Asia-Pacific
Economic Cooperation

2005/ATCWG/WKSP3/012
Agenda Item: Session IV

Threat Identification and Pathway Analysis

Submitted by: CAB International

Workshop on Building Biosecurity Planning and Surveillance Capacity for APEC Member Economies
Kuala Lumpur, Malaysia
15-20 August 2005

Bactrocera carambolae (carambola fruit fly)

HOST RANGE

B. carambolae is a serious pest of Averrhoa carambola. However, its total host list is very extensive and the following list of economically important hosts is necessarily a mix of important hosts and others that are rarely attacked. Most of the data was gathered by an extensive hosts fruit survey carried out in Malaysia and Thailand (Allwood et al., 1999) supplemented with some extra records from Yong (1994), Ranganath and Veenakumari (1995) and Ranganath et al. (1997).

In addition to the hosts listed, Annona montana, Artocarpus elasticus, A. odoratissimus, A. rigidus, Baccaurea motleyana, Lansium domesticum, Solanum ferox [S. lasiocarpum] and Triphasia trifolia are also hosts of B. carambolae.

Primary hosts: Averrhoa carambola (carambola), Artocarpus integer (jack tree), Annona muricata (soursop), Carica papaya (papaw), Citrus aurantiifolia (lime), Citrus limon (lemon), Citrofortunella mitis, Fortunella margarita (oval kumquat), Garcinia mangostana (mangosteen), Mimusops elengi (Asian bulletwood), Persea americana (avocado), Pouteria campechiana, Psidium cattleianum (strawberry guava), Punica granatum (pomegranate), Rhizophora, Rollinia pulchrinervis, Syzygium aqueum (water apple), Syzygium jambos (rose apple), Thevetia peruviana.

Secondary hosts: Artocarpus altilis (breadfruit), Artocarpus heterophyllus (jackfruit), Arenga pinnata (sugar palm), Anacardium occidentale (cashew nut), Averrhoa bilimbi, Citrus x paradisi (grapefruit), Citrus reticulata (mandarin), Citrus sinensis (navel orange), Capsicum annuum (bell pepper), Chrysophyllum cainito (caimito), Eugenia uniflora (brazil cherry), Lycopersicon esculentum (tomato), Malpighia glabra (acerola), Mangifera indica (mango), Manilkara zapota (sapodilla), Psidium guajava (common guava), Syzygium malaccense (malay-apple), Syzygium samarangense (malay apple), Terminalia catappa (beach almond), Ziziphus jujuba (common jujube).

Affected Plant Stages: Fruiting stage.

Affected Plant Parts: Fruits/pods.

GEOGRAPHIC DISTRIBUTION

List of countries :

Asia
Brunei Darussalam
India
  Andaman and Nicobar Islands
Indonesia
  Java
  Kalimantan
  Nusa Tenggara:
Malaysia
  Peninsular Malaysia
  Sabah
Singapore
Thailand

Western Hemisphere
Brazil
  Amapa
French Guiana

Suriname

BIOLOGY AND ECOLOGY

No specific details on the biology of B. carambolae are available. Eggs of related species are laid below the skin of the host fruit. These hatch within a day (although delayed up to 20 days in cool conditions) and the larvae feed for another 6-35 days, depending on season. Pupariation is in the soil under the host plant for 10-12 days but may be delayed for up to 90 days under cool conditions. Adults occur throughout the year and begin mating after about 8-12 days, and may live 1-3 months depending on temperature (up to 12 months in cool conditions) (Christenson and Foote, 1960). Adult flight and the transport of infected fruit are the major means of movement and dispersal to previously uninfested areas. Many Bactrocera spp. can fly 50-100 km (Fletcher, 1989).

Means of Movement and Dispersal

Plant parts liable to carry the pest in trade/transport:
- Fruits (inc. pods): Eggs, larvae; borne internally; visible to naked eye.
- Growing medium accompanying plants: Pupae; borne internally; visible to naked eye.

