Australian Government

Biosecurity Australia

DRAFT

Draft Extension of Existing Policy for Sweet Oranges from Italy

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This *Draft Extension of Existing Policy for Sweet Oranges from Italy* is produced for consultation and stakeholder comments.

Every effort has been made to ensure that the information provided in this document is true and accurate at the time of publication. A number of factors may affect the accuracy or completeness of this information. These factors include changes in pest and disease status, in scientific information, and in material continuing to be reviewed by Biosecurity Australia or otherwise provided that is relevant to the final import risk assessment.

This draft extension of existing policy for sweet oranges from Italy should not be relied upon for making any business decisions.

TABLE OF CONTENTS

GLOSSARY OF TERMS AND ABBREVIATIONS

Additional declaration	a statement that is required by an importing country to be entered on a Phytosanitary Certificate and which provides specific additional information pertinent to the phytosanitary condition of a consignment
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
Biological control agent	a natural enemy, antagonist or competitor, or other self-replicating biotic entity, used for pest control
Biosecurity Australia	a prescribed Agency within the Australian Government Department of Agriculture, Fisheries and Forestry
Certificate	an official document, which attests to the phytosanitary status of any consignment affected by phytosanitary regulations
Competitor	an organism that competes with pests for essential elements (e.g. food, shelter) in the environment
Consignment	a quantity of plants, plant products and/or other articles being moved from one country to another and covered, when required, by a single phytosanitary certificate (a consignment may be composed of one or more commodities or lots)
Control (of a pest)	suppression, containment or eradication of a pest population
DAFF	Australian Government Department of Agriculture, Fisheries and Forestry
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
Establishment	the perpetuation, for the foreseeable future, of a pest within an area after entry
Fresh	living; not dried, deep-frozen or otherwise conserved
Fruits and vegetables	a commodity class for fresh parts of plants intended for consumption or processing and not for planting
Harmonisation	the establishment, recognition and application by different countries of phytosanitary measures based on common standards
Host range	species of plants capable, under natural conditions, of suiting a specific pest

Import Permit	official document authorising importation of a commodity in accordance with specified phytosanitary requirements
Infestation (of a commodity)	presence in a commodity of a living pest of the plant or plant product concerned. Infestation includes infection
Inspection	official visual inspection of plant, plant products or other regulated articles to determine if pests are present and/or to determine compliance with phytosanitary regulations
Intended use	declared purpose for which plants, plant products, or other regulated articles are imported, produced, or used
Interception (of a pest)	the detection of a pest during inspection or testing of an imported consignment
Introduction	entry of a pest resulting in its establishment
IPPC	International Plant Protection Convention, as deposited with FAO in Rome in 1951 and as subsequently amended
IRA	Import Risk Analysis, an administrative process through which quarantine policy is developed or reviewed, incorporating risk assessment, risk management and risk communication
ISPM	International Standard on Phytosanitary Measures
Lot	a number of units of a single commodity, identifiable by its homogeneity of composition, origin etc., and forming part of a consignment
MPAF	Ministero della Politiche Agricole e Forestali (Italian Ministry of Agricultural and Forestry Policies)
National Plant Protection Organisation	official service established by a government to discharge the functions specified by the IPPC (DAFF is Australia's NPPO)
Official	established, authorised or performed by a National Plant Protection Organisation
Official control	the active enforcement of mandatory phytosanitary regulations and the application of mandatory phytosanitary procedures with the objective of eradication or containment of quarantine pests or for the management of regulated non-quarantine pests
Pathway	any means that allows the entry, or spread of a pest
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-free place of production	place of production in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained for a defined period
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
Pest risk analysis area	area in relation to which a pest risk analysis is conducted
Pest risk assessment (for quarantine pests)	evaluation of the probability of the introduction and spread of a pest and of the associated potential economic consequences
Pest risk management (for quarantine pests)	evaluation and selection of options to reduce the risk of introduction and spread of a pest
Phytosanitary Certificate	Certificate patterned after the model certificates of the IPPC
Phytosanitary measure	any legislation, regulation or official procedure having the purpose to prevent the introduction and/or spread of quarantine pests
Polyphagous	feeding on a relatively large number of host plants from different plant families
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 article	any plant, plant product, storage place, packing, conveyance, container, soil and any other organism, object or material capable of harbouring or spreading pests, deemed to require phytosanitary measures, particularly where international transportation is involved
Restricted risk	‘Restricted’ risk estimates are those derived when risk management measures are used
Spread	expansion of the geographical distribution of a pest within an area
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, including the proponent/applicant for a specific proposal
Unrestricted risk	‘Unrestricted’ risk estimates are those derived in the absence of risk management measures
WTO	World Trade Organization

EXECUTIVE SUMMARY

This draft extension of existing policy proposes that sweet oranges from Italy be allowed entry into Australia subject to phytosanitary measures for Mediterranean fruit fly, citrophilus mealybug, citrus pyralid and citrus flower moth. These pests will require the use of risk management measures in addition to Italy's standard commercial production practices. The proposed risk management measures aim to provide a high level of sanitary and phytosanitary protection that will reduce risk to a level below Australia's appropriate level of protection (ALOP).

The risk assessment identified four pests as requiring risk management measures to reduce the risk to an acceptable level. A combination of risk management measures and operational systems is proposed to reduce the risk associated with the importation of sweet oranges from Italy to a level below Australia's ALOP, specifically:

- cold disinfestation, or area freedom for Mediterranean fruit fly;
- inspection and remedial action for citrophilus mealybug, citrus pyralid and citrus flower moth; and
- supporting operational systems to maintain and verify phytosanitary status.

Australia initiated an import risk analysis for the importation of citrus from Italy in November 1998, following a request for market access from the Italian Ministero della Politiche Agricole e Forestali (Ministry of Agricultural and Forestry Policies) (MPAF) in March 1998. In September 2003, MPAF advised that Italy's market access request was specifically for blood oranges originating from the regions of Sicily and Calabria. Blood oranges are cultivars of sweet orange (*Citrus sinensis* (L.) Osbeck).

An assessment by Biosecurity Australia of the pests potentially associated with sweet oranges from Italy indicated that the pests do not pose significantly different quarantine risks, or require significantly different management measures, than those for which policy exists, namely for the pests associated with citrus from Egypt, Israel and Spain. In view of this, Biosecurity Australia determined that the market access request from Italy could be progressed as an extension of existing policy. Accordingly, Biosecurity Australia advised stakeholders on 5 March 2004 (Plant Biosecurity Policy Memorandum 2004/05) that the access request would be considered as an extension of existing policy.

Although the proposed policy extension was initially for blood oranges from Sicily and Calabria, the technical information supplied by MPAF was sufficiently comprehensive to enable import conditions to be developed for sweet oranges from Italy.

In the pest risk analysis for sweet oranges from Italy into Australia, Biosecurity Australia identified 288 pests (222 arthropods, 3 gastropods and 63 pathogens) as being possibly associated with citrus production in Italy. Of the 288 pests associated with citrus production in Italy, 52 pests (44 arthropods and 8 pathogens) were considered to be associated with the sweet orange fruit pathway. Of the 52 pests associated with the pathway, 14 arthropods and one pathogen were found to either not be in Australia or if in Australia to be under official control, and to have the potential for entry, establishment or spread within Australia as well as associated potential economic consequences. On this basis, 15 pests were categorised as quarantine pests.

Detailed risk assessments were conducted for these quarantine pests to determine an unrestricted risk estimate for each organism. For each pest with an unrestricted risk above

Australia’s ALOP, risk management measures were considered. This report presents details of proposed risk management measures, operational procedures and draft import conditions, together with their objectives.

Biosecurity Australia invites comments on the technical and economic feasibility of the proposed risk management measures. In particular, comments are sought on their appropriateness and any other measures that stakeholders consider would provide equivalent risk management.

1 INTRODUCTION

Biosecurity Australia is a prescribed Agency within the Australian Government Department of Agriculture, Fisheries and Forestry (DAFF) responsible for developing international quarantine policy for imports and for liaising with overseas National Plant Protection Organisations (NPPOs) to determine their requirements for exports of Australian plants and plant products.

In September 2003, the Ministero della Politiche Agricole e Forestali (Ministry of Agricultural and Forestry Policies) (MPAF) advised that Italy's market access request for citrus was limited to sweet oranges (*Citrus sinensis*).

Quarantine policy currently exists for the import of citrus into Australia from Egypt, Israel, New Zealand, Spain and the USA (Arizona, California, Texas). An assessment by Biosecurity Australia of the pests potentially associated with sweet oranges from Italy indicated that the pests do not pose significantly different quarantine risks, or require significantly different management measures, than those for which policy exists, namely the pests associated with citrus from Egypt, Israel and Spain.

In view of the similarity in climatic conditions and the quarantine risk associated with citrus in the Mediterranean region, Biosecurity Australia determined that the market access request for sweet oranges from Italy could be progressed as an extension of existing policy. Accordingly, Biosecurity Australia advised stakeholders that the access request would be considered as an extension of existing policy in Plant Biosecurity Policy Memorandum 2004/05 on 5 March 2004.

In the pest risk analysis (PRA) process for sweet oranges from Italy into Australia, Biosecurity Australia first categorised the pests associated with sweet oranges from Italy to identify the quarantine pests for Australia. The likelihood of entry, establishment or spread and associated potential consequences were then assessed to arrive at an unrestricted risk estimate for each quarantine pest.

Risk management measures in addition to the standard commercial practices were then identified for each quarantine pest that was above the appropriate level of protection (ALOP) for Australia and used to develop proposed import conditions.

This document includes the following sections:

- method for risk analysis;
- background to this review;
- a description of the scope of this review;
- an outline of current quarantine policy for the importation of fresh citrus fruit from Egypt, Israel, and Spain;
- results of pest categorisation and risk assessment;
- proposed risk management measures; and
- draft import conditions.

2 METHOD FOR PEST RISK ANALYSIS

An outline of the methodology used for pest risk analysis (PRA) is given to provide the context for the technical information that is provided later in this document. In accordance with the International Standards for Phytosanitary Measures Publication Number 11 *Pest Risk Analysis for Quarantine Pests including Analysis of Environmental Risks and Living Modified Organisms* (ISPM 11), this pest risk analysis comprises three discrete stages:

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

Stage 1: Initiation of the PRA

The aim of the *initiation* stage is to identify the pest(s) and pathway(s) (e.g. commodity imports) that are of quarantine concern and should be considered for risk analysis in relation to the identified PRA area.

Stage 2: Pest Risk Assessment

The pest risk assessment is carried out in accordance with International Plant Protection Convention (IPPC) standards and reported in the following steps:

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

Pest categorisation

Pest categorisation is a process to examine, for each pest, whether the criteria for a quarantine pest are satisfied. The process of pest categorisation is summarised by the IPPC in the five elements outlined below:

- identity of the pest;
- presence or absence in the endangered area;
- regulatory status;
- potential for entry, establishment or spread in the PRA area; and
- potential for economic consequences in the endangered area.

The pests are categorised according to their presence or absence, their association with commodity pathway, their potential to establish or spread, and their potential for economic consequences. Categorisation for potential of establishment or spread and potential for economic consequences was expressed using the terms ‘feasible’ / ‘not feasible’, and ‘significant’ / ‘not significant’, respectively.

Pests found to have potential for entry, establishment or spread and potential for consequences satisfy the criteria for a quarantine pest. A quarantine pest is defined as "*A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled*" (FAO, 2002). The methodology used for the detailed risk assessments conducted on the quarantine pests is given below.

Assessment of the probability of entry, establishment or spread

Details of assessing the 'probability of entry', 'probability of establishment' and 'probability of spread' of a pest are given in ISPM 11.

Assessing the probability of entry requires an analysis of each of the pathways with which a pest may be associated, from its origin to distribution in the PRA area. The probability of entry may be divided for administrative purposes into the following components:

> *The probability of importation*: the probability that a pest will arrive in Australia when a given commodity is imported; and
>
> *The probability of distribution*: the probability that the pest will be distributed (as a result of the processing, sale or disposal of the commodity) to the endangered area, and subsequently be transferred to a suitable site on a susceptible host.

In breaking down the probability of entry into these two components, Biosecurity Australia has not altered the original meaning. The two components have been identified and separated to enable onshore and offshore pathways to be described individually.

The probability of establishment is estimated on the basis of 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; and cultural practices and control measures. Similarly, the probability of spread is estimated on the basis of 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; and potential natural enemies of the pest in the PRA area.

Qualitative likelihoods are assigned to the probability of entry (comprising an importation step and a distribution step), the probability of establishment and the probability of spread. Likelihoods are categorised according to a descriptive scale from 'high' to 'negligible' as shown in Table 1.

Table 1: 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

The likelihoods of entry, of establishment and of spread are combined using the tabular matrix shown in Table 2.

Table 2: 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

Assessment of consequences

The basic requirements for the assessment of consequences are described in the SPS Agreement, in particular Article 5.3 and Annex A. Further detail on assessing consequences is given in the "potential economic consequences" section of ISPM 11. This ISPM separates the consequences into "direct" and "indirect" and provides examples of factors to consider within each. In this PRA, 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.

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*' is not usually distinguishable from normal day-to-day variation in the criterion;
- '*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.
- '*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; and
- '*highly significant*' 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 are translated into a qualitative score (A–F) using the schema outlined in Table 3.

Table 3: The assessment of local, district, regional and national consequences

Impact 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'.

Method for determining the unrestricted risk estimate

The unrestricted risk estimate for each pest is determined by combining the likelihood estimates of entry, of establishment and of spread with the overall potential consequences. This is done using the risk estimation matrix shown in Table 4. The cells of this matrix describe the product of likelihood of entry, establishment or spread and consequences of entry, establishment or spread.

Table 4: Risk estimation matrix

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

Consequences of entry, establishment or spread

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. The band of cells in Table 4 marked 'very low risk' represents Australia's ALOP.

Stage 3: Pest Risk Management

Risk management describes the process of identifying and implementing measures to manage risks so as to achieve Australia's ALOP, while ensuring that any negative effects on trade are minimised.

To implement risk management appropriately, it is necessary to formalise the difference between 'unrestricted' and 'restricted' risk estimates. Unrestricted risk estimates are those derived in the absence of specific risk management measures, or following only baseline risk management procedures based on commercial production practices. By contrast, restricted or mitigated risk estimates are those derived when 'risk management' is applied.

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. Where the unrestricted risk estimate exceeds Australia's ALOP, risk management measures are required to reduce this risk to a very low level. 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.

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 the 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.

Risk management measures are identified for each quarantine pest that is above the ALOP as required and are presented in the “Pest Risk Management” section of this document. The pests that are above the ALOP require the use of risk management measures in addition to the standard commercial practices. The proposed phytosanitary regulations based on these measures are presented in the “Draft Import Conditions” section of this document.

3 PROPOSAL TO IMPORT SWEET ORANGES FROM ITALY

3.1 Background

A market access request for citrus (sweet orange, lemon, mandarin and clementine) from Italy to Australia was received in March 1998. Background information on citrus production and a pest list for *Citrus* species for Italy was provided by MPAF.

Stakeholders were advised in November 1998 that an IRA was to commence for citrus fruit from Italy. Stakeholders were advised in May 1999 that the routine IRA process would be used.

In a letter dated 2 September 2003, MPAF advised that Italy's market access request was specifically for blood oranges originating from the regions of Sicily and Calabria. Blood oranges are cultivars of sweet orange (*Citrus sinensis* (L.) Osbeck).

PBPM 2004/05 advised stakeholders on 5 March 2004 that the Italian Citrus IRA would cease and Italy's market access request would be progressed as an extension of existing policy based on current citrus quarantine policy for Egypt, Israel and Spain.

On the basis of the information provided by MPAF, the PRA was conducted forsweet oranges (*Citrus sinensis*) for all of Italy.

3.2 Administration

3.2.1 Scope

In the PRA section of this extension of existing policy, Biosecurity Australia has considered the quarantine risks associated with the importation of fresh fruit of sweet orange (*Citrus sinensis*) from Italy.

The PRA forms the basis for development of import policy with respect to the entry of sweet orange fruit into Australia from Italy that has been cultivated, harvested, packed and transported to Australia under commercial conditions.

The policy developed in this PRA for sweet oranges is applicable to any cultivar of sweet orange from Italy.

3.3 Australia's Current Quarantine Policy for Imports of Fresh Citrus Fruit

Fresh citrus fruit may be imported into Australia from Egypt, Israel, New Zealand, Spain and the USA (Arizona, California, Texas) subject to specific import conditions.

Citrus of the following types can be imported from Egypt, Israel and Spain:

Egypt Lime, sweet orange and Tahitian lime;

Israel Etrog, grapefruit, mandarin or tangerine, sweet orange, pomelo and tangelo; and

Spain Calamondin, cumquat, grapefruit, kaffir lime, lemon, lime, mandarin or tangerine, sour orange, sweet orange, pomelo, Rangpur lime, Tahitian lime, tangelo and tangor.

The following import conditions apply to fruit imports from Egypt, Israel and Spain:

- Requirement for an Australian Quarantine Inspection Service (AQIS) import permit;
- Issuing of a phytosanitary certificate from the National Plant Protection Organization following satisfactory phytosanitary inspection;
- Specific requirements for packaging and labelling of produce;
- Pre-shipment or in transit cold treatment for *Ceratitis capitata*;
- Freedom from soil and other debris; and
- Inspection on-arrival by AQIS.

In addition, the following conditions apply:

- A post harvest wash to control *Alternaria* brown spot (Egypt);
- Production area freedom for Mal secco (Israel).

Further advice on the import requirements for citrus fruit is available in the AQIS Import Conditions database (ICON) website (http://www.aqis.gov.au/icon/).

3.4 Citrus Production in Italy

Citrus production in Italy, although widely distributed geographically, is located primarily in the southern regions of Sicily and Calabria. Sicily produces 61% of national production, followed by Calabria with 28%. The remaining regions produce 11%. The orange is the most cultivated citrus fruit in Italy, with 108,000 hectares under production. Blood oranges make up about 60% of orange production. When blood oranges are grown in Mediterranean type climates with hot days and cool nights, the fruit develops a deep red flesh colour from the development of anthocyanins.

Italy is proposing to export the following blood orange cultivars to Australia:

Tarocco has round, medium to large, seedless fruit that have an ideal balance between sweetness and acidity, a distinctive aroma and mature from mid-December to April; and

Moro has round to oval, medium, seedless fruit with a characteristic blood orange flavour that mature from mid-December to January.

4 PEST RISK ANALYSIS

The methodology for this PRA for sweet oranges from Italy is set out in Section 2 - Method for Pest Risk Analysis.

4.1 Stage 1: Initiation of the PRA

Initiation of this PRA followed advice from MPAF in September 2003 that Italy's market access request was specifically for blood oranges originating from the regions of Sicily and Calabria.

A list of pests likely to be associated with sweet oranges from Italy (i.e. the biosecurity risk pathway) was generated from information supplied by MPAF and literature and database searches. This list was used in this PRA.

In this PRA, the "PRA area" is defined as Australia for the pests that do not occur in Australia or Western Australia for the pests that occur in Australia but for which Western Australia has regional freedom. The 'endangered area' is defined as any area within Australia, where susceptible hosts are present and in which ecological factors favour the establishment of a pest that might be introduced in association with sweet oranges from Italy. The pathway in this PRA is considered to be sweet oranges for consumption from export orchards in Italy.

4.2 Stage 2: Pest Risk Assessment

4.2.1 Pest categorisation

The quarantine pests for sweet oranges from Italy have been determined through a comparison of the pests recorded on *Citrus* species in Italy and Australia (present or absent, present but with restricted/limited distribution and under official control [Appendix 1a], presence on the pathway under consideration [Appendix 1b], and potential for establishment or spread and associated consequences [Appendix 1c]). Pests that do not meet the definition of a quarantine pest are not considered further in the PRA.

Of the 288 pests recorded on *Citrus* species in Italy that have the potential to occur on sweet oranges, many occur in Australia or are not present on the import pathway and were therefore not considered further in this PRA. A number of pests are present in Australia but absent from Western Australia (based on advice provided to Biosecurity Australia by the Department of Agriculture Western Australia) and these pests are considered further in this PRA. A summary of this analysis is given in Table 5.

Table 5: Summary of potential pests of sweet oranges in Italy and their status in Australia

Pest type	Potentially associated with sweet orange in Italy	Australian status		Associated with pathway
		Present*	Absent	
Arthropods	222	88 (18)	134	44
Gastropods	3	3		0
Bacteria	4	4	0	0
Fungi	43	36 (4)	7	8
Nematodes	9	9 (1)	0	0
Viruses/Virus like organisms	7	5 (5)	2	0
Total	**288**	**145 (28)**	**143**	**52**

* The number in brackets refers to species that are retained for further consideration due to having restricted/limited distribution in Australia and being under official control.

The 52 pests shown in Table 5 with the potential for being on the pathway were categorised according to their potential for establishment or spread and associated consequences in Australia. Table 6 presents a summary of this assessment.

Table 6: Summary of potential for establishment or spread and associated consequences for pests of sweet oranges in Italy

Pest type	Number of species with potential for being on the pathway (from Table 5)	Potential for establishment or spread	Potential for consequences
Arthropods	44	44	14
Fungi	8	7	1
Total	**52**	**51**	**15**

The 15 quarantine pests for sweet oranges from Italy, determined through this process of pest categorisation, are listed in Table 7. These pests require detailed risk assessment since they meet the IPPC criteria for a quarantine pest, specifically:

- the pest is known to be associated with sweet oranges in Italy;
- the pest is absent from Australia, or has a limited distribution and is under official control;
- the pest has the potential for being on the pathway;
- the pest has the potential for establishment or spread in the PRA area; and
- the pest has the potential for consequences.

Table 7: Quarantine pests for sweet oranges from Italy

Pest Type	**Common name**
ARTHROPODS	
Acari (mites)	
Aculops pelekassi (Keifer) [Acari: Eriophyidae]	Pink citrus rust mite
Brevipalpus cuneatus Canestrini & Fanzago [Acari: Tenuipalpidae]	False spider mite
Panonychus citri McGregor [Acari: Tetranychidae]	Citrus red mite*
Diptera (flies)	
Ceratitis capitata (Wiedemann) [Diptera: Tephritidae]	Mediterranean fruit fly; Medfly
Hemiptera (aphids, leafhoppers, mealybugs, psyllids, scales, true bugs, whiteflies)	
Aleurothrixus floccosus (Maskell) [Hemiptera: Aleyrodidae]	Woolly whitefly
Chrysomphalus dictyospermi (Morgan) [Hemiptera: Diaspididae]	Palm scale*
Lepidosaphes gloverii (Packard) [Hemiptera: Diaspididae]	Glover's scale*
Parabemisia myricae (Kuwana) [Hemiptera: Aleyrodidae]	Bayberry whitefly
Parlatoria pergandii Comstock [Hemiptera: Diaspididae]	Chaff scale*
Parlatoria ziziphi (Lucas) [Hemiptera: Diaspididae]	Black parlatoria scale
Pseudococcus calceolariae (Maskell) [Hemiptera: Pseudococcidae]	Citrophilus mealybug*
Unaspis yanonensis (Kuwana) [Hemiptera: Diaspididae]	Arrowhead scale
Lepidoptera (moths, butterflies)	
Cryptoblabes gnidiella (Millière) [Lepidoptera: Pyralidae]	Citrus pyralid
Prays citri Millière [Lepidoptera: Yponomeutidae]	Citrus flower moth
PATHOGENS	
Fungi	
Phoma tracheiphila (Petri) Cif	Mal secco

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

4.2.2 Risk assessments for quarantine pests

A detailed risk assessment is presented in this PRA for each of the quarantine pests identified through the process of pest categorisation. Each risk assessment involved the "assessment of the probability of entry, establishment or spread" and "assessment of consequences" as described in Section 2 – Method for Pest Risk Analysis. The unrestricted risk posed by each quarantine pest for sweet oranges from Italy was estimated by combining the likelihood for entry, of establishment and of spread with the estimate of associated potential consequences. The unrestricted risk estimates were then compared with Australia's appropriate level of protection (ALOP) to determine which quarantine pests presented an unacceptable level of risk requiring the further consideration of risk mitigation options.

Likelihood estimates for entry, establishment or spread and estimates of associated potential consequences are supported by relevant biological information. Because of similarities in pest biology, and consequent similarities between the risk assessments for some of the pests, the descriptions below are based, where relevant, on groupings of the pests. Detailed information on the biology and economic importance of each quarantine pest or pest group is provided in the data sheets in Appendix – 2.

The risk assessments were conducted on the basis of the use of standard cultivation, harvesting and packing activities in the commercial production of sweet oranges (e.g. in-field hygiene and management of pests, cleaning and hygiene during packing, and commercial quality control activities).

4.2.2.1 Pink citrus rust mite

Eriophyid mites are the smallest phytophagous mites ranging in size from 0.15 to 0.3 mm. Most of them are host specific, and cause gall formation, russeting, and leaf or shoot defoliation of host plants (Ashihara *et al*., 2004). Eriophyids are almost invisible to the naked eye and are exclusively plant feeders (Razak *et al*., 2000). Eriophyid mites are important pests of citrus fruit grown for the fresh market. Mites inhabiting citrus generally move within the tree from mature, ageing plant parts to newly formed leaves and stems, and subsequently to mature fruit.

The eriophyid mite examined in this extension of existing policy is:

- *Aculops pelekassi* (Keifer) [Acari: Eriophyidae] – Pink citrus rust mite (PCRM)

Introduction and spread probability

Probability of importation

The likelihood that PCRM will arrive in the PRA area with the importation of sweet oranges from Italy: **High**.

- PCRM is present in citrus orchards in Italy (AAN, 1998).
- Since citrus is a perennial plant that flushes continuously in subtropical and tropical regions of the world, eriophyid mites inhabiting citrus generally move within the tree

from mature, aging plant parts to newly formed leaves and stems and subsequently to mature fruit (Seki, 1981).

- Eggs are laid on the surface of leaves, fruit and green twigs (Childers, *et al.*, 2004).
- The small size of these mites makes them difficult to detect (Ashihara *et al*., 2004). PCRM disperse from the leaves to the fruit (Ashihara *et al*., 2004).
- The presence of fruit with typical symptoms of mite infestation (Burditt & Reed, 1963) increases the likelihood of down grading of fruit during packinghouse procedures.
- PCRM can survive packinghouse procedures. For example, AQIS inspectors have intercepted eriophyid mites on citrus fruit from California into Australia.
- Standard post-harvest practices for export of sweet oranges will minimise the occurrence of PCRM on the fruit. However, mites may occur in the calyx where they may not be detected during pre-export inspection.

Probability of distribution

The likelihood that PCRM will be distributed to the endangered area, as a result of the processing, sale or disposal of sweet oranges from Italy: **Very low**.

- Adults or nymphs may remain on the surface of the fruit during distribution via wholesale or retail trade.
- The commodity may be distributed throughout the PRA area for retail sale, as the intended use of the commodity is human consumption. Waste material would be generated.
- Individual eriophyid mites rely on wind currents and animals for dispersal (Mijuskovic, 1973). These dispersal mechanisms would not be very effective in enabling mites to transfer from discarded fruit to suitable host species.
- Transfer of PCRM from the fruit pathway to a suitable host is a significant limiting factor in the distribution of this pest. However, unassisted movement of the immature and mature stages does occur within a host plant.

Probability of entry (importation x distribution)

The likelihood that PCRM will enter the PRA area as a result of trade in sweet orange fruit from Italy and be distributed in a viable state to the endangered area: **Very low**.

- 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 2).

Probability of establishment

The likelihood that PCRM 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**.

- PCRM is restricted to *Citrus* spp. (Childers *et al*., 2004) and citrus species are widespread in the PRA area.
- PCRM is found in Italy (Benfatto, 1980), Japan (Matsumoto *et* al., 1983), Taiwan (Huang & Wang, 1997), United States (Childers *et al*., 2004), Yugoslavia (Mijuskovic & Kosac, 1972), Thailand and Brazil (Ashihara *et al*., 2004). There are similar environments in the PRA area that would be suitable for its establishment.

- PCRM overwinter within the scales of citrus tree buds and lay eggs on the sprouting buds (Ashihara *et al*., 2004). The mite begins to disperse from the leaves to fruit. Population densities on fruit decrease later in the season and the adults move to their overwintering site (Ashihara *et al*., 2004).
- PCRM has a relatively short generation time and a high reproductive rate (Mijuskovic & Kosac, 1972). The life cycle of PCRM can be completed within 5–7 days during summer (Childers *et al*., 2004). Females are capable of laying up to 30 eggs (Mijuskovic & Kosac, 1972).
- PCRM is adapted to a wide range of environments (i.e. temperate, tropical and sub tropical). Similar environments (e.g. temperature, rainfall) occur both in Italy and Australia.
- Existing control programs (IPM, application of miticide or petroleum spray oil) may control PCRM.

Probability of spread

The likelihood that PCRM 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 commercial crop hosts of PCRM are located in many parts of Australia. Natural barriers such as arid areas, climatic differentials and long distances exist between these areas. The long distances between the main Australian commercial crops would make unaided dispersal difficult.
- Movement of the commodity would help the dispersal of PCRM because eggs and mites can be on the fruit. Adults and immature forms may spread undetected via the movement of fruit or infested vegetative host material (Childers *et al*., 2004).
- Individual eriophyid mites rely on wind currents, animals and orchard workers for dispersal (Mijuskovic, 1973).
- Natural predators may be able to attack PCRM but there is no evidence that they would have an effect on its spread.

Probability of entry, establishment or spread

The overall likelihood that PCRM will enter the PRA area as a result of trade in sweet oranges from Italy, be distributed in a viable state to suitable hosts, establish in that area and subsequently spread within the PRA area: **Very low**.

- The probability of entry, establishment or spread is determined by combining the probabilities of entry, of establishment and of spread using the matrix of ‘rules’ for combining descriptive likelihoods (Table 2).

Consequences

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

Criterion	Estimate
Direct consequences	
Plant life or health	**C** — PCRM is capable of causing direct harm to its hosts. PCRM cause cosmetic damage to citrus fruit (Tono *et al*., 1978; Mijuskovic & Velimirovic, 1971) and fruit destined for fresh market would be down graded during packinghouse procedures. PCRM causes russeting of leaves and mild to severe

Criterion	Estimate
	distortion of new growth, chlorosis and leaf drop (Burditt & Reed, 1963).
Any other aspects of the environment	**A** — There are no known direct consequences of PCRM on the natural or urban environment but their introduction into a new environment may lead to competition for resources with native species.
Indirect consequences	
Eradication, control etc.	**C** — Additional programs to minimise the impact of PCRM on host plants may be necessary. Existing control programs may be effective for some hosts but not all hosts.
Domestic trade	**C**— The presence of PCRM in commercial production areas may have a significant effect at the local level due to any resulting interstate trade restrictions on citrus fruit. These restrictions could lead to a loss of markets, which in turn would be likely to require industry adjustment.
International trade	**C**— The presence of PCRM in commercial production areas on a range of commodities could 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 PCRM 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 3 (The assessment of local, district, regional and national consequences) and text under the 'Method for assessing consequences' section for details on the method used for consequence assessment).

Unrestricted risk estimate

The unrestricted risk estimate for PCRM, determined by combining the overall 'probability of entry, of establishment and of spread' with the 'consequences' using the risk estimation matrix (Table 4): **Negligible**.

4.2.2.2 Citrus red mite

Spider mites primarily feed on mature leaves and cause visible white stippling, mesophyll collapse and leaf drop. These mites often occur at low levels in their natural environment. They are most common on the upper leaf surface of recently mature flush, and all stages of the mites orient themselves along the mid-vein. As populations increase, they move to leaf margins and fruit (Childers *et al*., 2004). Spider mites feed primarily on mature leaves and differ from rust mites by feeding beneath the epidermal layer of cells. They are capable of removing cellular contents, causing cell destruction and reducing photosynthesis.

The spider mite examined in this extension of existing policy is:

- **Panonychus citri* Koch [Acari: Tetranychidae] – Citrus red mite.

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

Introduction and spread probability

Probability of importation

The likelihood that citrus red mite (CRM) will arrive in Western Australia with the importation of sweet oranges from Italy: **High**.

- CRM is reported on citrus in Italy (AAN, 1998).
- CRM attacks all species of citrus, but prefers sweet oranges. Various varieties of lemon, clementines and hybrids are affected equally (Izquierdo *et al*., 2002).

- If populations are low, CRM is mainly found in the upper parts of trees, where there is strong sunlight. When populations are high, CRM can be found over the entire tree, on leaves, fruits and twigs (Izquierdo *et al*., 2002).
- CRM feeds on fruit, foliage and young branches. It is found on both surfaces of leaves but is considered to feed primarily on the upper surfaces (Jones & Parrella, 1984).
- CRM lays eggs most commonly on the leaves and on green succulent twigs. Egg laying on leaves generally occurs on the upper side, along the midrib and frequently on the petiole (Childers & Fasulo, 1995).
- Feeding by nymphs and adults produces tiny grey or silvery spots on leaves and fruit (Davidson & Lyon, 1987).
- The presence of fruit with typical symptoms of mite infestation increases the likelihood of detection of infested fruit during pre-export inspection. However, mites may occur in the calyx where they may not be detected during pre-export inspection.
- Spider mites are known to be associated with citrus fruit. AQIS inspectors have intercepted Tetranychid mites on citrus imported into Australia from various countries.

