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Importation of *Magnifera indica (L)* (Mango) Fruit from Ghana into the United States

A Qualitative, Pathway-Initiated Risk Assessment

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Executive Summary

This risk assessment examined the risks associated with the importation of mango (*Mangifera indica* (L.)) into the United States. Information on pests associated with *Mangifera indica* in Ghana and neighboring countries revealed that sixteeen quarantine pests could potentially be introduced into the United States via this pathway. The quarantine pests likely to follow the pathway were all insects

Sternochetus mangiferae (Coleoptera: Curculionidae)
Bactrocera cucurbitae Coquillett (Diptera: Tephritidae)
Bactrocera invadens (Diptera: Tephritidae)
Ceratitis capitata (Wiedemann) (Diptera: Tephritidae)
Ceratitis cosyra (Diptera: Tephritidae)
Ceratitis rosa Karsch (Diptera: Tephritidae)
Udinia catori (Green) (Hemiptera: Coccidae)
Udinia farquharsoni (Newstead) (Hemiptera: Coccidae)
Udinia pattersoni Hanford (Hemiptera: Coccidae)
Icerya aegyptiaca (Douglas) (Hemiptera: Margarotididae)
Icerya seychellarum (Westwood) (Hemiptera: Margarotididae)
Dysmicoccus neobrevipes Beardsley (Hemiptera: Pseudococcidae)
Maconellicoccus hirsutus (Green) (Hemiptera: Pseudococcidae)
Nipaecoccus viridis (Newstead) (Hemiptera: Pseudococcidae)
Planococcus minor (Maskell) (Hemiptera: Pseudococcidae)
Rastrococcus invadens Williams (Hemiptera: Pseudococcidae)

The quarantine pests were analyzed qualitatively based on international principles and internal guidelines as described in the PPQ Guidelines for Pathway-Initiated Pest Risk Assessments, Version 5.02 (USDA APHIS, 2000). This document examined pest biology in the context of Consequences of Introduction and Likelihood of Introduction. These elements were used to estimate the Pest Risk Potential. All of these pests pose phytosanitary risks to American agriculture. Port-of-entry inspections, as a sole mitigative measure, are considered insufficient to safeguard U.S. agriculture from all of these pests, and additional phytosanitary measures are necessary to reduce risks to acceptable levels.

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A. Introduction

This risk assessment was prepared for the Animal and Plant Health Inspection Service, (APHIS), U. S. Department of Agriculture (USDA) through a working group meeting of Ghanaian risk analysts, APHIS PPQ analysts and APHIS PPD analysts held in Accra, Ghana May 23-June 3, 2005. This working meeting was sponsored by the PRA advisor to the USAID West Africa Regional Program. The original risk assessment draft from which this one proceeded was completed by the Ministry of Food and Agriculture (MoFA) of Ghana as a result of training provided under an USDA/ICD/APHIS and Ghana PPQ Project [ATRIP Agricultural Grades and Standard Activity (PASA #641-P00-00-0042)].

The purpose of this risk assessment was to examine pest risks associated with the importation of *Mangifera indica* (mango) as fruit from Ghana into the United States.

This document is a qualitative risk assessment in which risk is expressed in terms such as high and low rather than in numerical terms such as probabilities or frequencies. The details of the methodology and rating criteria can be found in: *Pathway-Initiated Pest Risk Assessments: Guidelines for Qualitative Assessments, Version 5.02* (USDA APHIS, 2000).

International plant protection organizations, such as the North American Plant Protection Organization (NAPPO) and the International Plant Protection Convention (IPPC) of the United Nations Food and Agriculture Organization (FAO), provide guidance for conducting pest risk analyses. The methods used to initiate, conduct, and report this plant pest risk assessment are consistent with guidelines provided by NAPPO, IPPC, and FAO. Biological and phytosanitary terms (*e.g.*, *introduction*, *quarantine pest*) conform with the NAPPO Compendium of Phytosanitary Terms (Hopper, 1995) and the Definitions and Abbreviations (Introduction Section) in International Standards for Phytosanitary Measures: Guidelines for Pest Risk Analysis (FAO, 1996).

FAO (1996) defines *pest risk assessment* as "determination of whether a pest is a quarantine pest and evaluation of its introduction potential." *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" (FAO, 1996; Hopper, 1995). Thus, pest risk assessments should consider both the consequences and likelihood of introduction of quarantine pests.

The FAO guidelines describe three stages of pest risk analyses: Stage 1 (initiation), Stage 2 (risk assessment), and Stage 3 (risk management). This document satisfies the requirements of FAO Stages 1 and 2. A separate risk management document should accompany this risk assessment.

B. Risk Assessment

1. Initiating Event: Proposed Action

The risk assessment is a commodity based and therefore "pathway-initiated." It was conducted in response to a request for the USDA to permit the importation of a particular commodity likely to be a potential plant pest risk. The importation into the United States of mango as a commodity from Ghana is a potential pathway for the introduction of plant pests. The regulatory authority for the importation of fruits and vegetables from foreign sources into the United States may be found in the Code of Federal Regulations (7CFR§319.56).

2. Assessment of Weed Potential of Mangifera indica, (mango).

Table 1. Process for Determining Weed Potential of the Commodity

Commodity: Fresh fruits of *Mangifera indica,* mango.

Phase 1: Mango is a subtropical plant that is grown in Florida, Hawaii, and other subtropical areas of the United States.

Phase 2: Is the species listed in:

Yes	*Geographical Atlas of the World Weeds* (Holm *et al.*, 1979). Listed as a weed in Jamaica but its rank of importance is not known, but not listed as a serious, principal or common weed in any country.
No	*World's Worst Weeds* (Holm *et al.*, 1977).
No	*World Weeds* Natural Histories and Distribution (Holm, 1997).
No	*Report of the Technical Committee to Evaluate Noxious Weeds; Exotic Weeds-for Federal Noxious Weed Act* (Gunn and Ritchie, 1982).
No	*Economically Important Foreign Weeds* (Reed, 1977).
No	*Composite List of Weeds* (*Weed Science Society of America*, 1989).
No	*World Weeds* (Holm *et al.*, 1997).
No	Is there any literature reference indicating weed potential (e.g., AGRICOLA, CAB, Biological Abstracts, AGRIS search on "species name" combined "weed").

Phase 3: Conclusion: A survey of scientific literature showed that mango is not a weed in any country and is already grown in the United States. Consequently the weed potential is negligible.

3. Previous Risk Assessments and Pest Interceptions for Ghana

Table 2. Previous APHIS decisions regarding mango from Africa.

Year	Origin	Decision	Pests of Concern	Rationale (notes)
1934	Egypt	Refused	*Ceratitis capitata, Dacus zonatus* and *Sternochetus mangiferae*	(Original decision sheet not available, information taken from records)
1971	South Africa	Refused	*Ceratitis capitata, C. rosa, C. quinaria, C. rubivora, Sternochetus mangiferae, Deilephila nerri, scale insects, Erwinia mangiferae, Physalospora perseae*	Lack of adequate treatments for the wide range of pests concerned (APHIS, 1971)
1983	Cameroon	Refused	*Pardalaspis punctata* and *Dacus bivittatus cucumarius*	No approved treatment available for the fruit flies.

Year	Origin	Decision	Pests of Concern	Rationale (notes)
1983	Senegal	Refused	*Ceratitis capitata, Paradalaspis punctata, Pseudoaonidia triloitiformis, Erwinia mangiferae, Pseudomonas mangiferae, Stigmina mangiferae*	No approved treatment available for *P. punctata*. (*E. mangiferae* and *P.* mangiferae not shown to be present in Senegal) (APHIS, 1983)
1983	Guinea	Refused	*Ceratitis capitata, Paradalaspis punctata, Pseudoaonidia triloitiformis, Erwinia mangiferae, Pseudomonas mangiferae, Stigmina mangiferae*	No approved treatment available for *P. punctata*. (*E. mangiferae* and *P.* mangiferae not shown to be present in Senegal)
1984	Mali	Refused	*Ceratitis capitata, Paradalaspis punctata, Pseudoaonidia triloitiformis, Erwinia mangiferae, Pseudomonas mangiferae, Stigmina mangiferae*	Various insect pests including *P. punctata*, for which there is no approved treatment (APHIS, 1984)
1988	Kenya	Refused	*Ceratitis capitata, Cisaberotus kenyae, Dacus bivittatus, Pardalspis cosyra, Sternochetus mangiferae, Erwinia mangiferae, Physalospora perseae, Pseudoaonidia triloitiformis*	No acceptable treatment available for complex of fruit flies and *Cryptorrhynchus (=Sternochetus) mangiferae* (APHIS, 1988)
1989	Sierra Leone	Approved		Inspection and treatment with T107 (APHIS, 1989). Importation was approved, but the Decision sheet did not meet the cut off deadline so the order never went into effect. A subsequent decision in 1993 denied entry.
1990	Liberia	Refused	*Ceratitis capitata, C. rosa, Cryptophlebia* leucotreta, *Pseudaonidia triloitiformis, Sternochetus mangiferae*	No acceptable treatment for fruit flies *C. capitata* and *C. rosa* (APHIS, 1990)
1993	Sierra Leone	Refused	*Ceratitis punctata, C. capitata, C. rosa, Dacus bibittatus, D. ciliatus, D. vertebratus, Xanthomonas campestris* pv *mangiferaeindica*	No approved treatment. Data lacking for many species of fruit flies (APHIS, 1993b)
1993	Senegal	Refused	*Ceratitis punctata, C. capitata, C. rosa, Dacus bivittatus, D. ciliatus, D. vertebratus*	No approved treatment (APHIS, 1993a)
1996	South Africa	Refused	*Sternochetus mangiferae, Ceratitis cosyra, C. capitata, C. punctata, Pterandrus rosa and Cryptophlebia leucotreta*	No quarantine treatment for pest/host associations (APHIS, 1996)

Table 3. Pests intercepted three or more times from West Africa and on mango worldwide, 1985 - 2003 (PIN, 2003).

Pest	Interceptions on mango worldwide	Interceptions from West Africa on any commodity
Aulacaspis tubercularis Newstead (Hemiptera: Diaspididae)	47573	191
Anastrepha sp. (Diptera: Tephritidae)	34479	11
Sternochetus mangiferae (Fabricius) (Coleoptera: Curculionidae)	11538	88
Pseudaonidia trilobitiformis (Green) (Hemiptera: Diaspididae)	5177	42
Bactrocera sp. (Diptera: Tephritidae)	975	12
Sternochetus sp. (Coleoptera: Curculionidae)	872	55
Dacus sp. (Diptera: Tephritidae)	342	35
Lepidosaphes tapleyi Williams (Hemiptera: Diaspididae)	108	17
Ceratitis capitata (Wiedemann) (Diptera: Tephritidae)	97	89
Planococcus minor (Maskell) (Hemiptera: Pseudococcidae)	55	9
Cladosporium sp. (Fungi)	38	25
Conotrachelus sp. (Coleoptera: Curculionidae)	36	3
Parlatoria ziziphi (Lucas) (Hemiptera: Diaspididae)	33	352
Udinia catori (Green) (Hemiptera: Coccidae)	33	57
Planococcus sp. (Hemiptera: Pseudococcidae)	27	114
Colletotrichum sp. (Fungi)	26	21
Pseudococcus sp. (Hemiptera: Pseudococcidae)	23	13
Coccus sp. (Hemiptera: Coccidae)	14	3
Dysmicoccus sp. (Hemiptera: Pseudococcidae)	13	4
Phoma sp. (Fungi)	12	54
Phomopsis sp. (Fungi)	11	45
Pestalotiopsis sp. (Fungi)	10	26
Pseudaonidia sp. (Hemiptera: Diaspididae)	9	3
Phenacoccus sp. (Hemiptera: Pseudococcidae)	8	15
Ceratitis sp. (Diptera: Tephritidae)	7	56
Saissetia sp. (Hemiptera: Coccidae)	7	6
Icerya sp. (Hemiptera: Margarodidae)	6	6
Cryptophlebia sp. (Lepidoptera: Tortricidae)	5	1003
Contarinia sp. (Diptera: Cecidomyiidae)	5	82
Hypothenemus sp. (Coleoptera: Scolytidae)	5	38
Udinia farquharsoni (Newstead) (Hemiptera: Coccidae)	5	10
Tarsonemus sp. (Acari: Tarsonemidae)	5	6
Ferrisia sp. (Hemiptera: Pseudococcidae)	5	3
Asterolecanium sp. (Hemiptera: Asterolecaniidae)	5	3
Curculio sp. (Coleoptera: Curculionidae)	4	7
Cercospora sp. (Fungi)	4	5
Parlatoria cinerea Hadden (Hemiptera: Diaspididae)	4	3
Pheidole sp. (Hymenoptera: Formicidae)	3	46
Aspidiotus sp. (Hemiptera: Diaspididae)	3	8
Bactrocera cucurbitae (Coquillett) (Diptera: Tephritidae)	3	7
Lindingaspis musae (Laing) (Hemiptera: Diaspididae)	3	6
Aleurotrachelus sp. (Hemiptera: Aleyrodidae)	3	5

Pest	Interceptions on mango worldwide	Interceptions from West Africa on any commodity
Udinia sp. (Hemiptera: Coccidae)	3	4

4. Pest Categorization

The pests that have been reported in the scientific or regulatory literature to infest mango from Ghana are recorded in Table 4. Table 4 also presents information about geographic distribution, host associations and regulatory data. Table 4 represents a "master list" of these organisms and serves as a basis for selecting pests for more detailed biological analyses.

