Australian Government

Department of Agriculture, Fisheries and Forestry

Tahitian Limes from New Caledonia

Draft Import Risk Analysis Report

September 2003

Foreword

Contents

LIST OF TABLES

GLOSSARY OF TERMS AND ABBREVIATIONS.

ALOP	appropriate level of protection
AQIS	Australian Quarantine and Inspection Service
Area	an officially defined country, part of a country or all or parts of several countries
Arthropoda	A phylum of invertebrate animals. The major classes are Insecta (insects), Arachnida (mites, spiders) and Crustacea (shrimps, prawns, crabs)
Biosecurity Australia	a major operating group within the Department of Agriculture, Fisheries and Forestry
Contaminating pest	a pest that is carried by a commodity and, in the case of plants and plant products, does not infest those plants or plant products
Control (of a pest)	suppression, containment or eradication of a pest population
DAFF	Department of Agriculture, Fisheries and Forestry
DAF-NC	Department of Agriculture and Forestry - New Caledonia
Endangered area	an area where ecological factors favour the establishment of a pest whose presence in the area will result in economically important loss
Entry (of a pest)	movement of a pest into an area where it is not yet present, or present but not widely distributed and being officially controlled
Entry potential	likelihood of the entry of a pest
Establishment	the perpetuation, for the foreseeable future, of a pest within an area after entry
Establishment potential	likelihood of the establishment of a pest
FAO	Food and Agriculture Organization of the United Nations
Fresh	not dried, deep-frozen or otherwise conserved
ICA	Interstate Certification Assurance
ICON	AQIS Import Conditions database
Introduction	entry of a pest resulting in its establishment
Introduction potential	likelihood of the introduction of a pest
IPPC	International Plant Protection Convention, as deposited in 1951 with FAO in Rome and as subsequently amended
IRA	import risk analysis
ISPM	International Standard on Phytosanitary Measures
National Plant Protection	

Organisation	official service established by a government to discharge the functions specified by the IPPC
Non-quarantine pest	pest that is not a quarantine pest for an area
Official	established, authorised or performed by a National Plant Protection Organisation
Official control (of a regulated pest)	the active enforcement of mandatory phytosanitary regulations and the application of mandatory phytosanitary procedures with the objective or eradication or containment of quarantine pests or for the management of regulated non-quarantine pests
Pathogen	a parasite able to cause disease in a particular host or range of hosts. Pathogens include bacteria, fungi, nematodes, viroids and viruses
Pathway	the ordered sequence of steps leading to an outcome, or event
PBPM	Plant Biosecurity Policy Memorandum
Pest	any species, strain or biotype of plant, animal, or pathogenic agent, injurious to plants or plant products
Pest categorisation	the process for determining whether a pest has or has not the characteristics of a quarantine pest or those of a regulated non-quarantine pest
Pest free area	an area in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained
Pest risk analysis	the process of evaluating biological or other scientific evidence to determine whether a pest should be regulated and the strength of any phytosanitary measures to be taken against it
Phytosanitary measure	any legislation, regulation or official procedure having the purpose to prevent the introduction and/or spread of quarantine pests
PRA	pest risk analysis
PRA area	area in relation to which a pest risk analysis is conducted
QP	Quarantine Proclamation
Quarantine pest	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
Regulated non-quarantine pest	a non-quarantine pest whose presence in plants for planting affects the intended use of those plants with an economically unacceptable impact and which is therefore regulated within the territory of the importing contracting party.
Spread	expansion of the geographical distribution of a pest within an area

Spread potential	likelihood of the spread of a pest
SPS	Sanitary and Phytosanitary
SPS Agreement	WTO Agreement on the Application of Sanitary and Phytosanitary Measures
Stakeholders	Government agencies, individuals, community or industry groups or organisations, whether in Australia or overseas, with an interest in the subject matter of an IRA, including the proponent/applicant for a specific proposal
WTO	World Trade Organization

EXECUTIVE SUMMARY

This *Draft Import Risk Analysis (IRA) Report* contains the following:

- Information on the background to this IRA, Australia's framework for quarantine policy and import risk analysis, the international framework for trade in plants and plant products, and Australia's current policy for the importation of fresh Tahitian limes;
- an outline of the methodology and results of pest categorisation, risk assessment and risk management;
- draft quarantine import conditions for fresh Tahitian limes from New Caledonia;
- further steps in the IRA process; and
- a summary of stakeholder comments received on the Technical Issues Paper and Biosecurity Australia's response.

The risk assessment identified fifteen arthropods and one pathogen as requiring risk management measures to reduce the risk to an acceptable level.

This draft IRA Report concludes that the risks associated with the importation of fresh Tahitian lime fruit from New Caledonia can be managed by applying a combination of risk management measures and operational maintenance systems, specifically:

- systems approach for fruit flies;
- visual inspection for scales/mealybugs and a mite;
- orchard control of *Sphaceloma fawcettii* (exotic citrus scab isolates);
- registration of export orchards and packinghouses;
- pre-export inspection and phytosanitary certification by Department of Agriculture and Forestry - New Caledonia;
- packing and labelling compliance;
- security of fruit;
- on-arrival quarantine clearance by the Australian Quarantine and Inspection Service (AQIS); and
- specific phytosanitary requirements for fruit flies – certified mature green fruit.

Details of these proposed risk management measures, including their objectives, are provided within this draft IRA report. Details are also provided on how these measures may be implemented through the draft import conditions. Biosecurity Australia invites comments on the technical and economic feasibility of the proposed risk management measures and import conditions. In particular, comments are sought on their appropriateness and any alternatives that stakeholders consider would achieve the identified objectives.

BIOSECURITY FRAMEWORK

INTRODUCTION

This section outlines:

- The legislative basis for Australia's biosecurity regime
- Australia's international rights and obligations
- Australia's Appropriate Level of Protection
- Import risk analysis
- Policy determination

AUSTRALIAN LEGISLATION

The *Quarantine Act 1908* and its subordinate legislation, including the *Quarantine Proclamation 1998*, are the legislative basis of human, animal and plant biosecurity in Australia.

Some key provisions are set out below.

Quarantine Act: Scope

Sub section 4 (1) of the *Quarantine Act 1908* defines the scope of quarantine as follows.

In this Act, quarantine includes, but is not limited to, measures:

(a) *for, or in relation to:*

(i) the examination, exclusion, detention, observation, segregation, isolation, protection, treatment and regulation of vessels, installations, human beings, animals, plants or other goods or things; or

(ii) the seizure and destruction of animals, plants, or other goods or things; or

(iii) the destruction of premises comprising buildings or other structures when treatment of these premises is not practicable; and

(b) *having as their object the prevention or control of the introduction, establishment or spread of diseases or pests that will or could cause significant damage to human beings, animals, plants, other aspects of the environment or economic activities.*

Section 5D of the *Quarantine Act 1908* covers the level of quarantine risk.

A reference in this Act to a level of quarantine risk is a reference to:

(a) *the probability of:*

(i) a disease or pest being introduced, established or spread in Australia or the Cocos Islands; and

(ii) the disease or pest causing harm to human beings, animals, plants, other aspects of the environment, or economic activities; and

(b) *the probable extent of the harm.*

Section 5D of the *Quarantine Act 1908* includes harm to the environment as a component of the level of quarantine risk.

Environment is defined in Section 5 of the *Quarantine Act 1908,* in that it:

> *includes all aspects of the surroundings of human beings, whether natural surroundings or surroundings created by human beings themselves, and whether affecting them as individuals or in social groupings.*

Quarantine Proclamation

The *Quarantine Proclamation 1998* is made under the under the *Quarantine Act 1908*. It is the principal legal instrument used to control the importation into Australia of goods of quarantine (or biosecurity) interest. The Proclamation empowers a Director of Quarantine to grant a permit to import.

Section 70 of the *Quarantine Proclamation 1998* sets out the matters to be considered when deciding whether to grant a permit to import:

> *Things a Director of Quarantine must take into account when deciding whether to grant a permit for importation into Australia*
>
> *(1) In deciding whether to grant a permit to import a thing into Australia or the Cocos Islands, or for the removal of a thing from the Protected Zone or the Torres Strait Special Quarantine Zone to the rest of Australia, a Director of Quarantine:*
>
> *(a) must consider the level of quarantine risk if the permit were granted; and*
>
> *(b) must consider whether, if the permit were granted, the imposition of conditions on it would be necessary to limit the level of quarantine risk to one that is acceptably low; and*
>
> *(ba) for a permit to import a seed of a kind of plant that was produced by genetic manipulation -- must take into account any risk assessment prepared, and any decision made, in relation to the seed under the Gene Technology Act; and*
>
> *(c) may take into account anything else that he or she knows that is relevant.*

Development of Biosecurity Policy

As can be seen from the above extracts, the legislation establishes the concept of the level of biosecurity (quarantine) risk as the basis of decision-making under Australian quarantine legislation.

Import risk analyses are a significant contribution to the information available to the Director of Animal and Plant Quarantine - a decision maker for the purposes of the Quarantine Proclamation. Import risk analysis is conducted within an administrative process – known as the IRA process (described in the *IRA Handbook*[1])

---

[1] Biosecurity Australia (2003) *Import Risk Analysis Handbook*. Australian Government Department of Agriculture, Fisheries and Forestry, Canberra

The purpose of the IRA process is to deliver a policy recommendation to the Director of Animal and Plant Quarantine that is characterised by sound science and by transparency, fairness and consistency. The key elements of the IRA process are covered in "Import Risk Analysis" below.

AUSTRALIA'S INTERNATIONAL RIGHTS AND OBLIGATIONS

It is important that import risk analyses conform with Australia's rights and obligations as a WTO Member country. These rights and obligations derive principally from the World Trade Organization's *Agreement on the Application of Sanitary and Phytosanitary Measures* (SPS Agreement), although other WTO agreements may also be relevant. Specific international guidelines on risk analysis developed under the International Plant Protection Convention (IPPC) and by the Office International des Epizooties (OIE) are also relevant.

The SPS Agreement recognises the right of WTO Member countries to determine the level of sanitary and phytosanitary protection they deem appropriate, and to take the necessary measures to achieve that protection. Sanitary (human and animal health) and phytosanitary (plant health) measures typically apply to trade in or movement of animal and plant based goods within or between countries. The SPS Agreement applies to measures that may directly or indirectly affect international trade and that protect human, animal or plant life or health from pests and diseases or a Member's territory from a pest.

The SPS Agreement provides for the following:

- The right of WTO Member countries to determine the level of sanitary and phytosanitary protection (its appropriate level of protection, or ALOP) they deem appropriate;
- An importing Member has the sovereign right to take measures to achieve the level of protection it deems appropriate to protect human, animal or plant life or health within its territory;
- An SPS measure must be based on scientific principles and not be maintained without sufficient scientific evidence;
- An importing Member shall avoid arbitrary or unjustifiable distinctions in levels of protection, if such distinctions result in discrimination or a disguised restriction on international trade;
- An SPS measure must not be more trade restrictive than required to achieve an importing Member's ALOP, taking into account technical and economic feasibility;
- An SPS measure should be based on an international standard, guideline or recommendation where these exist, unless there is a scientific justification for a measure which results in a higher level of SPS protection to meet the importing Member's ALOP;
- An SPS measure conforming to an international standard, guideline or recommendation is deemed to be necessary to protect human, animal or plant life or health, and to be consistent with the SPS Agreement;
- Where an international standard, guideline or recommendation does not exist or where, in order to meet an importing Member's ALOP, a measure needs to provide a higher level of protection than accorded by the relevant international standard, such a measure must be based on a risk assessment; the risk assessment must take into account available scientific evidence and relevant economic factors;
- Where the relevant scientific evidence is insufficient, an importing Member may provisionally adopt SPS measures on the basis of available pertinent information. In such circumstances,

Members shall seek to obtain the additional information necessary for a more objective assessment of risk and review the SPS measure accordingly within a reasonable period of time;

- An importing Member shall accept the measures of other countries as equivalent, if it is objectively demonstrated that the measures meet the importing Member's ALOP.

AUSTRALIA'S APPROPRIATE LEVEL OF PROTECTION (ALOP)

The SPS Agreement defines the concept of an 'appropriate level of sanitary or phytosanitary protection (ALOP)' as the level of protection deemed appropriate by the WTO Member establishing a sanitary or phytosanitary measure to protect human, animal or plant life or health within its territory.

Like many other countries, Australia expresses its ALOP in qualitative terms. Australia's ALOP, which reflects community expectations through government policy, is currently expressed as providing a high level of sanitary or phytosanitary protection aimed at reducing risk to a very low level, but not to zero.

ALOP can be illustrated using a 'risk estimation matrix' Table 1. The cells of this matrix describe the product of likelihood[2] and consequences — termed 'risk'. When interpreting the risk estimation matrix, it should be remembered that, although the descriptors for each axis are similar ('low', 'moderate', 'high' etc), the vertical axis refers to *likelihood* and the horizontal axis refers to *consequences*.

Table 1 Risk estimation matrix

Likelihood 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

Consequences of entry, establishment or spread

The band of cells in Table 1 marked 'very low risk' represents Australia's ALOP, or tolerance of loss.

2 The terms "likelihood" and "probability" are synonymous. "Probability" is used in the *Quarantine Act 1908* while "likelihood" is used in the WTO SPS Agreement. These terms are used interchangeably in this IRA Report.

Risk Management and SPS Measures

Australia’s plant and animal health status is maintained through the implementation of measures to facilitate the importation of products while protecting the health of people, animals and plants.

Australia bases its national measures on international standards where they exist and where they deliver the appropriate level of protection from pests and diseases. However, where such standards do not achieve Australia’s level of biosecurity protection, or relevant standards do not exist, Australia exercises its right under the SPS Agreement to take appropriate measures, justified on scientific grounds and supported by risk analysis.

Australia’s approach to addressing requests for imports of animals, plants and their products, where there are biosecurity risks, is, where appropriate, to draw on existing sanitary and phytosanitary measures for similar products with comparable risks. However, where measures for comparable biosecurity risks have not previously been established, further action would be required to assess the risks to Australia and determine the sanitary and phytosanitary measures needed to achieve Australia’s ALOP.

IMPORT RISK ANALYSIS

Description

In animal and plant biosecurity, an import risk analysis identifies the pests and diseases relevant to an import proposal, assesses the risks posed by them and, if those risks are unacceptable, specifies the measures that could be taken to reduce those risks to an acceptable level. These analyses are conducted via an administrative process (described in the *IRA Handbook*) that involves, among other things, notification to the WTO, consultation and appeal.

Undertaking IRAs

Biosecurity Australia may undertake an IRA if:

- there is no relevant existing biosecurity measure for the good and pest/disease combination; or
- a variation in established policy is desirable because pests or diseases, or the likelihood and/or consequences of entry, establishment or spread of the pests or diseases could differ significantly from those previously assessed.

Environment and human health

When undertaking an import risk analysis, Biosecurity Australia takes into account harm to the environment as part of its assessment of biosecurity risks associated with the potential import.

Under the *Environment Protection and Biodiversity Conservation Act 1999*, Environment Australia may assess proposals for the importation of live specimens and their reproductive material. Such an assessment may be used or referred to by Biosecurity Australia in its analyses.

Biosecurity Australia also consults with other Commonwealth agencies where they have responsibilities relevant to the subject matter of the IRA, e.g. Food Standards Australia New Zealand (FSANZ) and the Department of Health and Ageing.

The IRA process in summary

The process consists of the following major steps:

***Initiation*: This is the stage where the identified need for an IRA originates.

Scheduling and Scoping: At this stage, Biosecurity Australia considers all the factors that affect scheduling. Consultation with States, Territories and other Commonwealth agencies is involved. There is opportunity for appeal by stakeholders at this stage.

Risk Assessment and Risk Management: Here, the major scientific and technical work relating to risk assessment is performed. There is detailed consultation with stakeholders.

Reporting: Here, the results of the IRA are communicated formally. There is consultation with States and Territories. The Executive Manager of Biosecurity Australia then delivers the biosecurity policy recommendation arising from the IRA to the Director of Animal and Plant Quarantine. There is opportunity for appeal by stakeholders at this stage.

POLICY DETERMINATION

The Director of Animal and Plant Quarantine makes the policy determination, which is notified publicly.

METHOD FOR PEST RISK ANALYSIS

The technical component of an IRA for plants or plant products is termed a ‘pest risk analysis’, or PRA. Biosecurity Australia conducts PRA in accordance with the International Standard for Phytosanitary Measure (ISPM) 11 *Pest Risk Analysis for Quarantine Pests.* A summary of the requirements of ISPM 11 is given in this section plus descriptions of the methodology used to meet these requirements in this IRA. This summary is given to provide a description of the methodology used for this IRA and to provide a context for the technical information that is provided later in this document.

A PRA comprises three discrete stages:

- Stage 1: initiation of the PRA
- Stage 2: risk assessment
- Stage 3: risk management.

The *initiation* of a risk analysis involves the identification of the pest(s) and pathways of concern that should be considered for analysis. *Risk assessment* comprises pest categorisation, assessment of the probability of introduction and spread, and assessment of the potential economic consequences (including environmental impacts). *Risk management* describes the evaluation and selection of options to reduce the risk of introduction and spread of a pest.

STAGE 1: INITIATION

The aim of the initiation stage is to identify the pest(s) and pathways (e.g. commodity imports) which are of quarantine concern and should be considered for risk analysis in relation to the identified PRA area. This PRA was initiated by the market access request from Department of Agriculture and Forestry - New Caledonia (DAF-NC) to export commercially produced fresh Tahitian limes from New Caledonia into Australia for human consumption.

STAGE 2: PEST RISK ASSESSMENT

The process for pest risk assessment can be broadly divided into three interrelated steps:

- pest categorisation
- assessment of probability of entry, establishment or spread
- assessment of potential consequences (including environmental impacts).

Pest risk assessment needs to be only as complex as is technically justified by the circumstances. ISPM 11 allows a specific PRA to be judged against the principles of necessity, minimal impact, transparency, equivalence, risk analysis, managed risk and non-discrimination.

Pest categorisation

Pest categorisation is a process to examine for each pest whether the criteria for a quarantine pest are satisfied. That is, whether the pests identified in Stage 1 (Initiation of the PRA) are 'quarantine pests' or not.

The categorisation of a pest as a quarantine pest includes the following primary elements:

- *Identity of the pest*. The identity of the pest should be clearly defined to ensure that the assessment is being performed on a distinct organism, and that biological and other information used in the assessment is relevant to the organism in question. If this is not possible because the causal agent of particular symptoms has not yet been fully identified, then it should have been shown to produce consistent symptoms and to be transmissible.

  The taxonomic unit for the pest is generally species. The use of a higher or lower taxonomic level should be supported by scientifically sound rationale. For levels below the species, this should include evidence demonstrating that factors such as differences in virulence, host range or vector relationships are significant enough to affect phytosanitary status.

  Where a vector is involved, the vector may also be considered a pest to the extent that it is associated with the causal organism and is required for transmission of the pest.

- *Presence or absence in the endangered area*. The pest should be absent from all or part of the endangered area.

- *Regulatory status*. If the pest is present but not widely distributed in the PRA area, it should be under official control or be expected to be under official control in the near future.

- *Potential for establishment and spread in the PRA area*. Evidence should be available to support the conclusion that the pest could become established or spread in the PRA area. The PRA area should have ecological/climatic conditions including those in protected conditions suitable for the establishment and spread of the pest where relevant, host species (or near relatives), alternate hosts and vectors should be present in the PRA area.

- *Potential for economic consequences in the endangered area*. There should be clear indication that the pest is likely to have an unacceptable economic impact (including environmental impact) in the PRA area.

Pest categorisation was carried out in two stages for this IRA.

In the *Technical Issues Paper* released in August 2002 (Technical Issues Paper: Import Risk Analysis (IRA) for the importation of Tahitian limes from New Caledonia), a list of pests of Tahitian limes was categorised according to the presence or absence of each pest in Australia, and the association of each pest with mature Tahitian lime fruit. Where there was any doubt or contention regarding the occurrence of a pest or its association with Tahitian lime fruit, that pest was retained on the list of potential quarantine pests.

The second stage of pest categorisation is documented in this report. This stage was based on the categorisation of each pest absent from Australia and associated with Tahitian lime fruit according to (a) its potential to become established in Australia, and, (b) the potential for consequences. Categorisation of establishment potential and potential for consequences was dichotomous, and expressed using the terms 'feasible' / 'not feasible', and 'significant' / 'not significant', respectively. A summary of the results of pest categorisation for this IRA is given in the 'Pest Categorisation' section of this document.

Assessment of the probability of introduction or spread

Details on assessing the 'probability of entry', 'probability of establishment' and 'probability of spread after establishment' of a pest are given in ISPM 11. A synopsis of these details is given below, followed by a description of the qualitative methodology used in this IRA.

Pest introduction is comprised of both entry and establishment. Assessing the probability of introduction requires an analysis of each of the pathways with which a pest may be associated from its origin to its establishment in the PRA area. In a PRA initiated by a specific pathway, the probability of pest entry is evaluated for the pathway in question. The probabilities for pest entry with other pathways, if any, need to be investigated as well.

The assessment of probability of spread is based primarily on biological considerations similar to those for entry and establishment.

Probability of entry

The probability of entry of a pest depends on the pathways from the exporting country to the destination, and the frequency and quantity of the pests associated with them. The higher the number of pathways, the greater the probability of the pest entering the PRA area.

Steps identified in ISPM 11 relevant to PRA initiated by a pathway are:

- *Probability of the pest being associated with the pathway at origin* – e.g. prevalence in the source area, occurrence of life stages that would be associated with the commodity, volume and frequency of movement along the pathway, seasonal timing, pests management, cultural and commercial procedures applied at the place of origin
- *Probability of survival during transport or storage* – e.g. speed and conditions of transport and duration of the lifecycle, vulnerability of the life-stages during transport or storage, prevalence of the pest, commercial procedures applied.
- *Probability of pest surviving existing pest management procedures*
- *Probability of transfer to a suitable host* – e.g. dispersal mechanisms, whether the imported commodity is sent to few or many destination points in the PRA area, time of year at which import takes place, intended use of the commodity, risks from by-products and waste.

Probability of establishment

In order to estimate the probability of establishment of a pest, reliable biological information (life cycle, host range, epidemiology, survival etc) should be obtained from the areas where the pest currently occurs. The situation in the PRA area can then be compared with that in the areas where it currently occurs and expert judgement used to assess the probability of establishment. Examples provided in ISPM 11 of factors to consider are:

- Availability, quantity and distribution of hosts in the PRA area
- Environmental suitability in the PRA area
- Potential for adaptation of the pest
- Reproductive strategy of the pest
- Method of pest survival
- Cultural practices and control measures.

Probability of spread after establishment

In order to estimate the probability of spread of the pest, reliable biological information should be obtained from areas where the pest currently occurs. The situation in the PRA area can then be carefully compared with that in the areas where the pest currently occurs and expert judgement used to assess the probability of spread. Examples provided in ISPM 11 of factors to consider are:

- Suitability of the natural and/or managed environment for natural spread of the pest
- Presence of natural barriers
- The potential for movement with commodities or conveyances
- Intended use of the commodity
- Potential vectors of the pest in the PRA area
- Potential natural enemies of the pest in the PRA area.

Method for evaluating the probability of entry, establishment or spread

Evaluation and reporting of likelihoods can be done qualitatively, semi-quantitatively or quantitatively. For qualitative evaluation, likelihoods assigned to steps in the scenarios are categorised according to a descriptive scale – eg ‘low’, ‘moderate’, ‘high’ etc –where no attempt has been made to equate descriptors with numeric values or scores. For semi-quantitative evaluation, likelihoods are given numeric ‘scores’ (eg. 1, 2, 3), or probabilities and/or probability intervals (eg. 0–0.0001, 0.0001–0.001, 0.001-0.01, 0.01-1). For quantitative evaluation, likelihoods are described in purely numeric terms.

Each of these three approaches to likelihood evaluation has its advantages and constraints and the choice of approach depends on both technical and practical considerations. For this IRA, likelihood was evaluated and reported qualitatively using the terms described in Table 2.

Table 2 Nomenclature for qualitative likelihoods

Likelihood	Descriptive definition
High	The event would be very likely to occur
Moderate	The event would occur with an even probability
Low	The event would be unlikely to occur
Very low	The event would be very unlikely to occur
Extremely low	The event would be extremely unlikely to occur
Negligible	The event would almost certainly not occur

Qualitative likelihoods can be assigned to individual steps or to the probability that all the steps will occur. If the likelihoods have been assigned to individual steps then some form of ‘combination rule’ is needed for calculating the probability that all steps will occur. For this IRA the likelihoods were combined using a tabular matrix, as shown in Table 3.

Table 3 Matrix of rules for combining descriptive likelihoods

	High	Moderate	Low	V. Low	E. Low	Negligible
High	High	Moderate	Low	V. Low	E. Low	Negligible
Moderate		Low	Low	V. Low	E. Low	Negligible
Low			V. Low	V. Low	E. Low	Negligible
Very low				E. Low	E. Low	Negligible
E. low					Negligible	Negligible
Negligible						Negligible

In this IRA, qualitative likelihoods were assigned to the probability of entry (comprising an importation step and a distribution step), the probability of establishment and the probability of spread. In other IRAs it may be considered relevant to assign qualitative likelihoods to additional steps. This would depend on the complexity of the issue and the information that was available. For example, within the importation step, separate qualitative likelihoods could be assigned to the probabilities that source fruit is infested, that the pest survives packinghouse procedures and that it survives storage and transport.

The procedure for combining likelihoods is illustrated in Table 4. A likelihood is assigned to the probability of importation (low) and the probability of distribution (moderate) then they are combined to give the probability of entry (low). The likelihoods are combined using the 'rules' provided in Table 3. The probability of entry is then combined with the likelihoods assigned to the probability of establishment (high) and probability of spread (very low) to give the overall probability of entry, establishment or spread (very low).

Table 4 Qualitative evaluation of the imported fruit scenario

Step	Qualitative descriptor		Product of likelihoods
Probability of importation	Low		
Probability of distribution	Moderate		
➔ Probability of entry		➔	Low
Probability of establishment	High	➔	Low
Probability of spread	Very low		
➔ Probability of entry, establishment or spread		➔	Very low

Assessment of consequences

The basic requirements for the assessment of consequences are described in the SPS Agreement, with Article 5.3 stating that:

"Members shall take into account as relevant economic factors: the potential damage in terms of loss of production or sales in the event of the entry, establishment or spread of a pest or disease; the costs of control or eradication in the territory of the importing Member; and the relative cost-effectiveness of alternative approaches to limiting risks"

Assessment of consequences is also referred to in Annex A of the SPS Agreement in the definition of risk assessment:

"The evaluation of the likelihood of entry, establishment or spread of a pest or disease within the Territory of an importing Member according to the sanitary or phytosanitary measures which might be applied, and of the associated potential biological and economic consequences"

Further detail on assessing these "relevant economic factors" or "associated potential biological and economic consequences" for plant-based analysis is given under the "potential economic consequences" section in ISPM 11[3]. This ISPM separates the consequences into "direct" and "indirect" and provides examples of factors to consider within each. These examples are listed below under the headings where they may be considered in an IRA. This is followed by a description of the methodology used in this IRA.

In this IRA, the term "consequence" is used to reflect the "relevant economic factors"/"associated potential biological and economic consequences" and "potential economic consequences" terms as used in the SPS Agreement and ISPM 11 respectively.

Direct pest effects

Plant life or health

Examples from ISPM 11 that could be considered for the direct consequences on plant life or health:

- Known or potential host plants
- Types, amount and frequency of damage
- Crop losses, in yield and quality
- Biotic factors (e.g. adaptability and virulence of the pest) affecting damage and losses
- Abiotic factors (e.g. climate) affecting damage and losses
- Rate of spread
- Rate of reproduction
- Control measures (including existing measures), their efficacy and cost
- Effect of existing production practices
- Environmental effects.

[3] A revised version of ISPM 11 was released in April 2003. The supplement on analysis of environmental risks endorsed by the ICPM has been integrated into ISPM 11 to produce ISPM No. 11 Rev. 1

Any other aspects of the environment

Examples from ISPM 11 that could be considered for the direct consequences on any other aspects of the environment:

- Environmental effects (*listed as a general example in ISPM 11*)
- Reduction of keystone plant species
- Reduction of plant species that are major components of ecosystems (in terms of abundance or size), and endangered native plant species (including effects below species level where there is evidence of such effects being significant)
- Significant reduction, displacement or elimination of other plant species.

Indirect pest effects

Eradication, control etc

Examples from ISPM 11 that could be considered for the indirect consequences on eradication, control etc:

- Changes to producer costs or input demands, including control costs
- Feasibility and cost of eradication or containment
- Capacity to act as a vector for other pests
- Resources needed for additional research and advice.

Domestic trade & International trade

Examples from ISPM 11 that could be considered for the indirect consequences on domestic & international trade (the two are considered separately):

- Effects on domestic and export markets, including particular effects on export market access
- Changes to domestic or foreign consumer demand for a product resulting from quality changes.

Environment

Examples from ISPM 11 that could be considered for the indirect consequences on the environment:

- Environmental and other undesired effects of control measures
- Social and other effects (e.g. tourism)
- Significant effects on plant communities
- Significant effects on designated environmentally sensitive or protected areas
- Significant change in ecological processes and the structure, stability or processes of an ecosystem (including further effects on plant species, erosion, water table changes, increased fire hazard, nutrient cycling, etc)
- Effects on human use (e.g. water quality, recreational uses, tourism, animal grazing, hunting, fishing)
- Costs of environmental restoration.

Method for assessing consequences in this IRA

The relevant examples of direct and indirect consequences from ISPM 11 are considered for each of the broad groups (as listed above) and estimates of the consequences are assigned. The broad groups are shown in table form in the 'Risk Assessments for Quarantine Pests' section of this document.

The direct and indirect consequences were estimated based on four geographic levels. The terms 'local', 'district', 'regional' and 'national' are defined as:

Local: an aggregate of households or enterprises — e.g. a rural community, a town or a local government area

District: a geographically or geopolitically associated collection of aggregates — generally a recognised section of a state, such as the 'North West Slopes and Plains' or 'Far North Queensland'

Region: a geographically or geopolitically associated collection of districts — generally a state, although there may be exceptions with larger states such as Western Australia

National: Australia-wide

The consequence was described as 'unlikely to be discernible', of 'minor significance', significant' or 'highly significant':

- an '*unlikely to be discernible*' consequence is not usually distinguishable from normal day-to-day variation in the criterion
- a consequence of '*minor significance*' is not expected to threaten economic viability, but would lead to a minor increase in mortality/morbidity or a minor decrease in production. For non-commercial factors, the consequence is not expected to threaten the intrinsic 'value' of the criterion — though the value of the criterion would be considered as 'disturbed'. Effects would generally be reversible.
- a '*significant*' consequence would threaten economic viability through a moderate increase in mortality/morbidity, or a moderate decrease in production. For non-commercial factors, the intrinsic 'value' of the criterion would be considered as significantly diminished or threatened. Effects may not be reversible.
- a '*highly significant*' consequence would threaten economic viability through a large increase in mortality/morbidity, or a large decrease in production. For non-commercial factors, the intrinsic 'value' of the criterion would be considered as severely or irreversibly damaged.

