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Importation of Eggplant, *Solanum melongena* from Ghana into the United States

Bernard A. Boateng, Entomologist, University of Ghana, Legon, Ghana
Haruna Braimah, Entomologist, Crops Research Institute, Kumasi, Ghana
Mary Glover-Amengor, Biochemist, Food Research Institute, Accra, Ghana
Angela Osei-Sarfo, Applied Biologist, Ghana Ministry of Food and Agriculture
Ruth Woode, Entomologist, Ghana Ministry of Food and Agriculture
Shawn Robertson, Entomologist, APHIS-IS
Yu Takeuchi, Plant Physiologist, APHIS-PPQ

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A Qualitative, Pathway-Initiated Risk Assessment

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Agency contact:
Shawn Robertson
United States Department of Agriculture
Animal and Plant Health Inspection Service
Plant Protection and Quarantine
Center for Plant Health Science and Technology
Plant Epidemiology and Risk Analysis Laboratory
1017 Main Campus Drive, Suite 1550
Raleigh, NC 27606

Executive Summary

This assessment examined the risks associated with the importation of eggplant (*Solanum melongena*) from Ghana into the United States. Information on pests associated with eggplant in Ghana and neighboring countries revealed that seven quarantine pests could potentially be introduced into the United States via this pathway, five moths and two fruit flies.

Cryptophlebia leucotreta (Meyrick) (Lepidoptera: Tortricidae)
Daraba laisalis (Walker) = *Sceliodes laisalis* (Lepidoptera: Pyralidae)
Leucinodes orbonalis (Lepidoptera: Pyralidae)
Helicoverpa armigera (Hübner) (Lepidoptera: Noctuidae)
Sesamia nonagrioides (Lefebvre) (Lepidoptera: Noctuidae)
Spodoptera littoralis (Boisduval) (Lepidoptera: Noctuidae)
Bactrocera cucurbitae (Coquillet) (Diptera: Tephritidae)
Ceratitis captitata (Wiedemann) (Diptera: Tephritidae)

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., 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 mitigation 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.

Table of Contents

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)].

This is a qualitative pest risk assessment that expresses risk in terms of high, medium, or low. Importing a new commodity gives exotic pests a potential pathway into the United States; this risk assessment is "pathway-initiated" in response to that threat.

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.

B. Risk Assessment

1. Initiating Event: Proposed Action

The USDA developed this risk assessment in response to a request by Ghana for a permit to import Eggplant (*Solanum melongena*) into the United States. The USDA has the authority to regulate imports of fruits and vegetables from foreign countries into the United States under Title 7, Part 319, Section 56 of the United States Code of Federal Regulations (7 CFR §319.56). The purpose of this risk assessment is to determine the likelihood that exotic plant pests would enter the United States with this commodity.

2. Assessment of Weed Potential of *Solanum melongena*.

This step examines the potential of the commodity to become a weed after it enters the United States (Table 1). If the assessment were to indicate significant weed potential, then a "pest-initiated" risk assessment would be conducted.

Table 1. Assessment of the Weed Potential of *Solanum melongena*

Commodity: Eggplant, *Solanum melongena*

Phase 1: Many varieties of *Solanum melongena* are widely cultivated in the United States.
Phase 2: Is the species listed in:

- No *Geographical Atlas of World Weeds* (Holm *et al.*, 1979)
- No *World's Worst Weeds: Natural History 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 Weed Science Society of America list (WSSA, 1989)
- No Is there any literature reference indicating weed potential, *e.g.,* AGRICOLA, CAB, Biological Abstracts, AGRIS; search on "species name" combined with "weed." Such a search returns a prohibitive number of references, a sample of which do not indicate weed potential, but that there are weeds associated with the cultivation of *Solanum melongena.*

Phase 3: The literature indicates that *Solanum melongena* is not likely to become a weed in the United States because of imports from Ghana.

3. Previous Risk Assessments, Current Status, and Pest Interceptions

Decision History for *Solanum melongena* from Africa

1930. Eggplant from Egypt. The request was denied because of the presence of too many insect pests (APHIS, 1930).

1936. Eggplant from Egypt. The request was denied because of the presence Ceratitis capitata, although not a pest of eggplant in Egypt, the decision cited eggplant as a host of this plant in Hawaii and Greece (no references) (APHIS, 1936).

1951. Eggplant from Liberia. The request was approved for North Atlantic ports. The noctuid larvae of Heliothis sp. and *Leucinodes orbonalis* were considered easy to detect with inspection (APHIS, 1951).

1965. Eggplant from Liberia. *Leucinodes orbonalis* was intercepted three times and Leucinodes sp. twice on eggplant from Liberia, so the decision of 1951 to allow entry was revoked (APHIS, 1965).

Pest Interceptions

Between 1985 and 2004, U.S. agricultural inspectors intercepted numerous pests of eggplant, generally from passenger baggage (PIN, 2003). The following is a list of pests that were intercepted at least three times both on *Solanum melongena* from anywhere in the world and from Ghana on any commodity.

Pest	World Interceptions (eggplant)	West African interceptions (all commodities)	West African interceptions (eggplant)
Leucinodes orbonalis Guenee (Lepidoptera: Pyralidae)	2107	3365	1745
Cryptophlebia sp. (Lepidoptera Tortricidae)	89	1003	75
Tephritidae, Species of (Diptera)	70	1258	63
Leucinodes sp. (Lepidoptera: Pyralidae)	45	48	33

Pest	World Interceptions (eggplant)	West African interceptions (all commodities)	West African interceptions (eggplant)
Ceratitini, Species Of (Diptera)	33	887	31
Cryptophlebia leucotreta (Meyrick)	28	237	24
Bactrocera sp. (Diptera: Tephritidae)	20	12	1
Helicoverpa sp. (Lepidoptera: Noctuidae)	18	79	9
Anthonomus sp. (Coleoptera: Curculionidae)	16	4	
Cladosporium Sp. (Fungi)	12	25	6
Dacinae, Species of (Diptera: Tephritidae)	11	59	10
Planococcus sp. (Hemiptera: Pseudococcidae)	8	114	
Dacus sp. (Diptera: Tephritidae)	8	35	7
Frankliniella sp. (Thysanoptera: Thripidae)	6	14	1
Colletotrichum sp. (Fungi)	4	21	
Anastrepha sp. (Diptera: Tephritidae)	4	11	
Atherigona sp. (Diptera: Muscidae)	4	5	1
Ceratitis sp. (Diptera: Tephritidae)	3	56	2
Diaphania sp. (Lepidoptera: Crambidae)	3	53	2
Fusarium sp. (Fungi)	3	32	2
Frankliniella schultzei (Trybom) (Thysanoptera: Thripidae)	3	10	1
Etiella sp. (Pyralidae Lepidoptera)	3	4	
Conotrachelus sp. (Coleoptera: Curculionidae)	3	3	

Comments on interceptions

Pests intercepted fewer than three times were not included in this list because of the possibility that the interceptions were errors, either of misidentification or of country of origin. Pests identified to the genus level were only added to the pest list if they were intercepted from West Africa on eggplant.

