
| *Unaspis yanonensis* | *Citrus* sp. | Baggage | 1 |
| *Utetheisa pulchella* | *Citrus* sp. (Fruit) | Baggage | 1 |
| *Xanthomonas axonopodis* pv.*citri* | *Citrus aurantiifolia* (Fruit) | Baggage | 1 |
| *Xanthomonas axonopodis* pv.*citri* | *Citrus aurantiifolia* (Fruit) | Stores | 2 |
| *Xanthomonas axonopodis* pv.*citri* | *Citrus hystrix* (Fruit) | Baggage | 1 |
| *Xanthomonas axonopodis* pv.*citri* | *Citrus hystrix* | Baggage | 1 |
| *Xanthomonas axonopodis* pv.*citri* | *Citrus limon* (Fruit) | Baggage | 5 |
| *Xanthomonas axonopodis* pv.*citri* | *Citrus limon* (Fruit) | Mail | 1 |
| *Xanthomonas axonopodis* pv.*citri* | *Citrus limon* | Stores | 1 |
| *Xanthomonas axonopodis* pv.*citri* | *Citrus paradisi* (Fruit) | Baggage | 1 |
| *Xanthomonas axonopodis* pv.*citri* | *Citrus reticulata* (Dried Fruit) | Baggage | 1 |
| *Xanthomonas axonopodis* pv.*citri* | *Citrus reticulata* (Fruit) | Baggage | 30 |
| *Xanthomonas axonopodis* pv.*citri* | *Citrus reticulata* (Fruit) | Permit cargo | |

| PEST | HOST | WHERE | TOTAL |
|---|---|---|---|
| | | | 2 |
| *Xanthomonas axonopodis* pv.*citri* | *Citrus reticulata* (Fruit) | Stores | 2 |
| *Xanthomonas axonopodis* pv.*citri* | *Citrus sinensis* (Dried Fruit) | Baggage | 3 |
| *Xanthomonas axonopodis* pv.*citri* | *Citrus sinensis* (Dried Fruit) | Cargo | 1 |
| *Xanthomonas axonopodis* pv.*citri* | *Citrus sinensis* (Fruit) | Baggage | 6 |
| *Xanthomonas axonopodis* pv.*citri* | *Citrus sinensis* | Baggage | 2 |
| *Xanthomonas axonopodis* pv.*citri* | *Citrus* sp. (Dried Fruit) | Baggage | 6 |
| *Xanthomonas axonopodis* pv.*citri* | *Citrus* sp. (Dried Fruit) | Mail | 2 |
| *Xanthomonas axonopodis* pv.*citri* | *Citrus* sp. (Fruit) | Baggage | 47 |
| *Xanthomonas axonopodis* pv.*citri* | *Citrus* sp. (Fruit) | Mail | 6 |
| *Xanthomonas axonopodis* pv.*citri* | *Citrus* sp. (Fruit) | Quarters | 1 |
| *Xanthomonas axonopodis* pv.*citri* | *Citrus* sp. (Leaf) | Baggage | 25 |
| *Xanthomonas axonopodis* pv.*citri* | *Citrus* sp. | Baggage | 19 |
| *Xanthomonas axonopodis* pv.*citri* | *Citrus* sp. (Fruit) | Stores | 2 |
| *Xanthomonas axonopodis* pv.*citri* | *Citrus* sp. (Leaf) | Baggage | 2 |