The values were translated into a qualitative score (A–F) using the schema outlined in Table 5.

Table 5 The assessment of local, district, regional and national consequences

Consequence score	Local	District	Regional	National
F	-	-	-	Highly significant
E	-	-	Highly significant	Significant
D	-	Highly significant	Significant	Minor
C	Highly significant	Significant	Minor	Unlikely to be discernible
B	Significant	Minor	Unlikely to be discernible	Unlikely to be discernible
A	Minor	Unlikely to be discernible	Unlikely to be discernible	Unlikely to be discernible

Level

The overall consequence for each pest was achieved by combining the qualitative scores (A–F) for each direct and indirect consequence using a series of decision rules. These rules are mutually exclusive, and were addressed in the order that they appeared in the list — for example, if the first rule did not apply, the second rule was considered. If the second rule did not apply, the third rule was considered and so on until one of the rules applied:

- Where the consequences of a pest with respect to any direct or indirect criterion is ‘F’, the overall consequences are considered to be ‘extreme’.
- Where the consequences of a pest with respect to more than one criterion is ‘E’, the overall consequences are considered to be ‘extreme’.
- Where the consequences of a pest with respect to a single criterion is ‘E’ and the consequences of a pest with respect to each remaining criterion is ‘D’, the overall consequences are considered to be ‘extreme’.
- Where the consequences of a pest with respect to a single criterion is ‘E’ and the consequences of a pest with respect to remaining criteria is not unanimously ‘D’, the overall consequences are considered to be ‘high’.
- Where the consequences of a pest with respect to all criteria is ‘D’, the overall consequences are considered to be ‘high’.
- Where the consequences of a pest with respect to one or more criteria is ‘D’, the overall consequences are considered to be ‘moderate’.
- Where the consequences of a pest with respect to all criteria is ‘C’, the overall consequences are considered to be ‘moderate’.
- Where the consequences of a pest with respect to one or more criteria is considered ‘C’, the overall consequences are considered to be ‘low’.
- Where the consequences of a pest with respect to all criteria is ‘B’, the overall consequences are considered to be ‘low’.
- Where the consequences of a pest with respect to one or more criteria is considered ‘B’, the overall consequences are considered to be ‘very low’.
- Where the consequences of a pest with respect to all criteria is ‘A’, the overall consequences are considered to be ‘negligible’.

STAGE 3: PEST RISK MANAGEMENT

The conclusions from pest risk assessment are used to decide whether risk management is required and if so, the strength of measures to be used. Since zero-risk is not a reasonable option, the guiding principle for risk management is to manage risk to achieve the required degree of safety that can be justified and is feasible within the limits of available options and resources. Pest risk management (in the analytical sense) is the process of identifying ways to react to a perceived risk, evaluating the efficacy of these actions, and identifying the most appropriate options.

Overall risk is determined by the examination of the outputs of the assessments of the probability of introduction and the consequence. If the risk is found to be unacceptable, then the first step in risk management is to identify possible phytosanitary measures that will reduce the risk to, or below, an acceptable level.

ISPM 11 provides details on the identification and selection of appropriate risk management options and notes that the choice of measures should be based on their effectiveness in reducing the probability of introduction of the pest.

Examples given of measures commonly applied to traded commodities include:

- *Options for consignments* – e.g. inspection or testing for freedom, prohibition of parts of the host, a pre-entry or post-entry quarantine system, specified conditions on preparation of the consignment, specified treatment of the consignment, restrictions on end use, distribution and periods of entry of the commodity.
- *Options preventing or reducing infestation in the crop* – e.g. treatment of the crop, restriction on the composition of a consignment so it is composed of plants belonging to resistant or less susceptible species, harvesting of plants at a certain age or specified time of the year, production in a certification scheme.
- *Options ensuring that the area, place or site of production or crop is free from the pest* – e.g. pest-free area, pest-free place of production or pest-free production site.
- *Options for other types of pathways* – e.g. consider natural spread, measures for human travellers and their baggage, cleaning or disinfestation of contaminated machinery.
- *Options within the importing country* – e.g. surveillance and eradication programs.
- *Prohibition of commodities* – e.g. if no satisfactory measure can be found.

The result of the pest risk management procedure will be either that no measures are identified which are considered appropriate or the selection of one or more management options that have been found to lower the risk associated with the pest(s) to an acceptable level. These management options form the basis of phytosanitary regulations or requirements.

Method for pest risk management in this IRA

The unrestricted risk estimate for each pest was determined by combining the overall estimate for ‘entry, establishment or spread potential’ with the overall expected consequence using a risk estimate matrix (Table 1). The requirement for risk management was then determined by comparing the unrestricted risk estimate with Australia’s ALOP. Australia’s ALOP is represented in this matrix by the row of cells marked ‘very low risk’.

Where the estimate of unrestricted risk does not exceed Australia’s ALOP, risk management is not required. Where the unrestricted risk estimate exceeds Australia’s ALOP, risk management measures are required to reduce the risk to an acceptable level. Using this risk estimation matrix, risk management measures are required when the unrestricted risk estimate is low, moderate, high or extreme. Risk management measures are not required when the unrestricted risk estimate is very low or negligible.

Risk management measures were identified for each pest as required and are presented in the Risk Management section of this document. The proposed phytosanitary regulations based on these measures are presented in the Draft Quarantine Conditions section of this document.

PROPOSAL TO IMPORT TAHITIAN LIMES FROM NEW CALEDONIA

BACKGROUND

AQIS received an application from the Department of Agriculture and Forestry, New Caledonia (DAF-NC) in May 1996 seeking access for Tahitian limes to Australia. In response to this application, AQIS requested further technical information from New Caledonia. New Caledonia responded to AQIS's request and provided various technical submissions between 1996 and 1999. This information included pests and diseases recorded as being associated with Tahitian limes and statistics on the citrus industry in New Caledonia. The full report of non-host status studies of four economic fruit fly species on Tahitian limes conducted by New Caledonian authorities (Sales & Paulaud, 1995) was provided to AQIS in 1999. The methodology of the non-host status studies followed the procedures described in New Zealand National Agriculture Security Service (NASS) Standard 155.02.01.08 "Specification for Determination of Fruit Fly Host Status as a Treatment" (Anon., 1991a). Further information on the integrated pest management schedule recommended to export lime growers in New Caledonia was submitted to AQIS in September 1999.

Changes to the internal structure of DAFF resulted in the formation of Biosecurity Australia on 6 October 2000. Biosecurity Australia is responsible for the IRA function that was formerly the responsibility of AQIS.

ADMINISTRATION

Timetable

The section "Further steps in the Import Risk Analysis process" presented later in this report lists the steps for completion of this IRA.

Scope

This IRA considers quarantine risks that may be associated with the importation to Australia of fresh individual Tahitian limes from New Caledonia, and possible management measures to address those risks. In this IRA, fresh Tahitian limes are defined as the harvested individual fresh fruits of *Citrus latifolia* Tanaka with all vegetative parts removed, that have been cultivated, harvested, packed and transported to Australia under commercial conditions.

Other assessments

In addition to potential pests directly associated with Tahitian limes in New Caledonia, there are other organisms that may be carried by the fruit (present on the import pathway). Biosecurity Australia calls these contaminating pests. These contaminating pests could pose a quarantine risk. For this IRA, Biosecurity Australia proposes that such contaminating pests be categorised and assessed in the same way as pests directly associated with the fruit. In this draft IRA, one contaminating pest of quarantine concern was identified (*Wasmannia auropunctata* – the little fire ant).

AUSTRALIA'S CURRENT QUARANTINE POLICY FOR THE IMPORTATION OF FRESH LIMES

International quarantine policy

Currently, Australia allows the importation of the following species of fresh limes: *C. latifolia* (Tahitian lime), *C. aurantifolia* (West Indian lime), *C. hysterix* (Kaffir lime) and *C. limonia* (Rangpur lime) from Egypt, New Zealand, Spain and the USA (Arizona, California and Texas only).

Further details of the import requirements for limes are available at the ICON website http://www.aqis.gov.au/icon

Domestic arrangements

The Commonwealth Government is responsible for regulating the movement of plants and plant products into and out of Australia. However, the State and Territory Governments are responsible for plant health controls within Australia. Legislation relating to resource management or plant health may be used by State and Territory Government agencies to control interstate movement of plants and their products.

The Interstate Certification Assurance (ICA) scheme facilitates interstate trade. It recognises pest free areas within Australia and ensures produce entering such areas is free of specific pests of quarantine concern. The scheme is accepted by all Australian States and the Northern Territory and is based on documented operational procedures developed by the Queensland Department of Primary Industries (QDPI) in conjunction with industry and interstate quarantine authorities. It provides a harmonised approach to the audit and accreditation of businesses throughout Australia and the mutual recognition of Plant Health Assurance Certificates accompanying consignments of produce moving within or between States and territories. Interstate quarantine authorities maintain the right to inspect certified produce at any time and to refuse to accept a certificate where produce is found not to conform with specific requirements.

States and Territories within Australia have accepted ICA arrangements for domestic trade of horticultural commodities that are susceptible to Queensland fruit fly infestation. Tahitian limes produced in Queensland fruit fly infestation areas are allowed movement interstate under ICA-15: *"Mature green condition of passion fruit, Tahitian limes and black sapotes*". Tahitian lime fruit certified for the "*mature green condition*" under this quarantine policy needs to comply with two requirements: mature green and unbroken skin.

Mature green	fruit has skin free from yellow colouring.
Unbroken skin	the skin has no pre-harvest crack, puncture, pulled stem or other break that penetrates through to the flesh and has not healed with callus tissue.

PEST CATEGORISATION

Details of the pest categorisation for Tahitian limes is presented in Appendices 1 and 2. Appendix 1 contains the potential pests (arthropods and pathogens) and contaminating pests associated with Tahitian limes from New Caledonia based on their presence or absence in Australia. Appendix 2 indicates whether the potential pest or contaminating pest occurs on the pathway under consideration in this IRA (ie. in association with mature Tahitian lime fruit). Plant pests (weeds) were not considered to be potential pests for orchard crops of Tahitian lime as the structure of the fruit is not a receptacle for weed seeds. A number of pests listed in Appendix 1 are considered to be present in Australia but absent from Western Australia (based on evidence provided to Biosecurity Australia by the Department of Agriculture Western Australia).

Appendix 3 contains the potential pests associated with Tahitian limes in New Caledonia based on their potential for establishment and spread in the PRA area and potential for consequences.

The pests assessed as having ‘feasible’ potential for establishment and spread in the PRA area and having ‘significant’ potential for consequences, were considered to be quarantine pests (Appendix 3). Table 6 presents a list of the quarantine pests for Tahitian limes from New Caledonia. The detailed risk assessments for these quarantine pests are provided in the next section. Information on quarantine pests is provided in Appendix 4 (datasheets) and the risk assessment section.

Table 6 Quarantine pests for Tahitian limes from New Caledonia

Scientific name	Common name
ARTHROPODS	
Diptera (flies)	
Bactrocera curvipennis (Froggatt) [Diptera: Tephritidae]	banana fruit fly
Bactrocera psidii (Froggatt) [Diptera: Tephritidae]	south sea guava fruit fly
Bactrocera tryoni Froggatt [Diptera: Tephritidae]	Queensland fruit fly
Bactrocera umbrosa Fabricius [Diptera: Tephritidae]	breadfruit fly
Acari (mites)	
**Tetranychus neocaledonicus* Andre [Acari: Tetranychidae]	vegetable spider mite
Hemiptera (scales, mealybugs)	
**Coccus viridis* (Green) [Hemiptera: Coccidae]	soft green scale
**Ferrisia virgata* Cockerell [Hemiptera: Margarodidae]	striped mealybug
**Lepidosaphes gloverii* Packard [Hemiptera: Diaspididae]	glover scale
Lopholeucaspis cockerelli (Grandpré & Charmoy) [Hemiptera: Diaspididae]	diaspine scale
**Morganella longispina* Morgan [Hemiptera: Diaspididae]	plumose scale
Nipaecoccus filamentosus (Cockerell) [Hemiptera: Pseudococcidae]	mealybug
Parlatoria cinerea Hadden [Hemiptera: Diaspididae]	tropical grey chaff scale
**Pseudaonidia trilobitiformis* Green [Hemiptera: Diaspididae]	trilobite scale
**Unaspis citri* Comstock [Hemiptera: Diaspididae]	citrus snow scale
Hymenoptera (ants)	
Wasmannia auropunctata (Roger) [Hymenoptera: Formicidae]	little fire ant
PATHOGENS	
Fungi	
Sphaceloma fawcettii Jenkins	citrus scab
Meliola citricola H. & P. Sydow	black mildew

*WA only – this species is a quarantine pest for the State of Western Australia due to its absence from this state

RISK ASSESSMENTS FOR QUARANTINE PESTS

Detailed risk assessments were conducted for quarantine pests identified in the pest categorisation stage. Where pests shared similar biological characteristics, risk assessments were based on groupings of such pests (e.g. fruit flies). The proposed risk management measures were also developed for these groups. Some groups only contain one species but the "group" terminology was used for consistency.

In the context of the scope of this IRA, the risk assessments were conducted on the basis of the occurrence of standard cultivation, harvesting and packing activities involved in the commercial production of Tahitian limes e.g. in-field hygiene and management of pests and cleaning and hygiene during packing.

Risk assessments were conducted for the following groups of pests: fruit flies, Hemiptera (scales and mealybugs), spider mite, little fire ant, citrus scab and black mildew.

Each risk assessment includes a summary of supporting evidence with each likelihood estimate. More detailed technical information used in the risk assessments is provided in the pest data sheets in Appendix 4.

FRUIT FLIES

Bactrocera curvipennis (Froggatt) (banana fruit fly), *B. psidii* (Froggatt) (south sea guava fruit fly), *B. tryoni* (Froggatt) (Queensland fruit fly) and *B. umbrosa* (Fabricius) (breadfruit fly).

Probability of importation

The likelihood that fruit flies will arrive in Australia with the importation of fresh Tahitian limes from New Caledonia: **Moderate**.

Infestation of limes is generally lower than other tropical fruits (Hennessey *et al*., 1992).

The larvae of fruit flies in a shipment have to survive for at least 2-3 weeks before emerging from fruit and developing to pupae in soil or under debris or in fruit cases etc. (Anon., 1983) upon arrival. There is a high probability of fruit fly larvae surviving shipment due to their ability to tolerate cold temperatures and the availability of an ample food supply. Some fruit fly larvae may survive the cold storage temperature of 1± 0.5°C for up to 16 days (Hill *et al*., 1988). Adult flies cannot survive more than a few days without feeding.

Probability of distribution

The likelihood that fruit flies will be distributed to the endangered area as a result of the processing, sale or disposal of Tahitian lime fruit from New Caledonia: **High**.

When a fruit fly oviposits in citrus fruit, tissue around the oviposited puncture grows as a protuberance, or a sting may turn brown after a few days or the rind around a sting may turn yellow making it easy to identify the attacked fruits (Yang, 1991). Fruit in this condition is likely to be detected and not distributed. However, a new sting caused by a recent infestation may not be easily seen, therefore the efficacy of detecting fruit fly infested fruit can be lower than for other insects.

Probability of entry

The likelihood that fruit flies will arrive in Australia as a result of trade in fresh Tahitian lime fruit from New Caledonia, and be distributed to the endangered area: **Moderate**.

The overall probability of entry is determined by combining the likelihoods of importation and distribution using the matrix of 'rules' for combining descriptive likelihoods (Table 3).

Probability of establishment

The likelihood that fruit flies will establish based on a comparative assessment of factors in the source and destination areas considered pertinent to the ability of the pest to survive and propagate: **Moderate**.

To avoid establishment and spread of pests, a threshold limit must not be exceeded. This threshold limit is the smallest number of pests capable of establishing a colony. It was suggested that a limit of 10 mating pairs or 300 individuals (with random sex) is the minimum necessary for establishment of bi-parental species (Baker *et al.,* 1990). However, such an estimate may be too high for fruit flies. Unlike other species, one infested fruit is likely to contain more than one larva.

Where an infested fruit with three fruit fly larvae is discarded in suitable areas, with factors affecting mortality rate taken into account, such as predators, disease, adverse microclimate, finding suitable mating partners and the availability of a suitable host, it is expected that less than two individuals would survive. Therefore, to complete a life cycle and establish a colony, more than three individual fruit fly larvae from infested fruit must be imported in the same shipment and transported into endangered areas. This is likely to occur without management measures. Based on this information, it was assessed that without management to reduce the risk, the probability of a fruit fly colony establishing from infested fruits was moderate.

Probability of spread

The likelihood that fruit flies will spread based on a comparative assessment of those factors in the area of origin and in Australia considered pertinent to the expansion of the geographical distribution of the pest: **High**.

Once established, the spread potential of fruit flies will be high because they possess many characters that facilitate successful colonisation. These include high reproductive rate, broad environmental tolerances and broad host range of both commercial and wild species, which are widespread in Australia.

Probability of entry, establishment or spread

The overall likelihood that fruit flies will enter Australia as a result of trade in fresh Tahitian lime fruit from New Caledonia, be distributed in a viable state to suitable hosts, establish in that area or subsequently spread within Australia: **Low**.

The probability of entry, establishment or spread is determined by combining the likelihoods of entry, establishment or spread using the matrix of ‘rules’ for combining descriptive likelihoods (Table 3).

Consequences

Consequences (direct and indirect) of fruit flies: **High**.

Criterion	Estimate
Direct consequences	
Plant life or health	D — Fruit flies can cause direct harm to a wide range of plant hosts and are estimated to have consequences of minor significance at the national level.
Any other aspects of the environment	A — There are no known consequences of these pests on other aspects of the environment.
Indirect consequences	
Eradication, control etc.	E — The control program adds considerably to the cost of production of the host fruit, costing between $200-900 per ha depending on the variety of fruit produced and the time of harvest (Anon., 1991b). An extensive outbreak of Queensland fruit fly was discovered in Perth, Western Australia in 1989, leading to a very expensive eradication program (Yeates, 1990). Fruit flies are estimated to have consequences of minor significance at the national level.
Domestic trade	D — The presence of fruit flies in commercial production areas may have a significant effect at the regional level due to any resulting interstate trade restrictions on a wide range of commodities.
International trade	D — Fruit flies are regarded as the most destructive horticultural pests in the world. While they can cause considerable yield losses in orchards and suburban backyards, the major consequence facing Australian horticultural industries is the negative effect they have on gaining and maintaining export markets. Fruit flies are estimated to have consequences of minor significance at the national level.
Environment	A — Pesticides required to control fruit flies are estimated to have consequences that are unlikely to be discernible at the national level and of minor significance at the local level.

Note: Refer to Table 5 (The assessment of local, district, regional and national consequences) and text under the ‘Method for assessing consequences’ section for details on the approach taken to consequence assessment.

Unrestricted risk estimate

The unrestricted risk estimate for fruit flies, determined by combining the overall ‘probability of entry, establishment or spread’ with the ‘consequences’ using the risk estimation matrix (Table 1): **Moderate**.

HEMIPTERA

The scales (*Coccus viridis* Green, *Lepidosaphes gloverii* Packard, 1869, *Lopholeucaspis cockerelli* Grandpre′ & Charmoy, 1899, *Morganella longispina* Morgan, *Parlatoria cinerea* Hadden, 1909, *Pseudaonidia trilobitiformis* Green and *Unaspis citri* Comstock and the mealybugs (*Ferrisia virgata* Cockerell, 1893 and *Nipaecoccus filamentosus* Cockerell, 1893).

Probability of importation

The likelihood that Hemiptera will arrive in Australia with the importation of fresh Tahitian lime fruit from New Caledonia: **High**.

Citrus orchards in New Caledonia may be infested by the scale and mealy bug species. It is likely that fruit sent to be packed for export will contain some of these pests as field control may not give complete control of scales (Taverner & Bailey, 1995).

Scale insects and mealybugs are sessile, often inconspicuous and usually live around the sepal or under the calyx of the fruit from flowering onwards. The crawlers feed upon plant juices by inserting their piercing-sucking mouthparts into the host plant. They generally remain anchored to the host permanently. Therefore, they may be difficult to clean or detect during fruit sorting, especially at low population levels (Taverner & Bailey, 1995).

The standard washing procedure in the packing-lines will remove some of these pests but is unlikely to be highly effective without post harvest treatment (Bailey & Brown, 1999; Taverner & Bailey, 1995).

Interceptions of these species have been made on produce imported into New Zealand from the Pacific area (Downs, pers. comm., 1999; Williams & Watson, 1988).

Probability of distribution

The likelihood that Hemiptera will be distributed to the endangered area as a result of the processing, sale or disposal of fresh Tahitian lime fruit from New Caledonia: **Moderate**.

The pests are likely to survive storage and transportation because scale insects and mealybugs generally tolerate cold temperatures and overwinter at various stages of growth. It takes 42 days storage at 0°C for a complete mortality of *Pseudococcus affinis* (Hoy & Whiting, 1997).

Probability of entry

The likelihood that Hemiptera will arrive in Australia as a result of trade in fresh Tahitian lime fruit from New Caledonia, and be distributed to the endangered area: **Moderate**.

The overall probability of entry is determined by combining the likelihoods of importation and distribution using the matrix of 'rules' for combining descriptive likelihoods (Table 3).

Probability of establishment

The likelihood that Hemiptera will establish based on a comparative assessment of factors in the source and destination areas considered pertinent to the ability of the pest to survive and propagate: **High**.

Scales and mealybugs are highly polyphagous and host plants are common in Australia. Lemon/lime trees are commonly grown in suburban backyards in Australia. The skin of infested fruit is likely to be thrown into backyard compost heaps, therefore these pests may survive and find suitable hosts.

This group of pests has a high reproductive rate. Reproduction is bisexual (production of fertilised eggs) with two to eight generations per year. Females lay between 90-600 eggs during their lifetime. The eggs hatch in 6-14 days and the first instars or ‘crawlers’ disperse to suitable feeding sites on their new host plants. Nymphs are active during the first instar stage and may travel some distance to a new plant where they become sessile for the remaining nymphal (larval) instars. Crawlers can survive only about a day without feeding. Most mealybugs overwinter at various juvenile stages. The complete life cycle for *Nipaeccocus sp*. takes between 3 and 8 weeks (Smith *et al*., 1997a). Although mealybugs imported with fruit are likely to be at non-mobile stages, they can be transported by ants to a suitable host. Parthenogenesis was not recorded in these species. The probability of establishment of these species is considered high due to their high reproductive rate and adaptability, even though a number of natural enemies known to attack diaspine scales and mealy bugs are present in Australia.

Probability of spread

The likelihood that Hemiptera will spread based on a comparative assessment of those factors in the area of origin and in Australia considered pertinent to the expansion of the geographical distribution of the pest: **High**.

Field experiments in South Australia demonstrated that crawlers and males of the armoured scale *Aonidiella aurantii* were carried up to 312 m by wind and are able to establish themselves on a suitable host following dispersal (Willard, 1974). The spread of *Parlatoria* spp. depends on relative humidity and temperature (Gerson, 1980). They cannot spread well under low relative humidity and high temperatures. Australia has a wide climate range and many areas are suitable for the establishment and spread of scale insects and mealybugs. Many scale insects have shown the ability to adapt to new hosts and new environments (Hanks & Denno, 1994; McClure, 1983; Schvester, 1985).

Probability of entry, establishment or spread

The overall likelihood that Hemiptera will enter Australia as a result of trade in fresh Tahitian lime fruit from New Caledonia, be distributed in a viable state to suitable hosts, establish in that area or subsequently spread within Australia: **Moderate**.

The probability of entry, establishment or spread is determined by combining the likelihoods of entry, establishment or spread using the matrix of ‘rules’ for combining descriptive likelihoods (Table 3).

Consequences

Consequences (direct and indirect) of Hemiptera: **Low**.

Criterion	Estimate
Direct consequences	
Plant life or health	C — Scales and mealybugs can cause direct harm to a wide range of plant hosts and have also been reported as disease vectors. Fruit quality can be reduced by the presence of secondary sooty moulds. It is estimated that the consequences are unlikely to be discernible at the national level and of minor significance at the regional level.
Any other aspects of the environment	A — There are no known consequences of these pests on other aspects of the environment.
Indirect consequences	
Eradication, control etc.	B — Programs to minimise the impact of these pests on host plants are likely to be costly and include pesticide applications and crop monitoring. Hemiptera are estimated to have consequences that are unlikely to be discernible at the national level and of minor significance at the district level.
Domestic trade	B — The presence of these pests in commercial production areas may have a significant effect at the local level due to any resulting interstate trade restrictions on a wide range of commodities. These restrictions may lead to a loss of markets, which in turn would be likely to require industry adjustment.
International trade	C — The presence of these pests in commercial production areas of a range of commodities (e.g. citrus) may have a significant effect at the district level due to any limitations to access to overseas markets where these pests are absent.
Environment	A — Pesticides required to control Hemiptera are estimated to have consequences that are unlikely to be discernible at the national level and of minor significance at the local level.

Note: Refer to Table 5 (The assessment of local, district, regional and national consequences) and text under the 'Method for assessing consequences' section for details on the approach taken to consequence assessment.

Unrestricted risk estimate

The unrestricted risk estimate for Hemiptera, determined by combining the overall 'probability of entry, establishment or spread' with the 'consequences' using the risk estimation matrix (Table 1): **Low**.

SPIDER MITE

Tetranychus neocaledonicus André

Probability of importation

The likelihood that the spider mite will arrive in Australia with the importation of fresh Tahitian lime fruit from New Caledonia: **High**.

Infested fruit may show symptoms and be detected during commercial pre-export inspections but these pests may occur beneath the calyx and not be detected during such inspections.

Probability of distribution

The likelihood that the spider mite will be distributed to the endangered area as a result of the processing, sale or disposal of fresh Tahitian lime fruit from New Caledonia: **High**.

Adults or immature stages may remain under the calyx and be distributed via wholesale or retail trade.

The commodity may be distributed throughout Australia for retail sale. The intended use of the commodity is human consumption but waste material would be generated.

Probability of entry

The likelihood that the spider mite will arrive in Australia as a result of trade in fresh Tahitian lime fruit from New Caledonia, and be distributed in a viable state to the endangered area: **High**.

The overall probability of entry is determined by combining the probabilities of importation and distribution using the matrix of 'rules' for combining descriptive likelihoods (Table 3).

Probability of establishment

The likelihood that the spider mite will establish based on a comparative assessment of factors in the source and destination areas considered pertinent to the ability of the pest to survive and propagate: **High.**

A range of plants commonly found in Australia can act as hosts for the spider mite e.g. *Citrus* spp.; *Carica papaya* (papaya) and *Cucumis sativus* (cucumber).

The life cycle for spider mites can take as little as 10 days in optimal conditions (Jeppson *et al*., 1975).

Probability of spread

The likelihood that the spider mite will spread based on a comparative assessment of those factors in the area of origin and in Australia considered pertinent to the expansion of the geographical distribution of the pest: **High**.

Natural physical barriers (e.g. deserts/arid areas) may prevent these pests spreading unaided but adults and immature forms may spread undetected via the movement of fruit or infested vegetative host material.

The relevance of natural enemies in Australia is not known.

Similar environmental conditions are found in New Caledonia and the tropical north of Australia.

Probability of entry, establishment or spread

The overall likelihood that the spider mite will enter Australia as a result of trade in fresh Tahitian lime fruit from New Caledonia, be distributed in a viable state to suitable hosts, establish in that area or subsequently spread within Australia: **High**.

The probability of entry, establishment or spread is determined by combining the likelihoods of entry, establishment or spread using the matrix of 'rules' for combining descriptive likelihoods (Table 3).

Consequences

Consequences (direct and indirect) of the spider mite: **Low**

Criterion	Estimate
Direct consequences	
Plant life or health	C— Spider mites are capable of causing direct harm to a wide range of hosts. This includes damage in the form of chlorosis, leaf drop and reduced yields. Spider mites are estimated to have consequences of minor significance at the regional level.
Any other aspects of the environment	A— There are no known consequences of these pests on other aspects of the environment.
Indirect consequences	
Eradication, control etc.	B — Additional programs to minimise the impact of this spider mite on host plants may be necessary. An appropriate miticide or biological control would be required if this pest reached high levels of infestation. Spider mites are estimated to have consequences that are unlikely to be discernible at the regional level but may be significant at the local level.
Domestic trade	B — The presence of this spider mite in commercial production areas may result in interstate trade restrictions on a wide range of commodities. These restrictions may lead to a loss of markets. Spider mites are estimated to have consequences that are unlikely to be discernible at the regional level but may be significant at the local level.
International trade	C — The presence of this spider mite in commercial production areas of a wide range of commodities (e.g. *Citrus, Carica papaya, Cucumis sativus*) is estimated to have minor consequences at the regional level due to any limitations to access to overseas markets where these pests are absent.
Environment	A — Pesticides required to control spider mite are estimated to have consequences that are unlikely to be discernible at the regional level and of minor significance at the local level.

Note: Refer to Table 5 (The assessment of local, district, regional and national consequences) and text under the 'Method for assessing consequences' section for details on the approach taken to consequence assessment.

Unrestricted risk estimate

The unrestricted risk estimate for the spider mite, determined by combining the overall 'probability of entry, establishment or spread' with the 'consequences' using the risk estimation matrix (Table 1): **Low**.

LITTLE FIRE ANT

Wasmannia auropunctata Roger, 1863

Probability of importation

The likelihood that little fire ant will arrive in Australia with the importation of fresh Tahitian lime fruit from New Caledonia: **Moderate**.

Little fire ant populations multiply rapidly and invade citrus orchards and coffee plantations in New Caledonia, coffee plantations in Cuba and cocoa plantations in Brazil (Fabres & Brown, 1978; Castineiras *et al.*, 1987). At high populations, the ants forage over branches and foliage of trees.

Little fire ant is widely known as a "tramp" ant due to its ability to hitch-hike and establish itself throughout the world. It was originally found in Cuba and has spread widely throughout the warmer regions of the world (Brooks & Nickerson, 2000).

The species may be found within lime consignments because they invade *Citrus* plantations in New Caledonia. Some may be removed during post harvest processing. However, the species may also travel in packaging material associated with lime exports from New Caledonia.

Probability of distribution

The likelihood that little fire ant will be distributed to the endangered area as a result of the processing, sale or disposal of Tahitian lime fruit from New Caledonia: **Moderate**.

Although the ants are unlikely to be cold hardy (Ayre, 1977), they are highly adaptive (Nickerson, 1983) and may survive during cold storage and transportation. They are minute in size (1-2 mm), so they may be difficult to detect. Upon arrival, the pest may remain on the fruit or packaging or find an alternate habitat.

Probability of entry

The likelihood that little fire ant will arrive in Australia as a result of trade in fresh Tahitian lime fruit from New Caledonia, and be distributed to the endangered area: **Low**.

The overall probability of entry is determined by combining the likelihoods of importation and distribution using the matrix of 'rules' for combining descriptive likelihoods (Table 3).

Probability of establishment

The likelihood that little fire ant will establish based on a comparative assessment of factors in the source and destination areas considered pertinent to the ability of the pest to survive and propagate: **Low**.