Probability of distribution

The likelihood that CRM will be distributed to the endangered area as a result of the processing, sale or disposal of sweet oranges from Italy: **Very low**.

- Adults or nymphs may remain on the surface of the fruit during distribution via wholesale or retail trade.
- The commodity may be distributed throughout Western Australia for retail sale, as the intended use of the commodity is human consumption. Waste material would be generated.
- The adults of CRM 'balloon' in order to disperse when densities are high by crawling to a high point, rearing up on their hind legs and catching a wind current to balloon on a silken thread (Lawson *et al*., 1996). The reliance on this dispersal mechanism, as opposed to independent movement, limits the ability of the CRM to move onto a suitable host from discarded fruit.

Probability of entry (importation x distribution)

The likelihood that CRM will enter Western Australia as a result of trade in sweet oranges from Italy and be distributed in a viable state to the endangered area: **Very low**.

- 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 2).

Probability of establishment

The likelihood that CRM 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.**

- CRM has a wide host range including citrus, apple, pear, peach, plum, carambola, papaya, loquat and grapevines (Bolland *et al*., 1998). Hosts of CRM are widespread in Western Australia.
- CRM is already established in Sydney and Gosford in New South Wales (Smith *et al*., 1997a). Similar environments occur in Western Australia that would be suitable for establishment of this mite.

- Adult females lay 17 to 37 eggs on foliage or fruit that hatch into the larval stage after one week. Development time from egg to adult varies with temperature and humidity, with a mean development time of 10 days at 26^{0}C and 70% relative humidity (Jeppson *et al.*, 1975).
- CRM reproduces sexually. However, it is not necessary for females to find a male, as unfertilised females will produce only male offspring that then mate and go on to start a colony.
- CRM has a short generation time. Depending on the region, 16 generations may occur within one year, with the majority of these (10-11) occurring in spring/summer (Jeppson *et al.*, 1975).
- Existing control programs (IPM, application of petroleum spray oil) may control CRM.

Probability of spread

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

- CRM has a restricted distribution in Australia and there are similar environments in Western Australia that would be suitable for its spread.
- The commercial fruit crop hosts of CRM are grown in the southwestern part of Western Australia and there are natural barriers present between some districts. It would be difficult for the mites to disperse from one district to another by natural spread.
- CRM is more likely to disperse in association with host material. Interstate quarantine controls are in-place on the movement of nursery stock. However, these controls would have no effect on the spread of CRM on nursery stock within Western Australia.
- Spider mites do not have wings, and are therefore limited in their ability to disperse. Mites travel short distances by crawling, but depend on wind for long distance dispersal (Jeppson *et al.*, 1975).
- Dispersal of these mites within and between orchards, if in close proximity, is typical of Tetranychidae in that the species utilises strands of webbing to ‘balloon’ with prevailing wind (Lawson *et al.*, 1996). Adults may disperse accidentally i.e. via farm machinery (Helle & Sabelis, 1985).
- The relevance of natural enemies of CRM in Western Australia is not known.

Probability of entry, establishment or spread

The overall likelihood that CRM will enter Western Australia as a result of trade in sweet oranges from Italy, be distributed in a viable state to suitable hosts, establish in that area and subsequently spread within the PRA area: **Very low**.

- The probability of entry, establishment or spread is determined by combining the probabilities of entry, of establishment and of spread using the matrix of ‘rules’ for combining descriptive likelihoods (Table 2).

Consequences

Consequences (direct and indirect) of CRM: **Low**

Criterion	Estimate
Direct consequences	
Plant life or health	C— CRM is capable of causing direct harm to a wide range of hosts. This

Criterion	Estimate
	includes damage in the form of chlorosis and premature leaf drop (Hall & Simms, 2003). Spider mites feed primarily on mature leaves, removing cellular contents, causing cell destruction and reducing photosynthesis (Childers *et al*., 2004).
Any other aspects of the environment	**A**— There are no known direct consequences of CRM on the natural or urban environment but their introduction into a new environment may lead to competition for resources with native species.
Indirect consequences	
Eradication, control etc.	**B** — Additional programs to minimise the impact of CRM on host plants may be necessary. An appropriate miticide or biological control would be required if this pest reached high levels of infestation. CRM is not a serious pest of citrus on the New South Wales central coast due to effective biocontrol strategies (Smith *et al*., 1997a). The implementation of these strategies, if CRM became established in Western Australia, would require significant resources at the local level.
Domestic trade	**A** — The presence of CRM in the commercial citrus production areas of Western Australia is estimated to have consequences that are unlikely to be discernible at the regional level and of minor significance at the local level. It is doubtful that there would be any resulting interstate trade restrictions on host plants and plant material as CRM is present in other states.
International trade	**C** — The presence of CRM in commercial production areas of a wide range of commodities 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 CRM 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 3 (The assessment of local, district, regional and national consequences) and text under the 'Method for assessing consequences' section for details on the method used for consequence assessment).

Unrestricted risk estimate

The unrestricted risk estimate for CRM, determined by combining the overall 'probability of entry, of establishment and of spread' with the 'consequences' using the risk estimation matrix (Table 4): **Negligible**.

4.2.3.3 False spider mite

Various species of false spider mites feed on a variety of ornamental, fruit, and vegetable crops. The family is considered to be cosmopolitan (Baker & Bambara, 1997). Most species of false spider mite are not of economic importance, however, all feed on plant tissue. A few species have been identified as pests that cause economic damage to agricultural crops, ornamentals and timber (Baker, 1949; Baker & Tuttle, 1987; Ochoa & Salas, 1989; Evans *et al*., 1993). False spider mites, also known as flat mites, are related to spider mites but do not spin webs (Mersino, 2002).

The false spider mite examined in this extension of existing policy is:

- *Brevipalpus cuneatus* Canestrini & Fanzago [Acari: Tenuipalpidae] – False spider mite

Introduction and spread probability

Probability of importation

The likelihood that the false spider mite will arrive in Australia with the importation of sweet oranges from Italy: **High**.

- False spider mite is reported on citrus in Italy (AAN, 1998).
- The eggs are usually laid singly near the main veins on the undersides of leaves. The false spider mite is slow-moving and is occasionally seen on the undersides of leaves and on leaf stalks in dry weather in summer (Astridge & Fay, 2004).
- Infestations occur mainly during hot, dry weather and cause scarring and discoloration of maturing fruits, which become unmarketable. Generally, damage is uncommon but the mites blemish orange fruits, tending to infest areas of the fruit surface already damaged by insects.
- The presence of fruit with typical symptoms of mite infestation increases the likelihood of detection of infested fruit during pre-export inspection. However, mites may occur in the calyx where they may not be detected during pre-export inspection.
- False spider mites are known to be associated with citrus fruit. AQIS inspectors have intercepted tetranychid mites on citrus imported into Australia from various countries.

Probability of distribution

The likelihood that the false spider mite will be distributed to the endangered area as a result of the processing, sale or disposal of sweet oranges from Italy: **Low**.

- Adults or nymphs may remain on the surface of the fruit during distribution via wholesale or retail trade.
- The commodity may be distributed throughout the PRA area for retail sale, as the intended use of the commodity is human consumption. Waste material would be generated.
- Transfer of the false spider mite from the fruit pathway to a suitable host is a significant limiting factor in its distribution. False spider mites are mainly sedentary (Kane, 2004) and slow moving (Jeppson *et al*., 1975), although unassisted movement of the immature and mature stages occurs within the canopy of host plants.

Probability of entry (importation x distribution)

The likelihood that the false spider mite will enter the PRA area as a result of trade in sweet oranges from Italy and be distributed in a viable state to the endangered area: **Low**.

- 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 2).

Probability of establishment

The likelihood that the false 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**.

- The false spider mite has a wide host range including citrus (Baker & Bambara, 1997), orchids, passionfruit, papaw, rambutan, durian and mangosteen (Astridge & Fay, 2004). These hosts are widespread in the PRA area.
- Tenuipalpid mites appear to be best adapted to subtropical or tropical regions (Baker & Bambara, 1997). Some species of *Brevipalpus*, namely *Brevipalpus californicus*,

Brevipalpus lewisi, *Brevipalpus obovatus* and *Brevipalpus phoenicis*, are already established in Australia (Smith *et al*., 1997a). The establishment of these species in Australia indicates that environmental conditions would be suitable for establishment of false spider mite in Australia.

- Adult females lay 40 to 60 eggs on foliage and the life cycle ranges from 26 to 30 days (Mersino, 2002). False spider mites have longer life cycles and lower fecundity than spider mites, with only 4 to 6 generations per year (Baker & Bambara, 1997).
- Other species of *Brevipalpus* reproduce sexually, follow the classic pattern of fertilization and subsequent production of male and female progeny, but may also reproduce by parthenogenesis (Haramoto, 1969).
- Abundance of host plants, a warm and humid climate would favour the development of high population densities of this mite.
- Existing control programs may be effective for some hosts (e.g. broad spectrum pesticide applications) but not for all hosts.

Probability of spread

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

- False spider mites may go undetected on plants due to their minute size, flat bodies, and somewhat sedentary behaviour (Kane, 2004). Movement of commodities would help the dispersal of the false spider mite because mites could spread on infested fruit and vegetative host material.
- The false spider mite moves relatively slowly (Astridge & Fay, 2004) and lies very flat against the plant surfaces (Mersino, 2002).
- Given the polyphagous nature of the false spider mite, the occurrence of other host plants between commercial fruit orchards in the PRA area would aid the spread of this mite.
- Natural predators may be able to attack the false spider mite but there is no evidence that they would have an effect on its spread.

Probability of entry, establishment or spread

The overall likelihood that false spider mite will enter the PRA area as a result of trade in sweet oranges from Italy, be distributed in a viable state to suitable hosts, establish in that area and subsequently spread within the PRA area: **Low**.

- The probability of entry, establishment or spread is determined by combining the probabilities of entry, of establishment and of spread using the matrix of 'rules' for combining descriptive likelihoods (Table 2).

Consequences

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

Criterion	Estimate
Direct consequences	
Plant life or health	**C**— The false spider mite is capable of causing direct harm to a wide range of hosts (Baker & Bambara, 1997). The false spider mite is estimated to have consequences of minor significance at the regional level.
Any other aspects of the environment	**A**— There are no known direct consequences of the mite on the natural or urban environment but its introduction into a new environment may lead to competition

Criterion	Estimate
	for resources with native species.
Indirect consequences	
Eradication, control etc.	**A** — Additional programs to minimise the impact of this mite on host plants may not be necessary. An appropriate miticide or biological control would be required if this pest reached high levels of infestation. Several other species within this genus are already established in various parts of Australia and existing control programs may be effective.
Domestic trade	**C** — The presence of this mite in commercial production areas may result in interstate trade restrictions. The false spider mite is estimated to have consequences that are minor at the regional level but may be highly significant at the local level.
International trade	**C** — The presence of this mite in commercial production areas may have a significant effect at the district level.
Environment	**A** — Pesticides required to control the false 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 3 (The assessment of local, district, regional and national consequences) and text under the 'Method for assessing consequences' section for details on the method used for consequence assessment).

Unrestricted risk estimate

The unrestricted risk estimate for the false spider mite, determined by combining the overall 'probability of entry, of establishment and of spread' with the 'consequences' using the risk estimation matrix risk estimation matrix (Table 4): **Very low**.

4.2.3.4 Mediterranean fruit fly

Mediterranean fruit fly (Medfly) is one of the world's most destructive fruit pests. Because of its wide distribution around the world, its ability to tolerate colder climates, and its wide range of hosts, it is ranked one of the most economically important fruit fly species (Thomas *et al*., 2001; White & Elson-Harris, 1994). Medfly is widely distributed in Europe, Africa and South America. It is present in the State of Western Australia but is absent and subject to official control to prevent its entry into other Australian States and Territories.

The fruit fly examined in this extension of existing policy is:

- *Ceratitis capitata* (Wiedemann) [Diptera: Tephritidae] – Mediterranean fruit fly.

Introduction and spread probability

Probability of importation

The likelihood that Medfly will arrive in the PRA area with the importation of sweet oranges from Italy: **High**.

- Medfly has been reported in Italy (EPPO, 2002). Medfly is known to infest and damage a wide range of fruit crops. In Mediterranean countries, it is particularly damaging on citrus and peaches.
- Medfly is known to be associated with the citrus fruit pathway. Eggs are laid under the skin of fruit (Christenson & Foote, 1960). Larvae feed and develop within the fruit until ready to pupate in the soil (Knapp, 1998).
- Medfly larvae are internal feeders and may not be readily detected by on-arrival inspection (Fimmiani, 1989).

- The potential for infested fruit to decay (Cayol *et al*., 1994) increases the likelihood of detection of infested fruit during inspection. However, the presence of only eggs in the fruit reduces the likelihood of detection during inspection.

Probability of distribution

The likelihood that Medfly will be distributed to the endangered area as a result of the processing, sale or disposal of sweet oranges from Italy: **Moderate**.

- The commodity may be distributed throughout the PRA area for retail sale, as the intended use of the commodity is human consumption. Waste material would be generated.
- Eggs may produce larvae within stored fruit, fruit at the point of sale, or fruit that has been purchased. Larvae may then develop into adult flies, which are then able to move into the environment.
- Wholesalers, retailers or consumers could discard spoiled fruit containing eggs or larvae. These eggs or larvae could then complete their development into adult flies, which would move into the environment and seek out host fruit.

Probability of entry (importation x distribution)

The likelihood that Medfly will enter the PRA area as a result of trade in sweet oranges from Italy and be distributed in a viable state to the endangered area: **Moderate**.

- 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 2).

Probability of establishment

The likelihood that Medfly 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.**

- Medfly is polyphagous, feeding on the fruit of many plants such as citrus, peach, pear, apple, apricot, fig, plum, kiwifruit, quince, grape, sweet cherry, pomegranate and strawberry. Its host relationships vary from region to region depending on what fruits are available (White & Elson-Harris, 1994).
- Hosts are widely distributed throughout the PRA area, both in commercial orchard districts and suburban areas.
- Mediterranean type climates that favour the establishment of Medfly occur in various parts of Australia.
- Medfly is already established in areas of Western Australia. The largest populations occur in the Perth metropolitan area and in towns in the south west of the State (Woods, 1997).
- All other States of Australia are free of Medfly. Small, isolated outbreaks have occurred in the city of Adelaide in South Australia and the Northern Territory due to the illegal movement of infested fruit by humans. These incursions were quickly detected by the extensive fruit fly surveillance network in Australia and contained and rapidly eradicated through the use of established containment and eradication procedures (Meats *et al.* 2003).
- Development of Medfly is principally dependent on temperature: the optimum temperature for development is 32^{0}C, which enables completion of a generation within 2 weeks. There are 4-5 generations per year, with the number of generations

determined by temperature (Fletcher, 1989). In tropical and subtropical regions there may be as many as 12-13 generations per year. In southern Italy, 6 to 7 generations per year have been reported (HYPP, 2004b).

- Females lay eggs in clusters of 3 to 7 eggs, about 2 to 5 mm deep inside the fruit. Under optimum conditions, the female may lay 500 to 600 eggs during her life (HYPP, 2004b). Multiple ovipositions by different females can result in many larvae occurring in the same fruit (Thomas *et al*., 2001). During warm weather eggs hatch in 1.5 – 3 days. Larvae feed and develop within the fruit until ready to pupate in the soil (Thomas *et al*., 2001).
- Females will not lay eggs when temperatures drop below 16^{0}C except when exposed to sunlight for several days. Development in egg, larval and pupal stages stop at 10^{0}C (Thomas *et al*., 2001).
- Medfly can survive the winter in both adult and immature stages (De Lima, 1998). Pupae carry the species through unfavourable conditions. In southern Italy, a small number of adults may survive on late-season orange trees (HYPP, 2004b). In Australia, adults may over-winter in host trees (Smith *et al*., 1997a).

Probability of spread

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

- Medfly has a wide host range (Thomas *et al*., 2001) and a wide tolerance to environmental conditions, and without appropriate controls may spread within Australia.
- Medfly is under official control in Australia to prevent its spread from Western Australia into other States (De Lima *et al*., 1993).
- There are restrictions in place in Australia on the movement of fruit to prevent the spread of fruit flies, including Medfly.
- Movement of infested fruit can spread Medfly to previously uninfested areas (Thomas *et al*., 2001; Meats *et al*., 2003). Occasional, isolated, small outbreaks occur in the city of Adelaide in South Australia and in the Northern Territory due to the illegal movement of infested fruit by humans.
- Established detection (including a national fruit fly trap surveillance network), containment and eradication procedures in place in Australia for Medfly have been used previously to control its spread when outbreaks occur (Meats *et al*., 2003).

Probability of entry, establishment or spread

The overall likelihood that Medfly will enter the PRA area as a result of trade in sweet oranges from Italy, be distributed in a viable state to suitable hosts, establish in that area and subsequently spread within the PRA area: **Low**.

- The probability of entry, establishment or spread is determined by combining the probabilities of entry, of establishment and of spread using the matrix of ‘rules’ for combining descriptive likelihoods (Table 2).

Consequences

Consequences (direct and indirect) of the Medfly: **High**.

Criterion	Estimate

Criterion	Estimate
Direct consequences	
Plant life or health	**D** — Medfly is polyphagous and the most serious fruit fly pest in the Mediterranean environment (Christenson & Foote, 1960). It is capable of causing significant reductions in the production of marketable fruit.
Any other aspects of the environment	**B** — Fruit flies introduced into a new environment will compete for resources with the native species. There may be significant consequences of these pests for native plants at a local level, which would be unlikely to be discernible at a national level.
Indirect consequences	
Eradication, control etc.	**E** — Programs to control/eradicate this pest from areas in Australia would be costly. For example, the cost of eradication of Medfly is estimated at AU$70m for Western Australia and US$20m for Florida. In 1995, the papaya fruit fly eradication program, using male annihilation and protein bait sprays, cost AU$ 34 million (QDPI, 2003). The potential economic risk associated with Medfly is considerable, with an endemic infestation in California estimated to cost in excess US$ 1 billion per annum (Siebert, 1994). Over US$ 350 million has already been spent to prevent Medfly becoming established in California (Metcalf, 1995). Increases in the existing monitoring programs would also be costly.
Domestic trade	**D** — The presence of fruit flies in commercial production areas has a significant effect at the regional level due to interstate trade restrictions on a wide range of commodities.
International trade	**D** — The major risk for Australia arises from the imposition of additional phytosanitary restrictions on fruit exports should Medfly become established, even temporarily, in areas currently free of this pest. When the papaya fruit fly outbreak occurred in northern Queensland, Australia experienced trade restrictions that affected the whole country.
Environment	**A** — Although additional pesticide applications or other control activities would be required to control these pests on susceptible crops, any impact on the environment is unlikely to be discernible.

Note: Refer to Table 3 (The assessment of local, district, regional and national consequences) and text under the 'Method for assessing consequences' section for details on the method used for consequence assessment).

Unrestricted risk estimate

The unrestricted risk estimate for the Medfly, determined by combining the overall 'probability of entry, of establishment, and of spread' with the 'consequences' using the risk estimation matrix (Table 4): **Moderate**.

4.2.3.5 Citrophilus mealybug

Mealybugs injure plants by extracting large quantities of sap and producing honeydew that serves as a substrate for the development of sooty moulds. They generally prefer warm, humid, sheltered sites away from adverse environmental conditions and natural enemies. Many mealybug species pose particularly serious problems to agriculture when introduced into new areas of the world without their specific natural enemies (Miller *et al*., 2002).

The mealybug species examined in this extension of existing policy is:

- * *Pseudococcus calceolariae* Maskell [Hemiptera: Pseudococcidae] – citrophilus mealybug.

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

Introduction and spread probability

Probability of importation

The likelihood that citrophilus mealybug will arrive in Western Australia with the importation of sweet oranges from Italy: **High**.

- Citrophilus mealybug has been reported on citrus in Italy (AAN, 1998).
- Mealybugs usually live around the calyx of the fruit from flowering onwards. They generally remain anchored to the host. Therefore, they may be difficult to detect on fruit during sorting, especially at low population levels (Taverner & Bailey, 1995).
- Routine packinghouse procedures (washing, waxing and grading) may not remove all mealybugs from around the calyx. This is particularly true of adult females and/or nymphs that have found protective spaces around the calyx or are protected by waxy cocoons.
- Mealybugs can survive packinghouse procedures. AQIS inspectors have intercepted mealybugs on citrus imported from California into Australia.

Probability of distribution

The likelihood that citrophilus mealybug will be distributed to the endangered area as a result of the processing, sale or disposal of sweet oranges from Italy: **Moderate**.

- Adults or immature forms may remain on the surface of the fruit during distribution via wholesale or retail trade.
- The commodity may be distributed throughout Western Australia for retail sale, as the intended use of the commodity is human consumption. Waste material would be generated.
- Mealybugs are likely to survive storage and transportation. *Pseudococcus affinis* can survive up to 42 days storage at 0^{o}C (Hoy & Whiting, 1997).
- Citrophilus mealybug may enter the environment as adults discarded with fruit or as juveniles blown by wind or carried by other vectors.
- Mealybugs are mobile at all life stages. Crawlers are mobile while adults are slow-moving (Smith *et al*., 1997a).
- Adult females are wingless and would need to be carried onto hosts by vectors such as humans or insects. Adult females can only crawl a few metres, restricting their ability to move from discarded fruit waste to a suitable host.
- Adult males are winged, capable of short flights and are short lived. Male dispersal by crawling or flight is strongly affected by the location of females and their production of sex pheromones.
- Because all stages of mealybugs survive in the environment for some time and because they are polyphagous, they could be transferred to a susceptible host.

Probability of entry (importation x distribution)

The likelihood that citrophilus mealybug will enter Western Australia as a result of trade in sweet citrus from Italy and be distributed in a viable state to the endangered area: **Moderate**.

- 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 2).

Probability of establishment

The likelihood that citrophilus mealybug 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**.

- Citrophilus mealybug is endemic to eastern Australia and now also occurs in the USA, South America, New Zealand, South Africa and Europe (Smith *et al*., 1997a).
- Citrophilus mealybug is a highly polyphagous species that has been recorded on 40 plant families (Ben-Dov, 1994) and these hosts are widespread in Western Australia.
- Mealybug development is temperature dependent. There is a minimum threshold temperature for each species of mealybug, below which development either ceases or is slowed significantly. There is also a maximum threshold temperature, beyond which development is slowed significantly or ceases all together. If temperatures remain elevated for prolonged periods, mortality increases significantly.
- Mild to warm conditions are most favourable with temperatures of about 25°C and a high relative humidity being optimum for mealybug development. In Australia, mealybug populations peak in spring and autumn.
- Mealybugs have high reproductive capabilities with multiple generations possible per year (Smith *et al*., 1997a). Mature females commonly move to a protected site to lay eggs over a period of up to 2 weeks. Females lay approximately 500 eggs and these hatch within a few days. Females cease feeding before egg laying and die at the end of egg laying.
- Modelling studies in Western Australia suggest that certain regions within Western Australia are suitable for the establishment of this pest.
- Existing control programs may be effective. Control strategies are already in place as Western Australia has several economically important mealybug species. These existing control strategies would minimise the impact of the citrophilus mealybug within Western Australia. Biological control agents are available that provide control of citrophilus mealybug.

Probability of spread

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

- Citrophilus mealybug has limited independent dispersal capabilities and the long-range dispersal of this pest requires the movement of nymphs and adults on infested host material, such as fruit and nursery stock.
- Quarantine controls are in place on the movement of nursery stock into Western Australia. However, these controls would have no effect on the spread of citrophilus mealybug within Western Australia.
- Commercial fruit crop hosts of citrophilus mealybug are grown in southwestern Western Australia and there are natural barriers between some districts. It would be difficult for the mealybugs to disperse from one district to another by natural means.
- Female mealybugs do not have wings and are therefore limited in their ability to disperse. However, the spread of this pest would be aided if other host plants occurred between the commercial fruit orchards in different districts of Western Australia.
- Short-range dispersal of juveniles could occur through the movement of crawlers in wind currents or as contaminants on biological or mechanical vectors (Williams, 1996).

- Adult males are winged, capable of short flights and are short lived. Male dispersal by crawling or flight is strongly affected by the location of females and their production of sex pheromones.
- Natural enemies of the citrophilus mealybug, such as *Cryptolaemus montrouzieri* and parasitoids *Tetracnemus pretisous* and *Coccophagus gurneyi*, are used to control this pest in Australia and other countries. However, only *Cryptolaemus montrouzieri* is known to be present in Western Australia.

Probability of entry, establishment or spread

The overall likelihood that the citrophilus mealybug will enter Western Australia as a result of trade in sweet oranges from Italy, be distributed in a viable state to suitable hosts, establish in that area and subsequently spread within the PRA area: **Moderate**.

- The probability of entry, establishment or spread is determined by combining the probabilities of entry, of establishment and of spread using the matrix of 'rules' for combining descriptive likelihoods (Table 2).

Consequences

Consequences (direct and indirect) of the citrophilus mealybug: **Low**.

Criterion	Estimate
Direct consequences	
Plant life or health	**C** — Citrophilus mealybug is capable of causing direct harm to a wide range of hosts (Hely *et al.,* 1982). Fruit quality can be reduced by the presence of sooty mould. The citrophilus mealybug is highly polyphagous and host plants are common in Western Australia.
Any other aspects of the environment	**A** — There are no known direct consequences of citrophilus mealybug on the natural or built environment but its introduction into a new environment may lead to competition for resources with native species.
Indirect consequences	
Eradication, control etc.	**B** — Existing control programs may be effective. Control strategies are already in place as Western Australia has several economically important mealybug species. These existing control strategies would minimise the impact of the citrophilus mealybug within Western Australia. Biological control agents are available that provide control of citrophilus mealybug.
Domestic trade	**A** — The presence of citrophilus mealybug in the commercial citrus production areas of Western Australia is estimated to have consequences that are unlikely to be discernible at the regional level and of minor significance at the local level. It is doubtful that there would be any resulting interstate trade restrictions on host plants and plant material as these mealybugs are present in other states.
International trade	**A** — The presence of citrophilus mealybug in the commercial citrus production areas in Western Australia would not have a significant effect, as the mealybug is widespread in areas other than Western Australia.
Environment	**A** — Additional pesticide applications or other control activities may be required to control these pests on susceptible crops but any impact on the environment is unlikely to be discernible at the local level.

Note: Refer to Table 3 (The assessment of local, district, regional and national consequences) and text under the 'Method for assessing consequences' section for details on the method used for consequence assessment).

Unrestricted risk estimate

The unrestricted risk estimate for citrophilus mealybug, determined by combining the overall 'probability of entry, of establishment and of spread' with the 'consequences' using the risk estimation matrix (Table 4): **Low**.

4.2.3.6 Scales

Scale insects are primarily sedentary, small and often inconspicuous and have been spread widely on plants and plant products. Scales are present in most citrus production areas of the world. A wax-based covering protects armoured scales.

The scales examined in this extension of existing policy are:

- **Chrysomphalus dictyospermi* (Morgan) [Hemiptera: Diaspididae] – Palm scale
- **Lepidosaphes gloverii* (Packard) Hemiptera: Diaspididae] – Glover's scale
- **Parlatoria pergandii* Comstock [Hemiptera: Diaspididae] – Chaff scale
- *Parlatoria ziziphi* (Lucas) [Hemiptera: Diaspididae] – Black parlatoria scale
- *Unaspis yanonensis* (Kuwana) [Hemiptera: Diaspididae] – Arrowhead scale

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

Introduction and spread probability

Probability of importation

The likelihood that scales will arrive in the PRA area with the importation of sweet oranges from Italy: **High**.

- These scales have been reported as being present on citrus in Italy (AAN, 1998).
- These scales feed on fruit (Timmer & Duncan, 1999), and it is likely that fruit sent to be packed for export will be infested by some of these scales as field control practices may not give complete control (Taverner & Bailey, 1995).
- *Parlatoria ziziphi* feeds almost exclusively on citrus. High numbers of this pest may occur on fruit (Fasulo & Brooks, 2001).
- *Parlatoria pergandii* feeds on fruit tissue, which sometimes leads to fruit abscission (Davies & Albrigo, 1994).
- *Unaspis yanonensis* feeds almost exclusively on citrus (Ohkubo, 1980) and is more severe on fruit and leaves resulting in delayed colour development (Davies & Albrigo, 1994).
- Scales are difficult to remove from fruit during cleaning due to their protective covers. *Parlatoria ziziphi* can be firmly attached to the fruit and may not be removed during packinghouse procedures.
- Routine washing procedures (washing, waxing and grading) may not remove all scales from the fruit surface. Armoured scales are unlikely to be killed by the washing solution, as the physical properties of their protective covers provide an effective barrier against contact toxicants (Foldi, 1990).
- Scales are known to be associated with citrus fruit and have been intercepted by AQIS inspectors on citrus imported from California into Australia.

Probability of distribution

The likelihood that scales will be distributed to the endangered area as a result of the processing, sale or disposal of sweet orange from Italy: **Low**.

- Adults or immature forms may remain on the surface of the fruit during distribution via wholesale or retail trade.
- Adults or immature forms are likely to survive storage and transport and be associated with infested waste.

- The commodity may be distributed throughout the PRA area for retail sale, as the intended use of the commodity is human consumption. Waste material would be generated.
- The natural dispersal mechanism that allows for the movement of scale species from discarded fruit waste to a suitable host is a significant limiting factor. Scales have a limited ability to disperse independently from the citrus fruit pathway.

Probability of entry

The likelihood that scales will enter the PRA area as a result of trade in sweet oranges from Italy and be distributed in a viable state to the endangered area: **Low**.

- 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 2).

Probability of establishment

The likelihood that scales 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**.

- Some of these scales are polyphagous (*Chrysomphalus dictyospermi*, *Lepidosaphes gloverii* and *Parlatoria pergandii*) and have shown the ability to adapt to new hosts and environments (McClure, 1983; Schvester, 1985; Hanks & Denno, 1994).
- Although the precise climate tolerance of scales is unknown, they are considered to be tropical or subtropical pests, and are therefore less likely to establish in either cool or hot and dry climates.
- A range of plants commonly found in the PRA area can act as hosts for these species, including *Citrus* spp., *Severinia buxifolia*, *Murraya paniculata*, *Cocos nucifera*, *Mangifera indica* and *Nipa* spp.
- Scales have a high reproductive rate. Reproduction is bisexual with three to seven generations per year. The generation time is much longer during colder weather (Fasulo & Brooks, 2001).
- *Parlatoria ziziphi* is reported to have 2-4 generations per year with females producing approximately 30 eggs (Sweilem *et al*., 1984).
- *Unaspis yanonensis* is reported to have three generations per year (Nohara, 1962).
- *Parlatoria ziziphi* has established and been eradicated in the Northern Territory. Some of the scales (*Chrysomphalus dictyospermi*, *Lepidosaphes gloverii* and *Parlatoria pergandii*) are already established in parts of Australia, indicating that suitable environments for their establishment are available in the PRA area.
- Existing control programs may be effective for some hosts (e.g. broad spectrum pesticide applications) but not necessarily all hosts.

Probability of spread

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

- The commercial fruit crop hosts of the scales are located in many parts of Australia. Natural barriers such as arid areas, climatic differentials and long distances exist between these areas. The long distances between commercial host crops in Australia would make it difficult for the scales to disperse by natural spread.

- Some of the scales (*Chrysomphalus dictyospermi*, *Lepidosaphes gloverii* and *Parlatoria pergandii*) are already recorded in Australia (AICN, 2004) but are absent from Western Australia. There are similar environments in Western Australia that would be suitable for their spread.
- Australia has a wide climate range and many areas are suitable for the establishment and spread of scales. Low humidity and high temperatures limit the spread of *Parlatoria* spp. (Gerson, 1980).
- Adults and nymphs may be moved within and between orchards or other commercial production sites with the movement of equipment, personnel and infested plant material (Dreistadt *et al*., 1994).
- The hard scale family Diaspididae has limited independent dispersal capabilities and these scales are more likely to disperse in association with host material such as infested fruit, nursery stock and equipment.
- Spread by active movement and wind-accomplished dispersal is by first-instar crawlers. Birds, insects and other animals may act as vectors (Beardsley & Gonzalez, 1975). Subsequent instars are sessile.
- Adult males are short-lived, winged and capable of weak flight. They lack functional mouthparts and cannot feed. Longevity of this stage generally is limited to a few hours (Beardsley & Gonzalez, 1975).
- Short-range dispersal can occur though the movement of first instar crawlers in wind currents or by biological or mechanical vectors (Willard, 1974).
- Long-range movement of scales occurs when gravid females are transferred *insitu* with the vegetative material upon which they are feeding.
- Several natural enemies that attack scales occur in the PRA area.

Probability of entry, establishment or spread

The overall likelihood that scales will enter the PRA area as a result of trade in sweet orange from Italy, be distributed in a viable state to suitable hosts, establish in that area and subsequently spread within the PRA area: **Low**.

- The probability of entry, establishment or spread is determined by combining the probabilities of entry, of establishment and of spread using the matrix of 'rules' for combining descriptive likelihoods (Table 2).