Plant parts not known to carry the pest in trade/transport:
- Bark
- Bulbs/tubers/corms/rhizomes
- Flowers/inflorescences/cones/calyx
- Leaves
- Seedlings/micropropagated plants
- Roots
- Stems (above ground)/shoots/trunks/branches
- True seeds (inc. grain)
- Wood.

Transport pathways for long distance movement:
- Conveyances (transport vehicles): Aeroplanes and boats, with fruit cargo.
- Mail: Fruit in post.
- Containers and packing: Of fruit cargo.
- Soil, gravel, water, etc.: Risk of puparia in soil.
- Travellers and baggage: Fruit in case or handbag.

NATURAL ENEMIES

Bactrocera spp. can be attacked as larvae either by parasitoids or by vertebrates eating fruit (either on the tree or as fallen fruit). Mortality due to vertebrate fruit consumption can be very high as can puparial mortality in the soil, either due to predation or environmental mortality. Parasitoids appear to have little effect on the populations of most fruit flies. To date there are no records of biological control success for any Bactrocera or Dacus spp..

ECONOMIC IMPACT

B. carambolae is a very serious pest in Malaysia where it attacks such small carambola fruits that bagging (a normally effective control) is quite impractical.

PHYTOSANITARY RISK

The major risk is from the import of fruit containing larvae, either as part of cargo, or through the smuggling of fruit in airline passenger baggage or mail. For example, in New Zealand Baker and Cowley (1991) recorded 7-33 interceptions of fruit flies per year in cargo and 10-28 per year in passenger baggage. Individuals who successfully smuggle fruit are likely to discard it when they discover that it is rotten. This method of introduction probably accounts for the discovery of at least one fly in a methyl eugenol trap in California every year although immediate implementation of

eradication action plans has ensured that the fly has never been able to establish a proper breeding population.

SYMPTOMS

Following oviposition there may be some necrosis around the puncture mark ('sting'). This is followed by decomposition of the fruit.

Descriptors: Fruits/pods: internal feeding; lesions: black or brown; premature drop.

DETECTION AND INSPECTION METHODS

Fruits (locally grown or samples of fruit imports) should be inspected for puncture marks and any associated necrosis. Suspect fruits should be cut open and checked for larvae. Larval identification is difficult, so if time allows, mature larvae should be transferred to saw dust (or similar dry medium) to allow pupariation. Upon emergence, adult flies must be fed with sugar and water for several days to allow hardening and full colour to develop, before they can be identified. Detection is described in the control section under Early Warning Systems.

CONTROL

Regulatory Control

Many countries, such as the mainland USA, forbid the import of susceptible fruit without strict post-harvest treatment having been applied by the exporter. This may involve fumigation, heat treatment (hot vapour or hot water), cold treatments, insecticidal dipping, or irradiation. Irradiation is not accepted in most countries and many have now banned methyl bromide fumigation. Heat treatment tends to reduce the shelf life of most fruits and so the most effective method of regulatory control is preferentially to restrict imports of a given fruit to areas free of fruit fly attack.

Cultural Control and Sanitary Methods

One of the most effective control techniques against fruit flies in general is to wrap fruit, either in newspaper, a paper bag, or in the case of long/thin fruits, a polythene sleeve. This is a simple physical barrier to oviposition but it has to be applied well before the fruit is attacked. Little information is available on the attack time for most fruits but few Bactrocera spp. attack prior to ripening.

Chemical Control

Although cover sprays of entire crops are sometimes used, the use of bait sprays is both more economical and more environmentally acceptable. A bait spray consists of a suitable insecticide (e.g. malathion) mixed with a protein bait. Both males and females of fruit flies are attracted to protein sources emanating ammonia, and so insecticides can be applied to just a few spots in an orchard and the flies will be attracted to these spots. The protein most widely used is hydrolysed protein, but some supplies of this are acid hydrolysed and so highly phytotoxic. Smith and Nannan (1988) have developed a system using autolysed protein. In Malaysia this has been developed into a very effective commercial product derived from brewery waste.