This species is highly adaptable as the ants can nest in both open and shaded situations under moist or dry conditions (Nickerson, 1983). The climate in Australia is suitable for the pest to establish, particularly in tropical and sub-tropical areas. However, a fertilised queen would need to be introduced to establish a colony.

Probability of spread

The likelihood that little fire ant will spread based on a comparative assessment of those factors in the area of origin and in Australia considered pertinent to the expansion of the geographical distribution of the pest: **High**.

If this ant becomes established in Australia, it is likely to spread into various parts of Australia. Nests of this ant usually have more than one laying queen. The queens have a high fecundity which, when coupled with a rapid development of workers, can lead to a rapid increase in the population in a short period.

Probability of entry, establishment or spread

The overall likelihood that the little fire ant will enter Australia as a result of trade in fresh Tahitian lime fruit from New Caledonia, be distributed in a viable state to suitable hosts, establish in that area or subsequently spread within Australia: **Very low**.

The probability of entry, establishment or spread is determined by combining the likelihoods of entry, establishment or spread using the matrix of 'rules' for combining descriptive likelihoods (Table 3).

Consequences

Consequences (direct and indirect) of little fire ant: **Moderate**.

Criterion	Estimate
Direct consequences	
Plant life or health	B— Little fire ants do not directly affect the health of the tree. They may however stimulate outbreaks of citrus pests by reducing the impact of beneficial insects. It is estimated that little fire ant has consequences that are unlikely to be discernible at the national level and a significant effect at the local level.
Any other aspects of the environment	D— Introduction of little fire ants into a new environment may be significant. The invasive characteristics of *W. auropunctata,* such as high adaptive ability, food searching and competitive ability, would have impacts on native fauna and flora, particularly in tropical rainforests. The low number

	of natural parasitic or predator species in Australia would contribute to a lower mortality rate of little fire ant populations. The disequilibria they provoke among the communities of phytophagous insects often lead to explosions of pest populations such as scale insects, aleurodids and psyllids (Fabres & Brown, 1978). Little fire ant is estimated to have consequences of minor significance at the national level and a significant effect at the regional level.
Indirect consequences	
Eradication, control etc.	D— Little fire ants can reduce the productivity of farm workers and increase the cost of pest control. This species has a potent sting that is annoying to agricultural workers during cultivation and harvest of fruit. It has been reported that premium wages have to be paid to harvest fruit in some groves (Brooks & Nickerson, 2000). Where the ant is present, the production of land is seriously affected, as their mounds make it difficult to cultivate the land and their presence deters animals and humans from the infested area. Little fire ant is estimated to have consequences of minor significance at the national level and a significant effect at the regional level.
Domestic trade	D— The presence of these pests in commercial production areas is estimated to have highly significant consequences at the district level due to any resulting interstate trade restrictions on a wide range of commodities. These restrictions may lead to a loss of markets.
International trade	C— The presence of these pests in commercial production areas of a wide range of commodities (e.g. citrus) is estimated to have significant consequences at the district level due to any limitations to access to overseas markets where these pests are absent.
Environment	C— Pesticides required to control little fire ant are estimated to have consequences that are unlikely to be discernible at the national level and of high significance at the local level.

Note: Refer to Table 5 (The assessment of local, district, regional and national consequences) and text under the ‘Method for assessing consequences’ section for details on the approach taken to consequence assessment.

Unrestricted risk estimate

The unrestricted risk estimate for little fire ant, determined by combining the overall ‘probability of entry, establishment or spread’ with the ‘consequences’ using the risk estimation matrix (Table 1): **Very low**.

CITRUS SCAB

Sphaceloma fawcettii Jenkins

Probability of importation

The likelihood that citrus scab will arrive in Australia with the importation of fresh Tahitian lime fruit from New Caledonia: **High**.

Sphaceloma fawcettii is known to infect the fruit of susceptible varieties of *Citrus*, as well as leaves, twigs and blossom pedicels. Most cultivars of *C. latifolia* were recorded to be moderately tolerant to citrus scab (Smith *et al.,* 1997b).

Infected fruit may show symptoms and be detected during commercial pre-export inspections but they may also be symptomless.

Probability of distribution

The likelihood that citrus scab will be distributed to the endangered area as a result of the processing, sale or disposal of fresh Tahitian lime fruit from New Caledonia: **Moderate**.

Sphaceloma fawcettii is present on infected fruit as conidia in pustules on the fruit surface. It has also been known to survive on susceptible *Citrus* as dormant mycelium. Spores can also be wind dispersed from infected fruit.

The commodity may be distributed throughout Australia for retail sale. The intended use of the commodity is human consumption but waste material would also be generated.

Probability of entry

The likelihood that citrus scab will arrive in Australia as a result of trade in fresh Tahitian lime fruit from New Caledonia, and be distributed to the endangered area: **Moderate**.

The overall probability of entry is determined by combining the likelihoods of importation and distribution using the matrix of 'rules' for combining descriptive likelihoods (Table 3).

Probability of establishment

The likelihood that citrus scab will establish based on a comparative assessment of factors in the source and destination areas considered pertinent to the ability of the pest to survive and propagate: **Moderate**.

The establishment of citrus scab is considered moderate because although suitable hosts are widespread, suitable conditions for spores to germinate require an interaction of temperature and moisture on the susceptible hosts. Other factors are the degree of varietal susceptibility, presence of young host plant tissue and the inoculum potential.

The pathotype of *Sphaceloma fawcettii* affecting lemon and rough lemon is established in Australia, indicating that other pathotypes could also establish here.

Probability of spread

The likelihood that citrus scab will spread based on a comparative assessment of those factors in the area of origin and in Australia considered pertinent to the expansion of the geographical distribution of the pest: **Moderate**.

Dissemination of the pathogen is mostly by rain or irrigation water (Gottwald, 1995), although insects and, to a certain extent, wind-carried water droplets containing spores may contribute to the spread of this pathogen (Whiteside, 1975). This pathogen can be carried on infected nursery stock, ornamental citrus plants and fruits. When dispersed by dry wind, conidia remain viable at least until the following night and then germinate if high moisture conditions occur (Whiteside, 1975).

Although spores can be spread by various means, conditions for infection require high moisture conditions for 2.5-3.5 hours and temperatures between 14-25°C. The host range is specific to *Citrus* spp. and *Fortunella* spp. (Kumquats).

Probability of entry, establishment or spread

The overall likelihood that citrus scab will enter Australia as a result of trade in fresh Tahitian lime fruit from New Caledonia, be distributed in a viable state to suitable hosts, establish in that area or subsequently spread within Australia: **Low**.

The probability of entry, establishment or spread is determined by combining the likelihoods of entry, establishment or spread using the matrix of 'rules' for combining descriptive likelihoods (Table 3).

Consequences

Consequences (direct and indirect) of citrus scab: **Moderate**.

Criterion	Estimate
Direct consequences	
Plant life or health	D — The host range of *Sphaceloma fawcettii* is restricted to *Citrus* spp. and *Fortunella* spp. and there are no records of this fungus attacking other species. *Sphaceloma fawcettii* attacks the young fruit causing 66-72% fruit drop (Huang & Huang, 1999) during autumn if the temperature and humidity are favourable. Each year, the diseases can cause the loss of millions of dollars due to the poor marketability of deformed fruit, although it may not generally affect yields of *Citrus* spp. (Barkley *et al*., 1995; Dede & Varma, 1987). Citrus scab is estimated to have consequences of minor significance at the national level.
Any other aspects of the environment	A— There are no known direct consequences of this pathogen on any other aspect of the environment.
Indirect consequences	
Eradication, control etc.	C— Once established, the pathogen can be persistent and is unlikely to be eradicated. Citrus scab is estimated to have consequences that are unlikely to be discernible at the national level and significant at the district level.
Domestic trade	C — The presence of this pathogen in commercial production areas is estimated to have significant consequences at the district level due to any resulting interstate trade restrictions on citrus.
International trade	B — The presence of this pathogen in commercial production areas of citrus is estimated to have minor consequences at the district level due to any limitations to access to overseas markets while suitable phytosanitary management measures are developed.
Environment	A — Fungicides required to control citrus scab are estimated to have consequences that are unlikely to be discernible at the national level and of minor significance at the local level.

Note: Refer to Table 5 (The assessment of local, district, regional and national consequences) and text under the 'Method for assessing consequences' section for details on the approach taken to consequence assessment.

Unrestricted risk estimate

The unrestricted risk estimate for citrus scab, determined by combining the overall 'probability of entry, establishment or spread' with the 'consequences' using the risk estimation matrix (Table 1): **Low**.

BLACK MILDEW

Meliola citricola H. & P. Sydow, 1917

Probability of importation

The likelihood that black mildew will arrive in Australia with the importation of fresh Tahitian lime fruit from New Caledonia: **Low**.

Meliola citricola occurs in some countries in the south Pacific and is widespread throughout Southeast Asia, particularly in the wet season (Beattie, 2003).

The fungus is found on leaves and fruit and appears as dense, black, velvety, circular patches of mycelial growth, up to about 5mm in diameter. With respect to leaves, the fungus is more commonly found on the lower surface (Ecoport, 1999).

When infected, the cosmetic quality of the fruit is reduced, and therefore would be likely to be visually detected and rejected during sorting and grading prior to packing with validation by inspection before export. The probability of importation of this disease is, therefore considered low.

Probability of distribution

The likelihood that black mildew will be distributed to the endangered area as a result of the processing, sale or disposal of fresh Tahitian lime fruit from New Caledonia: **Moderate**.

Little is known about the ability of this species to survive commercial distribution methods. Dormant mycelium or spores on fruit may survive during distribution.

If infected fruit is not detected at inspection, infection rates are likely to be low and may not be detected by commercial operations. In this instance distribution may occur.

Probability of entry

The likelihood that black mildew will arrive in Australia as a result of trade in fresh Tahitian lime fruit from New Caledonia, and be distributed to the endangered area: **Low**.

The overall probability of entry is determined by combining the likelihoods of importation and distribution using the matrix of 'rules' for combining descriptive likelihoods (Table 3).

Probability of establishment

The likelihood that black mildew will establish based on a comparative assessment of factors in the source and destination areas considered pertinent to the ability of the pest to survive and propagate: **Low**.

The probability of this disease establishing in Australia is considered to be low. *Meliola citricola* appears to be limited to tropical countries and is favoured by long wet seasons and heavy dews at night in the dry season (Saenz & Taylor, 1999). Tahitian limes are mainly grown in tropical and subtropical regions of Australia (DAFF, 2002). However the main market for imported limes will be in large cities in temperate areas. While *M. citricola* is recorded on many citrus species, most records of this fungus are recorded on a smooth skinned cultivar of *Citrus reticulata* (Whittle, 1992).

Probability of spread

The likelihood that black mildew will spread based on a comparative assessment of those factors in the area of origin and in Australia considered pertinent to the expansion of the geographical distribution of the pest: **Moderate**.

The fungus produces ascospores (Ecoport, 1999) that are spread by wind and air currents. Ascospores of *M. citricola* require young leaves or fruits for penetration and infection (Ecoport, 1999).

Probability of entry, establishment or spread

The overall likelihood that black mildew will enter Australia as a result of trade in fresh Tahitian lime fruit from New Caledonia, be distributed in a viable state to suitable hosts, establish in that area or subsequently spread within Australia: **Very low**.

The probability of entry, establishment or spread is determined by combining the likelihoods of entry, establishment or spread using the matrix of 'rules' for combining descriptive likelihoods (Table 3).

Consequences

Consequences (direct and indirect) of black mildew: **Very low**.

Criterion	**Estimate**
Direct consequences	
Plant life or health	A — The host range of *Meliola citricola* appears to be restricted to *Citrus* spp. There are no known direct consequences on animal or plant life, health or welfare.
Any other aspects of the environment	A— There are no known direct consequences of this pathogen on any other aspects of the environment.
Indirect consequences	
Eradication, control etc.	B— *Meliola citricola* is easily controlled with mineral oil sprays. In some cases, bleaching in a weak solution may be required to improve the cosmetic quality of the fruit. *Meliola citricola* is estimated to have consequences that are unlikely to be discernible at the national level and significant at the local

	level.
Domestic trade	A— The presence of this pathogen in commercial production areas of citrus is estimated to have consequences that are unlikely to be discernible at the national level and of minor significance at the local level. It is doubtful that there would be any resulting interstate trade restrictions on citrus.
International trade	A — The presence of this pathogen in commercial production areas of citrus is estimated to have consequences that are unlikely to be discernible at the national level and of minor significance at the local level. It is doubtful that there would be any limitations in access to overseas markets where this pathogen is absent.
Environment	A— Mineral oil sprays required to control black mildew are estimated to have consequences that are unlikely to be discernible at the national level and of minor significance at the local level.

Note: Refer to Table 5 (The assessment of local, district, regional and national consequences) and text under the 'Method for assessing consequences' section for details on the approach taken to consequence assessment.

Unrestricted risk estimate

The unrestricted risk estimate for black mildew, determined by combining the overall 'probability of entry, establishment or spread' with the 'consequences' using the risk estimation matrix (Table 1): **Negligible**.

CONCLUSIONS: RISK ASSESSMENTS

The results of the risk assessments are summarised in Table 7. The results show that unrestricted risk estimates for fruit flies, Hemiptera, spider mite and citrus scab exceed the ALOP. Risk management measures are required for these pests. The proposed risk management measures are described in the following section.

Table 7 Results of the risk assessments

Scientific name	Common name	Probability of			Overall Probability of entry establishment or spread	Consequences	Unrestricted Risk
		Entry	Establishment	Spread			
Bactrocera curvipennis	banana fruit fly	moderate	moderate	high	low	high	moderate
Bactrocera psidii	south sea guava fruit fly	moderate	moderate	high	low	high	moderate
Bactrocera tryoni	Queensland fruit fly	moderate	moderate	high	low	high	moderate
Bactrocera umbrosa	breadfruit fly	moderate	moderate	high	low	high	moderate
Coccus viridis	green coffee scale	moderate	high	high	moderate	low	low
Ferrisia virgata	striped mealybug	moderate	high	high	moderate	low	low
Lepidosaphes gloverii	glover scale	moderate	high	high	moderate	low	low
Lopholeucaspis cockerelli	scale insect	moderate	high	high	moderate	low	low
Morganella longispina	plumose scale	moderate	high	high	moderate	low	low
Nipaecoccus filamentosus	mealy bug	moderate	high	high	moderate	low	low
Parlatoria cinerea	chaff scale	moderate	high	high	moderate	low	low
Pseudaonidia trilobitiformis	trilobite scale	moderate	high	high	moderate	low	low
Unaspis citri	citrus snow scale	moderate	high	high	moderate	low	low

Scientific name	Common name	Probability of			Overall Probability of entry establishment or spread	Consequences	Unrestricted Risk
		Entry	Establishment	Spread			
Tetranychus neocaledonicus	vegetable spider mite	high	high	high	high	low	low
Wasmannia auropunctata	little fire ant	low	low	high	very low	moderate	very low
Sphaceloma fawcettii	citrus scab	moderate	moderate	moderate	low	moderate	low
Meliola citricola	black mildew	low	low	moderate	very low	very low	negligible

RISK MANAGEMENT

Pest risk management evaluates and selects options for measures to reduce the risk of entry, establishment or spread of quarantine pests assessed to pose an unacceptable level of risk to Australia via the importation of commercially produced Tahitian limes from New Caledonia (i.e. fruit sourced from commercial production sites subjected to standard cultivation, harvesting and packing activities). Pests in this category were identified in the previous section.

Biosecurity Australia considers that the risk management measures proposed below are commensurate with the identified risks and invites technical comments on their economic and technical feasibility. In particular, technical comments are welcome on the appropriateness of the measures and any alternative measures that stakeholders consider would achieve the objective(s) indentified for each of the measures.

The measures described below will form the basis of proposed import conditions for fresh Tahitian lime fruit from New Caledonia, and are detailed in the section entitled 'Draft Quarantine Conditions'. The proposal for the use of the risk management measures described below does not preclude consideration of other risk management measures should they be proposed by stakeholders.

PROPOSED RISK MANAGEMENT MEASURES

There are four categories of measures proposed to manage the risks identified in the pest risk assessment:

1. systems approach for fruit flies;
2. visual inspection for scales/mealybugs and a mite;
3. orchard control of *Sphaceloma fawcettii* (exotic citrus scab isolates); and
4. operational procedures and verification of phytosanitary status.

[1] Systems approach for fruit flies (*Bactrocera curvipennis, B. psidii, B. tryoni and B. umbrosa*)

Fruit flies have been assessed as having an unrestricted risk estimate of moderate and measures are therefore required to manage that risk.

Visual inspection alone is not considered to be an appropriate risk management option in view of the level of risk identified and because clear visual external signs of infestation (particularly in recently infested fruit) may not be present. If infested fruit was not detected at inspection, fruit flies may enter, establish or spread.

The objective of this measure is to ensure that no viable life stages of fruit flies are present in export consignments of Tahitian lime fruit from New Caledonia. This measure is considered to reduce the risk associated with fruit flies to an acceptable level. Components of the systems approach are as follows;

Harvesting and sorting fruit to meet mature green requirements

DAF-NC provided Biosecurity Australia with results of non-host status tests for four species of quarantine fruit fly. Host status tests indicated that Tahitian limes at the mature green stage of development were not a preferred host for economic fruit fly species in New Caledonia (Sales & Paulaud, 1995). Therefore, these fruit fly species can be managed by harvesting fruit at the mature green stage (defined in section "Australia's current quarantine policy for import of fresh limes").

Orchard sanitation

In tropical climates, uncontrolled breeding of fruit flies in poorly managed or abandoned orchards and in a variety of wild hosts results in high populations of adult flies. Orchard sanitation, i.e. collection and destruction of all unwanted fruit on the trees and on the ground, contributes significantly towards reducing damaging fly populations (Vijaysegaran, 1985). The objective of this measure is to reduce the amount of fruit fly host material thus reducing fruit fly populations and the chance of fruit being infested in orchards.

[2] Visual inspection for scale insects, mealy bugs and a mite

The seven scales, two mealybugs and spider mite have been assessed as having an unrestricted risk estimate of low. See Table 7 for details of species names. Measures are therefore required to manage the risks for scales, mealybugs and mites.

Visual inspection is considered to be an appropriate risk management option for these pests in view of the level of risk identified and because these pests can be detected visually by trained inspectors.

The objective of this measure is to ensure that consignments of Tahitian lime fruit from New Caledonia infested with quarantine scales, mealybugs or mites are detected. This measure is considered to reduce the risk associated with scale insects, mealybugs and mites to an acceptable level.

[3] Orchard control of *Sphaceloma fawcettii* (exotic citrus scab isolates)

Exotic isolates of *Sphaceloma fawcettii* have been assessed to have an unrestricted risk estimate of low and measures are therefore required to manage that risk.

Visual inspection of fruit alone is not considered to be an appropriate risk management option as clear visual external signs of infection may not be present. If infected fruit was not detected at inspection, citrus scab may enter, establish or spread. Other identified options to manage risks associated with citrus scab are either the sourcing of fruit from pest free areas or the implementation of fungicide control programs in orchards.

DAF-NC has not proposed citrus export areas in New Caledonia as pest free areas for citrus scab. Rather, the risk posed by citrus scab would be managed by the inclusion of an effective fungicide in the pesticide spray program to prevent infection by *S. fawcettii*. The objective of this measure is to ensure that Tahitian lime fruit from New Caledonia are not infected by *S. fawcettii*. This measure is considered to reduce the risk associated with *S. fawcettii* to an acceptable level. This proposed measure is further discussed as follows;

Chemical control

A DAF-NC approved effective fungicide application should be integrated into the pesticide spray program to prevent infection by *S. fawcettii*. Fungicides such as thiophanate methyl, difolatan or benomyl applied to *Citrus* spp. when the scab disease symptoms first appear on leaves and further sprays at 15-28 day intervals, gave effective control (Gonzalez, 1980; Reddy *et al*., 1983; Whiteside, 1981). To protect the fruit from citrus scab, systemic fungicides should be applied once or twice during the fruiting season, depending on the likelihood of the outbreak, for example before flushing and during or after petal fall.

Information on the DAF-NC approved orchard control program for *S. fawcettii* must be made available to AQIS if requested.

[4] Operational procedures and verification of phytosanitary status

A Work Plan will be developed between Biosecurity Australia/AQIS, in consultation with DAF-NC, following the finalisation of this IRA.

It is necessary to have a system of operational procedures in place to ensure that the phytosanitary status of Tahitian lime fruit from New Caledonia is maintained and verified during the process of production and export to Australia. This is to ensure that the objectives of the risk mitigation measures previously identified have been met and are being maintained.

Biosecurity Australia proposes a system consistent with those currently in place for the importation of Tahitian limes from other sources. Details of this system, or of an equivalent one, will be determined by agreement with DAF-NC. This is to ensure that requirements are appropriate to the circumstances of Tahitian lime production in New Caledonia and export of fruit to Australia. Biosecurity Australia is willing to consider any alternative arrangements that DAF-NC may wish to propose.

The proposed system of operational procedures for the production and export of fresh Tahitian limes from New Caledonia to Australia consists of:

- registration of export orchards;
- registration of packinghouses and auditing of procedures;
- specific packaging and labelling requirements;
- specific conditions for storage and movement of produce;
- phytosanitary inspection by DAF-NC;
- phytosanitary certification by DAF-NC; and
- on-arrival quarantine clearance by AQIS.

[4A] Registration of export orchards

All Tahitian lime exports from New Caledonia must be sourced only from orchards registered for export to Australia with DAF-NC. Copies of the registration records must be made available to AQIS if requested. DAF-NC is required to register export orchards prior to commencement of exports.

All export orchards are expected to produce commercial Tahitian lime fruit under standard cultivation, harvesting and packing activities.

The objective of this procedure is to ensure that orchards from which Tahitian limes are sourced can be identified. This is to allow trace back to individual orchards and growers in the event of non-compliance and for audit (of control measures). For example, if live pests are frequently intercepted, the ability to identify a specific orchard/grower allows the investigation and corrective action to be targeted rather than applying to all possible orchards/growers.

[4B] Registration of packinghouses and auditing of procedures

All packinghouses intending to export Tahitian lime fruit to Australia need to be registered with DAF-NC.

Sorting of fruit to meet mature green requirements for freedom from fruit flies is to be completed within the registered packinghouses.

Packinghouses would be required to identify the individual orchard with a numbering system and identify fruit from individual orchards by marking boxes or pallets (i.e. one orchard per pallet) with the unique orchard number. The list of registered packinghouses must be kept by DAF-NC and provided to AQIS prior to exports commencing with updates provided if packinghouses are added or removed from the list.

Registration of orchards and packinghouses is to include an audit program by DAF-NC. An audit is to be conducted prior to registration and then done at least annually.

The objective of this measure is to ensure that packinghouses at which treatment procedures are carried out can be identified. This is to allow trace back to individual packinghouses and orchards in the event of non-compliance.

[4C] Specific packaging and labelling requirements

All Tahitian lime fruit for export would be free from contaminated plant materials including trash and weed seeds and would meet Australia's general import conditions for fresh fruits and vegetables (C6000 General Requirements for All Fruit and Vegetables, available at http://www.aqis.gov.au/icon/). Trash refers to soil, splinters, twigs, leaves and other plant material. Inspected and treated fruits would be required to be packed in new boxes. Packing material would be synthetic or processed if of plant origin. No unprocessed packing material of plant origin, such as straw, will be allowed. All wood material used in packaging of Tahitian limes must comply with the AQIS conditions (eg those in "Cargo containers: quarantine aspects and procedures") (AQIS, 2003).

All boxes would be labelled with the orchard registration number and packinghouse registration number for the purposes of trace back in the event that this is necessary. The pallet should be securely strapped only after phytosanitary inspection has been carried out. Palletised product is to be identified by attaching a uniquely numbered pallet card to each pallet or part pallet to enable trace back to registered orchards.

The objectives of this procedure are to ensure that:

- The Tahitian limes exported to Australia are not contaminated by weeds or trash
- Unprocessed packing material (which may vector pests identified as not on the pathway and pests not known to be associated with Tahitian limes) is not imported with the Tahitian limes.
- The packaged Tahitian limes are labelled in such a way as to identify the orchard and packinghouse (see measures 4A,B).

[4D] Specific conditions for storage and movement of produce

Packed product and packaging is to be protected from pest contamination during and after packing, during storage and during movement between locations (e.g. packinghouse to cool storage/depot, to inspection point, to export point).

Product for export to Australia that has been inspected and certified by DAF-NC must be maintained in secure conditions that will prevent mixing with fruit for export to other destinations.

Security of the consignment is to be maintained until release from quarantine in Australia.

The objective of this procedure is to ensure that the phytosanitary status of the product is maintained during storage and movement.

[4E] Pre-export phytosanitary inspection by DAF-NC

DAF-NC will inspect all consignments in accordance with official procedures for all visually detectable quarantine pests and trash using sampling rates developed by DAF-NC in consultation with Biosecurity Australia/AQIS.

The objective of this procedure is to ensure that Tahitian lime fruit exported to Australia does not contain quarantine pests or trash, are clean of any extraneous organic material on the surface of the fruit, and complies with packing and labelling requirements.

Records of the interceptions made during these inspections (live or dead quarantine pests, and trash) are to be maintained by DAF-NC and made available to Biosecurity Australia as requested. This information will assist in future reviews of this import pathway and consideration of the appropriateness of the phytosanitary measures that have been applied.

[4F] Phytosanitary certification by DAF-NC

DAF-NC is required to issue a Phytosanitary Certificate for each consignment upon completion of the pre-export phytosanitary inspection. The objective of this procedure is to provide formal documentation to AQIS verifying that the relevant measures have been done offshore. Each Phytosanitary Certificate is to contain the following information:

Additional declarations

> *"The Tahitian lime fruit in this consignment has been produced in New Caledonia in accordance with the conditions governing the entry of fresh Tahitian lime fruit to Australia and inspected and found to be free of quarantine pests".*

Distinguishing marks

The orchard registration number, packinghouse registration number, number of boxes per consignment, and container and seal numbers (as appropriate); (to ensure trace back to the orchard in the event that this is necessary).

Note: A consignment is the quantity of Tahitian lime fruits from New Caledonia covered by one Phytosanitary Certificate that arrives at one port in one shipment. All consignments would need to be shipped directly from one port or city in New Caledonia to a designated port or city in Australia.

[4G] On-arrival quarantine clearance by AQIS

On arrival in Australia, each consignment would be inspected by AQIS. AQIS would undertake a documentation compliance examination for consignment verification purposes at the port of entry in Australia prior to release from quarantine. Fruit from each consignment would be randomly sampled for inspection. Such sampling methodology would provide 95% confidence that there is not more than 0.5% infestation in a consignment.

The objective of this procedure is to verify that the required measures have been undertaken.

Where consignments are found to be non-compliant with requirements on-arrival, the importer will be given the option to treat (if suitable treatments for the pests detected can be applied), re-export or destroy the consignment. If product continually fails inspection, AQIS reserves the right to suspend the export program and conduct an audit of the Tahitian lime risk management systems in New Caledonia. The program will continue only once Biosecurity Australia/AQIS is satisfied that appropriate corrective action has been taken.

Uncategorised pests

If an organism is detected on Tahitian lime fruit from New Caledonia that has not been categorised, it will require assessment to determine its quarantine status and if phytosanitary action is required. The detection of any pests of quarantine concern not already identified in the analysis may result in the suspension of trade while a review is conducted, to ensure that the existing measures continue to provide the appropriate level of phytosanitary protection for Australia.

DRAFT QUARANTINE CONDITIONS

The components of the draft quarantine conditions are summarised in alphabetical format below and Biosecurity Australia invites comments on their technical and economic feasibility. The proposed risk management measure that links with each component is given in brackets ( ).

a. Registration of export orchards (links with risk management measure 4A)

b. Packinghouse registration and auditing of procedures (4B)

c. In orchard pest and disease control programs (1; 3)

d. Harvest procedure and pre-sorting (1)

e. Pre-export inspection (4E)

f. Tahitian limes packing and labelling compliance (4C)

g. Phytosanitary certification (4F)

h. Security of fruit (4D)

i. On-arrival quarantine clearance by AQIS (2; 4G)

j. Review of policy

k. Specific phytosanitary requirements for fruit flies – Certified mature green fruit (1)

a. Registration of export orchards

All Tahitian lime fruit for export to Australia must be sourced from export orchards registered with DAF-NC. Copies of the registration records must be made available to AQIS if requested. DAF-NC is required to register all export orchards and growers prior to commencement of exports.

All export orchards are expected to produce commercial Tahitian lime fruit under standard cultivation, harvesting and packing activities.

b. Packinghouse registration and auditing of procedures

All packinghouses intending to export Tahitian lime fruit to Australia need to be registered with DAF-NC.

Sorting of fruit to meet mature green requirements for freedom from fruit flies is to be completed within the registered packinghouses.

Packinghouses would be required to identify the individual orchard with a numbering system and identify fruit from individual orchards by marking boxes or pallets (i.e. one orchard per pallet) with the unique orchard number. The list of registered packinghouses must be kept by DAF-NC and provided to AQIS prior to exports commencing with updates provided if packinghouses are added or removed from the list.

Registration of orchards and packinghouses is to include an audit program by DAF-NC. An audit is to be conducted prior to registration and then done at least annually.

c. Orchard control program

Registered growers would have an orchard control program developed by DAF-NC, incorporating appropriate fungicide applications for citrus scab control and field sanitation for fruit fly control. Care would be taken to ensure that the chemicals used are approved for use on the produce exported to Australia and that any residues do not exceed Australian Maximum Residue Limits. Registered growers would keep records of control measures for auditing purposes and be given registration numbers.

The program would include:

- Field sanitation with all fallen fruit to be removed from the orchards regularly (ie. every 7 days) and destroyed or deep buried (for fruit fly control); and
- Chemical control, using an appropriate and effective fungicide (for citrus scab control).
- DAF-NC to audit grower compliance with the orchard control program. Orchards found not to be complying with the program must have their export registration suspended until DAF-NC have re-inspected orchards and confirmed compliance with requirements.
- DAF-NC grower audit records are to be available for Biosecurity Australia/AQIS review as requested.

d. Harvest procedure and pre-sorting

Tahitian lime fruits for export to Australia would be required to be harvested when mature, firm and green, cleaned of adhering debris and free of other plant parts. Only clean mature green fruit should be packed for export.

The exporter would implement sorting systems during the grading and packing process to ensure fruit certified as mature green meets the requirements specified in the section *"Specific phytosanitary requirements for fruit flies - certified mature green fruit"*. Any fruit that shows a yellow colour or pre-harvest cracks, punctures or other breaks of the skin that penetrate through to the flesh and have not healed with callus tissue would need to be excluded.

Any fruit that does not conform to the requirements specified in the above-mentioned section would be regarded as not conforming and would be rejected for certification under this protocol. Any fruit that does not conform to these specified requirements would need to be clearly identified and segregated to prevent mixing with product for export.

e. Pre-export inspection

DAF-NC will inspect all consignments in accordance with official procedures for all visually detectable quarantine pests and trash using sampling procedures developed by DAF-NC in consultation with Biosecurity Australia/AQIS.