Consequences

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

Criterion	Estimate
Direct consequences	
Plant life or health	**C** — Scales can cause direct harm to a wide range of plant hosts (Williams & Watson, 1988). Damage to fruit produces green spots and such fruit is downgraded for the fresh market (Beardsley & Gonzalez, 1975; Brooks & Knapp, 1983). These scales are highly polyphagous and host plants are widely distributed in Australia.
Any other aspects of the environment	**A** — Scales introduced into a new environment will compete for resources with the native species. They are estimated to have consequences that are unlikely to be discernible at the national level and of minor significance at the local level.
Indirect consequences	

Criterion	Estimate
Eradication, control etc.	**B** — Additional programs to minimise the impact of these pests on host plants may be necessary. Existing control programs may be effective for some hosts but not all hosts.
Domestic trade	**C** — The introduction of the scales not present in Australia into commercial production areas may have a highly 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.
International trade	**C** — The presence of these pests in commercial production areas of a range of commodities 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 scales 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 3 (The assessment of local, district, regional and national consequences) and text under the 'Method for assessing consequences' section for details on the method used for consequence assessment).

Unrestricted risk estimate

The unrestricted risk estimate for scales, determined by combining the overall 'probability of entry, of establishment and of spread' with the 'consequences' using the risk estimation matrix (Table 4): **Very low**.

4.2.3.7 Whiteflies

Whiteflies in sufficient numbers can lead to sooty mould development. Sooty moulds interfere with photosynthesis (Walker & Aitken, 1985) and may lower fruit quality (Soto *et al*., 2002). Woolly whitefly is controlled in Mediterranean climates by parasitic wasps such as *Cales noacki* and *Eretmocerus* spp.

The whiteflies examined in this extension of existing policy are:

- *Aleurothrixus floccosus* (Maskell) [Hemiptera: Aleyrodidae] – Woolly whitefly
- *Parabemisia myricae* (Kuwana) [Hemiptera: Aleyrodidae] – Bayberry whitefly

Introduction and spread probability

Probability of importation

The likelihood that whiteflies will arrive in the PRA area with the importation of sweet oranges from Italy: **High**.

- These whitefly species have been reported on citrus in Italy (AAN, 1998).
- Whiteflies are generally foliage feeders and insert their eggs into the underside of mature leaves (Salinas *et al*., 1996).
- Eggs are rarely deposited on the fruit (Vulic & Beltran, 1977; Uygun *et al*., 1990).
- Adults fly in the morning and evening, redistributing themselves within the crop and locating leaves suitable for feeding and oviposition (Meyerdirk & Moreno, 1984).
- Honeydew produced by whiteflies on fruit may result in the development of sooty moulds (Salinas *et al*., 1996; Uygun *et al*., 1990). Fruit in this condition is likely to be detected during pre-export inspections.
- Post harvest grading, washing and packing procedures are likely to remove many of these pests from the fruit.

- Whiteflies are known to be associated with citrus fruit and have been intercepted by AQIS inspectors on citrus imported from California into Australia.

Probability of distribution

The likelihood that whiteflies will be distributed to the endangered area as a result of the processing, sale or disposal of sweet oranges from Italy: **Low**.

- Immature forms (eggs, crawlers, sessile instars) may remain on the surface of the fruit during distribution via wholesale or retail trade.
- The commodity may be distributed throughout the PRA area for retail sale, as the intended use of the commodity is human consumption. Waste material would be generated.
- Nymphs are active only during the first instar stage, becoming sedentary for the remaining nymphal instars (van Lenteren & Noldus, 1990).
- The natural dispersal mechanism that would allow the movement of whiteflies from discarded fruit waste to a suitable host could be a significant limiting factor in their distribution. Whiteflies are weak flyers and have a limited ability to direct their flight (Byrne *et al*., 1990).

Probability of entry (importation x distribution)

The likelihood that whiteflies will enter the PRA area as a result of trade in sweet oranges from Italy and be distributed in a viable state to the endangered area: **Low**.

- 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 2).

Probability of establishment

The likelihood that whiteflies 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**.

- These whitefly species are highly polyphagous and have shown the ability to adapt to new environments (Mound & Halsey, 1978; Uygun *et al*., 1990). A range of plants commonly found in the PRA area can act as hosts for these species (e.g. *Citrus* spp.; *Persea* spp.; *Prunus* spp. and *Vitis* spp.).
- Reproduction of *Aleurothrixus floccosus* is sexual and oviposition can occur within one day of adult emergence (Paulson & Beardsley, 1986; Salinas *et al*., 1996). Reproduction of *Parabemisia myricae* is by parthenogenesis (Uygun *et al*., 1990).
- The life cycle of *Aleurothrixus floccosus* can be completed in 23–31 days, with females capable of laying up to 178 eggs (Salinas *et al*., 1996). The lifecycle of *Parabemisia myricae* can be completed in approximately 24 days, with females capable of laying up to 70 eggs (Uygun *et al*., 1990).
- In Mediterranean environments, *Aleurothrixus floccosus* reproduces almost continuously with multiple generations per year. *Parabemisia myricae* is reported to have five generations per year in California (Walker & Aitken, 1985) and up to nine generations per year in Cyprus (Orphanides, 1991).
- *Parabemisia myricae* has extended its geographical range in the past 30 years, particularly in the Mediterranean region.
- Existing control programs may be effective for some hosts but not all hosts.

Probability of spread

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

- The commercial fruit crop hosts of these pests are located in many parts of Australia. Natural barriers such as arid areas, climatic differentials and long distances exist between these areas.
- The long distances between the main orchard districts in Australia would make it difficult for these whiteflies to disperse from one area to another by natural spread. However, the highly polyphagous nature of these species may enable them to locate suitable hosts in the intervening areas.
- Movement of commodities would help disperse whiteflies. Adults and immature forms may spread undetected via the movement of fruit or infested vegetative host material (Salinas *et al*., 1996).
- Short-distance dispersal may occur, as adults are mobile and able to move between host plants (Byrne *et al*., 1990). Long-distance dispersal occurs principally through the movement of infested plants and plant products.
- Adults of *Aleurothrixus floccosus* are sluggish and seldom fly but wind, vehicles or humans could assist in their dispersal (Salinas *et al*., 1996).
- Crawlers are able to disperse within a host plant. Nymphs are mobile for a short time (van Lenteren & Noldus, 1990) and will settle along veins on the underside of leaves (Salinas *et al*., 1996).
- Most whiteflies remain on the plants on which they originated, especially if conditions remain favourable (Gerling & Horowitz, 1984).
- Environments (e.g. temperature, rainfall) similar to those in Italy occur in parts of Australia.
- A wide range of parasitoids and generalist predators attacks whiteflies but their importance in controlling whitefly populations in Australia is not known.

Probability of entry, establishment or spread

The overall likelihood that whiteflies will enter the PRA area as a result of trade in sweet oranges from Italy, be distributed in a viable state to suitable hosts, establish in that area and subsequently spread within the PRA area: **Low**.

- The probability of entry, establishment or spread is determined by combining the probabilities of entry, of establishment and of spread using the matrix of 'rules' for combining descriptive likelihoods (Table 2).

Consequences

Consequences (direct and indirect) of the whiteflies: **Low**.

Criterion	Estimate
Direct consequences	
Plant life or health	**C**— These pests cause direct damage to host plants. Sooty moulds growing on honeydew reduce photosynthesis and productivity (Salinas *et al*., 1996; Uygun *et al*., 1990). *Parabemisia myricae* is a damaging pest of citrus in California (Rose & Rosen, 1991), Turkey (Sengonca *et al*., 1993) and Israel (Swirski *et al*., 1985). In Florida, *Parabemisia myricae* has been recorded damaging citrus seedlings (Hamon, 2001). In Turkey, *P. myricae* has been shown to be able to transmit citrus chlorotic dwarf virus (Korkmaz *et al*., 1996).

Criterion	Estimate
Any other aspects of the environment	**A**— There are no known direct consequences of whiteflies on the natural or urban environment but their introduction into a new environment may lead to competition for resources with native species.
Indirect consequences	
Eradication, control etc.	**B** — Additional programs to minimise the impact of these pests on host plants may be necessary. Existing control programs may be effective for some hosts (e.g. broad spectrum pesticide applications) but not all hosts (e.g. where specific integrated pest management programs are used).
Domestic trade	**C** — 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 could 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 on a range of commodities 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 whiteflies 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 3 (The assessment of local, district, regional and national consequences) and text under the 'Method for assessing consequences' section for details on the method used for consequence assessment).

Unrestricted risk estimate

The unrestricted risk estimate for whiteflies, determined by combining the overall 'probability of entry, of establishment and of spread' with the 'consequences' using the risk estimation matrix (Table 4): **Very low**.

4.2.3.8 Citrus Pyralid

Citrus pyralid is native to the Mediterranean region, able to feed on almost any plant and most often found on commercial crops. Citrus pyralid is a cosmopolitan species in warm climates but is unable to survive winters in cooler, temperate areas into which it may be imported with produce (Carter, 1984). This species has been intercepted in Denmark, Finland, the Netherlands, Norway, Sweden and the United Kingdom on imported material (Karsholt, 1996).

The citrus pyralid examined in this extension of existing policy is:

- *Cryptoblabes gnidiella* Millière [Lepidoptera: Pyralidae] – citrus pyralid

Introduction and spread probability

Probability of importation

The likelihood that citrus pyralid will arrive in Australia with the importation of sweet oranges from Italy: **Moderate**.

- Citrus pyralid has been recorded as being present on citrus in Italy (AAN, 1998).
- Eggs are laid on the fruit and the foliage (Carter, 1984). Larvae feed mainly on fruit but also feed on foliage (Liotta & Mineo, 1964). Pupation takes place on the host plant or on the ground (Swirski *et al*., 1980).
- Fully-grown larvae of the citrus pyralid are 12 mm long (Singh & Singh, 1995) and are likely to be detected during pre-export inspections.

- Larvae of citrus pyralid are often found in association with infestations by other pests, for example on citrus with *Planococcus citri* and on grapes following attack by the European vine moth, *Lobesia botrana* (Carter, 1984).
- Post harvest rots can develop on infested fruits and such fruit may be detected during pre-export inspections.
- Citrus pyralid is likely to survive storage and transportation.
- Routine packinghouse procedures (washing, waxing and grading) may not remove all the citrus pyralid from the fruit.

Probability of distribution

The likelihood that citrus pyralid will be distributed to the endangered area as a result of the processing, sale or disposal of sweet oranges from Italy: **Low**.

- The commodity may be distributed throughout the PRA area for retail sale, as the intended use of the commodity is human consumption. Waste material would be generated.
- Citrus pyralid may enter the environment via adult emergence from pupae in waste that has been discarded before the fruit desiccates or decays. The larvae and pupae may survive cool storage employed by the wholesalers and retailers.
- If adult moths were to survive cold storage, they could enter the environment by flight from fruit at the point of sale, during transportation of purchased fruit from retailers to households and from discarded fruit at landfill.
- The natural dispersal stage for this lepidopteran is the adult.
- Early instar larvae that have escaped detection during inspection would be unlikely to develop in discarded fruit before the fruit desiccates or decays.
- The larvae would also be unlikely to find a suitable host on which to complete their development.

Probability of entry (importation x distribution)

The likelihood that citrus pyralid will enter the PRA area as a result of trade in sweet oranges from Italy and be distributed in a viable state to the endangered area: **Low**.

- 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 2).

Probability of establishment

The likelihood that citrus pyralid 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**.

- Citrus pyralid is polyphagous and able to feed on almost any plant, often being found on commercial crops including citrus (Silva & Mexia, 1999), coffee, tropical fruits (Wysoki, 1986; Hashem *et al*., 1997), apple (Carter, 1984), banana (Jager & Daneel, 1999), avocado (Ascher *et al*., 1983), *Prunus* spp. and grapes (Carter, 1984). Many of these hosts are widely distributed in the PRA area.
- The life cycle of the citrus pyralid can be completed in 28 days, depending on temperature. Females are capable of laying up to 100 eggs. There are three to four generations per year in southern Italy, up to five in North America (Carter, 1984) and nine in India (Singh & Singh, 1995). The pre-ovipositional period lasts a full day after mating, and then most of the eggs are laid during the first night (Wysoki *et al*., 1993).

- Citrus pyralid is a cosmopolitan species in warm climates, but is unable to survive winters in cooler, temperate areas into which it may be imported with produce (Karsholt, 1996).
- Citrus pyralid is likely to adapt to Australian conditions, given its wide distribution in Mediterranean regions.
- Existing control programs may be effective for some hosts but not all hosts.

Probability of spread

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

- The long distances between the main Australian commercial orchard districts would make it difficult for the citrus pyralid to disperse directly from one area to another by natural spread. However, the polyphagous nature of this species may enable it to locate suitable hosts in the intervening areas.
- Short-distance dispersal occurs, as adult moths are mobile and able to rapidly move between host plants.
- Environments (e.g. temperature, rainfall) similar to those in the Mediterranean region occur in parts of Australia.
- The relevance of natural enemies to the spread of the citrus pyralid in Australia is not known.

Probability of entry, establishment or spread

The overall likelihood that citrus pyralid will enter the PRA area as a result of trade in sweet oranges from Italy, be distributed in a viable state to suitable hosts, establish in that area and subsequently spread within the PRA area: **Low**.

- The probability of entry, establishment or spread is determined by combining the probabilities of entry, of establishment and of spread using the matrix of ‘rules’ for combining descriptive likelihoods (Table 2).

Consequences

Consequences (direct and indirect) of the Citrus pyralid: **Moderate**.

Criterion	Estimate
Direct consequences	
Plant life or health	**C** — Citrus pyralid is capable of causing direct damage to a range of host plants. Larval feeding on foliage and fruits causes direct crop losses. It is an important pest in fruit orchards in the Mediterranean region, including citrus, avocado, grape, loquat and pomegranate (Balachowsky, 1972). The losses caused by this pest are not quantified in the literature, although combined losses of macadamia nuts in Israel as a result of *Cryptoblabes gnidiella*, *Apomyelois ceratoniae* and *Cryptoblabes leucotreta* amounted to 30% (Wysoki, 1986). Serious damage on hybrid sorghum has been reported from India (Singh & Singh, 1995).
Any other aspects of the environment	**A** — Citrus pyralid introduced into a new environment will compete for resources with native species. It is estimated to have consequences that are unlikely to be discernible at the national level and of minor significance at the local level.
Indirect consequences	
Eradication, control etc.	**D** — Programs to minimise the impact of this pest on host plants are likely to be costly and include pesticide applications and crop monitoring. A control program would have to be implemented in infested orchards to reduce fruit damage and

Criterion	Estimate
	yield losses, thereby increasing production costs. Eradication and control would be significant at the regional level. Citrus pyralid may potentially increase production costs by triggering specific control measures requested by trading partners.
Domestic trade	**C** — The presence of citrus pyralid in commercial production areas may have a highly significant effect at the local level due to any resulting interstate trade restrictions on a wide range of commodities.
International trade	**D** — The presence of this pest in the commercial production areas of a range of commodities (citrus, grapes, avocados, sorghum and rice) may have a significant effect at the regional level due to any limitations to access to overseas markets where this pest is absent. These restrictions may lead to a loss of markets, which in turn would be likely to require industry adjustment.
Environment	**A** — Pesticides required to control the citrus pyralid 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 3 (The assessment of local, district, regional and national consequences) and text under the 'Method for assessing consequences' section for details on the method used for consequence assessment).

Unrestricted risk estimate

The unrestricted risk estimate for citrus pyralid, determined by combining the overall 'probability of entry, of establishment and of spread' with the 'consequences' using the risk estimation matrix (Table 4): **Low**.

4.2.3.9 Citrus Flower Moth

The citrus flower moth is widespread in the Mediterranean region and it is also reported from some countries in Africa. European Plant Protection Organization (EPPO) reports of identifications of citrus flower moth on citrus from the east of Turkey, the Middle East, Asia and the Pacific (including Sri Lanka, Malaysia, Philippines, Pakistan, Fiji and Samoa) are likely to be erroneous. No voucher material has been provided and all 'citrus flower moth' specimens examined were misidentified (CABI, 2004). The species involved are probably the related *Prays endocarpa* (Indian subcontinent; South-East Asia); *Prays endolemma* (Philippines); and *Prays nepholemina* (Borneo, Australasia). Citrus flower moth had previously been reported in Australia by EPPO but was removed in 2002 following an authoritative check of the genus by Nielsen and Edwards (1996) that found *Prays nepholemina* to be endemic in Australia, with no records of *Prays citri*.

The flower moth in this extension of existing policy is:

- *Prays citri* Millière [Lepidoptera: Yponomeutidae] – citrus flower moth.

Introduction and spread probability

Probability of importation

The likelihood that the citrus flower moth (CFM) will arrive in the PRA area with the importation of sweet oranges from Italy: **Moderate**.

- CFM has been recorded as being present on citrus in Italy (EPPO, 2002).
- In the Mediterranean region, all stages of the insect may be found throughout the year (Garrido & Ventura, 1993).

- Eggs are laid individually on the flowers and sometimes on fruit (Mineo *et al*., 1991).
- The young caterpillar enters the flower bud and devours the folded flower parts, then exits by a round lateral hole and enters another bud that it precedes to empty in the same fashion. It spins silken threads that cover the attacked inflorescences. After the first stage of fruit formation, it attacks the young fruit, penetrating it laterally via the receptacle (HYPP, 2004a).
- Studies conducted in Sicily indicate the presence of eggs and larvae all year round (Mineo *et al*., 1991). Cocoons may be found on fruits, flowers and leaves (Mendonca *et al*., 1997).
- On lemons, females lay eggs not only on the flower buds and the developing fruits but also on leaf shoots and larger fruits (Mineo, 1967).
- Fully-grown larvae are 7 mm long and adults are 10 to 12 mm (HYPP, 2004a) and are likely to be detected during pre-export inspections.
- Post harvest rots can develop on infested fruits and such fruit may be detected during pre-export inspections.
- CFM is likely to survive storage and transportation.
- Routine packinghouse procedures (washing, waxing and grading) may not remove all citrus flower moth from the fruit.

Probability of distribution

The likelihood that the CFM will be distributed to the endangered area as a result of the processing, sale or disposal of sweet oranges from Italy: **Low**.

- The commodity may be distributed throughout the PRA area for retail sale, as the intended use of the commodity is human consumption. Waste material would be generated.
- CFM could enter the environment via adult emergence from pupae in waste that has been discarded before the fruit desiccates or decays.
- If adult moths were to survive cold storage, they could enter the environment by flight from fruit at the point of sale, during transportation of purchased fruits from retailers to households and from discarded fruit waste at landfills.
- The natural dispersal stage for the citrus flower moth is the adult.
- Early instar larvae that have escaped detection during inspection would be unlikely to develop in discarded fruit before the fruit desiccates or decays.
- The larvae would also be unlikely to find a suitable host on which to complete their development.

Probability of entry (importation x distribution)

The likelihood that the CFM would enter the PRA area as a result of trade in sweet oranges from Italy and be distributed in a viable state to the endangered area: **Low**.

- 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 2).

Probability of establishment

The likelihood that CFM 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**.

- All citrus species are hosts of this pest, although it demonstrates a preference for *Citrus limon*, *Citrus aurantifolia*, *Citrus decumana*, and to a lesser extent, *Citrus aurantium*, *Citrus reticulata*, *Citrus sinensis*, *Casimiroa edulis*, *Ligustrum lucidum*, and *Manilkara zapota* (Ibrahim & Shahateh, 1984; Garrido & Ventura, 1993; Sinacori & Mineo, 1997). Many of these species are wide spread in the PRA area.
- The life cycle of CFM can be completed in 20 days, depending on temperature (20 days in summer and 60 days in winter). Females lay 1 to 3 eggs on a flower bud and then move to another.
- Females are reported to be capable of laying 60-165 eggs (Balachowsky, 1966, Garrido & Ventura, 1993, Carvalho & Aguiar, 1997) although in Egypt, females have been reported to lay up to 334 eggs (Ibrahim & Shahateh, 1984).
- The number of generations per year varies from 3-16, depending on climatic conditions. In Sicily and across the Mediterranean region there are 11 generations per year (HYPP, 2004a), in Israel there are between 8 and 10 generations per year (CABI, 2004) and in Egypt 15 generations per year are reported (Ibrahim & Shahateh, 1984).
- CFM is likely to adapt to Australian conditions, given its wide climatic tolerance in the Mediterranean region. The related *Prays parilis* and *Prays nephelomima* are already established in New South Wales and Queensland (Smith *et al*., 1997a).
- Existing control programs may be effective for some hosts but not all hosts.

Probability of spread

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

- The long distances between the main Australian commercial citrus orchard districts may make it difficult for CFM to disperse directly from one area to another by natural spread.
- Short-distance dispersal occurs, as adult moths are mobile and able to rapidly move between host plants.
- Long-distance dispersal occurs as adults are capable of flight. Adults fly at dusk and during the day rest in host trees.
- Environments (e.g. temperature, rainfall) similar to those in Mediterranean region occur in parts of Australia.
- The relevance of natural enemies to the spread of the CFM in Australia is not known.

Probability of entry, establishment or spread

The overall likelihood that the CFM will enter the PRA area as a result of trade in sweet oranges from Italy, be distributed in a viable state to suitable hosts, establish in that area and subsequently spread within the PRA area: **Low**.

- The probability of entry, establishment or spread is determined by combining the probabilities of entry, of establishment and of spread using the matrix of 'rules' for combining descriptive likelihoods (Table 2).

Consequences

Consequences (direct and indirect) of the Citrus flower moth: **Moderate**

Criterion	Estimate
Direct consequences	
Plant life or health	**C** — CFM is capable of causing direct damage to a wide range of citrus hosts. It

Criterion	Estimate
	is a serious pest of citrus in the Mediterranean region. Larval feeding has resulted in up to 90% loss in flower production in Spain, and 15-70% flower reduction in Portugal (Mendonca *et al*., 1997). It is also considered an economically important pest in Egypt (Ibrahim & Shahateh, 1984), Israel (Sternlicht *et al*., 1990) and Portugal (Mendonca *et al*., 1997).
Any other aspects of the environment	**A** — **CFM** introduced into a new environment will compete for resources with native species. This is estimated to have consequences that are unlikely to be discernible at the national level and of minor significance at the local level.
Indirect consequences	
Eradication, control etc.	**D** — Programs to minimise the impact of this pest on host plants are likely to be costly and include pesticide applications and crop monitoring. A control program would have to be implemented in infested orchards to reduce fruit damage and yield losses, thereby increasing production costs. CFM is a key-pest of lemon orchards. The management of CFM is actually dependent on chemical control and up to 12 insecticide treatments per year may be carried out against CFM. Eradication and control would be significant at the regional level.
Domestic trade	**C** — The presence of citrus flower moth in commercial production areas may have a highly 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	**D** — The presence of these pests in the commercial production areas of a range of commodities may have a significant effect at the regional level due to any limitations to access to overseas markets where this pest is absent. The major risk for Australia arises from the imposition of additional phytosanitary restrictions on exported fruits should CFM become established, even temporarily, in Australia.
Environment	**A** — Pesticides required to control leafrollers 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 3 (The assessment of local, district, regional and national consequences) and text under the 'Method for assessing consequences' section for details on the method used for consequence assessment).

Unrestricted risk estimate

The unrestricted risk estimate for citrus flower moth, determined by combining the overall 'probability of entry, of establishment and of spread' with the 'consequences' using the risk estimation matrix (Table 4): **Low**.

4.2.3.10 Mal Secco

Mal secco is a serious fungal disease of citrus, particularly lemons, in the Mediterranean Basin (Tuttobene, 1993). Mal secco also affects *Fortunella*, *Poncirus* and *Severinia* species. Infection of grapefruit and sweet orange is rare and usually not severe (Solel & Salerno, 2000). Mal secco is a tracheomycotic disease causing wilting and dieback of citrus trees (Tuttobene, 1993). It causes a characteristic leaf veinal chlorosis, followed by shedding of the leaves and eventual dieback of the twigs and branches. Following the death of the woody tissue, the causal fungus invades the bark and forms pycnidia under the epidermis. Conidia are dispersed from the pycnidia for limited distances by raindrops and wind-blown rain (Solel & Salerno, 2000). Host resistance, in conjunction with cultural practices (removal and burning of infected twigs and branches and spraying with fungicides), is the most effective means of control (Palm, 1987).

The pathogen examined in this extension of existing policy is:

- *Phoma tracheiphila* (Petri) Kantachveli & Gikachvili – mal secco

Introduction and spread probability

Probability of importation

The likelihood that *Phoma tracheiphila* will arrive in the PRA area with the importation of sweet oranges from Italy: **Low**.

- *Phoma tracheiphila* has been reported on lemon, sour orange, citron, bergamot and chinotto orange (*Citrus myrtifolia*) in Italy (AAN, 1998).
- Infection of trees of cultivars of sweet orange (*Citrus sinensis*) is rare and usually not severe (Solel & Salerno, 2000).
- The fungus has affected normally tolerant cultivars of sweet oranges under favourable conditions (Solel & Oren, 1975).
- In lemon, fruit infection occurs when the pathogen moves from infected branches into fruit (Ippolito *et al*., 1987).
- There are no published records of fruit infection of sweet orange.
- Infected lemon fruit normally withers and falls to the ground. However, when infected branches desiccate rapidly the fruit remain attached, eventually mummifying on the tree (Ippolito *et al*., 1987).
- When unripe lemon fruit is infected, it shows partial or total yellowing of the peel, depending on the age of the infection. When ripe lemon fruit is infected, it turns dark yellow, almost reddish, in colour (Ippolito *et al*., 1987).
- Propagules of the pathogen were present in the greatest numbers from late autumn to early spring and their quantity appeared to be correlated to rainfall (Tuttobene, 1994).
- Lemon fruit showing symptoms of mal secco is likely to be detected during pre-export inspections but fruit in the early stages of infection could escape detection.
- If infected trees of lemon or other susceptible species are present in an orchard, conidia carried in wind blown rain could contaminate the surface of sweet orange fruit.
- Post harvest grading, washing and packing procedures are likely to remove conidia of this fungus from the fruit surface.

Probability of distribution

The likelihood that *Phoma tracheiphila* will be distributed to the endangered area as a result of the processing, sale or disposal of sweet oranges from Italy: **Low**.

- If sweet oranges were imported, they would be distributed in Australia for retail sale, as the intended use of the commodity is human consumption. Waste material would be generated.
- It is unlikely the fungus would survive for long periods in discarded waste, as infected fruit would rot quickly in dumpsites, landfills and compost heaps due to the activity of saprophytic organisms.
- On infected lemon fruit, conidia can be produced from both pycnidia and phialides produced on mycelium. Free phialides are only produced under specific conditions of humidity and temperature (Ippolito *et al*., 1987).
- Temperatures above 30°C stop mycelial growth but do not kill the fungus within infected host tissues (EPPO, 2004).
- The distance conidia could spread from citrus waste material by water splash is limited (Tuttobene, 1994), but natural hosts, including highly susceptible citrus species, are

widely distributed throughout Australia, both in commercial orchard districts and suburban areas.

- *Phoma tracheiphila* is seed-borne in lemon (Stepanov & Shaluishkina, 1952).
- *Phoma tracheiphila* survives in lemon seed as mycelium but is unable to pass from the seed coat to developing seedlings (Ippolito *et al*., 1987).

Probability of entry (importation x distribution)

The likelihood that *Phoma tracheiphila* will enter the PRA area as a result of trade in sweet oranges from Italy and be distributed in a viable state to the endangered area: **Very low**.

- 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 2).

Probability of establishment

The likelihood that *Phoma tracheiphila* 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**.

- *Phoma tracheiphila* has a wide range of natural hosts in the family Rutaceae including *Citrus* spp., *Poncirus trifoliata*, *Fortunella* spp. and *Severinia buxifolia* (Palm, 1987). Native citrus in the genera *Eremocitrus* and *Microcitrus* are widespread in Australia but their susceptibility to mal secco is not known.
- Lemon (*Citrus limon*), citron (*Citrus medica*) and mandarin (*Citrus reticulata*) and some of its hybrids are highly susceptible to the disease (Punithalingam & Holliday, 1973). Lime (*Citrus aurantifolia*) has been severely affected in Israel (Palm, 1987).
- Natural hosts, including highly susceptible citrus species, are widely distributed throughout Australia, both in commercial orchard districts and suburban areas.
- *Phoma tracheiphila* is established in the Mediterranean basin, around the Black Sea and in Asia Minor (Solel & Salerno, 2000). Environments similar to these areas exist in various parts of Australia.
- The temperature range at which infection occurs is considered to be between 14 and 28°C. The optimum temperature for growth of the pathogen, and for symptom expression, is 20-25°C, whereas the maximum temperature for mycelial growth is 30°C (Smith *et al.*, 1997b).
- Infection and transmission occur from November to February in Sicily and mid-November to mid-April in Israel, coinciding with the rainy season (Palm, 1987).
- In the Mediterranean region, infection periods depend on local climatic and seasonal conditions and in Sicily infections usually occur between September and April (Smith *et al.*, 1997b).
- The fungus enters the plant mainly through injuries to the leaves, branches, trunk and roots. Entry through stomata has not been proven (Palm, 1987).
- Injuries to trees caused by wind, frost and hail provide sites for initial infections (Perrotta & Graniti, 1988). Destructive outbreaks may occur after frost spells and hail storms in spring (Perrotta & Graniti, 1988).
- Young tissue is particularly susceptible to infection (Perrotta & Graniti, 1988).
- New infections are initiated by water-borne conidia (Solel, 1976).

- When infection starts in the canopy, it may take several years for the disease to move downward and involve the trunk. However, when the disease originates as a basal or root infection, tree collapse can be rapid.
- Development of races of *Phoma tracheiphila* has been postulated but specialisation in the fungus has not been reported (Palm, 1987).
- A combination of cultural practices, use of resistant cultivars and to a lesser extent chemical control treatments is used to manage and control this fungus (Palm, 1987).

Probability of spread

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

- *Phoma tracheiphila* spreads in the Mediterranean basin, around the Black Sea and in Asia Minor (Solel & Salerno, 2000), and environments similar to these areas exist in various parts of Australia.
- Natural hosts, including highly susceptible citrus species, are widely distributed throughout Australia, both in commercial orchard districts and suburban areas.
- The long distances between the main citrus production districts in Australia would make it difficult for this fungus to move directly from one district to another by natural spread.
- Conidia are produced by pycnidia present on infected host tissue (Punithalingam & Holliday, 1973), including branches, leaves and to a lesser extent, fruit on the ground (Holliday, 1980). Inoculum is usually provided by conidia extruded from pycnidia on withered twigs and suckers (EPPO, 2004).
- Conidia produced on the surface of wounds following pruning of infected twigs or branches can provide a source of inoculum for several weeks (Perrotta & Graniti, 1988).
- Conidia are also produced from phialides borne on free hyphae on exposed woody surfaces of the tree or on debris (Solel, 1976).
- Lemon fruit (Ippolito *et al*., 1987) and above ground shoots/branches/trunks (Palm, 1987) are known to carry spores and hyphae of the pathogen, which can be internally or externally borne.
- The fungus can survive within infected twigs in the soil for more than 4 months (Ippolito *et al*., 1987).
- Reports indicate that the disease spreads rapidly during autumn, winter and early spring but spread in the host ceases at high summer temperatures (Punithalingam & Holliday, 1973).
- Infection and transmission occur from November to February in Sicily and mid-November to mid-April in Israel, coinciding with the rainy season (Palm, 1987).
- Conidia are dispersed by wind and rain between trees and adjacent orchards (Solel, 1976).
- Long-distance spread of mal secco occurs through the movement of infected propagative material and plants (Laviola & Scarito, 1989). Interstate quarantine controls are in-place on the movement of nursery plants in Australia. Restrictions are in place on movement of budwood from Queensland.
- Birds and insects are suspected to be vectors of *Phoma tracheiphila* (Perrotta & Graniti, 1988).

Probability of entry, establishment or spread

The overall likelihood that *Phoma tracheiphila* will enter the PRA area as a result of trade in sweet oranges from Italy, be distributed in a viable state to suitable hosts, establish in that area and subsequently spread within the PRA area: **Very low**.

- The probability of entry, establishment or spread is determined by combining the probabilities of entry, of establishment and of spread using the matrix of 'rules' for combining descriptive likelihoods (Table 2).

Consequences

Consequences (direct and indirect) of the *Phoma tracheiphila*: **Moderate**.

Criterion	Estimate
Direct consequences	
Plant life or health	**D** — In the Mediterranean region, *Phoma tracheiphila* is the most destructive fungal disease of citrus. Up to 100% of trees of susceptible cultivars in lemon orchards can be affected (Perrotta & Graniti, 1988). The disease reduces the quantity and quality of citrus produced in the area where the pathogen is present, and limits the use of susceptible species and cultivars. Reduction in lemon yield in Italy has resulted in estimated annual losses of more than US$ 160 million (Palm, 1987). The disease not only lowers production but also kills trees.
Any other aspects of the environment	**B** — There are no known direct consequences of this pathogen on any other aspects of the environment. The fungus may affect native citrus (*Eremocitrus* spp. and *Microcitrus* spp.). The consequences are unlikely to be discernible at a national level.
Indirect consequences	
Eradication, control etc.	**D** — Programs to minimise the impact of this fungus on host plants are likely to be costly and include fungicidal applications and crop monitoring. No satisfactory genetic or chemical control measures are available for *Phoma tracheiphila*. Tolerant lemon cultivars have been selected in Italy but they lack the productivity and fruit quality of standard cultivars (Solel & Salerno, 2000). Therefore, eradication or control of this pathogen is likely to be significant at the regional level, if it were to establish.
Domestic trade	**C** — The presence of *Phoma tracheiphila* in commercial citrus production areas may have a significant affect due to possible interstate trade restrictions. These restrictions may lead to a loss of markets, which in turn would be likely to require industry adjustment.
International trade	**D** — The presence of *Phoma tracheiphila* in commercial citrus production areas may have a significant effect due to any limitations imposed on access to overseas markets while suitable phytosanitary management measures, where possible, are developed. This fungus is of quarantine concern to most regional plant protection organisations.
Environment	**A** — Fungicides required to control *Phoma tracheiphila* 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 3 (The assessment of local, district, regional and national consequences) and text under the 'Method for assessing consequences' section for details on the method used for consequence assessment).