Fruit flies were intercepted at least 116 times on eggplant from West Africa, but never identified to species. Specimens identified to the family Tephritidae were intercepted 63 times, from the subfamily Dacinae 31 times, and from the tribe Ceratitini 10 times. It is impossible to know which species were intercepted, but Ceratitis capitata is a possible candidate. Two specimens of *Bactrocera* were also intercepted. Apart from the 10 Ceratitini interceptions, all of the others could have been *Bactrocera* as well. The Crop Protection Compendium (CABI, 2004) lists four species of *Bactrocera* known to be pests of eggplant: *Bactrocera latifrons, B. papayae, B. passiflorae,* and *B. tryoni*, none of which are known to occur in West Africa. *Bactrocera cucurbitae* is present in West Africa. It was not listed as a pest of eggplant by Alwood *et al.*, (1999) or CABI (2004), although White and Elson-Harris (1994) list eggplant as a possible host of *B. cucurbitae* and Mau and Kessing (1991) list *B. cucurbitae* as a major pest of eggplant in Hawaii. *Ceratitis capitata* and *Bactrocera cucurbitae* were further analyzed in this document.

4. Pest Categorization–Identification of Quarantine Pests and Quarantine Pests Likely to Follow the Pathway

Common pests that are associated with *Solanum melongena* and occur in Ghana are listed in Table 2. This list includes information on the presence or absence of these pests in the United States, the affected plant part(s), the quarantine status of the pest with respect to the United States, pest-host association, and pertinent references for pest distribution and biology.

Pests identified only to genus or higher taxa were not considered for further analysis. Genera can contain many species; it is unrealistic to analyze an entire genus in which many species may not be pests. If pests identified only to higher taxa are intercepted in the future, the USDA may re-evaluate their risk. Intercepted pests are sometimes not identified to the species level because the current taxonomic knowledge is limited, the pest is too immature, or the specimen is in poor condition. By necessity, pest risk assessments focus on the organisms for which biological information is available. The lack of identification at the species level does not rule out the possibility that a high-risk quarantine pest was intercepted, or that the intercepted pest was not a quarantine pest. Conversely, detailed assessments for known pests that inhabit a variety of ecological niches, such as the surfaces or interiors of fruit, stems or roots, allow effective mitigation measures to eliminate the known organisms as well as similar, but incompletely identified organisms that inhabit the same niche.

Table 2. Pests commonly associated with *Solanum melongena* in Ghana

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quarantine	Follow Pathway	References
Acari						
Eriophyidae						
Aculops lycopersici (Massee)	SG	US HI	F L W	No	Yes	CABI, 2004
Tarsonemidae						
Polyphagotarsonemus latus (Banks)	BF CI LB LB ML NG SG	US HI VI GU PR	F FW L S W	No	Yes	CABI, 2004
Tetranychidae						
Eutetranychus orientalis Klein	CV NG SG		L	Yes	No	CABI, 2004
Tetranychus cinnabarinus (Boisduval)	CV TG	US HI	L	No	No	CABI, 2004
Tetranychus urticae Koch	SL	US	L	No	No	CABI, 2004

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).

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quarantine	Follow Pathway	References
Coleoptera						
Coccinellidae						
Henosepilachna elaterii (Rossi) =*Epilachna chrysomelina*	West Africa		L	Yes	No	CABI, 2004; Frempong, 1979; Youdeowei, 2002
Chrysomelidae						
Epitrix aethiopica Wse.	GH		L	Yes	No	Frempong, 1979
Podagrica sjoestedti (Jacobi)	GB GH NG SG		L	Yes	No	Frempong, 1979
Podagrica uniformis (Jacobi)	GH NG		L	Yes	No	Frempong, 1979
Curculionidae						
Anthonomus sp.	NG		F	Yes	Yes	PIN, 2003
Conotrachelus sp.	CI NG		F	Yes	Yes	PIN, 2003
Elateridae						
Conoderus sp.	LB		F	Yes	Yes	PIN, 2003
Lagriidae						
Lagria cuprina Thomas	GH		L	Yes	No	Frempong, 1979
Lagria villosa Fabricius	GH		L	Yes	No	Frempong, 1979
Scarabaeidae						
Niphobleta viveosparsa Kraatz	GH		S	Yes	No	Frempong, 1979
Pacnoda cordata (Drury)	GH		S	Yes	No	Frempong, 1979
Smaragdesthes africana (Drury)	GH		S	Yes	No	Frempong, 1979
Stephanorrhina guttata Ol.	GH		S	Yes	No	Frempong, 1979
Tenebrionidae						
Blapstinus sp.	NG		F	Yes	Yes	PIN, 2003
Diptera						
Agromyzidae						
Liriomyza sativae Blanchard	NG	US HI GU PR	L	No	No	CABI, 2004
Liriomyza trifolii Burgess in Comstock, 1880	BN CI GU NG SG	US HI VI GU PR	L	No	No	CABI, 2004
Muscidae						
Atherigona sp.	CV CI NG		F	Yes	Yes	PIN, 2003
Atherigona orientalis Schiner	BF BN CV CI GH ML NR SL SG TG	US HI GU PR	F L W R Sd W	No	Yes	CABI, 2004
Tephritidae						
Bactrocera sp.	GH ML NG		F	Yes	Yes	PIN, 2003
Bactrocera cucurbitae (Coquillet)	CI GM GU ML	HI GU	F	Yes	Yes	CABI, 2004; Mau and Kessing, 1991; White and Elson-Harris, 1994

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quarantine	Follow Pathway	References
Ceratitis sp.	CI GH LB NG SN		F	Yes	Yes	PIN, 2003
Ceratitis capitata (Wiedemann)	BF BN CV CI GH GU	HI	F	Yes	Yes	CABI, 2004; White and Elson-Harris, 1994
Hemiptera						
Aleyrodidae						
Aleurodicus dispersus Russell	BN NG TG	US HI GU PR	L	No	No	CABI, 2004
Aleurothrixus floccosus Maskell	BN GM NR NG TG	US HI VI PR	F Fw L S	No	Yes	CABI, 2004
Bemisia tabaci Gennadius	BF BN CV CI GM GH GU NG SL SG TG	US HI GU PR	L	No	No	CABI, 2004
Aphididae						
Aphis gossypii Glover	BF CV CI GM GU ML NR NG SL SG TG	US HI GU NMI PR	Fw L S W	No	No	CABI, 2004
Aphis spiraecola Patch	BN CI GH NG SG	US HI VI PR	F Fw L Sd W	No	Yes	CABI, 2004
Myzus persicae Sulzer (1776)	BN CI GH NG SL	US HI PR	Fw L S W	No	No	CABI, 2004
Rhopalosiphum rufiabdominale (Sasaki)	CI GH NG	US HI PR	R S W	No	No	CABI, 2004
Cicadellidae						
Jacobiella facialis (Jacobi)	TG		L	Yes	No	Dreyer, 1987a, 1987b
Coccidae						
Parasaissetia nigra (Nietner)	BF BN CV CI GH GU NG SL	US HI VI GU PR	L S	No	No	CABI, 2004
Saissetia coffeae (Walker)	CV CI GH NG SL TG	US HI VI GU PR	L S	No	No	CABI, 2004
Coreidae						
Anoplocnemis curvipes (Fabricius)	GH		L S	Yes	No	Frempong, 1979
Riptortus tenuicornis Dall.	GH		L S	Yes	No	Frempong, 1979
Diaspididae						
Aonidomytilus albus (Cockerell)	CI CV GH NG SN	US(FL,NM)	L	Yes	No	Ben-Dov *et al.*, 2004