The inspection procedures would ensure that Tahitian lime fruit is free from pests of quarantine concern to Australia, is free of any contaminant plant material (leaves, twigs, seed, etc.) and soil, and is free from mealybugs, scales and mites.

Consignments that do not comply with the above requirements will be rejected for export to Australia.

During pre-export inspection, any consignment that is found to contain fruit that does not comply with the mature green requirement will subsequently be rejected, withdrawn and isolated and clearly distinguished from others lots or consignments.

Records of the interceptions made during these inspections (live or dead quarantine pests, and trash) are to be maintained by DAF-NC and made available to Biosecurity Australia/AQIS as requested. This information will assist in future reviews of this import pathway and consideration of the appropriateness of the phytosanitary measures that have been applied.

f. Tahitian limes packing and labelling compliance

All packages of Tahitian limes for export would be free from contaminated plant materials including trash and weed seeds and would meet Australia's general import conditions for fresh fruits and vegetables (C6000 General Requirements for All Fruit and Vegetables, available at http://www.aqis.gov.au/icon/). Trash refers to soil, splinters, twigs, leaves and other plant materials.

Inspected and treated fruits would be required to be packed in new boxes. Packing material would be synthetic or processed if of plant origin. No unprocessed packing material of plant origin, such as straw, will be allowed. All wood material used in packaging of Tahitian limes must comply with the AQIS conditions (e.g. those in "Cargo containers: Quarantine aspects and procedures" (AQIS, 2003).

All boxes would be labelled with the orchard registration number and packinghouse registration number for the purposes of trace back in the event that this is necessary. The pallets should be securely strapped only after phytosanitary inspection has been carried out. Palletised product is to be identified by attaching a uniquely numbered pallet card to each pallet or part pallet to enable trace back to registered orchards.

g. Phytosanitary Certification

DAF-NC is required to issue a Phytosanitary Certificate for each consignment upon completion of pre-export inspection. Each Phytosanitary Certificate is to contain the following information:

Additional declarations

"The Tahitian limes in this consignment have been produced in New Caledonia in accordance with the conditions governing entry of fresh Tahitian lime fruit to Australia and inspected and found to be free of quarantine pests".

Distinguishing marks

The orchard registration number, packinghouse registration number, number of cartons per consignment, and container and seal numbers (as appropriate); (to ensure trace back to orchard in the event that this is necessary).

A consignment is the quantity of Tahitian lime fruit covered by one Phytosanitary Certificate that arrives at one port in one shipment. All consignments would need to be shipped directly from one port or city in New Caledonia to a designated port or city in Australia.

h. Security of fruit

All certified fruit and packaging is to be protected from pest contamination during and after packing, during storage and during movement between locations (e.g. packinghouse to cool storage/depot, to inspection point, to export point).

Product for export to Australia that has been inspected and certified by DAF-NC must be maintained in secure conditions that will prevent mixing with fruit for export to other destinations. This could be achieved through segregation of fruit for export to Australia in separate storage facilities, netting or shrink-wrapping pallets in plastic, or by placing sealed cartons in low temperature cold storage before loading into a shipping container. Alternatively, packed fruit would be directly transferred at the packinghouse into a shipping container, which would be sealed and not opened until the container reached Australia.

Security of the consignment is to be maintained until release from quarantine in Australia.

i. On-arrival quarantine clearance by AQIS

On arrival, each consignment would be inspected by AQIS and documentation examined for consignment verification purposes at the port of entry in Australia prior to release from quarantine. Sampling methodology would provide 95% confidence that there is not more than 0.5% infestation in a consignment.

An example of a sampling size for inspection of Tahitian limes is given below.

Consignment size (Units)	Sample size (Units)
For ‘consignments’ of fruit of less than 1000 units*	either 450 units or 100% of consignment (whichever is smaller)
For ‘consignments’ of fruit of greater than or equal to 1000 units	600 units

*Unit = one Tahitian lime fruit

Where consignments are found to be non-compliant with requirements on-arrival, the importer will be given the option to treat (if suitable treatments for the pest detected can be applied), re-export or destroy the consignment. If product continually fails the inspection, Biosecurity Australia/AQIS reserves the right to suspend the export program and conduct an audit of New Caledonian Tahitian lime risk management systems. The program will continue only after Biosecurity Australia/AQIS is satisfied that appropriate corrective action has been taken.

Uncategorised pests

If an organism that is detected on Tahitian limes from New Caledonia has not been categorised, it will require assessment to determine its quarantine status and if phytosanitary action is required. The detection of any pests of quarantine concern not already identified in the analysis may result in the suspension of the trade while a review is conducted to ensure that the existing measures continue to provide the appropriate level of phytosanitary protection for Australia.

j. Review of policy

Biosecurity Australia reserves the right to review this policy.

k. Specific phytosanitary requirements for fruit flies - Certified mature green fruit

In accordance with ICA-15, Tahitian limes would be harvested at the mature green stage. Fruit certified as mature green under this import policy would comply with the following two requirements:

Mature green	mature green fruit with skin free from yellow colouring.
Unbroken skin	the skin has no pre-harvest crack, puncture, pulled stem or other break that penetrates through to the flesh and has not healed with callus tissue.

The sampling system used to certify mature green status, would be conducted during the general inspection for quarantine pests and comply with sampling regimes required under ICA-15. Each fruit in the sampling package shall be removed and examined for green colour and unbroken skin as described above.

If sample fruits do not comply with the mature green requirements detailed above, the consignment would be rejected or the importers will be offered the option of re-sorting, re-export or destruction. If sorting is to be performed and agreed by importers, the process would be undertaken in quarantine-approved premise under the supervision of AQIS inspectors. AQIS would re-inspect the consignments after re-sorting to confirm that remedial action has been effective.

CONCLUSIONS

The findings of this draft IRA report are based on a comprehensive analysis of relevant scientific literature, and existing import requirements for citrus from Egypt, New Zealand, Spain and the USA (California, Arizona, Texas).

Biosecurity Australia considers that the risk management measures proposed in this draft IRA report will provide an appropriate level of protection against the pests identified in the risk assessment. Various risk management measures may be suitable to manage the risks associated with fresh Tahitian lime fruit from New Caledonia and Biosecurity Australia will consider any other measures suggested by stakeholders that provide an equivalent level of phytosanitary protection.

FURTHER STEPS IN THE IMPORT RISK ANALYSIS PROCESS[4]

The IRA will now proceed through the following steps:

- Consultation with stakeholders on the Draft IRA Report[4]
  - Stakeholders having 60 days to submit comments
- Preparation of the Final IRA Report
- Consideration of the Final IRA Report by the Executive Manager, Biosecurity Australia
- Consultation with State and Territory Government agencies
- Release of Final IRA Report and recommendation for a policy determination
  - Stakeholders having 30 days from the publication of the recommendation for a policy determination to lodge an appeal in writing
  - With determination of appeals, if required
- Final policy determination by the Director of Animal and Plant Quarantine and public notification
  - Notification being made to the proponent/applicant, registered stakeholders and the WTO

Stakeholders will be advised of any significant variations to this process.

4 This is the new process as outlined in Biosecurity Australia's *Import Risk Analysis Handbook* 2003. The process described here differs from that in *The AQIS Import Risk Analysis Process Handbook*.

STAKEHOLDER COMMENTS TO THE ISSUES PAPER AND RESPONSE FROM BIOSECURITY AUSTRALIA

All stakeholder comments and Biosecurity Australia's response to the comments have been placed on the Public File for this IRA.

Fruit flies

Stakeholder comment: that the four fruit fly species (*Bactrocera curvipennis, B. psidii, B. tryoni and B. umbrosa*) be closely considered in the IRA. Appropriate disinfestation measures, consistent with international and domestic standards, should be required.

All four species have been considered further in the Draft IRA and management measures have been proposed (see Risk Management section). These measures are consistent with international standards, and in the case of *Bactrocera tryoni*, also meet domestic interstate trade standards.

Stakeholder comment: that suitable disinfestations (cold treatment or fumigation) should be a prerequisite for any fruit fly host fruit.

As a result of non-host status tests carried out by the Department of Agriculture and Forestry - New Caledonia (DAF-NC), it has been found that Tahitian limes at the mature green stage of development are not a preferred host for economic fruit fly species in New Caledonia. Further host status tests were carried out in Australia for Queensland fruit fly (*B. tryoni*), confirming that mature green Tahitian lime fruit is not a preferred host. Therefore it has been determined that the four fruit fly species assessed in the IRA can be managed by harvesting fruit at the mature green stage. Combined with orchard sanitation measures, Biosecurity Australia believes that this will be an effective management technique. Therefore, standard disinfestations practices such as cold treatment or fumigation are not deemed necessary to maintain Australia's ALOP.

Re-export of citrus from New Caledonia

Stakeholder comment: that re-exports of citrus from New Caledonia may pose an unacceptable risk to the Australian industry.

Biosecurity Australia has proposed measures that will protect Australia from re-exported Tahitian limes. It is proposed that all export Tahitian lime orchards must be registered to enable traceback in the event of non-conformance. In addition to this, boxes must be labeled with the orchard registration number and packing date. Phytosanitary certificates must be provided with all shipments. These will contain information such as lot numbers, orchard registration numbers, numbers of cartons per 'lot', container and seal numbers and inspection date. In addition, an additional declaration will be required stating "Produced in New Caledonia in accordance with the conditions governing entry of fresh Tahitian lime fruits to Australia".

Orchard and Packinghouse management techniques

Stakeholder comment: that pests will require orchard and packinghouse management techniques to reduce the risk of entry into Australia. If these control techniques are not available or unsatisfactory then commercial trade of New Caledonia limes should not commence.

Two orchard and packinghouse management techniques have been nominated as part of the draft quarantine conditions. A brief outline of these management techniques are as follows;

Orchard sanitation - involves the removal of ripe and fallen fruit. This fruit is then treated with insecticides or deep buried.

Pre-export visual inspection - carried out by DAF-NC inspectors in accordance with an agreed sampling plan. Inspection will be carried out to ensure fruit is free from pests of quarantine concern to Australia, is not affected with citrus scab, complies with mature green condition and is free of any contaminant plant material (including weed seeds) and soil.

Glassy-winged sharp-shooter

Stakeholder comment: that Biosecurity Australia should check the presence of glassy-winged sharp-shooter in New Caledonia. An official detection in Tahiti has apparently only recently been published despite detection a few years ago.

Biosecurity Australia is working in close collaboration with the Secretariat of the Pacific Community and the Department of Agriculture and Forestry - New Caledonia. Biosecurity Australia is confident that it will be notified immediately if glassy-winged sharp-shooter is detected in New Caledonia, as the policy outlined in this draft IRA requires that DAF-NC inform AQIS/Biosecurity Australia of any new pests that are potentially of quarantine concern to Australia.

Absence of *Septobasidium crustaceum* in Australia

Stakeholder comment: that according to the Australian Plant Disease Database (APDD) *Septobasidium crustaceum* is not found in Australia, although there are several specimens of *Septobasidium* sp. on citrus. Is *S. pseudopedicellatum* or *S. pillosum* a synonym of *S. crustaceum*?

Biosecurity Australia conducted further research into *Septobasidium crustaceum* and found that this pathogen is not present in Australia. This has been corrected in the Pest Categorisation Table (Appendix 1) and the Pest Categorisation (Pathway Association) Table (Appendix 2). Neither *S. pseudopedicellatum* or *S. pillosum* are synonyms of *S. crustaceum*.

Regional freedoms

Stakeholder comment: It is suggested that the Commonwealth's commitment to addressing Australia's regional freedoms as part of the IRA process is documented in the Issues Papers and IRA's under the headings of *Biosecurity Framework* and *Method for Pest Risk Analysis*.

Biosecurity Australia notes this suggestion of including information in the introduction and methodology on how regional differences in pest status are addressed in the IRA process. The templates and generic text used for IRA documents are under review and the suggested addition of information regarding regional freedoms will be considered for inclusion.

Clarification of pest categories

Stakeholder comment: Clarification is required on the differences between and the rationale behind separating pests into the categories of "present in Australia but subject to area freedom" and "pests that are under official control".

Definitions for these concepts are found in the International Standards for Phytosanitary Measures (ISPM). ISPM No. 5 defines a "Pest Free Area (PFA)". This is discussed in more detail in ISPM No. 4. Closely related terms are "pest free place of production" and "pest free production site", these are discussed in more detail in ISPM No. 10. ISPM No. 5 defines official control. This concept is discussed in more detail in Supplement No. 1 – ISPM No. 5.

Official control is a concept essential to the definition of a quarantine pest and relates to the protection of an endangered area from a pest, which is of limited distribution within a PRA area. Area freedom is the establishment and maintenance of freedom from a pest, for the purpose of meeting importing country requirements. The latter may involve phytosanitary measures. Therefore, consideration of the objectives is critical in distinguishing between the two concepts. For example, Queensland fruit fly is under official control in Australia, which affects its quarantine status. Western Australia is a pest free area for Queensland fruit fly, which allows WA host produce access to certain markets without treatment specifically for this pest.

Accuracy of the pest information presented in the Issues Paper

Stakeholder comment: that technical inaccuracies occur in the taxonomic relationships of *Pulvinaria psidii* and *Ceresium flavipes*.

The corrections to the taxonomic relationships of *Pulvinaria psidii* and *Ceresium flavipes* have been made in the Pest Categorisation tables (Appendix 1 & 2).

Pests not requiring further consideration

Stakeholder comment: that there are several pests which no longer need to be considered further in the IRA, due to records being found in areas thought to be free of the pests. These pests are;

Arthropods - citrus rust mite (*Phyllocoptruta oleivora*), circular black scale (*Chrysomphalus aonidium* syn. *Chrysomphalus ficus*), long brown scale (*Coccus longulus* syn. *Coccus elongatus*) and spherical mealybug (*Nipaecoccus viridis*). Pathogens - *Cochliobolus geniculatus* and *Phytophthora nicotianae*.

Biosecurity Australia has corrected the Pest Categorisation tables (Appendix 1 & 2) to reflect the changes in area freedom status of these pests.

Pests requiring further consideration

Stakeholder comment: that there are several pests that require further consideration in the IRA due to area freedom. These pests are; Arthropods - Seychelles fluted scale (*Icerya seychellarum*) and fern scale (*Pinnaspis aspidistrae*). Pathogens - *Septobasidium crustaceum*, *Sphaceloma fawcetti* and Citrus Ringspot virus.

Biosecurity Australia has corrected the Pest Categorisation tables (Appendix 1 & 2) to reflect the changes in area freedom status of these pests. It has been found that *Septobasidium crustaceum* is not present in Australia (see comment **"Absence of *Septobasidium crustaceum* in Australia"**) and therefore inclusion of area freedom information in the Pest Categorisation tables is not necessary. Citrus Ringspot virus is discussed further below, under the comment **"Citrus Ringspot virus and its association with the Citrus psorosis virus complex"**.

Consideration of *Tetranychus neocaledonicus*

Stakeholder comment: that the pathway association of *Tetranychus neocaledonicus* be reviewed. The reference, Martin & Mau (1991) indicates that *T. neocaledonicus* can be present on the fruit pathway.

The reference cited does indicate that *T. neocaledonicus* can be present on the pathway. Therefore the Pest Categorisation table (Pathway Association) (Appendix 2) has been changed to reflect the presence of this species on the fruit pathway. This species has been considered further in this draft IRA.

Consideration of *Pseudaonidia trilobitiformis*

Stakeholder comment: that the pathway association reference cited doesn't appear to give any indication as to the presence or absence on the fruit pathway.

Due to the minimal amount of scientific data available on this species, Biosecurity Australia has made the decision to take a cautious approach and consider it to be on the fruit pathway.

Consideration of the fruit piercing moths, *Eudocima salaminia*, *Ophiusa coronata* and *Serrodes mediopallens*

Stakeholder comment: that the pathway association reference cited doesn't appear to give any indication as to the presence or absence on the fruit pathway.

The fruit piercing moths *Eudocima salaminia*, *Ophiusa coronata* and *Serrodes mediopallens* have been reviewed with respect to their presence/absence on the fruit pathway. New references have been found for *Eudocima salaminia* and *Ophiusa coronata*, which give more information about each species. Fruit piercing moths suck the juices of citrus, causing damage to the fruit, but are only transient pests. These moths feed at night and therefore are not present when the fruit is harvested. The eggs and larvae are not present on the fruit. Fruit piercing moths are not considered to be present on the fruit pathway for these reasons.

The removal of pests from preliminary pest lists

Stakeholder comment: that several pests have been removed from the preliminary pest lists and not included in the Technical Issues Paper. Clarification is requested to facilitate transparency throughout the IRA process. These pests include *Fusarium stilboides* (*Gibberella stilboides*), *Ganoderma philippii* (*G. pseudoferreum*) and *Guignardia citricarpa*.

The pathogens *Fusarium stilboides* and *Ganoderma philippii* have been added to the pest categorisation table (Appendix 1). *Ganoderma philippii* has also been added to the pathway association table (Appendix 2) due to its absence from Australia. Both these pathogens do not occur on the fruit pathway and therefore will not be considered further during the IRA process. *Guignardia citricarpa* has not been added to the pest tables as we have no evidence that this species occurs in New Caledonia.

Citrus Ringspot virus and its association with the Citrus psorosis virus complex

Stakeholder comment: There are indications that the Citrus psorosis virus complex – A and B is a synonym of Citrus Ringspot virus, this warrants further investigation. It is recommended that this pathogen is considered further in the investigation due to uncertainty regarding seed borne transmission and the potential for several strains of the virus to occur.

Biosecurity Australia has further investigated the link between Citrus Ringspot Virus (CRV) and the Citrus Psorosis complex. Research indicates that CRV is associated with Psorosis B. Psorosis B is graft transmitted and is not transmitted through seed (Timmer *et al*., 2000). This pathogen is not present on the fruit pathway and therefore will not be considered further during the IRA process.

Consideration of Citrus tristeza closterovirus (CTV)

Stakeholder comment: that due to the presence of several strains of CTV in Australia the exporting nation needs to present further information on the strains present. This pathogen is also considered to be under official control.

Citrus Tristeza Closterovirus (CTV) is present in Australia and New Caledonia. As it is not present on the fruit pathway, no further information on strains present in New Caledonia is required. Official control is not relevant in the case of this pathogen and due to its absence from the fruit pathway it will not be considered further during the IRA process.

APPENDICES

APPENDIX 1 PEST CATEGORISATION FOR TAHITIAN LIMES

Pest[1]	Common name/s	Present in Australia[2]	Reference	Present in New Caledonia	Reference	Consider further[3]
ARTHROPODS						
Acari [mites]						
Brevipalpus phoenicis Geijskes [Acari: Tenuipalpidae]	red crevice mite	yes	CABI (2002)	yes	Brun & Chazeau (1980)	no
Phyllocoptruta oleivora Ashmead [Acari: Eriophyidae]	citrus rust mite	yes	Smith *et al.* (1997a); Woods *et al*. (1996)	yes	Brun & Chazeau (1980)	no
Polyphagotarsonemus latus Banks [Acari: Tarsonemidae]	broad mite	yes	Smith *et al.* (1997a)	yes	Brun & Chazeau (1980)	no
Tetranychus neocaledonicus Andre [Acari: Tetranychidae]	vegetable spider mite	yes* (not in WA)	Smith *et al.* (1997a)	yes	Brun & Chazeau (1980)	yes

Pest[1]	Common name/s	Present in Australia[2]	Reference	Present in New Caledonia	Reference	Consider further[3]
Coleoptera [beetles; weevils]						
Bradymerus amicorum Kulzer [Coleoptera: Tenebrionidae]	beetle	no	NA	yes	Brun & Chazeau (1980)	yes
Ceresium flavipes (Fabricius) [Coleoptera: Cerambycidae]	longhorn beetle	yes* (not in WA)	Storey (2002)	yes	Brun & Chazeau (1980)	yes
Onidistus pacificus Pascoe [Coleoptera: Curculionidae]	weevil	no	NA	yes	Brun & Chazeau (1980)	yes
Plintheria dufouri Montrouzier [Coleoptera: Anthribidae]	beetle	no	NA	yes	Brun & Chazeau (1980)	yes
Diptera [flies]						
Bactrocera curvipennis (Froggatt) [Diptera: Tephritidae]	banana fruit fly	no	NA	yes	Amice & Sales (1997)	yes
Bactrocera psidii (Froggatt) [Diptera: Tephritidae]	South sea guava fruit fly	no	NA	yes	Amice & Sales (1997)	yes
Bactrocera tryoni Froggatt [Diptera: Tephritidae]	Queensland fruit fly	yes (under official control in some regions)	Drew (1989)	yes	Amice & Sales (1997)	yes
Bactrocera umbrosa Fabricius	fruit fly	no	NA	yes	Amice & Sales (1997)	yes

Pest[1]	Common name/s	Present in Australia[2]	Reference	Present in New Caledonia	Reference	Consider further[3]
[Diptera: Tephritidae]						
Dirioxa pornia Walker [Diptera: Tephritidae]	South sea fly, Island fruit fly	yes	White & Elson-Harris (1994)	yes	Brun & Chazeau (1980)	no
Hemiptera [aphids; leafhoppers; mealybugs; psyllids; scales; true bugs; whiteflies]						
Aonidiella aurantii Maskell [Hemiptera: Diaspididae]	red scale	yes	Smith *et al.* (1997a)	yes	Brun & Chazeau (1980)	no
Aphis gossypii Glover [Hemiptera: Aphidae]	cotton aphid	yes	Smith *et al.* (1997a)	yes	Brun & Chazeau (1980)	no
Bemisia giffardi Dumbleton synonym *Asterobemisia helyi* (Kotinsky) [Hemiptera: Aleyrodidae]	Giffardi white fly	yes* (not in WA)	Carver & Reid (1996); Stuart (2000)	yes	Brun & Chazeau (1980)	yes
Ceroplastes ceriferus Fabricius [Hemiptera: Coccidae]	wax scale	yes	APPD (2003)	yes	Brun & Chazeau (1980)	no
Ceroplastes rubens Maskell [Hemiptera: Coccidae]	pink waxy scale	yes	Smith *et al.* (1997a)	yes	Brun & Chazeau (1980)	no
Chrysomphalus aonidum Linnaeus synonym *Chrysomphalus ficus* Ashmead [Hemiptera: Diaspididae]	purple scale	yes	Smith *et al.* (1997a); Woods (2001)	yes	Brun & Chazeau (1980)	no
Coccus hesperidum Linnaeus	soft scale	yes	Smith *et al*. (1997a)	yes	Ben-Dov (1993); Williams & Watson (1990)	no

Pest[1]	Common name/s	Present in Australia[2]	Reference	Present in New Caledonia	Reference	Consider further[3]
[Hemiptera: Coccidae]						
Coccus longulus Douglas synonym *Coccus elongatus* (Sing.) [Hemiptera: Coccidae]	long brown scale	yes	Smith *et al*. (1997a); Richards (1968)	yes	Brun & Chazeau (1980)	no
Coccus viridis Green [Hemiptera: Coccidae]	soft green scale	yes* (not in WA)	Smith *et al.* (1997a); Stuart (2000)	yes	Brun & Chazeau (1980)	yes
Euricania translucida Melichar [Hemiptera: Ricaniidae]	leafhopper	no	NA	yes	Brun & Chazeau (1980)	yes
Ferrisia virgata Cockerell [Hemiptera: Pseudococcidae]	striped mealybug	yes* (not in WA)	CABI (2002); Stuart (2000); Williams (1985)	yes	Brun & Chazeau (1980)	yes
Icerya purchasi Maskell [Hemiptera: Margarodidae]	cottony cushion scale	yes	Smith *et al.* (1997a)	yes	Brun & Chazeau (1980)	no
Icerya seychellarum Westwood [Hemiptera: Margarodidae]	Seychelles fluted scale	yes* (not in WA)	Smith *et al*. (1997a)	yes	Brun & Chazeau (1980)	yes
Lepidosaphes beckii Newman [Hemiptera: Diaspididae]	mussel scale	yes	Smith *et al.* (1997a)	yes	Brun & Chazeau (1980)	no
Lepidosaphes gloverii Packard [Hemiptera: Diaspididae]	glover scale	yes* (not in WA)	Smith *et al.* (1997a); Stuart (2000)	yes	Brun & Chazeau (1980)	yes
Lopholeucaspis cockerelli (Grandpré &	diaspine scale	no	NA	yes	Brun & Chazeau (1980)	yes

Pest[1]	Common name/s	Present in Australia[2]	Reference	Present in New Caledonia	Reference	Consider further[3]
Charmoy) [Hemiptera: Diaspididae]						
Mictis profana Fabricius [Hemiptera: Coreidae]	crusader bug	yes	Smith *et al.* (1997a)	yes	Brun & Chazeau (1980)	no
Morganella longispina Morgan [Hemiptera: Diaspididae]	plumose scale	yes* (not in WA)	Naumann (1993)	yes	Brun & Chazeau (1980)	yes
Nezara viridula Linnaeus [Hemiptera: Pentatomidae]	green vegetable bug	yes	Smith *et al*. (1997a)	yes	Brun & Chazeau (1980)	no
Nipaecoccus filamentosus (Cockerell) [Hemiptera: Pseudococcidae]	mealybug	no	NA	yes	Brun & Chazeau (1980)	yes
Nipaecoccus viridis Newstead synonym *Nipaecoccus vastator* Maskell [Hemiptera: Pseudococcidae]	spherical mealybug	yes	Smith *et al.* (1997a); NAQS (1992)	yes	Brun & Chazeau (1980)	no
Orchamoplatus caledonicus Dumbleton [Hemiptera: Aleyrodidae]	white fly	no	NA	yes	Brun & Chazeau (1980)	yes
Orchamoplatus dentatus Dumbleton [Hemiptera: Aleyrodidae]	white fly	no	NA	yes	Brun & Chazeau (1980)	yes
Orchamoplatus dumbletoni Cohic [Hemiptera: Aleyrodidae]	white fly	no	NA	yes	Brun & Chazeau (1980)	yes
Orchamoplatus noumeae Russell	white fly	no	NA	yes	Brun & Chazeau (1980)	yes

Pest[1]	Common name/s	Present in Australia[2]	Reference	Present in New Caledonia	Reference	Consider further[3]
[Hemiptera: Aleyrodidae]						
Parlatoria cinerea Hadden [Hemiptera: Diaspididae]	tropical grey chaff scale	no	NA	yes	Brun & Chazeau (1980)	yes
Pinnaspis aspidistrae Signoret [Hemiptera: Diaspididae]	fern scale	yes* (not in WA)	CIE (1977)	yes	Brun & Chazeau (1980)	yes
Planococcus citri Risso [Hemiptera: Pseudococcidae]	citrus mealybug	yes	Smith *et al.* (1997a); Williams (1985)	yes	Brun & Chazeau (1980)	no
Pseudaonidia trilobitiformis Green [Hemiptera: Diaspididae]	trilobite scale	yes* (not in WA)	CIE (1981)	yes	Brun & Chazeau (1980)	yes
Pulvinaria psidii Maskell synonym *Pulvinaria darwiniensis* Froggatt [Hemiptera: Coccidae]	soft scale	yes* (not in WA)	Qin & Gullan (1992); Stuart (2000)	yes	Brun & Chazeau (1980)	yes
Tectocoris diophthalmus (Thunberg) [Hemiptera: Scutelleridae]	cotton harlequin bug	yes	Page (1970)	yes	Amice (1996)	no
Toxoptera aurantii Boyer [Hemiptera: Aphididae]	black citrus aphid	yes	Smith *et al.* (1997a)	yes	Brun & Chazeau (1980)	no
Unaspis citri Comstock [Hemiptera: Diaspididae]	citrus snow scale	yes* (not in WA)	Smith *et al.* (1997a); Stuart (2000)	yes	Brun & Chazeau (1980)	yes

Pest[1]	Common name/s	Present in Australia[2]	Reference	Present in New Caledonia	Reference	Consider further[3]
Lepidoptera [butterflies; moths]						
Eudocima fullonia Clerck synonym *Othreis fullonia* Linnaeus [Lepidoptera: Noctuidae]	fruit piercing moth	yes	Smith *et al.* (1997a)	yes	Brun & Chazeau (1980)	no
Eudocima materna Linnaeus synonym *Othreis materna* Linnaeus [Lepidoptera: Noctuidae]	fruit piercing moth	yes	Smith *et al.* (1997a)	yes	Brun & Chazeau (1980)	no
Eudocima salaminia Cramer [Lepidoptera: Noctuidae]	fruit piercing moth	yes* (not in WA)	Smith *et al.* (1997a); Stuart (2000)	yes	Brun & Chazeau (1980)	yes
Ophiusa coronata Fabricius [Lepidoptera: Noctuidae]	fruit piercing moth	yes* (not in WA)	Herbison-Evans & Crossley (2002)	yes	Brun & Chazeau (1980)	yes
Papilio anactus W.S. Macleay [Lepidoptera: Papilionidae]	small citrus butterfly	yes	Nielsen *et al.* (1996)	yes	Brun & Chazeau (1980)	no
Papilio ilioneus amynthor Boisduval [Lepidoptera: Papilionidae]	citrus swallowtail	no	NA	yes	Brun & Chazeau (1980)	yes
Papilio montrouzieri Boisduval [Lepidoptera: Papilionidae]	citrus swallowtail	no	NA	yes	Brun & Chazeau (1980)	yes
Phyllocnistis citrella Stainton [Lepidoptera: Gracillaridae]	Asian leafminer	yes	Smith *et al.* (1997a)	yes	Brun & Chazeau (1980)	no

Pest[1]	**Common name/s**	**Present in Australia**[2]	**Reference**	**Present in New Caledonia**	**Reference**	**Consider further**[3]
Serrodes campana Guenée [Lepidoptera: Noctuidae]	fruit piercing moth	yes* (not in WA)	Common (1990); Nielsen *et al*. (1996)	yes	Brun & Chazeau (1980)	yes
Serrodes mediopallens A.E. Prout [Lepidoptera: Noctuidae]	fruit piercing moth	yes* (not in WA)	Nielsen *et al.* (1996)	yes	Brun & Chazeau (1980)	yes
CONTAMINATING PESTS						
Wasmannia auropunctata (Roger) [Hymenoptera: Formicidae]	little fire ant	no	NA	yes	Fabres & Brown (1978)	yes
ALGAE						
Cephaleuros virescens Kunze	algal disease	yes* (not in WA)	APPD (2003); Stuart (2000)	yes	Kolher (1987)	yes
FUNGI						
Lasiodiplodia theobromae (Pat.) Griffon & Maubl.	diplodia stem-end rot	yes	APPD (2003)	yes	Kolher (1987)	no
Cochliobolus geniculatus Nelson anamorph *Curvularia geniculata* (Tracy & Earle) Boedijn	root rot	yes	Shivas (1989)	yes	Kolher (1987)	no
Corticium salmonicolor Berk. & Broome	pink disease	yes* (not in WA)	APPD (2003)	yes	Kolher (1987)	yes

Pest[1]	**Common name/s**	**Present in Australia**[2]	**Reference**	**Present in New Caledonia**	**Reference**	**Consider further**[3]
Diaporthe citri Wolf	melanose	yes* (not in WA)	APPD (2003); Stuart (2000)	yes	Kolher (1987)	yes
Fusarium stilboides Wollenw. synonym *Gibberella stilboides* Gordon ex Booth T	bark disease	yes	APPD (2003)	yes	Amice (1996)	no
Ganoderma philippii (Bres. & Henn. ex Sacc.) Bres. synonym *Ganoderma pseudoferreum* (Wakef.) Overreem & Steinm.	red root rot	no	IMI (1993)	yes	Amice (1996)	yes
Geotrichum candidum Link	sour rot	yes	APPD (2003)	yes	Kolher (1987)	no
Glomerella cingulata (Stonem.) Spaulding & Schrenk	anthracnose, fruit rot	yes	APPD (2003)	yes	Kolher (1987)	no
Meliola citricola H. & P. Sydow	black mildew	no	NA	yes	Kolher (1987)	yes
Penicillium digitatum Saccardo	green mould	yes	APPD (2003)	yes	Kolher (1987)	no
Penicillium italicum Wehmer	blue mold	yes	APPD (2003)	yes	Kolher (1987)	no
Phellinus noxius (Corner) G. Cunn.	brown root rot	yes* (not in WA)	CABI (2002); Stuart (2000)	yes	Kolher (1987)	yes
Phytophthora nicotianae Breda de Haan synonym *Phytophthora parasitica* (Dastur) var. *nicotianae* (Breda de Haan) Tucker	root and collar rot	yes	APPD (2003); Shivas (1989)	yes	Kolher (1987)	no
Septobasidium crustaceum Couch	felty fungus	no	NA	yes	Kolher (1987)	yes
Sphaceloma fawcettii Jenkins	citrus scab	yes (possibly a	APPD (2003);	yes	Kolher (1987)	yes

Pest[1]	Common name/s	Present in Australia[2]	Reference	Present in New Caledonia	Reference	Consider further[3]
		different pathotype)* (not in WA)	Barkley (1998)			
VIRUSES						
Citrus ringspot virus (CRSV)	citrus scaly bark, psorosis of citrus	yes* (not in WA)	Fraser & Broadbent (1979)	yes	Kolher (1987)	yes
Citrus tristeza closterovirus (CTV)	tristeza, quick decline, grapefruit stem pitting, lime dieback	yes	CABI (2002)	yes	Kolher (1987)	no

NA No known record of this species in Australia.
* Comment from Agriculture WA (Mark Stuart, personal communication), and will only be considered further for imports into WA.
1 The initial list contains all pests known to be associated with Tahitian lime in New Caledonia.
2 As described in Pest Categorisation (see *Method for Stage 2: Risk assessment*).
3 Pest present in New Caledonia, but not in Australia or present but officially controlled, are considered further in the 'present on pathway' stage of pest categorisation.
4 Describes whether the pest is associated with fresh individual limes and therefore if it is on the pathway.
Pests that are known to be associated with individual fruit and either not present in Australia or present but officially controlled, are considered further in the second stage of pest categorisation.