Unrestricted risk estimate

The unrestricted risk estimate for *Phoma tracheiphila*, determined by combining the overall 'probability of entry, of establishment and of spread' with the 'consequences' using the risk estimation matrix (Table 4): **Very low**.

4.2.4 Risk assessment conclusion

Table 8 summarises the detailed risk assessments and provides unrestricted risk estimates for the quarantine pests considered to be associated with sweet oranges from Italy.

Mediterranean fruit fly, and citrophilus mealybug, citrus pyralid and citrus flower moth were assessed to have unrestricted estimates of moderate and low respectively. The unrestricted risk estimates for these pests exceed Australia's appropriate level of protection. Specific risk management measures are therefore required to be applied to import sweet oranges from Italy into Australia to adequately address the potential quarantine risk.

Five groups of arthropod pests (eriophyid mite, spider mite, false spider mite, scales and whiteflies) and one fungus (*Phoma tracheiphila*) were assessed to have an unrestricted risk of negligible or very low and therefore do not require the application of any specific phytosanitary measures in order to maintain Australia's appropriate level of protection.

Table 8: Unrestricted risk summary

Pest name	Probability of					Overall probability of entry, of establishment and of spread	Consequences	Unrestricted Risk
	Entry			Establishment	Spread			
	Importation	Distribution	Overall probability of entry					
ARTHROPODS								
Pink citrus rust mite	High	Very low	Very low	Moderate	Moderate	Very low	Low	Negligible
Citrus red mite	High	Very low	Very low	Moderate	Moderate	Very low	Low	Negligible
False spider mite	High	Low	Low	High	Moderate	Low	Low	Very low
Mediterranean fruit fly	High	Moderate	Moderate	High	Moderate	Low	High	**Moderate**
Citrophilus mealybug	High	Moderate	Moderate	High	High	Moderate	Low	**Low**
Scales	High	Low	Low	High	Moderate	Low	Low	Very low
Whiteflies	High	Low	Low	High	Moderate	Low	Low	Very low
Citrus pyralid	Moderate	Low	Low	High	High	Low	Moderate	**Low**
Citrus flower moth	Moderate	Low	Low	High	High	Low	Moderate	**Low**
PATHOGEN								
Mal Secco	Low	Low	Very low	High	High	Very low	Moderate	Very low

Table 9 provides the final list of quarantine pests of sweet oranges from Italy that have been assessed to have an unrestricted risk estimate above Australia's ALOP. These pests require the use of risk management measures in addition to the standard practices used in the production of commercial sweet oranges in Italy to meet Australia's ALOP. The proposed risk management measures are described in the following section.

Table 9: Quarantine pests of sweet oranges from Italy assessed to have unrestricted risk estimates above Australia's ALOP

Pest	Common name
ARTHROPODS	
Ceratitis capitata (Wiedemann) [Diptera: Tephritidae]	Mediterranean fruit fly; Medfly
Pseudococcus calceolariae (Maskell) [Hemiptera: Pseudococcidae]	Citrophilus mealybug
Cryptoblabes gnidiella (Millière) [Lepidoptera: Pyralidae]	Citrus pyralid
Prays citri Millière [Lepidoptera: Yponomeutidae]	Citrus flower moth

4.3 Stage 3: Pest 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 have an unrestricted risk estimate above Australia's ALOP via the importation of commercially produced sweet oranges from Italy, i.e. fruit from commercial production sites and subjected to standard cultivation, harvesting and packing activities.

It is important to note that it is only appropriate for the unrestricted risk estimates to take into account the minimum border procedures used by relevant government agencies and not those measures approved by such agencies that are intended to mitigate risks associated with the commodity itself. The minimum procedures include verifying that the commodity is as described in the shipping documents and identifying external and internal contaminations of containers and packaging. In order to have least trade restrictive measures, evaluation of restricted risk management options started with consideration of the use of a 600-unit inspection in detecting quarantine pests requiring risk management, and the subsequent remedial actions or treatments that might be applied if a quarantine pest is intercepted.

The standard AQIS sampling protocol requires inspection of 600 units, for quarantine pests in systematically selected random samples per homogeneous consignment or lot. The unit for citrus is defined as one fruit. Biometrically, if no pests are detected by the inspection, this size sample achieves a confidence level of 95% that not more than 0.5% of the units in the consignment are infested/infected. The level of confidence depends on each fruit in the consignment having about the same likelihood of being affected by a quarantine pest and the inspection technique being able to reliably detect all quarantine pests in the sample. If no live quarantine pests are detected in the sample, the consignment is considered to be free from quarantine pests and would be released from quarantine. Where a quarantine pest is intercepted in a sample, the remedial actions or treatments may (depending on the location of the inspection) include:

- withdrawing the consignment from export to Australia;
- re-export of the consignment from Australia;
- destruction of the consignment; or
- treatment of the consignment and re-inspection to ensure that the pest is no longer viable.

It should be emphasised that inspection is not a measure that mitigates the risk of a pest. It is the remedial actions or treatment that can be taken based on the results of the inspection that would reduce a pest risk.

Biosecurity Australia considers that the risk management measures proposed in this document will provide an appropriate level of protection against Mediterranean fruit fly, citrophilus mealybug, citrus pyralid and citrus flower moth. Various risk management measures may be suitable to manage the risks associated with sweet oranges from Italy. Biosecurity Australia will consider any other measures suggested by stakeholders that provide an equivalent level of phytosanitary protection.

Biosecurity Australia considers that the proposed risk management measures below are commensurate with the identified risks and, unless stakeholders suggest equivalent measures, the proposed measures will form the basis of final import conditions for sweet oranges from Italy.

Biosecurity Australia invites comment on the economic and technical feasibility of these proposed measures. In particular, technical comments are welcome on the appropriateness of the measures and any alternative measures that stakeholders consider would achieve the identified objectives. Note that Biosecurity Australia regards the measures proposed below to be consistent with measures that are currently in place for the importation of citrus from Egypt, Israel and Spain.

4.3.1 Risk management measures and phytosanitary procedures

The measures described below will form the basis of proposed import conditions for sweet oranges from Italy. These measures are detailed in the section entitled Draft Import Conditions.

The following measures and phytosanitary procedures are proposed to mitigate the risks identified in the PRA:

- cold treatment or pest free area for Medfly;
- inspection and remedial action for citrophilus mealybug, citrus pyralid and citrus flower moth; and
- operational systems for the maintenance and verification of the phytosanitary status of sweet oranges.

4.3.1.1 Mediterranean fruit fly

Mediterranean fruit fly (Medfly) has been assessed to have an unrestricted risk estimate of moderate and measures are therefore required to manage this risk.

Visual inspection of fruit alone is not considered to be an appropriate risk management measure because clear visual external signs of infestation (particularly in recently infested fruit) may not be present. If infested fruit was not detected at inspection, Medfly may enter, establish or spread in Australia.

Option 1: Cold treatment

Cold treatment is a measure that might be applied to manage the risk posed by Medfly. It is a disinfestation method applied to the fruit that is able to mitigate the level of risk by killing live fruit fly eggs and larvae present in infested fruit. Citrus fruit from Spain, Egypt and Israel is permitted entry into Australia with a cold treatment applied pre-export or in-transit that is effective against Medfly. The disinfestation schedule is presented in Table 10.

Table 10: Cold disinfestation schedule

Temperature	Exposure Period (days)
0.0°C (32°F) or below	10

0.6°C (33°F) or below	11
1.1°C (34°F) or below	12
1.7°C (35°F) or below	14
2.2°C (36°F) or below	16

The above table forms the cold disinfestation treatments schedule for all Medfly host produce being imported or exported into or from Australia under AQIS requirements.

Before such an option could be adopted in the form of import conditions, it would be necessary to confirm operational arrangements for the application of the treatment and for the maintenance and verification of the phytosanitary status of the sweet oranges in a manner acceptable to Australia, based on Australia's appropriate level of protection.

Subject to the necessary verifications and confirmations outlined above, the risk of entry, establishment or spread of Medfly associated with the importation of sweet oranges from Italy following cold treatment, as described above, would be negligible.

In the absence of the necessary verifications and confirmations outlined above, the risk of entry, establishment or spread of Medfly associated with the importation of sweet oranges from Italy following cold treatment as described above would be greater than very low (but would not exceed the unrestricted risk estimate of moderate). This is because treatment failure, either via inadequate application of the treatment or system failure via inadequate operational arrangements to maintain and verify the phytosanitary status of the sweet oranges, is likely to result in the presence of live fruit fly eggs or larvae in the fruit. The likelihood of this occurring depends on the nature and extent of the failure.

Option 2: Sourcing fruit from pest free areas

Area freedom is a measure that might be applied to manage the risk posed by Medfly. However, MPAF has not proposed that sweet oranges for export to Australia would be from Medfly pest free areas. If MPAF wishes to consider this option, Biosecurity Australia will assess the proposal.

If such a proposal came forward, it would be assessed according to the requirements for establishing, maintaining and verifying pest freedom for Medfly, as defined by the International Standards for Phytosanitary Measures (ISPM), Food and Agriculture Organization (FAO), Publication No. 10 *Requirements for the establishment of pest free places of production and pest free production sites.*

The objective of this risk management measure is to ensure that sweet oranges exported to Australia are not infested with Medfly. MPAF would be required to verify maintenance of pest free area status for this pest by routine crop monitoring/surveillance. Technical information justifying pest area freedom for Medfly must be provided to Biosecurity Australia for consideration.

4.3.1.2 Citrophilus mealybug, citrus pyralid and citrus flower moth

Citrophilus mealybug, citrus pyralid and citrus flower moth have been assessed to have an unrestricted risk estimate of low and measures are therefore required to manage this risk.

Inspection and remedial action

Visual inspection would involve the examination of a sample of sweet orange fruit to detect the presence of the citrophilus mealybug, citrus pyralid and citrus flower moth. Remedial action when pests are present is proposed as an appropriate risk management option for these pests, given that trained inspectors can readily detect these pests.

The objective of this measure is to ensure that consignments of sweet oranges from Italy infested with these pests can be readily identified and subjected to appropriate remedial action. This measure is considered to reduce the risk associated with citrophilus mealybug, citrus pyralid and citrus flower moth to a very low level.

4.3.1.3 Operational systems for the maintenance and verification of phytosanitary status

It is necessary to have a system of operational procedures in place to ensure that the phytosanitary status of sweet oranges, from Italy is maintained and verified during the process of production and export to Australia. Biosecurity Australia proposes a system that is equivalent to the systems currently in place for the importation of citrus from Spain, Egypt and Israel. Details of the system, or equivalent, will be determined by agreement with MPAF.

The proposed system of operational procedures for the production and export of sweet oranges from Italy to Australia would include:

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

4.3.1.3a Registration of export orchards

All sweet oranges exported from Italy must be sourced from registered export orchards. Copies of the registration records must be available for audit by AQIS if requested. MPAF will be required to register all export orchards prior to commencement of exports from that orchard.

The hygiene of export orchards must be maintained by appropriate pest management options that have been approved by MPAF, to manage pests and diseases of quarantine concern to Australia. Registered growers must keep records of control measures for auditing purposes. If required, the details of the pest control program will be submitted to Biosecurity Australia/AQIS through MPAF.

The objective of this procedure is to ensure that orchards from which sweet oranges are sourced can be identified. This is to allow trace-back to individual orchards in the event of non-compliance. For example, if live pests are regularly intercepted during on arrival inspection, the ability to identify a specific orchard allows investigation and corrective action to be targeted rather than applying to all contributing orchards.

4.3.1.3b Registration of packinghouses and auditing of procedures

All packinghouses intending to export fruit to Australia will be required to be registered with MPAF for trace-back purposes.

Packinghouses will be required to identify individual orchards with a unique identifying system and identify fruit from individual orchards by marking cartons or pallets (i.e. one orchard per pallet) with a unique orchard number.

4.3.1.3c Packaging and labelling

All sweet oranges for export must be free from regulated articles[1] (e.g. trash) and pests of quarantine concern to Australia. No unprocessed packing material of plant origin will be allowed. All wood material used in packaging of sweet oranges must comply with the AQIS conditions, as set out in "Cargo containers: quarantine aspects and procedures".

All boxes must be labelled with the orchard registration number. 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 sweet oranges exported to Australia are not contaminated by regulated articles and pests of quarantine concern to Australia; and
- Unprocessed packing material is not imported with sweet oranges.

4.3.1.3d Specific conditions for storage and movement

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

Product for export to Australia that has been inspected and certified by MPAF must be maintained in secure conditions that will prevent mixing with fruit for domestic consumption or export to other destinations.

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

Arrangements for secure storage and movement of produce are to be developed by MPAF in consultation with Biosecurity Australia/AQIS.

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

4.3.1.3e Phytosanitary inspection by MPAF

MPAF will inspect all consignments in accordance with official procedures for all visually detectable quarantine pests and other regulated articles. Sample rates must achieve a confidence level of 95% that not more than 0.5% of the units in the consignment are infested/infected. This equates to a level of zero unit infested by quarantine pests in a

[1] The IPPC defines regulated article as "any plant, plant product, storage place, packaging, conveyance, container, soil and any other organism, object or material capable of harbouring or spreading pests, deemed to require phytosanitary measures, particularly where international transportation is involved.

random sample size of 600 units from the homogenous lot in the consignment[2]. The 600-unit sample must be selected randomly from every lot[3] in the consignment.

Detection of live quarantine pests or other regulated articles will result in failure of the consignment. If a consignment fails inspection by MPAF, the exporter will be given the option of treatment and re-inspection of the consignment or removal of the consignment from the export pathway.

Records of the interceptions made during these inspections (live or dead quarantine pests, and regulated articles) are to be maintained by MPAF 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.

4.3.1.3f Phytosanitary certification by MPAF

MPAF will issue a phytosanitary certificate for each consignment after 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 undertaken offshore. Each phytosanitary certificate is to contain the following additional declaration:

> *"The sweet oranges in this consignment have been produced in Italy in accordance with the conditions governing entry of sweet oranges to Australia and inspected and found free of quarantine pests"*

consistent with International Standards for Phytosanitary Measures No. 7 *Export Certification Systems* (FAO, 1997).

4.3.1.3g On-arrival phytosanitary inspection by AQIS

AQIS will undertake a documentation compliance examination for consignment verification purposes prior to inspection and release from quarantine. Consignments will be inspected by AQIS on arrival in Australia, using the AQIS standard sampling plan. No land bridging of goods will be permitted unless goods have cleared quarantine. The detection of live quarantine pests and/or regulated article will result in the failure of the inspection lot.

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

4.3.2 Action for non-complying lots

Where inspection lots are found to be non-compliant with requirements, then remedial action must be taken as outlined at the beginning of this section. If product continually fails inspection, Biosecurity Australia/AQIS reserves the right to suspend the export program and conduct an audit of the citrus risk management systems in Italy. The program will recommence only after Biosecurity Australia/AQIS is satisfied that appropriate corrective action has been taken.

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[2] A consignment is the number of boxes of sweet oranges from shipment from Italy to Australia covered by one phytosanitary certificate.

[3] An inspection lot is the number of boxes presented for a single phytosanitary inspection.

4.3.3 Uncategorised pests

If an organism is detected on sweet oranges from Italy 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.

4.3.4 Conclusions

The findings of this draft extension of existing policy are based on a comprehensive analysis of relevant available scientific literature and existing import requirements for citrus from Egypt, Israel and Spain.

Biosecurity Australia considers that the risk management measures proposed in the draft extension of existing policy will provide an appropriate level of protection against the pests identified in the PRA. Various risk management measures may be suitable to manage the risks associated with sweet oranges, from Italy and Biosecurity Australia will consider any other measures suggested by stakeholders that provide an equivalent level of phytosanitary protection.

5 DRAFT IMPORT CONDITIONS

The draft import conditions described below are based on the conclusions of the pest risk analysis contained in this draft extension of existing policy. Specifically, they reflect the proposed risk management measures in the previous section.

The components of the import conditions are summarised in dot point format below and the risk management measure that links with each component is given in brackets ( ).

- Registration of export orchards (4.3.1.3a)
- Registration of packinghouses and auditing of procedures (4.3.1b)
- Orchard control program (4.3.1.3a)
- Pre-export cold treatment (4.3.3.1)
- Packing and labelling (4.3.1.3c)
- Storage (4.3.1.3d)
- Pre-export phytosanitary inspection (4.3.1.3e)
- Phytosanitary certification (4.3.1.3f)
- On-arrival phytosanitary inspection by AQIS (4.3.1.3g)
- Review of protocol

5.1 Registration of Export Orchards

Sweet oranges for export to Australia must be sourced from orchards registered with MPAF. Copies of the registration records must be made available to AQIS if requested. Registration by MPAF is required to enable trace-back in the event of non-conformance.

All export orchards are expected to produce commercial sweet oranges under Italy's commercial cultivation, harvesting and packing practices.

5.2 Registration of Packinghouses and Auditing of Procedures

All packinghouses intending to export fruit to Australia must be registered with the MPAF, for trace-back purposes.

Packinghouses must identify individual orchards with a numbering system and identify fruit from individual orchards by marking cartons or pallets (one orchard per pallet) with a unique orchard number. The packinghouse and packing area would need to be well lit, and the storage areas will need to be secure to ensure fruit is not infested after packing.

Packing procedures must ensure that the sweet oranges are free of arthropods and diseases of concern to Australia and trash.

MPAF must ensure that fruit destined for Australia is not mixed with fruit for other destinations. The identity and origin of the fruit for export must be maintained throughout the process.

The list of registered packinghouses must be kept by MPAF and provided to AQIS prior to exports commencing, with updates provided if packinghouses are added or removed from the list. A sample of growers and packinghouses are to be audited by MPAF at agreed intervals to ensure compliance with Biosecurity Australia requirements. This would be performed initially on an annual basis until the effectiveness of the system can be assessed.

5.3 Orchard Control Program

Registered growers must implement an orchard control program (i.e. good agricultural practice/integrated pest management (IPM) programs for export sweet oranges) that has been approved by MPAF, incorporating field sanitation and appropriate biocontrol and/or pesticide/fungicide applications for the management of pests and diseases of quarantine concern to Australia. MPAF will be responsible for ensuring that growers are aware of pests of quarantine concern to Australia, and that export orchards are subject to field sanitation and control measures against these pests. Registered growers must keep records of control measures for auditing purposes. If required, the details of the pest control program will be submitted to Biosecurity Australia/AQIS through MPAF.

If any pest of potential quarantine concern to Australia is detected, Biosecurity Australia/AQIS would require immediate notification by MPAF to ensure that appropriate action is taken.

5.4 Pre-export Cold Treatment

Cold treatment may be conducted in Italy or in-transit in containers designated by MPAF for such use. The temperature x time combinations specified in the treatment schedule as described under 4.3.1.1 is to be followed and recorded and monitored by MPAF. If treatment is conducted in containers, fruit must not be loaded until the pulp temperature of the fruit has reached the treatment temperature. If warehouses in Italy are used, MPAF will have to ensure the security of each consignment and check on the progress of the treatment.

5.5 Packing and Labelling

Sweet oranges must be packed into new cardboard boxes or cartons. No fresh or dried packing material of plant origin (e.g. straw) is to be used; only processed or synthetic packing material can be used.

Each carton must identify the packinghouse and be labelled with a unique ‘orchard’ number to allow trace-back in the event of non-compliance.

5.6 Specific Conditions for Storage and Movement of Produce

MPAF must ensure that:

- registered packinghouses are maintained in a condition that would provide security against reinfestation/reinfection;
- the movement of sweet oranges from the time of arrival at the storage premises through to the time of export is recorded; and
- records of sufficient detail to allow trace-back to orchard and packinghouse must be available to AQIS through MPAF, if required. Packinghouses must ensure that records are kept to facilitate auditing by MPAF during grading, packing and storage.

Fruit inspected and certified by MPAF for export to Australia must be stored under quarantine security and segregated by at least one metre from all other fruit in a cold store until loaded into refrigerated containers. MPAF must ensure that container doors are sealed after loading.

Non-compliance with any of the above requirements will result in suspension of the facility by MPAF until corrective action has been completed and AQIS has agreed to reinstate the facility.

5.7 Pre-export Inspection and Remedial Action

MPAF will inspect all consignments in accordance with the AQIS procedures for all visually detectable quarantine pests and other regulated articles[4] (e.g. trash). The AQIS sampling protocol requires inspection of 600 units for quarantine pests, in systematically selected random samples per homogeneous consignment[5] or lot[6]. Biometrically, if no pests are detected by the inspection, this size sample achieves a confidence level of 95% that not more than 0.5% of the units in the consignment are infested/infected. The level of confidence depends on each fruit in the consignment having about the same likelihood of being affected by a quarantine pest and the inspection technique being able to reliably detect all quarantine pests in the sample. For citrus AQIS defines a unit as one fruit.

The detection of live quarantine pests or regulated articles during an inspection will result in the failure of the inspection lot. Remedial action may then be taken. Action may include:

- withdrawing the consignment from export to Australia; or
- treatment of the consignment and re-inspection to ensure that the pest is no longer viable.

The export program to Australia will be suspended if any live Mediterranean fruit flies are detected in cold disinfested fruit, until Biosecurity Australia and MPAF are satisfied that appropriate corrective action has been taken.

Records of the interceptions made during these inspections (live quarantine pests, and regulated articles) must be maintained by MPAF 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.

5.8 Phytosanitary Certification

MPAF will issue an International Phytosanitary Certificate (IPC) for each consignment upon completion of pre-export inspection and cold treatment for Medfly disinfestation, containing the following information:

[4] The IPPC defines regulated article as "any plant, plant product, storage place, packaging, conveyance, container, soil and any other organism, object or material capable of harbouring or spreading pests, deemed to require phytosanitary measures, particularly where international transportation is involved.

[5] A consignment is the number of boxes of sweet oranges from shipment from Italy to Australia covered by one phytosanitary certificate.

[6] An inspection lot is the number of boxes presented for a single phytosanitary inspection.

Additional declarations

- Additional declaration stating, *"The sweet oranges in this consignment have been produced in Italy in accordance with the conditions governing entry of sweet oranges to Australia and inspected and found free of quarantine pests"*.

Distinguishing marks

- The appropriate 'orchard' numbers, packinghouse identification, number of cartons per 'inspection lot', container and seal numbers, and date.

Treatments

- For cold treatment: method of treatment (pre-shipment or in-transit), treatment temperature, duration and dates of treatment.

5.9 On-arrival Inspection, Remedial Action and Clearance by AQIS

On arrival, each consignment will be inspected by AQIS and documentation will be examined for consignment verification purposes at the port of entry in Australia prior to release from quarantine.

The standard AQIS inspection protocol will apply. The sampling methodology provides 95% confidence that there is not more than 0.5% infestation in the consignment. The sample size for inspection of sweet oranges is given below.

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

* Unit = one sweet orange fruit

If no live quarantine pests are detected in the sample, the consignment is considered to be free from quarantine pests and would be released from quarantine.

5.9.1 Remedial action

If live quarantine pests or regulated articles are found during an inspection, the importer will be given the option to treat (if a suitable treatment is available), re-export or destroy the consignment.

5.9.2 Documentation errors

Any 'consignment' with incomplete documentation, or where certification does not conform to specifications, or seals on the containers are damaged or missing, will be held pending clarification by MPAF and determination by AQIS, with the options of re-export or destruction. MPAF will be notified immediately by AQIS of any such problems.

5.10 Audit of Protocol

During the first season of trade, an officer from Biosecurity Australia and/or an officer from AQIS will visit areas in Italy designated for export of sweet oranges to Australia in order to audit the operation of the protocol including registration and operational procedures.

5.11 Review of Policy

This policy will be reviewed at the end of the first year of export of sweet oranges from Italy to Australia and in the event of new outbreaks in Italy of pests of concern to Australia.

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APPENDIX – 1: PEST CATEGORISATION

1a: Pest Categorisation for sweet oranges from Italy (Presence/Absence)

1b: Pest Categorisation for sweet oranges from Italy (pathway association)

1c: Potential for establishment or spread and associated consequences for pests of sweet oranges from Italy

Appendix – 1a: Pest Categorisation for sweet oranges from Italy – (Presence/Absence)

Pest	Common name	Presence in		Consider further (yes/no)
		Italy	Australia	
ARTHROPODS				
Acari (mites)				
Aceria sheldoni (Ewing) [Acari: Eriophyidae]	Bud mite	AAN, 1998	AICN, 2004	
Aculops pelekassi (Keifer) [Acari: Eriophyidae]	Pink citrus rust mite	AAN, 1998		Yes
Aculus schlechtendali (Nalepa) [Acari: Eriophyidae]	Apple rust mite	Ceparano & Job, 1996	AICN, 2004	
Amblydromella rhenanoides (Athias-Henriot) [Acari: Phytoseiidae]	Predatory mite	Vacante & Nucifora, 1986a		Yes
Amblyseius barkeri (Hughes) [Acari: Phytoseiidae]	Predatory mite	Vacante & Nucifora, 1986a		Yes
Amblyseius degenerans (Berlese) [Acari: Phytoseiidae]	Predatory mite	Vacante & Nucifora, 1986a		Yes
Amblyseius italicus Chant [Acari: Phytoseiidae]	Predatory mite	Vacante *et al*., 1988		Yes
Amblyseius largoensis (Muma) [Acari: Phytoseiidae]	Predatory mite	Vacante & Nucifora, 1986a		Yes
Amblyseius messor (Weinstein) [Acari: Phytoseiidae]	Predatory mite	Vacante & Nucifora, 1986a		Yes
Amblyseius potentillae (Garman) [Acari: Phytoseiidae]	Predatory mite	Vacante & Nucifora, 1986a		Yes
Amblyseius stipulatus Athias-Henriot [Acari: Phytoseiidae]	Predatory mite	Vacante & Nucifora, 1986a		Yes
Amblyseius swirskii Athias-Henriot [Acari: Phytoseiidae]	Predatory mite	Vacante & Nucifora, 1986a		Yes
Anystis baccarum Linnaeus [Acari: Anystidae]	Whirlygig mite	Vacante *et al*., 1988	Holm & Wallace, 1989; ICDB, 2002	
Aplonobia histricina (Berlese) [Acari: Tetranychidae]	Soursob mite	Vacante & Nucifora, 1986a	AICN, 2004; ICDB, 2002	
Brevipalpus californicus (Banks) [Acari: Tenuipalpidae]	Red flat mite	AAN, 1998	AICN, 2004; ICDB, 2002	
Brevipalpus cuneatus Canestrini & Fanzago [Acari: Tenuipalpidae]	False spider mite	AAN, 1998		Yes
Brevipalpus obovatus Donnadieu [Acari: Tenuipalpidae]	Privet mite	Vacante & Nucifora, 1986a	AICN, 2004	
Brevipalpus phoenicis (Geijskes) [Acari: Tenuipalpidae]	False spider mite	AAN, 1998	AICN, 2004; Williams, 2001	

Pest	**Common name**	**Presence in**		**Consider further (yes/no)**
		Italy	Australia	
Bryobia praetiosa Koch [Acari: Tetranychidae]	Almond mite	Vacante & Nucifora, 1986a	Halliday, 1998; Michael & Carmody, 2002	
Calvolia hebeclinii Sicher [Acari: Saproglyphidae]	Astigmatid mite	Vacante & Nucifora, 1986a		Yes
Cheletogenes ornatus (Canestrini & Fanzago) [Acari: Cheyletidae]	Cheyletid mite	Vacante & Nucifora, 1986a		Yes
Cheletomimus berlesei (Oudemans) [Acari: Cheyletidae]	Cheyletid mite	Vacante & Nucifora, 1986a		Yes
Cheletomimus minutes (Oudemans) [Acari: Cheyletidae]	Cheyletid mite	Vacante & Nucifora, 1986a		Yes
Cunaxa capreolus Berlese [Acari: Cunaxidae]	Cunaxid mite	Vacante & Nucifora, 1986a		Yes
Cunaxa setirostris (Hermann) [Acari: Cunaxidae]	Cunaxid mite	Vacante & Nucifora, 1986a		Yes
Cunaxoides oliveri Schruft [Acari: Cunaxidae]	Cunaxid mite	Vacante *et al*., 1988		Yes
Daidalotarsonemus vandevrieri Suski [Acari: Tarsonemidae]	Tarsonemid mite	Vacante *et al*., 1988		Yes
Eryngiopus bifidus Wood [Acari: Stigmaeidae]	Stigmaeid mite	Vacante & Gerson, 1987		Yes
Eryngiopus siculus Vacante & Gerson [Acari: Stigmaeidae]	Predatory mite	Vacante & Gerson, 1987		Yes
Eupelops acromios (Hermann) [Acari: Phenopelopidae]	Oribatid mite	Vacante *et al*., 1988		Yes
Eutogenes citri Gerson [Acari: Cheyletidae]	Cheyletid mite	Vacante & Nucifora, 1986a		Yes
Fungitarsonemus monasterii Lombardini [Acari: Tarsonemidae]	Tarsonemid mite	Vacante & Nucifora, 1986a		Yes
Glycyphagus domesticus (DeGeer) [Acari: Glycyphagidae]	House itch mite	Vacante & Nucifora, 1986a	AICN, 2004	
Hemisarcoptes malus (Shimer) [Acari: Hemisarcoptidae]	Hemisacopid mite	Vacante & Nucifora, 1986a		Yes
Hirstiella insignis Berlese [Acari: Pterygosomatidae]	Mite	Vacante *et al*., 1988		Yes
Humerobates rostrolamellatus Grandjean [Acari: Ceratozetidae]	Oribatid mite	Vacante & Nucifora, 1986a		Yes
Kampimodromus aberrans Oudemans [Acari: Phytoseiidae]	Predatory mite	Vacante & Nucifora, 1986a		Yes
Ledermuelleriopsis plumosus Willmann [Acari: Stigmaeidae]	Astigmatid mite	Vacante & Nucifora, 1986a		Yes
Lorryia australensis (Baker) [Acari: Tydeidae]	Tydeid mite	Vacante & Nucifora, 1986a		Yes
Lorryia ferula Baker [Acari: Tydeidae]	Tydeid mite	Vacante & Nucifora, 1986a		Yes
Lorryia formosa Cooreman [Acari: Tydeidae]	Tydeid mite	Vacante *et al*., 1988		Yes
Lorryia reticulata (Oudemans) [Acari: Tydeidae]	Tydeid mite	Vacante & Nucifora, 1986a		Yes
Lorryia teresae (Carmona) [Acari: Tydeidae]	Tydeid mite	Vacante & Nucifora, 1986a		Yes

Pest	Common name	Presence in		Consider further (yes/no)
		Italy	Australia	
Mediolata similans Willmann [Acari: Stigmaeidae]	Astigmatid mite	Vacante *et al*., 1988		Yes
Metalorryia magdalenae (Baker) [Acari: Tydeidae]	Tydeid mite	Vacante *et al*., 1988		Yes
Micreremus gracilior Willmann [Acari: Micremidae]	Oribatid mite	Vacante & Nucifora, 1986b		Yes
Neoseiulus californicus McGregor [Acari: Phytoseiidae]	Predatory mite	Vacante & Nucifora, 1986a		Yes
Orthotydeus californicus (Banks) [Acari: Tydeidae]	Tydeid mite	Vacante & Nucifora, 1986a		Yes
Orthotydeus caudatus (Dugès) [Acari: Tydeidae]	Tydeid mite	Vacante & Nucifora, 1986a		Yes
Orthotydeus foliorum [Acari: Tydeidae]	Tydeid mite	Vacante & Nucifora, 1986a		Yes
Orthotydeus kochi Oudemans [Acari: Tydeidae]	Tydeid mite	Castagnoli, 1984		Yes
Panonychus citri McGregor [Acari: Tetranychidae]	Citrus red mite	AAN, 1998	AICN, 2004 (except WA)	Yes
Petrobia tunisiae Manson [Acari: Tetranychidae]	Spider mite	Vacante & Nucifora, 1986a		Yes
Phauloppia lucorum C. L. Koch [Acari: Oribatulidae]	Oribatulid mite	Vacante *et al*., 1988		Yes
Phyllocoptruta oleivora (Ashmead) [Acari: Eriophyidae]	Citrus rust mite	CABI, 2004	AICN, 2004; Woods *et al*., 1996	
Phytoseiulus finitimus Ribaga [Acari: Phytoseiidae]	Predatory mite	Vacante & Nucifora, 1986a		Yes
Phytoseiulus panormita Ragusa & Swirski [Acari: Phytoseiidae]	Predatory mite	Vacante *et al*., 1988		Yes
Phytoseiulus persimilis Athias-Henriot [Acari: Phytoseiidae]	Chilean predatory mite	Vacante & Nucifora, 1986a	Graham & Gatter, 1990	
Polyphagotarsonemus latus Banks [Acari: Tarsonemidae]	Broad mite	AAN, 1998	AICN, 2004	
Proctolaelaps pygmaeus (Muller) [Acari: Ascidae]	Ascid mite	Vacante & Nucifora, 1986a	Halliday *et al*., 2004	
Pronematus ubiquitus (McGregor) [Acari: Tydeidae]	Tydeid mite	Vacante & Nucifora, 1986a		Yes
Seiulus amaliae Ragusa & Swirski [Acari: Phytoseiidae]	Predatory mite	Vacante & Nucifora, 1986a		Yes
Seiulus finlandicus (Oudemans) [Acari: Phytoseiidae]	Predatory mite	Vacante *et al*., 1988		Yes
Siculobata sicula Berlese [Acari: Oribatulidae]	Oribatulid mite	Vacante & Nucifora, 1986a		Yes
Tarsonemus aurantii Oudemans [Acari: Tarsonemidae]	Tarsonemid mite	Vacante & Nucifora, 1986a		Yes
Tarsonemus bilobatus Suski [Acari: Tarsonemidae]	Tarsonemid mite	Nucifora & Vacante, 2004		Yes
Tarsonemus confusus Ewing [Acari: Tarsonemidae]	Tarsonemid mite	Vacante *et al*., 1988		Yes