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quarantine	Follow Pathway	References
Chrysomphalus dictyospermi (Morgan)	BN CV CI GU ML NR NG SL SG TG	US HI PR	F L S	No	Yes	CABI, 2004
Hemiberlesia lataniae (Signoret)	BN CV CI GH GU ML NG SL	US HI VI	F L S	No	Yes	CABI, 2004
Pinnaspis strachani (Cooley) 1899	BN CV CI GM LB LB NG SL SG TG	US HI PR	F L S W	No	Yes	CABI, 2004
Miridae						
Nesidiocoris tenuis (Reuter)	CV GH ML NG SL SG	US VI GU PR	F Fw L S	No	Yes	CABI, 2004
Ortheziidae						
Orthezia insignis Browne	CV GH NG SL	US HI PR	F L S W	No	Yes	CABI, 2004
Pentatomidae						
Nezara viridula (Linnaeus)	BF BN CV CI GH GU ML NR NG SL SG TG	US HI VI GU PR	F Fw L Sd S	No	Yes	CABI, 2004
Pseudococcidae						
Ferrisia virgata (Cockerell)	CI GH GU NG SL SG TG	US HI VI PR	F L S	No	No	CABI, 2004
Phenacoccus madeirensis Green	BN CV CI GM GH LB LB NG SL SG TG	US GU PR	L S W	No	No	CABI, 2004
Planococcus sp.	CV CI GH LB NG SN		L S	Yes	No	PIN, 2003
Planococcus citri (Risso)	West Africa	US HI GI NMI VI	L S	No	No	Ben-Dov *et al.*, 2004
Pseudococcus longispinus (Targioni-Tozzetti)	CV CI GH NG TG	US HI PR	F Fw L S	No	Yes	CABI, 2004
Tingidae						
Urentius hystricellus (Richter)	GH		L	Yes	No	Brempong-Yeboah and Okoampah, 1989; Duodu and Boakye, 1987
Urentius sp	GH		L	Yes	No	Cobbinah and Osei-Owusu, 1988
Urentius hystricellus (Richter)	GH NR NG SG		L	Yes	No	CABI, 2004

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quarantine	Follow Pathway	References
Orthoptera						
Diabolocatantops axillaris (Thunberg)	BF BN CV GH GU ML NR NG SG		F Sd L S W	Yes	No	CABI, 2004
Lepidoptera						
Arctiidae						
Alpenus investigatorum Karsch = *Diacrisia investigatorum*	GH		L	Yes	No	Frempong and Buahin, 1978
Creatonotus marginalis Walker	GH		L	Yes	No	Frempong, 1979
Diacrisia rattrayi Rothschild	GH		L	Yes	No	Frempong, 1979
Gelechiidae						
Phthorimaea operculella (Zeller)	SG	US HI GU PR	L R S	No	No	CABI, 2004
Scrobipalpa ergasima Meyrick	TG SG		L S	Yes	No	Dreyer, 1987b
Scrobipalpa blapsigona (Meyrick)	GH		Fw	Yes	No	Duodu, 1985; Youdeowei, 2002
Scrobipalpa heliopa (Lower)	CI NG		Fw S	Yes	No	CABI, 2004
Hesperidae						
Coeliades forestan (Stoll.)	GH		L	Yes	No	Frempong, 1979
Lycaenidae						
Virachola lorisona Hew.	GH		L	Yes	No	Frempong, 1979
Noctuidae						
Agrotis ipsilon Hufnagel	BF BN CI LB LB ML SG TG	US HI	F L S W	No	No	CABI, 2004
Eudocima fullonia (Clerck)	BN CI GH GU LB LB NG SL	US HI GU	F	No	Yes	CABI, 2004
Eublemma admota Fldr.	GH		L	Yes	No	Frempong, 1979
Helicoverpa armigera (Hübner)	BF BN CV CI GM GH GU ML NR NG SL SG TG	GU	F Fw L	Yes	Yes	CABI, 2004
Helicoverpa sp.	CI GM GH LB ML NG SN		F	Yes	Yes	PIN, 2003
Plusia signata (Fabricius) = *Argyrogramma signata*	GH		L	Yes	No	Frempong and Buahin, 1978

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quarantine	Follow Pathway	References
Selepa docilis Butler	GH		L	Yes	No	Cobbinah and Osei-Owusu, 1988; Duodu and Boakye, 1987; Frempong, 1984; Frempong and Buahin, 1978
Sesamia nonagrioides (Lefebvre)	CV CI GH ML NG TG		F Fw R Sd S W	Yes	Yes	CABI, 2004
Spodoptera exigua (Hübner)	BF BN CI GH GU ML NR SG TG	US HI	F Fw L	No	Yes	CABI, 2004
Spodoptera littoralis (Boisduval)	BF BN CV CI GM GH GU ML NR NG SL SG TG		F L	Yes	Yes	CABI, 2004
Thysanoplusia orichalcea (F.)	GH ML NG		F L	Yes	No	CABI, 2004
Trichoplusia ni (Hübner)	CV GM NG SG	US HI VI PR	L W	No	No	CABI, 2004
Nymphalidae						
Acraea egina Cham.	GH		L	Yes	No	Frempong, 1979
Pyralidae						
Daraba laisalis (Walker) = *Sceliodes laisalis*	NG		F	Yes	Yes	Aina, 1984
Diaphania sp.	Chad CI GH NG		F	Yes	Yes	PIN, 2003
Etiella sp.	CV GH NG		F	Yes	Yes	PIN, 2003
Euzophera villora	GH		S	Yes	No	Frempong and Buahin, 1978
Haritalodes derogata (Fabricius)	BF BN CI GH ML NR NG SL SG TG		L	Yes	No	CABI, 2004
Leucinodes orbonalis Guenee	CI Gabon GAMBIA GH GU LB ML NG NR SL SN		F Fw S	Yes	Yes	CABI, 2004; Duodu, 1986; PIN, 2003
Leucinodes sp.	GH GU LB NG		F	Yes	Yes	PIN, 2003
Phycita melongenae Aina	TG NG		Fw, L	Yes	No	Dreyer, 1987b Aina, 1983

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quarantine	Follow Pathway	References
Spoladea recurvalis (Fabricius)	GM GH LB LB ML NR NG SL SG	US HI PR	Fw L R	No	No	CABI, 2004
Sphingidae						
Acherontia atropos (L.)	GH		L	Yes	No	Frempong, 1979
Coelonia fulvinotata Butler	GH		L	Yes	No	Frempong, 1979
Syntomidae						
Syntomis cerberana Strand	GH		L	Yes	No	Frempong, 1979
Tineidae						
Opogona sacchari (Bojer)	CV NG	US HI	Fw L S W	No	No	CABI, 2004
Tortricidae						
Cryptophlebia leucotreta (Meyrick)	BN CV CI GAMBIA GH GU LB NG SN		F L Sd	Yes	Yes	PIN, 2003
Cryptophlebia sp.	BN CV CI Gabon GAMBIA GH GU LB NG SN		F	Yes	Yes	PIN, 2003
Orthoptera						
Acrididae						
Zonocerus variegatus (L.)	GH		F Fw Sd R S W	Yes	No	CABI, 2004; Cobbinah and Osei-Owusu, 1988
Grylotalpidae						
Bracytrupes sp.	GH		R	Yes	No	Youdeowei, 2002
Thysanoptera						
Thripidae						
Frankliniella schultzei (Trybom)	Gabon GH NG		F Fw L S	Yes	No[3]	PIN, 2003
Frankliniella sp.	CI NG		F	Yes	No[4]	PIN, 2003
Thrips tabaci (Lindeman)	GH NG SG	US HI	Fw L	No	No	CABI, 2004
Thrips palmi Karny	CI NG	US HI GU PR	F L	No	Yes	CABI, 2004
Nematode						
Criconematidae						
Criconemella sp.	BF CI GH GU SG TG	US HI	R	No	No	CABI, 2004
Heteroderidae						

3 The insect feeds primarily on the leaves and flowers. Infested fruit may drop prematurely and not enter the harvest chain. Infested fruits bear lesions and scars and other external damages that are easy to detect, thus fruits will be culled on inspection.