APPENDIX 2 PEST CATEGORISATION FOR TAHITIAN LIMES (PATHWAY ASSOCIATION)

Pest[1]	Common name/s	Present on the pathway[4]	Reference	Consider pest further[5]
ARTHROPODS				
Acari [mites]				
Tetranychus neocaledonicus Andre [Acari: Tetranychidae]	vegetable spider mite	yes	Martin & Mau (1991)	yes
Coleoptera [beetles; weevils]				
Bradymerus amicorum Kulzer [Coleoptera: Tenebrionidae]	beetle	no	Mademba-Sy (1999)	no
Ceresium flavipes (Fabricius) [Coleoptera: Cerambycidae]	longhorn beetle	no	Humble *et al.* (1996)	no
Onidistus pacificus Pascoe [Coleoptera: Curculionidae]	weevil	no	Lawrence & Britton (1991)	no
Plintheria dufouri Montrouzier [Coleoptera: Anthribidae]	beetle	no	Kuschel (1998)	no

Pest[1]	Common name/s	Present on the pathway[4]	Reference	Consider pest further[5]
Diptera [flies]				
Bactrocera curvipennis (Froggatt) [Diptera: Tephritidae]	banana fruit fly	yes	Drew (1989); Drew *et al.* (1982)	yes
Bactrocera psidii (Froggatt) [Diptera: Tephritidae]	South sea guava fruit fly	yes	Drew (1989); Drew *et al.* (1982)	yes
Bactrocera tryoni Froggatt [Diptera: Tephritidae]	Queensland fruit fly	yes	Drew (1989); Drew *et al.* (1982)	yes
Bactrocera umbrosa Fabricius [Diptera: Tephritidae]	fruit fly	yes	Drew (1989); Drew *et al*. (1982)	yes
Hemiptera [aphids; leafhoppers; mealybugs;psyllids; scales; true bugs; whiteflies]				
Bemisia giffardi Dumbleton [Hemiptera: Aleyrodidae]	Giffardi white fly	no	Brun & Chazeau (1980)	no
Coccus viridis Green [Hemiptera: Coccidae]	soft green scale	yes	Smith *et al.* (1997a)	yes
Euricania translucida Melichar [Hemiptera: Ricaniidae]	planthopper	no	Chou *et al.* (1985); Logan *et al*. (2002)	no
Ferrisia virgata Cockerell Hemiptera: Margarodidae]	striped mealybug	yes	CABI (2002)	yes
Icerya seychellarum Westwood	seychelles fluted scale	no	CABI (2002)	no

Pest[1]	**Common name/s**	**Present on the pathway**[4]	**Reference**	**Consider pest further**[5]
[Hemiptera: Margarodidae]				
Lepidosaphes gloverii Packard [Hemiptera: Diaspididae]	glover scale	yes	Smith *et al.* (1997a)	yes
Lopholeucaspis cockerelli (Grandpré & Charmoy) [Hemiptera: Diaspididae]	diaspine scale	yes	Williams & Watson (1988)	yes
Morganella longispina Morgan [Hemiptera: Diaspididae]	plumose scale	yes	Hamon (1981)	yes
Nipaecoccus filamentosus (Cockerell) [Hemiptera: Pseudococcidae]	mealybug	yes	Smith *et al.* (1997a)	yes
Orchamoplatus caledonicus Dumbleton [Hemiptera: Aleyrodidae]	white fly	no	Martin (1985); Nguyen *et al.* (1993)	no
Orchamoplatus dentatus Dumbleton [Hemiptera: Aleyrodidae]	white fly	no	Mound & Halsey (1978)	no
Orchamoplatus dumbletoni Cohic [Hemiptera: Aleyrodidae]	white fly	no	Mound & Halsey (1978)	no
Orchamoplatus noumeae Russell [Hemiptera: Aleyrodidae]	white fly	no	Mound & Halsey (1978)	no
Parlatoria cinerea Hadden [Hemiptera: Diaspididae]	tropical grey chaff scale	yes	Williams &Watson (1988)	yes

Pest[1]	**Common name/s**	**Present on the pathway**[4]	**Reference**	**Consider pest further**[5]
Pinnaspis aspidistrae Signoret [Hemiptera: Diaspididae]	fern scale	no	Tenbrink & Hara (1992)	no
Pseudaonidia trilobitiformis Green [Hemiptera: Diaspididae]	trilobite scale	yes	Miller (1997)	yes
Pulvinaria psidii Maskell [Hemiptera: Coccidae]	soft scale	no	Mau & Kessing (1992)	no
Unaspis citri Comstock [Hemiptera: Diaspididae]	citrus snow scale	yes	Smith *et al.* (1997a)	yes
Lepidoptera [butterflies; moths]				
Eudocima salaminia Cramer [Lepidoptera: Noctuidae]	fruit piercing moth	no	Fay (2000); Smith *et al*. (1997a)	no
Ophiusa coronata Fabricius [Lepidoptera: Noctuidae]	fruit piercing moth	no	Herbison-Evans & Crossley (2002)	no
Papilio ilioneus amynthor Boisduval [Lepidoptera: Papilionidae]	citrus swallowtail	no	Holloway & Peters (1976)	no
Papilio montrouzieri Boisduval [Lepidoptera: Papilionidae]	citrus swallowtail	no	Holloway & Peters (1976)	no
Serrodes campana Guenée [Lepidoptera: Noctuidae]	fruit piercing moth	no	Common (1990)	no

Pest[1]	**Common name/s**	**Present on the pathway**[4]	**Reference**	**Consider pest further**[5]
Serrodes mediopallens A.E. Prout [Lepidoptera: Noctuidae]	fruit piercing moth	no	Nielsen *et al.* (1996)	no
CONTAMINATING PESTS				
Wasmannia auropunctata (Roger) [Hymenoptera: Formicidae]	little fire ant	yes	Fabres & Brown (1978)	yes
ALGAE				
Cephaleuros virescens Kunze	red rust	no	Timmer *et al*. (2000)	no
FUNGI				
Corticium salmonicolor Berk. & Broome	pink disease	no	Timmer *et al*. (2000)	no
Diaporthe citri Wolf	melanose	no	Timmer *et al*. (2002)	no
Ganoderma philippii (Bres. & Henn. ex Sacc.) Bres.	red root rot	no	CABI (2002)	no
Meliola citricola H. & P. Sydow	black mildew	yes	Beattie (2003)	yes
Phellinus noxius (Corner) G. Cunn.	brown root rot	no	CABI (2002)	no
Septobasidium crustaceum (Couch)	felty fungus	no	Timmer *et al*. (2000)	no
Sphaceloma fawcettii Jenkins	citrus scab	yes	Kolher (1987); Timmer *et al*. (2000)	yes

Pest[1]	Common name/s	Present on the pathway[4]	Reference	Consider pest further[5]
VIRUSES				
Citrus ringspot virus (CRSV)	citrus scaly bark, psorosis of citrus	no	Timmer *et al*. (2000)	no

APPENDIX 3 PESTS ASSOCIATED WITH TAHITIAN LIMES (*CITRUS LATIFOLIA*) FRUIT FROM NEW CALEDONIA TO BE CONSIDERED FURTHER IN THE IRA

Scientific name	Common name	Potential for establishment and spread in the PRA area	Reference	Potential for economic consequences	Reference	Pest to be considered further?
Bactrocera curvipennis (Froggatt)	banana fruit fly	feasible	Drew *et al*. (1982)	significant	Drew *et al*. (1982)	yes
Bactrocera psidii (Froggatt)	south sea guava fruit fly	feasible	Drew *et al*. (1982)	significant	Drew *et al*. (1982)	yes
Bactrocera tryoni Froggatt	Queensland fruit fly	feasible	Drew *et al*. (1982)	significant	Drew *et al*. (1982)	yes
Bactrocera umbrosa Fabricius	breadfruit fly	feasible	Drew *et al*. (1982)	significant	Drew *et al*. (1982)	yes
Coccus viridis (Green)	green coffee scale	feasible	Smith *et al*. (1997a)	significant	Smith *et al*. (1997a)	yes
Ferrisia virgata Cockerell	striped mealybug	feasible	CABI (2002)	significant	Schreiner (2000)	yes
Lepidosaphes gloveri Packard	glover scale	feasible	Smith *et al*. (1997a)	significant	Smith *et al*. (1997a)	yes
Lopholeucaspis cockerelli (Grandpré & Charmoy)	diaspine scale	feasible	Anon. (1976); Williams & Watson (1988)	significant	Anon. (1976); Williams & Watson (1988)	yes
Morganella longispina Morgan	plumose scale	feasible	Fasulo & Brooks (2001) (note: this reference does not give specific information on this species, but gives general information about the Diaspididae family and other diaspid scales. Little information is available on this species)	significant	Pena & Johnson (2001)	yes

Scientific name	Common name	Potential for establishment and spread in the PRA area	Reference	Potential for economic consequences	Reference	Pest to be considered further?
Nipaecoccus filamentosus (Cockerell)	mealybug	feasible	APPPC (1987); Williams & de Willink (1992)	significant	APPPC (1987); Williams & de Willink (1992)	yes
Parlatoria cinerea Hadden	tropical grey chaff scale	feasible	Williams & Watson (1988)	significant	Gravena *et al*. (1993); Williams & Watson (1988)	yes
Pseudaonidia trilobitiformis Green	trilobite scale	feasible	Fasulo & Brooks (2001) (note: this reference does not give specific information on this species, but gives general information about the Diaspididae family and other diaspid scales. Little information is available on this species)	significant	Morton (1987)	yes
Unaspis citri Comstock	citrus snow scale	feasible	Smith *et al*. (1997a)	significant	Smith *et al*. (1997a)	yes
Tetranychus neocaledonicus (André)	vegetable spider mite	feasible	Martin & Mau (1991)	significant	Martin & Mau (1991)	yes
Wasmannia auropunctata (Roger)	little fire ant	feasible	Anon. (1999)	significant	Williams (1994)	yes
Sphaceloma fawcettii Jenkins	citrus scab	feasible	Timmer *et al.* (2000)	significant	Tan *et al.* (1999)	yes
Meliola citricola H. & P. Sydow	black mildew	feasible	Dingley *et al.* (1981)	significant	Beattie (2003)	yes

REFERENCES

DAFF (2002). Technical Issues Paper – Import Risk Analysis (IRA) for the Importation of Tahitian Limes from New Caledonia.

AICN (2003). Australian Insect Common Names database. http://www.ento.csiro.au/aicn/

Amice, R. (1996). Pest list of Tahitian limes. Written communication dated 3rd May, 1996.

Amice, R. and Sales, F. (1997). Fruit fly fauna in New Caledonia. pp. 68-76. *In* Allwood, A.J. and Drew, R.A.I. (eds). Management of Fruit Flies in the Pacific: A Regional Symposium. ACIAR Proceedings No. 76. Australian Centre for International Agricultural Research (ACIAR), Canberra. 267 pp.

Animal and Plant Health Inspection Service. (1994). T102 Water treatment. *In* Plant Protection and Quarantine Treatment Manual. 5.45-5.50. US Department of Agriculture. Hyattsville, Maryland, USA.

Anon. (1976). New records. Quarterly-Newsletter, Plant Protection Committee for the South East Asia and Pacific Region 19: 6-8.

Anon. (1983). Queensland fruit fly. South Pacific Commission. Advisory leaflet No. 18.

Anon. (1991a). NASS Standard 155.02.01.08. Specification for determination of fruit fly host status as a treatment. National Agricultural Security Service (NASS). Ministry of Agriculture and Fisheries, Wellington, New Zealand.

Anon. (1991b). The impact of fruit flies on Australian Horticulture. Report to the Honorable John Kerin, Minister for Primary Industries and Energy. Horticultural Policy Council. April 1991.

Anon. (1999). Ag Alert No. 18. Introduction of the fire ant *Wasmannia auropunctata* into Vanuatu.

APPD (2003). Australian Plant Pest Database. http://www.planthealthaustralia.com.au/APPD/queryForm.asp

AQIS (2003). Australian Quarantine and Inspection Service Import Conditions Database. http://www.aqis.gov.au/ICON

APPPC (1987). Insect pests of economic significance affecting major crops of the countries in Asia and the Pacific region. Technical Document No. 135. Regional FAO Office for Asia and the Pacific (RAPA), Bangkok, Thailand.

Ayre, G.L. (1977). Exotic ants in Winnipeg. Manitoba Entomologist 11: 41-44.

Bailey, P. and Brown, M. (1999). Post-harvest disinfestation of surface arthropods from export navel oranges. SARDI, CSIRO Plant Industry. Horticultural Research & Development Corporation (HRDC) Final Report.

Baker, R.T., Cowley, J.M., Harte, D.S. and Frampton, E.R. (1990). Development of a maximum pest limit for fruit flies (Diptera: Tephritidae) in produce imported into New Zealand. Journal of Economic Entomology 83: 13-17.

Barkley, P. (1998). Plant Pathologist. Written communication.

Barkley, P., Timmer, L.W., Tan, M.K. and Priest, M. (1995). Citrus scab in Australia, Florida and South America: quarantine implications. Australian Citrus News. March 1995. pp. 5-8.

Beattie, G.A.C. (2003). Centre for Horticulture and Plant Sciences, University of Western Sydney. Personal Communication.

Beattie, G.A.C. and Ribbon, L.E. (1980). Phytotoxicity and scalicide efficacy of citrus spray oils. Proceeding of the International Society of Citriculture. Griffith. NSW, Australia. pp. 171-174.

Ben-Dov, Y. (1993). A systematic catalogue of the soft scale insects of the world (Homoptera: Coccidae: Coccidae) with data on geographical distribution, host plants, biology and economic importance. Sandhill Crane Press Inc., Gainsville, USA. 536 pp.

Benfatto, D. (1999). Protection from ants in citrus orchards by trunk treatment. Informatore Agrario 55:81-84.

Blank, R.H., Olson, M.H., Gill, G.S.C. and Dow, B.W. (1997). Timing of insecticide applications for control of soft wax scale (Homoptera: Coccidae) on citrus. New Zealand Journal of Crop and Horticultural Science. 25: 311-317.

Brooks, S. and Nickerson, J.C. (2000). Little fire ant profile. Featured Creatures website. University of Florida – Department of Entomology and Nematology and Florida Department of Agriculture and Consumer Services – Division of Plant Industry. http://creatures.ifas.ufl.edu/urban/ants/little_fire_ant.htm

Brun, L.O. and Chazeau, J. (1980). Catalogue des Ravageurs d'Interet Agricole de Nouvelle-Caledonie. Laboratoire de Zoologie Appliquee, ORSTOM, Noumea. 25 pp.

CABI (2000). Crop Protection Compendium Global Module. CAB International, Wallingford, UK.

CABI (2002). Crop Protection Compendium Global Module. CAB International, Wallingford, UK.

Carver, M. and Reid, I.A. (1996). Aleyrodidae (Hemiptera: Sternorrhyncha) of Australia. Systematic catalogue, host plant spectra, distribution, natural enemies and biological control. CSIRO Division of Entomology Technical Paper No. 37, 55 pp.

Castineiras, A., Monteagudo, S. and Gonzalez, M. (1987). Observations on *Wasmannia auropunctata* (Hymenoptera: Formicidae) in coffee and citrus crops in Cuba. Revista de Proteccion Vegetal. 2(3): 234-238.

Chou, I., Lu, J., Huang, J. and Wang, S. (1985). Homoptera: Fulgoroidea. Economic Insect Fauna of China 36: 1-152.

CIE (1977). *Pinnaspis aspidistrae*. Distribution Maps of Pests. Series A, Map No. 369. CAB International, Wallingford, UK.

CIE (1981). *Pseudaonidia trilobitiformis*. Distribution Maps of Pests. Series A, Map No. 418. CAB International, Wallingford, UK.

Common, I.F.B. (1990). Moths of Australia. Melbourne University Press, Carlton. 535 pp.

Daljeet, S., Kapur, S.P., Cheema, S.S. and Singh, D. (1997). Isolation and pathogenicity tests of the causal organism associated with citrus scab in Punjab. Plant Disease Research 12: 180-182.

Daljeet, S., Kapur, S.P., Chjabra, H.K., Kuldip, S., Singh, D. and Singh, K. (1998). Studies on the epidemiology of *Elsinoe fawcettii* causing scab of citrus. Plant Disease Research 13: 198-200.

Dede, A.P. and Varma, A. (1987). Citrus scab disease in Nigeria. Journal of Horticultural Science 62: 11-116.

Dingley, J.M., Fullerton, R.A. and McKenzie, E.H.C. (1981). Survey of Agricultural Pests and Diseases. Records of Fungi, Bacteria, Algae, and Angiosperms Pathogenic on Plants in Cook Islands, Fiji, Kiribati, Niue, Tonga, Tuvalu, and Western Samoa. Technical Report Volume 2. South Pacific Bureau for Economic Co-operation, United Nations Development Programme, Food and Agricultural Organization of the United Nations. 485pp.

Downs, J. (1999). Ministry of Agriculture and Forestry New Zealand. Personal communication.

Drew, R.A.I. (1989). The tropical fruit flies (Diptera: Tephritidae: Dacinae) of the Australasian and Oceanian Regions. Memoirs of the Queensland Museum 26: 1-521.

Drew, R.A.I., Hooper, G.H.S. and Bateman, M.A. (1982). Economic Fruit Flies of the South Pacific Region (2nd edition). Queensland Department of Primary Industries, Brisbane: 139 pp.

Ecoport (1999). Ecoport database record on *Meliola citricola*. University of Florida; Food and Agriculture Organisation of the United Nations; National Museum of Natural History, Smithsonian Institute. http://www.ecoport.org/default.htm

Fabres, G. and Brown Jr, W.L. (1978). The recent introduction of the pest ant *Wasmannia auropunctata* into New Caledonia. Journal of Australian Entomological Society 17(2): 139-142.

Fasulo, T.R. and Brooks, R.F. (2001b). Scale pests of Florida citrus. Entomology and Nematology. Department Florida Cooperative Extension Services, Institute of Food and Agricultural Sciences, University of Florida. Fact Sheet ENY-814.

Fay, H. (2000). Fruit piercing moth on citrus, a perspective including control developments. DPI Note. Queensland Department of Primary Industries.

Fletcher, B.S. (1973). The ecology of a natural population of the Queensland fruit fly, *Dacus tryoni*. V. The dispersal of adults. Australian Journal of Zoology 22: 189-202.

Fletcher, B.S. (1989). Ecology; movement of Tephritid fruit flies. In: World Crop Pests 3(B). Fruit flies; their biology, natural enemies and control (Ed. By Robinson, A.S.; Hooper, G.), Elsevier, Amsterdam, Netherlands. pp. 209-219.

Foguet, J.L., Blanco, A. and Vinciguerra, H. (1994). La lima Tahiti en Tucuman. Advance Agroindustrial, Julio: 43-45.

Fraser, L.R. and Broadbent, P. (1979). Virus and related diseases of citrus in New South Wales. NSW Department of Agriculture, Rydalmere, New South Wales, Australia.

Gerson, U. (1980). The scale insect *Parlatoria paranoid* Comstock and its natural enemies in Israel. Seminar on biological control of scale insects and aleurodids on citrus. Boletin del Servicio de Lucha Biologica Contra Plagas e Inspeccion Fitopatoloica 21: 21-53.

Gonzalez, E. (1980). Study of the effectiveness of various fungicides against scab in Persian lime. Cultivos Tropicales 2: 129-138.

Gonzalez, E. and Cachon, A.K. (1993). Determination of incubation time of *Spaceloma fawcettii* Jenkins in three species of *Citrus* genera. Revista de Proteccion Vegetal 8: 99-100.

Gottwald, T.R. (1995). Spatio-temporal analysis and isopath dynamics of citrus scab in nursery plots. Phytopathology 85: 1082-1092.

Gravena, S., Paiva, P.E.B. and Yamamoto, P.T. (1993). Impact of methidathion on citrus entomofauna: I – perspective of ecological selectivity. Bulletin – OILB-SROP. 16: 16-25.

Hamacek, E. (1997). Host records of fruit flies in the South Pacific. pp.102-104. *In* Allwood, A.J. and Drew, R.A.I. Management of fruit flies in the Pacific. A regional symposium, Nadi, Fiji 28-31 October 1996.

Hamon, A.B. (1981). Plumose scale, *Morganella longispina* (Morgan) (Homoptera: Coccidae: Diaspididae). Entomology Circular. Division of Plant Industry, Florida Department of Agriculture and Consumer Services. No. 226: 2 pp.

Hanks, L.M. and Denno, R.F. (1994). Local adaptation in the armored scale insect *Pseudaulacaspis pentagona* (Homoptera: Diaspididae). Ecology 75: 2301-2310.

Hata, T.Y., Hara, A.H., Jang, E.B., Imaino, L.S., Hu, B.K.S. and Tenbrink, V.L. (1992). Pest management before harvest and insecticidal dip after harvest as a systems approach to quarantine security for red ginger. Journal of Economic Entomology 85: 2310-2316.

Hennessey, M.K., Baranowski, R.M. and Sharp, J.L. (1992). Absence of natural infestation of Carribean fruit fly (Diptera: Tephritidae) from commercial Florida "Tahiti" lime fruits. Journal of Economic Entomology. 85 (5): 1843-1845.

Herbison-Evans, D. and Crossley, S. (2002). Australian moths and their caterpillars. http://www.usyd.edu.au/su/macleay/larvae/

Hill, A.R., Rigney, C.J. and Sproul, A.N. (1988). Cold storage of oranges as a disinfestation treatment against the fruit flies *Dacus tryoni* (Froggatt) and *Ceratitis capitata* (Wiedemann) (Diptera: Tephritidae). Journal of Economic Entomology 81: 257-260.

Holloway, J.D. and Peters, J.V. (1976). The butterflies of New Caledonia and the Loyalty Islands. Journal of Natural History 10: 273-318.

Hoy, L.E. and Whiting, D.C. (1997). Low temperature storage as a post-harvest treatment to control *Pseudococcus affinis* (Homoptera: Pseudococcidae) on Royal gala apples. Journal of Economic Entomology 90: 1377-1381.

Huang, H. and Huang, H.M. (1999). The occurrence of citrus scab and its control. South China Fruits 28: 18.

Humble, L.M., Allen, E.A. and Bell, J.D. (1996). Exotic wood boring beetles in British Columbia: Interceptions and Establishments. British Columbia: Canadian Forest Service, Pacific Forestry Centre, Victoria, Canada. http://www.pfc.forestry.ca/biodiversity/exotics/index_e.html

IMI (1993). International Mycological Institute. *Ganoderma philippii.* Distribution Maps of Plant Diseases. Map No. 98. Edition 4. CAB International, Wallingford, UK.

Jeppson, L.R, Hartford, H.K. and Baker, E.W. (1975). Mites Injurious to Economic Plants. University of California Press, Los Angeles. 614 pp.

Kolher, F. (1987). Agents pathogens et malagies physiologiques des plantes cultivees en Nouvelle-Cledonie at aux Iles Wallis Futuna. Catalogue Sciences de la Vie. Phytopathologie No. 1, OSTOM. Centre de Noumea.

Kuschel, G. (1998). The subfamily Anthribinae in New Caledonia and Vanuatu (Coleoptera: Anthribidae). New Zealand Journal of Zoology 25: 335-408.

Lawrence, J.F. and Britton, E.B. (1991). Coleoptera (Beetles). *in* CSIRO The Insects of Australia (2nd edition). Volume I. Melbourne University Press, Carlton. pp. 1-542.

Logan, D.P., Allison, P.A. and Stannard, K. (2002). Selection of wild hosts for feeding by Passion Vine Hopper, *Scolypopa australis* (Walker) (Hemiptera: Ricaniidae) in the Bay of Plenty. New Zealand Plant Protection 55: 368-373.

Mademba-Sy, F. (1999). Plant Pathologist. Centre de Cooperation International en Recherche Agronomigue Pour le Development. CIRAD. Personal communication with Dr Pat Barkley dated 16 March 1999.

Martin, J.H. (1985). The whitefly fauna of Australia (Sternorrhyncha: Aleyrodidae). A taxonomic account and identification guide. CSIRO Entomology Technical Paper No. 38. 197 pp.

Martin, J.L. and Mau, R.F.L. (1991). *Tetranychus neocalidonicus* (Andre). http://www.extento.hawaii.edu/kbase/crop/Type/t_neoca.htm (Dec/1991). University of Hawaii.

Mau, R.F.L. and Kessing, J.L.M. (1992). *Pulvinaria psidii* (Maskell). http://www.extento.hawaii.edu/kbase/crop/Type/p_psidii.htm (Feb/1992). University of Hawaii.

McClure, M.S. (1983). Reproduction and adaptation of exotic hemlock scales (Homoptera: Diaspididae) on their new and native hosts. Environmental Entomology 12: 1811-1815.

Miller, C.E. (1997). Hazard identification analysis: Evaluation of San Juan pre-departure interceptions in baggage (FY 1994-96). http://www.aphis.usda.gov/ppq/pra/commodity/hazardsanjuan.html

Morton, J.F. (1987). Pummelo (*Citrus maxima*). In: Fruits of warm climates. Miami, Florida. pp. 147-151. http://www.hort.purdue.edu/newcrop/morton/pummelo.html

Mound, L.A. and Halsey, S.H. (1978). Whitefly of the world: A systematic catalogue of the Aleyrodidae (Homoptera) with host plant and natural enemy data. British Museum (Natural History) Publication No. 787. John Wiley and Sons, Chichester, UK. 340 pp.

Nakao, S.I., Nohara, K. and Ono, T. (1974). Experimental study on the integrated control of three important pests in the summer orange groves. Mushi 47: 81-110.

NAQS (1992). A record of specical mealybug (*Nipaecoccus viridis* (Newstead) [Hemiptera: Pseudococcidae]) in Western Australia (Gibb River rd ne Derby) on citrus. NAQS survey 25/05/92 ex WAQIS Pest host quick list 18/11/92.

Naumann, I. (1993). CSIRO Handbook of Australian insect names. Common and scientific names for insects and allied organisms of economic and environmental importance (6th edition). CSIRO, East Melbourne, Australia. 200 pp.

Nguyen, R., Sailer, R.I. and Hamon, A.B. (1993). Catalog of Aleyrodidae on citrus and their natural enemies (Homoptera – Aleyrodidae). Occasional Papers of the Florida State Collection of Arthropods. Florida Department of Agriculture and Consumer Services, Division of Plant Industry Contribution No. 730. 57 pp.

Nickerson, J.C. (1983). The little fire ant, *Ochetomyrmex auropunctata* (Roger) (Hymenoptera: Formicidae). Florida Department of Agriculture and Consumer Services, Division of Plant Industry, Entomology Circular No. 248. 2 pp.

Nielsen, E.S., Edwards, E.D. and Rangsi, T.V. (1996). Checklist of the Lepidoptera of Australia, 1st edition. 529 pp.

Page, F.D. (1970) Life history and longevity of the cotton harlequin bug (*Tetrocoris diophthalmus*) (Thunb.). Queensland Journal of Agriculture and Animal Science 27(1): 115-117

Pena, J. and Johnson, F. (2001). Insect Management in Mango. University of Florida extension. Institute of Food and Agricultural Sciences. ENY-413.

Qin, T.K. and Gullan, P.J. (1992). A Revision of the Australian Pulvinariine Soft Scales (Insecta: Hemiptera: Coccidae). Journal of Natural History 26: 103-164.

Reddy, M.R.S., Reddy, B.C. and Reddy, G.S. (1983). Control of scab on Rangpur lime (*Citrus limonia* Osb.). Current Research. University of Agricultural Sciences. Bangalore 12: 19.

Richards, K.T. (1968). Insect pest complex of the Ord River Irrigation Area. Masters Thesis, University of Western Australia.

Saenz, G.S. and Taylor, J.W. (1999). Phylogenetic relationships of *Meliola* and *Meliolina* inferred from nuclear small subunit rRNA sequences. Mycol. Res. 103(8): 1049-1056.

Sales, P.F. and Paulaud, D. (1995). Rapport sur les premiers resultats des tests de statut hote. Service Entomologie de la Station de Researches Fruitieres de Pocquereux. Octobre 1994–Juillet 1995. CIRAD-FLHOR.

Schreiner, I. (2000). Striped Mealybug (*Ferrisia virgata* [Cockerell]). Agricultural Pests of the Pacific Series. Agricultural Development in the American Pacific (ADAP). 2000-18.