Pest	Common name	Presence in		Consider further (yes/no)
		Italy	Australia	
Tarsonemus floricolus Canestrini & Fanzago [Acari: Tarsonemidae]	Tarsonemid mite	Nucifora & Vacante, 2004		Yes
Tarsonemus idaeus Suski [Acari: Tarsonemidae]	Tarsonemid mite	Nucifora & Vacante, 2004		Yes
Tarsonemus lobosus Suski [Acari: Tarsonemidae]	Tarsonemid mite	Nucifora & Vacante, 2004		Yes
Tarsonemus parawaitei Kim *et al*. [Acari: Tarsonemidae]	Tarsonemid mite	Vacante *et al*., 1988	Kim *et al*., 1987 (except WA)	Yes
Tarsonemus smithi Ewing [Acari: Tarsonemidae]	Tarsonemid mite	Vacante & Nucifora, 1986a		Yes
Tarsonemus waitei Banks [Acari: Tarsonemidae]	Tarsonemid mite	Vacante & Nucifora, 1986a	Smith *et al*., 1997 (except WA)	Yes
Tetranychina harti (Ewing) [Acari: Tetranychidae]	Spider mite	Ciampolini *et al*., 1985		Yes
Tetranychus urticae Koch [Acari: Tetranychidae]	Two spotted spider mite	AAN, 1998	AICN, 2004; ICDB, 2002	
Thyreophagus cooremani Fain [Acari: Acaridae]	Acarid mite	Vacante, 1989		Yes
Thyreophagus corticalis (Michael) [Acari: Acaridae]	Acarid mite	Vacante & Nucifora, 1986a		Yes
Thyreophagus entomophagus (Laboulbène & Robin) [Acari: Acaridae]	Thyreophagus flour mite	Vacante & Nucifora, 1986a	AICN, 2004	
Thyreophagus entomophagus italicus Vacante [Acari: Acaridae]	Acarid mite	Vacante, 1989		Yes
Thyreophagus gallegoi Portus & Gomez [Acari: Acaridae]	Acarid mite	Vacante, 1989		Yes
Trichoribates angustatus Mihelcic [Acari: Ceratozetidae]	Mite	Vacante & Nucifora, 1986a		Yes
Triophtydeus triophthalmus (Oudemans) [Acari: Tydeidae]	Tydeid mite	Vacante & Nucifora, 1986a		Yes
Typhlodromus athenas Porath & Swirski [Acari: Phytoseiidae]	Predatory mite	Vacante & Nucifora, 1986a		Yes
Typhlodromus cryptus (Oudemans) [Acari: Phytoseiidae]	Predatory mite	Vacante & Nucifora, 1986a		Yes
Typhlodromus exhilaratus Ragusa [Acari: Phytoseiidae]	Predatory mite	Ragusa, 1981		Yes
Typhlodromus phialatus Athias-Henriot [Acari: Phytoseiidae]	Predatory mite	Vacante *et al*., 1988		Yes
Typhlodromus talbii Athias-Henriot [Acari: Phytoseiidae]	Predatory mite	Vacante *et al*., 1988		Yes
Tyrophagus neiswanderi Johnson & Bruce [Acari: Acaridae]	Acarid mite	Vacante, 1989		Yes
Tyrophagus palmarum (Oudemans) [Acari: Acaridae]	Acarid mite	Vacante *et al*., 1988		Yes
Tyrophagus putrescentiae (Schrank) [Acari: Acaridae]	Cereal mite	Vacante & Nucifora, 1986a	ICDB, 2002	

Pest	Common name	Presence in		Consider further (yes/no)
		Italy	Australia	
Tyrophagus tropicus Robertson [Acari: Acaridae]	Acarid mite	Vacante & Nucifora, 1986a		Yes
Zetzellia collyerae (Gonzalez-Rodriguez) [Acari: Stigmaeidae]	Stigmaeid mite	Vacante & Nucifora, 1986a		Yes
Zetzellia graeciana Gonzales [Acari: Stigmaeidae]	Stigmaeid mite	Vacante & Nucifora, 1986a		Yes
Zetzellia mali (Ewing) [Acari: Stigmaeidae]	Stigmaeid mite	Vacante & Nucifora, 1986a		Yes
Coleoptera (beetles, weevils)				
Adalia bipunctata Linnaeus [Coleoptera: Coccinellidae]	Two-spotted ladybird	AAN, 1998	AICN, 2004	
Anoplophora malasiaca (Thomson) [Coleoptera: Cerambycidae]	Longicorn beetle	CABI, 2004		Yes
Apate monachus Fabricius [Coleoptera: Bostrichidae]	Black borer	CABI, 2004		Yes
Aphtona nigriceps Redtb [Coleoptera: Chrysomelidae]	Chrysomelid beetle	Benfatto & Longo, 1986		Yes
Araecerus coffeae (Fabricius) [Coleoptera: Anthribidae]	Coffee bean weevil	Mphuru, 1974	APPD, 2004	
Asynonychus cervinus (Boheman) [Coleoptera: Curculionidae]	Fuller's rose weevil	CABI, 2004	Smith *et al*., 1997	
Carpophilus hemipterus (Linnaeus) [Coleoptera: Nitidulidae]	Dried fruit beetle	Giudice & Lanza, 1973	James *et al*., 2000	
Carpophilus humeralis (Fabricius) [Coleoptera: Nitidulidae]	Pineapple sap beetle	Ciampolini & Maiulini, 1991	James et al., 1995	
Carpophilus mutilatus Erichson [Coleoptera: Nitidulidae]	Flower beetle	CABI, 2004	James *et al*., 2000	
Cetonia arurata Linnaeus [Coleoptera: Scarabeidae]	Flower weevil	Benfatto & Longo, 1986		Yes
Coccinella septempunctata Linnaeus [Coleoptera: Coccinellidae]	Seven-spotted ladybird	CABI, 2004		Yes
Crepidptera impressa Fabricius [Coleoptera: Chrysomelidae]	Chrysomelid beetle	Benfatto & Longo, 1986		Yes
Crepidptera ventralis [Coleoptera: Chrysomelidae]	Chrysomelid beetle	Benfatto & Longo, 1986		Yes
Cryptolaemus montrouzieri Mulsant [Coleoptera: Coccinellidae]	Mealybug ladybird	CABI, 2004	Booth & Pope, 1986	
Epitrix hirtipennis (Melsheimer) [Coleoptera: Chrysomelidae]	Tobacco flea beetle	CABI, 2004		Yes
Longitarsus brunneus Duft [Coleoptera: Chrysomelidae]	Chrysomelid beetle	Benfatto & Longo, 1986		Yes
Longitarsus tabidus Fabricius [Coleoptera: Chrysomelidae]	Chrysomelid beetle	Benfatto & Longo, 1986		Yes
Otiorhynchus armatus Bodenheimer [Coleoptera: Curculionidae]	Curculio weevil	Benfatto & Longo, 1986		Yes
Otiorhynchus cribricollis Gyllenhal [Coleoptera: Curculionidae]	Curculio weevil	AAN, 1998	AICN, 2004	
Otiorhynchus rhacusensis Germ. [Coleoptera: Curculionidae]	Curculio weevil	Benfatto & Longo, 1986		Yes
Oxythyrea funesta Poda [Coleoptera: Scarabeidae]	Scarabeid weevil	Benfatto & Longo, 1986		Yes

Pest	Common name	Presence in		Consider further (yes/no)
		Italy	Australia	
Pentodon punctatus Vill [Coleoptera: Scarabeidae]	Scarabeid weevil	Benfatto & Longo, 1986		Yes
Rhizotrogus rugifrons Burmeister [Coleoptera: Scarabaeidae]	Scarab beetle	Zanardi *et al*., 1979		Yes
Rodolia cardinalis Mulsant [Coleoptera: Curculionidae]	Vedalia ladybird	CABI, 2004	AICN, 2004	
Stethorus punctillum (Weise) [Coleoptera: Coccinellidae]	Mite eating ladybird	CABI, 2004		Yes
Synoxylon sexdentatum Oliver [Coleoptera: Bostrichidae]	Bostrichid beetle	Benfatto & Longo, 1986		Yes
Trichoferus griseus Fabricius [Coleoptera: Cerambycidae]	Cerambycid beetle	Benfatto & Longo, 1986		Yes
Tropinota hirta Poda [Coleoptera: Scarabeidae]	Scarabeid weevil	Benfatto & Longo, 1986		Yes
Tropinota squalida Scopoli [Coleoptera: Scarabeidae]	Scarabeid weevil	Benfatto & Longo, 1986		Yes
Xylomedes coronata Mars [Coleoptera: Bostrichidae]	Bostrichid beetle	Benfatto & Longo, 1986		Yes
Dermaptera (Earwigs)				
Forficula auricularia Linnaeus. [Dermaptera: Forficulidae]	European earwig	Santini, 1995	AICN, 2004	
Diptera (flies)				
Ceratitis capitata (Wiedemann) [Diptera: Tephritidae]	Mediterranean fruit fly; Medfly	AAN, 1998	WA only (Under official control)	Yes
Syrphus spp. [Diptera: Syrphidae]	Hover fly	AAN, 1998		Yes
Hemiptera (aphids, leafhoppers, mealybugs, scales, true bugs, whiteflies)				
Aleurothrixus floccosus (Maskell) [Hemiptera: Aleyrodidae]	Woolly whitefly	CABI/EPPO, 1997		Yes
Aonidiella aurantii (Maskell) [Hemiptera: Diaspididae]	California red scale	AAN, 1998	AICN, 2004	
Aonidiella citrina (Coquillet) [Hemiptera: Diaspididae]	Citrus yellow scale	CABI/EPPO, 1998	AICN, 2004; Watson, 2004	
Aphis craccivora Koch [Hemiptera: Aphididae]	Cowpea aphid	AAN, 1998	APPD, 2004	
Aphis fabae Scopoli [Hemiptera: Aphididae]	Black bean aphid	AAN, 1998		Yes
Aphis gossypii Glover [Hemiptera: Aphididae]	Cotton aphid	AAN, 1998	APPD, 2004	
Aphis spiraecola Patch [Hemiptera: Aphididae]	Brown citrus aphid	CABI/EPPO, 2001	APPD, 2004	
Aspidiotus nerii Bouché [Hemiptera: Diaspididae]	Aucuba scale	AAN, 1998	AICN, 2004; Abbot, 1995	
Asymmetrasca decedens (Paoli) [Hemiptera: Cicadellidae]	Green leafhopper	AAN, 1998		Yes
Bemisia afer (Priesner & Hosny) [Hemiptera: Aleyrodidae]	Whitefly	Martin, 1987	Martin, 1999 (except WA)	Yes

Pest	Common name	Presence in		Consider further (yes/no)
		Italy	Australia	
Bemisia tabaci biotype B (Gennadius) [Hemiptera: Aleyrodidae]	Tobacco whitefly	CABI, 2004	APPD, 2004 (Under official control in WA)	Yes
Calocoris trivialis (Costa) [Hemiptera: Miridae]	Mirid bug	AAN, 1998		Yes
Ceroplastes floridensis Comstock [Hemiptera: Coccidae]	Florida wax scale	Ben-Dov, 1993	AICN, 2004 (except WA)	Yes
Ceroplastes japonicus Green [Hemiptera: Coccidae]	Wax scale	Pellizzari & Camporese, 1994		Yes
Ceroplastes rusci (Linnaeus) [Hemiptera: Coccidae]	Fig tree scale	AAN, 1998	AICN, 2004 (Except WA)	Yes
Ceroplastes sinensis Del Guercio [Hemiptera: Coccidae]	Chinese wax scale	AAN, 1998	AICN, 2004	
Chrysomphalus aonidum (Linnaeus) [Hemiptera: Diaspididae]	Citrus black scale	CABI, 2004	APPD, 2004	
Chrysomphalus dictyospermi (Morgan) [Hemiptera: Diaspididae]	Palm scale	AAN, 1998	AQIS, 1994 (except WA)	Yes
Coccus hesperidum Linnaeus [Hemiptera: Coccidae]	Brown scale	AAN, 1998	APPD, 2004	
Coccus pseudomagnoliarum (Kuwana) [Hemiptera: Coccidae]	Citricola scale	AAN, 1998	AICN, 2004	
Dialeurodes citri (Ashmead) [Hemiptera: Aleyrodidae]	Citrus whitefly	EPPO, 2004		Yes
Diaspidiotus perniciosus (Comstock) [Hemiptera: Diaspididae]	San Jose scale	EPPO, 2004	AICN, 2004	
Dysmicoccus brevipes (Cockerell) [Hemiptera: Pseudococcidae]	Pineapple mealybug	CABI, 2004	AICN, 2004	
Hemiberlesia lataniae (Signoret) [Hemiptera: Diaspididae]	Lataniae scale	CABI, 2004	AICN, 2004	
Icerya purchasi Maskell [Hemiptera: Margarodidae]	Fluted scale	AAN, 1998	APPD, 2004	
Lepidosaphes beckii (Newman) [Hemiptera: Diaspididae]	Purple scale	AAN, 1998	AICN, 2004	
Lepidosaphes gloverii (Packard) [Hemiptera: Diaspididae]	Glover's scale	CABI, 2004	AICN, 2004 (except WA)	Yes
Macrosiphum euphorbiae (Thomas) Hemiptera: Aphididae]	Potato aphid	AAN, 1998	APPD, 2004	
Metcalfa pruinosa (Say) [Hemiptera: Flatidae]	Citrus planthopper	Zangheri & Donadini, 1980		Yes
Myzus persicae (Sulzer) [Hemiptera: Aphididae]	Potato aphid	AAN, 1998	APPD, 2004	
Neoaliturus tenellus (Baker) [Hemiptera: Cicadellidae]	Beet leafhopper	EPPO, 2004		Yes
Nezara viridula (Linnaeus) [Hemiptera: Aphididae]	Green vegetable bug	EPPO, 2004	APPD, 2004	
Orthezia insignis Browne [Hemiptera: Ortheziidae]	Lantana bug	CABI, 2004		Yes
Parabemisia myricae (Kuwana) [Hemiptera: Aleyrodidae]	Bayberry whitefly	CABI, 2004	Restricted distribution (QDPI, 2002)	Yes

Pest	Common name	Presence in		Consider further (yes/no)
		Italy	Australia	
Parasaissetia nigra (Nietner) [Hemiptera: Coccidae]	Nigra scale	EPPO, 2004 (absent & formerly present)	AICN, 2004	
Parlatoria pergandii Comstock [Hemiptera: Diaspididae]	Chaff scale	AAN, 1998	AICN, 2004 (except WA)	Yes
Parlatoria ziziphi (Lucas) [Hemiptera: Diaspididae]	Black parlatoria scale	AAN, 1998		Yes
Parthenolecanium corni (Bouché) [Hemiptera: Coccidae]	European fruit scale	EPPO, 2004	AICN, 2004 (except WA)	Yes
Parthenolecanium persicae (Fabricius) [Hemiptera: Coccidae]	Peach scale	CABI, 2004	APPD, 2004	
Phenacoccus madeirensis Green [Hemiptera: Pseudococcidae]	Madeira mealybug	CABI/EPPO, 2000		Yes
Planococcus citri (Risso) [Hemiptera: Pseudococccidae]	Citrus mealybug	AAN, 1998	APPD, 2004	
Pseudococcus viburni Maskell [Hemiptera: Pseudococccidae]	Tuber mealybug	Williams, 1985	APPD, 2004	
Pseudococcus calceolariae (Maskell) [Hemiptera: Pseudococccidae]	Citrophilus mealybug	AAN, 1998	AICN, 2004 (except WA)	Yes
Pseudococcus longispinus Targioni-Tozzetti [Hemiptera: Pseudococccidae]	Long-tailed mealybug	AAN, 1998	APPD, 2004	
Pterochloroides persicae (Cholodkovsky) [Hemiptera: Aphididae]	Brown peach aphid	EPPO, 2004		Yes
Pulvinaria floccifera Westwood [Hemiptera: Coccidae]	Cushion scale	CABI, 2004	AICN, 2004 (except WA)	Yes
Rhopalosiphum maidis (Fitch) [Hemiptera: Aphididae]	Corn aphid	AAN, 1998	APPD, 2004	
Saissetia coffeae (Walker) [Hemiptera: Coccidae]	Brown coffee scale	CABI, 2004	APPD, 2004	
Saissetia oleae (Olivier) [Hemiptera: Coccidae]	Mediterranean black scale	Ben-Dov, 1993	APPD, 2004	
*Toxoptera aurantii (*Boyer De Fonscolombe) [Hemiptera: Aphididae]	Black citrus aphid	AAN, 1998	AICN, 2004; Berlandier, 1997	
Trialeurodes vaporariorum (Westwood) [Hemiptera: Aleyrodidae]	Greenhouse whitefly	CABI, 2004	APPD, 2004	
Trioza alacris Flor [Hemiptera: Triozidae]	Laurel psyllid	Sampo, 1977		Yes
Unaspis yanonensis (Kuwana) [Hemiptera: Diaspididae]	Arrowhead scale	Vacante & Gerson, 1987		Yes
Hymenoptera (ants, wasps)				

Pest	Common name	Presence in		Consider further (yes/no)
		Italy	Australia	
Ageniaspis citricola Logvinovskaya [Hymenoptera: Encyrtidae]	Citrus leafminer parasite	AAN, 1998	AICN, 2004; Woods, 2005	
Aphanogmus steinitzi Priesner [Hymenoptera: Ceraphronidae]	Wasp	Sinacori *et al*., 1992		Yes
Aphytis chilensis Howard [Hymenoptera: Aphelinidae]	Parasitic wasp	Liotta, 1975		Yes
Aphytis melinus DeBach [Hymenoptera: Aphelinidae]	Red scale parasite	AAN, 1998	AICN, 2004; Anon, 1981	
Cales noacki Howard [Hymenoptera: Aphelinidae]	Parasitic wasp	AAN, 1998	CABI, 2004 (except WA)	Yes
Camponotus nylanderi Emery [Hymenoptera: Formicidae]	Ant	Tumminelli *et al*., 1997		Yes
Encarsia formosa Gahan [Hymenoptera: Aphelinidae]	Parasitic wasp	CABI, 2004	AICN, 2004	
Leptomastix dactilopii Howard [Hymenoptera: Encyrtidae]	Mealybug parasite	Mineo & Viggiani, 1976	AICN, 2004 (except WA)	Yes
Linepithema humile (Mayr) [Hymenoptera: Formicidae]	Argentine ant	AAN, 1998	APPD, 2004	
Lysiphlebus testaceipes (Cresson) [Hymenoptera: Aphidiinae]	Parasitic wasp	Melia, 1993	Stary & Carver, 1979 (except WA)	Yes
Tapinoma erraticum Linnaeus [Hymenoptera: Formicidae]	Ant	Tumminelli *et al*., 1997		Yes
Tapinoma nigerrimum (Nylander) [Hymenoptera: Formicidae]	Black ant	AAN, 1998		Yes
Lepidoptera (moths, butterflies)				
Agrotis ipsilon (Hufnagel) [Lepidoptera: Noctuidae]	Black cutworm	CABI, 2004	AICN, 2004	
Apomyelois ceratoniae Zeller [Lepidoptera: Pyralidae]	Locust bean moth	AAN, 1998	ICDB, 2002	
Archips rosanus Linnaeus [Lepidoptera: Tortricidae]	Rose tortrix moth	AAN, 1998		Yes
Cacoecimorpha pronubana Hübner [Lepidoptera: Tortricidae]	Mediterranean carnation tortrix	CABI, 2004		Yes
Cadra cautella Walker [Lepidoptera: Pyralidae]	Tropical warehouse moth	Mineo, 1986	AICN, 2004	
Charaxes jasius (Linnaeus) [Lepidoptera: Nymphalidae]	Butterfly	Longo, 1992		Yes
Cryptoblabes gnidiella (Millière) [Lepidoptera: Pyralidae]	Citrus pyralid	Karsholt, 1996		Yes
Gymnoscelis rufifasciata (Haworth) [Lepidoptera: Geometridae]		Mineo, 1986		Yes
Helicoverpa armigera (Hübner) [Lepidoptera: Noctuidae]	Cotton bollworm	EPPO, 2004	AICN, 2004	
Hyphantria cunea Drury [Lepidoptera: Arctiidae]	Fall web-worm	EPPO, 2004		Yes
Peridroma saucia (Hübner) [Lepidoptera: Noctuidae]	Variegated cutworm	CABI, 2004		Yes

Pest	Common name	Presence in		Consider further (yes/no)
		Italy	Australia	
Phyllocnistis citrella Stainton [Lepidoptera: Gracillariidae]	Asian leaf miner	AAN, 1998	Wilson, 1991	
Prays citri Millière [Lepidoptera: Yponomeutidae]	Citrus flower moth	AAN, 1998		Yes
Spodoptera exigua (Hübner) [Lepidoptera: Noctuidae]	Beet armyworm	CABI, 2004	AICN, 2004; ICDB, 2002	
Spodoptera littoralis (Boisduval) [Lepidoptera: Noctuidae]	Mediterranean climbing cutworm	EPPO, 2004		Yes
Trichoplusia ni (Hübner) [Lepidoptera: Noctuidae]	Cabbage looper	CABI, 2004		Yes
Xestia c-nigrum (Linnaeus) [Lepidoptera: Noctuidae]	Spotted cutworm	CABI, 2004		Yes
Neuroptera (lacewings)				
Anisochrysa venusta [Neuroptera: Chrysopidae]	Lacewing	Pantaleoni & Lepera, 1985		Yes
Chrysopa carnea Stephens [Neuroptera: Chrysopidae]	Green lacewing	Pantaleoni & Lepera, 1985		Yes
Conwentzia psociformis (Curtis) [Neuroptera: Coniopterygidae]	Lacewing	Sinacori *et al*., 1992		Yes
Thysanoptera (thrips)				
Aeolothrips ericae Bagnall [Thysanoptera: Thripidae]	Predatory thrips	Conti *et al*., 2002		Yes
Frankliniella occidentalis (Pergande) [Thysanoptera: Thripidae]	Western flower thrips	Marullo, 2002	Mound & Gillespie, 1997	
Heliothrips haemorrhoidalis (Bouché) [Thysanoptera: Thripidae]	Greenhouse thrips	AAN, 1998	AICN, 2004	
Limothrips cerealium (Haliday) [Thysanoptera: Thripidae]	Grain thrips	CABI, 2004	AICN, 2004	
Pezothrips kellyanus Bagnall [Thysanoptera: Thripidae]	Kelly's citrus thrip	Conti *et al*., 2002	Broughton & De Lima, 2002	
Pseudodendrothrips mori [Thysanoptera: Dendrothripidae]	Mulberry thrips	Cappellozza & Miotto, 1975	Mound, 2004	
Thrips alni Uzel [Thysanoptera: Thripidae]	Flower thrips	Longo, 1986		Yes
Thrips flavus Shrank [Thysanoptera: Thripidae]	Flower thrips	Conti *et al*., 2002		Yes
Thrips tabaci Lindeman [Thysanoptera: Thripidae]	Onion thrips	Conti *et al*., 2002	AICN, 2004	
Thrips urticae Fabr. [Thysanoptera: Thripidae]	Flower thrips	Longo, 1986		Yes
GASTROPODS				
Deroceras reticulatum O.F. Muller [Gastropoda: Limacidae]	Slug	CABI, 2004	Young, 1996	
Helix aspersa Muller [Gastropoda: Helicidae]	Brown garden snail	Dogan, 1983	Davis *et al*., 1997	

Pest	Common name	Presence in		Consider further (yes/no)
		Italy	Australia	
Theba pisana [Gastropoda: Helicidae]	White garden snail	EPPO, 2004	Buckland *et al*., 1990	
PATHOGENS				
Bacteria				
Pseudomonas syringae van Hall pv. *syringae* van Hall	Bacterial blast	AAN, 1998	APPD, 2004	
Pseudomonas viridiflava (Burkholder) Dowson	Bacterial blight	CABI, 2004	Bradbury, 1986	
Rhizobium radiobacter (Beijerinck & van Delden) Young *et al*.	Crown gall	CABI, 2004	APPD, 2004	
Xanthomonas campestris pv. *campestris* (Pammel) Dowson	Black rot	CABI, 2004	APPD, 2004	
Fungi				
Alternaria alternata (Fr.: Fr.) Keissl.	Alternaria leaf blight	CABI, 2004	APPD, 2004	
Alternaria brassicae (Berk.) Sacc.	Alternaria blight	CABI, 2004	APPD, 2004	
Alternaria citri Ellis & N. Pierce	Core rot of citrus	AAN, 1998	APPD, 2004	
Armillaria mellea (Vahl) P. Kummer	Armillaria root rot	AAN, 1998		Yes
Armillaria tabescens (Scop.) Dennis *et al*.	Armillaria root rot	CABI, 2004		Yes
Aspergillus niger Tiegh.	Aspergillus rot	CABI, 2004	APPD, 2004	
Athelia rolfsii (Curzi) C.C. Tu & Kimbrough	Seedling blight	CABI, 2004	APPD, 2004	
Botryosphaeria obtuse (Schwein.) Shoemaker	Black rot	CABI, 2004	APPD, 2004	
Botryosphaeria ribis Grossenbacher & Duggar	Stem end rot	AAN, 1998	Shivas, 1989	
Botrytis cinerea Pers: Fr.	Grey mould	AAN, 1998	APPD, 2004	
Capnodium citri Mont.	Sooty mould	AAN, 1998		Yes
Ceratocystis fimbriata Ellis & Halst.	Ceratocystis blight	EPPO, 2004	Walker *et al*., 1988	
Cercospora penzigii Sacc.	Leaf spot	Farr *et al*., 1989		Yes
Cochliobolus lunatus R.R. Nelson & Haasis	Black leaf spot	CABI, 2004	APPD, 2004	
Colletotrichum acutatum Simmonds ex Simmonds	Anthracnose	EPPO, 2004[7]	APPD, 2004[8]	

[7] Strain of *Colletotrichum acutatum* causing postbloom fruit drop (PFD), is endemic in the humid tropics of the Americas only (Peres *et al*., 2002). PFD strain does not cause anthracnose.

[8] There is only one record of *Colletotrichum acutatum* on citrus in Australia (APPD, 2004). The strain responsible for postbloom fruit drop is not present in Australia.

Pest	Common name	Presence in		Consider further (yes/no)
		Italy	Australia	
Colletotrichum gloeosporioides (Penz.) Penz. & Sacc. In Penz.	Anthracnose	AAN, 1998	APPD, 2004	
Diaporthe citri F.A. Wolf	Gummosis; Melanose	EPPO, 2004	APPD, 2004 (except WA)	Yes
Elsinoë australis Bitanc. & Jenkins	Sweet orange scab	Ciccarone, 1957; EPPO, 2004[9]		
Eutypa lata (Per.: Fr.) L.R. Tulasne & C. Tulasne	Eutypa dieback	CABI, 2004	APPD, 2004, Shivas, 1989	
Fusarium lateritium Nees: Fr.	Dieback	AAN, 1998	APPD, 2004	
Fusarium solani (Martin) Sacc.	Dry root rot	CABI, 2004	APPD, 2004	
Geotrichum candidum Link	Sour rot	CABI, 2004	APPD, 2004	
Lasiodiplodia theobromae (Pat.) Griffiths & Maubl.	Stem-end rot	CABI, 2004	APPD, 2004	
Macrophomina phaseolina (Tassi) Goidanich	Charcoal root rot	CABI, 2004	APPD, 2004	
Nematospora coryli Peglion	Yeast spot	EPPO, 2004		Yes
Penicillium digitatum (Pers.: Fr) Sacc.	Green mould	AAN, 1998	Shivas, 1989	
Penicillium italicum Wehmer	Blue mould	AAN, 1998	Shivas, 1989	
Phoma tracheiphila (Petri) Kantachveli & Gikachvili	Mal secco	AAN, 1998		Yes
Phytophthora cactorum (Lebert & Cohn) Schröter	Seedling damping-off	AAN, 1998	APPD, 2004	
Phytophthora citricola Saw.	Root rot	AAN, 1998	Shivas, 1989	
Phytophthora citrophthora (R.H. Sm. & E. Sm.) Leonian	Foot rot of Citrus	AAN, 1998	APPD, 2004	
Phytophthora cryptogea Pethybridge & Lafferty	Damping off	EPPO, 2004	APPD, 2004	
Phytophthora hibernalis Carne	Root rot	AAN, 1998	Shivas, 1989	
Phytophthora nicotianae Breda de Haan	Root rot	AAN, 1998	APPD, 2004	
Phytophthora palmivora (E. J. Butler) E. J. Butler	Brown rot of fruit	CABI, 2004	APPD, 2004 (except WA)	Yes
Phytophthora parasitica Dastur	Root rot	CABI, 2004	APPD, 2004	
Phytophthora syringae Kleb.	Brown rot	AAN, 1998	APPD, 2004 (except WA)	Yes
Pythium debaryanum Hesse	Damping off	CABI, 2004	APPD, 2004	
Pythium splendens H. Braun	Root rot	CABI, 2004	APPD, 2004	

9 Ciccarone (1957) identified a scab on lemon fruits in Sicily as caused by *E. australis* but there have been no further records in Italy. EPPO (2004) lists the current status of *E. australis* as absent in Italy. Therefore, this pathogen is not considered further.

Pest	Common name	Presence in		Consider further (yes/no)
		Italy	Australia	
Rosellinia necatrix Prill	Dematophora root rot	CABI, 2004	APPD, 2004	
Sclerotinia sclerotiorum (Lib.) De Bary	Collar rot	AAN, 1998	APPD, 2004	
Septoria citri Pass.	Septoria leaf spot	AAN, 1998	APPD, 2004 (except WA)	Yes
Thielaviopsis basicola (Berk. & Broome) Ferraris	Black root rot	CABI, 2004	APPD, 2004	
Nematodes				
Helicotylenchus multicinctus (Cobb) Golden	Spiral nematode	CABI, 2004	McLeod *et al*., 1994	
Meloidogyne incognita (Kofoid & White) Chitwood	Root-knot nematode	CABI, 2004	McLeod *et al*., 1994	
Meloidogyne javanica (Treub) Chitwood	Root-knot nematode	CABI, 2004	McLeod *et al*., 1994	
Pratylenchus coffeae (Zimmermann) Filipjev & Schuurmans Steckhoven	Root lesion nematode	CABI, 2004	McLeod *et al*., 1994	
Pratylenchus penetrans (Cobb) Filipjev & Schuurmans Stekhoven	Root lesion nematode	CABI, 2004	McLeod *et al*., 1994	
Pratylenchus vulnus Allen & Jensen	Root lesion nematode	AAN, 1998	McLeod *et al*., 1994	
Radopholus similis (Cobb) Thorne	Burrowing nematode	CABI, 2004	McLeod *et al*., 1994	
Tylenchulus semipenetrans Cobb	Root nematode	AAN, 1998	McLeod *et al*., 1994	
Xiphinema index Thorne & Allen	Dragger nematode	CABI, 2004	McLeod *et al*., 1994 (except WA)	Yes
Phytoplasma				
Spiroplasma citri Saglio *et al*.	Stubborn disease of citrus	EPPO, 2004		Yes
Viroids				
Citrus exocortis viroid	Citrus exocortis	AAN, 1998	Fraser & Broadbent, 1979 (except WA)	Yes
Citrus xyloporosis viroid	Citrus cachexia	AAN, 1998	Fraser & Broadbent, 1979 (except WA)	Yes
Viruses				
Citrus impietratura virus	Citrus impietratura disease	CABI, 2004		Yes

Pest	Common name	Presence in		Consider further (yes/no)
		Italy	Australia	
Citrus ring spot virus (CRSV)	Psorosis complex	AAN, 1998	Fraser & Broadbent, 1979 (except WA)	Yes
Citrus tristeza *closterovirus* (CTV)	Lime die-back	AAN, 1998	Fraser & Broadbent, 1979[10]	Yes
Citrus variegation virus	Variegation disease	AAN, 1998	Buchen-Osmond, 1988 (except WA)	Yes

10 A stem pitting strain that only affects limes, grapefruit and sweet orange exists (Timmer *et al*., 2000). A strain that affects sweet orange is presented in a restricted area of Queensland and there are intra and interstate restrictions on the movement of budwood.