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quarantine	Follow Pathway	References
Globodera rostochiensis (Woll.) Behrens	SL	US		No	No	CABI, 2004
Hoplolaimidae						
Helicotylenchus pseudorobustus (Steiner) Golden	BN CI GM GH GU LB LB NG	US	R	No	No	CABI, 2004
Helicotylenchus dihystera (Cobb) Sher	BF CI LB LB NG SG	US HI PR	L R W	No	No	CABI, 2004
Hoplolaimus seinhorsti Luc	NG		R W	Yes	No	CABI, 2004
Scutellonema clathricaudatum Whitehead	BF BN CI ML NR NG SL		L R W	Yes	No	CABI, 2004
Longidoridae						
Xiphinema ifacolum Luc	CI GU LB LB SL		L R W	Yes	No	CABI, 2004
Meloidogynidae						
Meloidogyne incognita (Kofoid & White) Chitwood	BF CI GM GH GU LB LB NR NG SG	US HI PR	L R W	No	No	CABI, 2004
Meloidogyne javanica (Treub) Chitwood	CI GM GH LB LB NG SG	US HI PR	L R W	No	No	CABI, 2004
Meloidogyne mayaguensis Rammah and Hirschmann, 1988	SG	US PR	L R W	No	No	CABI, 2004
Pratylenchidae						
Pratylenchus brachyurus (Godfrey) Filipjev & Schuurmans Stekhoven	BN CI GM GU NG SG TG	US HI PR	L R Sd S W	No	No	CABI, 2004
Pratylenchus penetrans (Cobb)	NG	US	F R W	No	No	CABI, 2004
Fungi						
Alternaria dauci (J.G. Kühn) J.W. Groves & Skolko	GM GH GU NG	US HI PR	F L R S W	No	Yes	CABI, 2004
Aspergillus niger Tiegh.	BF CI GU NR NG	US PR	F Fw L R Sd S W	No	Yes	CABI, 2004
Cercospora melongenae C. Welles	GH	US	L	No	No	CABI, 2004; Oduro, 1998
Cercospora nicotianae Ellis & Everh.	GM NG SL	US HI PR	L	No	No	CABI, 2004
Choanephora cucurbitarum (Berk. & Ravenel)	BN NG SG	US PR	F Fw L Sd S W	No	Yes	CABI, 2004

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quarantine	Follow Pathway	References
Cladosporium sp.	Chad GH GU LB NG SN		F	Yes	Yes	PIN, 2003
Cochliobolus lunatus R.R. Nelson & Haasis	BF BN GH NR NG	US HI PR	F L Sd	No	Yes	CABI, 2004
Colletotrichum capsici (Syd.) E.J. Butler & Bisby	BF CI NG	US GU	L	No	No	CABI, 2004
Corticium rolfsii Curzi	BF BN CV CI GM GH GU LB LB ML NR NG SL SG TG	US HI GU PR	F Fw L R Sd S W	No	Yes	CABI, 2004
Diaporthe vexans Gratz = *Phomopsis vexans*	GH	US PR	F L S	No	Yes	CABI, 2004; Oduro, 1998
Didymella lycopersici Kleb.	CI NG TG	US PR	F L S W	No	Yes	CABI, 2004
Fusarium pallidoroseum (Cooke) Sacc. = *Fusarium semitectum*	GH	US	R S	Yes	No	Farr *et al.*, 1989; Youdeowei, 2002
Gibberella fujikuroi (Sawada) S. Ito	BN CI GM GH ML NR NG SL SG TG	US HI VI GU PR	F L R Sd S W	No	Yes	CABI, 2004
Glomerella cingulata (Stonem.) Spauld. & Schrenk	CI GH NG TG	US HI GU PR	F Fw L S	No	Yes	CABI, 2004
Lasiodiplodia theobromae (Pat.) Griffon & Maubl. = Botryodiplodia theobromae Pat., = Diplodianatalensis Pole-Evans, teleomorph = Physalospora rhodina (Berkeley & Curtis) Cooke	BF GM GH GU NG SG TG	US GU PR	F Fw Sd R S	No	Yes	CABI, 2004
Leveillula taurica (Lév.) G. Arnaud	CI GM GH GU NR NG SL SG TG	US HI PR	L S	No	No	CABI, 2004
Macrophomina phaseolina (Tassi) Goid	BF BN CI GM NR NG SL SG TG	US PR	L R Sd S W	No	No	CABI, 2004
Myrothecium roridum Tode	GH	US PR	L	No	No	CABI, 2004; Oduro, 1998
Nectria haematococca Berk. & Broome	GH		L R S W	Yes	No	CABI, 2004
Phytophthora nicotianae Breda de Haan	CI GH NG SL SG	US HI PR	F L R W	No	Yes	CABI, 2004; Oduro, 1998

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quarantine	Follow Pathway	References
Phytophthora infestans (Mont.) de Bary	GH NG	US HI PR	F L W	No	Yes	CABI, 2004
Phytophthora capsici Leonian	NG	US HI PR		No	Yes	CABI, 2004
Pseudocercospora fuligena (Roldan) Deighton	CI GM NG SG TG	US	L S W	No	No	CABI, 2004
Puccinia substriata var. penicillariae (Speg.) Ramachar & Cumm. = *Puccinia pennseti*	GH		L	Yes	No	CABI, 2004; Oduro, 1998
Pythium aphanidermatum (Edson) Fitzp.	CI GH ML NG SL SG TG	US HI PR	R W	No	No	CABI, 2004
Pythium myriotylum Drechsler	NG SL	US VI	L R W	No	No	CABI, 2004
Rigidoporus microporus (Fr.) Overeem	BN CI GH NG SL	US	Fw L R Sd W	No	Yes	CABI, 2004
Schiffnerula solani	GH		L	Yes	No	Oduro, 1998
Sclerotinia sclerotiorum (Lib.) de Bary	NG	US HI	F Fw L R Sd S W	No	Yes	CABI, 2004
Thanatephorus cucumeris (Frank) Donk	CI NG SL	US HI PR	F Fw R L Sd S W	No	Yes	CABI, 2004
Verticillium dahliae Kleb.	NG	US	L S W	No	No	CABI, 2004
Bacteria						
Enterobacteriaceae						
Erwinia chrysanthemi Young et al.	CI SG	US PR	F Fw L R S W	No	Yes	CABI, 2004
Ralstoniaceae						
Ralstonia solanacearum (Smith) Yabuuchi et al.	BF GM NG SL SG	US HI GU	F L R Sd S W	No	Yes	CABI, 2004
Virus						
Cucumber Mosaic Virus	CI GH NG SL TG	US HI PR	F L W	No	No	CABI, 2004
Tomato Spotted Virus	BF CI NR NG SG	US HI PR	F L W	No	No	CABI, 2004
Tobacco Ringspot Virus	NG	US	F L S R W	No	No	CABI, 2004
Potato spindle viroid	NG	US	Sd	No	Yes	CABI, 2004

Pest	West African Distribution[1]	US Distribution	Plant Part Affected[2]	Quarantine	Follow Pathway	References
Pepper Veinal Virus	BF CI GH LB LB NG SG TG		L W	Yes	No	CABI, 2004

Notes on the pest list
Fruit flies in the genera *Bactrocera*, *Ceratitis*, and *Dacus* have been intercepted 20, 8, and 3 times respectively on eggplant worldwide between 1985 and 2003. None were identified to species. CABI (2004) lists no fruit flies as pests of eggplant. The only fruit fly present in these genera in West Africa known to occasionally infest eggplant is *Bactrocera* (*Dacus*) *cucurbitae* (Furusawa *et al.*, 1984; PINKTO, 1983). *Bactrocera cucurbitae* is potentially the fly intercepted by U.S. Agricultural Officers, possibly under the genera *Bactrocera* and *Dacus*. The interceptions were made on passenger baggage, probably on overripe fruit. The potential for this fruit fly to follow the pathway of export grade eggplant is very small, so this insect was not further evaluate.