Schvester, D. (1985). Insects and French forests. Revue Forestiere Francaise 37: Special issue, 45-64.

Shivas, R.G. (1989). Fungal and bacterial diseases of plants in Western Australia. Jnl Royal Soc. Western Australia. 72: 1-62.

Smith, D., Beattie, G.A.C. and Broadley, R. (eds.). (1997a). Citrus pests and their natural enemies: Integrated Pest Management in Australia. Brisbane: State of Queensland, Department of Primary Industries, and Horticultural Research and Development Corporation, Australia. 272 pp.

Smith, I.M., McNamara, D.G., Scott, P.R. and Holderness, M. (1997b). *Elsinoe fawcettii* and *E. australi*s. *In* Quarantine pest for Europe. CAB International. European and Mediterranean Plant Protection Organisation (EPPO).

Spencer, H. (1941). The small fire ant *Wasmannia* in citrus groves – A preliminary report. Florida Entomologist 24: 6-14.

Storey, R. (2002). Australian Cerambycidae List (Longicorn Beetles). http://rainforest-australia.com/australian_cerambycidae.htm Queensland Department of Primary Industries.

Stuart, M. (2000). Agriculture Western Australia. Personal communication.

Tan, M.K., Timmer, L.W., Broadbent, P. and Priest, M. (1999). Causal fungi of citrus scab on three continents. *In* Conference Handbook 12th Biennial Conference. Rydges, Canberra: Asia-Pacific Plant Pathology for the New Millennium, 27–30 September 1999.

Taverner, P. and Bailey, P. (1995). Commercial trial of citrus post-harvest oil for removal of surface pests. South Australian Research & Development Institute Research report series. SARDI South Australia.

Tenbrink, V.L. and Hara, A.H. (1992). *Pinnaspis aspidistrae* (Signoret). http://www.extento.hawaii.edu/kbase/crop/Type/p_aspidi.htm (Mar/1992). University of Hawaii.

Timmer, L.W., Garnsey, S.M. and Graham, J.H. (eds) (2000). Compendium of Citrus Diseases. 2nd Edition. APS Press, Minnesota.

Timmer, L.W., Roberts, P.D. and Chung, K.R. (2002). 2003 Florida Citrus Pest Management Guide: Melanose. Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. http://edis.ifas.ufl.edu/TOPIC_BOOK_Florida_Citrus_Pest_Management_Guide

Tumminelli, R., Saraceno, F. and Conti, D. (1997). Ants in citrus groves. Informatore Agrario 53: 57-60.

Vijaysegaran, S. (1985). Management of fruit flies. *In*: Lee, B.S. and Heong, K.L. ed., Proceeding seminar on integrated pest management in Malaysia, 1984. Kuala Lumpur. pp 231-254.

Waller, J.B. (1990). Insecticidal soaps for post-harvest control of thrips in asparagus. pp. 60-62, In Proceedings of 43rd New Zealand Weed & Pest Control Conference. Auckland, New Zealand.

Wardowski, W.F., Nagy, S. and Grierson, W. (1986). Fresh citrus fruits. AVI Publishing Company, INC. Westport, Connecticut.

White, I.M. and Elson-Harris, M.M. (1994). Fruit Flies of Economic Significance: Their Identification and Bionomics. CAB International Institute of Entomology and ACIAR, Wallingford, UK. 601 pp.

Whiteside, J.O. (1975). Biological characteristics of *Elsinoe fawcettii* pertaining to the epidemiology of sour orange scab. Phytopatholgy 65: 1170-1175.

Whiteside, J.O. (1981). Evolution of current methods for citrus scab control. Proceedings of the Florida State Horticultural Society 94: 5-8.

Whittle, A.M. (1992). *Meliola citricola* on *Citrus suhuiensis* in Southeast Asia. FAO Plant Protection Bulletin 40: 112-115.

Willard, J.R. (1974). Horizontal and vertical dispersal of California red scale, *Aonidiella aurantii* (Mask.), (Homoptera: Diaspididae) in the field. Australian Journal of Zoology 22: 531-548.

Williams, D.F. (1994). Exotic ants: biology, impact, and control of introduced species. Westview Press, Colorado, USA.

Williams, D.J. (1985). Australian Mealybugs. British Museum (Natural History), London, UK. 431 pp.

Williams, D.J. and de Willink, M.C.G. (1992). Mealybugs of Central and South America. CAB International, Wallingford, UK. 635 pp.

Williams, D.J. and Watson, G.W. (1988). The Scale Insects of the Tropical South Pacific Region. Part 1. The Armoured Scales (Diaspididae). CAB International, Wallingford, UK. 289 pp.

Williams, D.J. and Watson, G.W. (1990). The scale insects of the tropical South Pacific region. Part 3: the soft scales (Coccidae) and other families. CAB International, Wallingford, UK. 267 pp.

Woods, W., Dick, J. and Learmonth, S. (eds.) (1996). Orchard and Vineyard pest and disease management guide, March 1996. Bulletin 4313. Department of Agriculture, Government of Western Australia.

Woods, W. (2001). The distribution of circular black scale *Chrysomphalus aonidum* (Linnaeus) in Western Australia. Personal Communication. Department of Agriculture, Government of Western Australia.

Yang, P.J. (1991). Status of fruit fly research in China. *In*: Vijaysegaran, S. and Ibrahim, A.G., ed., Proceedings of the First International Symposium on Fruit Flies in the Tropics, Kuala Lumpur, Malaysia, 1988. MARDI: 161-168.

Yeates, D. (1990). Queensland fruit fly eradication campaign in Perth. Myrmecia 26: 24-27.

APPENDIX 4 DATASHEETS

ARTHROPODS

Bactrocera (*Bactrocera*) *curvipennis* (Froggatt, 1909) [Diptera: Tephritidae]

Synonyms and changes in combination: *Dacus curvipennis* Froggatt, 1909; *Strumeta curvipennis* Perkins, 1939; *Dacus* (*Strumeta*) *curvipennis* Drew, 1974.

Common name(s): Banana fruit fly.

Hosts: *Anacardium occidentale* (cashew); *Annona reticulata* (custard apple); *Annona squamosa* (sugar apple); *Calophyllum inophyllum* (Alexandrian laurel); *Capsicum annuum* (bell pepper, capsicum); *Carica papaya* (pawpaw); *Citrus* spp.; *Citrus latifolia* (Tahitian limes: ripe fruit); *Citrus maxima* (pummelo); *Citrus* x *paradisi* (grapefruit); *Citrus reticulata* (mandarin); *Citrus sinensis* (sweet orange); *Diospyros macrocarpa* (ebony); *Eugenia uniflora* (Surinam cherry); *Guettarda speciosa*; *Lycopersicon esculentum* (tomato); *Malpighia glabra* (Barbados cherry); *Mangifera indica* (mango); *Prunus persica* (nectarine, peach); *Psidium cattleianum* (cherry guava); *Psidium guajava* (guava); *Syzygium jambos* (rose apple); *Terminalia catappa* (tropical almond, wild almond) (Anon., 1996).

Plant part affected: fruit, pod.

Distribution: New Caledonia; Vanuatu.

Biology

Life history: Adults of this species are smaller than the average fruit fly and have a predominantly dark thorax and orange brown abdomen with a characteristic wing pattern. The adults have a habit of holding their wings at an angle to the body and slowly raising and lowering them. Adults have very small pale brown facial spots. The scutum is predominately black with lateral yellow stripes. The wings have a broad brown costal band, which extends along the cross veins and forms an anal streak. The outer corner of the costal cells is pale brown. The orange-brown abdomen has a narrow brown transverse band that merges into broad lateral black margins toward the base (Drew, 1989).

The female fly has a very conspicuous ovipositor, which is greatly extended when eggs are being laid. Females lay eggs just below the surface of the rind of fruits that are within a few weeks of maturity. Eggs are cream-coloured and are one mm long and 0.2 mm wide. The eggs are laid in batches and after two to three days the larvae hatch and feed within fruit. The number of larvae per fruit varies from one to 12 or more. The larvae go through three instars and vary in length from 7–9 mm. The larvae are yellowish in colour, broad at the anal end and tapering to a point in front. When mature, the larvae pupate in the soil, under debris, in fruit cases, etc. The pupa, or resting stage, is enclosed in a brown, cylindrical puparium, consisting of the hardened cast skin of the larvae (O'Conor, 1969). Adults emerge after approximately 7-10 days, but do not become sexually mature for a further 7-10 days. Adult females can live for some months and can lay hundreds of eggs (Drew, 1989). Adult flies cannot survive more than a few days without feeding.

The ‘stings’ or punctures made in the rind of citrus fruit by the ovipositor of the female can allow the entry of pathogens, which can cause rapid decay of the fruit. The ‘sting’ may show as a circular, brown spot. Infested fruit often falls to the ground prematurely. *Bactrocera curvipennis* may infest Tahitian lime fruits when they are overripe. This species of fruit fly is attracted to Cue lure.

Control

Mature green condition

This measure will reduce the chance of quarantine fruit flies being introduced with Tahitian limes by excluding fruit that shows yellowing (entering the final stage of maturity), pre-harvest cracks, stings or punctures or other breaks in the skin (indicating a potential wound site through which the fruit flies may have deposited eggs within the fruit). Sorting and rejection of fruit for these reasons may occur during the harvesting, grading and packing of export fruit (quality control stage). Pre-export inspection and on-arrival inspection (details in Section 5: Proposed Phytosanitary Import Requirements) will verify the mature green status of Tahitian limes in the consignment in accordance with the requirements of ICA-15.

Orchard sanitation

Some authors have reported that overripe fruit of *Citrus* spp., including Tahitian limes, can be hosts for economic fruit fly species in New Caledonia (Anon., 1996; Drew *et al*., 1982; Sales & Paulaud, 1995). The chance of fruit fly infestation during field production would be reduced by implementing orchard sanitation involving the removal of ripe and fallen Tahitian lime fruits from the orchard regularly, and then, deeply burying or spraying these fruit with insecticides.

In China, infested fruits were handpicked, buried in the soil to about one metre in depth and the soil surface sprayed with insecticide. If infested fruit had dropped and decayed on the ground, insecticide was sprayed around the fruit to kill newly emerged larvae and pupae (Yang, 1991). The most effective record of destruction of fallen host fruit was reported from China. By implementing orchard sanitation, fruit fly infestations were reduced (Yang, 1991).

References:

Anon. (1996). Station de recherches fruittieres de pocquereux Rapport d’Activite 1995-1996. CIRAD-FLHOR, 45-53 pp.

Drew, R.A.I. (1989). The tropical fruit flies (Diptera: Tephritidae: Dacinae) of the Australasian and Oceanian Regions. Memoirs of the Queensland Museum 26: 1-521.

Drew, R.A.I, Hooper, G.H.S. and Bateman, M.A. (1982). Economic Fruit Flies of the South Pacific Region (2nd edition). Queensland Department of Primary Industries, Brisbane. 139 pp.

O’Conor, B.A. (1969). Exotic plant pests and diseases: A handbook of plant pests and diseases to be excluded from or prevented from spreading within the area of the South Pacific Commission. Noumea, New Caledonia.

Sales, P.F. and Paulaud, D. (1995). Rapport sur les premiers resultats des tests de statut hote. Service entomologie de la Station de Researches Fruitieres de pocquereux. Octobre 1994–Juillet 1995. CIRAD-FLHOR.

Yang, P.J. (1991). Status of fruit fly research in China. In: Vijaysegaran, S. and Ibrahim, A.G., ed., Proceedings of the First International Symposium on Fruit Flies in the Tropics, Kuala Lumpur, Malaysia, 1988. MARDI: 161-168.

Bactrocera (*Bactrocera*) *psidii* (Froggatt, 1899) [Diptera: Tephritidae]

Synonyms and changes in combination: *Dacus ornatissimus* Froggatt, 1909; *Dacus psidii* Froggatt, 1909; *Dacus* (*Strumeta*) *psidii* Drew, 1974; *Dacus virgatus* Coquillett, 1910; *Strumeta psidii* Perkins, 1939; *Tephrititis psidii* Froggatt, 1899.

Common name(s): South Sea guava fruit fly.

Hosts: *Anacardium occidentale* (cashew); *Annona reticulata* (custard apple); *Annona squamosa* (sugar apple); *Citrus* spp.; *Citrus maxima* (pummelo); *Diospyros macrocarpa* (ebony); *Eugenia uniflora* (Surinam cherry); *Ficus sp*. (fig); *Inocarpus fagifer* (Polynesian chestnut, Tahiti chestnut); *Mangifera indica* (mango); *Passiflora quadrangularis* (giant granadilla); *Prunus persica* (nectarine, peach); *Psidium cattleianum* (cherry guava); *Psidium guajava* (guava); *Syzygium jambos* (rose apple); *Syzygium malaccense* (Malay apple); *Terminalia catappa* (tropical almond, wild almond); *Vitis vinifera* (wine grape) (Anon., 1996).

Some species such as *Nephelium sp*. (rambutan, pulasan and formerly lychee) were not recorded from New Caledonia and were probably based on misidentifications of another species.

Plant part affected: fruit, pod.

Distribution: New Caledonia (Drew *et al*., 1982; White & Elson-Harris, 1994).

Biology

Life history: The life history of this species has not been thoroughly studied. Adults are medium-sized and are predominantly dark orange-brown to black in colour, with small facial spots. The thorax is orange-brown to black with short lateral yellow stripes and broad triangular dorsal markings. The abdomen is entirely glossy black. The wings have a narrow tint of extremely pale brown colouration around the costal margin, a narrow red-brown anal streak and a narrow tint of brown colouration around the cross veins. The species is attracted to Cue lure and Willison's lure (Drew, 1989).

This species has only been recorded from New Caledonia. It has the capacity to become a serious pest of horticultural crops in regions where host crops are produced (Drew, 1989). Compared with *B. tryoni*, (Queensland fruit fly), this species will probably be less economically important in New Caledonia due to its narrower host range (Drew *et al*., 1982).

When a fruit fly oviposits in green citrus fruit, tissue around the oviposited puncture grows as a protuberance, or a sting would turn brown after few days or the rind around a sting may turn yellow making it easy to identify the attacked fruits (Yang, 1991).

Control

Mature green condition

This measure will reduce the chance of quarantine fruit flies being introduced with Tahitian limes by excluding fruit that shows yellowing (entering the final stage of maturity), pre-harvest cracks, stings or punctures or other breaks in the skin (indicating a potential wound site through which the fruit flies may have deposited eggs within the fruit). Sorting and rejection of fruit for these reasons may occur during the harvesting, grading and packing of export fruit (quality control stage). Pre-export inspection and on-arrival inspection (details in Section 5: Proposed Phytosanitary Import Requirements) will verify the mature green status of Tahitian limes in the consignment in accordance with the requirements of ICA-15.

Orchard sanitation

Some authors have reported that overripe fruit of *Citrus* spp., including Tahitian limes, can be hosts for economic fruit fly species in New Caledonia (Anon., 1996; Drew *et al*., 1982; Sales & Paulaud, 1995). The chance of fruit fly infestation during field production would be reduced by implementing orchard sanitation involving the removal of ripe and fallen Tahitian lime fruits from the orchard regularly, and then, deeply burying or spraying these fruit with insecticides.

In China, infested fruits were handpicked, buried in the soil to about one metre in depth and the soil surface sprayed with insecticide. If infested fruit had dropped and decayed on the ground, insecticide was sprayed around the fruit to kill newly emerged larvae and pupae (Yang, 1991). The most effective record of destruction of fallen host fruit was reported from China. By implementing orchard sanitation, fruit fly infestations were reduced (Yang, 1991).

References:

Anon. (1996). Station de recherches fruittieres de pocquereux Rapport d'Activite 1995-1996. CIRAD-FLHOR, 45-53 pp.

Drew, R.A.I. (1989). The tropical fruit flies (Diptera: Tephritidae: Dacinae) of the Australasian and Oceanian Regions. Memoirs of the Queensland Museum 26: 1-521.

Drew, R.A.I, Hooper, G.H.S. and Bateman, M.A. (eds). (1982). Economic Fruit Flies of the South Pacific Region (2nd edition). Queensland Department of Primary Industries, Brisbane. 139 pp.

Sales, P.F. and Paulaud, D. (1995). Rapport sur les premiers resultats des tests de statut hote. Service entomologie de la Station de Researches Fruitieres de pocquereux. Octobre 1994–Juillet 1995. CIRAD-FLHOR.

White, I.M. and Elson-Harris, M.M. (1994). Fruit Flies of Economic Significance: Their Identification and Bionomics. CAB International Institute of Entomology and ACIAR, Wallingford, UK. 601 pp.

Yang, P.J. (1991). Status of fruit fly research in China. In: Vijaysegaran, S. and Ibrahim, A.G., ed., Proceedings of the First International Symposium on Fruit Flies in the Tropics, Kuala Lumpur, Malaysia, 1988. MARDI: 161-168.

Bactrocera (*Bactrocera*) *tryoni* (Froggatt, 1899) [Diptera: Tephritidae]

Synonyms and changes in combination: *Dacus (Bactrocera) tryoni* Drew, 1982; *Strumeta tryoni* May, 1963; *Dacus (Strumeta) tryoni* Hardy, 1951; *Chaetodacus tryoni* Tryon, 1927; *Chaetodacus tryoni* var. *juglandis* Tryon, 1927; *Chaetodacus tryoni* var. *sarcocephali* Tryon, 1927; *Dacus tryoni* Froggatt, 1909; *Tephritis tryoni* Froggatt, 1897.

Common name(s): Queensland fruit fly.

Hosts: Commercial hosts - *Anacardium occidentale* (cashew); *Annona reticulata* (custard apple); *Annona squamosa* (sugar apple, sweetsop); *Artocarpus heterophyllus* (jackfruit); *Averrhoa carambola* (carambola); *Cananga odorata* (ylang-ylang); *Capsicum annuum* (bell pepper, capsicum); *Capsicum frutescens* (chilli pepper, tabasco pepper); *Carica papaya* (pawpaw); *Casimiroa edulis* (white sapote); *Citrus* spp. (Lemontey & Mademba, 1994); *Citrus aurantium* (sour orange); *Citrus latifolia* (Tahitian limes); *Citrus limon* (lemon); *Citrus maxima* (pummelo); *Citrus medica* (citron); *Citrus x paradisi* (grapefruit); *Citrus reticulata* (mandarin); *Citrus sinensis* (sweet orange); *Coffea arabica* (arabica coffee); *Cydonia oblonga* (quince); *Diospyros kaki* (Chinese persimmon); *Dovyalis caffra* (kei apple); *Eremocitrus glauca* (Australian desert lime); *Eriobotrya japonica* (loquat); *Eugenia uniflora* (Surinam cherry); *Ficus benjamini* (weeping fig); *Ficus carica* (fig); *Ficus racemosa* (cluster fig); *Flacourtia jangomas* (Indian plum); *Fortunella japonica* (round kumquat); *Juglans regia* (English walnut); *Hernandia cordigera*; *Lycopersicon esculentum* (tomato); *Malpighia glabra* (Barbados cherry); *Malus domestica* (apple); *Mangifera indica* (mango); *Mimusops elengi* (Spanish cherry); *Morus alba* (white mulberry); *Morus nigra* (black mulberry); *Musa acuminata* (dwarf banana); *Olea europaea* (olive); *Opuntia ficus-indica* (Indian prickly pear); *Passiflora edulis* (passionfruit); *Passiflora quadrangularis* (giant granadilla); *Persea americana* (avocado); *Phoenix dactylifera* (date palm); *Physalis peruviana* (Cape gooseberry); *Pometia pinnata*; *Prunus armeniaca* (apricot); *Prunus avium* (sweet cherry); *Prunus cerasifera* (cherry plum, myrobalan); *Prunus domestica* (plum, prune); *Prunus persica* (nectarine, peach); *Psidium cattleianum* (cherry guava); *Psidium guajava* (guava); *Psidium littorale* (strawberry guava); *Punica granatum* (pomegranate); *Pyrus communis* (pear); *Rubus fruticosa* (blackberry); *Rubus ursinus* (loganberry); *Solanum laciniatum* (kangaroo apple); *Solanum seaforthianum* (Brazilian nightshade); *Spondias cytherea* (Jew plum); *Syzygium aqueum* (watery rose apple); *Syzygium jambos* (rose apple); *Terminalia catappa* (Pacific almond, tropical almond); *Vitis labrusca* (fox grape); *Vitis vinifera* (wine grape); *Ziziphus mauritiana* (Indian jujube). Unconfirmed reports include *Musa x paradisiaca* (banana) (CABI, 2000).

Wild hosts - Recorded from 60 wild hosts by Drew (1989), belonging to the families Anacardiaceae; Annonaceae; Apocynaceae; Capparidaceae; Celastraceae; Combretaceae; Cunoniaceae; Davidsoniaceae; Ebenaceae; Euphorbiaceae; Lauraceae; Meliaceae; Moraceae; Myrtaceae; Naucleaceae; Oleaceae; Passifloraceae; Rhamnaceae; Rutaceae; Sapindaceae; Sapotaceae; Siphonodontaceae; Smilacaceae; Solanaceae and Vitaceae (CABI, 2000).

Plant part affected: Fruit, pod.

Distribution: Australia* – (East coast from Cape York, Queensland to east Gippsland, Victoria); Chile (Easter Island (eradicated in 1974)); French Polynesia (Austral Islands, Society Islands); New Caledonia; Papua New Guinea; Torres Strait Islands (O'Conor, 1969) (CABI, 2000).

* An extensive outbreak of Queensland fruit fly was discovered in Perth, Western Australia in 1989, leading to a very expensive eradication program (Yeates, 1990).

Biology

Life history: Adult flies are about 7 mm in length, reddish brown with yellow lateral markings or stripes on the thorax. The pointed ovipositor is clearly visible at the end of the female's abdomen (Smith *et al*., 1997). The male fly is distinguished by a row of spines on either side of the abdomen (Smith *et al*., 1997). The wings have a narrow, brown costal band, a broad brown fuscous anal streak and brown costal cells.

Adult females can lay several hundred eggs when they are two to three weeks old (Anon., 1983). Females lay eggs below the surface of the fruit skin which are within a few weeks of maturity. The eggs are laid in batches of 10-12. Eggs are white in colour, banana-shaped and about 0.9-1 mm in length. The eggs hatch in two to three days and the larvae burrow into the fruit pulp to feed. The number of larvae per fruit can vary from one to 12 or more (Smith *et al*., 1997). If the fruit is green, the eggs remain dormant until the fruit begins to ripen. There is high mortality of eggs and young larvae of fruit flies, particularly in immature fruit, caused by oil released from oil cells in the rind ruptured during egg laying (Smith *et al*., 1997).

Larvae vary in length from about 3-15 mm in length, are yellow or white in colour, broad at the rear end and tapering to a point at the head end. Mature larvae are about 9 mm long and can move up to 15 cm at a time by skipping or flicking themselves into the air. In summer, larvae can complete their development in about 10 days (Smith *et al*., 1997). Mature larvae drop to the ground to find a suitable place to pupate. Pupation occurs in the soil and during summer, the emergence of adult flies can take as little as nine days. Normally pupation takes about two weeks. Pupae are brown, barrel-shaped and about four to five mm in length (Anon., 1983; Smith *et al*., 1997). The life cycle takes about four to five weeks. There are at least six generations per year in northern Queensland and the Northern Territory, with the number of generations determined by temperature.

Fruit damage results from puncturing of the rind during egg laying and larvae feeding on the fruit pulp. The rind puncture is not visible at first, but later a circular yellow or brown area develops around the 'sting' site (it is similar in appearance to fruit piercing moth feeding damage). The 'stings' or punctures made in the fruit rind can allow the entry of fungi and bacteria that cause decay. Stung fruit eventually drop to the ground where mature larvae can leave the fruit and pupate in the soil or under debris.

Adult females must feed on protein (e.g. bacteria growing on fruit and plant surfaces and on sugars in honeydew or nectar) for up to a week before they can mature and lay their eggs. Adult flies cannot survive more than a few days without feeding. Mating occurs when the females reach maturity and once hosts have been located. Movements of adult flies become localised and egg laying alternates with periods of feeding. Once suitable hosts become diminished, the females disperse in search of other hosts. The host searching ability of Queensland fruit fly is very effective, particularly when there is no suitable host nearby (Fletcher, 1973; 1989). Adults may travel over many kilometres.

B. tryoni is the most destructive insect pest of fruit and vegetable crops in Australia. It infests many commercial fruit crops, costing between $200-900 per ha depending on the variety of fruit produced and the time of harvest (Anon., 1991). Many wild plant fruits contribute to the development of extremely large fly populations in forest areas. Males are attracted to Cue lure (Drew *et al*., 1982; Drew, 1989). This species is highly competitive in comparison to other fruit flies in the South Pacific (Amice & Sales, 1997).

B. tryoni may survive the cold storage temperature of 1±0.5ºC for up to 16 days (Hill *et al*., 1988).

Control

Mature green condition

Australia has conducted host status tests for Queensland fruit fly and the results confirmed that Tahitian lime fruits at mature green stage were not a preferred host of Queensland fruit fly as reported at a Tri–State Fruit Fly Meeting (Anon., 2000). As discussed earlier in this document, States and Territories within Australia have accepted Interstate Certification Assurance (ICA) arrangements for domestic trade of horticultural commodities that are susceptible hosts to Queensland fruit fly infestations. ICA-15 allows interstate movement of Tahitian limes based on the 'mature green condition'. To harmonise international and domestic quarantine measures, fruit flies from New Caledonia should be managed in accordance with Australian ICA-15: "Mature green condition of passion fruit, Tahitian limes and black sapotes".

This measure will reduce the chance of quarantine fruit flies being introduced with Tahitian limes by excluding fruit that shows yellowing (entering the final stage of maturity), pre-harvest cracks, stings or punctures or other breaks in the skin (indicating a potential wound site through which the fruit flies may have deposited eggs within the fruit). Sorting and rejection of fruit for these reasons may occur during the harvesting, grading and packing of export fruit (quality control stage). Pre-export inspection and on-arrival inspection (details in Section 5: Proposed Phytosanitary Import Requirements) will verify the mature green status of Tahitian limes in the consignment in accordance with the requirements of ICA-15.

Orchard sanitation

Some authors have reported that overripe fruit of *Citrus* spp., including Tahitian limes, can be hosts for economic fruit flies species in New Caledonia (Anon., 1996; Drew *et al*., 1982; Sales & Paulaud, 1995). The chance of fruit fly infestation during field production would be reduced by implementing orchard sanitation involving the removal of ripe and fallen Tahitian lime fruits from the orchard regularly, and then, deeply burying or spraying these fruit with insecticides.

In China, infested fruits were handpicked, buried in the soil to about one metre in depth and the soil surface sprayed with insecticide. If infested fruit had dropped and decayed on the ground, insecticide was sprayed around the fruit to kill newly emerged larvae and pupae (Yang, 1991). The most effective record of destruction of fallen host fruit was reported from China. By implementing orchard sanitation, fruit fly infestations were reduced (Yang, 1991).

References:

Amice, R. and Sales, F. (1997). Fruit fly fauna in New Caledonia. pp. 68-76 In Allwood, A.J. and Drew, R.A.I. (eds). Management of Fruit Flies in the Pacific: A Regional Symposium. ACIAR Proceedings No. 76. Australian Centre for International Agricultural Research (ACIAR), Canberra. 267 pp.

Anon. (1983). Queensland fruit fly. South Pacific Commission. Advisory leaflet 18. Shepson Printery Pty Ltd, Sydney, NSW.

Anon. (1991). The impact of fruit flies on Australian Horticulture. Report to the Honorable John Kerin, Minister for Primary Industries and Energy. Horticultural Policy Council. April 1991.

Anon. (1996). Station de recherches fruittieres de pocquereux Rapport d'Activite 1995-1996. CIRAD-FLHOR, 45-53 pp.

Anon. (2000). Report of Tri-State Fruit Fly Meeting at The University of Sydney. NSW Agriculture.

CABI (2000). Crop Protection Compendium Global Module. CAB International, Wallingford, UK.

Drew, R.A.I. (1989). The tropical fruit flies (Diptera: Tephritidae: Dacinae) of the Australasian and Oceanian Regions. Memoirs of the Queensland Museum 26: 1-521.

Drew, R.A.I, Hooper, G.H.S. and Bateman, M.A. (1982). Economic Fruit Flies of the South Pacific Region (2nd edition). Queensland Department of Primary Industries, Brisbane. 139 pp.

Fletcher, B.S. (1973). The ecology of a natural population of the Queensland fruit fly, *Dacus tryoni.* V. The dispersal of adults. Australian Journal of Zoology 22: 189-202.

Fletcher, B.S. (1989). Ecology; movement of Tephritid fruit flies. In: World Crop Pests 3(B). Fruit flies; their biology, natural enemies and control (Ed. By Robinson, A.S.; Hooper, G.), Elsevier, Amsterdam, Netherlands. pp. 209-219.

Hill, A.R., Rigney, C.J. and Sproul, A.N. (1988). Cold storage of oranges as a disinfestation treatment against the fruit flies *Dacus tryoni* (Froggatt) and *Ceratitis capitata* (Wiedemann) (Diptera: Tephritidae). Journal of Economic Entomology 81: 257-260.

Lemontey, J.M. and Mademba-Sy, F. (1994). The fruit fly research programme in New Caledonia. Fruits (Paris) 49 (5-6): 496-499.

O'Conor, B.A. (1969). Exotic plant pests and diseases: A handbook of plant pests and diseases to be excluded from or prevented from spreading within the area of the South Pacific Commission. Noumea, New Caledonia.

Sales, P.F. and Paulaud, D. (1995). Rapport sur les premiers resultats des tests de statut hote. Service entomologie de la Station de Researches Fruitieres de pocquereux. Octobre 1994–Juillet 1995. CIRAD-FLHOR.

Smith, D., Beattie, G.A.C. and Broadley, R. (eds.). (1997). Citrus Pests and Their Natural Enemies: Integrated Pest Management in Australia. Department of Primary Industries and Horticultural Research and Development Corporation, Brisbane, Queensland, Australia. 272 pp.

Yang, P.J. (1991). Status of fruit fly research in China. In: Vijaysegaran, S. and Ibrahim, A.G., ed., Proceedings of the First International Symposium on Fruit Flies in the Tropics, Kuala Lumpur, Malaysia, 1988. MARDI: 161-168.

Yeates, D. (1990). Queensland fruit fly eradication campaign in Perth. Myrmecia 26: 24-27.

Bactrocera (*Bactrocera*) *umbrosa* (Fabricius, 1805) [Diptera: Tephritidae]

Synonyms and changes in combination: *Bactrocera fasciatipennis* Doleschall, 1856; *Dacus conformis* Walker, 1857; *Dacus diffusus* Walker, 1860; *Dacus fascipennis* Wiedemann, 1819; *Dacus frenchi* Froggatt, 1909; *Dacus umbrosus* Fabricius, 1805; *Dacus* (*Bactrocera*) *umbrosus* Malloch, 1939; *Dacus* (*Strumeta*) *umbrosus* Hardy & Adachi, 1954; *Strumeta frenchi* Perkins, 1939; *Strumeta umbrosa* Perkins, 1939.