Appendix – 1b: Pest Categorisation for sweet oranges from Italy (pathway association)

Pest	Common name	Pathway association		Consider further (yes/no)
		Associated with fruit (yes/no)	Comment	
ARTHROPODS				
Acari (mites)				
Aculops pelekassi (Keifer) [Acari: Eriophyidae]	Pink citrus rust mite	Yes	Feeds on green stems, leaves and fruit (Benfatto, 1980).	**Yes**
Amblydromella rhenanoides (Athias-Henriot) [Acari: Phytoseiidae]	Predatory mite	No	This mite is predatory on leaf feeding pests. Predator of *Panonychus ulmi*, *Aculus fockeui* and *Cenopalpus lineola* (CABI, 2004).	
Amblyseius barkeri (Hughes) [Acari: Phytoseiidae]	Predatory mite	Yes	This mite is predatory on leaf feeding pests. Main prey is thrips including *Frankliniella occidentalis*, *F. intosa*, *Thrips tabaci*, *T. palmi* and *Parthenothrips dracaenae*, although the predator can survive on pollen. Also recorded as preying on *Polyphagotarsonemus latus*, *Tetranychus kanzawai* and *Tyrophagus putrescentiae* (CABI, 2004).	**Yes**
Amblyseius degenerans (Berlese) [Acari: Phytoseiidae]	Predatory mite	No	This mite is predatory on leaf feeding pests. This mite is not a plant feeder. Main prey is *Frankliniella occidentalis*. *Thrips tabaci* are less favored as prey. The predator will eat the spider mites *Polyphagotarsonemus latus* and *Tetranychus urticae* and can survive on pollen (CABI, 2004).	
Amblyseius italicus Chant [Acari: Phytoseiidae]	Predatory mite	No	This mite is not a plant feeder. Predator of *Panonychus ulmi,* a leaf-feeding pest (CABI, 2004).	
Amblyseius largoensis (Muma) [Acari: Phytoseiidae]	Predatory mite	Yes	Natural enemy of the leaf feeding pests *Brevipalpus phoenicis*, *Polyphagotarsonemus latus* and *Tetranychus truncates* (CABI, 2004). This species is found in association with prey (*Brevipalpus phoenicis*, *Polyphagotarsonemus latus* and *Tetranychus truncates*) that can be associated with the fruit pathway. Therefore, this species is associated with the fruit pathway.	**Yes**

Pest	Common name	Pathway association		Consider further (yes/no)
		Associated with fruit (yes/no)	Comment	
Amblyseius messor (Weinstein) [Acari: Phytoseiidae]	Predatory mite	No	This mite is not a plant feeder. Predator of the leaf feeding pest *Panonychus ulmi* (CABI, 2004).	
Amblyseius potentillae (Garman) [Acari: Phytoseiidae]	Predatory mite	No	This mite is not a plant feeder. Predator of the leaf feeding pests *Aculus schlechtendali*, *Cecidophyopsis ribis* and *Panonychus ulmi* (CABI, 2004).	
Amblyseius stipulatus Athias-Henriot [Acari: Phytoseiidae]	Predatory mite	No	This mite is not a plant feeder. Predator of the leaf feeding pests *Panonychus ulmi*, *Aculus fockeui* and *Cenopalpus lineola* (CABI, 2004).	
Amblyseius swirskii Athias-Henriot [Acari: Phytoseiidae]	Predatory mite	Yes	Predator of the leaf feeding pests *Aphis gossypii*, *Brevipalpus californicus*, *Eutetranychus orientalis*, *Metaculus mangiferae*, *Parabemisia myricae*, *Pseudococcus cryptus*, *Tetranychus cinnabarinus* and *Thrips tabaci* (CABI, 2004). This species is found in association with prey (*Aphis gossypii*, *Brevipalpus californicus*, *Eutetranychus orientalis*, *Metaculus mangiferae*, *Parabemisia myricae*, *Pseudococcus cryptus*, *Tetranychus cinnabarinus* and *Thrips tabaci*) that can be associated with the fruit pathway. Therefore, this species is associated with the fruit pathway.	**Yes**
Brevipalpus cuneatus Canestrini & Fanzago [Acari: Tenuipalpidae]	False spider mite	Yes	While there is little information on this species, other mites from this genus are known pests. Three main *Brevipalpus* spp (*B. californicus; B. obovatus and B. phoenicis*) are associated primarily with leaves but are also known to feed on fruit (Childers, 1994).	**Yes**
Calvolia hebeclinii Sicher [Acari: Saproglyphidae]	Stigmaeid mite	No	Species of this genus have been recorded as fungus feeders (Oatman, 1973), phoretic on tabanid flies (Mullen *et al.*, 1989) and associated with bark beetles (Kielczewski & Seniczak, 1972). This genus has been placed in the families Wintershmidtiidae and Glycyphagidae by other authors.	
Cheletogenes ornatus (Canestrini & Fanzago) [Acari: Cheyletidae]	Predatory mite	Yes	Natural enemy of the leaf and stem feeding pests *Brevipalpus californicus*, *Cenopalpus pulcher*, *Parlatoria oleae*, *Pinnaspis aspidistrae*, *Pinnaspis strachani* and *Pseudaulacaspis cockerelli* (CABI, 2004). This species is found in association with prey (*Brevipalpus californicus*) that can be associated with the fruit pathway. Therefore, this species is associated with the fruit pathway.	**Yes**

Pest	Common name	Pathway association		Consider further (yes/no)
		Associated with fruit (yes/no)	Comment	
Cheletomimus berlesei (Oudemans) [Acari: Cheyletidae]	Predatory mite	No	Natural enemy of the leaf feeding pests *Cenopalpus lineola* and *Hemiberlesia lataniae* (CABI, 2004).	
Cheletomimus minutes (Oudemans) [Acari: Cheyletidae]	Predatory mite	Yes	Cheyletid mites are mostly free-living predators found in association with prey that includes acarids, tetranychids and scales (Baker & Wharton, 1952). This species is found in association with prey that includes tetranychids (*Panonychus citri*) and scales (*Lepidosaphes gloverii*) that can be associated with the fruit pathway. Therefore, this species is associated with the fruit pathway.	**Yes**
Cunaxa capreolus (Berlese) [Acari: Cunaxidae]	Cunaxid mite	No	This mite is recorded mainly from leaf litter but also in citrus trees in Florida. It is a predaceous mite that feeds on Psocopterans and *Eutetranychus orientalis* (Muma *et al.*, 1975), a leaf-feeding pest (CABI, 2004).	
Cunaxa setirostris (Hermann) [Acari: Cunaxidae]	Cunaxid mite	No	Natural enemy of *Agistemus industani* (predator) and *Tetranychus cinnabarinus* (leaf feeder) (CABI, 2004).	
Cunaxoides oliveri Schruft [Acari: Cunaxidae]	Cunaxid mite	Yes	Cunaxid mites are considered to be a predatory genus that feed on scale insects and small arthropods (Smiley, 1975). *Cunaxoides* species are listed as potential predators of *Scirtothrips aurantii* (Milne, 1977). As this mite is predatory on small arthropods (*Panonychus citri)* and scales (*Lepidosaphes gloverii*), it is considered associated with the pathway.	**Yes**
Daidalotarsonemus vandevrieri [Acari: Tarsonemidae]	Tarsonemid mite	No	Mites of this genus feed on moss and lichen.	
Eryngiopus bifidus Wood [Acari: Stigmaeidae]	Predatory mite	Yes	Mites of this genus are predatory and are recorded to attack *Aonidiella aurantii* (Krishnamoorty & Rajagopal, 1999). *Eryngiopus citri* has been collected from citrus leaves in Florida and was recorded to be feeding on *Tydeus mumai (*Rakha & McCoy, 1984). This species is found in association with prey (*Aonidiella aurantii*) that can be associated with the fruit pathway. Therefore, this species is associated with the fruit pathway.	**Yes**

Pest	Common name	Pathway association		Consider further (yes/no)
		Associated with fruit (yes/no)	Comment	
Eryngiopus siculus Vacante & Gerson [Acari: Stigmaeidae]	Predatory mite	Yes	Mites of this genus are predatory and are recorded as attacking *Aonidiella aurantii* (Krishnamoorty & Rajagopal, 1999). *Eryngiopus citri* has been collected from citrus leaves in Florida and was recorded to be feeding on *Tydeus mumai* (Rakha & McCoy, 1984). This species is found in association with prey (*Aonidiella aurantii*) that can be associated with the fruit pathway. Therefore, this species is associated with the fruit pathway.	**Yes**
Eupelops acromios (Hermann) [Acari: Phenopelopidae]	Oribatid mite	No	This genus of mites is associated with fungi (O'Connell & Bolger, 1997) and leaf litter (Hagvar & Kjondal, 1981).	
Eutogenes citri Gerson [Acari: Cheyletidae]	Predatory mite	Yes	Cheyletid mites are mostly free-living predators found in association with prey that includes acarids, tetranychids and scales (Baker & Wharton, 1952). This species is found in association with prey that includes tetranychids (*Panonychus citri*) and scales (*Lepidosaphes gloverii*) that can be associated with the fruit pathway. Therefore, this species is associated with the fruit pathway.	**Yes**
Fungitarsonemus monasterii Lombardini [Acari: Tarsonemidae]	Tarsonemid mite	No	Other species of this genus are known bio-control agents commonly used in fruit orchards.	
Hemisarcoptes malus (Shimer) [Acari: Hemisarcoptidae]	Predatory mite	Yes	A minute predaceous mite, which feeds on scale insects (Vacante, 1989). This species is found in association with prey that includes scales (*Lepidosaphes gloverii*) that can be associated with the fruit pathway. Therefore, this species is associated with the fruit pathway.	**Yes**
Hirstiella insignis Berlese [Acari: Pterygosomatidae]	Mite	No	Mites of the genus *Hirstiella* are parasites of lizards and iguanas (Baker, 1998; Walter & Shaw, 2002).	
Humerobates rostrolamellatus Grandjean [Acari: Ceratozetidae]	Oribatid mite	No	Recorded as living on bark (Lebrun *et al.*, 1978). Mites of the family Ceratozetidae are principally saprophagous or fungivorous and are found in litter (Smith *et al.*, 1998).	

Pest	Common name	Pathway association		Consider further (yes/no)
		Associated with fruit (yes/no)	Comment	
Kampimodromus aberrans Oudemans [Acari: Phytoseiidae]	Predatory mite	No	This mite is not a plant feeder. Predator of *Bryobia rubrioculus* and *Cecidophyopsis ribis* in Europe, *Cenopalpus lineola* and *Colomerus vitis* in South Africa, *Eotetranychus carpini*, *Eotetranychus carpini vitis*, *Myzocallis coryli*, *Panonychus ulmi* and *Phytoptus avellanae* (CABI, 2004).	
Ledermuelleriopsis plumosus Willmann [Acari: Stigmaeidae]	Stigmaeid mite	No	Found on leaf litter, mould and in soil (Fan *et al.*, 2003).	
Lorryia australensis (Baker) [Acari: Tydeidae]	Tydeid mite	Yes	*Lorryia* mites feed on fungi, honeydew, and other mites and their eggs (Ueckermann & Smith Meyer, 1979). This species is found in association with prey that includes mites (*Panonychus citri*) that can be associated with the fruit pathway. Therefore, this species is associated with the fruit pathway.	**Yes**
Lorryia ferula Baker [Acari: Tydeidae]	Tydeid mite	Yes	*Lorryia* mites feed on fungi, honeydew, other mites and their eggs (Ueckermann & Smith Meyer, 1979). This species is found in association with prey that includes mites (*Panonychus citri*) that can be associated with the fruit pathway. Therefore, this species is associated with the fruit pathway.	**Yes**
Lorryia formosa Cooreman [Acari: Tydeidae]	Tydeid mite	Yes	Present on leaves along the mid-rib (Badii *et al.*, 2001), feeding on scale excreted honeydew and sooty mold (Mendel & Gerson, 1982). This species is found in association with prey that includes mites (*Panonychus citri*) that can be associated with the fruit pathway. Therefore, this species is associated with the fruit pathway.	**Yes**
Lorryia reticulata (Oudemans) [Acari: Tydeidae]	Tydeid mite	Yes	*Lorryia* mites feed on fungi, honeydew, and other mites and their eggs (Ueckermann & Smith Meyer, 1979). This species is found in association with prey that includes mites (*Panonychus citri*) that can be associated with the fruit pathway. Therefore, this species is associated with the fruit pathway.	**Yes**
Lorryia teresae (Carmona) [Acari: Tydeidae]	Tydeid mite	Yes	*Lorryia* mites feed on fungi, honeydew, and other mites and their eggs (Ueckermann & Smith Meyer, 1979). This species is found in association with prey that includes mites (*Panonychus citri*) that can be associated with the fruit pathway. Therefore, this species is associated with the fruit pathway.	**Yes**

Pest	Common name	Pathway association		Consider further (yes/no)
		Associated with fruit (yes/no)	Comment	
Mediolata similans Willmann [Acari: Stigmaeidae]	Stigmaeid mite	No	This mite is a predator (Komlovsky & Jenser, 1992). Other species of this genus are predators of *Panonychus ulmi*. As the prey of this species is not reported on citrus in Italy, this is not associated with the fruit pathway.	
Metalorryia magdalenae (Baker) [Acari: Tydeidae]	Tydeid mite	No	Tydeid mites are found in mosses, lichens and plant leaves where they feed on fungi or prey on small insects, and mites and their eggs (Baker & Wharton, 1952).	
Micreremus gracilior Willmann [Acari: Micremidae]	Oribatid mite	No	Mites of this genus feed on mosses, lichens and fungi found on the leaves and branches of fruit trees (Karg, 1971).	
Neoseiulus californicus McGregor [Acari: Phytoseiidae]	Predatory mite	Yes	Predator of *Polyphagotarsonemus latus* in Italy. It will survive on other small arthropods and on pollen but it will not reproduce in the absence of spider mites (CABI, 2004). This species is found in association with prey that includes spider mites (*Panonychus citri, Polyphagotarsonemus latus*) that can be associated with the fruit pathway. Therefore, this species is associated with the fruit pathway.	**Yes**
Orthotydeus californicus (Banks) [Acari: Tydeidae]	Tydeid mite	Yes	Natural enemy of *Tetranychus arabicus* and *Tetranychus cucurbitacearum* (CABI, 2004). This species is also known to prey on Tetranychus spider mites, other spider mites, eriophyid mites, other mites. Some of these prey mites are associated with the fruit pathway.	**Yes**
Orthotydeus caudatus (Dugès) [Acari: Tydeidae]	Tydeid mite	Yes	Other species of this genus are natural enemies of various mite species. Tydeid mites are generally scavengers, feeding on debris on the surface of citrus leaves and fruits. Collected only from leaves in Sicily (Vacante & Nucifora, 1986a). Some of its prey mites are associated with the fruit pathway.	**Yes**
Orthotydeus foliorum (Schrank) [Acari: Tydeidae]	Tydeid mite	Yes	Other species of this genus are natural enemies of various mite species. Tydeid mites are generally scavengers, feeding on debris on the surface of citrus leaves and fruits. Some of these prey mites are associated with the fruit pathway.	**Yes**
Orthotydeus kochi Oudemans [Acari: Tydeidae]	Tydeid mite	Yes	Other species of this genus are natural enemies of various mite species. Tydeid mites are generally scavengers, feeding on debris on the surface of citrus leaves and fruits. Collected only from leaves in Sicily (Vacante & Nucifora, 1986a). Some of these prey mites are associated with the fruit pathway.	**Yes**

Pest	Common name	Pathway association		Consider further (yes/no)
		Associated with fruit (yes/no)	Comment	
Panonychus citri **McGregor** [Acari: Tetranychidae]	Citrus red mite	Yes	Feeds on foliage and fruits (Smith *et. al.*, 1997).	**Yes**
Petrobia tunisiae Manson [Acari: Tetranychidae]	Spider mite	No	A polyphagous species from herbaceous plants beneath the canopy. Rarely found on citrus and causes no damage. Recovered only from lemon leaves in Italy (Vacante & Nucifora, 1986a).	
Phauloppia lucorum C.L. Koch [Acari: Oribatulidae]	Oribatulid mite	No	These mites live in the soil and eat fungi, algae and dead plant material. Associated with moss and lichen (Smrz, 1992; Froberg *et.al.*, 2003)	
Phytoseiulus finitimus Ribaga [Acari: Phytoseiidae]	Predatory mite	No	Other species of this genus are one of the mainstays of greenhouse integrated pest management programs for control of spider mites on vegetables and ornamentals.	
Phytoseiulus panormita Ragusa & Swirski [Acari: Phytoseiidae]	Predatory mite	No	Other species of this genus are one of the mainstays of greenhouse integrated pest management programs for control of spider mites on vegetables and ornamentals.	
Pronematus ubiquitus (McGregor) [Acari: Tydeidae]	Tydeid mite	Yes	Natural enemy of *Brevipalpus californicus* and *Tetranychus urticae* (CABI, 2004). Tydeid mites are generally scavengers, feeding on debris on the surface of citrus leaves and fruit. Some of these prey mites are associated with the fruit pathway.	**Yes**
Seiulus amaliae Ragusa & Swirski [Acari: Phytoseiidae]	Predatory mite	No	A predatory mite found on leaves (Vacante & Nucifora, 1986a). Feeds on *Panonychus ulmi*.	
Seiulus finlandicus (Oudemans) [Acari: Phytoseiidae]	Predatory mite	No	Predator of *Aculus schlechtendali*, *Cecidophyopsis ribis* and *Panonychus ulmi* (CABI, 2004).	
Siculobata sicula Berlese [Acari: Oribatulidae]	Oribatulid mite	No	A mycophagous or saprophagous mite (Vacante & Nucifora, 1986a).	
Tarsonemus aurantii Oudemans [Acari: Tarsonemidae]	Tarsonemid mite	Yes	A mycophagous mite recorded from leaves and fruit of lemon and orange (Vacante & Nucifora, 1986a).	**Yes**

Pest	Common name	Pathway association		Consider further (yes/no)
		Associated with fruit (yes/no)	Comment	
Tarsonemus bilobatus **Suski** [Acari: Tarsonemidae]	Tarsonemid mite	Yes	Present sporadically on orange fruit and leaves, with sooty mould (Nucifora & Vacante, 2004). Most mites of this genus are mycophagous.	**Yes**
Tarsonemus confusus Ewing [Acari: Tarsonemidae]	Tarsonemid mite	No	Found on the bark of lemon and orange trees (Nucifera & Vacante, 2004).	
Tarsonemus floricolus Canestrini & Fangazo [Acari: Tarsonemidae]	Tarsonemid mite	Yes	Present sporadically on orange fruit and leaves, with sooty mould (Nucifora & Vacante, 2004). Most mites of this genus are mycophagous.	**Yes**
Tarsonemus idaeus Suski [Acari: Tarsonemidae]	Tarsonemid mite	Yes	Present on leaves and fruit of orange and lemon with sooty mould (Nucifora & Vacante, 2004). This mite develops either on fungi or on yeast (Suski, 1968), and is known as a fungivorous species (Korah & Osman, 1978).	**Yes**
Tarsonemus lobosus Suski [Acari: Tarsonemidae]	Tarsonemid mite	No	Occasionally present on bark crevices of the trunk and large branches of oranges and lemon trees (Nucifora & Vacante, 2004).	
Tarsonemus parawaitei Kim *et al*. [Acari: Tarsonemidae]	Tarsonemid mite	No	Adults of tarsonemid mite are mainly found on insects, plants and litter. Adults are parasitoids, predaceous and phytophagous.	
Tarsonemus smithi Ewing [Acari: Tarsonemidae]	Tarsonemid mite	No	A mycophagous species sporadically present on leaves of orange and lemon in Sicily (Vacante & Nucifora, 1986a).	
Tarsonemus waitei Banks [Acari: Tarsonemidae]	Tarsonemid mite	No	A mycophagous species present on leaves of orange and lemon in Sicily (Vacante & Nucifora, 1986a).	
Tetranychina harti (Ewing) [Acari: Tetranychidae]	Spider mite	No	Overwinters on the trunk and branches of citrus (Ciampolini *et al.*, 1985). Food plants include *Oxalis* spp. (Ciampolini *et al.*, 1985).	
Thyreophagus cooremani Fain Acari: Acaridae]	Acarid mite	No	*Thyreophagus* spp. are associated with woody substrates, decaying matter and fungi (O'Conner, 2001).	
Thyreophagus corticalis (Michael) Acari: Acaridae]	Acarid mite	No	*Thyreophagus* spp. are associated with woody substrates, decaying matter and fungi (O'Conner, 2001).	

Pest	**Common name**	**Pathway association**		**Consider further (yes/no)**
		Associated with fruit (yes/no)	Comment	
Thyreophagus entomophagus italicus Vacante Acari: Acaridae]	Acarid mite	No	*Thyreophagus* spp. are associated with woody substrates, decaying matter and fungi (O'Conner, 2001).	
Thyreophagus gallegoi Portus & Gomez [Acari: Acaridae]	Acarid mite	No	*Thyreophagus* spp. are associated with woody substrates, decaying matter and fungi (O'Conner, 2001).	
Trichoribates angustatus Mihelcic [Acari: Ceratozetidae]	Mite	No	Present on twigs of lemon and orange in Sicily (Vacante & Nucifora, 1986a). Probably mycophagous.	
Triophtydeus triophthalmus (Oudemans) [Acari: Tydeidae]	Tydeid mite	No	Natural enemy of *Coleophora serratella* (CABI, 2004).	
Typhlodromus athenas Porath & Swirski [Acari: Phytoseiidae]	Predatory mite	No	A predatory mite present on leaves of orange and lemon (Vacante & Nucifora, 1986a).	
Typhlodromus cryptus (Oudemans) [Acari: Phytoseiidae]	Predatory mite	No	A predatory mite found on leaves of lemon, orange and mandarin (Vacante & Nucifora, 1986a).	
Typhlodromus exhilaratus Ragusa [Acari: Phytoseiidae]	Predatory mite	Yes	A predatory mite found on leaves and fruit of citrus (Vacante & Nucifora, 1986a).	**Yes**
Typhlodromus phialatus Athias-Henriot [Acari: Phytoseiidae]	Predatory mite	No	Frequent predator of *Panonychus ulmi* in Spain (Ferragut *et al.*, 1992).	
Typhlodromus talbii Athias-Henriot [Acari: Phytoseiidae]	Predatory mite	Yes	This mite is a predator of economic pests, especially in vineyards (Camporese & Duso, 1995). Preys on tydeid, tetranychids and eriophyid mites. This species is found in association with prey that includes tetranychids (*Panonychus citri*) and eriophyid mites (*Aculops pelekassi*) that can be associated with the fruit pathway. Therefore, this species is associated with the fruit pathway.	**Yes**

Pest	Common name	Pathway association		Consider further (yes/no)
		Associated with fruit (yes/no)	Comment	
Tyrophagus neiswanderi Johnson & Bruce [Acari: Phytoseiidae]	Acarid mite	No	*Tyrophagus* spp. are associated with dried organic substances (Russell, 2001). Other species of this genus live on all sorts of organic substances, bulbs and plant debris. These mites are scavengers, feeding on fungi, bacteria and decaying leaf material.	
Tyrophagus palmarum (Oudemans) [Acari: Phytoseiidae]	Acarid mite	No	*Tyrophagus* spp. are associated with dried organic substances (Russell, 2001). Other species of this genus live on all sorts of organic substances, bulbs and plant debris. These mites are scavengers, feeding on fungi, bacteria and decaying leaf material.	
Tyrophagus tropicus Robertson [Acari: Phytoseiidae]	Acarid mite	No	*Tyrophagus spp.* are associated with dried organic substances (Russell, 2001). Other species of this genus live on all sorts of organic substances, bulbs and plant debris. These mites are scavengers, feeding on fungi, bacteria and decaying leaf material.	
Zetzellia collyerae (Gonzalez-Rodriguez) [Acari: Stigmaeidae]	Stigmaeid mite	Yes	This genus of stigmaeid mites is reported as predators of tetranychid and eriophyid mites (Clements & Harmsen, 1990; O'Dowd, 1994). This species is found in association with prey that includes tetranychids (*Panonychus citri*) and eriophyid mites (*Aculops pelekassi*) that can be associated with the fruit pathway. Therefore, this species is associated with the fruit pathway.	**Yes**
Zetzellia graeciana Gonzales [Acari: Stigmaeidae]	Stigmaeid mite	Yes	This genus of stigmaeid mites is reported as predators of tetranychid and eriophyod mites (Clements & Harmsen, 1990). This predatory species was present on buds and leaves, but not on fruit, in Italy (Vacante & Nucifora, 1986a). This species is found in association with prey that includes tetranychids (*Panonychus citri*) and eriophyid mites (*Aculops pelekassi*) that can be associated with the fruit pathway. Therefore, this species is associated with the fruit pathway.	**Yes**

Pest	Common name	Pathway association		Consider further (yes/no)
		Associated with fruit (yes/no)	Comment	
Zetzellia mali (Ewing) [Acari: Stigmaeidae]	Stigmaeid mite	Yes	This genus of stigmaeid mites is reported as predators of tetranychid and eriophyod mites (Clements & Harmsen, 1990; O'Dowd, 1994). This species is found in association with prey that includes tetranychids (*Panonychus citri*) and eriophyid mites (*Aculops pelekassi*) that can be associated with the fruit pathway. Therefore, this species is associated with the fruit pathway.	**Yes**
Coleoptera (beetle, weevils)				
Anoplophora malasiaca (Thomson) [Coleoptera: Cerambycidae]	White-spotted longicorn beetle	No	Polyphagous on living wood (Kojima & Nakamura, 1986). Larvae bore into the stems (Mitomi *et al*., 1990) and adults feed on foliage and bark of the tree (Kajiwara *et al*., 1986). The flight potential of adults results in natural dispersal (Adachi, 1990). In international trade, species of *Anoplophora* are most likely to be moved as eggs, larvae or pupae in woody planting material.	
Apate monachus Fabricius [Coleoptera: Bostrichidae]	Black borer	No	Polyphagous and a wood-boring beetle. Completes its life cycle on a wide range of African trees and host crops. Adults bore deeply into the wood of living host trees while feeding. Females excavate galleries in dead wood, in which eggs are also laid. Larvae live in dead trees, excavating their own tunnels deep in the wood (Chararas & Balachowsky, 1962).	
Aphtona nigriceps Redtb [Coleoptera: Chrysomelidae]	Chrysomelid beetle	No	Feeds on citrus flowers (Benfatto & Longo, 1986).	
Cetonia arurata Linnaeus [Coleoptera: Scarabeidae]	Flower weevil	No	Adults of this species have been recorded feeding on flowers, leaves and twigs (Benfatto & Longo, 1986).	
Coccinella septempunctata Linnaeus [Coleoptera: Coccinellidae]	Seven-spotted ladybird	No	Primarily feeds on aphids, however, ladybird larvae and adults may supplement their normal prey in times of scarcity of other types of food (Frank & Mizell, 2004). It is widely used for control against aphids on cotton in China, on brassica crops in Pakistan, and in apple orchards in Hungary, Poland, Belgium and Canada.	
Crepidptera impressa Fabricius [Coleoptera: Chrysomelidae]	Chrysomelid beetle	No	Feeds on citrus flowers (Benfatto & Longo, 1986).	

Pest	Common name	Pathway association		Consider further (yes/no)
		Associated with fruit (yes/no)	Comment	
Crepidptera ventralis [Coleoptera: Chrysomelidae]	Chrysomelid beetle	No	Feeds on citrus flowers (Benfatto & Longo, 1986).	
Epitrix hirtipennis (Melsheimer) Coleoptera: Chrysomelidae]	Tobacco flea beetle	No	The tobacco flea beetle is a pest of tobacco, tomato, and potato and will also attack jimsonweed, ground cherry and occasionally has been found on citrus. Eggs are laid on the soil surface beneath the plants. Eggs hatch in about a week and larvae feed on, and tunnel in, the roots and stems. Adults feed on leaves causing small round “shot-holes” (Roberts & Guillebeau, 2000).	
Longitarsus brunneus Duft [Coleoptera: Chrysomelidae]	Chrysomelid beetle	No	Feeds on citrus flowers (Benfatto & Longo, 1986).	
Longitarsus tabidus Fabricius [Coleoptera: Chrysomelidae]	Chrysomelid beetle	No	Feed on flowers of citrus trees (Benfatto & Longo, 1986).	
Otiorhynchus armatus Bodenheimer [Coleoptera: Curculionidae]	Curculio weevil	No	Larvae feed on the roots and adults feed on leaves (Benfatto & Longo, 1986).	
Otiorhynchus rhacusensis Germ. [Coleoptera: Curculionidae]	Curculio weevil	No	Larvae feed on the roots and adults feed on leaves (Benfatto & Longo, 1986).	
Oxythyrea funesta Poda [Coleoptera: Scarabeidae]	Scarabeid weevil	No	Adults of this species have been recorded feeding on flowers, leaves and twigs (Benfatto & Longo, 1986).	
Pentodon punctatus Vill [Coleoptera: Scarabeidae]	Scarabeid weevil	No	Adults of this species have been recorded feeding on flowers, leaves and twigs (Benfatto & Longo, 1986).	
Rhizotrogus rugifrons Burmeister [Coleoptera: Scarabaeidae]	Scarab beetle	No	*Rhizotrogus* beetles are scarabs belonging to the subfamily Melolonthinaeare (chafers). Larvae feed on roots and decaying matter, while adults are leaf feeders (Lawrence & Britton, 1991).	

Pest	Common name	Pathway association		Consider further (yes/no)
		Associated with fruit (yes/no)	Comment	
Stethorus punctillum (Weise) [Coleoptera: Coccinellidae]	Mite eating ladybird	No	Lady beetles are among the most beneficial insects. Mite eating ladybird is a common species. It feeds on *Aculus schlechtendali*, *Bryobia rubrioculus*, *Eotetranychus pruni*, *Panonychus ulmi*, *Phytoseiulus persimilis*, *Tetranychus cinnabarinus* and *Tetranychus truncatus* (CABI, 2004).	
Synoxylon sexdentatum Oliver [Coleoptera: Bostrichidae]	Bostrichid beetle	No	Adults feed on branches and twigs whereas larvae feed on dead wood (Benfatto & Longo, 1986).	
Trichoferus griseus Fabricius [Coleoptera: Cerambycidae]	Cerambycid beetle	No	Not associated with fruit pathway (Benfatto & Longo, 1986).	
Tropinota hirta Poda [Coleoptera: Scarabeidae]	Scarabeid weevil	No	Adults of this species have been recorded feeding on flowers (Benfatto & Longo, 1986).	
Tropinota squalida Scopoli [Coleoptera: Scarabeidae]	Scarabeid weevil	No	Adults of this species have been recorded feeding on flowers (Benfatto & Longo, 1986).	
Xylomedes coronata Mars [Coleoptera: Bostrichidae]	Bostrichid beetle	No	Adults feed on branches and twigs whereas larvae feed on dead wood (Benfatto & Longo, 1986).	
Diptera (flies)				
Ceratitis capitata (Wiedemann) Diptera: Tephritidae]	Mediterranean fruit fly; Medfly	Yes	Lays eggs in the fruit. Larvae feed and develop within the fruit. Mature larvae leave the fruit to pupate in the soil (Fletcher, 1989).	**Yes**
Syrphus spp. [Diptera: Syrphidae]	Hover fly	No	Natural enemy of *Diuraphis noxia* and *Metopolophium festucae* (CABI, 2004).	
Hemiptera (aphids, leafhoppers, mealybugs, psyllids, scales, true bugs, whiteflies)				
Aleurothrixus floccosus (Maskell) [Hemiptera: Aleyrodidae]	Woolly whitefly	Yes	Primarily feeds on leaves. Lives on the lower surfaces of young rolled leaves and lays eggs there and on fruit (Vulic & Beltran, 1977).	**Yes**

Pest	Common name	Pathway association		Consider further (yes/no)
		Associated with fruit (yes/no)	Comment	
Aphis fabae Scopoli [Hemiptera: Aphididae]	Black bean aphid	No	Polyphagous foliage and blossom feeder (Beniecki, 2002).	
Asymmetrasca decedens (Paoli) [Hemiptera: Cicadellidae]	Green leafhopper	No	Leafhoppers are sapsuckers that feed on the leaves, twigs and branches of the host tree. Excretes copious amounts of honeydew on which sooty moulds grow. Eggs are usually laid in slits in the bark on branches or twigs. All nymphal and adult stages feed by sucking the sap of the host tree. Primarily feeds on the underside of leaves by sucking out the liquid cell contents.	
Bemisia tabaci biotype B (Gennadius) [Hemiptera: Aleyrodidae]	Tobacco whitefly	No	Eggs are laid and immature stages develop on the undersides of the leaves. Primarily feeds on leaves (Hamon, 2001). Adults congregate, feed and mate on the under surface of the leaves. Numbers can be large enough to create ’clouds’ when the insects are disturbed.	
Calocoris trivialis (Costa) [Hemiptera: Miridae]	Mirid bug	No	Mirid bugs are considered beneficial, being predators of pest mites and aphids. From bloom until shortly after petal fall, however, they may severely damage fruit by feeding on flower parts or young fruitlets (Kain & Kovach, 2001).	
Ceroplastes floridensis Comstock [Hemiptera: Coccidae]	Florida wax scale	No	Wax scales feed by extracting sap from the vascular system and a heavy infestation can rob the host of enough sap to cause premature leaf drop and branch dieback. Wax scales secrete large quantities of honeydew. Sooty mould grows on honeydew, rendering the plant and its surroundings unsightly (Stimmel, 1998).	
Ceroplastes japonicus Green [Hemiptera: Coccidae]	Wax scale	No	Wax scales feed by extracting sap from the vascular system and a heavy infestation can rob the host of enough sap to cause premature leaf drop and branch dieback. In addition to the direct feeding damage, the honeydew secreted forms a substrate for the growth of black sooty moulds, which screen light from the leaves and impair gas exchange and photosynthesis. Sooty mould also reduces the market value of plants and produce (Prokopenko & Mokrousova, 1981).	