Male Suppression

The males B. carambolae are attracted to methyl eugenol (4-allyl-1,2-dimethoxybenzene), sometimes in very large numbers. On a small scale many farmers use male suppression as a control technique; however, with flies attracted over a few hundred metres the traps may be responsible for increasing the fly level (at least of males) on a crop as much as for reducing it. However, the technique has been used as an eradication technique (male annihilation), in combination with bait.

Early Warning Systems

Many countries that are free of Bactrocera spp., e.g. the USA (California and Florida) and New Zealand, maintain a grid of methyl eugenol and cue lure traps, at least in high-risk areas (ports and

airports) if not around the entire climatically suitable area. The trap used will usually be modelled on the Steiner trap.

Field Monitoring

Monitoring is largely carried out by traps (see Early Warning Systems) set in areas of infestation. However, there is evidence that some fruit flies have different host preferences in different parts of their range and host fruit surveys should also be considered as part of the monitoring process.

Example of threat identification

Import commodity: Carambola

All known pests (From CABI Crop Protection Compendium)

major host of:
- Attacus atlas (atlas moth)
- Bactrocera aquilonis
- Bactrocera carambolae (carambola fruit fly)
- Bactrocera dorsalis (Oriental fruit fly)
- Bactrocera dorsalis species complex (Oriental fruit fly species complex)
- Bactrocera kandiensis
- Bactrocera occipitalis
- Bactrocera philippinensis
- Bactrocera tryoni (Queensland fruit fly)
- Conogethes punctiferalis (castor borer)
- Cryptophlebia leucotreta (false codling moth)
- Cryptophlebia ombrodelta (macadamia nut borer)
- Cryptophlebia sp (starfruit borer)
- Diacrotricha fasciola
- Eudocima fullonia (fruit-piercing moth)
- Euproctis scintillans
- Lymantria lunata (tussock moth)
- Maconellicoccus hirsutus (pink hibiscus mealybug)
- Pterolophia bigibbera

minor host of:
- Aleurocanthus woglumi (citrus blackfly)
- Anastrepha fraterculus (South American fruit fly)
- Anastrepha obliqua (fruitfly, West Indian)
- Anastrepha suspensa (caribbean fruit fly)
- Bactrocera correcta (guava fruit fly)
- Bactrocera frauenfeldi (mango fruit fly)
- Bactrocera jarvisi (Jarvis' fruit fly)
- Bactrocera kirki
- Bactrocera neohumeralis
- Bactrocera papayae (papaya fruit fly)
- Ceratitis rosa (Natal fruitfly)
- Corticium salmonicolor (damping off)
- Glomerella cingulata (anthracnose)
- Icerya seychellarum (Okada cottony-cushion scale)
- Marasmiellus scandens (white thread blight)
- Panonychus citri (citrus red mite)
- Pseudotheraptus wayi (coconut bug)
- Rotylenchulus reniformis (reniform nematode)
- Selenaspidus articulatus (West Indian red scale)

wild host of:
- Homona coffearia (coffee tortrix)

[from data mining] host of:
- Ceratitis capitata (fruit fly, mediterranean)
- Eucosma notanthes
- Tetranychus urticae (two-spotted spider mite)

1. Which of these pests occur in exporting country
    "export country list"

2. Which of the export country list also occur in importing country
    "common pest list"

3. The remaining pests will be those occurring in exporting country, which are NOT in the importing country – these are potential threats.
    "potential threat list"

4. Each potential threat has to be analysed to assess whether it poses a real risk
- What are the entry, establishment and spread possibilities?
- What are the likely impacts of the pest?
- How difficult is the organism to control?

4a. What is the potential for entry
- Risk represented by the no. consignments
- The likelihood that pest associated with pathway at origin
- Likelihood of pest surviving during transportation
- Likelihood of pest surviving existing management practices
- Take into account previous interceptions of pest
- What is pathway destination?
- Risk of intended use of commodity

4b What is the potential for establishment?
- Are there suitable hosts in importing country?
- If pest transmitted by vectors are suitable vectors available?
- Is environment suitable for pest?
- Risk that existing controls for other pests unable to provide control
- What risk does biology of pest represent?