Table 4. Pests Associated with Mangifera indica from West Africa

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quar-antine	Follow Pathway	References
Acari						
Tarsonemidae						
Polyphagotarsonemus latus (Banks)	BF LB LB ML SN	HI US VI GU PR	F, Fw, L, S, W	No	Yes	CABI, 2004
Tarsonemus sp.	NG		Fw, L, W	Yes	No	PIN, 2003
Tenuipalpidae						
Brevipalpus phoenicis	MT	HI US PR	F, L, S,	No	Yes	CABI, 2004
Coleoptera						
Bostrichidae						
Apate monachus Fabricius	GH NR TG	PR	S	Yes	No	CABI, 2004; Hill, 1994
Sinoxylon conigerum Gerstacker	LB LB	HI US	S, W	No	No	CABI, 2004
Curculionidae						
Chalcodermus sp.	NG		F	Yes	Yes	PIN, 2003
Conotrachelus sp.	NG		F	Yes	Yes	PIN, 2003
Curculio sp.	GH, GU LB, NG	US	F, L, R, W	No	Yes	CABI, 2004; PIN, 2003
Sternochetus mangiferae (Fabricius) (= *Cercospora mangiferae*)	CM GB GH GM LB LB NG	HI VI GU	F, Sd	No[3]	Yes	CABI, 2004; Hill, 1994; IIE, 1964; PIN, 2003

1 BF = Burkina Faso; BN = Benin; CI = Côte d'Ivoire; CM = Cameroun; CV = Cape Verde; FL = Florida; GH = Ghana; GM = Gambia;GU = Guinea; LB = Liberia; ML = Mali;MT = Mauritania; NG = Nigeria; NR = Niger; PR = Puerto Rico; SL = Sierra Leone; SN = Senegal; STP = Sao Tome & Principe; TG = Togo; US = United States; VI = Virgin Islands

2 F = Fruits; Fw = Flower; L = Leaves; = Roots; S = Stems; Sd = Seeds; W = whole plants (directly or indirectly as a result or crown or root destruction).

3 Evidence is lacking that this pest poses any economic damage to US agriculture, so by the definition in ISPM 11, 2.1.1.5 this is not a quarantine pest. It has been analyzed later in the document because of concern about infesting Mexico with this pest.

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quar-antine	Follow Pathway	References
Elateridae						
Conoderus sp.	LB		F, Sd	Yes	Yes	PIN, 2003
Scarabaeidae						
Pachnoda interrupta	ML SN		Fw, R, Sd	Yes	No	CABI, 2004
Scolytidae						
Hypothenemus sp.	LB NG		F,S	Yes	Yes	PIN, 2003
Xyleborus similis	MT	HI US GU	S	No	No	CABI, 2004
Xylosandrus compactus Eichhoff	BN GB GH LB SL SN TG	HI US VI PR	L, S, W	Yes	No	CABI, 2004
Xylosandrus crassiusculus	SL	HI US	L, S, W	No	No	CABI, 2004
Silvanidae						
Oryzaephilus mercator (Fauval)	GM NG	US	Sd	No	No	CABI, 2004
Tenebrionidae						
Blapstinus sp.	NG		F	Yes	Yes	PIN, 2003
Diptera						
Cecidomyiidae						
Contarinia sp.	NG		F, W	Yes	Yes	PIN, 2003
Muscidae						
Atherigona orientalis Schiner	BF BN CV GH ML NR SL SN TG	HI US GU PR	F, Fw, L, S, W	No	Yes	CABI, 2004
Tephritidae						
Anastrepha sp.	NG		F	Yes	Yes	PIN, 2003
Bactrocera cucurbitae (Coquillett)	GM ML NG	HI GU	F, Fw, L, R, S	Yes	Yes	CABI, 2004; PIN, 2003
Bactrocera dorsalis (Hendel)	NG		F	Yes	No[4]	PIN, 2003
Bactrocera invadens	BN, CM, GH, NG, TG.SN		F	Yes	Yes	Mwatawala *et al.*, 2004
Bactrocera sp.	ML NG		F	Yes	Yes	PIN, 2003
Ceratitis capitata (Wiedemann)	BF BN CV GH GM LB LB ML NR SL SN TG	HI	F	Yes	Yes	CABI, 2004; IIE, 1999; PIN, 2003
Ceratitis cosyra	BF BN ML SL SN TG		F	Yes	Yes	CABI, 2004
Ceratitis rosa Karsh	ML NG		F	Yes	Yes	CABI, 2004
Ceratitis sp.	LB SN		F	Yes	Yes	PIN, 2003
Dacus sp.	BN CV LB NG		F	Yes	Yes	PIN, 2003

4 Probably not in West Africa, maybe a false interception or misidentification of *Bactrocera invadens*.

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quar-antine	Follow Pathway	References
Hemiptera						
Aleyrodidae						
Aleurocanthus woglumi (Asby)	W/A	US	L	No	No	Peña and Moyhuddin, 1997
Aleurodicus dispersus Russell	BN TG	HI US GU PR	L	Yes	No	CABI, 2004
Aleurothrixus floccosus Maskell	BN GM NR TG	HI US VI PR	F, Fw, L, S	No	Yes	CABI, 2004
Aleurotrachelus sp.	NG		L	Yes	No	PIN, 2003
Tetraleurodes sp.	NG		F, L, St	Yes	No[5]	PIN, 2003
Aphididae						
Toxoptera aurantii Boyer de Fonscolombe)	BN GH GM SL	HI US VI GU PR	Fw, L	No	Yes	CABI, 2004
Asterolecaniidae						
Asterolecanium sp.	NG		F, L	Yes	Yes	PIN, 2003
Coccidae						
Ceroplastes sp.	NG		F, L, S, W	Yes	Yes	PIN, 2003
Ceroplastes rusci (L.)	CV GH SN STP	US VI PR	F, L, S, W	Yes	No	Ben-Dov, 1993; CABI, 2004
Ceroplastes floridensis Comstock	SL	US VI GU PR	F, L, S, W	No	Yes	CABI, 2004
Ceroplastes mangiferae Green	W/A	??	L		No	Peña and Moyhuddin, 1997
Coccus viridis (Green)	BF BN CV GH ML NR SL SN TG	HI US(FL) GU PR	F, L, S	Yes	No[6]	Ben-Dov, 1993; CABI, 2004; PIN, 2003
Coccus sp.	SN		L, S	Yes	Yes	PIN, 2003
Coccus longulus (Douglas)	CV STP SN		L, S	Yes	No	Ben-Dov, 1993
Coccus hesperidum L.	BF CV GH GM ML NR SL SN TG	HI US VI PR	L, S	No	No	CABI, 2004
Eucalymnatus tessellatus (Signoret)	CV		L, S	Yes	No	Ben-Dov, 1993
Lagosinia strachani (Cockerell)	CAR MT NR NG SN		L, S	Yes	No	Ben-Dov, 1993
Parasaissetia nigra (Nietner)	BF BN Chad CV GH SL STP	HI US VI GU PR	L, S	No	No	Ben-Dov, 1993; CABI, 2004; IIE, 1997

5 Small, delicate insects, unlikely to survive the packing procedure.
6 "*Coccus viridis* (Hemiptera: Coccidae) was not selected for further analysis, because, although this scale is reported to attack fruit (CABI, 2004), it mainly attacks the leaves of its hosts (Dekle, 1976; Miller, 2003b).

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quar-antine	Follow Pathway	References
Protopulvinaria mangferae (Green)	W/A		L	Yes	No	Peña and Moyhuddin, 1997
Pulvinaria sp.	NG		F, Fw, L, S, W	Yes	Yes	PIN, 2003
Pulvinaria psidii Maskell	CV SN GH	HI US VI NMI PR	F, Fw, L, S, W	No	Yes	Ben-Dov, 1993; CABI, 2004; IIE, 1955
Saissetia oleae (Olivier)	SN		L,S	Yes	No	Ben-Dov, 1993
Saissetia sp.	CV NG		L,S	Yes	No	PIN, 2003
Saissetia coffeae (Walker)	CV GH SL STP TG	HI US VI GU PR	L,S	No	No	Ben-Dov, 1993; CABI, 2004
Udinia catori (Green)	GH GM LB SN		F	Yes	Yes	Ben-Dov, 1993; PIN, 2003
Udinia farquharsoni (Newstead)	CAR GB SN		F	Yes	Yes	Ben-Dov, 1993; PIN, 2003
Udinia pattersoni Hanford	SN		F	Yes	Yes	Ben-Dov, 1993
Udinia sp.	NG		F	Yes	Yes	PIN, 2003
Vinsonia stellifera (Westwood)	CV SN	US(FL)	F, L, S	Yes	No7	Ben-Dov, 1993; PIN, 2003
Diaspididae[8]						
Abgrallaspis cyanophylli (Signoret)	CM SN		F, L, S	Yes	No	Ben-Dov, 1993; Miller, 1985b
Aonidiella citrina (Coquillett)	BN CM GB ML NR SN		F, L, S, W	Yes	No	Ben-Dov, 1993; Miller, 1985b
Aonidiella inornata McKenzie	GU		F, L, S, W	Yes	No	Ben-Dov, 1993; Miller, 1985b
Aonidiella sp.	NG		F, L, S, W	Yes	No	Miller, 1985b; PIN, 2003
Aonidiella aurantii (Maskell)	GU	US PR	F, L, S, W	No	No	CABI, 2004; Miller, 1985b
Aonidiella orientalis Signoret	NR NG	US VI PR	F, L, S, W	No	No	CABI, 2004; Miller, 1985b
Aonidomytilus albus (Cockerell)	GM		L, S	Yes	No	Ben-Dov, 1993; Miller, 1985b
Aspidiotus sp.	NR, NG		F, L, S	Yes	No	Miller, 1985b; PIN, 2003
Aspidiotus nerii Bouche	CV NG	HI US	F, L, S	No	No	CABI, 2004; Miller, 1985b

7 "*Vinsonia stellifera* (Hemiptera: Coccidae) was not selected for further analysis, because, although this scale is reported to attack fruit (Dekle, 1969), it mainly attacks the leaves of its hosts (PIN, 2003).

8 Although armored scales are often intercepted on fruit in passenger baggage (Miller, 1985a), fruit is rarely attacked in orchard conditions, is very unlikely to be exported commercially, and so the insects are considered unlikely to become introduced via fruit (CABI, 2004).

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quar-antine	Follow Pathway	References
Aspidiotus destructor Signoret	BN CV GB GH SL SN STP TG	HI US VI GU PR	F, L, S	No	No	Ben-Dov, 1993; CABI, 2004; Hill, 1994; IIE, 1966c, 1966b
Aulacaspis tubercularis Newstead	BN GH GM LB LB SL SN MG TG	PR	F, L, S	Yes	No	CABI, 2004; IIE, 1993; Miller, 1985a
Aulacaspis rosae (Bouch)	CV		L, S	Yes	No	Ben-Dov, 1993
Chrysomphalus dictyospermi (Morgan)	BN CV ML NR SL SN TG	HI US PR	F, L, S	No	No	CABI, 2004; Miller, 1985b; Peña and Moyhuddin, 1997
Chrysomphalus aonidum (L.)	GU, SN	HI US VI PR	F, L, S	No	No	Ben-Dov, 1993; CABI, 2004; Miller, 1985b
Clavaspis herculeana (Cockerell & Hadden, (in): Doane & Hadden)	GU		L, S	Yes	No	Ben-Dov, 1993
Diaspis boisduvalii Signoret	CM, SL		L, R, S, W	Yes	No	Ben-Dov, 1993
Fiorinia fioriniae (Targioni Tozzetti)	STP		F, L, S,W	Yes	No	Ben-Dov, 1993; Miller, 1985b
Hemiberlesia palmae (Cockerell)	CM TG		F, L, S	Yes	No	Ben-Dov, 1993; Miller, 1985b
Hemiberlesia sp.	SN		F, L, S	Yes	No	Miller, 1985b; PIN, 2003
Hemiberlesia lataniae (Signoret)	BN CM CV GH ML SL STP	HI US VI	F, L, S	No	No	Ben-Dov, 1993; CABI, 2004; IIE, 1976; Miller, 1985b
Howardia biclavis (Comstock)	STP		L, R, S, W	Yes	No	Ben-Dov, 1993
Ischnaspis longirostris (Signoret)	CM, CV NG SN SL		F, L, S	Yes	No	Ben-Dov, 1993
Lepidosaphes beckii (Newman)	CM CV GH GM SL SN	HI US PR	F,	No	No	Ben-Dov, 1993, CABI, 2004; Hill, 1994
Lepidosaphes gloverii (Packard)	GM SL SN STP	HI US PR	F, L, S	No	No	CABI, 2004; Miller, 1985b
Lepidosaphes sp.	NG		F, L, S	Yes	No	Miller, 1985b; PIN, 2003
Lepidosaphes tapleyi Williams	GB GH ML NG		F	Yes	No	PIN, 2003
Lindingaspis rossi (Maskell)	CM SL TG		F, L, S	Yes	No	Ben-Dov, 1993