Common name(s): Breadfruit fly.

Hosts: This species generally attacks *Artocarpus* spp. (breadfruit), including *Artocarpus altilis* (breadfruit); *Artocarpus balncoi* (Antipolo), *Artocarpus camansi, Artocarpus champeden*, *Artocarpus heterophyllus* (jackfruit), *Artocarpus integer* (chempedak), *Artocarpus odoratissima, Artocarpus rigida* and *Momordica charantia* (balsam pear, bitter gourd). Unconfirmed reports include *Citrus* spp.; *Citrus aurantium* (sour orange); *Citrus maxima* (pummelo) and *Passiflora quadrangularis* (giant granadilla) (Drew *et al.*, 1982; Lemontey & Mademba, 1994).

Plant part affected: fruit, pod.

Distribution: Widespread in south east Asia and the Pacific: Malaysia; New Caledonia (lowlands especially disturbed areas); Papua New Guinea (Bismarck Archipelago, Bougainville Island); The Philippines; Solomon Islands; Vanuatu.

Biology

Life history: Adults are medium-sized and have black facial spots. The thorax is predominately black with yellow lateral stripes. The abdomen is orange-brown with variable orange markings that are sometimes broadly black laterally. Females lay eggs beneath the skin of the host fruit. The eggs hatch within one to two days and the hatching larvae feed on the host fruit for about one week. Mature larvae pupate in the soil beneath the host plant for a week or more, depending on environmental conditions. Adults occur throughout the year and commence mating within two weeks of hatching. Adult flies cannot survive more than a few days without feeding. Male flies are attracted to methyl eugenol (White & Elson-Harris, 1994).

This species is widespread and occurs throughout Southeast Asia where it attacks jackfruit, breadfruit and custard apples. In the Pacific, it has been found to attack breadfruit, jackfruit and *Citrus* spp. Yukawa (1984) reported that it is a serious pest of breadfruit and jackfruit in Indonesia.

It was also found in chempedak in Malaysia. It is said to infest *Momordica charantia* (balsam pear, bitter gourd) in Kalimantan.

When a fruit fly oviposits in green citrus fruit, tissue around the oviposited puncture grows as a protuberance, or a sting would turn brown after few days or the rind around a sting may turn yellow making it easy to identify the attacked fruits (Yang, 1991).

Control

Mature green condition

This measure will reduce the chance of quarantine fruit flies being introduced with Tahitian limes by excluding fruit that shows yellowing (entering the final stage of maturity), pre-harvest cracks, stings or punctures or other breaks in the skin (indicating a potential wound site through which the fruit flies may have deposited eggs within the fruit). Sorting and rejection of fruit for these reasons may occur during the harvesting, grading and packing of export fruit (quality control stage). Pre-export inspection and on-arrival inspection (details in Section 5: Proposed Phytosanitary Import Requirements) will verify the mature green status of Tahitian limes in the consignment in accordance with the requirements of ICA-15.

Orchard sanitation

Some authors have reported that overripe fruit of *Citrus* spp., including Tahitian limes, can be hosts for economic fruit flies species in New Caledonia (Anon., 1996; Drew *et al*., 1982; Sales & Paulaud, 1995). The chance of fruit fly infestation during field production would be reduced by implementing orchard sanitation involving the removal of ripe and fallen Tahitian lime fruits from the orchard regularly, and then, deeply burying or spraying these fruit with insecticides.

In China, infested fruits were handpicked, buried in the soil to about one metre in depth and the soil surface sprayed with insecticide. If infested fruit had dropped and decayed on the ground, insecticide was sprayed around the fruit to kill newly emerged larvae and pupae (Yang, 1991). The most effective record of destruction of fallen host fruit was reported from China. By implementing orchard sanitation, fruit fly infestations were reduced (Yang, 1991).

References:

Anon. (1996). Station de recherches fruittieres de pocquereux Rapport d'Activite 1995-1996. CIRAD-FLHOR, 45-53 pp.

Drew, R.A.I, Hooper, G.H.S. and Bateman, M.A. (1982). Economic Fruit Flies of the South Pacific Region (2nd edition). Queensland Department of Primary Industries, Brisbane. 139 pp.

Lemontey, J.M. and Mademba-Sy, F. (1994). The fruit fly research programme in New Caledonia. Fruits (Paris) 49 (5-6): 496-499.

Sales, P.F. and Paulaud, D. (1995). Rapport sur les premiers resultats des tests de statut hote. Service entomologie de la Station de Researches Fruitieres de pocquereux. Octobre 1994–Juillet 1995. CIRAD-FLHOR.

White, I.M. and Elson-Harris, M.M. (1994). Fruit Flies of Economic Significance: Their Identification and Bionomics. CAB International Institute of Entomology and ACIAR, Wallingford, UK. 601 pp.

Yang, P.J. (1991). Status of fruit fly research in China. In: Vijaysegaran, S. and Ibrahim, A.G., ed., Proceedings of the First International Symposium on Fruit Flies in the Tropics, Kuala Lumpur, Malaysia, 1988. MARDI: 161-168.

Yukawa, J. (1984). Fruit flies of the genus Dacus (Diptera: Tephritidae) on the Krakatau Islands in Indonesia, with special reference to an outbreak of *Dacus albistrigatus* De Meijere. Japanese Journal of Ecology 34: 281-288.

Scales

Coccus viridis Green

Lepidosaphes gloverii Packard, 1869

Lopholeucaspis cockerelli (Grandpré & Charmoy, 1899)

Morganella longispina Morgan

Parlatoria cinerea Hadden, 1909

Pseudaonidia trilobitiformis Green

Unaspis citri Comstock

Synonyms and changes in combination:

Coccus viridis: *Eulecanium viridis; Lecanium viridis; Lecanium viride*.

Lepidosaphes gloverii: *Aspidiotus gloverii* Packard, 1869; *Insulaspis gloverii* (Packard); *Mytilaspis gloverii* (Packard); *Myrtilaspis gloveri* (Packard); *Myrtilococcus gloveri* (Packard); *Myrtilococcus gloverii* (Packard).

Lopholeucaspis cockerelli: *Fiorinia cockerelli* Grandpré & Charmoy, 1899; *Leucaspis cockerelli* (Grandpré & Charmoy).

Morganella longispina: *Aspidiotus longispina; Aspidiotus maskelli; Hemiberlesea longispina; Morganella maskelli; Hemiberlesia longispina; Hemiberlesia maskelli.*

Parlatoria cinerea: None known.

Pseudaonidia trilobitiformis: *Aspidiotus trilobitiformis.*

Unaspis citri: *Chionaspis annae* Malenotti; *Chionaspis citri* Comstock, 1883; *Dinaspis annae* Malenotti; *Dinaspis veitchi* Green & Laing, 1923; *Prontaspis citri* (Comstock) MacGillivray, 1921; *Unaspis annae* Malenotti.

Common name(s):

Coccus viridis: soft green scale, green coffee scale, green scale, green shield scale

Lepidosaphes gloverii: Citrus scale, Glover scale, Glover's scale, long scale, long mussel scale

Lopholeucaspis cockerelli: Diaspine scale

Morganella longispina: Plumose scale, Maskell scale

Parlatoria cinerea: Chaff scale

Pseudaonidia trilobitiformis: Trilobite scale, Armoured scale

Unaspis citri: citrus snow scale

Hosts:

Coccus viridis: Citrus spp. Polyphagous, including coffee, mango, cassava and guava.

Lepidosaphes gloverii: Attacks all *Citrus* cultivars. *Alocasia macrorrhiza* (giant taro); *Carissa*; *Citrus*; *Codiaeum variegatum* (croton); *Erythrina* spp.; *Euonymus* (spindle trees), *Fortunella* (kumquat), *Mangifera indica* (mango); *Poncirus*.

Lopholeucaspis cockerelli: Aleurites moluccana (candlenut tree); *Barringtonia* sp.; *Barringtonia racemosa*; *Calophyllum inophyllum* (Alexandrian laurel); *Citrus* spp.; *Citrus aurantifolia* (lime); *Citrus limon* (lemon); *Citrus maxima* (pummelo); *Heliconia sp*. (false bird-of-paradise, lobster claw); *Inocarpus fagifer* (Polynesian chestnut, Tahiti chestnut); *Passiflora edulis* (passionfruit); *Persea americana* (avocado); *Pinus caribaea* var. *caribaea* (Caribbean pine); *Pinus caribaea* var. *hondurensis* (Nicaraguan pine); *Piper aduncum* (spiked pepper); *Schefflera sp*.; *Theobroma cacao* (cocoa).

Morganella longispina: Carica papaya (papaw); *Citrus*.

Parlatoria cinerea: Annona muricata (soursop); *Citrus* spp.; *Citrus aurantifolia* (lime); *Citrus latifolia* (Tahitian limes); *Citrus limon* (lemon); *Citrus maxima* (pummelo); *Citrus reticulata* (mandarin); *Citrus sinensis* (sweet orange); *Malus sylvestris* (crabapple); *Vitis vinifera* (wine grape).

Pseudaonidia trilobitiformis: Anacardium occidentale (cashew nut); *Anthurium andreanum*; *Citrus*; *Cocos nucifera* (coconut); *Coffea* (coffee); *Mangifera indica* (mango); *Persea americana* (avocado); *Theobroma cacao* (cocoa); *Zingiber officinale* (ginger).

Unaspis citri: Polyphagous on a wide range of hosts, *Citrus* being the main host of economic importance. *Ananas comosus* (pineapple); *Annona muricate* (soursop); *Artocarpus heterophyllus* (jackfruit); *Capsicum* (peppers); *Citrus*; *Citrus aurantiifolia* (lime); *Citrus aurantium* (sour orange); *Citrus limon* (lemon); *Citrus maxima* (pummelo); *Citrus reticulata* (mandarin); *Citrus sinensis* (navel orange); *Citrus x paradisi* (grapefruit); *Cocos nucifera* (coconut); *Fortunella* (kumquat); *Hibiscus* (rosemallows); *Musa* (banana); *Poncirus trifoliata* (Trifoliate orange); *Psidium guajava* (common guava); *Tillandsia usneoides* (Spanish moss).

Plant part affected: bark, twig, branch, fruit, leaf, stem.

Distribution:

Coccus viridis: American Samoa; Angola; Antigua and Barbuda; Australia (no record in Western Australia) (Queensland); Bahamas; Bangladesh; Barbados; Belau; Benin; Bermuda; Bolivia; Brazil; British Virgin Islands; Brunei; Burkina Faso; Cambodia; Cameroon; Cape Verde; Cayman Islands; China (Taiwan); Colombia; Congo Democratic Republic; Côte d'Ivoire; Cuba; Dominica; Dominican Republic; East Africa; El Salvador; Ethiopia; Federated States of Micronesia; Fiji;

French Guiana; French Polynesia; Ghana; Grenada; Guadelope; Guam; Guatemala; Guinea; Guyana; Haiti; India; Indonesia (Irian Jaya, Java, Sumatra); Jamaica; Kenya; Kiribati; Laos; Madagascar; Malaysia; Mali; Martinique; Mauritius; Mexico; Montserrat; Myanmar; Nauru; New Caledonia; Nicaragua; Niger; Nigeria; Niue; Northern Mariana Islands; Pakistan; Panama; Papua New Guinea; Peru; Philippines; Portugal; Puerto Rico; Réunion; Saint Kitts and Nevis; Saint Lucia; Saint Vincent and the Grenadines; Samoa; Sao Tome and Principe; Senegal; Seychelles; Sierra Leone; Singapore; South Africa; Sri Lanka; Suriname; Tanzania; Thailand; Togo; Tonga; Trinidad and Tobago; Uganda; USA (Florida, Hawaii); Vanuatu; Venezuela; Vietnam; Zambia.

Lepidosaphes gloverii: Algeria; Argentina; Australia (no record in Western Australia); Belarus; Bolivia; Cameroon; China (Hong Kong, Taiwan); Cook Islands; Costa Rica; Cuba; Dominican Republic; Ecuador; Egypt; Federated states of Micronesia; Fiji; France; French Polynesia; Gambia; Greece; Guinea; Honduras; India; Indonesia; Israel; Italy; Jamaica; Japan; Korea, DPR; Korea, Republic of; Lebanon; Madagascar; Malaysia; Mauritius; Mexico; Morocco; Mozambique; Myanmar; Nigeria; Niue; Northern Mariana Islands; Pakistan; Papua New Guinea; Philippines; Puerto Rico; Réunion; Russian Federation; Samoa; Senegal; Sierra Leone; South Africa; Spain; Sri Lanka; Suriname; Thailand; Tonga; Trinidad and Tobago; Turkey; Uganda; USA (Alabama, California, Florida, Hawaii, Louisiana, Texas); Venezuela (CABI, 2002).

Lopholeucaspis cockerelli: Cook Islands; Fiji; Kiribati; New Caledonia; Niue; Tonga; Samoa; Vanuatu. This species has a wide distribution, although it has still not been reported from some tropical countries (Williams and Watson, 1988).

Morganella longispina: Australia (AICN, 2001) (no record in Western Australia); Barbados; Bermuda; India (unconfirmed record); New Caledonia; USA (Florida, Hawaii) (CABI, 2002).

Parlatoria cinerea: Cook Islands; French Polynesia; New Caledonia; Niue; Pitcairn; Samoa; Vanuatu. This species is found on numerous host plants (Williams and Watson, 1988).

Pseudaonidia trilobitiformis: Australia (CIE, 1981) (no record in Western Australia); Barbados; Dominican Republic; Grenada; Jamaica; New Caledonia (Amice, 1996); Réunion; Saint Vincent and the Grenadines; Tanzania (CABI, 2002).

Unaspis citri: Antigua and Barbuda; Argentina; Australia (no record in Western Australia) (New South Wales, Queensland, South Australia, Victoria); Barbados; Benin; Bermuda; Bolivia; Brazil; British Virgin Islands; Cameroon; Chile; China; Colombia; Congo; Congo Democratic Republic; Cook Islands; Côte d'Ivoire; Cuba; Dominica; Dominican Republic; Ecuador; El Salvador; Federated States of Micronesia; Fiji; Gabon; Grenada; Guadeloupe; Guinea; Guyana; Haiti; Honduras; Jamaica; Java; Kiribati; Malaysia; Malta; Mauritius; Mexico; Montserrat; New Caledonia; New Zealand; Niger; Nigeria; Niue; Panama; Papua New Guinea; Paraguay; Peru; Portugal; Puerto Rico; Saint Kitts and Nevis; Saint Lucia; Saint Vincent and the Grenadines; Samoa; Senegal; Sierra Leone; Singapore; Solomon Islands; Togo; Tonga; Trinidad and Tobago; United States Virgin Islands; Uruguay; USA (California, Florida, Georgia, Louisiana); Vanuatu; Venezuela; Vietnam; Wallis and Futuna; West Indies; Yemen (CABI, 2002).

Biology:

Most armoured scales are very small (2-4 mm long), the body is covered with a hard, waxy 'armour'. The cover may be separate or attached to the body (Smith *et al*., 1997). The armour covers adult females and immature males.

Adult scale females are immobile, being wingless and often without legs. Adult males are tiny, fragile, usually with one pair of wings and well-developed legs. They lack mouthparts as they do not feed. The female pupillarial (cast exuvium of the second instar) is elongate, ridged and triangular in cross section, brown in colour and covered with a thin secretion of white wax. Male scales are similar to females but are narrower in length and much smaller. Adult females are elongate-oval. (Williams and Watson, 1988).

Nymphs are active only during the first instar (or crawler) stage and may travel some distance to a new plant; they become sessile for the remaining nymphal (larval) instars. The crawlers settle down and feed upon plant juices by inserting their piercing-sucking mouthparts into the host plant. First instars (crawlers) are able to disperse by active wandering and by wind.

Armoured scales do not produce honeydew, but their feeding can damage fruit or cause leaf drop. They inject toxins into plant tissues and high populations can cause the death of the trees. This species is polyphagous and is often found in large numbers on the leaves.

In cooler regions during winter, development of all scales progresses very slowly up to the adult stage for females and up to pupal stage for males. At this stage, development stops until the onset of warmer weather. Once the warmer weather starts, adult males emerge and mating begins with adult females. Females then start reproducing within one to two months. Crawlers hatch and move onto young, new season fruit after petal fall and continue moving for several weeks. From this time until summer, the population tends to be at the same stage of development. Scale insects develop well during summer, even at low humidity.

Brun and Chazeau (1980) recorded *Lopholeucaspis cockerelli* species from New Caledonia on *Citrus* spp. *Lopholeucaspis cockerelli* was first recorded attacking *Pinus caribaea* var. *caribaea* and *P. caribaea* var. *hondurensis* in Fiji in 1974 (Anon., 1976). Little is published about *Lopholeucaspis cockerelli*, which may imply that it is of minor importance.

The spread of *Parlatoria* spp. depends on relative humidity and temperature (Gerson, 1980). They cannot spread well under low relative humidity and high temperatures. Chaff scales establish their population on limbs and trunks, but it can be widely distributed on the tree. Adults and nymphs feed on leaves, stems and fruit, which sometimes lead to fruit abscission. Chaff scales are often associated with gumming, flaking and splitting of the bark, causing dieback of branches and sometimes killing the tree. This species has been found to cover nearly 100% of bark and 70% of twigs of *Citrus sinensis* (sweet orange) in the Cook Islands (Walker & Deitz, 1979).

Parlatoria cinerea and *P. citri* McKenzie are similar species, which are found on citrus in some parts of the world (Gill, 1997). *Parlatoria cinerea* has been recorded on *Citrus* spp. in New Caledonia where it is common but difficult to find underneath colonies of *Lepidosaphes beckii* (citrus mussel scale) and *Unaspis citri* (citrus snow scale) (Williams & Watson, 1988). *Parlatoria cinerea* is usually associated with citrus and is probably one of the commonest scale insects on citrus in the South Pacific area.

Unaspis citri is one of the main pests of citrus in regions where citrus is grown throughout the world. This species is usually found on the trunk and main limbs of the tree, during heavy infestations they spread to twigs, leaves and fruit. A small numbers of scales can cause serious damage (CABI, 2002).

Lepidosaphes gloverii is a minor pest of citrus. This species is polyphagous in tropical countries, however it is unable to survive hot, dry summers. (Gill, 1997).

Soft scales do not have a separate protective covering, adults secrete a thick waxy cover on the upper surface of their body (Smith *et al*., 1997).

Coccus viridis is most commonly found on leaves (Ben Dov & Hodgson, 1997) but can be found on fruit (Smith *et al*., 1997). This species and other soft scales remove nutrients from plants by feeding on the phloem and cause indirect injury via the production of honeydew, which attracts sooty mould growth.

In general, scale insects are major citrus pests and being small, they are difficult to detect in quarantine inspections, especially at low population levels. They generally live around the sepal or under the calyx of the fruit from flowering onwards. Damage is usually caused by removal of plant sap and results in senescence of the branch or leaf drop.

Control

Field insecticide treatments

Insecticide application gave effective control against scale insects and resulted in the harvest of 95-99% export quality fruit while the unsprayed control had only 50% export quality fruit (Frankel *et al.,* 1976). The application of oil soap and/or insecticide reduced the number of scale insects and mealybugs in citrus by 93-100% (Baker & Shearin, 1992; Beattie & Ribbon, 1980; Lindquist, 1981); and with the same efficacy (93-100%) for grapevine (Su and Wang, 1988).

In Australian citrus production areas, trees are inspected regularly for scale insects, when pest levels reach 20-30% a spray is used. Monitoring is effective in determining when the pest is at its most vulnerable (the young crawler stage), as timing is vital with oil sprays (Moulds and Tugwell, 1999).

Post-harvest insecticide treatments

Citrus fruit severely infested with scale insects could also be managed by brushing in the packinghouse or by high-pressure water sprays (Bohler, 1981). High-pressure water sprays could physically remove 97-99.9% of the red scale from citrus fruit and were equally effective in removing either live or dead scale (Walker *et al*., 1999).

References:

AICN (2001). Australian Insect Common Names database. http://www.ento.csiro.au/aicn/

Amice, R. (1996). Pest list of Tahitian limes. Written communication dated 3rd May, 1996.

Anon. (1976). New records. Plant Protection Committee for the South East Asia and Pacific Region Quarterly-Newsletter 19: 6-8.

Baker, J.R. and Shearin, E.A. (1992). Fern scale insects. North Carolina Flower Growers Bulletin 37: 1-3.

Beattie, G.A.C. and Ribbon, L.E. (1980). Phytotoxicity and scalicide efficacy of citrus spray oils. Proceeding of the International Society of Citriculture. Griffith. NSW, Australia. pp. 171-174.

Ben-Dov, Y. and Hodgson, C.J. (Eds) (1997). World Crop Pests: Soft Scale Insects. Their Biology, Natural Enemies and Control, Volume 7B. Elsevier, Amsterdam. 442 pp.

Bohler, D. (1981). Blast scale insects with water jets and reduce citrus loss. Information bulletin, Citrus and Subtropical Fruit Research Institute. No 111: 1-2.

Brun, L.O. and Chazeau, J. (1980). Catalogue des ravageurs d'interêt agricole de Nouvelle-Calédonie. [Catalogue of pests of agricultural importance in New Caledonia.] Laboratoire de Zoologie Appliquée, ORSTOM, Noumea, New Caledonia. 125 pp.

CABI (2002). Crop Protection Compendium Global Module. CAB International, Wallingford, UK.

CIE (1981). *Pseudaonidia trilobitiformis*. Distribution Maps of Pests. Series A, Map No. 418. CAB International, Wallingford, UK.

Frankel, H., Gross, Y., Austerweil, M., Nahir, D. and Neubauer, I. (1976). Red scale control in citrus with a peripheral low-volume sprayer. Hassadeh 57: 467-468.

Gerson, U. (1980). The scale insect *Parlatoria paranoid* Comstock and its natural enemies in Israel. Seminar on biological control of scale insects and aleurodids on citrus. Boletin del Servicio de Lucha Biologica Contra Plagas e Inspeccion Fitopatoloica 21: 21-53.

Gill, R.J. (1997). The Scale Insects of California. Part 3: The Armored Scales (Homoptera: Coccoidea: Diaspididae). Technical Series in Agricultural Biosystematics and Plant Pathology No. 3. Sacramento, California: Department of Food and Agriculture, California, USA. 307 pp.

Lindquist, R.K. (1981). Controlling the citrus mealybug on greenhouse foliage plants. Ohio Florists Association Bulletin. 622: 6-8.

Moulds, G. and Tugwell, B. (1999). Citrus Growing Manual: a manual for quality decision making. Horticultural Research and Development Corporation. JC Irving Printers, Berri, South Australia.

Smith, D., Beattie, G.A.C. and Broadley, R. (eds.). (1997). Citrus pests and their natural enemies: Integrated Pest Management in Australia. Brisbane: State of Queensland, Department of Primary Industries, and Horticultural Research and Development Corporation, Australia. 272 pp.

Su, T.H. and Wang, C.M. (1988). Life history and control measures for the citrus mealybug and the latania scale insects on grapevine. Plant Protection Bulletin 30: 279-288.

Walker, A.K. and Deitz, L.L. (1979). A review of entomophagous insects in the Cook Islands. New Zealand Entomology 7: 70-82.

Walker, G.P., Zareh, N. and Arpaia, M.L. (1999). Effect of pressure and dwell time on efficiency of a high-pressure washer for post-harvest removal of California red scale (Homoptera: Diaspididae) from citrus fruit. Journal of Economic Entomology 92: 906-914.

Williams, D.J. and Watson, G.W. (1988). The Scale Insects of the Tropical South Pacific Region. Part 1. The Armoured Scales (Diaspididae). CAB International, Wallingford, UK. 289 pp.

Mealybugs

***Ferrisia virgata* (Cockerell, 1893) [Hemiptera: Pseudococcidae]**

***Nipaecoccus filamentosus* (Cockerell, 1893) [Hemiptera: Pseudococcidae]**

Synonyms and changes in combination:

Ferrisia virgata: Dactylopius ceriferus Newstead, 1894; *Dactylopius dasylirii* Cockerell; *Dactylopius magnolicida* King, 1902; *Dactylopius segregatus* Cockerell, 1893; *Dactylopius setosus* Hempel, 1900; *Dactylopius talini* Green, 1896; *Dactylopius virgatus* Cockerell, 1893; *Dactylopius virgatus* var. *farinosus* Cockerell, 1893; *Dactylopius virgatus* var. *humilis* Cockerell, 1893; *Dactylopius virgatus* var. *madagascariensis* Newstead, 1908; *Ferrisiana setosus* (Hempel); *Heliococcus malvastras* McDaniel, 1962; *Pseudococcus bicaudatus* Keuchenius, 1915; *Pseudococcus ceriferus* Newstead; *Pseudococcus dasylirii* (Cockerell); *Pseudococcus magnolicida* (King); *Pseudococcus marchali* Vayssière, 1912; *Pseudococcus segregatus* (Cockerell); *Pseudococcus setosus* Hempel; *Pseudococcus talina* Green; *Pseudococcus virgatus* (Cockerell); *Pseudococcus virgatus farinosus* (Cockerell); *Pseudococcus virgatus humilis* (Cockerell); *Pseudococcus virgatus madagascariensis* (Newstead).

Nipaecoccus filamentosus: Dactylopius filamentosus Cockerell, 1893; *Pseudococcus filamentosus* (Cockerell); *Ceroputo filamentosus* (Cockerell).

Common name(s):

Ferrisia virgata: striped mealybug, cotton scale, grey mealybug, guava mealybug, spotted mealybug, tailed coffee mealybug, tailed mealybug, white-tailed mealybug.

Nipaecoccus filamentosus: mealybug

Hosts:

Ferrisia virgata: Highly polyphagous. *Abelmoschus esculentus* (okra); *Acalypha* (Copperleaf); *Anacardium occidentale* (cashew nut); *Ananas comosus* (pineapple); *Annona*; *Arachis hypogaea* (groundnut); *Cajanus cajan* (pigeon pea); *Carica papaya* (papaw); *Citrus*; *Coccoloba uvifera* (Jamaican kino); *Cocos nucifera* (coconut); *Codiaeum variegatum* (croton); *Coffea* (coffee); *Colocasia esculenta* (taro); *Corchorus* (jutes); *Cucurbita maxima* (banana squash); *Cucurbita pepo* (ornamental gourd); *Dracaena*; *Elaeis guineensis* (African oil palm); *Ficus*; *Gossypium* (cotton); *Hibiscus* (rosemallows); *Ipomoea batatas* (sweet potato); *Leucaena leucocephala* (horse tamarind); *Litchi chinensis* (lychee); *Lycopersicon esculentum* (tomato); *Malpighia punicifolia* (Barbados cherry tree); *Mangifera indica* (mango); *Manihot esculenta* (cassava); *Manilkara*; *Musa* (banana); *Nicotiana tabacum* (tobacco); *Persea americana* (avocado); *Phaseolus* (beans); *Phoenix dactylifera* (date-palm); *Piper betle* (betel pepper); *Piper nigrum* (black pepper); *Psidium guajava* (common guava); *Punica granatum* (pomegranate); *Saccharum officinarum* (sugercane); *Solanum melongena* (aubergine); *Solanum nigrum* (black nightshade); *Theobroma cacao* (cocoa); *Vigna unguiculata* (cowpea); *Vitis vinifera* (grapevine); *Zea mays* (maize); *Zingiber officinale* (ginger) (CABI, 2002).

Nipaecoccus filamentosus: Annona reticulata (custard apple); *Asparagus sp*.; *Citrus* spp.; *Citrus aurantifolia* (lime); *Citrus aurantium* (sour orange); *Citrus deliciosa* (Mediterranean mandarin); *Citrus reticulata* (mandarin); *Clerodendrum heterophyllum*; *Euphorbia hirta* (asthma plant); *Ficus carica* (fig); *Gossypium sp*. (cotton); *Hibiscus manihot*; *Leucaena leucocephala* (leucaena); *Lysiloma sp*.; *Mangifera indica* (mango); *Punica granatum* (pomegranate); *Tamarindus indica* (tamarind); *Tamarix sp*. (tamarisk); *Vernonia glabra*; *Ximenia americana* (tallow-wood) (CABI, 2002; Williams and Watson, 1988).

Plant part affected: flower, fruit, leaf, trunk, twig.

Distribution:

Ferrisia virgata: Angola; Argentina; Australia (Northern Territory, Queensland) (no record in Western Australia); Bahamas; Bangladesh; Barbados; Belau; Belize; Bermuda; Bolivia; Brazil; Brunei; Cambodia; Cameroon; Cayman Islands; Chagos Archipelago; China; Cook Islands; Colombia; Comoros; Congo; Congo Democratic Republic; Costa Rica; Côte d'Ivoire; Cuba; Dominica; Ecuador; Egypt; Ethiopia; Federated states of Micronesia; Fiji; French Polynesia; Ghana; Guatemala; Guinea; Guyana; Haiti; Honduras; India; Indonesia; Jamaica; Japan; Kenya; Kiribati; Laos; Madagascar; Malawi; Malaysia; Marshall Islands; Martinique; Mauritius; Mexico; Mozambique; Myanmar; Netherlands Antilles; New Caledonia; Nicaragua; Nigeria; Northern Mariana Islands; Pakistan; Panama; Papua New Guinea; Paraguay; Peru; Philippines; Puerto Rico; Saint Kitts and Nevis; Samoa; Sao Tome and Principe; Saudi Arabia; Senegal; Seychelles; Sierra Leone; Singapore; Solomon Islands; Somalia; South Africa; Sri Lanka; Sudan; Suriname; Tanzania; Thailand; Togo; Tonga; Trinidad and Tobago; Tuvalu; Uganda; United Arab Emirates; USA (Alabama, California, Florida, Hawaii, Louisiana, Maryland, Mississippi, New Mexico, New York, Pennsylvania, Texas); United States Virgin Islands; Vanuatu; Venezuela; Vietnam; Wallis and Futuna; Yemen; Zambia; Zimbabwe (CABI, 2002).

Nipaecoccus filamentosus: Afghanistan; China (Taiwan); Haiti; India; Iran; Jamaica; Kiribati; Madagascar; Mexico; New Caledonia; Papua New Guinea; Philippines; Solomon Islands; South Africa, Thailand; Zimbabwe.

Biology

Life history: Adults are generally 3–4 mm in length and covered with a thin coating of white, mealy wax, which extends into filaments around the edge of the body. Adult females are covered in copious secretions, usually white or yellow, or enclosed in compact or felted wax. The body is often blue-green or purplish in colour. Females are broadly oval in body, wingless and quite sedentary, with well-developed legs. Females produce (spin) loose cottony ovisacs that contain and enclose the egg masses. The ovisac in this species completely covers the body. Following completion of the ovisac, females produce eggs until their death. Females lay between 90–600 eggs during their lifetime.

Nymphs are active only during the first instar (or crawler) stage, becoming sessile for the remaining nymphal (larval) instars. The first instar is the primary dispersal phase in the life cycle. The crawlers migrate and settle mainly in protected areas, under the sepals of the fruitlets when they are 0.5 cm or larger (CABI, 2002). They often settle in cryptic places on lime fruit such as around the calyx. Female *Nipaecoccus viridis* (a closely related species to *Nipaecoccus* *filamentosus*) pass through three moults before reaching adulthood and males pass through four moults before emerging as a fragile-winged adult. Most mealybugs overwinter as various juvenile stages. The complete life cycle takes between 3 and 8 weeks (Smith *et al*., 1997).