4c What is the potential for spread?
- How suitable is natural or managed environment?
- Are vectors likely to spread
- Risk that pest transported with commodities in importing country
- Likelihood pest spreading to area of higher economic importance
- Level of risk represented by intended use of commodity
- Likelihood natural enemies unable to control spread

5. Estimating the potential for economic or environmental damage
- What is economic loss in existing geographical range
- Potential economic loss in importing country
- Potential loss to non-agricultural factors (e.g. natural environment)

Consequences of entry, establishment or spread

		Negligible impact	Very low	Low	Moderate	High	Extreme impact
Likelihood of entry, establishment or spread	High likelihood	Negligible risk	Very low risk	Low risk	Moderate risk	High risk	Extreme risk
	Moderate	Negligible risk	Very low risk	Low risk	Moderate risk	High risk	Extreme risk
	Low	Negligible risk	Negligible risk	Very low risk	Low risk	Moderate risk	High risk
	Very low	Negligible risk	Negligible risk	Negligible risk	Very low risk	Low risk	Moderate risk
	Extremely low	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Very low risk	Low risk
	Negligible likelihood	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Very low risk

6. Build a threat summary table
E.g.

Common name	Carambola Fruit fly	Castor borer	Fruit piercing moth
Scientific name	Bactrocera carambolae	Conogethes punctiferalis	Eudocima fullonia
Primary host			
Plant part affected			
Entry potential			
Establishment potential			
Spread potential			
Economic impact			

Etc.

7. To help build table it might be useful for plant health officials to fill-in a pest threat questionnaire

8. From threat summary table you can now build a priority pest list

Pest Threat Questionnaire for Carambola Fruit Fly

1. What is the pest status on Carambola in other countries
   - ☐ Not a pest in any country
   - ☐ Requires some management practice to control it in another country
   - ☐ Requires management practice to control it in most countries where it is present
   - ☐ Pest is of national importance in one country
   - ☐ Pest is of national importance wherever it has established
   - ☐ Unknown*

2. What is expected long term pest status in assessing country
   - ☐ Pest status is likely to decline within 5 years
   - ☐ Pest status is likely to decline in more than 10 years
   - ☐ Pest status is likely to remain unchanged
   - ☐ Pest status is likely to increase in 10 years
   - ☐ Pest status is likely to increase in 5 years
   - ☐ Unknown*

3. Ability to invade (enter & establish)
   - ☐ Species not known to have spread beyond native range
   - ☐ Last major species demographic change was more than 50 years ago
   - ☐ Last major species demographic change was 10 – 50 years ago
   - ☐ Last major species demographic change was 5 – 10 years ago
   - ☐ Last major species demographic change was less than 5 years ago
   - ☐ Unknown*

4. Pest distribution
   - ☐ Not established in neighbouring country or one exporting host commodities or with direct tourist flights
   - ☐ Species has long been established
   - ☐ Species recently established (within 2 years)
   - ☐ Pest already in assessing country
   - ☐ Unknown*

5. Ability to enter
   - ☐ Species has never been intercepted
   - ☐ Species has been intercepted
   - ☐ Host material has been frequently intercepted
   - ☐ Species has been frequently intercepted
   - ☐ Unknown*

6. Pest host range
   - ☐ Single host species
   - ☐ Small number of host species
   - ☐ Large number of host species
   - ☐ Unknown*

7. Number of individuals required to establish a breeding population
- ☐ More than 100
- ☐ 100
- ☐ 50
- ☐ 10
- ☐ 1
- ☐ Unknown*

8. Demographics of host
- ☐ Host distribution discontinuous across a small area of assessing country
- ☐ Host distribution continuous across a small area of assessing country
- ☐ Host distribution discontinuous across most urban and rural areas of assessing country
- ☐ Host distribution continuous across a large area of assessing country
- ☐ Unknown*