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quar-antine	Follow Pathway	References
Lindingaspis musae (Laing)	GM NG		F	Yes	No	PIN, 2003
Morganella longispina (Morgan)	CM STP		L, S	Yes	No	Ben-Dov, 1993
Mycetaspis personata (Comstock)	CM SN SL TG		L, S	Yes	No	Ben-Dov, 1993
Neoselenaspidus silvaticus (Lindinger)	CM STP		L, S	Yes	No	Ben-Dov, 1993
Parlatoria pseudaspidiotus Lindinger	CM		F, L, S	Yes	No	Ben-Dov, 1993
Parlatoria sp.	NG		F, L, S	Yes	No	PIN, 2003
Parlatoria cinerea Hadden	GM NG		F, L, S	Yes	No	PIN, 2003
Parlatoria crypta Mckenzie	NG		F, L, S	Yes	No	PIN, 2003
Parlatoria proteus (Curtis)	GM		F, L, S	Yes	No	Ben-Dov, 1993
Parlatoria ziziphi (Lucas)	BN GB GM LB NIGER SN		F, L, S	Yes	No	PIN, 2003
Pinnaspis aspidistrae (Signoret)	STP SL		F, L, S, W	Yes	No	Ben-Dov, 1993
Pinnaspis sp.	LB NG		F, L, S, W	Yes	No	PIN, 2003
Pinnaspis strachani (Cooley)	BN CM CV GM LB MT SL SN TG	HI US PR	F, L, S, W	No	No	Ben-Dov, 1993; CABI, 2004
Pseudaonidia trilobitiformis (Green)	BF Chad CM GM GH ML SL SN TG		L	Yes	No	Ben-Dov, 1993; PIN, 2003; USDA, 1979
Pseudaonidia sp.	NG		L	Yes	No	PIN, 2003
Pseudaulacaspis pentagona (Targioni-Tozzetti)	CV GH	US VI GU PR	L, R, S, W	No	No	CABI, 2004
Radionaspis indica (Marlatt)	CV SN		L, S	Yes	No	Ben-Dov, 1993
Selenaspidus malzyi Balachowsky	CM Mauritania		L, S	Yes	No	Ben-Dov, 1993
Selenaspidus articulatus (Morgan)	Chad GH SL STP TG	US	F, L, S	No	No	Ben-Dov, 1993; CABI, 2004; IIE, 1976
Margarodidae						
Icerya aegyptiaca (Douglas)	BN SN TG	GU	L, S, W	Yes	Yes	CABI, 2004
Icerya seychellarum (Westwood)	SN		F, L, S, W	Yes	Yes	CABI, 2004

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quar-antine	Follow Pathway	References
Icerya sp.	NG		F, L, S, W	Yes	Yes	PIN, 2003
Icerya purchasi Maskell	CV SN TG	HI US GU PR	L, S, W	No	Yes	CABI, 2004
Miridae						
Helopeltis schoutedeni	GH LB LB ML SL TG		F, L, S	Yes	No[9]	CABI, 2004; Hill, 1994; IIE, 1972
Pentatomidae						
Bathycoelia thalassina	GH GM SL		F, Sd	Yes	No[10]	CABI, 2004; IIE, 1984
Pseudococcidae						
Dysmicoccus neobrevipes Beardsley	SN		F, L, R, S, W	Yes	Yes	Ben-Dov, 1994; Hill, 1994; PIN, 2003
Dysmicoccus sp.	NG		F, L, R, S, W	Yes	Yes	PIN, 2003
Dysmicoccus brevipes (Cockerell)	BF BN GH ML NR SL SN TG	HI US VI GU PR	F, L, R, S, W	No	Yes	CABI, 2004
Dysmicoccus grassii (Leonardi)	NG	US	F, L, R, S, W	No	Yes	Ben-Dov, 1993
Ferrisia virgata (Cockerell)	GH SL SN TG	HI US VI PR	F, L, S	No	Yes	CABI, 2004; IIE, 1966a
Geococcus coffeae Green	NG		R	Yes	No	Ben-Dov, 1993
Maconellicoccus hirsutus (Green)	BF BN GB GM LB LB NR SN	HI US(FL) VI GU PR	F, Fw, L, S	Yes	Yes	Ben-Dov, 1993; CABI, 2004; PIN, 2003
Nipaecoccus viridis (Newstead)	BF BN ML NR SN TG	HI US GU	F, Fw, L, S, W	Yes	Yes	CABI, 2004
Phenacoccus madeirensis Green	BN CM CV GM LB STP SN SL TG		Fw, L, S, W	Yes	No	Ben-Dov, 1993
Phenacoccus sp.	NG		F, Fw, L, S, W	Yes	Yes	PIN, 2003

9 The adults of *Helopeltis schouledeni* are active throughout the day and, when disturbed, they can fly for short distances when disturbed (CABI, 2004). Nymphs are mobile insects unlikely to remain with the commodity through harvest.
10 Attacks young fruit and causes premature ripening (2004), so it is unlikely to be present with mature fruit at harvest.

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quar-antine	Follow Pathway	References
Phenacoccus parvus Morrison	GB SN		F, Fw, L, S, W	Yes	No	Ben-Dov, 1993
Planococcoides njalensis (Laing)	BN GH LB LB SL SN TG		F, Fw, L, S, W	Yes	No[11]	CABI, 2004; IIE, 1974
Planococcus minor (Maskell)	NG		F, Fw, L, S	Yes	Yes	PIN, 2003
Planococcus sp.	CV LB SN		F, Fw, L, S	Yes	Yes	PIN, 2003
Planococcus citri (Risso)	BF BN CV GH LB LB ML NR SL SN STP TG	HI US GU PR	F, Fw, L, S	No	Yes	CABI, 2004
Pseudococcus longispinus (Targioni Tozzetti)	GB, STP	US, HI,PR	F, Fw, L, S	No	Yes	Ben-Dov, 1993; CABI, 2004
Pseudococcus sp.	NG		F, Fw, L, S	Yes	Yes	PIN, 2003
Pseudococcus occiduus De Lotto	CM GB ML MT SN		L, S	Yes	No	Ben-Dov, 1993
Rastrococcus invadens Williams	BN GB GH SL TG		F, Fw, L, S, W	Yes	Yes	Ben-Dov, 1993; CABI, 2004; IIE, 1998
Lygaeidae						
Nysius sp.	SN		F, L, St	Yes	No	PIN, 2003
Hymenoptera						
Formicidae						
Pheidole sp.	LB NG		W	Yes	No[12]	PIN, 2003
Lepidoptera						
Noctuidae						
Eudocima fullonia (Clerck)	BN GH LB LB SL	HI US GU	F	Yes	No	CABI, 2004
Helicoverpa armigera (Hübner)	BF BN CV GH GM ML NR SL SN TG	GU	F, Fw, L	Yes	No[13]	CABI, 2004; IIE, 1968
Pyralidae						
Cadra cautella Walker =*Cadra defecta* Walker	GH GM ML SN TG	US	F, Sd	No	Yes	CABI, 2004

11 CABI (PIN, 2003) lists mango as a minor host for *Planococcoides njalensis*, but does not give the reference for this assertion. The pest has not been intercepted on mango (CABI, 2004).
12 Worker ants cannot reproduce and do not represent a quarantine hazard.
13 Larvae of *Helicoverpa armigera* feed on immature fruit (Javaid, 1986) and would not likely be present at harvest.

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quar-antine	Follow Pathway	References
Cryptoblabes gnidiella (Milliere)	LB SL	HI US	F, L, S	Yes	No	CABI, 2004
Tortricidae						
Cryptophlebia leucotreta (Meyrick)	BN, BF, CM, CV, CAM, CI, GM, GH, ML, NR, NG, SN, SL, TG		F, L, Sd	Yes	No[14]	CABI, 2004; Javaid, 1986 PIN, 2003
Orthoptera						
Acrididae						
Anacridium melanorhodon (Walker)	W/A		L	Yes	No	Peña and Moyhuddin, 1997
Zonocerus variegatus (L.)	BF BN GB GH GM LB LB ML NR SL SN TG		F,Fw, L, Sd, S, W	Yes	No15	CABI, 2004
Thysanoptera						
Thripidae						
Heliothrips haemorrhoidalis	GH CV SL	HI US PR	F, L	No	No[6]	CABI, 2004
Scirtothrips aurantii	CV GH NG		F, Fw, L	Yes	No[16]	CABI, 2004; IIE, 1961b
Scirtothrips dorsalis Hood	CI	HI US	Fw, L, W	Yes	No	CABI, 2004
Selenothrips rubrocinctus	CV GH SL TG	HI US VI GU PR	F, L, S	No	Yes	CABI, 2004; IIE, 1961a
Thrips palmi Karny	NG	HI US(FL) GU PR	Fw, F, L	Yes	No[17]	CABI, 2004
Thrips tabaci (Lindeman)	GH SN	HI US	Fw, L	No	No[6]	CABI, 2004
Thrips hawaiiensis (Morgan)	SL	HI US GU	F, Fw, L	No	No[6]	CABI, 2004
Fungi						
Armillaria mellea (Vahl: Fr.) P. Kumm	GH		L, R, S, W	Yes	No	Farr *et al.*, 2004

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14 *Cryptophlebia leucotreta* has been recorded on wild mangoes (1997), but is not known to be a pest of commercial mangoes. Peña and Mohyuddin (CABI, 2004) do not list this insect as a pest of mango.
15 *Zonocerus variegates* is a large mobile species. It is unlikely to stay on traded commodities during the harvesting.
16 *Scirtothrips aurantii* feeds on the immature fruit (CABI, 2004); therefore, it is unlikely to be transported by traded commodities.
17 These insects are mainly flower pests. Small and delicate, they are unlikely to remain with the commodity through post harvest handling.

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quar-antine	Follow Pathway	References
Aspergillus niger Tiegh.	BF NR NG	US PR	R, F, Fw, L, Sd, S, W	No	Yes	CABI, 2004
Botryosphaeria ribis Gross. & Duggar, anamorph = *Fusicoccum sp.*	GH NR TG	HI US	F, Fw, L, S, W	No	Yes	Alfieri *et al.*, 1994; ARS, 1960; CABI, 2004; CMI, 1973; Farr *et al.*, 1989
Ceratocystis fimbriata Ellis & Halsted, anamorph = *Chalara sp.*	GH	HI US PR	F, L, R, S, W	No	Yes	CABI, 2004
Ceratocystis paradoxa (Dade) Moreau, anamorph = *Chalara paradoxa* Sacc.	BF GH SL SN TG	HI US PR	F, L, R, S, W	No	Yes	Alfieri *et al.*, 1994, CABI, 2004; CMI, 1967, 1987
Cercospora mangiferae Koord.	GH		L, W	Yes	No	CABI, 2004
Cercospora sp.	NG		L, W	Yes	No	PIN, 2003
Cladosporium sp.	Chad LB SN		F, L, S, W	Yes	Yes	PIN, 2003
Colletotrichum sp.	LB NG		F, L	Yes	Yes	PIN, 2003
Corticium salmonicolor	SL TG	US GU PR	L, S	Yes	No	CABI, 2004
Corticium rolfsii Curzi	BF BN CV GH GM LB ML NR SL SN TG	HI US GU PR	F, Fw, L, Sd, S, W	No	Yes	CABI, 2004; CMI, 1969, 1974; Farr *et al.*, 1989; Mordue, 1974
Gibberella zeae (Schwein.) Petch, anamorph = *Fusarium graminearum* Schwabe	GM NG	HI US	L, S, W	No	No	CABI, 2004
Glomerella cingulata (Stonem.) Spauld. & Schrenk	GH TG	HI US GU PR	F, Fw, L, S	No	Yes	CABI, 2004; CMI, 1971; Farr *et al.*, 1989
Lasiodiplodia theobromae (Pat.) Griffon & Maubl. = *Botryodiplodia theobromae* Pat., = Diplodianatalensis Pole-Evans, teleomorph = *Physalospora rhodina* (Berkeley & Curtis) Cooke	BF GH GM SN TG	US GU PR	F, Fw, L, R, S, Sd	No	Yes	CABI, 2004; CMI, 1976, 1985; Farr *et al.*, 1989

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quar-antine	Follow Pathway	References
Leptosphaeria sp.	NG		F	Yes	Yes	PIN, 2003
Macrophomina phaseolina (Tassi) Goid	BF BN GM NR SL SN TG	US PR	L, R, Sd, S, W	No	No	CABI, 2004
Marasmius crinis-equi = *M. crinisequi* Muller ex Kalchbrenner = M. equicrinis Muller ex Berk. (Basidiomycota: Agaricales)	GH SL		L, S	Yes	No	CABI, 2004; CMI, 1997; Farr *et al.*, 1989
Nectria rigidiuscula Berk. & Br. (= *Calonectria rigidisucula*, = *Fusarium decemcellulare*)	GH SL	US[18] PR	F, Sd, S	No	Yes	CABI, 2004; Crowdy, 1947; Farr *et al.*, 1989
Nectria haematococca Berk. & Broome	GH		F, Sd, S	No	Yes	CABI, 2004
Pestalotiopsis sp.	BN SN		F, L	Yes	Yes	PIN, 2003
Phoma sp.	ML SN		F, L, Sd, S, W	Yes	Yes	PIN, 2003
Phomopsis sp.	NG		F, Fw, L, Sd, S, W	Yes	Yes	PIN, 2003
Puccinia sp.	NG		L, W	Yes	No	PIN, 2003
Pythium splendens Braun	NG	HI US PR	L, R, S, W	No	Yes	CABI, 2004
Rosellinia necatrix Prill.	NG	US	L, R, S, W	No	No	CABI, 2004
Verticillium dahliae Kleb.	NG	US	L, S, W	No	Yes	CABI, 2004
Nematode						
Criconematidae						
Criconemella sp.	BF SN TG	HI US	F, R, W	No	No	CABI, 2004
Hemicriconemoides mangiferae Siddiqi	NG	US	R	No	No	Anon, 1984; CABI, 2004; Cohn and Duncan, 1990