Quarantine Pests Selected for Further Analysis.

Cryptophlebia leucotreta (Meyrick) (Lepidoptera: Pyralidae)
Daraba laisalis (Walker) = *Sceliodes laisalis* (Lepidoptera: Pyralidae)
Leucinodes orbonalis (Guenee) (Lepidoptera: Pyralidae)
Helicoverpa armigera (Hübner) (Lepidoptera: Noctuidae)
Sesamia nonagrioides (Lefebvre) (Lepidoptera: Noctuidae)
Spodoptera littoralis (Boisduval) (Lepidoptera: Noctuidae)
Bactrocera cucurbitae (Coquillet) (Diptera: Tephritidae)
Ceratitis capitata (Wiedemann) (Diptera: Tephritidae)

5. Consequences of Introduction—Economic/Environmental Importance
Potential consequences of introduction are rated using five risk elements:

1. Climate-Host Interaction
2. Host Range
3. Dispersal Potential
4. Economic Impact
5. Environmental Impact

These elements reflect the biology, host ranges and climatic/geographic distributions of the pests. For each risk element, pests are assigned a rating of Low (1 point), Medium (2 points) or High (3 points) (USDA, 2000). A Cumulative Risk Rating is then calculated by summing all risk element values. The values determined for the Consequences of Introduction for each pest are summarized in Table 3.

The major sources of uncertainty in this risk assessment are similar to those in other risk assessments: the use of a developing process (Orr *et al.*, 1993; USDA, 2000), the approach used to combine risk elements (Bier, 1999; Morgan and Henrion, 1990), and the evaluation of risk by comparisons to lists of factors within the guidelines (Orr *et al.*, 1993). To address this last source of uncertainty, of factor lists were interpreted as illustrative and not exhaustive. Other traditionally recognized sources of uncertainty are the quality of the biological information (Gallegos and Bonano, 1993), which includes uncertainty whenever biological information is lacking on the regional flora and fauna. Inherent biological variation within a population of organisms also introduces uncertainty (Morgan and Henrion, 1990).

Risk Element #1- Climate-Host Interactions
If a species encounters suitable climate and hosts in the area where it is introduced, the organism may survive and achieve pest status in the new environment. This risk element is evaluated on the minimum number of U.S. "Plant Hardiness Zones" in which the species might achieve pest status (USDA, 1990). Risk ratings are based on the following criteria:

Low (1): the species is only likely to become established in one hardiness zone
Medium (2): the species is likely to become established in two or three hardiness zones
High (3): the species is likely to become established in four or more hardiness zones

Risk Element #2- Host Range
The risk posed by a plant pest depends on its ability to establish a viable, reproductive population and its potential to injure plants. For arthropods, risk is assumed to be positively correlated with host range. For pathogens, risk 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
A pest may disperse after arriving in a new area. The following items are considered in regard to dispersal potential: reproductive patterns of the pest (*e.g.*, voltinism, biotic potential); inherent powers of movement; factors facilitating dispersal, wind, water, presence of vectors, humans, *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 10km/year under its own power; via natural forces, wind, water, vectors, *etc.*, or human-assistance.

Risk Element #4-Economic Impact
Introduced pests can cause 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; and 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
A pest may cause significant, direct consequences to the environment, *e.g.,* cause an ecological disaster or reduce biodiversity. In the context of the National Environmental Policy Act (NEPA) (7CFR§372), significance is qualitative and encompasses the likelihood and severity of an environmental impact. The act describes an environmental pest as: "expected to have direct impacts on species listed by Federal Agencies as endangered or threatened (50CFR§17.11 and §17.12), by infesting/infecting a listed plant. If the pest attacks other species within the genus or other genera within the family, and preference/no preference tests have not been conducted with the listed plant and the pest, then the plant is assumed to be a host; pest is expected to have indirect impacts on species listed by Federal Agencies as endangered or threatened by disrupting sensitive, critical habitat; introduction of the pest would stimulate chemical or biological control programs."

Low (1): none of the above would occur
Medium (2): one of the above would occur
High (3): two or more of the above would occur.

Consequences of Introduction: *Cryptophlebia leucotreta* Meyrick (Lepidoptera: Tortricidae)	**Risk Value**
Risk Element #1: Climate – Host Interaction *Cryptophlebia leucotreta* is distributed throughout Africa (CABI, 2004). Its occurrence corresponds with U.S. Plant Hardiness Zones 9-11 (USDA, 1990).	Medium (2)
Risk Element #2: Host Range There are more than 70 species identified as host species to *C. leucotreta* (CABI, 2004). Primary species include Rutaceae (*Citrus* spp., *Citrus sinensis*), Malvaceae (*Gossypium* spp., *Solanum melongena*, *Abutilon hybridum*), Poaceae (*Zea mays*, *Sorghum*), Euphorbiaceae (*Ricinus communis*), Theaceae (*Camellia sinensis*), Lauraceae (*Persea Americana*), Myrtaceae (*Psidium guajava*), Oxalidaceae (*Averrhoa carambola*), Bromeliaceae (*Ananas comosus*), Annonaceae (*Annona muricata*), Bombacaceae (*Ceiba pentandra*), Rubiaceae (*Coffea Arabica*), Solanaceae (*Capsicum*), Sapindaceae (*Litchi chinensis*), Anacardiaceae (*Mangifera indica*), Oleaceae (*Olea europaea* subsp. *europaea*), Rosaceae (*Prunus persica*), Punicaceae (*Punica granatum*), and Proteaceae (*Macadamia* spp., *Macadamia ternifolia*).	High (3)
Risk Element #3: Dispersal Potential Females can lay between 100 – 400 eggs overnight (CABI, 2004), and typically lay 12 eggs per fruit (Bedford *et al.*, 1998). It is rare for them to lay more than 20 eggs per fruit; however, 65 eggs have been observed on a single fruit (Bedford *et al.*, 1998). Survival of the first instar is temperature dependent (low winter temperatures can be lethal) (Bedford *et al.*, 1998). The life cycle varies with the season, although *C. leucotreta* typically has 2-3 generations per year (Bedford *et al.*, 1998). Adults are attracted to light (CABI, 2004). Larvae can be internationally transported via fruit, pods, inflorescence and cones (CABI, 2004).	High (3)

Risk Element #4: Economic Impact	High
Cryptophlebia leucotreta is a serious pest of South African citrus. Losses in late crop of cotton ranges between 42-90% in Uganda. (CABI, 2004). Host species include several important crops, and the damages caused by this species would be high once it is introduced and established in the United States. In 2002, U.S. cotton production was worth more than $3593 million (NASS, 2003). In addition to cotton species, citrus and corn production for the year 2002 in U.S. Plant Hardiness Zones 9-12 valued at $2605 million and $1040 million, respectively (NASS, 2003). In South Africa, crop damages can be as high as 50% on citrus species (Bedford *et al.*, 1998).	(3)
Risk Element #5: Environmental Impact	Medium
This species attacks genera that also contain Endangered and Threatened species, such as *Quercus hinckleyi* (TX) (USFWS, 2002a).	(2)