Pest	Common name	Pathway association		Consider further (yes/no)
		Associated with fruit (yes/no)	Comment	
Ceroplastes rusci (Linnaeus) [Hemiptera: Coccidae]	Fig tree scale	No	Wax scales feed by extracting sap from the vascular system and a heavy infestation can rob the host of enough sap to cause premature leaf drop and branch dieback. In addition to the direct feeding damage, the honeydew secreted forms a substrate for the growth of black sooty moulds, which screen light from the leaves and impair gas exchange and photosynthesis. Sooty mould also reduces the market value of plants and produce (Pellizzari & Camporese, 1994).	
Chrysomphalus dictyospermi (Morgan) [Hemiptera: Diaspididae]	Palm scale	Yes	Armoured scales infest any part of a plant, although areas close to leaf veins and underside of leaves are preferred. Mobile nymphs settle on the upper surface of older leaves, and later on new shoots and immature fruits (HYPPZ, 2003). Heavily infested leaves dry up and fall. Branches wilt. Infested fruits are deformed.	**Yes**
Dialeurodes citri (Ashmead) [Hemiptera: Aleyrodidae]	Citrus whitefly	No	Injures the plant by consuming large quantities of sap. Further injury is caused by sooty mould fungi, which grow over fruit and foliage in the copious honeydew excreted by the whitefly. Heavily infested trees become weak and produce small crops of insipid fruit. Transport of living host plants or fresh foliage of host plants present the main quarantine risk (Fasulo, 1999).	
Lepidosaphes gloverii (Packard) [Hemiptera: Diaspididae]	Glover's scale	Yes	Occurs on most parts of a citrus tree, on fruit, leaves, twigs and sometimes larger limbs. Crawlers settle in sheltered sites, in older leaves and beneath fruit calyx lobes (Smith *et al*., 1997).	**Yes**
Metcalfa pruinosa (Say) [Hemiptera: Flatidae]	Citrus planthopper	No	Primarily feeds on foliage and overwinters as eggs inserted in woody tissue or under tree bark (Wilson & McPherson, 1981). Nymphs surround themselves with long, waxy filaments, which protect them from their copious honeydew.	
Neoaliturus tenellus (Baker) [Hemiptera: Cicadellidae]	Beet leafhopper	No	Primarily feeds on leaves and stems of host plants. Brassicae are the principal host of this insect. In North America, Aizoaceae, Chenopodiaceae and other arid-adapted plants serve as secondary hosts. Eggs are laid in the leaves and stems of the host plants. Eggs hatch from 5 days to 1 month, depending on temperature (Cook, 1941).	

Pest	Common name	Pathway association		Consider further (yes/no)
		Associated with fruit (yes/no)	Comment	
Orthezia insignis Browne Hemiptera: Ortheziidae]	Lantana bug	No	Polyphagous, usually preferring woody hosts, occurring mainly on shoots and twigs (Ezzat, 1956).	
Parabemisia myricae (Kuwana) [Hemiptera: Aleyrodidae]	Bayberry whitefly	Yes	Primarily feeds on the foliage. Eggs are laid on leaf edges or on the upper surface of very young leaves. At high population densities, eggs may also be laid on young fruit and young shoots (Uygun *et al*., 1990).	**Yes**
Parlatoria pergandii Comstock [Hemiptera: Diaspididae]	Chaff scale	Yes	Found on bark, leaves and fruits. When fruit is infested, the areas around the scale remain green at maturity. Chaff scale can also be found under the calyx of the fruit (Futch *et al*., 2001).	**Yes**
Parlatoria ziziphi (Lucas) [Hemiptera: Diaspididae]	Black parlatoria scale	Yes	Heavy infestations cause chlorosis and premature drop of leaves, dieback of twigs and branches, stunting and distortion and fruit drop before maturity. Individuals can be so firmly attached to fruit that they cannot be removed by washing (Fasulo & Brooks, 2001).	**Yes**
Parthenolecanium corni (Bouché) [Hemiptera: Coccidae]	European fruit scale	No	This soft scale sucks plant juices from leaves and twigs. They settle mostly on the underside of leaves, especially along the veins during spring, moving back to the twigs in autumn (Hodgson & Henderson, 2000).	
Phenacoccus madeirensis Green [Hemiptera: Pseudococcidae]	Madeira mealybug	No	Mealybugs are slow moving sucking insects. Mealybug infestations often occur underneath foliage and in hidden areas within dense foliage. Mealybugs remove sap from plants, which can cause yellowing of leaves and decline in vigour. Mealybug ovisacs and excreted honeydew are unsightly. Honeydew supports the growth of black sooty mould fungi and attracts ants. Ants may then carry mealybugs to uninfested plants and tend them for honeydew. Feeding occurs on underside of leaves and preference is shown for leaf ribs (CABI, 2004).	
Pseudococcus calceolariae (Maskell) [Hemiptera: Pseudococccidae]	Citrophilus mealybug	Yes	This mealybug primarily feeds on foliage but can feed on fruit and lays several hundred eggs on the leaves or twigs of its host plants (Rotundo *et* al., 1979). Adults and larvae cause damage by excreting honeydew onto fruit and leaves, leading to sooty mould growth (Grimes & Cone, 1985).	**Yes**

Pest	Common name	Pathway association		Consider further (yes/no)
		Associated with fruit (yes/no)	Comment	
Pterochloroides persicae (Cholodkovsky) [Hemiptera: Aphididae]	Brown peach aphid	No	Eggs are deposited on stems and branches. These aphids pierce the bark and feed on sap (CABI, 2004).	
Pulvinaria floccifera Westwood [Hemiptera: Coccidae]	Cushion scale	No	Other species of this genus are primarily foliage feeders causing yellowing, defoliation, reduction in fruit set and loss of plant vigour (Mau & Kessing, 1992).	
Trioza alacris Flor [Hemiptera: Triozidae]	Laurel psyllid	No	Other species of this genus primarily feed on young leaves, are temperature sensitive and transmit the causal agent of greening disease (Massonie *et al*., 1976).	
Unaspis yanonensis (Kuwana) [Hemiptera: Diaspididae]	Arrowhead scale	Yes	Fruits, leaves and small branches are attacked, but not large branches or trunks. Only the second and third generations are found on fruits (Ohkubo, 1980).	**Yes**
Hymenoptera (ants, wasps)				
Aphanogmus steinitzi Priesner [Hymenoptera: Ceraphronidae]	Wasp	No	Ceraphronidae wasps are parasitic or hyperparasitic (Naumann, 1991). This wasp is a general predator that feeds on a variety of insects including 3rd to 4th stage leafroller caterpillars. The larvae of the wasp feed externally on the caterpillar.	
Aphytis chilensis Howard [Hymenoptera: Aphelinidae]	Parasitic wasp	No	An important parasitoid of the oleander scale, *Aspidiotus nerii* Bouché. *Aphytis chilensis* is an ectoparasitoid of armoured scale insects. The 2nd stage nymphs, young females and scale prepupae are attacked, but the ovipositing females are the preferred stage for parasitization (Alexandrakis & Neuenschwander, 1980).	
Cales noacki (Howard) [Hymenoptera: Aphelinidae]	Parasitic wasp	No	*Cales noacki* is a parasite of Mediterranean origin that is effective against *Aleurothrixus floccosus* (CABI, 2004).	
Camponotus nylanderi Emery [Hymenoptera: Formicidae]	Ant	No	Colonies of this ant are commonly constructed under the cover of stones, boards, and other objects or at the base of plants.	

Pest	Common name	Pathway association		Consider further (yes/no)
		Associated with fruit (yes/no)	Comment	
Lysiphlebus testaceipes (Cresson) [Hymenoptera: Aphidiinae]	Parasitic wasp	No	This species only attacks aphids. The conspicuous sign of its activity is the presence of aphid "mummies" - swollen, dead aphids that have been tanned and hardened to form a protective case for the developing wasp pupa (Hoffmann & Frodsham, 1993).	
Leptomastix dactilopii Howard [Hymenoptera: Encyrtidae]	Mealybug parasite	No	Primarily a parasite of mealybugs.	
Tapinoma erraticum Linnaeus [Hymenoptera: Formicidae]	Ant	No	A very thermophilic species, it is found principally in sandy or peat soil exposed to the sun. Colonies are polygynous and have been recorded to contain up to 40 deälated females. Nests are shallow and small solaria often feature in nest structure to concentrate solar heat onto the ants' brood (Wikipedia, 2004).	
Tapinoma nigerrimum (Nylander) [Hymenoptera: Formicidae]	Black ant	No	Other species of this genus are associated with human habitation and hospitals in particular. These ants feed on many household foods.	
Lepidoptera (moths, butterflies)				
Archips rosanus Linnaeus [Lepidoptera: Tortricidae]	European leaf roller	No	Larvae initially feed in the developing flower-bud trusses and eventually feed within spun or curled leaves. Feeding damage is seen on on foliage, buds and developing fruitlets (AliNiazee, 1977; Chepurnaya & Rybalov, 1981), which subsequently heal leaving unsightly corky scares. This suggests that any larvae present on the developing fruitlet would have pupated before the fruit harvest.	

Pest	**Common name**	**Pathway association**		**Consider further (yes/no)**
		Associated with fruit (yes/no)	Comment	
Cacoecimorpha pronubana Hübner [Lepidoptera: Tortricidae]	Mediterranean carnation tortrix	No	Indigenous to the Mediterranean region, primarily feeds on foliage. Eggs are laid on smooth surfaces, which hatch after 6-22 days (van de Vrie, 1991). The larvae quickly move or are carried in wind to the young growing points or flowers. The adults can disperse themselves locally. In international trade, it may be carried on plants for planting or cut flowers of carnations, chrysanthemums, pelargoniums, roses and other host plants. In Algeria, it is found mainly on lemons, but is not considered a serious pest. In Sicily, surveys reported *C. pronubana* mainly on olives, weeds and roses but not on lemons (Inserra *et al*., 1987; Siscaro *et al*., 1988).	
Charaxes jasius (Linnaeus) [Lepidoptera: Nymphalidae]	Two-tailed Pasha	No	The primary food plant for this butterfly is *Arbutus* (strawberry tree). However, the larvae have been noted to feed on citrus leaves (Longo, 1992).	`
Cryptoblabes gnidiella (Millière) [Lepidoptera: Pyralidae]	Citrus pyralid	Yes	The symptoms vary according to the feeding site, but the presence of silk, which indicates larval activity, is normally the most obvious symptom of damage by this pest. Eggs are laid on the fruit or foliage (Carter, 1984).	**Yes**
Gymnoscelis rufifasciata (Haworth) [Lepidoptera: Geometridae]		No	Primarily feeds on citrus flowers (Mineo, 1986).	
Hyphantria cunea Drury [Lepidoptera: Arctiidae]	Fall web-worm	No	External leaf feeder. Woven silk nests enclosing several leaves are conspicuous. Rapid defoliation of forest and fruit trees occurs (Morris, 1976).	
Peridroma saucia (Hübner) [Lepidoptera: Noctuidae]	Variegated cutworm	No	Feeds on leaves of a wide variety of hosts (Berry & Shields, 1980). This species is known to climb the stems of other herbaceous plants, vines, shrubs, and trees and eat buds, leaves and fruits of vegetables and orchard and vineyard crops (Mau & Kessing, 1991).	
Prays citri Millière [Lepidoptera: Yponomeutidae]	Citrus flower moth	Yes	Eggs are laid individually on the flowers, and sometimes on young fruit. On hatching the larvae bore into flowers and small fruits. Cocoons may be found on fruits, flowers and leaves (Garrido & Ventura, 1993).	**Yes**

Pest	Common name	Pathway association		Consider further (yes/no)
		Associated with fruit (yes/no)	Comment	
Spodoptera littoralis (Boisduval) [Lepidoptera: Noctuidae]	Mediterranean climbing cutworm	No	Polyphagous, generalist feeder recorded on a wide range of plant species. Leaf eating is the main cause of damage to the host plant (HYPPZ, 2004).	
Trichoplusia ni (Hübner) [Lepidoptera: Noctuidae]	Silver moth	No	Larvae feed on the foliage of a wide variety of cultivated plants and weeds. Not all hosts are equivalent for larval development and survival (Hoo *et al*., 1984). Adults feed on nectar from a wide range of flowering plants	
Xestia c-nigrum (Linnaeus) [Lepidoptera: Noctuidae]	Spotted cutworm	No	Larvae feed on a wide range of herbaceous plants, both weedy and agriculturally important species. Eggs are usually laid on suitable host plants but may also be scattered on the soil under plants (Cayrol, 1972). Larvae feed on developing shoots and buds (CABI, 2004).	
Neuroptera (Lacewings)				
Anisochrysa venusta [Neuroptera: Chrysopidae]	Lacewing	No	Other species of this genus are predators of aphids, white flies and insect eggs. Larval stage is fiercely predatory. The adults reportedly feed on pollen, nectar and aphid honeydew (Canard, 1998).	
Chrysopa carnea Stephens [Neuroptera: Chrysopidae]	Green Lacewing	No	Larvae are voracious and efficient predators of aphids. The adult green lacewing is not a predator but feeds on nectar, honeydew and pollen (CABI, 2004).	
Conwentzia psociformi (Curtis) [Neuroptera: Coniopterygidae]	Lacewing	No	Lacewings are predators and this species is a natural enemy of aphids (CABI, 2004).	
Thysanoptera (thrips)				
Aeolothrips ericae Bagnall [Thysanoptera: Thripidae]	Predatory thrips	No	Attacks a range of plant eating thrips, mites and aphids. These thrips supplement their diet with pollen and plant juice and can complete their life cycle on plant material (Hoddle, 1999).	
Thrips alni Uzel [Thysanoptera: Thripidae]	Flower thrips	No	Recorded on citrus flowers and did not cause scarring on fruitlets (Longo, 1986).	

Pest	Common name	Pathway association		Consider further (yes/no)
		Associated with fruit (yes/no)	Comment	
Thrips falvus Shrank [Thysanoptera: Thripidae]	Flower thrips	No	Recorded on citrus flowers and did not cause scarring on fruitlets (Conti *et al*., 2002).	
Thrips urticae Fabr. [Thysanoptera: Thripidae]	Flower thrips	No	Recorded on citrus flowers and did not cause scarring on fruitlets (Longo, 1986).	
PATHOGENS				
Fungi				
Armillaria mellea (Vahl) P. Kummer	Armillaria root rot	No	A root pathogen (Timmer *et al*., 2000).	
Armillaria tabescens (Scop.) Dennis, P.D. Orton & Hora	Armillaria root rot	No	A root pathogen. Causes slow decline of trees, with leaf yellowing and leaf drop (Timmer *et al*., 2000).	
Capnodium citri Mont.	Sooty mould	Yes	This fungus is found on fruit and leaves and grows superficially on the honeydew excretions of aphids, scales, mealybugs and psyllids (Baker *et al*., 2002). Spores or fragments of sooty mould are carried to the honeydew and new colonies of sooty mould develop. Although the fungal threads may adhere to the plant surface, sooty mould does not parasitise plant tissue (Baker *et al*., 2002).	**Yes**
Cercospora penzigii Sacc.	Leaf spot	Yes	Causes leaf spot of sweet orange leaves (Timmer *et al*., 2000). Most recently this fungus has been reported with citrus fruit in Douth Africa (Pretorius *et al*., 2003).	**Yes**
Diaporthe citri F.A. Wolf	Gummosis; Melanose	Yes	Symptoms of melanose are found on fruit, but disease spread does not occur via fruit movement. No spores are produced on symptomatic leaves, fruit or living twigs (Timmer *et al*., 2002).	**Yes**
Nematospora coryli Peglion	Yeast spot	Yes	Other species of this genus cause dry rot of citrus fruit, associated with insect injury, and are transmitted by insects (Mukerji, 1968).	**Yes**
Phoma tracheiphila (Petri) Kantachveli & Gikachvili	Mal secco	Yes	*Phoma tracheiphila* causes a serious tracheomycotic disease in various *Citrus* species, especially in lemon in the Mediterranean basin. This pathogen has been detected in lemon seeds (Stepanov & Shaluishkina, 1952).	**Yes**

Pest	Common name	Pathway association		Consider further (yes/no)
		Associated with fruit (yes/no)	Comment	
Phytophthora palmivora (E. J. Butler) E. J. Butler	Brown rot	Yes	The fungus is splashed onto fruit from the soil and cause brown rot. This fungus is known to produce air-borne sporangia and can affect fruit throughout the canopy (Graham & Timmer, 2004).	**Yes**
Phytophthora syringae (Kleb.) Kleb.	Brown rot	Yes	This fungus is known to cause brown rot of citrus in the Mediterranean climates (Timmer *et al*., 2000).	**Yes**
Septoria citri Pass	Septoria leaf spot	Yes	Primarily associated with foliage but is also reported as causing damage to fruit rind (Timmer *et al*., 2000).	**Yes**
Nematodes				
Xiphinema index Thorne & Allen	Dagger nematode	No	Migratory root ectoparasite; all stages feed at root tips. Reproduction is by meiotic parthenogenesis (Siddiqi, 1986).	
Phytoplasma				
Spiroplasma citri Saglio *et al*.	Stubborn	No	An obligate parasite, surviving in citrus or in a variety of other host plants. Naturally transmitted by leafhoppers (Klein *et al*., 1988). Natural transmission by leafhoppers will only carry this pathogen over local distances. International spread is more likely to occur with infected budwood (although this does not transmit the pathogen very reliably). Although the possibility exists that infective vectors may be carried on citrus plants, the insects concerned are actively mobile and do not preferentially feed on citrus, so the risk is considered minimal.	
Viroids				
Citrus exocortis viroid	Citrus exocortis	No	Grafting readily transmits this viroid. It is not vectored or seed transmitted (Timmer *et al*., 2000).	

Pest	Common name	Pathway association		Consider further (yes/no)
		Associated with fruit (yes/no)	Comment	
Citrus xyloporosis viroid	Citrus cachexia	No	Grafting readily transmits this viroid. It is not vectored or seed transmitted (Timmer *et al*., 2000).	
Viruses				
Citrus impietratura virus	Citrus impietratura disease	No	Grafting readily transmits this virus. It is not vectored or seed transmitted (Timmer *et al*., 2000).	
Citrus ring spot virus (CRSV)	Psorosis complex A & B	No	Graft-transmitted disease (Timmer *et al*., 2000).	
Citrus tristeza *closterovirus* (CTV)	Lime die-back	No	Graft-transmitted disease (Timmer *et al*., 2000). Local movement of CTV into new planting is by propagation and movement of CTV-infected plants and long distance spread between countries is by movement of infected budwood.	
Citrus variegation virus	Variegation disease	No	Graft-transmitted disease (Timmer *et al*., 2000).	

Appendix – 1c: Potential for establishment or spread and associated consequences for pests of sweet oranges from Italy

Scientific name	Common name	Potential for establishment or spread in the PRA area		Potential for consequences		Consider pest further? (yes/no)
		Feasible/ not feasible	Comments	Significant/ not significant	Comments	
ARTHROPODS						
Acari (mites)						
Aculops pelekassi (Keifer) [Acari: Eriophyidae]	Pink citrus rust mite	Feasible	Narrow host range (Benfatto, 1980), but high reproductive rate (Mijuskovic & Kosac, 1972). Dispersed by wind.	Significant	Direct economic losses occur when distorted fruit is downgraded in packinghouses.	Yes
Amblyseius barkeri (Hughes) [Acari: Phytoseiidae]	Predatory mite	Feasible	Some of its prey is wide spread and established in Australia.	Not significant	As this mite is used as a biocontrol agent against two-spotted spider mite and this pest is also present in Australia, it is expected that the mite would not have a negative impact in Australia.	
Amblyseius largoensis (Muma) [Acari: Phytoseiidae]	Predatory mite	Feasible	Some of its prey is wide spread and established in Australia.	Not significant	As this mite is used as a biocontrol agent against two-spotted spider mite and this pest is also present in Australia, it is expected that the mite would not have a negative impact in Australia.	

Scientific name	**Common name**	**Potential for establishment or spread in the PRA area**		**Potential for consequences**		**Consider pest further? (yes/no)**
		Feasible/ not feasible	Comments	Significant/ not significant	Comments	
Amblyseius swirskii Athias-Henriot [Acari: Phytoseiidae]	Predatory mite	Feasible	Some of its prey is wide spread and established in Australia.	Not significant	As this mite is used as a biocontrol agent against two-spotted spider mite and this pest is also present in Australia, it is expected that the mite would not have a negative impact in Australia.	
Brevipalpus cuneatus Canestrini & Fanzago [Acari: Tenuipalpidae]	False spider mite	Feasible	Mites typically have a high reproductive rate.	Significant	Mites of this genus include some of the most damaging species on citrus and cause damage to fruit.	Yes
Cheletogenes ornatus (Canestrini & Fanzago) [Acari: Cheyletidae]	Predatory mite	Feasible	Some of its prey is wide spread and established in Australia.	Not significant	As this mite is used as a biocontrol agent against two-spotted spider mite and this pest is also present in Australia, it is expected that the mite would not have a negative impact in Australia.	
Cheletomimus minutes (Oudemans) [Acari: Cheyletidae]	Predatory mite	Feasible	Some of its prey is wide spread and established in Australia.	Not significant	As this mite is used as a biocontrol agent against two-spotted spider mite and this pest is also present in Australia, it is expected that the mite would not have a negative impact in Australia.	

Scientific name	Common name	Potential for establishment or spread in the PRA area		Potential for consequences		Consider pest further? (yes/no)
		Feasible/ not feasible	Comments	Significant/ not significant	Comments	
Cunaxoides oliveri Schruft [Acari: Cunaxidae]	Cunaxid mite	Feasible	Some of its prey is wide spread and established in Australia.	Not significant	As this mite is used as a biocontrol agent against two-spotted spider mite and this pest is also present in Australia, it is expected that the mite would not have a negative impact in Australia.	
Eryngiopus bifidus Wood [Acari: Stigmaeidae]	Predatory mite	Feasible	Some of its prey is wide spread and established in Australia.	Not significant	As this mite is used as a biocontrol agent against two-spotted spider mite and this pest is also present in Australia, it is expected that the mite would not have a negative impact in Australia.	
Eryngiopus siculus Vacante & Gerson [Acari: Stigmaeidae]	Predatory mite	Feasible	Some of its prey is wide spread and established in Australia.	Not significant	As this mite is used as a biocontrol agent against two-spotted spider mite and this pest is also present in Australia, it is expected that the mite would not have a negative impact in Australia.	
Eutogenes citri Gerson [Acari: Cheyletidae]	Predatory mite	Feasible	Some of its prey is wide spread and established in Australia.	Not significant	As this mite is used as a biocontrol agent against two-spotted spider mite and this pest is also present in Australia, it is expected that the mite would not have a negative impact in Australia.	

Scientific name	Common name	Potential for establishment or spread in the PRA area		Potential for consequences		Consider pest further? (yes/no)
		Feasible/ not feasible	Comments	Significant/ not significant	Comments	
Hemisarcoptes malus (Shimer) [Acari: Hemisarcoptidae]	Hemisacopid mite	Feasible	Some of its prey is wide spread and established in Australia.	Not significant	As this mite is used as a biocontrol agent against two-spotted spider mite and this pest is also present in Australia, it is expected that the mite would not have a negative impact in Australia.	
Lorryia australensis (Baker) [Acari: Tydeidae]	Tydeid mite	Feasible	Some of its prey is wide spread and established in Australia.	Not significant	As this mite is used as a biocontrol agent against two-spotted spider mite and this pest is also present in Australia, it is expected that the mite would not have a negative impact in Australia.	
Lorryia ferula Baker [Acari: Tydeidae]	Tydeid mite	Feasible	Some of its prey is wide spread and established in Australia.	Not significant	As this mite is used as a biocontrol agent against two-spotted spider mite and this pest is also present in Australia, it is expected that the mite would not have a negative impact in Australia.	
Lorryia formosa Cooreman [Acari: Tydeidae]	Tydeid mite	Feasible	Some of its prey is wide spread and established in Australia.	Not significant	As this mite is used as a biocontrol agent against two-spotted spider mite and this pest is also present in Australia, it is expected that the mite would not have a negative impact in Australia.	

Scientific name	Common name	Potential for establishment or spread in the PRA area		Potential for consequences		Consider pest further? (yes/no)
		Feasible/ not feasible	Comments	Significant/ not significant	Comments	
Lorryia reticulata (Oudemans) [Acari: Tydeidae]	Tydeid mite	Feasible	Some of its prey is wide spread and established in Australia.	Not significant	As this mite is used as a biocontrol agent against two-spotted spider mite and this pest is also present in Australia, it is expected that the mite would not have a negative impact in Australia.	
Lorryia teresae (Carmona) [Acari: Tydeidae]	Tydeid mite	Feasible	Some of its prey is wide spread and established in Australia.	Not significant	As this mite is used as a biocontrol agent against two-spotted spider mite and this pest is also present in Australia, it is expected that the mite would not have a negative impact in Australia.	
Neoseiulus californicus McGregor [Acari: Phytoseiidae]	Predatory mite	Feasible	Some of its prey is wide spread and established in Australia.	Not significant	As this mite is used as a biocontrol agent against two-spotted spider mite and this pest is also present in Australia, it is expected that the mite would not have a negative impact in Australia.	
Orthotydeus californicus (Banks) [Acari: Tydeidae]	Tydeid mite	Feasible	Some of its prey is wide spread and established in Australia.	Not significant	As this mite is used as a biocontrol agent against two-spotted spider mite and this pest is also present in Australia, it is expected that the mite would not have a negative impact in Australia.	

Scientific name	Common name	Potential for establishment or spread in the PRA area		Potential for consequences		Consider pest further? (yes/no)
		Feasible/ not feasible	Comments	Significant/ not significant	Comments	
Orthotydeus caudatus (Dugès) [Acari: Tydeidae]	Tydeid mite	Feasible	Some of its prey is wide spread and established in Australia.	Not significant	As this mite is used as a biocontrol agent against two-spotted spider mite and this pest is also present in Australia, it is expected that the mite would not have a negative impact in Australia.	
Orthotydeus foliorum (Schrank) [Acari: Tydeidae]	Tydeid mite	Feasible	Some of its prey is wide spread and established in Australia.	Not significant	As this mite is used as a biocontrol agent against two-spotted spider mite and this pest is also present in Australia, it is expected that the mite would not have a negative impact in Australia.	
Orthotydeus kochi Oudemans [Acari: Tydeidae]	Tydeid mite	Feasible	Some of its prey is wide spread and established in Australia.	Not significant	As this mite is used as a biocontrol agent against two-spotted spider mite and this pest is also present in Australia, it is expected that the mite would not have a negative impact in Australia.	
Panonychus citri McGregor [Acari: Tetranychidae]	Citrus red mite	Feasible	Wide host range (Bolland *et al*., 1998) and already established in restricted areas of New South Wales (Hely *et al*., 1982).	Significant	This mite is considered to be an economically important pest of citrus crops (Jeppson *et al*., 1975).	Yes

Scientific name	Common name	Potential for establishment or spread in the PRA area		Potential for consequences		Consider pest further? (yes/no)
		Feasible/ not feasible	Comments	Significant/ not significant	Comments	
Pronematus ubiquitus (McGregor) [Acari: Tydeidae]	Tydeid mite	Feasible	Some of its prey is wide spread and established in Australia.	Not significant	As this mite is used as a biocontrol agent against two-spotted spider mite and this pest is also present in Australia, it is expected that the mite would not have a negative impact in Australia.	
Tarsonemus aurantii Oudemans [Acari: Tarsonemidae]	Tarsonemid mite	Feasible	Some of its prey is wide spread and established in Australia.	Not significant	As this mite is used as a biocontrol agent against two-spotted spider mite and this pest is also present in Australia, it is expected that the mite would not have a negative impact in Australia.	
Tarsonemus bilobatus Suski [Acari: Tarsonemidae]	Tarsonemid mite	Feasible	Some of its prey is wide spread and established in Australia.	Not significant	As this mite is used as a biocontrol agent against two-spotted spider mite and this pest is also present in Australia, it is expected that the mite would not have a negative impact in Australia.	
Tarsonemus floricolus Canestrini & Fangazo [Acari: Tarsonemidae]	Tarsonemid mite	Feasible	Some of its prey is wide spread and established in Australia.	Not significant	As this mite is used as a biocontrol agent against two-spotted spider mite and this pest is also present in Australia, it is expected that the mite would not have a negative impact in Australia.	

Scientific name	**Common name**	**Potential for establishment or spread in the PRA area**		**Potential for consequences**		**Consider pest further? (yes/no)**
		Feasible/ not feasible	Comments	Significant/ not significant	Comments	
Tarsonemus idaeus Suski [Acari: Tarsonemidae]	Tarsonemid mite	Feasible	Some of its prey is wide spread and established in Australia.	Not significant	As this mite is used as a biocontrol agent against two-spotted spider mite and this pest is also present in Australia, it is expected that the mite would not have a negative impact in Australia.	
Typhlodromus exhilaratus Ragusa [Acari: Phytoseiidae]	Predatory mite	Feasible	Some of its prey is wide spread and established in Australia.	Not significant	As this mite is used as a biocontrol agent against two-spotted spider mite and this pest is also present in Australia, it is expected that the mite would not have a negative impact in Australia.	
Typhlodromus talbii Athias-Henriot [Acari: Phytoseiidae]	Predatory mite	Feasible	Some of its prey is wide spread and established in Australia.	Not significant	As this mite is used as a biocontrol agent against two-spotted spider mite and this pest is also present in Australia, it is expected that the mite would not have a negative impact in Australia.	
Zetzellia collyerae (Gonzalez-Rodriguez) [Acari: Stigmaeidae]	Stigmaeid mite	Feasible	Some of its prey is wide spread and established in Australia.	Not significant	As this mite is used as a biocontrol agent against two-spotted spider mite and this pest is also present in Australia, it is expected that the mite would not have a negative impact in Australia.	