18 *Nectria rigidiuscula* (teleomorph) (= *Calonectria rigidisucula*, = *Fusarium decemcellulare* (anamorph)) are associated with tropical or sub-tropical hosts in general and cacao in particular (Crowdy, 1947, CABI, 2004). The fungus is primarily a wound pathogen and/or a saprophyte. The teleomorph has been reported on mango in Ghana (ARS, 2001, Ploetz *et al.*, 1996) but not on mango in the United States. However, the anamorph has been reported on mango germplasm collection in Florida (Alfieri *et al.*, 1994) and on ten hosts in Florida ()

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quar-antine	Follow Pathway	References
Hoplolaimidae						
Helicotylenchus multicinctus (Cobb) Golden	BF BN NG	HI US	L, R, W	No	No	CABI, 2004
Helicotylenchus dihystera (Cobb, 1893) Sher, 1961	BF LB SN	HI US PR	L, R, W	No	No	CABI, 2004
Hoplolaimus pararobustus	BF GM NR SN TG		R	Yes	No	CABI, 2004
Hoplolaimus seinhorsti Luc	NG		R, W	Yes	No	CABI, 2004
Longidoridae						
Xiphinema americanum Cobb	NG	HI US	R	No	No	CABI, 2004
Meloidogynidae						
Meloidogyne incognita (Kofoid & White) Chitwood	BF GM LB NR SN	HI US PR	R	No	No	Anon, 1984; CABI, 2004
Pratylenchidae						
Pratylenchus loosi Loof. (Tylenchida: Pratylenchidae)	SN		L, R, W	Yes	No	CABI, 2004
Pratylenchus brachyurus (Godfrey) Filipjev & Schuurmans Stekhoven	BN GM SN TG	HI US PR	L, R, Sd, S, W	No	No	CABI, 2004
Pratylenchus penetrans (Cobb)	NG	US	L, R, W	No	No	CABI, 2004
Rotylenchulidae						
Rotylenchulus reniformis Linford & Oliveira	GH		R	No	No	Ben-Dov, 1994; CABI, 2004; Hill, 1994; SON, 1984; USDA ARS SEL, 2005

Quarantine pests that were reasonably be expected to follow the pathway, *i.e.*, be included in commercial shipments of mango (*Mangifera indica*), were analyzed in detail (Step 5-7, USDA APHIS, 2000). Other plant pests in this assessment, not chosen for further scrutiny, may be potentially detrimental to the agricultural production systems the United States, but there were a variety of reasons for not subjecting them to further analysis. For example, they were associated mainly with plant parts other than the commodity; they may be associated with the commodity, but it was not considered reasonable to expect these pests to remain with the commodity during processing; or they have been intercepted as biological contaminants of these commodities during inspection by Plant Protection and Quarantine Officers but would not be expected to be present with commercial shipments. In addition, the biological hazard of organisms identified only to the genus level was not assessed due to the lack of adequate biological taxonomic information. This lack of biological information on any given insect or pathogen should not be equated with low risk. By necessity, pest assessments focus on those organisms for which biological information is available. By developing detailed assessments for known pests that inhabit a variety of niches on the parent species, *e.g.*, on the surface of or within the bark/wood, on the foliage, etc., effective mitigation measures may be developed to eliminate the known organism and any similar unknown ones that inhabit the same niches.

The organisms in this risk assessment that were only identified to genus level were *Anastrepha sp., Asterolecanium sp., Bactrocera sp., Blapstinus sp., Ceratitis sp., Ceroplastes* sp., *Chalcodermus sp., Cladosporium sp., Coccus sp., Colletotrichum sp., Conoderus sp., Conotrachelus sp., Contarinia sp., Dacus sp., Dysmicoccus sp., Hypothenemus sp., Icerya sp., Leptosphaeria sp., Pestalotiopsis sp., Phenacoccus sp., Phoma sp., Phomopsis sp., Planococcus sp., Pseudococcus sp., Pulvinaria sp.*, and *Udinia sp.* The quarantine pests that are likely to follow the pathway of importation on mango (*Mangifera indica*) from Ghana and that were further analyzed in this risk assessment are:

Sternochetus mangiferae (Fabricius) (Coleoptera: Curculionidae)
Bactrocera cucurbitae Coquillett (Diptera: Tephritidae)
Bactrocera invadens (Diptera: Tephritidae)
Ceratitis capitata (Wiedemann) (Diptera: Tephritidae)
Ceratitis cosyra (Diptera: Tephritidae)
Ceratitis rosa Karsch (Diptera: Tephritidae)
Udinia catori (Green) (Hemiptera: Coccidae)
Udinia farquharsoni (Newstead) (Hemiptera: Coccidae)
Udinia pattersoni Hanford (Hemiptera: Coccidae)
Icerya aegyptiaca (Douglas) (Hemiptera: Margarotididae)
Icerya seychellarum (Westwood) (Hemiptera: Margarotididae)
Dysmicoccus neobrevipes Beardsley (Hemiptera: Pseudococcidae)
Maconellicoccus hirsutus (Green) (Hemiptera: Pseudococcidae)
Nipaecoccus viridis (Newstead) (Hemiptera: Pseudococcidae)
Planococcus minor (Maskell) (Hemiptera: Pseudococcidae)
Rastrococcus invadens Williams (Hemiptera: Pseudococcidae)

5. Consequences of Introduction

The consequences of introduction were evaluated for the quarantine pests likely to follow the pathway. For each of those quarantine pests, the potential consequences of introduction were rated using five risk elements; these elements reflect the biology, host range and climatic/geographic distribution of the pest. For each risk element, pests were assigned a rating of Low (1 point), Medium (2 points), or High (3 points). A Cumulative Risk Rating was then calculated by summing all risk element values. The values determined for the Consequences of Introduction for each pest are summarized in Table 5

The Consequences of Introduction rating system is based on five elements: Climate, Host

Interaction, Host Range, Dispersal Potential, Economic Impact, and Environmental Impact. Each element is evaluated at one of three levels, Low (1 point), Medium (2 points), or High (3 points), in order to arrive at a Risk Value. A summation of each Risk Value component determines the Pest Risk Potential for the organism. The Pest Risk Potential is a relative measure of the seriousness of the organism based upon its biology, it is considered to be a biological indicator of the potential of the pest to establish, spread, and cause economic and environmental impacts.

Risk Element #1: Climate – Host Interaction

When introduced to new areas, pest can be expected to behave as they do in their native areas if host plants and climates are similar. Ecological zonation and the interactions of pests with their biotic and abiotic environments are considered in this element. Estimates are based on the availability of host material and suitable climate conditions. To rate this Risk Element, the U.S. "Plant Hardiness Zones" created by U.S. Department of Agriculture (USDA-ARS, 1990), is used (Figure 1). Due to the availability of both suitable host plants and suitable climate, the pest has the potential to establish a breeding colony:

Low (1): In a single plant hardiness zone.
Medium (2): In two or three plant hardiness zones.
High (3): In four or more plant hardiness zones.

In none of the quarantine pests are capable of becoming established in the PRA area because of the absence of suitable climates or host, the PRA stops.

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 for causing plant damage. For arthropods, risk is assumed to be positively correlated with host range. For pathogens, risk is one complex and is assumed to depend on host range, aggressiveness, virulence and pathogenicity; for simplicity, risk is rated as a function of host range.

Low (1): Pest attacks a single species or multiple species within a single genus.
Medium (2): Pest attacks multiple species within a single plant family.
High (3): Pest attacks multiple species among multiple plant families.

Risk Element #3: Dispersal Potential

Risk may disperse after introduction to a new area. The following items are considered: reproductive patterns of the pest (e.g., voltinism, biotic potential); inherent powers of movement; factors facilitating dispersal, wind, water, presence of vectors, human, etc.

Low (1): Pest has neither high reproductive potential nor rapid dispersal capability.
Medium (2): Pest has either high reproductive potential OR the species is capable of rapid dispersal.
High (3): Pest has high biotic potential, e.g., many generations per year, many offspring per reproduction ("r-selected" species), AND evidence exists that the pest is capable

of rapid dispersal, e.g., over 10 km/per under its own power; via natural forces, wind, water, vectors, etc., or human assistance.

Risk Element#4: Economic Impact

Introduced pests are capable of causing a variety of direct and indirect economic impacts. These impacts are divided into three primary categories (other types of impacts may occur): lower yield of the host crop, e.g., by causing plant mortality, or by acting as a disease vector; lower value of the commodity, e.g., by increasing costs of production, lowering market price, or a combination; loss of foreign or domestic markets due to the presence of a new quarantine pest.

Low (1): Pest causes any one or none of the above impacts.
Medium (2): Pest causes any two of the above impacts.
High (3): Pest causes all three of the above impacts.

Risk Element #5: Environmental Impact

The potential of each pest to cause environmental damage (IPPC, 1996) proceeds by considering the introduction of the pest as it is expected to cause significant, direct environmental impacts, e.g., ecological disruptions, reduced biodiversity. (1) When used within the context of the National Environmental Policy Act (NEPA) (7CFR §372), significance is qualitative and encompasses the likelihood and severity of an environmental impacts; (2) a pest that is expected to have a direct impact on other existing species is listed by federal agencies as endangered or threatened (50 CFR §17.11 and §17.12), by infesting/infecting a list plant. If the pest attacks other species within the genus or other genera within the family, and preference/no preference tests have not been conducted with the listed plant and the pest, then the plant is assumed to be a host; (3) the pest is expected to have an indirect impact on the species listed by federal agencies as endangered or threatened by disrupting the sensitive, critical habitats; (4) the introduction of such a pest would stimulate chemical or biological control programs.

Low (1): None of the above would occur; it is assumed that introduction of a nonindigenous pest will have some environmental impact (by definition, introduction of a nonindigenous species affects biodiversity).
Medium (2): One of the above would occur.
High (3): Two or more of the above would occur.

Consequences of Introduction: ***Sternochetus mangiferae*** **(Coleoptera: Curculionidae)**	Risk Value
Risk Element #1: Climate-Host Interaction The weevil occurs in most countries where mangoes are grown, except for the Canary Islands (Spain), Italy, Israel and Egypt and the Americas (CABI, 2004). The mango weevil occurs only in tropical regions where mango is cultivated (CABI, 2004), corresponding to USDA Plant Hardiness Zones 10 and 11. Mango is only cultivated in zone 11 of the United States, so the Climate-Host Interaction is rated Low (1).	Low (1)
Risk Element #2: Host Range *Sternochetus mangiferae* only feeds on mangoes, *Mangifera indica*, L (CABI, 2004).	Low (1)
Risk Element #3: Dispersal Potential. One female may lay 15 eggs per day, with a maximum of almost 300 over a 3-month period in the laboratory (Balock and Kozuma, 1964). Incubation varies with the season and temperature but typically takes 5-7 days (Balock and Kozuma, 1964). In Hawaii, the larval period ranged from 22 days to 10 weeks (Balock and Kozuma, 1964; CABI, 2004). Pupation usually occurs within the seed and rarely in the flesh and lasts about a week (Balock and Kozuma, 1964; CABI, 2004). The estimated time required for development from egg to adult is 35-54 days (CABI, 2004). Adults are capable of surviving long, unfavorable periods. During non-fruiting periods, weevils diapause under loose bark on mango tree trunks and in branch terminals, or in crevices near mango trees (Balock and Kozuma, 1964). A few adults live through two seasons with a diapause period in between. The mango weevil has become established in virtually every mango growing area of the old world, except in the Canary Islands (Spain), Italy, Israel and Egypt (CABI, 2004). Dispersal potential is rated High (3).	High (3)
Risk Element #4: Economic Impact Marketability is not directly affected because the weevil resides inside the seed within a thick husk in mature mangoes and is rarely encountered (CABI, 2004). However, emerging adults cause post-harvest damage to the pulp of late-maturing cultivars in South Africa (CABI, 2004). Mango seed weevil infestation may increase fruit drop during early fruit development (Follett, 2002), and may reduce the germination capacity of seeds. In India, all cultivars are susceptible and levels of infestation vary from 48 to 87% (CABI, 2004). The mango seed weevil has the potential to limit exports and has an economic impact on the mango industry because of its status as a quarantine pest (Follett, 2002). In 1997, domestic mango production in Florida was worth $1.45 million (Mossler and Nesheim, 2002). Although the presence of mango weevil in the United States would prevent export to several countries, the economic impact would be small because the United States does not export mangoes. The overall economic impact of the mango seed weevil in the United States is expected to be Low (1).	Low (1)

Risk Element #5: Environmental Impact	
None of threatened or endangered species would be attacked by the mango seed weevil (USFWS, 2002). Introduction of the mango seed weevil would not stimulate large scale of biological and chemical control measures in the United States. Therefore the environmental impact is Low (1).	Low (1)