Consequences of Introduction: *Daraba laisalis* (Walker) = *Sceliodes laisalis* (Lepidoptera: Pyralidae)	**Risk Value**
Risk Element #1: Climate – Host Interaction	High
This insect has been recorded in Nigeria (Aina, 1984) and the United Kingdom (UK Checklist, 2003), areas that span USDA Plant Hardiness Zones 8-12.	(3)
Risk Element #2: Host Range	Low
This insect feeds on *Solanum melongena* (Aina, 1984; Collingwood and Bourdouxhe, 1979) and tomatao, *S. lycopersicum* (Nyst, 2004). This assessment found no other hosts.	(1)
Risk Element #3: Dispersal Potential	High
Adult behavior has been little studied, but other moths in the family Pyralidae have been shown to be capable of medium to long range flight (Cherry and Wilson, 2005; Shirai, 1998)	(3)
Risk Element #4: Economic Impact	Low
Eggplant stem and fruit borers lower the yield of marketable eggplant (Youdeowei, 2002) and presumably tomatoes.	(1)
Risk Element #5: Environmental Impact	Medium
Daraba laisalis feeds on the genus *Solanum*, which also contains three endangered species: *Solanum drymophilum* (Puerto Rico), *S. incompletum* and *S. sandwicense* (Hawaii).	(2)

Consequences of Introduction: *Leucinodes orbonalis* (Lepidoptera: Pyralidae)	**Risk Value**
Risk Element #1: Climate – Host Interaction	Medium
Climate-Host Interaction, This insect is found in sub-Saharan Africa and India corresponding to U.S. Plant Hardiness Zones 10-13 (CABI, 2004). Only zone 10 occurs in the southern extremes of the United States (USDA, 1990).	(2)
Risk Element #2: Host Range	High
Leucinodes orbonalis feeds primarily on hosts in the family Solanaceae, but has been recorded on plants in the families Convolvulaceae and Fabaceae (CABI, 2004)	(3)

Risk Element #3: Dispersal Potential Suresh et al., (1996) recorded fecundity of 62 and 164 eggs per female, but Singh and Singh (2001) recorded an average of 174 eggs per female. Adult behavior has been little studied, but other moths in the family Pyralidae have been shown to be capable of medium to long range flight (Cherry and Wilson, 2005; Shirai, 1998)	High (3)
Risk Element #4: Economic Impact This insect causes extensive damage to okra and eggplant, lowering the yield and marketability of the crops (Frempong, 1979; Youdeowei, 2002).	High (3)
Risk Element #5: Environmental Impact *Leucinodes orbonalis* feeds on plants in the genus *Solanum*, which also contains the endangered species *Solanum drymophilum* in Puerto Rico and *S. incompletum* and *S. sandwicense* in Hawaii.	Medium (2)

Consequences of Introduction: *Sesamia nonagrioides* (Lefebvre) (Lepidoptera: Noctuidae)	**Risk Value**
Risk Element #1: Climate – Host Interaction *Sesamia nonagrioides* is present in West and East Africa, southern Europe, and parts of the Middle East (CABI, 2004), covering USDA Plant Hardiness Zones 8-13.	High (3)
Risk Element #2: Host Range This insect feeds on the genera *Oryza, Saccharum, Zea, Diospyros, Gladiolus, Musa, Solanum, Sorghum, Strelitzia,* and *Carex* which occur in the families Poaceae, Ebenaceae, Iridaceae, Musaceae, Solanaceae, and Strelitzeaceae.	High (3)
Risk Element #3: Dispersal Potential Noctuid moths are strong fliers (Rochester *et al.*, 2002). Females of *S. nonagrioides* lay circa 100-400 eggs and the species undergoes three to four generations a year in Europe (Fantinou *et al.*, 2004).	High (3)
Risk Element #4: Economic Impact *Sesamia nonagrioides* feeds on corn, rice, sorghum, and sugarcane (CABI, 2004), all important crops in the United States. It lowers yield and the value of the commodities.	High (3)
Risk Element #5: Environmental Impact This insect feeds on genera that also contain the following threatened or endangered species: *Carex albida* (CA), *C. lutea* (NC), *C. specuicola* (AZ, UT), *Solanum drymophilum*, (PR), *S. incompletum* (HI), and *S. sandwicense* (HI) (USFWS, 2005), so it is possible, although unlikely that if this species were introduced it could feed on an endangered plant.	Medium (2)

Consequences of Introduction: *Helicoverpa armigera* (Lepidoptera: Noctuidae)	**Risk Value**
Risk Element #1: Climate – Host Interaction This insect is widely distributed and known to occur in all parts of Europe, Middle East, Central and South Asia, Far East, Africa, Australia, and Oceania (CABI, 2003). Establishment is possible in U.S. Plant Hardiness Zones 5-11.	High (3)
Risk Element #2: Host Range *Helicoverpa armigera* is polyphagous. It infests crop and non-crop hosts representing over 10 genera and over four families (Zhang, 1994). It is a major pest of cotton (*Gossypium* spp.), pigeon pea (*Cajanus cajan*), chickpea (*Cicer arietinum*), tomato (*Lycopersicum esculentum*), sorghum (*Sorghum* spp.) and cowpea (*Vigna unguiculata*). Other hosts include groundnut (*Arachis hypogaea*), eggplant (*Solanum melongena*), peas (*Pisum sativum*), soybeans (*Glycine max*), other legumes, tobacco (*Nicotiana tabacum*), potatoes (*Solanum tuberosum*), maize (*Zea mays*), flax (*Linum usitatissimum*), a number of fruits (*Prunus* spp. and *Citrus* spp.), forest trees and a range of vegetable crops (CABI, 2004).	High (3)
Risk Element #3: Dispersal Potential As with other noctuids, the pest is capable of flying long distances of many miles to disperse. Internal larvae may be dispersed long distances in fruits (CABI, 2004). Females may lay over 700 eggs during their lifetime and there may be up to six generations per year (CABI, 2004) and may produce two to six generations depending on the climatic conditions (Smith *et al.*, 1997). Larvae have limited mobility, but adults are capable of flight (CABI, 2004; Smith *et al.*, 1997).	High (3)
Risk Element #4: Economic Impact Economic Impact, Larvae are major pests of tomato, maize, cotton, and other crops (CABI, 2004), becoming major pests if they establish. For example, in India, losses of up to 50% of the potato crop have been recorded (CABI, 2004). As an A2 pest for Europe, establishment in the United States could lead to loss of export markets (EPPO, 2003).	High (3)
Risk Element #5: Environmental Impact A wide range of wild plant species support larval development of *H. armigera*. Among others, larvae can feed on the genera *Allium*, *Amaranthus*, *Helianthus*, *Helianthus*, *Prunus, Solanum,* and *Vigna* (CABI, 2004), which contain threatened or endangered species (USFWS, 2002a). *Helicoverpa armigera* is very similar to *H. virescens* in phylogeny and in behavior (Farrow and Daly, 1987). *Heliothis virescens* is widespread in the United States so it is unlikely that the introduction of the similar species, *H. armigera*, would have a large environmental impact.	Medium (2)

Consequences of Introduction: *Spodoptera littoralis* (Lepidoptera: Noctuidae)	**Risk Value**
Risk Element #1: Climate – Host Interaction Climate-Host Interaction, This insect is found in Africa, southern Europe, and the Middle East (CABI, 2004). It could become established in U.S. Plant Hardiness Zones 8-11.	High (3)
Risk Element #2: Host Range The host range of *S. littoralis* covers over 40 families, containing at least 87 species of plants of economic importance (CABI, 2004). For example: cotton (*Gossypium spp.*), tobacco (*Nicotiana tabacum*), potato (*Solanum tuberosum*), tomato (*Lycopersicum esculentum*), onion (*Allium cepa*), citrus (*Citrus spp.*), beans (*Phaseolus spp.*), carrots (*Daucus carota*), peppers (*Capsicum annuum*), grapes (*Vitis spp.*), alfalfa (*Medicago sativa*) and various grasses (CABI, 2004).	High (3)