9. Species climatic requirements
- ☐ Species climatic requirements limited
- ☐ Species climatic requirements restricted to a narrow niche
- ☐ Species climatic range and economic host distribution have a limited overlap
- ☐ Species climatic range and economic host distribution overlap considerably
- ☐ Species is unrestricted by climatic types present in assessing country
- ☐ Unknown*

10. Ability to spread once established
- ☐ Species will not spread from site of introduction
- ☐ Species has a limited spread and only with host material
- ☐ Species has a limited spread independent of host material
- ☐ Species will spread widely in association with host
- ☐ Species will spread widely independent with host
- ☐ Species will spread widely independently or in association with host
- ☐ Unknown*

11. Impact on industry
- ☐ None
- ☐ Minor financial impacts in the short term
- ☐ Minor financial impacts in the long term
- ☐ Industry not profitable in short term
- ☐ Major financial impacts in the long term
- ☐ Industry not profitable in long term
- ☐ Unknown*

12. Social costs
- ☐ Presence of pest will not result in downsizing of industry
- ☐ Presence of pest will result in minor downsizing of industry
- ☐ Presence of pest will result in major downsizing of industry
- ☐ Presence of pest will result in loss of industry
- ☐ Unknown*

13. Annual cost of control or eradication following establishment

- ☐ less than US$100,000 per year
- ☐ US$100,000 to US$1 million per year
- ☐ US$1 to 10 million per year
- ☐ US$10 to 100 million per year
- ☐ more than US$100 million per year
- ☐ Unknown*

14. Insect species is a vector

- ☐ No record
- ☐ Potential
- ☐ Vector of a minor disease/parasite
- ☐ Vector of a significant disease/parasite
- ☐ Vector of 3 or more diseases/parasites
- ☐ Unknown*

* Please note answering Unknown to more than 2 questions in the questionnaire raises a question mark over the validity of the results. More information needs to be gathered.

THREAT IDENTIFICATION AND PATHWAY ANALYSIS

GROUP I

INFORMATION SOURCES

a. Info. of the particular pest in the country
b. CABI – Crop Compendium
c. Host- Pest list of exporting country
d. Relevant Research institute
e. Experts on the particular pest
f. Pest interception record
g. Pest management practices of the exporting countries
h. Information from internet / library

HOW MANY OF THESE INFO AVAILABLE IN OUR COUNTRY

1. Info on the pests in our country?
   - Only some countries have
2. CABI
3. Relevant info from experts / research institute
   - Only some countries have
4. Pest interception records
   - All have the list
5. Info – internet / library / other sources

IS BIOLOGICAL AND ECOLOGICAL INFO AVAILABLE?

a. Pest data sheet
   - Deal with local info sources
   - Approach export / countries for more info

b. Tool like CLIMEX

MAJOR CONSTRAINTS

a. Lack of accurate info in general
b. Lack of quantitative tools for PRA-

c. Lack of expertise / staff

d. Lack of a permanent assessment team
e. Lack of funding

THREAT IDENTIFICATION AND PATHWAY ANALYSIS

GROUP II

1. Exporting country: Malaysia
   Importing country: Australia
   Commodity: Carambola (starfruit)

2. Common Pest List

Presence of pest in exporting and importing country

Exporting country (Malaysia)	**Importing country (Australia)**
Attacus atlas	Attacus atlas
Bactrocera carambolae	Absent
Bactrocera dorsalis	Absent
Bactrocera dorsalis sp. complex	Absent
Bactrocera occipitalis	Absent
Bactrocera philippinensis	Absent
Conogethes punctiferalis	Absent
Cryptophlebia leucotreta	Absent
Absent	Cryptophlebia ombrodelta
Cryptophlebia sp. (carambolae)	Absent
Eudocima fullonia	Eudocima fullonia (assumed)
Euproctis scintillans	Absent
Lymantria lunata	Absent
Maconellicoccus hirsutus	Absent

* potential threats in red

The 5 *Bactrocera* treated together, *Cryptophlebia* sp. (?*carambolae*) and *Maconellicoccus* hirsutus considered threats.