Consequences of Introduction: *Bactrocera cucurbitae* Coquillett (Diptera: Tephritidae)	**Risk Value**
Risk Element #1: Climate – Host Interaction *B. cucurbitae* is native to Asia and distributed throughout much of subtropical and tropical Asia. It is also reported as present in Eastern and Western Africa, and the Pacific Islands (CABI, 2002). Its distribution corresponds to U.S. Plant Hardiness Zones 9-11 (USDA-ARS, 1990). One or more of its potential hosts occurs in these Zones (USDA NRCS, 2002).	Medium (2)
Risk Element #2: Host Range *Bactrocera cucurbitae* is a serious pest of cucurbit crops (CABI, 2004). Primary hosts are **Cucurbitaceae** (*Cucumis melo*, *Cucurbita maxima*, *Cucurbita pepo*, *Trichosanthes cucumerina var. anguinea*) (CABI, 2004). Other host species include **Cucurbitaceae** (*Cucumis sativus*, *Benincasa hispida*, *Citrullus colocynthis*, *Citrullus lanatus*, *Cucumis auguria*, *Cucurbita moschata*, *Lagenaria siceraria*, *Luffa acutangula*, *Luffa aegyptiaca*, *Momordica balsamina*, *Momordica charantia*, *Sechium edule*, *Trichosanthes cucumerina*), **Moraceae** (*Artocarpus heterophyllus*, *Ficus carica*), **Malvaceae** (*Abelmoschus moschatus*), **Caricaceae** (*Carica papaya*), **Rutaceae** (*Citrus maxima*, *Citrus sinensis*), **Rosaceae** (*Cydonia oblonga*, *Prunus persica*), **Solanaceae** (*Cyphomandra betacea*, *Lycopersicon esculentum*), **Anacardiaceae** (*Mangifera indica*), **Sapotaceae** (*Manilkara zapota*), **Passifloraceae** (*Passiflora* spp., *Passiflora edulis*), **Lauraceae** (*Persea americana*), **Fabaceae** (*Phaseolus vulgaris*, *Sesbania grandiflora*, *Vigna unguiculata*), **Myrtaceae** (*Psidium guajava*, *Syzygium samarangense*), and **Rhamnaceae** (*Ziziphus jujube*) (CABI, 2004). Wild hosts of *B. cucurbitae* are wild species of Cucurbitaceae and rarely fruits of other families, as follows: **Cucurbitaceae**: *Cucumis trigonus* (White and Elson-Harris, 1994), *Diplocyclos palmatus*, *Gymnopetalum integrifolium*, *Melothria wallichii, Mukia maderaspatana* (CABI, 2004), *Trichosanthes ovigera, T. tricuspidata, T. wallichiana* and *T. wawraei* (Allwood *et al.*, 1999; CABI, 2004). **Agavaceae**: *Dracaena curtissi* (Allwood *et al.*, 1999); *Capparidaceae: Capparis sepiaria, C. thorellii* and *Maerua siamensis* (Allwood *et al.*, 1999); **Moraceae**: *Ficus chartacea* (Allwood et al., 1999); **Rutaceae***:* *Citrus hystrix* (Allwood *et al.*, 1999); **Solanaceae**: *Solanum trilobatum* (Allwood *et al.*, 1999); and **Vitaceae**: *Tetrastigma lanceolarium* (Allwood *et al.*, 1999).	High (3)

Risk Element #3: Dispersal Potential Females lay up to 40 eggs below the fruit skin or in the vegetative parts of plants. Females may produce 800-1000 eggs over their life span (CABI, 2004; Capinera, 2001; Weems, 1964). Reproduction is continuous as adults occur throughout the year. Under warm conditions, the development from egg to adult requires from 12-28 days (CABI, 2004). Eggs hatch within 1-2 days, and larval stages last for 4-17 days, depending on the thickness of fruit skin (CABI, 2004). Pupation takes place in the soil under the host plants for 7-13 days (CABI, 2004). Adult starts mating after 10-12 days and may live 5 to 15 months (Fletcher, 1989). This fruit fly may disperse naturally by flight. Fletcher 1989reports that many *Bactrocera* species can fly 50-100 km. Additionally, *B. cucurbitae* can be dispersed by infected plant materials, such as fruits and flowers (PIN, 2003). In commodities originating from Hawaii alone, it has been intercepted at ports of entry over 150 times (USDA, 1983; Weems, 1964).	High (3)
Risk Element #4: Economic Impact *B. cucurbitae* has been considered the most destructive pest of cucurbits in the Indo-Malayan region USDA, 1983; Weems, 1964 and it has greatly reduced the production of melons, cucumbers, tomatoes, and similar vegetables in Hawaii CABI, 2002. Around 1915, *B. cucurbitae* caused a loss of nearly $1 million in Hawaii in terms of destroyed crops. For example, more than 95% of the pumpkin crop was destroyed. Damage levels have been reported to be anything up to 100% of unprotected fruit (EPPO, 2004). If *B. cucurbitae* were introduced into the continental United States, an eradication program would be expected to be implemented to eliminate the pest before widespread damage could occur. Similar eradication programs for other Tephritidae fruit flies (i.e. *B. dorsalis* and *Ceratitis capitata)* have cost an average of $10 million per introduction. Vo and Miller, 1989 records this as an A1 pest, thus, should this species become established in the US, there would likely be a loss of export markets. Losses in export revenue of fruit fly susceptible hosts could amount to over $300 million annually (USFWS, 2002).	High (3)
Risk Element #5: Environmental Impact *B. cucurbitae* has a high potential to damage threatened and endangered species which is listed in Title 50, Part 17, Section 12 of the United States Code of Federal Regulations (50 CFR §17.12). Threatened and endangered species such as *Cucurbita okeechobeensis* spp. *okeechobeensis* (endangered species in FL), *Prunus geniculata* (endangered species in FL), and *Ziziphus celaata* (endangered species in FL) could be damaged by *B. cucurbitae* (White and Elson-Harris, 1992). Since this fruit fly represents an important economic threat, establishment and introduction of *B. cucurbitae* in the continental U.S. would trigger the initiation of eradication programs using biological and chemical methods.	High (3)

Consequences of Introduction: *Bactrocera invadens* (Diptera: Tephritidae)	Risk Value
Risk Element #1: Climate – Host Interaction Bactrocera invadens has been identified from Sri Lanka, and countries in East and West Africa (Drew *et al.*, 2005) corresponding to USDA Plant Hardiness Zones 11-13. This species could probably become established in the United States in areas corresponding to Plant Hardiness Zones 9-11 (CABI, 2004; White and Elson-Harris, 1994).	Medium (2)
Risk Element #2: Host Range The host plant list is also growing at a rapid rate and *Bactrocera invadens* has now been recorded from **Guava, Citrus, Papaya**, **Tandam**, **Tomatoes** and, especially **Mango,** and a number of wild hosts including ***Strychnos*** (Mansell, 2005).	High (3)
Risk Element #3: Dispersal Potential This insect has proven its ability to disperse rapidly over great distances. Believed to originate in Sri Lanka, B. invadens has spread to East and West Africa (Drew *et al.*, 2005; Mansell, 2005).	High (3)
Risk Element #4: Economic Impact *Bactrocera invadens* is a serious pest of mango and infests a variety of other fruits (Mansell, 2005). The fly closely resembles *Bactrocera dorsalis* and may mimic some of that fly's destructive potential.	High (3)
Risk Element #5: Environmental Impact Because of wide host range, *B. invadens* has a potential to feed on Threatened or/and Endangered species. Also, introduced fruit flies often stimulate chemical or biological control programs, similar to programs that have been established in Hawaii.	Medium (3)

Consequences of Introduction: *Ceratitis capitata* (Wiedemann) (Diptera: Tephritidae)	
Risk Element #1: Climate-Host Interaction *Ceratitis capitata* is found in southern Europe and west Asia, throughout Africa and South and Central America (CABI, 2004), and in northern Australia (Weems, 1981). This species has the capacity to tolerate colder climates better than most other species of fruit fly (USDA-ARS, 1990). It is estimated that *C. capitata* could become established in areas of the United States corresponding to Plant Hardiness Zones 8-11 (CABI, 2004).	High (3)
Risk Element #2: Host Range This pest has a wide range of host species and attacks over 400 different species (Capinera, 2001). Those species include **Rubiaceae** (*Coffee* spp.), **Solanaceae** (*Capsicum annuum*), **Rutaceae** (*Citrus* spp.), **Rosaceae** (*Malus pumila*, *Prunus* spp.), **Moraceae** (*Ficus carica*), **Myrtaceae** (*Psidium guajava*), **Sterculiaceae** (*Theobroma cacao*), **Arecaceae** (*Phoenix dactylifera*), and **Anacardiaceae** (*Mangifera indica*), **Lauracea** (*Persea* americana) (Capinera, 2001; Weems, 1981).	High (3)

Risk Element #3: Dispersal Potential Eggs are deposited on fruits in clusters of 3-9 eggs, with an average of 300 eggs laid per female (CABI, 2004). Breeding is continuous throughout the year, the species exhibiting several overlapping generations (Capinera, 2001). Under ideal conditions, it only takes 18 days to complete a generation; however, 30-40 days is common (Bedford *et al.*, 1998). Up to 15 generations can be observed per year (Capinera, 2001). In the adult stage, *C. capitata* is highly mobile flying distances of 2 kilometers or more when associated with wind (CABI, 2003); additionally, there is an evidence that it can fly at least 20 kilometers (CABI, 2003). The transportation of infested fruits is a major means of movement and dispersal to previously un-infested areas (NASS, 2003).	High (3)
Risk Element #4: Economic Impact *Ceratitis capitata* is an important pest in Africa and has spread to almost every other continent to become the single most important pest species in its family. It is a serious pest of *Prunus* and *Citrus*. In 2002, CA, TX, and FL produced over $2.3 billion worth of *Citrus* and $333 million worth of *Prunus* (CABI, 2004). In Mediterranean countries, it is particularly damaging to citrus and peach crops (1998). Bedford, et al. *et al.* (CABI, 2004) stated that susceptible deciduous fruits crops can suffer losses up to 80% when control measures are not applied. It may also transmit fruit-rotting fungi (CABI, 2004). The species is of quarantine significance throughout the world, especially for Japan and the United States. Its presence, even as temporary adventive populations, can lead to severe additional constraints for export of fruits to uninfested areas in other parts of the world. In this respect, *C. capitata* is one of the most significant quarantine pests for any tropical or warm temperate areas in which it is not yet established (USFWS, 2002).	High (3)
Risk Element #5: Environmental Impact *Ceratitis capitata* has the potential to damage Endangered/Threatened species, such as *Prunus genuclata* (FL), *Argemone pleiacantha* (NM), *Asimina tetramera* (FL), *Berberis nevivii* (CA), *B. pinnata* (CA), *B. sonnei* (CA), *Cucurbita okeechobeensis* (FL), *Echinocereus chisoensis* (TX), *E. reichenbachii* (TX), *E iridiflorus* (TX), *E. fendleri* (NM), *E. triglochidiatus* (AZ), *E. telephioides* (FL), *Opuntia treleasei* (CA), *Solanum drymophilum* (PR), *Ribes echinellum* (FL, SC), and *Ziziphus celata* (FL) (Clausen, 1978; Smith *et al.*, 1997). Because it represents a significant threat to citrus and peach production, the establishment of *C. capitata* in the United States undoubtedly would trigger the initiation of chemical or biological control programs, as has occurred in Hawaii and California (CABI, 2004).	High (3)

Consequences of Introduction: ***Ceratitis cosyra*** **(Diptera: Tephritidae)**	**Risk Value**
Risk Element #1: Climate-Host Interaction *Ceratitis cosyra* is widely distributed in West Africa, East Africa, Central Africa, and Southern Africa (USDA-ARS, 1990) . Its distribution corresponds to U.S. Plant Hardiness Zones 8 – 11 (CABI, 2004).	High (3)

Risk Element #2: Host Range *Ceratitis cosyra* primary attacks mango (CABI, 2004). Host species include Anacardiaceae (*Mangifera indica, Sclerocarya birrea*), Annonaceae (*Annona cherimola, Annona reticulata, Annona senegalensis),* Rutaceae *(Citrus aurantium),* Lauraceae (*Persea americana*) and Myrtaceae (*Psidium guajava, Prunus persica*).	High (3)
Risk Element #3: Dispersal Potential There are several generations in a year (CABI, 2004). Oviposition varies with host species but usually starts at the beginning of ripening stage (CABI, 2004). There are three larval instars which develop about a week. Pupation occurs in the soil and usually takes 10-12 days; emergence occurs after 1-2 weeks (CABI, 2004). The major means of dispersal and movement are adult flight and infested fruits (CABI, 2004).	High (3)
Risk Element #4: Economic Impact *C. cosyra* primarily attacks only mango (CABI, 2004). Guava damage by *C. cosyra* was reported in Ivory Coast (CABI, 2004). In the United States, mango and guava productions are limited; therefore the economic impact is rated Low.	Low (1)
Risk Element #5: Environmental Impact None of the Endangered and Threatened species is likely to be attacked by *C. cosyra. C. cosyra* is typically controlled together with other *Ceratitis* species. Introduction and establishment of *C. cosyra* may stimulate biological and/or chemical controls in the United States.	Medium (2)

Consequences of Introduction: *Ceratitis rosa* Karsch (Diptera: Tephritidae)	Risk Value
Risk Element #1: Climate – Host Interaction *Ceratitis rosa* is native to tropical rainforests, savannahs, and deserts in Africa (USDA-ARS, 1990). It has the potential to establish in USDA Plant Hardiness Zones 9-11 (CABI, 2002).	Medium (2)
Risk Element #2: Host Range The primary hosts are *Coffee* spp. (Rubiaceae) and *Citrus* spp. (Rutaceae) (CABI, 2004). This fly will also attack numerous species, including Rosaceae (*Malus* spp., *Pyrus* spp., *Prunus* spp., *Rubus* spp.), Solanaceae (*Lycopersicum esculentum*, *Capsicum annuum*), Vitaceae (*Vitis* spp.), Myrtaceae (*Psidium guajava*), Lauraceae (*Persea Americana*), Moraceae (*Ficus carica*), Caricaeae (*Carica papaya*), and Anacardiaceae (*Mangifera indica*) (Weems and Fasulo., 2002; Weems and Fasulo., 2002).	High (3)
Risk Element #3: Dispersal Potential *Ceratitis rosa* tolerates temperatures as low as 20°F; however, food, water, and shelter are more important factors for overwintering rather than temperature (Weems and Fasulo., 2002). Females lay 10-20 eggs at a time on host fruits. Depending on the temperature, eggs usually hatch within four days after oviposition (Weems, 2002). Larval and prepupal stages generally last 12 days, and the pupal stage can range from 10-20 days (Weems and Fasulo., 2002). Under the conditions of central Florida, *C. rosa* is estimated to have 10 generations per year (CABI, 2002). The two major ways of movement and dispersal to uninfested areas	High (3)

are flight in adult stage and via the transportation of infested fruits (Duyck and Quilici, 2002).	
Risk Element #4: Economic Impact Like *C. capitata*, this species can cause tremendous loss to fruit and vegetable production (NASS, 2003). *Citrus* and *Prunus* species were worth over $2.88 billion in CA, FL, and TX during 2002 (NASS, 2003). Avocado, which is the host species of *C. capitata*, is produced in CA, FL, and HI. Total avocado productions in 2002 from those states were over $362 million (USFWS, 2002).	High (3)
Risk Element #5: Environmental Impact *Ceratitis rosa* has the potential to attack species listed by Federal agencies as Threatened or Endangered, such as *Prunus geniculata* (FL), *Eugenia haematocarpa* (PR), *E. koolauensis* (HI), *E. woodburyana* (PR), *Solanum drymophilum* (PR), *S. incompletum* (HI), *S. andwicense* (HI), and *Ziziphus celata* (FL) (Ben-Dov *et al.*, 2004). The introduction and establishment of *C. rosa* in the United States would stimulate chemical or biological control programs.	High (3)