Risk Element #3: Dispersal Potential Noctuids can disperse over long distances (Farrow and Daly, 1987). Adult *S. litttoralis* fly at night, with a flight range of 1.5 km in a 4-hour period (CABI, 2004). In optimal climates, the pest can have up to 7 overlapping generations per year, with an average of 20-1000 eggs produced by each female (CABI, 2004).	High (3)
Risk Element #4: Economic Impact *Spodoptera littoralis* is one of the most destructive agricultural lepidopterous pests within this subtropical and tropical range (CABI, 2004). It can attack numerous economically important crops throughout the year. It lowers crop yield, increases production costs, and will cause market loss as a new quarantine pest.	High (3)
Risk Element #5: Environmental Impact Threatened and endangered and species of *Allium*, *Solanum*, *Vigna*, *Amaranthus*, *Prunus*, *Hibiscus*, *Trifolium* and Quercus may be at risk since these genera are known to be hosts for *S. littoralis*. New control measures would be unlikely because the current practices in commercial agriculture address a complex of similar noctuid pests.	Medium (2)

Consequences of Introduction: *Bactrocera cucurbitae* (Diptera: Teprhitidae)	Risk Rating
Risk Element #1: Climate-Host Interaction *Bactrocera cucurbitate* is found in tropical regions of the world such as West and North Africa, Oceana, and southeast Asia in climates equivalent to USDA Plant Hardiness Zones 10 and 11.	High (3)
Risk Element #2: Host Range *Bactrocera cucurbitaceae* feeds mainly on cucurbit hosts, but has been listed as attacking plants in the families Caricaceae, Loganiaceae, Malvaceae, Myrtaceae, Pandanaceae, Passifloraceae, Rhamnaceae, Sapotaceae, and Solanaceae, so the Host Range was considered to be High.	Medium (2)
Risk Element #3: Dispersal Potential Fruit flies in the genus *Bactrocera* generally have a high reproductive rate and disperse over long distances. There appears to be a dispersal phase imediately after adults emerge and before they reach sexual maturity (Fletcher, 1989). Adults fly away from their host field within one hour after emergence from the pupal stage (Kazi, 1976). In a mark-recapture experiment, flies moved approximately 12-13 km over their lifetimes, and some moved as far as 24 km within three weeks after emergence (Fletcher, 1989). Individuals of *B. cucurbitaceae* flew as far as 82 km in a mark-recapture experiment (Kohoma and Kuba, 1996). Once flies find a host their behavior changes and the dispersal phase ends (Fletcher, 1989). Reported reproductive rates vary, and population doubling times range from 4.3 to 18.2, depending on the host and strain (Carey, 1989; Liedo and Carey, 1996). *Bactrocera cucurbitae* is rated High (3) for Dispersal Potential because of its ability to disperse rapidly and high reproductive rate.	High (3)
Risk Element #4: Economic Impact CABI (2004) described *B. cucurbitae* as is a very serious pest of cucurbit crops throughout its native range (tropical Asia) and in introduced areas such as the Hawaiian Islands. The fly is capable of damaging up to 100% of unprotected fruit.	High (3)
Risk Element #5: Environmental Impact Although *Bactrocera* spp. can attack a wide range of hosts and cause growers to lose money (because of unattractive fruit), fruit flies do not harm host plants nor do they prevent seeds from germinating. The introduction of B. cucurbitae into the United States would almost certainly trigger eradication efforts, which may harm the environment. The environmental impact was therefore rated Medium (2).	Medium (2)

Consequences of Introduction: *Ceratitis capitata* (Diptera: Teprhitidae)	**Risk Rating**
Risk Element #1: Climate-Host Interaction *Ceratitis capitata* is present throughout many parts of South America, Africa, southern Europe, Australia, and Hawaii (CABI, 2003; Peña and Moyhuddin, 1997). The Mediterranean fruit fly is clearly capable of becoming established in California, Florida, and Texas, because it has been eradicated from these areas in the past (CABI, 2003). The areas of inhabited by *C. capitata* fall into USDA Plant Hardiness Zones 9-11. As per the criteria stated above, an insect inhabiting three USDA Plant Hardiness Zones was rated Medium (2) for Climate-Host Interaction.	Medium (2)
Risk Element #2: Host Range *Ceratitis capitata* is a highly polyphagous species and its pattern of host relationships from region to region appears to relate largely to what fruits are available. Hosts include species in the following families: Annonaceae, Apocyanaceae, Caricaceae, Clusiaceae, Combretaceae, Ebenaceae, Eleocarpaceae, Flacourtiaceae, Juglandaceae, Lauraceae, Malpighiaceae, Moraceae, Myrtaceae, Oxalidaceae, Passifloraceae, Proteaceae, Punicaceae, Rosaceae, Rubiaceae, Rutaceae, Santalaceae, Sapindaceae, Sapotaceae, Solanaceae, Sterculiaceae, Vitaceae, (CABI, 2003). *Ceratitis capitata* was rated High (3) for Host Range.	High (3)
Risk Element #3: Dispersal Potential *Ceratitis capitata* has a high rate of reproduction; the net reproductive rate is 71.30, and the doubling time for a population is 6.8 days under optimal conditions (Liedo and Carey, 1996). Movements of *C. capitata* adults appear to be on a smaller scale than species of *Bactrocera*, but migratory movements of up to 20 km have been reported (Fletcher, 1989). In general, movement is limited to around 200 m, but adults appear to fly further when released into areas deficient in hosts (Fletcher, 1989). This insect was rated High (3) for Dispersal Potential due to its high reproductive rate and its ability to migrate over 10 km in one year.	High (3)
Risk Element #4: Economic Impact *Ceratitis capitata*, or medfly, causes damage to fruit production, both in quality and quantity in Spain. In the early part of the 20th century some peach orchards in Italy were 100% infested in some cases and in the 1970's losses of upt to 92% were recorded (Fimiani, 1989). Medfly is a major pest in Western Australia, but it is has been irradicated or maintained at a very low prevalence in other parts of Australia (Hooper and Drew, 1989). Medfly was rated High (3) for economic impact because it damages fruit and lowers yield, and because it would become the target of irradication programs.	High (3)
Risk Element #5: Environmental Impact Medfly feeds on a large number of hosts, some in genera that also contain threatened or endangered species in the United States (USFWS, 2002b). Although medfly could potentially feed on threatened or endangered species (USFWS, 2002b), it is not likely to injur them or reduce their ability to thrive, because it only feeds on fruit pulp (CABI, 2003). Fruit drop to the ground naturally upon maturity and because medfly does not harm the seeds, it would not affect its hosts. Introduction of *C. capitata* in the past has triggered eradication efforts which may harm the environment. For these reasons *Ceratitis capitata* was rated Medium (2) for Environmental Impact.	Medium (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 3.

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

Table 3. 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
Cryptophlebia leucotreta	Medium (2)	High (3)	High (3)	High (3)	Medium (2)	High (13)
Daraba laisalis	High (3)	Low (1)	High (3)	Low (1)	Medium (2)	Medium (10)
Leucinodes orbonalis	Medium (2)	High (3)	High (3)	High (3)	Medium (2)	High (13)
Sesamia nonagrioides	High (3)	High (3)	High (3)	High (3)	High (2)	High (14)
Helicoverpa armigera	High (3)	High (3)	High (3)	High (3)	Medium (2)	High (14)
Spodoptera littoralis	High (3)	High (3)	High (3)	High (3)	Medium (2)	High (14)
Bactrocera cucurbitae	High (3)	Medium (2)	High (3)	High (3)	Medium (2)	High (13)
Ceratitis capitata	Medium (2)	High (3)	High (3)	High (3)	Medium (2)	High (13)

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 (2000); the ratings and cumulative score for Risk Element #6 and #7, i.e., the "Likelihood of Introduction Risk Rating" are shown in Table 4.