Ferrisia virgata is a highly polyphagous species of mealybug. Annecke and Moran (1982) list this species as a minor pest of citrus. It secretes honeydew, attracting ants and causing problems with sooty mould growth. This species has been known to produce several overlapping generations per year (CABI, 2002).

Adults and larvae damage the host plant by sucking sap and excreting honeydew onto the fruit and leaves, leading to sooty mould growth that interferes with photosynthesis. Mealybugs often form dense colonies on plants, making it difficult to distinguish individual insects. Heavy infestations by these species may severely stunt the growth of young trees. Infestations on young fruit result in the fruit turning yellow and eventually dropping off the tree. Late infestations on larger fruit can result in yellow spots at feeding areas or in fruit distortion (Cilliers and Bedford, 1978).

Control

Field insecticide treatments

The application of oil soap and/or insecticide reduced the number of scale insects and mealybugs in citrus by 93-100% (Baker & Shearin, 1992; Beattie & Ribbon, 1980; Lindquist, 1981); and with the same efficacy (93-100%) for grapevine (Su and Wang, 1988).

Post-harvest insecticide treatments

A 30-second dip in oil (Ampol) during post harvest processing was found to be effective in eliminating live mealybugs, mites and thrips from Citrus (Bailey & Brown, 1999). The efficacy of a post-harvest oil dip to control arthropod pests (e.g. mealybugs, light brown apple moth and mites) was found to be 95-100%, depending on the oil concentration used (Bailey & Brown, 1999; Taverner & Bailey, 1995). When mealybug infestation was less than 6%, a combination of insecticidal soap and insecticide can kill all the mealybug survivors remaining after harvest (Hata et al., 1992).

References:

Annecke, D.P. and Moran, V.C. (1982). Insects and Mites of Cultivated Plants in South Africa. Butterworth and Co. (South Africa) Pty Ltd. 383 pp.

Bailey, P. and Brown, M. (1999). Post-harvest disinfestation of surface arthropods from export navel oranges. SARDI, CSIRO Plant Industry. Horticultural Research & Development Corporation (HRDC) Final Report.

Baker, J.R. and Shearin, E.A. (1992). Fern scale insects. North Carolina Flower Growers Bulletin 37: 1-3.

Beattie, G.A.C. and Ribbon, L.E. (1980). Phytotoxicity and scalicide efficacy of citrus spray oils. Proceeding of the International Society of Citriculture. Griffith. NSW, Australia. pp. 171-174.

CABI (2002). Crop Protection Compendium Global Module. CAB International, Wallingford, UK.

Cilliers, C.J. and Bedford, E.C.G. (1978). Citrus mealybugs. pp. 89-97 In Bedford, E.C.G. (ed.). Citrus Pests in the Republic of South Africa. Science Bulletin No. 391. Department of Agricultural Technical Services, Republic of South Africa. 253 pp.

Hata, T.Y., Hara, A.H., Jang, E.B., Imaino, L.S., Hu, B.K.S. and Tenbrink, V.L. (1992). Pest management before harvest and insecticidal dip after harvest as a systems approach to quarantine security for red ginger. Journal of Economic Entomology 85: 2310-2316.

Lindquist, R.K. (1981). Controlling the citrus mealybug on greenhouse foliage plants. Ohio Florists Association Bulletin. 622: 6-8.

Smith, D., Beattie, G.A.C. and Broadley, R. (eds.). (1997). Citrus Pests and Their Natural Enemies: Integrated Pest Management in Australia. State of Queensland, Department of Primary Industries and Horticultural Research and Development Corporation, Brisbane, Australia. 272 pp.

Su, T.H. and Wang, C.M. (1988). Life history and control measures for the citrus mealybug and the latania scale insects on grapevine. Plant Protection Bulletin 30: 279-288.

Taverner, P. and Bailey, P. (1995). Commercial trial of citrus post-harvest oil for removal of surface pests. South Australian Research & Development Institute Research report series. SARDI South Australia.

Williams, D.J. and Watson, G.W. (1988). The Scale Insects of the Tropical South Pacific Region. Part 2. The Mealybugs (Pseudococcidae). CAB International, Wallingford, UK. 260 pp.

Tetranychus neocaledonicus André, 1933 [Acari: Tetranychidae]

Synonyms and changes in combination: *Eotetranychus neocaledonicus*; *Tetranychus cucurbitae; Tetranychus equatorius*

Common name(s): vegetable spider mite; spider mite

Hosts: *Solanum melongena* (aubergine) is the major host. Other hosts include; *Abelmoschus esculentus* (okra); *Arachis hypogaea* (groundnut); *Cocos nucifera* (coconut); *Cucumis sativus* (cucumber); *Cucurbita*; *Eucalyptus*; *Leucaena*; *Luffa acutangula* (angled luffa); *Luffa aegyptiaca* (loofah); *Manihot esculenta* (cassava); *Morus* (mulberrytree); *Musa* (banana); *Phaseolus vulgaris* (common bean); *Vigna unguiculata* (cowpea) (CABI, 2002). Jeppson *et al*. (1975) reported that this species has also been recorded on *Prunus persica* (peach) and *Carica papaya* (papaya). Amice (1996) reported this pest on citrus.

Plant part affected: leaves, fruit, twigs.

Distribution: Australia (no record in Western Australia); Brazil; China; Congo; Gabon; India; Japan; Madagascar; New Caledonia; Nigeria; Papua New Guinea; Spain (CABI, 2002). In addition, Jeppson *et al*. (1975) reports this species in Bahamas; Fiji; Hawaii, Mauritius; Puerto Rico; South America; southeastern United States and Venezuela.

Biology

Life history: Adult tetranychid/spider mites are usually about 0.5mm in size (Smith *et al*., 1997). Adults of this species are carmine red, whereas protonymph and deutonymph stages are green (Jeppson *et al*., 1975).

The life cycle of this species is very similar to other species of spider mite. The fertilized female overwinters on secondary hosts, and with the onset of warmer weather they start to breed rapidly and move to other hosts (Jeppson *et al*., 1975). Females usually lay eggs on the underside of leaves in webbing. The life cycle can take as little as 10 days in optimal conditions (Jeppson *et al*., 1975). Female mites can lay up to 90 eggs during their lifetime, which lasts an average of about 32 days (Jeppson *et al*., 1975).

Spider mites have the ability to undergo population explosions, but are very sensitive to a wide variety of conditions (Helle and Sabelis, 1985). Tetranychid mites generally produce 10-20 generations per year (Smith *et al*., 1997).

Tetranychid mites have various methods of dispersal to other plant hosts. They may crawl, disperse aerially (carried on air currents by silk threads) or disperse accidently (ie. via farm machinery) (Helle and Sabelis, 1985).

Some adult tetranychid mites and their eggs have the ability to survive temperatures below 0ºC (Helle and Sabelis, 1985).

Damage, in the form of chlorosis, can be caused to the leaves, twigs and fruit of host plants (Martin & Mau, 1991). Leaf drop is also common, as mites suck the plant sap causing wilting, drying and eventually dropping of the leaf (Jeppson *et al*., 1975; Smith *et al*., 1997). Growth, flowering and fruit yield is also adversely affected by mite damage to host plants (Helle and Sabelis, 1985; Jeppson *et al*., 1975).

Economic damage to citrus caused by infestations of tetranychid mites is usually caused by the misuse of broad-spectrum pesticides to control other pests. These pesticides kill the mites natural enemies (Smith *et al*., 1997). Mite control can be achieved by the application of an appropriate miticide when levels of infestation are above 20%, or the release of a biological control (Smith *et al*., 1997).

References:

Amice, R. (1996). Pest list of Tahitian limes. Written communication dated 3rd May, 1996.

CABI (2002). Crop Protection Compendium Global Module. CAB International, Wallingford, UK.

Helle, W. and Sabelis, M.W. (1985). Spider Mites – Their biology, natural enemies and control. Volume 1A. World Crop Pests. Elsevier, Amsterdam. 405 pp.

Jeppson, L.R, Hartford, H.K. and Baker, E.W. (1975). Mites Injurious to Economic Plants. University of California Press, Los Angeles. 614 pp.

Martin, J.L. and Mau, R.F.L. (1991). *Tetranychus neocalidonicus* (Andre). http://www.extento.hawaii.edu/kbase/crop/Type/t_neoca.htm (dec/1991). University of Hawaii.

Smith, D., Beattie, G.A.C. and Broadley, R. (eds.). (1997). Citrus pests and their natural enemies: Integrated Pest Management in Australia. Brisbane: State of Queensland, Department of Primary Industries, and Horticultural Research and Development Corporation, Australia. 272 pp.

Wasmannia auropunctata (Roger, 1863) [Hymenoptera: Formicidae]

Synonyms and changes in combination: *Hercynia panamana* Enzmann, 1947; *Ochetomyrmex auropunctata* Roger, 1963; *Tetramorium auropunctatum* (Roger).

Common name(s): Cocoa tree-ant, little fire ant, small fire ant, tramp ant.

Hosts: Many species including *Citrus* spp. and *Coffea* spp. (coffee).

Plant part affected: Fruit, leaf, trunk, whole plant.

Distribution: Argentina; Bolivia; Brazil; Cameroon; Colombia; Cuba; Dominican Republic; Ecuador (Galapagos Islands); New Caledonia; Solomon Islands (Santa Cruz Islands); Vanuatu; West Africa; United States (Florida).

Biology

Life history: Ants are golden-brown to yellow-brown in colour and 1–2 mm in length. Its head is covered with grooves and it can inflict a painful sting that is annoying to agricultural workers in plantations and gardens. This species of ant is unusual in having no definite nests (Spencer, 1941). The ants' colonies are found in soil, under logs, stones and leaf debris and in the ground either between dead leaves or in rotten wood. In the dry season the ants nest in soil at the base of trees and occasionally in dead wood on trees. The species is highly adaptable as the ants can nest in both open and shaded situations under moist or dry conditions (Nickerson, 1983). Although the ants are unlikely to be cold hardy (Ayre, 1977), they are highly adaptive (Nickerson, 1983) and may survive during cold storage and transportation.

Little fire ant is widely known as a "tramp" ant due to its ability to hitch-hike and establish itself throughout the world. It was originally found in Cuba and has spread widely throughout the warmer regions of the world (Brooks & Nickerson, 2000).

Polygyny (multiple-queen colonies) is common in this species. Multiple-queen colonies have many egg-laying queens (usually 20–60), with 100,000–500,000 workers. Multiple-queen colonies generally do not fight with other multiple-queen colonies. Consequently, mounds are close together and can reach densities of 200–800 mounds per acre. Multiple-queen mounds may also be inconspicuous, often being clusters of small, flattened excavations, in contrast to the distinct dome-shaped mounds of single-queen colonies. Multiple-queen colonies produce fewer winged queens that will start new colonies after a mating flight than single-queen colonies. However, multiple-queen colonies can establish new colonies by budding, where a portion of the queens and workers split off from a colony.

Fire ants are omnivorous, feeding on carbohydrates (e.g. honeydew, plant exudates, sugars and syrups), proteins (e.g. insects, meat) and lipids (e.g. grease, lard, oils from seeds). Adult ants require carbohydrates and/or lipids to sustain themselves throughout the year. Workers of this species are extremely voracious predators of arthropods, including some pest species. In capturing prey, this ant uses its sting and venom and it can quickly subdue most prey insects, even those much larger than itself. The ants forage all over the branches and foliage of nearby trees as well as on the ground. This species also tends honeydew-producing insects such as aphids and scale insects (Nickerson, 1983; Spencer, 1941) and the ants' presence favours increased populations of these pests. The excess honeydew on plants promotes sooty mould growth on leaves, which can affect photosynthesis.

This species is an insect pest that invades coffee and citrus plantations in New Caledonia. The rapid multiplication of the ant has become a hindrance to the culture and harvesting of coffee and citrus fruits in countries where it is present (Castineiras & Noyra, 1993; Fabres & Brown, 1978). This species is considered a pest because of the damage it does to the environment and the danger it poses to human health.

Control

Field insecticide treatments

Excellent control of ants was achieved using various insecticides, with records of 90-97% efficacy (Klotz *et a*l., 1996; Shorey *et al*., 1996).

References:

Ayre, G.L. (1977). Exotic ants in Winnipeg. Manitoba Entomologist 11: 41-44.

Brooks, S. and Nickerson, J.C. (2000). Little fire ant profile. Featured Creatures website. University of Florida - Department of Entomology and Nematology and Florida Department of Agriculture and Consumer Services - Division of Plant Industry. http://creatures.ifas.ufl.edu/urban/ants/little_fire_ant.htm

Castineiras, A. and Noyra, M. (1993). Distribution and damage caused by *Wasmannia auropunctata* (Roger) (Hymenoptera: Formicidae) in three coffee-growing regions of Cuba. Centro Agricola 20: 84-85.

Fabres, G. and Brown, W.L. Jr (1978). The recent introduction of the pest ant *Wasmannia auropunctata* into New Caledonia. Journal of Australian Entomological Society 17(2): 139-142.

Klotz, J.H., Oi, D.H., Vail, K.M. and Williams, D.F. (1996). Laboratory evaluation of a boric acid liquid bait on colonies of *Tpinoma melanocephalum* Argentine ants and Pharaoh ants (Hymenoptera: Formicidae). Journal of Economic Entomology 89: 673-677.

Nickerson, J.C. (1983). The Little Fire Ant, *Ochetomyrmex auropunctata* (Roger) (Hymenoptera: Formicidae). Florida Department of Agriculture and Consumer Services, Division of Plant Industry, Entomology Circular No. 248, 2 pp.

Shorey, H.H., Gaston, L.K., Gerber, R.C., Sisk, C.B. and Phillips, P.A. (1996). Formulating farnesol and other ant-repellant semiochemicals for exclusion of Argentine ants (Hymenoptera: Formicidae) from citrus trees. Environmental Entomology 25: 114-119.

Spencer, H. (1941). The small fire ant *Wasmannia* in citrus groves – A preliminary report. Florida Entomologist 24: 6-14.

FUNGI

Sphaceloma fawcettii Jenkins [Coelomycetes]

Synonyms and changes in combination: *Sphaceloma citri* Jenkins; *Elsinoe fawcettii* Bitancourt and Jenkins, 1925; *Sphaceloma fawcettii* var. *fawcettii* Jenkins [anamorph]; *Sporotrichum citri* Butler (CABI, 2000).

The teleomorphs of the citrus scab pathogens *Sphaceloma fawcettii* and *S. australis* are only known from Brazil. The species are differentiated primarily by host range, tissues attacked and molecular markers (Tan *et al*., 1996; Timmer *et al*., 1996).

Common name(s): Citrus scab, common scab of orange, sour orange scab (CABI, 2000).

Hosts: Members of the family Rutaceae particularly: *Citrus aurantium* (sour orange); *C. hystrix* (papeda lime); *C. jambhiri* (rough lemon); *C. latifolia* (Tahitian limes); *Citrus limon* (lemon); *C. limonia* (lemandarin, Mandarin lime); *C. madurensis* (calamondin); *C.* x *nobilis* (tangor); *C.* x *paradisi* (grapefruit); *C. reticulata* (mandarin); *C. sinensis* (some cultivars of sweet orange); *C. unshiu* (Satsuma orange) and *Poncirus trifoliata* (trifoliate orange) (CABI, 2000; CABI/EPPO, 1997).

Most cultivars of *C. latifolia* (Tahitian limes), *Fortunella margarita* (oval kumquat), *C. sinensis* (sweet orange) and *C. maxima* (pummelo) are more resistant. *C. aurantium* (sour orange) is attacked by only the Florida Broad Host Range pathotype that is also capable of infecting *C. sinensis* (sweet orange) fruit. *C.* x *paradisi* (grapefruit) is affected by the Florida Broad and the Narrow Host Range pathotype but not by Tryon's or the lemon pathotype. All pathotypes affect *C. jambhiri* (rough lemon) and *C. limon* (lemon). Tryon's pathotype attacks certain *C. reticulata* (mandarin) cultivars whereas the lemon pathotype does not (Timmer *et al*., 1996).

Plant part affected: fruit, inflorescence, leaf, root, stem (CABI, 2000; Sivanesan & Critchett, 1974).

Distribution: American Samoa; Argentina; Australia (Tryon's and lemon pathotypes only - New South Wales, Northern Territory, Queensland and Victoria); Bangladesh; Barbados; Belize; Bermuda; Bolivia; Brazil (Bahia, Ceara, Espirito Santo, Minas Gerais, Rio de Janeiro, São Paulo); Brunei Darussalam; Cambodia; Cayman Islands; China (Fujian, Guangdong, Guangxi, Guizhou, Hong Kong (restricted), Hubei, Hunan, Jiangxi, Sichuan, Taiwan (restricted), Yunnan, Zhejiang); Colombia; Cook Islands; Costa Rica; Cuba; Dominica; Dominican Republic; Ecuador; El Salvador; Ethiopia; Fiji; French Guiana; French Polynesia; Gabon; Ghana; Georgia; Grenada;

Guadeloupe; Guam; Guatemala; Guyana; Haiti; Honduras; India (Assam, Karanataka, Madhya Pradesh, Maharashtra, Sikkim, Tamil Nadu, Uttar Pradesh, West Bengal); Indonesia (Irian Jaya, Java, Kalimantan); Jamaica; Japan (Honshu, Ryukyu Archipelago); Kenya; Korea, Democratic People's Republic of; Korea, Republic of; Laos; Madagascar; Malawi; Malaysia (Peninsular Malaysia, Sabah, Sarawak); Maldives; Martinique; Mexico; Micronesia, Federated States of (dubious record); Mozambique; Myanmar; Nepal; New Caledonia; New Zealand; Nicaragua; Nigeria; Pakistan; Panama; Papua New Guinea; Paraguay; Peru; Philippines; Puerto Rico; Saint Lucia; Samoa; Sierra Leone; Solomon Islands; Somalia; South Africa; Spain (Canary Islands); Sri Lanka; Suriname; Tanzania; Thailand; Trinidad and Tobago; Uganda; United States (Alabama, Florida, Georgia, Hawaii, Louisiana, Mississippi, Texas); Uruguay (restricted); Vanuatu; Venezuela; Vietnam; Zaire; Zambia; Zimbabwe (restricted) (CABI, 2000; CABI/EPPO, 1997).

Biology

Life history: This fungus infects young leaves, young twigs, tender shoots and stems of nursery plants, blossom pedicels and fruits in their early stages of development (Whiteside, 1975; Whiteside, 1988b; Sivanesan & Critchett, 1974). Leaves, shoots and fruits are infected when young, i.e. when leaves are up to 15 mm wide and fruits are not more than 20 mm across. Infected tissues form scabby lesions with corky eruptions (CABI, 2000). The pathogen survives from one season to the next in scab pustules on fruit remaining on the tree and other plant organs. Even in resistant cultivars, the fungus can survive on diseased shoots from susceptible rootstocks (Whiteside, 1975; Whiteside, 1988a).

The pathogen reproduces by forming conidia and ascospores in the scabs on leaves, twigs and fruits of infected trees. Conidia are produced copiously in wet scabs in a near saturated atmosphere at temperatures between 20°C and 28°C. Germination of conidia can occur in dew or under high moisture conditions. However, a wet period of 2.5 to 3.5 hours is required for infection by hyaline conidia to occur. Germination occurs at temperatures between 13° and 32°C, while infection will only occur between 14° and 25°C. Incubation period is approximately three to five days with a temperature of 20° to 25°C, relative humidity at 75-80% being optimal for disease development (Gonzalez & Cachon, 1993).

In general, if temperature and humidity are favourable, disease incidence was recorded at 77-80% for *Citrus jambhiri*, 11-20% for *C. sinensis* (Daljeet *et al*., 1997) and 10% in *C. aurantifolia* (Persian lime) (Gonzalez, 1980). Most cultivars of *C. latifolia* were recorded to be moderately tolerant to citrus scab (Smith *et al*., 1997).

Dissemination of the pathogen is mostly by rain (or irrigation water), although insects and, to a certain extent, wind-carried water droplets containing spores, may contribute to the spread of the pathogen. The pathogen can be carried on infected nursery stock, ornamental citrus plants and fruits in international trade.

Sphaceloma fawcettii is widespread in areas where suitable conditions of temperature and rainfall or high humidity prevails (wet subtropics and cooler tropics). Elsewhere, it occurs when new flush and fruit setting coincides with spells of relatively warm, humid weather. The disease does not present a serious problem in areas where the annual rainfall is limited to less than 1,300 mm, long periods of hot weather (mean monthly temperature above 24°C) or a dry summer (Whiteside, 1988b).

Three scab diseases have been described on citrus (Whiteside, 1988a): (i) citrus scab, formerly known as sour orange scab, caused by *S. fawcettii* Jenkins; (ii) Tryon's scab caused by *S. fawcettii* var. *scabiosa*; and (iii) sweet orange scab caused by *S. australis*.

Two pathotypes of *S. fawcettii* have been identified in Australia - one is referred to as Tryons' pathotype (*S. fawcettii* var. *scabiosa*) which infects the differentials rough lemon and Cleo mandarin, while the second pathotype called lemon pathotype infects rough lemon and close relatives (Tan *et al*., 1996; Timmer *et al*., 1996). Whiteside (1975) was able to differentiate two different pathotypes of *S. fawcettii* based on host range. One pathotype was reported to have a broad host range infecting the leaves and fruits of *C. limon* (lemon), *C. jambhiri* (rough lemon), *C.* x *paradisi* (grapefruit), *C. aurantium* (sour orange) and *C. sinensis* (Temple and Murcott tangors, sweet orange). The second pathotype infects all of the above except *C. aurantium* (sour orange) and *C. sinensis* (Temple tangor, sweet orange) fruit. Timmer *et al.* (1996) concluded that four pathotypes of *S. fawcettii* are now recognised based on host range: broad host range, narrow host range, Tryon's (formerly *S. fawcettii* var. *scabiosa*) and lemon.

Although *S. australis* was not readily differentiated from *S. fawcettii* morphologically, it is concluded that they are separate species on the basis of pathogenicity and molecular analysis. Restriction analysis of the amplified internal transcribed spacer (ITS) of ribosomal DNA with several endonucleases and sequence analysis of the ITS readily differentiated *S. australis* from *S. fawcettii* and *S. fawcettii* var. *scabiosa* (Tan *et al*., 1996).

All Australian isolates were separable from exotic isolates by the random amplified polymorphic DNA technique (RAPD) (Tan *et al.,* 1996). RAPD patterns also enabled subdivisions to be made within Australian pathotypes (Tryon's and lemon pathotypes). The RAPD technique will be a useful tool in identifying exotic types of citrus scab on shipments of fruit and help reduce introductions of these types into new areas. Tan *et al*. (1996, 1999) suggested that strict quarantine precautions should be taken to avoid moving the citrus scab fungi into Australia from other countries where citrus scab is known to occur since many, as yet unidentified pathotypes may exist in localised areas. Current AQIS import policy for *Citrus* spp. (from Egypt, New Zealand, Spain and the USA) identifies citrus scab as a regulated pest and prohibits the import of scab infested commodities into the country.

When fully formed, scab lesions are raised and range in colour from buff through pink to olive. Fruit heavily infected may drop shortly after being attacked whereas those remaining on the tree may be scarred and distorted to such a degree that they become unmarketable as flesh fruit. Scab does not invade the flesh and lesions do not provide an entry way for secondary fungi causing fruit rot (Knorr, 1973).

The incidence of scab is a function of interacting factors, which include degree of varietal susceptibility, presence of host tissue in a juvenile stage, inoculum potential, water for spore dispersal and germination, and temperature.

Citrus scab can be controlled using resistance cultivars and by fungicide applications both in the nursery and in the orchard. Systemic fungicides such as benomyl and carbendazim can be applied before flushing and after petal fall (Reddy *et al*., 1983). Benomyl-tolerant strains of the pathogen have been found (Whiteside, 1980).

References:

CABI (2000). Crop Protection Compendium Global Module. CAB International, Wallingford, UK.

CABI/EPPO (1997). *Elsinoe fawcettii* and *Elsinoe australis*. pp. 747-752 in Smith, I.M., McNamara, D.G., Scott, P.R., Holderness, M. and Burger, B. (eds.). Quarantine Pests for Europe (2nd edition). CAB International, Wallingford, UK. 1425 pp.

Daljeet, S., Kapur, S.P., Cheema, S.S. and Singh, D. (1997). Isolation and pathogenicity tests of the causal organism associated with citrus scab in Panjab. Plant Disease Research 12: 180-182.

Gonzalez, E. (1980). Study of the effectiveness of various fungicides against scab in Persian lime. Cultivos Tropicales 2: 129-138.

Gonzalez, E. and Cachon, A.K. (1993). Determination of incubation time of *Sphaceloma fawcettii* Jenkins in three species of Citrus genera. Revista de Proteccion Vegetal 8: 99-100.

Knorr, L.C. (1973). Citrus disease and disorders. An alphabetized compendium with particular reference to Florida. The University Presses of Florida. Gaineville, Florida, USA.

Reddy, M.R.S., Reddy, B.C. and Reddy, G.S. (1983). Control of scab of Rangpur lime (*Citrus limonia* Osb.). Current Research, University of Agricultural Sciences, Bangalore, India 12: 19.

Sivanesan, A. and Critchett, C. (1974). *Elsinoe fawcettii*. CMI Descriptions of Pathogenic Fungi and Bacteria No. 438. Commonwealth Agricultural Bureau, Kew, Surrey, UK. 2 pp.

Smith, I.M., McNamara, D.G., Scott, P.R. and Holderness, M. (1997). *Elsinoe fawcettii* and *E. australis*. In Quarantine Pests for Europe. CAB International. European and Mediterranean Plant Protection Organisation (EPPO).

Tan, M.K., Timmer, L.W., Broadbent, P. and Priest, M. (1999). Causal fungi of citrus scab on three continents. In Conference Handbook 12th Biennial Conference. Asia-Pacific Plant Pathology for the New Millennium, 27–30 September Rydges, Canberra.

Tan, M.K., Timmer, L.W., Broadbent, P., Priest, M. and Cain, P. (1996). Differentiation by molecular analysis of *Elsinoe* spp. causing scab diseases of citrus and its epidemiological implications. Phytopathology 86: 1039-1044.

Timmer, L.W., Priest, M., Broadbent, P. and Tan, M.K. (1996). Morphological and pathological characterization of species of Elsinoe causing scab diseases of citrus. Phytopathology 86: 1032-1038.

Whiteside, J.O. (1975). Biological characteristics of *Elsinoe fawcettii* pertaining to the epidemiology of sour orange scab. Phytopathology 65: 1170-1175.

Whiteside, J.O. (1980). Detection of benomyl-tolerant strains of *Elsinoe fawcettii* in Florida citrus groves and nurseries. Plant Disease 64: 871-872.

Whiteside, J.O. (1988a). Factors contributing to the rare occurrence of scab of sweet orange in Florida. Plant Disease 72: 626-628.

Whiteside, J.O. (1988b). Scab Diseases. pp. 26-27 In Whiteside, J.O., Garnsey, S.M. and Timmer, L.W. (eds). Compendium of Citrus Diseases. The American Phytopathological Society (APS) Press, St Paul, Minnesota, USA. 80 pp.

Meliola citricola H. & P. Sydow, 1917 [Meliolales: Melioaceae]

Synonyms and changes in combination: None known.

Common name(s): black mildew, black mould

Hosts: Members of the family Rutaceae; *Citrus aurantifolia* (West Indian lime, Mexican lime), *Citrus reticulata* (mandarin, tangerine), *Citrus sinensis* (L.) Osbeck (sweet orange), *Citrus paradisi* (grapefruit), *Citrus aurantium* L. (sour orange) (Dingley *et al*., 1981), *Citrus medica*, *Citrus grandis* (Whittle, 1992).

Plant part affected: leaves, fruit (Whittle, 1992; McKenzie, 2003)

Distribution: Southeast Asia (widespread); Western Samoa; Fiji (Dingley *et al*., 1981); New Caledonia (Amice, 1996); Philippines; Indonesia (Java, Sumatra and Borneo/Kalimantan); New Guinea; Sri Lanka (Whittle, 1992).

Biology

Life history: *Meliola citricola* is a parasitic fungus, penetrating leaf cuticles and forming haustoria within individual epidermal cells. No asexual spores are produced. Ascospores germinate on the surface of young leaves and immediately penetrate the cuticle. Symptoms are seen on mature leaves, due to the slow growth rate of fungal colonies (Ecoport, 1999). *Meliola citricola* is not a strong parasite (Whittle, 1992)

The fungus is found on leaves and fruit and appears as dense, black, velvety, circular patches of mycelial growth, up to about 5mm in diameter. With respect to leaves, the fungus is more commonly found on the lower surface (Ecoport, 1999).

This species is quite common in the wet season in Southeast Asia (Beattie, 2003), and is commonly mistaken for sooty mould. However, the symptoms are not considered dependent on honeydew, as is common with the sooty moulds (Whittle, 1992).

Meliolaceae are adapted to long wet seasons and heavy night dew during the dry season, they prefer warm low mountain areas and densely shaded areas (Saenz & Taylor, 1999).

Although little is known about the economic importance of *M. citricola*, it can reduce the cosmetic quality of fruit (Whittle, 1992) and may lead to a reduction in the vigour of the tree by direct loss of photosynthate from the epidermal cells (Ecoport, 1999).

Control

Colonies are essentially superficial, but are still difficult to remove manually (Whittle, 1992). *Meliola citricola* is easily controlled with mineral oil sprays, which have been trialled in Indonesia (Beattie, 2003).

References:

Amice, R. (1996). Pest list of Tahitian limes. Written communication dated 3rd May, 1996.

Beattie, G.A.C. (2003). Centre for Horticulture and Plant Sciences, University of Western Sydney. Personal Communication.

Dingley, J.M., Fullerton, R.A. and McKenzie, E.H.C. (1981). Survey of Agricultural Pests and Diseases. Records of Fungi, Bacteria, Algae, and Angiosperms Pathogenic on Plants in Cook Islands, Fiji, Kiribati, Niue, Tonga, Tuvalu, and Western Samoa. Technical Report Volume 2. South Pacific Bureau for Economic Co-operation, United Nations Development Programme, Food and Agricultural Organization of the United Nations. 485pp.

Ecoport (1999). Ecoport database record on *Meliola citricola*. University of Florida; Food and Agriculture Organisation of the United Nations; National Museum of Natural History, Smithsonian Institute. http://www.ecoport.org/default.htm

McKenzie, E.H.C. (2003). Plant Pathologist. Written communication.

Saenz, G.S. and Taylor, J.W. (1999). Phylogenetic relationships of *Meliola* and *Meliolina* inferred from nuclear small subunit rRNA sequences. Mycol. Res. 103(8): 1049-1056.

Whittle, A.M. (1992). *Meliola citricola* on *Citrus suhuiensis* in Southeast Asia. FAO Plant Protection Bulletin 40: 112-115.