Assuming Australia imports 20,000 tons per day

		Negligible impact	Very low	Low	Moderate	High	Extreme impact
Likelihood of entry, establishment or spread	High likelihood						
	Moderate					*Bactrocera, Cryptophlebia* sp. High risk	
	Low						
	Very low				*Maconelliccocus* Very low risk		
	Extremely low						
	Negligible likelihood						

Management would be required for *Bactrocera* and *Cryptophlebia*.

Threat identification and pathway analysis

An introduction to Group Discussion II

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What is a potential threat?

- Known exotic plant pest
- It is a variant form of an established plant pest
- It is a serious plant pest of unknown or uncertain origin
- Plant pest of potential economic importance

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To identify threats

- Past records
- Existing protection plans
- Relevant experience
- Relevant published literature
- Research
- Specialist and expert judgement
- Economic models

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To identify pest threats

- What pests do your neighbours have that aren't in your country?
- What are your imports?
- What are your most important industries?
- Is there import of planting materials and/or seeds?

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Ranking pest threats

- What are the entry, establishment and spread possibilities?
- What are the likely impacts of the pest?
- How difficult is the organism to control?

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Pathway analysis

- Potential for entry
- Potential for establishment
- Potential for spread
- Potential for economic or environmental damage

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Analysing potential threats

The potential for entry, establishment, spread and economic or environmental damage is ranked as:

- Negligible
- Low
- Medium
- High
- Unknown

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Estimating potential for entry

- Risk represented by the no. consignments
- The likelihood that pest associated with pathway at origin
- Likelihood of pest surviving during transportation
- Likelihood of pest surviving existing management practices
- Take into account previous interceptions of pest
- What is pathway destination?
- Risk of intended use of commodity

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Estimating potential for establishment

- Are there suitable hosts in importing country?
- If pest transmitted by vectors are suitable vectors available?
- Is environment suitable for pest?
- Risk that existing controls for other pests unable to provide control
- What risk does biology of pest represent?

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Estimating the potential for spread

- How suitable is natural or managed environment?
- Are vectors likely to spread
- Risk that pest transported with commodities in importing country
- Likelihood pest spreading to area of higher economic importance
- Level of risk represented by intended use of commodity
- Likelihood natural enemies unable to control spread

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Estimating potential for economic or environmental damage

- What is economic loss in existing geographical range
- Potential economic loss in importing country
- Potential loss to non-agricultural factors (e.g. natural environment)

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Risk estimation matrix

Likelihood of entry, establishment or spread

Consequences of entry, establishment or spread

	Negligible impact	Very low	Low	Moderate	High	Extreme impact
High likelihood	Negligible risk	Very low risk	Low risk	Moderate risk	High risk	Extreme risk
Moderate	Negligible risk	Very low risk	Low risk	Moderate risk	High risk	Extreme risk
Low	Negligible risk	Negligible risk	Very low risk	Low risk	Moderate risk	High risk
Very low	Negligible risk	Negligible risk	Negligible risk	Very low risk	Low risk	Moderate risk
Extremely low	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Very low risk	Low risk
Negligible likelihood	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Very low risk

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Threat Summary Table

Common name	Citrus huanglongbing	Coconut leaf moth	Spider mite
Scientific name	Liberibacter asiaticus	Artona catoxantha	Tetranychus piercei
Primary host	Citrus and citrus relatives	Polyphagous – coconut, sago	Polyphagous
Plant part affected	Whole plant		
Entry potential	Medium		High
Establishment potential	High	Low	High
Spread potential	High	Low	High
Economic impact	High	Low	Medium

etc.

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Pest priority list

The most serious threats from threat summary table can be identified through a process of risk assessment

Usually group them as:

1. pests currently not in your country
2. pests already present but under active control.

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Discussion points

- Information sources required for identifying potential threats
- How many of these information sources are readily available in your country
- Once potential threats identified, is ecological information available for accurate pathway analysis?
- What are the major threats facing you with respect to threat identification and pathway analysis?

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