Consequences of Introduction: *Udinia catori* (Green), *Udinia farquharsoni* (Newstead), *Udinia pattersoni* Hanford (Hemiptera: Coccidae)	**Risk Value**
Risk Element #1: Climate-Host Interaction *Udinia catori* is mainly distributed in West Africa. It has been recorded in Ivory Coast, Ghana, Guinea, Nigeria, Senegal, Sierra Leone and Sudan (USDA, 1990). Its distribution corresponds to US Plant Hardiness Zones of 10-11 (2004).	Medium (2)
Risk Element #2: Host Range Ben-Dov (1997) list several hosts of *U. catori*. The host species include **Anacardiaceae** (*Mangifera indica*), **Apocynaceae** (*Landolphia*, *Landolphia beudelotti*, *Tabernaemontan*). **Bignoniaceae** (*Oroxylon)*, **Guttiferae** (*Garcinia*), **Lauraceae** (*Persea americana*), **Leguminosae** (*Cassia nodosa*), **Meliaceae** (*Khaya senegalensis*), **Moraceae** (*Ficus*, *Ficus exasperata*), **Myrtaceae** (*Psidium guajava*), **Naucleaceae** (*Nauclea latifolia*), **Rubiaceae** (*Coffea*), **Rutaceae** (*Citrus*, *Citrus aurantium*), **Sapindaceae** (*Blighia sapida*), **Sapotaceae**: (*Chrysophyllum cainito*), **Sterculiaceae** (*Cola acuminata*, *Cola nitida, Theobroma cacao, Triplochito*) and **Verbenaceae** (*Tectona grandis*).	High (3)
Risk Element #3: Dispersal Potential There was no biology information available for *Udinia* species. Gullan & Kosztarab (Gullan and Kosztarab, 1997) stated that only first-instar Coccoidae insects were dispersed by wind, but the distances carried by wind could be several kilometers to hundreds of kilometers, although mortality rates were high at longer distances.	High (3)
Risk Element #4: Economic Impact This genus mainly attacks tropical and subtropical fruits and vegetables. The productions of tropical and subtropical crops are limited and Citrus species would be probably the only crops affected in the continental United States. Therefore, it is rated Medium.	Medium (2)

Risk Element #5: Environmental Impact None of the Endangered and Threatened species is likely to be attacked by *Udinia* species (CABI, 2004; USFWS, 2002). Introduction of *Udinia* species would probably not stimulate large scale of biological and chemical control measures in the United States	Low (1)

Consequences of Introduction: *Icerya aegyptiaca* (Douglas), *I. seychellarum* (Westwood) (Hemiptera: Margarotididae)	**Risk Value**
Risk Element #1: Climate-Host Interaction *Icerya seychellarum and I. aegyptiaca* are distributed in Southern Asia, Eastern and Southern Africa, Australia and Oceania (USDA, 2001). It s estimated that in the United Statews it could establish in Plant Hardiness Zones 8-11. One or more of its potential hosts occurs in these zones (CABI, 2004).	High (3)
Risk Element #2: Host Range Both species have a variety of hosts, especially woody plants (CABI, 2004). *Icerya aegyptica* major host species include *Annona* , *Annona muricata* (Annonaceae), *Artocarpus* (Moraceae), *Artocarpus altilis* (Moraceae), *Artocarpus heterophyllus* (Moraceae), *Citrus*(Rutaceae) , *Mangifera indica* (Anacardiaceae), *Manilkara zapota* (Sapotaceae), *Morus alba* (Moraceae) and *Psidium guajava* (Myrtaceae) (CABI, 2004). *Icerya seychellarum*'s extensive host list includes, but is not limited to: *Persea americana* (Lauraceae), *Cocos nucifera* (Arecaceae), *Psiduim guajava* (Myrtaceae), *Rosa* spp. (Rosaceae), *Pyrus* spp. (Rosaceae), *Camellia sinensis* (Theaceae), *Coffea* spp. (Rubiaceae), *Dioscora* spp. (Dioscoreaceae), *Ipomea batatas* (Convolvulaceae), *Lycopersicum esculentum* (Solonaceae), *Vitis vinifera* (Vitaceae), *Mangifera indica* (Anacardiaceae) (Anonymous, 1994), and *Dimocarpus longan* (Sapindaceae) (CABI, 2004).	High (3)
Risk Element #3: Dispersal Potential. For both species development usually takes three months (CABI, 2004; USDA, 1982). In Japan and South Africa, *I. seychellarum* has only one generation per year (CABI, 2004); elsewhere (Aldabra Island) more generations per year are documented (USDA, 1982). For both species males are rare and are not necessary for reproduction (Greathead, 1997). The only mobile stae is the first instar crawler, which can be transported by wind up to onehundred kilometers per day (Azab *et al.*, 1968). *Icerya aegyptiaca* may produce 70-140 eggs and complete 2-3 generations per year in Northern Africa (CABI, 2004).	Medium (2)

Risk Element #4: Economic Impact	
Icerya aegyptiaca has been recorded as a serious pest of citrus, fig and shade trees in Egypt, although it is now largely controlled by natural enemies (CABI, 2004). It is also a pest of breadfruit, avocado, banana, citrus and ornamentals in the South Pacific; annona, jackfruit, sapote (Pouteria sapota), guava and mulberry in India and breadfruit in the Maldive Islands (CABI, 2004). Heavy infestations of breadfruit on Pacific atolls have been reported to kill even mature trees but, more often, trees are partially defoliated and the crop reduced, sometimes by more than 50% (CABI, 2004). *Icerya seychellarum* has the potential to impact many economically important tropical tree species, attacking leaves, twigs, smaller branches, fruits and flowers. Feeding decreases plant vigor, reducing leaf production as much as 36% (Newgbury, 1980). Honeydew excrerted by the scale provides a medium for molds to grow, thereby reducing photosynthesis. This has been demonstrated in the Pacific Islands, where *I. seychellarum* has been recorded killing trees (CABI, 2004). *Icerya seychellarum* is a pest of guava (Psidium guajava), citrus (Citrus spp.), breadfruit (Artocarpus altilis), avocado (Persea americana), jackfruit (Artocarpus heterophllus), various genera of palms, and rose (Rosa spp.) (1983). Hill (1983) considered the scale to be a minor pest of various crops (eg. Coconut, jackfruit, breadfruit, citrus, etc). The scale is considered a minor pest of citrus in India, Japan, and South Africa. Establishment of this pest in the US could potentially cause a loss of foreign or domestic markets and would likely stimulate chemical and/or biological control programs, which would lower the value of the commodity by increasing production costs.	High (3)
Risk Element #5: Environmental Impact As the species is polyphagous, it is likely to affect Endangered and Threatened species, particularly from the genera Caesalpinia, Crotalaria, Eugenia, Euphorbia, Hibiscus, Solanum, Prunus and Scaevola (CABI, 2004). *Icerya spp.* have been controlled by the ladybird, *Rodolia cardinalis* in Australia (CABI, 2004). In Egypt, biological control was introduced and successfully controlling *I. aegyptiaca* (Ben-Dov *et al.*, 2004; CABI, 2004; Miller and Miller, 2002). Chemical and/or biological control is likely to be implemented upon introduction of this pest.	High (3)

Consequences of Introduction: *Dysmicoccus neobrevipes* Beardsley (Hemiptera: Pseudococcidae)	Risk Value
Risk Element #1: Climate-Host Interaction *Dysmicoccus neobrevipes* occurs throughout Central America, in northern South America, throughout the Caribbean, in Indo-China, the Philippines, and in parts of Oceania (USDA-ARS, 1990). Outside of greenhouse or other artificial situations, this species should be able to survive only in the warmer, southern parts of the United States (Plant Hardiness Zones 9-11) (USDA NRCS, 2002). One or more of its potential hosts occurs in these Zones (CABI, 2004).	Medium (2)

Risk Element #2: Host Range *Dysmicoccus neobrevipes* is highly polyphagous. Hosts include **Bromeliaceae** (*Ananas comosus*), **Rosaceae** (*Malus domestica*) (Nakahara and Miller, 1981), **Araceae** (*Colocasia esculenta, Pritchardia* sp.), **Moraceae** (*Ficus* sp.), **Musaceae** (*Musa paradisiaca*), **Cactaceae** (*Opuntia ficus-indica*), **Fabaceae** (*Acacia koa* , *Samanea saman*), **Asteraceae** (*Helianthus annuus (Ben-Dov et al., 2004*); **Agavaceae** (*Agave sisalana*), **Cucurbitaceae** (*Cucurbita maxima*), **Poaceae** (*Zea mays*), **Heliconiaceae** (*Heliconia latispatha*), **Lauracea** (*Persea* americana), **Rutaceae** (*Citrus* spp.), and **Solanaceae** (*Lycopersicon esculentum*) (Martin Kessing and Mau., 1992).	High (3)
Risk Element #3: Dispersal Potential The life span of *D. neobrevipes* varies from 59 to 117 days, averaging at 90 days (Martin Kessing and Mau., 1992). This mealybug is ovoviviparous, meaning the eggs hatch within the female; female produces about 350 larvae for 30 days, but some produces up to 1000 larvae (Gullan and Kosztarab, 1997). There are three instars for female and four instars for male. Total larval period for female varies from 26 to 52 days, averaging at 35 days, whereas the total larval period for male last from 22 days to 53 days. There may be several generations per year. As in all Coccoidea (CABI, 2004), the main dispersal stage of mealybugs is the first-instar crawler, which may be transported locally by wind or other animals. Dispersal over longer distances is accomplished through the movement of infested plant materials in commerce (Rohrbach and Beardsely, 1988).	High (3)
Risk Element #4: Economic Impact *Dysmicoccus neobrevipes* attacks a number of valuable commercial crops, and is a particularly serious pest of pineapple, *Ananas comosus* (Jahn, 1993). Like *D. brevipes*, it is a vector of the virus causing pineapple wilt disease. Feeding by large mealybug populations may cause a loss of host plant vigor. Also, honeydew deposited on leaves and fruit by mealybugs serves as a medium for the growth of black sooty molds, which interfere with photosynthesis and reduce the market value of the crop. Insecticides often are applied to control these mealybugs or the attending ants that aid in their spread and interfere with their biological control (Bartlett, 1978). *Dysmicoccus neobrevipes* is a quarantine pest for Korea and New Zealand.	High (3)
Risk Element #5: Environmental Impact Further introductions of *D. neobrevipes* likely would result in the initiation of chemical or biological control programs, as has occurred in Hawaii and Puerto Rico (CABI, 2004). The species is polyphagous, and has the potential to feed on plants listed as Threatened or Endangered (e.g., *Opuntia treleasei*, *Helianthus paradoxus*).	High (3)

Consequences of Introduction: *Maconellicoccus hirsutus* (Green) (Hemiptera: Pseudococcidae)	Risk Value
Risk Element #1: Climate-Host Interaction *Maconellicoccus hirsutus* is probably native to southern Asia (CABI, 2004). It is reported in Northern and part of sub-Saharan Africa, Middle East, South and Southeast Asia, Far East, Central America, Australia and Oceania (Hoy *et al.*, 2003). This pest currently has a limited distribution in the U.S. in Hawaii, California, and Florida (Capinera, 2001; USDA-ARS, 1990). It is estimated that it could potentially become established in the United States in the Plant hardiness zones 9-11 (USDA NRCS, 2003). One or more of its potential hosts occurs in these zones (CABI, 2002).	Medium (2)
Risk Element #2: Host Range This species is extremely polyphagous. It has been recorded on plants in over 200 genera from 73 families, showing some preference for hosts in the Malvaceae, Fabaceae, and Moraceae (Ben-Dov *et al.*, 2004). Hosts include species in the families: Acanthaceae, Amaranthaceae, Amaryllidaceae, Anacardiaceae, Annonaceae, Apiaceae, Apocynaceae, Araceae, Araliaceae, Basellaceae, Begoniaceae, Bignoniaceae, Bombacaceae, Boraginaceae, Cactaceae, Caricaceae, Casuarinaceae, Combretaceae, Convolvulaceae, Crassulaceae, Cucurbitaceae, Cyperaceae, Dilleniaceae, Dioscoraceae, Ebenaceae, Euphorbiaceae, Fabaceae, Fagaceae, Lamiaceae, Lauraceae, Lecythidaceae, Liliaceae, Lythraceae, Malvaceae, Melastomataceae, Meliaceae, Moraceae, Myrtaceae, Nyctaginaceae, Oleaceae, Orchidaceae, Oxalidaceae, Passifloraceae, Phytolacaceae, Piperaceae, Plumbaginaceae, Polygonaceae, Portulacaceae, Proteaceae, Flacourtiaceae, Rhamnaceae, Rosaceae, Compositae, Gesneriacae, Gramineae, Palmae (CABI, 2004; Meyerdirk, 1996).	High (3)
Risk Element #3: Dispersal Potential Each adult female can lay from 80 to 600 eggs over a one week period (CABI, 2004). Hatching occurs in 609 days (CABI, 2004). In warm conditions, a generation is completed in five weeks; in colder climates, the species survives cold conditions as eggs or other stages, on the host plant or in the soil. There may be as many as 15 generations per year. Local dispersal is accomplished by the first-instar crawler, most efficiently via air or water, or on animals (CABI, 2004). All stages may be dispersed over longer distances through the transport of infested plant materials.	High (3)