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

For each pest, the following six sub-elements were considered:

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 eggplant production in Ghana in 2003 was 6,400 metric tons (FAO, 2005). 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 (USTRIS, 2005). Anticipated volume of eggplant to be exported from Ghana is unknown; however, a low volume of eggplant (< 10 containers/year) is likely to be shipped into the United States. Therefore, Quantity of commodity imported annually is rated Low (1).

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.

Cryptophlebia leucotreta, *Daraba laisalis, Leucinodes orbonalis*, *Helcoverpa armigera, Sesamia nonagrioides* and *Spodoptera littoralis* are rated Medium. Eggplant will not be washed but inspected in the packing house to cull out malformed or damaged fruits. Therefore, all of the lepidopteran insects are rated Medium.

Fruits tend to decay around oviposition holes from *Bactrocera cucurbitate* (CABI, 2004) so many infestations will probably be culled out. *Certatitis capitata* may leave marks on the fruit (CABI, 2004), but these may be difficult to detect. The two fruit flies are rated Medium (2) and High (3), respectively, for this risk element.

3. Survive Shipment:
The shipping conditions of eggplant from Ghana are unknown, but would probably be short in duration owing to the perishable nature of fresh eggplant. All pests are rated High for this risk element.

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.

All the species except *Leucinoded orbonalis* are rated Medium. Fruits are harvested early to avoid overly mature fruits and attack by the borers. The entry points in fruits are visible, except in many cases with *L. orbonalis* (Frempong and Buahin, 1978) and could be detected by inspection.

5. Imported or move subsequently to an area with an environment suitable for survival: *Cryptophlebia leucotreta* and *Leucinodes orbonalis* 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.

Daraba laisalis, Sesamia nonagrioides, Helicoverpa armigera, and *Spodoptera littoralis* are rated High because suitable habitats contain not only subtropical and tropical zones but also temperate zones.

The fruit flies *B. cucurbitae* and *C. capitata* are limited to tropical and Mediterranean areas of the world and would encounter their hosts and habitats in parts of California and Florida. For that reason they are rated Medium for this risk element.

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.

Cryptophlebia leucotreta, Sesamia nonagrioides, Helicoverpa armigera, and *Spodoptera littoralis* are rated High. All five pests have wide range of host species. *Cryptophlebia leucotreta* and *Helicoverpa armigera* are polyphagous species. *Daraba laisalis* and *Leucinodes orbonalis* attack a more limited group of commodities that are grown sporadically through the United States, so it is rated Medium for this risk element.

Multiple fruit flies often infest one host plant, so there is a potential for larvae to emerge as adults and find mates. The flight capacity of fruit flies is such that they would be likely to find hosts if the infested fruit were shipped to an area where hosts are prevalent. For these reasons *C. capitata* and *B. cucurbitae* are rated High for coming into contact with hosts.

A summary of the ratings for Likelihood of Introduction is depicted in Table 4.

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

Table 4. 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
Cryptophlebia leucotreta	Low (1)	Medium (2)	High (3)	Medium (2)	Medium (2)	High (3)	Medium (13)
Daraba laisalis	Low (1)	Medium (2)	High (3)	Medium (2)	High (3)	Medium (2)	Medium (13)
Leucinodes orbonalis	Low (1)	Medium (2)	High (3)	High (3)	Medium (2)	Medium (2)	Medium (13)
Sesamia nonagrioides	Low (1)	Medium (2)	High (3)	Medium (2)	High (3)	High (3)	High (15)
Helicoverpa armigera	Low (1)	Medium (2)	High (3)	Medium (2)	High (3)	High (3)	Medium (14)
Spodoptera littoralis	Low (1)	Medium (2)	High (3)	Medium (2)	High (3)	High (3)	Medium (14)
Bactrocera cucurbitae	Low (1)	Medium (2)	High (3)	Medium (2)	Medium (2)	High (3)	Medium (13)
Ceratitis capitata	Low (1)	High (3)	High (3)	Medium (2)	Medium (2)	High (3)	Medium (14)

C. 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 5. The Pest Potential rating is as follows:

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

Table 5. Summary of pest risk potential

Pest	Consequences of Introduction	Likelihood of Introduction	Pest Risk Potential	Risk Rate
Cryptophlebia leucotreta	High (13)	Medium (13)	27	**High**
Daraba laisalis	Medium (10)	Medium (13)	23	**Medium**

Pest	Consequences of Introduction	Likelihood of Introduction	Pest Risk Potential	Risk Rate
Leucindoes orbonalis	High (13)	Medium (13)	26	**Medium**
Sesamia nonagrioides	High (14)	High (15)	29	**High**
Helicoverpa armigera	High (14)	Medium (14)	28	**High**
Spodoptera littoralis	High (14)	Medium (14)	28	**High**
Bactrocera cucurbitae	High (13)	Medium (13)	26	**Medium**
Ceratitis capitata	High (13)	Medium (14)	27	**High**

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.

This document did not examine potential mitigation strategies.

D. Pest Mitigation Options

APHIS has two approved treatments for *Bactrocera cucurbitae* and *Ceratitis capitata* on eggplant: Irradiation T105-a-10 (for Hawaii) and Vapor Heat T106-b-2. No approved treatments currently exist for the lepidopterous insects, although research could be conducted to discover the effect of irradiation and vapor heat on the moth larvae. APHIS has proposed a rule (FR 70:111 pages 33857-33873) to allow a generic dose of 400 gy to eliminate all insect pests except adults and pupae of Lepidoptera. If this rule is adopted, the generic dose would eliminate all pests of concern from Ghanaian eggplant. As of this writing the Ghana Atomic Energy Commission is studying the possibility of building a commercial irradiation facility.

Field control is an alternative that may be more in the short term and less injurious to fruit. A combination of field level control (insecticide sprays, natural enemies, sanitation, etc.), inspection in the packing house, and sampling of the produce could give a level of confidence that the produce is free of quarantine pests. Sampling plans can be constructed to give a high level of confidence that the prevalence of quarantine pests is below an acceptable threshold.

Although the fruit flies were considered in this risk analysis, they have not been important pests of commercial eggplant in West Africa (Frempong and Buahin, 1978), or generally outside of Hawaii (CABI, 2004) and are not likely to be present in commercial shipments of eggplant from Ghana. The pests most likely to be present are *Leucinodes orbonalis* (Frempong, 1979) and the false codling moth, *Cryptophlebia leucotreta* (PIN, 2003). Harvesting eggplant early gives no protection against *L. orbonalis* (Frempong, 1979), so chemical controls will probably be necessary.

E. Authors

Bernard A. Boateng, Entomologist, University of Ghana
Haruna Braimah, Entomologist, Crops Research Institute, Kumasi, Ghana
Mary Glover-Amengor, Biochemist, Food Research Institute, Accra, Ghana
Angela Osei-Sarfoh – Applied Biologist, Ghana Ministry of Food and Agriculture
Ruth Woode, Entomologist, Ghana Ministry of Food and Agriculture
Shawn Robertson – Entomologist, APHIS-IS
Yu Takeuchi – Plant Physiologist, APHIS-PPQ

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