Risk Element #4: Economic Impact	High (3)
Maconellicoccus hirsutus attacks a wide range of (usually woody) plants, including agricultural, horticultural, and forest species (CABI, 2004). Feeding on young growth causes severe stunting and distortion of leaves, thickening of stems, and a bunchy-top appearance of shoots; in severe cases the leaves may fall prematurely. Honeydew and sooty mold contamination of fruit may reduce its value. In Grenada, estimated annual losses to crops and the environment from this mealybug were $3.5 million before biological controls were implemented (PRF., 2004). Other crops seriously damaged by *M. hirsutus* include cotton in Egypt, with growth sometimes virtually halted; tree cotton in India, with reduction in yield; the fiber crop *Hibiscus sabdariffa* var. *altissima* (roselle) in India and Bangladesh, with reduction in yields of between 21 and 40%; and grapes in India, with up to 90% of bunches destroyed. It is a quarantine pest for Brazil, Chile, Colombia, Costa Rick, Korea, New Zealand, Panama, and Uruguay (EPPO, 2004), suggesting that its widespread establishment in the United States could result in a loss of foreign markets for various commodities. This species is an actual or potential pest of a wide range of economically important plants, and risk associated with its economic impact is estimated to be high. EPPO (2003) records this as an A1 pest, thus, establishment in the United States may lead to loss of export markets.	
Risk Element #5: Environmental Impact	High (3)
Because of its extreme polyphagy, this pest poses a threat to plants in the continental United States listed as Threatened or Endangered including *Cucurbita okeechobeensis* ssp. *Okeechobeensis* (FL), *Helianthus eggertii* (AL,KY, TN), *H. paradoxus (TX), H. schweinitzii* (NC, SC), *Manihot walkerae* (TX), *Opuntia treleasei* (CA), *Rhododendron chapmanii (FL), Amaranthus pumilus* (DE, MA, MD, NC, NJ, NY, RI, SC, VA), *Euporbia telephiodes (FL), Prunus geniculata* (FL), and others (CABI, 2002; USFWS, 2002). As it also is a potential threat to a number of crops of considerable economic value in the United States (e.g., soybean, cotton, corn, citrus, grapes; (Meyerdirk, 1996), its introduction into additional mainland states would likely lead to the initiation of chemical or biological control programs. This species is currently the target of an official program of biological control throughout its present range in the UnitedStates (Bartlett, 1978), and has been targeted for biological control in other countries, such as Egypt and India (CABI, 2004).	

Consequences of Introduction: *Nipaecoccus viridis* (Newstead) (Hemiptera: Pseudococcidae)	Risk Value
Risk Element #1: Climate-Host Interaction	Medium (2)
This species is widespread in tropical and subtropical Asia, occurs throughout Africa and in parts of Oceania, but has limited distribution in North America (Ben-Dov *et al.*, 2004). It should be able to survive only in the warmer, southern parts of the United States (Plant Hardiness Zones 9-11) (CABI, 2004).	

Risk Element #2: Host Range *Nipaecoccus viridis* has been recorded on host plants in more than 18 families (CABI, 2004). The primary host species are **Rutaceae** (*Citrus* spp.), **Rubiaceae** (*Coffea* spp.), and **Malvaceae** (*Gossypium* spp). However, this species is polyphagous and the following species are listed as host plants: **Fabaceae** (*Acacia karroo*, *Leucaena leucocephala*, *Leucaena* spp., *Albizia lebbeck*, *Glycine max*), **Lamiaceae** (*Clerodendrum infortunatum*), **Rutaceae** (*Citrus limon*, *Citrus aurantiifolia*, *Citrus aurantium*, *Citrus maxima*, *Citrus x paradisi*, *Citrus sinensis*), **Apocynaceae** (*Nerium oleander*), **Punicaceae** (*Punica granatum*), **Lauraceae** (*Percea* americana), **Moraceae** (*Artocarpus heterophyllus*, *Ficus carica*, *Morus nigra*), **Tiliaceae** (*Corchorus capsularis*), **Malvaceae** (*Alcea rosea*, *Gossypium hirsutum*, *Hibiscus manihot*), **Liliaceae** (*Asparagus officinalis*), **Faboideae** (*Cajanus* spp., *Tamarindus* spp., *Tamarindus indica*), **Rubiaceae** (*Coffea arabica*), **Rosaceae** (*Eriobotrya japonica*), **Euphorbiaceae** (*Euphorbia hirta*, *Phyllanthus niruri*), **Proteaceae** (*Grevillea robusta*), **Bignoniaceae** (*Jacaranda mimosifolia*, *Spathodea campanulata*), **Anacardiaceae** (*Mangifera indica*), **Myrtaceae** (*Psidium guajava*), **Asteraceae** (*Parthenium hysterophorus*), **Solanaceae** (*Solanum tuberosum*), **Tamaricaceae** (*Tamarix* spp.), **Vitaceae** (*Vitis vinifera*), and **Rhamnaceae** (*Ziziphus mauritiana*, *Ziziphus spina-christi*) (CABI, 2004).	High (3)
Risk Element #3: Dispersal Potential Life cycle of *N. viridis* is about 68 days under optimum condition (Bedford, *et al.*, 1998). In South Africa, there are three generations per year (CABI, 2004). A female lays 90-138 eggs, and the egg and nymphal stages lasted 10-13 and 31-43 days, respectively (CABI, 2004). Long distance dispersal method is via infected plant materials (CABI, 2004).	High (3)
Risk Element #4: Economic Impact Feeding on young twigs causes bulbous outgrowths, and heavy infestations may severely stunt the growth of young trees (CABI, 2004). Citrus fruits infested with *N. viridis* may develop lumpy outgrowths or raised shoulders near the stem end. Frequently, fruits turn yellow and then partly black around the stem end, finally dropping off the tree. Late infestations on large green fruits result in congregations of young mealybugs in clumps over the face of the fruit. Copious quantities of honeydew may contaminate fruit and other plant parts, and serve as a medium for the growth of sooty molds. This mealybug was responsible for losses up to 5% in vineyards in India (CABI, 2004). Losses in citrus orchards are due firstly to fruit drop caused by large infestations of mealybugs; in South Africa, 50% or more of the navel orange crop has been lost in this way. Secondly, fruits with deformities caused by mealybug feeding are culled in the packinghouse, resulting in further lost production.	High (3)

Risk Element #5: Environmental Impact	
This pest represents a potential threat to vulnerable native plants (*e.g.*, *Euphorbia, Hibiscus* spp., *Solanum* spp., and *Ziziphus celata*) (Ben-Dov *et al.*, 2004) in the United States. Its status as a citrus pest could lead to initiation of chemical or biological control programs were it to become more widely established in the United States.	High (3)

Consequences of Introduction: *Planococcus minor* (Maskell) (Hemiptera: Pseudococcidae)	**Risk Value**
Risk Element #1: Climate-Host Interaction *Planococcus minor* is reported in South Asia (Bangladesh; British Indian Ocean Territory; Burma; India; Indonesia; Kalimantan; Sumatra; Malaysia; Philippines; Singapore; Taiwan; Thailand), Australia and islands of the South Pacific (American Samoa; Cook Islands; Fiji; French Polynesia; Kiribati; New Caledonia; Niue; Papua New Guinea; Solomon Islands; Tokelau; Tonga; Venuatu; Western Samoa), Africa (Madagascar; Rodriques Islands; Seychelles), tropical areas of the New World (Antigua and Barbuda), Argentina, Bermuda, Brazil, Colombia, Costa Rica, Cuba, Dominican Republic, Galapagos Islands, Grenada; Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, St. Lucia, Suriname, Trinidad and Tobago, U.S. Virgin Islands, Uruguay, Mexico (ScaleNet, 2005). It is reported in only tropical areas of Mexico (Ben-Dov, 1994). Based on this geographical distribution, it is estimated that this species could establish in U.S. Plant Hardiness Zones 9 – 11 (Ben-Dov, 1994).	Medium (2)
Risk Element #2: Host Range This species is extremely polyphagous, having been recorded on hosts in at least 65 plant families (Ben-Dov, 1994; CABI, 2004). Hosts include *Colocasia esculenta* (Araceae), *Solanum* spp. (Solanaceae), *Theobroma cacao* (Sterculiaceae), *Citrus* spp. (Rutaceae), *Coffea* spp.(Rubiaceae), *Mangiferae indica* (Anacardiaceae), *Musa* spp. (Musaceae), *Eugenia* spp. (Myrtaceae), *Vitis vinifera* (Vitaceae), *Ziziphus* sp. (Rhamnaceae), *Amaranthus* spp. (Amaranthaceae), Annona spp. (Annonaceae), *Helianthus* spp. (Asteraceae), *Euphobia* spp. (Euphorbiaceae), *Persea americana* (Lauraceae), *Ipomoea* spp. (Convolvulaceae), *Brassica* spp. (Brassicaceae), *Cucumis* spp. (Cucurbitaceae), *Zea mays* (Poaceae), *Arachis hypogaea* (Fabaceae), *Artocarpus* spp. (Moraceae), *Cocos nucifera* (Arecaceae), *Pandanus* spp. (Pandanaceae), *Pyrus pyrifolia* (Rosaceae) and *Asparagus plumosus* (Liliaceae) (Sahoo *et al.*, 1999).	High (3)
Risk Element #3: Dispersal Potential. Reported fecundity ranges from about 200 to over 400 eggs per female, depending on host plant (Maity *et al.*, 1998; Martinez and Suris, 1998; Sahoo *et al.*, 1999). There may be as many as 10 generations per year (CABI, 2004). This insect can be transported long distance in shipments of fruit (Sugimoto, 1994).	High (3)

Risk Element #4: Economic Impact This species is an important pest of coffee in India (Reddy *et al.*, 1997). Severe outbreaks (originally attributed to P. citri [Risso] have been reported on coffee and sugarcane in New Guinea (CABI, 2004). Introduction of this mealybug into the US could cause the loss of domestic or foreign markets for a number of commodities.	High (3)
Risk Element #5: Environmental Impact The extreme polyphagy of this species predisposes it to attack native plants listed as threatened or Endangered in 50 CFR § 17.12 (eg. *Amaranthus*, *Cucurbita*, Solanum, *Helianthus, Abutilon, Eugenia, Euphorbia*). As it represents a potentially serious threat to economically valuable crops in the US (eg. Avocado, citrus, cucurbits), its introduction could stimulate chemical or biological control programs.	High (3)

Consequences of Introduction: *Rastrococcus invadens* Williams (Hemiptera: Pseudococcidae)	**Risk Value**
Risk Element #1: Climate-Host Interaction *Rastrococcus invadens* is distributed in WestAfrica and South Asia (Ben-Dov *et al.*, 2004). Its distribution corresponds to US Plant Hardiness Zones 9-11 (CABI, 2004).	Medium (2)
Risk Element #2: Host Range 45 species of host plants from 22 families attacked by *R. invadens* in West Africa (CABI, 2004). Host includes Moraceae (*Artocarpus altilis*), Rutaceae (*Citrus*) , Moraceae (*Ficus*), Anacardiaceae (*Mangifera indica*), Musaceae (*Musa*), Apocynaceae (*Plumeria*).	High (3)
Risk Element #3: Dispersal Potential In tropical Africa, *R. invadens* females produce first-instar larvae within 10-12 days into second instars which lasts 7-8.5 days (CABI, 2004). Third-instar males form a cocoon and go through to a fourth instar over 8-11 days and females take 6.5-8.5 days before moulting to adults (CABI, 2004). Males take 28-31 days from hatching to last moult and females take 25-27 days (CABI, 2004). The short-lived adult males are capable of mating upon emergence. Females survived up to 225 days and laid eggs up to about day 200 (CABI, 2004). This species was introduced into Africa (CABI, 2004). It can be transferred with infected plant materials over a long distance.	High (3)
Risk Element #4: Economic Impact *R. invadens* does not seem to be of great economic importance in India (CABI, 2004). In Africa, this mealybug is a pest of mango and sometimes of citrus; it does not primary cause feeding damages to host trees but causes honeydew and sooty mould on leaves (MoFA, 2000).	Low (1)

Risk Element #5: Environmental Impact	Medium
None of the Endangered and Threatened species are likely to be attacked by *Rastrococcus invadens* (CABI, 2004). After introduction into Africa, classical biological control was established and successfully reduced population (2000). Introduction and establishment of *R. invadens* may stimulate biological controls in the United States.	(2)

For each pest, the sum of the five risk elements gives a Cumulative Risk Rating. This Cumulative Risk Rating is considered to be a biological indicator of the potential of the pest to establish, spread, and cause economic and environmental impacts. The summary of risk ratings for Consequences of Introduction is shown in Table 5.

Low: 5-8 points
Medium: 9-12 points
High: 13-15 points

Table 5. Risk Rating for Consequences of Introduction

Pest	Risk Element 1 Climate/Host Interaction	Risk Element 2 Host Range	Risk Element 3 Dispersal Potential	Risk Element 4 Economic Impact	Risk Element 5 Environmental Impact	Cumulative Risk Rating
Sternochetus mangiferae	Low (1)	Low (1)	High (3)	Low (1)	Low (1)	Medium (12)
Bactrocera cucurbitae	Medium (2)	High (3)	High (3)	High (3)	High (3)	High (14)
Bactrocera invadens	Medium (2)	High (3)	High (3)	High (3)	High (3)	High (14)
Ceratitis capitata	High (3)	High (3)	High (3)	High (3)	High (3)	High (15)
Ceratitis cosyra	High (3)	High (3)	High (3)	Low (1)	Medium (2)	High (13)
Ceratitis rosa	Medium (2)	High (3)	High (3)	High (3)	High (3)	High (14)
Udinia catori *U. farquharzoni* *U. pattersoni*	Medium (2)	High (3)	High (3)	Medium (2)	Low (1)	Medium (11)
Icerya aegyptiaca	High (3)	High (3)	Medium (2)	High (3)	High (3)	High (14)
Icerya seychellarum	High (3)	High (3)	Medium (2)	High (3)	High (3)	High (14)

Table 5. Risk Rating for Consequences of Introduction						
Pest	Risk Element 1 Climate/Host Interaction	Risk Element 2 Host Range	Risk Element 3 Dispersal Potential	Risk Element 4 Economic Impact	Risk Element 5 Environmental Impact	Cumulative Risk Rating
Dysmicoccus neobrevipes	Medium (2)	High (3)	High (3)	High (3)	High (3)	High (14)
Maconellicoccus hirsutus	Medium (2)	High (3)	High (3)	High (3)	High (3)	High (14)
Nipaecoccus viridis	Medium (2)	High (3)	High (3)	High (3)	High (3)	High (14)
Planococcus minor	Medium (2)	High (3)	High (3)	High (3)	High (3)	High (14)
Rastrococcus invadens	Medium (2)	High (3)	High (3)	Low (2)	Medium (2)	Medium (12)

6. Introduction Potential

Each pest is rated with respect to its Likelihood of Introduction, which is based on two separate components. First, an estimate is made concerning the quality of the commodity likely to be imported (Risk Element #6). Second, pest opportunity (Risk Element # 7) is estimated using five biological features. Details of those two Risk Elements and their rating criteria are provided in USDA APHIS (Gullan and Kosztarab, 1997); the ratings and cumulative score for Risk Element #6 and #7, i.e., the "Likelihood of Introduction Risk Rating" are shown in Table 6.

Risk Element #6: Pest Opportunity (Survival and Access to Suitable Habitat and Hosts)

For each pest, consider six sub-elements

1. Quantity of commodity imported annually:
The likelihood that an exotic pest will be introduced depends on the amount of potentially infested commodity that is imported. For qualitative pest risk assessments, the amount of commodity imported is estimated in units of standard 40 foot long shipping containers. In those cases where the quantity of a commodity imported is provided in terms of kilograms, pounds, number of items, etc., the number of units is converted the units into terms of 40 foot shipping containers.

Low (1 point): < 10 containers/year
Medium (2 points): 10 – 100 containers/year
High (3 points): > 100 containers/year

Total mango production is unknown in Ghana. Ghana shipped 125,000 tons of mango into Europe in 2002. Sea shipping containers which are 40 foot in length hold approximately 40,000 pounds (20 U.S. tons); this is used for various estimate of commodity shipment (USDA FAS, 2003). Anticipated volume of mango to be exported from Ghana is unknown; however, high volume of mango (> 100 containers/year) is likely to be shipped into the United States. Therefore, Quantity of commodity imported annually is rated High (3).

2. Survive postharvest treatment:

For this sub-element, postharvest treatment refers to any manipulation, handling, or specific phytosanitary treatment to which the commodity is subjected. Examples of postharvest treatment include culling, washing, chemical treatment, cold storage, etc. If there is no postharvest treatment, the estimate the likelihood of this sub-element is High.

Mango seed weevil, *Sternochetus mangiferae*, and fruit flies, *Ceratitis capitata, C. cosyra, C. rosa, Bactrocera cucurbitae* and *B. invadens* have a high potential of surviving postharvest treatments because they are internal feeders. Fruit flies are not likely to be effectively treated by external treatments, such as washing and inspection, especially if the infestation of the fruit is not obvious.

Scales (*Udinia catori, U. farquharsoni,* and *U. pattersoni*) and mealybugs *(Icerya aegyptiaca, Icerya seychellarum, Dysmicoccus neobrevipes, Maconellicoccus hirsutus, Nipaecoccus viridis, Planococcus minor,* and *Rastrococcus invadens*) are rated medium. Mango will be washed and wiped at the packing house so that external feeders are not likely to survive after postharvest treatments. However, depending on their stage (egg, larva, adult) or instar, these scales and mealybugs might find shelter on fruit, particularly at the stem end, or in packing materials. Scale insects have sessile stages that live firmly pressed to the plant surfaces. Their cryptic behaviour, small size, water repellent, waxy coverings, and firm attachment to the substrate could make them difficult to see or dislodge, sepecially if seltered at the stem end of the fruit. Therefore scales and mealybugs are rated medium.

3. Survive Shipment:

The shipping conditions of mango from Ghana are unknown. Mangoes can be held for a maximum of 11-15 days if held at 7 to 14° C. At this temperature, all the insects are expected to survive. Therefore, all the insects are rated High.

4. Not be detected at the port of entry:

Unless specific protocols with special inspection of the commodity in question are in place, standard inspection protocols for like commodities are assumed. If no inspection is planned, estimate this sub-element as High.

Mango seed weevil, *Sternochetus mangiferae*, and fruit flies *Bactrocera cucurbitae, B. invadens* and *Ceratitis capitata, C.corysa. C.rosa* have high probability of not being detected at the port of entry. White and Elson-Harris (Blank *et al.*, 1993; Miller, 1985a) stated that fruit flies have high probability of escaping detection at a port of entry, and infested fruit could go unrecognized

Scales (*Udinia catori, U. farquharsoni* and *U. pattersoni*) and mealybugs *(Icerya aegyptiaca, Icerya seychellarum, Dysmicoccus neobrevipes, Maconellicoccus hirsutus, Nipaecoccus viridis*

Planococcus minor and *Rastrococcus invadens*) are rated medium. These species are external feeders and are likely to be inspected at the port of entry.

5. Imported or move subsequently to an area with an environment suitable for survival:
Consider the geographic location of likely markets and the proportion of the commodity that is likely to move to locations suitable for pest survival. Even if infested commodities enter the country, not all final destinations will have suitable climatic conditions for pest survival.

All species, except *Sternochetus mangiferae*, are rated Medium because they are tropical and subtropical species. Tropical and subtropical locations are limited in the United States; in the continental United States, those regions are limited to the South and the West Coast, which comprise an estimated 10-12% of the total land area of the continental United States. *S. mangiferae* is tropical and subtropical species; however, it attacks only mango plant. Therefore, it is rated Low.

6. Come into contact with host material suitable for reproduction:
Even if the final destination of infested commodities is conducive for pest survival, suitable host material must be available in order for the pest to survive. Consider the complete host range of the pest species.

Mango seed weevil, *Sternochetus mangiferae* is rated low because mango is the only host plant. Friut flies, *Bactrocera cucurbitae*, *B. invadens*, *Ceratitis capitata*, and *C. rosa* are rated High. Four fruits flies have wide range of host species, which habitats not only subtropical and tropical zones but also temperate zones. *Ceratitis cosyra* has limited host species. It mainly attacks mangoes, and other host species are tropical species which do not commonly occur in the continental United States. Therefore, it is rated Medium.

Scales (*Udinia catori, U. farquharsoni* and *U. pattersoni*) and mealybugs (*Icerya aegyptiaca*, *Icerya seychellarum*, *Dysmicoccus neobrevipes*, *Maconellicoccus hirsutus*, *Nipaecoccus viridis* *Planococcus minor* and *Rastrococcus invadens*) have limited powers of natural dispersal due to lack wings or other means to achieve flight (Gullan & Kosztarab, 1997). For these insects, successful establishment in a new environment is contingent on the likelihood of at least two necessary conditions occurring: close proximity of susceptible hosts and presence on the imported fruit of crawlers or other mobile forms to transfer to new hosts (APHIS, 2000), circumstances that are highly unlikely to occur. However, several species of these scales and mealybugs have become permanently or sporadically established in the continental United States. They are *Maconellicoccus hirsutus* (FL) and *Nipaecoccus viridis* (CA). Therefore, those species clearly proves that they have high probabilities of coming into contact with host material and are ranked High (3). The rest of the mealybugs and scales are rated low.

Summary of the ratings for Likelihood of Introduction is depicted in Table 6.

Low: 6 – 9 points
Medium: 10 – 14 points
High: 15 – 18 points

Table 6. Risk Rating for Likelihood of Introduction: (Risk Element #6)

Pest	Subelement 1 Quantity imported annually	Subelement 2 Survive postharvest treatment	Subelement 3 Survive shipment	Subelement 4 Not detected at port of entry	Subelement 5 Moved to suitable habitat	Subelement 6 Contact with host material	Cumulative Risk Rating
Sternochetus mangiferae	High (3)	High (3)	High (3)	High (3)	Low (1)	Low (1)	Medium (14)
Bactrocera cucurbitae	High (3)	High (3)	High (3)	High (3)	Medium (2)	High (3)	High (17)
Bactrocera invadens	High (3)	High (3)	High (3)	High (3)	Medium (2)	High (3)	High (17)
Ceratitis capitata	High (3)	High (3)	High (3)	High (3)	Medium (2)	High (3)	High (17)
Ceratitis cosyra	High (3)	High (3)	High (3)	High (3)	Medium (2)	Medium (2)	High (16)
Ceratitis rosa	High (3)	High (3)	High (3)	High (3)	Medium (2)	High (3)	High (17)
Udinia catori *U. farquharsoni* *U.pattersoni*	High (3)	Medium (2)	High (3)	Medium (2)	Medium (2)	Low (1)	Medium (13)
Icerya aegyptiaca	High (3)	Medium (2)	High (3)	Medium (2)	Medium (2)	Low (1)	Medium (13)
Icerya seychellarum	High (3)	Medium (2)	High (3)	Medium (2)	Medium (2)	Low (1)	Medium (13)
Dysmicoccus neobrevipes	High (3)	Medium (2)	High (3)	Medium (2)	Medium (2)	Low (1)	Medium (13)
Maconellicoccus hirsutus	High (3)	Medium (2)	High (3)	Medium (2)	Medium (2)	High (3)	High (15)
Nipaecoccus viridis	High (3)	Medium (2)	High (3)	Medium (2)	Medium (2)	High (3)	High (15)
Planococcus minor	High (3)	Medium (2)	High (3)	Medium (2)	Medium (2)	Low (1)	Medium (13)
Rastrococcus invadens	High (3)	Medium (2)	High (3)	Medium (2)	Medium (2)	Low (1)	Medium (13)

7. Conclusion – Pest Risk Potential and Pests Requiring Phytosanitary Measures

To estimate the Pest Risk Potential for each pest, the Cumulative Risk Rating for the consequences of Introduction and the Cumulative Risk Rating for the Likelihood of Introduction are summed in Table 7. The Pest Potential rating is as follows:

Low: 11 – 18 points
Medium: 19 – 26 points
High: 27 – 33 points

Table 7. Pest risk potential of quarantine pests.

Pest	Consequences of Introduction	Likelihood of Introduction	Pest Risk Potential	Risk Rate
Sternochetus mangiferae	Medium (12)	Medium (14)	26	**Medium**
Bactrocera cucurbitae	High (14)	High (17)	31	**High**
Bactrocera invadens	High (14)	High (17)	31	**High**
Ceratitis capitata	High (15)	High (17)	32	**High**
Ceratitis cosyra	High (13)	High (17)	30	**High**
Ceratitis rosa	High (14)	High (17)	31	**High**
Udinia catori *U. farquharsoni* *U. pattersoni*	Medium (11)	Medium (13)	24	**Medium**
Icerya aegyptiaca	High (14)	Medium (13)	27	**High**
Icerya seychellarum	High (14)	Medium (13)	27	**High**
Dysmicoccus neobrevipes	High (14)	Medium (13)	27	**High**
Maconellicoccus hirsutus	High (14)	High (15)	29	**High**
Nipaecoccus viridis	High (14)	High (15)	29	**High**

Planococcus minor	High (14)	Medium (13)	27	**High**
Rastrococcus invadens	Medium (12)	Medium (13)	25	**Medium**

Pest Risk Potential ratings have the following suggested meanings (APHIS, 2000):

Low: Pest will typically not require specific mitigation procedures. The port-of-entry inspection to which all imported commodities are subjected can be expected to provide sufficient phytosanitary security.

Medium: Specific phytosanitary measures may be necessary.

High: Specific phytosanitary measures are strongly recommended. Port-of-entry inspection is not considered sufficient to provide phytosanitary security.

As stated in the Guidelines (CABI, 2004) detailed examination and choice of appropriate sanitary and phytosanitary measures to mitigate pest risk for commodities with particular pest risk potential scores or ratings is undertaken as part of the pest risk management phase and is not discussed in this document. The appropriate risk management strategy for a particular pest depends on the risk posed by that pest.

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