Scientific name	**Common name**	**Potential for establishment or spread in the PRA area**		**Potential for consequences**		**Consider pest further? (yes/no)**
		Feasible/ not feasible	Comments	Significant/ not significant	Comments	
Zetzellia graeciana Gonzales [Acari: Stigmaeidae]	Stigmaeid mite	Feasible	Some of its prey is wide spread and established in Australia.	Not significant	As this mite is used as a biocontrol agent against two-spotted spider mite and this pest is also present in Australia, it is expected that the mite would not have a negative impact in Australia.	
Zetzellia mali (Ewing) [Acari: Stigmaeidae]	Stigmaeid mite	Feasible	Some of its prey is wide spread and established in Australia.	Not significant	As this mite is used as a biocontrol agent against two-spotted spider mite and this pest is also present in Australia, it is expected that the mite would not have a negative impact in Australia.	
Diptera (flies)						
Ceratitis capitata Wiedemann) [Diptera: Thripidae]	Mediterranean fruit fly; Medfly	Feasible	Polyphagous, with a wide host range. Strong flyer- adults can fly up to 20 km (Fletcher, 1989). Females pierce the skin of fruit and lay eggs. Larvae feed internally on fruit (Knapp, 1998).	Significant	Economic impact would occur primarily though domestic and international trading restrictions imposed on fruit from areas where Medfly becomes established.	Yes
Hemiptera (aphids, leafhoppers, mealybugs, psyllids, scales, true bugs and whiteflies)						
Aleurothrixus floccosus (Maskell) [Hemiptera: Aleyrodidae]	Woolly whitefly	Feasible	Wide host range and high reproductive rates (Vulic & Beltran, 1977). Weak flier and seldom takes flight when disturbed or flies only short distances.	Significant	Damage is direct through sap removal and indirect through reduction of photosynthesis as a result of sooty mould development (Reuther *et al*., 1989).	Yes

Scientific name	Common name	Potential for establishment or spread in the PRA area		Potential for consequences		Consider pest further? (yes/no)
		Feasible/ not feasible	Comments	Significant/ not significant	Comments	
Chrysomphalus dictyospermi (Morgan) [Hemiptera: Diaspididae]	Palm scale	Feasible	Wide host range (HYPPZ, 2003) and already established in Queensland (AICN, 2004).	Significant	Infested fruits are deformed (HYPPZ, 2003) and would be downgraded during packing house procedures.	Yes
Lepidosaphes gloverii (Packard) [Hemiptera: Diaspididae]	Glover's scale	Feasible	Wide host range (Davidson & Miller, 1990) and already established in New South Wales and Queensland (Smith *et al*., 1997).	Significant	Heavy infestation can cause a delay in the development of colour in maturing fruit (Bruwer, 1998).	Yes
Parabemisia myricae (Kuwana) [Hemiptera: Aleyrodidae]	Bayberry whitefly	Feasible	Wide host range (Mound & Halsey, 1978) and high reproductive rates (Rose *et al*., 1981).	Significant	Damage is direct through sap removal and indirect through reduction of photosynthesis as a result of sooty mould development.	Yes
Parlatoria pergandii Comstock [Hemiptera: Diaspididae]	Chaff scale	Feasible	Restricted host range (Davidson & Lyon, 1987). Already established in Queensland (Smith *et al*., 1997).	Significant	Causes green spots on fruit making them unsuitable for the fresh market (Cartwright & Browning, 2003).	Yes
Parlatoria ziziphi (Lucas) [Hemiptera: Diaspididae]	Black parlatoria scale	Feasible	Wide host range (Fasulo & Brooks, 2001).	Significant	Causes defoliation, reduction in plant vigour, distortion and stunting of fruit, and premature fruit drop.	Yes
Pseudococcus calceolariae (Maskell) [Hemiptera: Pseudococcidae]	Citrophilus mealybug	Feasible	Wide host range (Ben-Dov, 1994), high reproductive rates (Rotundo *et al*., 1979) and already established in New South Wales, Queensland, South Australia, Tasmania and Victoria (AICN, 2004).	Significant	Infested fruit is downgraded for fresh markets (Howitt, 2001).	Yes

Scientific name	Common name	Potential for establishment or spread in the PRA area		Potential for consequences		Consider pest further? (yes/no)
		Feasible/ not feasible	Comments	Significant/ not significant	Comments	
Unaspis yanonensis (Kuwana) [Hemiptera: Diaspididae]	Arrowhead scale	Feasible	Narrow host range (Nohara, 1962) and high reproductive rates (Ohkubo, 1980).	Significant	Principal pests of *Citrus* spp. in Japan (Ohkubo, 1980).	Yes
Lepidoptera (butterflies, moths)						
Cryptoblabes gnidiella (Millière) [Lepidoptera: Pyralidae]	Citrus pyralid	Feasible	Polyphagous (Karsholt, 1996) and high reproductive rate (Wysoki *et al*., 1993). Individual moths may make extended flights to new fields (Silva & Mexia, 1999).	Significant	Feeding of larvae can result in cosmetic degradation of fresh fruit (Hashem *et al*., 1997).	Yes
Prays citri Millière [Lepidoptera: Yponomeutidae]	Citrus flower moth	Feasible	Narrow host range (Sinacori & Mineo, 1997) and high reproductive rate (Mineo *et al*., 1980). Individual moths may make extended flights to new fields.	Significant	Feeding of larvae can result in cosmetic degradation of fresh fruit (Ibrahim & Shahateh, 1984).	Yes
PATHOGENS						
Fungi						
Capnodium citri Mont.	Sooty mould	Feasible	Narrow host range (Farr *et al*., 1989) and spores are windborne (Baker *et al*., 2002).	Not significant	This fungus does not penetrate the tissue of the plant but grows superficially on honeydew (Baker *et al*., 2002).	
Cercospora penzigii Sacc.	Leaf spot	Feasible	Narrow host range and and spread by air-borne conidia (Pretorius *et al*., 2003)	Not significant	Not considered of economic significance in commercially produced fruits for either domestic or international trade.	
Diaporthe citri F.A. Wolf	Melanose	Not feasible	No spores are produced on symptomatic leaves, fruit or living twigs (Timmer *et al*., 2002).			

Scientific name	**Common name**	**Potential for establishment or spread in the PRA area**		**Potential for consequences**		**Consider pest further? (yes/no)**
		Feasible/ not feasible	Comments	Significant/ not significant	Comments	
Nematospora coryli Peglion	Dry rot of fruit	Feasible	Narrow host range and transmitted by insects.	Not significant	Not considered of economic significance in commercially produced fruits for either domestic or international trade.	
Phoma tracheiphila (Petri) Kantachveli & Gikachvili	Mal secco	Feasible	Narrow host range and transmitted by seeds (Stepanov & Shaluishkina, 1952). Short-distance dispersal is caused by wind and rain (Laviola & Scarito, 1989). Long-distance spread of mal secco occurs through infected propagative material and plants.	Significant	The disease reduces the quantity and quality of lemon production in the areas where the pathogen is present, and limits the use of susceptible species and cultivars (Perrotta & Graniti, 1988).	Yes
Phytophthora palmivora (E. J. Butler) E. J. Butler	Brown rot	Feasible	Wide host range and spores are wind blown (Timmer *et al.,* 2002).	Non significant	Although this funus cause brown rot on the fruit, no specific control measures are taken against this pathogen. Furthermore, Australia and its trading partners do not consider it of economic significance for either domestic or international trade.	
Phytophthora syringae (Kleb.) Kleb.	Brown rot	Feasible	Wide host range and spores are wind blown (Timmer *et al.,* 2002).	Non significant	Although this funus cause brown rot on the fruit, no specific control measures are taken against this pathogen. Furthermore, Australia and its trading partners do not consider it of economic significance for either domestic or international trade.	

Scientific name	Common name	Potential for establishment or spread in the PRA area		Potential for consequences		Consider pest further? (yes/no)
		Feasible/ not feasible	Comments	Significant/ not significant	Comments	
Septoria citri Pass	Septoria leaf spot	Feasible	Restricted host range. Short-distance dispersal is caused by wind and rain.	Not significant	Although affected fruit may be downgraded for cosmetic reasons, no specific control measures are taken against this pathogen. Furthermore, Australia and its trading partners do not consider it of economic significance for either domestic or international trade.	

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Appendix – 2: DATA SHEETS FOR QUARANTINE PESTS

2.1 ARTHROPODS

2.1.1 Pink citrus rust mite

Aculops pelekassi (Keifer) [Acari: Eriophyidae] - pink citrus rust mite; Japanese citrus rust mite.

Synonym(s): *Aculus pelekassi* (Keifer)

Host(s): *Citrus* spp.; *Citrus reticulata* (clementine, mandarin, tangerine); *Citrus sinensis* (navel orange, sweet orange, Valencia orange).

Distribution: Italy (Benfatto, 1980); Japan (Matsumoto *et al*., 1983); Taiwan (Huang & Wang, 1997); United States (Childers *et al*., 2000); Yugoslavia (Mijuskovic & Kosac, 1972), Thailand; and Brazil (Ashihara *et al*., 2004).

Biology: The pink citrus rust mite (PCRM) is found on all citrus varieties throughout Florida and is an important pest of fruit grown for the fresh market (Childers *et al*., 2004). Since citrus is a perennial plant that flushes continuously in subtropical and tropical regions of the world, eriophyoid mites inhabiting citrus generally move within the tree from mature senescing plant parts to newly formed leaves and stems and subsequently to mature fruit. *Aculops pelekassi* migrate to newly formed stem growth and the under surface of the leaves before moving to the upper surface of the leaf and subsequently to the fruit (Seki, 1981). The distribution of mites on individual fruit and in the whole citrus tree suggests an avoidance of solar exposure (Pena & Baranowski, 1990; Hall *et al*., 1991). On the favoured areas of host plants, the mite wanders randomly, usually feeding on a single epidermal cell for a short time before retracting its stylets, briefly searching for a new feeding site and then feeding again. Extensive probing of the leaf surface and fruit within a short time subsequently causes destruction of masses of epidermal cells. Injuries to the upper leaf surface are confined to epidermal cells and appears as slightly rough brownish to black patches resembling typical “russet”. *Aculops pelekassi* not only causes russeting of leaves but also causes mild to severe distortion of new growth, mesophyll collapse, chlorosis and leaf drop (Burditt & Reed, 1963; Jeppson *et al*., 1975). PCRM feed on green stems, leaves and fruits and have four developmental stages during its life cycle: egg, first instar (larva), second instar (nymph) and adult (Childers *et al*., 2004).

Egg deposition begins within two days of the female reaching sexual maturity and continues throughout her life of 14 to 20 days. Eggs are laid singly or in clusters on the surface of leaves, fruit and green twigs (Childers *et al*., 2004). The female lays one to two translucent white eggs per day and up to 30 during her lifetime. Eggs hatch in about 3 days at 24.5^{o}C. The newly hatched nymphs resemble the adults, changing in colour from clear to lemon yellow or pink after commencing to feed. After about 2 days at 24.5^{o}C, moulting occurs. Males and females have an average life span of 6 and 14 days respectively at 24.5^{o}C. In the field, females can live nearly 30 days in the winter. The length of the life cycle from egg to adult is 6 days at 24.5^{o}C (Childers *et al*., 2004). The mites congregate at leaf edges and so are easily distributed by wind.

Economic importance: High, as fruit quality and quantity are affected when infestations are high. The primary effect of fruit damage caused by *Aculops pelekassi* is cosmetic, resulting in lower grade standards (Tono *et al*., 1978). Reduced fruit size, increased water loss and increased fruit drop have been associated with severe injury to fruit.

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2.1.2 Citrus red mite

Panonychus citri McGregor [Acari: Tetranychidae] – citrus red mite

Synonym(s): *Metatetranychus citri* Pritchard & Baker; *Panonychus mori* Yokoyama; *Paratetranychus citri* McGregor; *Tetranychus citri* McGregor.

Host(s): *Averrhoa carambola* (carambola); *Carica papaya* (papaw); *Citrus limon* (lemon); *Citrus reticulata* (mandarin); *Citrus sinensis* (navel orange); *Citrus unshiu* (satsuma); *Citrus x paradisi* (grapefruit); *Citrus* spp.; *Eriobotrya japonica* (loquat); *Fragaria*; *Ilex crenata* (box-leaved holly); *Malus pumila* (apple); *Manihot esculenta* (cassava); *Osmanthus fragrans*; *Prunus laurocerasus*; *Prunus persica* (peach); *Pyrus communis* (European pear); *Vitis vinifera* (grapevine); *Ziziphus mauritiana* (Chinese date).

Distribution: Reported in nearly all areas of the world where citrus is grown (Bolland *et al*., 1998).

Biology: Adult *Panonychus citri* females lay two to four eggs per day for up to 3-4 weeks. Eggs are laid on the foliage and fruits and hatch into the larval stage after 1 week. The larvae migrate over the plant and begin feeding after the first moult. Nymphs and adults extract nutrients from the host tissue using their piercing, sucking mouthparts. Nymphs progress through two stages before becoming adults. Between each of these active stages, the nymph enters into an immobile stage while molting, during which it anchors itself to the leaf or to its webbing. Development times from egg to adult vary depending on temperature and humidity, with a mean development time of 10 days at 26°C and 70% RH. Up to 16 generations may occur within one year, with the majority of these (10-11) occurring in spring/summer. This mite overwinters in all stages (Jeppson *et al*., 1975). Adults and nymphs feeding on the host tissue cause damage. This produces tiny grey or silvery spots on leaves and fruit (stippling). Infestations on leaves are frequently greater than on fruit. Damage to leaves inhibits photosynthesis and can lead to necrosis. Severe infestations can lead to premature leaf fall, dieback and decreased vigor (Kranz *et al*., 1977; Davidson & Lyon, 1987).

Economic importance: *Panonychus citri* is considered to be an economically important and widespread pest of citrus crops (Jeppson *et al*., 1975). Peak infestations of this pest can vary greatly both within and between seasons (McMurtry *et al*., 1992). However, studies by Hare & Phillips (1992) and Hare *et al*. (1992) were unable to confirm the seriousness of attacks by this mite on foliage and subsequent economic losses. Following a detailed 4-year study on orange groves in California, USA, they concluded that infestations of up to 10 adult females per leaf could be tolerated without any significant economic loss, and without cumulative injury over four consecutive generations.

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2.1.3 False spider mite

Brevipalpus cuneatus Canestrini & Fanzago [Acari: Tenuipalpidae] – false spider mite

Host(s): False spider mites have a wide host range including citrus (Baker & Bambara, 1997), orchids, passionfruit, papaw, rambutan, durian and mangosteen (Astridge & Fay, 2004).

Distribution: False spider mites are found throughout North America, parts of Europe, South Africa and Australia (Baker & Bambara, 1997). *Brevipalpus cuneatus* is recorded in Italy (AAN, 1998), Greece (Hatzinikolis, 1987) and Crimea, Georgia and Tajikstan (Livshits *et al*., 1980).

Biology: Generally, false spider mites are flat and orange to red with black spots. Adult mites are small (about 0.3 mm). Tenuipalpus mites are broad in the middle and narrow behind (Baker & Bambara, 1997). The eggs are red and oval, and usually laid singly near the main veins on the underside of leaves. False spider mites are slow-moving and are occasionally seen on the underside of leaves and on leaf stalks in dry weather in summer (Astridge & Fay, 2004). With their needle sharp mouthparts, false spider mites puncture the epidermis of the host plant and suck out the juices.

Female false spider mites lay eggs that take 20 to 321 days to hatch at room temperature. Larvae hatch from the eggs and feed for about two weeks before molting into protonymphs. After 15 days of feeding, the protonymphs molt into deutonymphs. Two weeks later, deutonymphs molt into adult mites (Baker & Bambara, 1997). Adult females lay 40 to 60 eggs on foliage and the life cycle ranges from 26 to 30 days (Mersino, 2002). False spider mites have longer life cycles and lower fecundity than spider mites and there are only 4 to 6 generations per year (Baker & Bambara, 1997).

Economic importance: Other species of this genus affect the quality, quantity and size of citrus fruits. Feeding causes pitting, scarring and splitting of orange skins and mandarin fruits, which downgrade their quality (Morishita, 1954; Attiah, 1956; Elmer & Jeppson, 1957).

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2.1.4 Mediterranean fruit fly

Ceratitis capitata (Wiedemann) [Diptera: Tephritidae] – Mediterranean fruit fly; Medfly

Synonym(s): *Tephritis capitata* Wiedemann; *Ceratitis citriperda* Macleay; *Ceratitis hispanica* De Brême; *Pardalaspis asparagi* Bezzi.

Host(s): Medfly is a highly polyphagous species and its pattern of host relationships from region to region appears to relate largely to what fruits are available (White & Elson-Harris, 1994). In Hawaii (USA), 60 out of 196 fruit species examined over the years 1945-85 were found as hosts of this pest at least once; the two most important hosts were *Coffea arabica* and *Solanum pseudocapsicum* (Liquido *et al.*, 1990). In the EPPO region, important hosts include apple, avocado, citrus, fig, kiwi fruit, mango, medlar, pear and *Prunus* spp. (CABI/EPPO, 1997).

Ceratitis capitata attacks a very wide range of deciduous and subtropical fruits, with over 200 hosts recorded (Smith *et al*., 1997). Hosts include: *Actinidia deliciosa* (kiwi fruit); *Anacardium occidentale* (cashew); *Ananas comosus* (pineapple); *Annona cherimola* (cherimoya); *Annona reticulata* (bullock's heart); *Antidesma dallachyana* (Herbert River-cherry, Queensland-cherry); *Arbutus unedo* (Irish strawberry); *Artocarpus altilis* (breadfruit); *Averrhoa carambola* (carambola); *Capsicum annuum* (bell pepper); *Capsicum frutescens* (chilli); *Carica papaya* (pawpaw); *Carissa edulis* (carandas plum); *Carissa macrocarpa* (Natal plum); *Casimiroa edulis* (white sapote); *Chrysophyllum cainito* (caimito); *Citrus aurantifolia* (lime); *Citrus aurantium* (sour orange); *Citrus limetta* (sweet lime); *Citrus limon* (lemon); *Citrus limonia* (mandarin lime); *Citrus madurensis* (calamondin); *Citrus maxima* (pummelo); *Citrus medica* (citron); *Citrus nobilis* (tangor); *Citrus paradisi* (grapefruit); *Citrus reticulata* (mandarin); *Citrus reticulata* × *C. paradisi* (tangelo); *Citrus sinensis* (navel orange); *Coffea arabica* (arabica coffee); *Coffea liberica* (liberica coffee); *Cotoneaster* sp.; *Cucumis sativus* (cucumber); *Cydonia oblonga* (quince); *Cyphomandra betacea* (tamarillo); *Diospyros kaki* (persimmon); *Dovyalis caffra* (kei apple); *Eriobotrya japonica* (loquat); *Eugenia brasiliensis* (Brazil cherry, grumichama); *Eugenia uniflora* (Surinam cherry); *Feijoa sellowiana* (feijoa); *Ficus carica* (fig); *Ficus* spp. (fig); *Fortunella japonica* (round kumquat); *Fortunella* spp. (kumquat); *Garcinia livingstonei* (African mangosteen); *Garcinia mangostana* (mangosteen); *Harpephyllum caffrum* (Kaffir plum); *Juglans regia* (walnut); *Litchi chinensis* (lychee), *Lycopersicon esculentum* (tomato); *Macadamia tetraphylla* (rough-shell Queensland nut); *Malpighia glabra* (acerola); *Malus domestica* (apple); *Malus sylvestris* (crabapple); *Malus* spp. (apple); *Mangifera indica* (mango); *Manilkara zapota* (sapodilla); *Mespilus germanica* (medlar); *Mimusops elengi* (Spanish cherry); *Monstera deliciosa* (Mexican breadfruit); *Morus nigra* (black mulberry); *Muntingia calabura* (Jamaica cherry); *Musa* × *paradisiaca* (banana, plantain); *Myrciaria cauliflora* (jaboticaba); *Olea europaea* (olive); *Opuntia* sp. (prickly pear); *Opuntia ficus-indica* (Indian fig prickly pear); *Passiflora edulis* (purple passionfruit); *Pereskia aculeata* (Barbados gooseberry); *Persea americana* (avocado); *Phoenix dactylifera* (date-palm); *Physalis peruviana* (Cape gooseberry); *Pouteria sapota* (mammee sapote); *Pouteria viridis* (sapodella); *Prunus armeniaca* (apricot); *Prunus* *domestica* (plum); *Prunus ilicifolia* (chaparral tree); *Prunus persica* (peach); *Prunus persica* var. *nucipersica* (nectarine); *Prunus* spp. (stonefruit); *Psidium cattleianum* (cherry guava); *Psidium guajava* (guava); *Psidium littorale* (strawberry guava); *Punica granatum* (pomegranate); *Pyrus communis* (pear); *Rosa* spp. (rose); *Rubus loganobaccus* (loganberry); *Rubus ursinus* var. *loganbaccus* (boysenberry); *Rubus* spp. (raspberry); *Santalum album* (Indian sandalwood); *Santalum freycinetianum*; *Solanum incanum* (bitter apple); *Solanum melongena* (eggplant); *Solanum muricatum* (pepino); *Solanum nigrum* (black nightshade); *Solanum pseudocapsicum* (Jerusalem cherry); *Spondias cytherea* (Hog's plum); *Spondias purpurea* (purple mombin, Spanish plum); *Syzygium cumini* (black plum); *Syzygium jambos* (rose apple); *Syzygium malaccense* (malay-apple); *Syzygium samarangense* (water apple); *Terminalia catappa* (water almond); *Theobroma cacao* (cocoa); *Thevetia peruviana* (yellow oleander); and *Vitis vinifera* (grape) (CABI, 2004).

Distribution: Albania; Algeria; Angola; Argentina; Australia (WA-restricted distribution); Benin; Bermuda; Bolivia; Botswana; Brazil; Burkina Faso; Burundi; Cameroon; Cape Verde; Chile; Colombia; Congo Democratic Republic; Costa Rica; Croatia; Cyprus; Ecuador; Egypt; El Salvador; Ethiopia; France; Gabon; Ghana; Greece; Guatemala; Guinea; Honduras; Israel; Italy; Ivory Coast; Jamaica; Jordan; Kenya; Lebanon; Liberia; Libya; Madagascar; Malawi; Mali; Malta; Mauritius; Mexico; Morocco; Mozambique; Nicaragua; Niger; Nigeria; Panama; Paraguay; Peru; Portugal; Réunion; Russian Federation; Saudi Arabia; Senegal; Sierra Leone; Slovenia; South Africa; Spain; Sudan; Syria; Tanzania; Togo; Tunisia; Turkey; Uganda; Uruguay; USA (California; Florida; Hawaii; Texas); Venezuela; Yemen; Yugoslavia; Zimbabwe (CABI/EPPO, 1998).

The distribution of Medfly in Australia is now limited to Western Australia and is mainly restricted to the horticultural and urban areas in the southwest of the State. The largest populations of the insect occur in the Perth metropolitan area and in towns in the southwest of the state (Woods, 1997). In all of the towns and areas south of Manjimup, Medfly can be found in summer only for short periods. It is not found in orchards during the cooler months. The Ord River Irrigation area in northern Western Australia is free of this pest.

All other states of Australia are free of Medfly. Occasional, isolated, small outbreaks sometimes occur in the city of Adelaide in South Australia and the Northern Territory due to the introduction of infested fruit by humans, but these outbreaks are quickly detected through extensive fruit fly surveillance networks, and the outbreaks are successfully contained and rapidly eradicated.

Biology: Adults are 4–5 mm in length with pale-green eyes, mottled wings and a yellow body marked with white, brown, blue and black. Adults take 2–3 days to become sexually mature at 25°C (Krainacker *et al*., 1987). Medflies attack fruit that is beginning to colour (Smith *et al*., 1997). Peak adult emergence takes place in the early morning. Adult females must feed on protein (e.g. bacteria growing on fruit and plant surfaces) and on sugars (in honeydew or nectar) for several days before they can mature and lay their eggs (Smith *et al*., 1997). Mating takes place on host plants with ripening fruit. Adult survival for up to a year has been observed in the laboratory but probably does not exceed two to three months in the field (Fletcher, 1989). Generally, adults live up to 2 months (CABI/EPPO, 1997; Christenson & Foote, 1960), although adult females can live for up to 6 months (Smith *et al*., 1997). This species has a relatively long reproductive phase (Fletcher, 1989).

Medfly development time is dependent upon environmental factors, with temperature being a key factor for all life stages. In general, the higher the temperature the faster the development time and *vice versa*. In cool regions this species may overwinter as pupae or adults, while in warmer regions it is reproductively active throughout the year.

The developmental rate of Medfly reaches an upper limit at temperatures between 30 and 33°C and then decreases at temperatures above 35°C (Shoukry & Hafez, 1979). On average, under Australian conditions, development from egg to adult will take 28 to 34 days in the summer and 60 to 115 days in the winter (De Lima & Woods, 1996). Medfly activity is possible over winter when daily maximum temperatures exceed 12°C and they can survive the winter in both adult and immature stages (De Lima, 1998). In Australia, adults overwinter in citrus trees (Smith *et al*., 1997). Numbers fall in winter, and start increasing in spring. Populations are highest in late summer and early autumn (Smith *et al*., 1997).

Females lay 1–14 eggs per fruit, depending on its size (McDonald & McInnis, 1985), and can produce 300–1000 eggs throughout their lives (Fletcher, 1989). Eggs are white, 1 mm in length and deposited in batches of 2–30 beneath the skin in the albedo (rind) of ripening fruit (Smith *et al*., 1997). The eggs hatch within 2–4 days (up to 16–18 days in cool weather) (CABI/EPPO, 1997). Larvae are cream-coloured with a pointed head and squarish rear end. They hatch from the eggs and tunnel into the fruit pulp. Heavy mortality of eggs and young larvae, particularly in immature citrus fruit, is caused by oil released from oil cells in the rind ruptured during egg laying (Smith *et al*., 1997). In thicker-skinned varieties, larval death follows the formation of gum in and around the egg-laying site (Smith *et al*., 1997). The larvae feed for 6–11 days at 13–28°C (CABI/EPPO, 1997). Mature larvae are 6.5–9 mm in length, and leave the fruit to pupate in the top 50 mm of soil (Smith *et al*., 1997). Pupation takes place in the soil under the host plant and adults emerge after 6–11 days at 24–26°C (longer in cool conditions) (CABI/EPPO, 1997).

In Australia, most damage in citrus occurs during late summer and early autumn, especially to early maturing varieties (Smith *et al*., 1997). This coincides with the end of the season for deciduous fruits. Mature deciduous fruits act as a reservoir for fruit flies that migrate onto ripening citrus fruit at the end of the deciduous fruit season (Smith *et al*., 1997). Fruit damage results from puncturing of the rind during egg laying and larvae feeding on the fruit pulp (Smith *et al*., 1997). In addition, organisms such as green mould (*Penicillium digitatum*) enter the fruit through the punctures and rots develop (Cayol *et al*., 1994; Smith *et al*., 1997). The life cycle takes 4–17 weeks, depending on the temperature (Smith *et al*., 1997). There are 4–5 generations per year, with the number of generations determined by temperature (Fletcher, 1989; Smith *et al*., 1997). In tropical and subtropical regions there may be as many as 12–13 generations a year.

Adult flight and the transport of infested fruits are the major means of movement and dispersal to uninfested areas. There is evidence that *C. capitata* can fly at least 20 km (Fletcher, 1989). Long distance flights of adults, particularly over water, have been recorded and when fruit is unavailable in an area, both immature and mature flies will rapidly disperse (Fletcher, 1989). However, when hosts are available and other conditions are favourable, the movements of the majority of adults seem to be restricted to a few hundred metres per week (Wong *et al*., 1982).

Coffea spp. are especially heavily attacked, although the attack on coffee does not impact on this crop as only the fleshy part of the fruit, which is discarded, is utilised by the larvae.

However, in many areas coffee crops appear to act as an important reservoir from which other crops may be attacked. In some areas wild hosts are of importance, for example in northern Africa the boxthorn, *Lycium europaeum*, is an important overwintering host (Cayol, 1996).

Economic importance: Tephritid flies (Diptera: Tephritidae) are the most important dipteran pests of agriculture worldwide, and include 418 genera and 4352 species. Fruit flies are responsible worldwide for considerable restrictions on the international movement of fruit. This pest is an important pest in Africa and has spread to almost every other continent to become the single most important pest species in its family. It is highly polyphagous and causes damage to a very wide range of unrelated fruit crops. In Mediterranean countries, it is particularly damaging to citrus and peach. It may also transmit fruit-rotting fungi (Cayol *et al*., 1994).

Medfly is of quarantine significance throughout the world and especially for Japan and the USA. Its presence in Hawaii, but not in mainland USA, has contributed to its high international profile as a quarantine pest (Smith *et al*., 1997). It has reached all tropical and warm temperate landmasses with the exception of Asia. Its presence, even as temporary adventive populations, can lead to severe additional constraints for the export of fruits to uninfested areas in other continents. In this respect, *C. capitata* is one of the most significant quarantine pests for any tropical or warm temperate region in which it is not yet established (Smith *et al*., 1997).

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2.1.5 Citrophilus mealybug

Pseudococcus calceolariae (Maskell) [Hemiptera: Pseudococcidae]–Citrophilus mealybug

Synonym(s): *Dactylopius calceolariae* Maskell; *Erium calceolariae* (Maskell) Lindinger; *Pseudococcus citrophilus* Clausen; *Pseudococcus fragilis* Brain; *Pseudococcus gahani* Green.

Host(s): Citrophilus mealybug is a highly polyphagous species that has been recorded from hosts in 40 plant families (Ben-Dov, 1994). *Abutilon* (Indian mallow); *Arachis hypogaea* (groundnut); *Brachychiton*; *Brassica*; *Ceanothus*; *Chenopodium* (Goosefoot); *Citrus medica* (citron); *Conium maculatum* (Poison hemlock); *Crataegus* (hawthorns); *Cydonia oblonga* (quince); *Daucus carota* (carrot); *Dodonaea viscosa* (switch sorrel); *Eugenia*; *Ficus*; *Fragaria*; *Geranium* (cranesbill); *Hedera helix* (ivy); *Helianthus* (sunflower); *Heliotropium arborescens* (Cherry-pie); *Hibiscus* (rosemallows); *Juglans regia* (Carpathian walnut); *Laburnum anagyroides* (laburnum); *Ligustrum*, Lolium (ryegrass); *Malus pumila* (apple); *Malus sylvestris* (crab-apple tree); *Malva* (mallow); *Musa paradisiaca* (plantain); *Nerium oleander* (oleander); *Palmae* (plants of the palm family); *Pelargonium* (pelargoniums); *Pinus radiata* (radiata pine); *Pisum sativum* (pea); *Pittosporum tobira* (Japanese pittosporum); *Pittosporum undulatum* (Australian boxwood); *Polyscias*; *Prunus* (stone fruit); *Pyrus communis* (European pear); *Rheum hybridum* (rhubarb); *Rhododendron* (azalea); *Ribes sanguineum* (flowering currant); *Rosa* (roses); *Rubus* (blackberry, raspberry); *Schinus molle* (California peppertree); *Sechium edule*; *Solanum tuberosum* (potato); *Theobroma cacao* (cocoa); *Vitis vinifera* (grapevine).

Distribution: Australia (NSW, Qld, Tas, Vic); Chile; China; Czechoslovakia; France; Georgia (Republic); Ghana; Italy; Madagascar; Mexico; Morocco; Namibia; Netherlands; New Zealand; Portugal; South Africa; Spain; Ukraine; United Kingdom; and USA (California, Louisiana).

Biology: Females lay in excess of 700 eggs within a waxy ovisac. Neonate crawlers spend the first few days of their lives sheltering under the disintegrating ovisac before dispersing to feed. They usually do not move far from their feeding site for the first moult. At the end of the second instar, males spin a tubular, silken cocoon in which they develop through a short-lived third (about 2 days) and a longer-lived fourth non-feeding instar (about 4 days) before moulting into a tiny, winged adult with a pair of stout, waxy terminal filaments. Females develop through three immature instars and undergo a final moult to the adult form. Males, at the end of the second instar, and females before oviposition, often seek out sheltered spots under bark or old vegetation for further development. Neither stage feeds from then on, so physical protection is more important than a food source.

Mature females produce a sex pheromone that attracts crawling males from short distances (Rotundo & Tremblay, 1981) or flying males from distances in excess of 1 m (Rotundo *et al*., 1980). The pheromone attracts large numbers of males in the field, and has been used to detect three seasonal male flight peaks in Italy (Rotundo *et al*., 1979). Adult females may mate almost immediately, but then spend up to several weeks maturing their eggs. Mature females commonly move to a protected site to lay eggs over a period of up to 2 weeks. They cease feeding before oviposition, when they are little more than a convenient bag for their eggs. Parthenogenesis has not been reported in this species and experience suggests that sexual reproduction is obligate. In New Zealand there are probably up to three generations per year (Charles, 1981), in Australia four generations per year (Smith & Armitage, 1931) and in California three to four generations per year (Clausen, 1915).

Citrophilus mealybug feeds on the phloem of deciduous and evergreen plants in warm, temperate climates. Under these conditions, populations seldom reach sufficiently high levels to debilitate the plant, and the symptoms of attack are usually restricted to visual sighting of mealybugs or sooty mould. When mealybugs shelter in fruit, within the calyx, around the stalk, or under fruit sepals, they are often hidden from view and cannot be seen without cutting open the fruit. Sooty mould fungi growing around the calyx or sepals on excreted honeydew are a good indicator of the presence of mealybugs in the fruit.

Economic importance: Mealybugs cause direct damage to citrus by extracting large quantities of sap and producing honeydew that serves as the substrate for the development of sooty mould, which prevents photosynthesis in addition to making the plant unsightly. Citrophilus mealybug is an endemic pest throughout most of Australia, and is perhaps the most serious pest of citrus in South Australia (Altmann & Green, 1991). It is commonly found throughout the major fruit-growing regions in New Zealand and may be very common locally on most fruit crops (Charles, 1993). It can be a severe pest, at least locally, in Italy (Laudonia & Viggiani, 1986).

Mealybugs are pests for several reasons. They may debilitate parts of the plant through depletion of sap, transmission of disease and scarring of fruit (for example; citrophilus mealybug feeding under the 'button' of citrus fruit causes a necrotic halo mark). A heavy infestation can cause fruit drop (Altmann & Green, 1991). More commonly, the presence of mealybugs in other perennial fruit crops leads to unacceptable growth of sooty mould fungi on honeydew deposits on the fruit, either as a deposit on the cheek or around the stalk, calyx or sepals. For growers producing fresh fruit for export markets, the presence of mealybugs or sooty mould may be sufficient to limit the sale of that fruit to local markets at reduced prices. Some countries accept the fruit following fumigation, but this is costly and results in poorer quality fruit with a shorter shelf life.

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2.1.6 Scales

Chrysomphalus dictyospermi (Morgan) [Hemiptera: Diaspididae]–Palm scale

Lepidosaphes gloverii Packard [Hemiptera: Diaspididae]–Glover’s scale

Parlatoria pergandii Comstock [Hemiptera: Diaspididae]–Chaff scale

Parlatoria ziziphi (Lucas) [Hemiptera: Diaspididae]–Black parlatoria scale

Unaspis yanonensis (Kuwana) [Hemiptera: Diaspididae]–Arrowhead scale

Synonym(s):

Chrysomphalus dictyospermi (Morgan): *Aspidiotus dictyospermi* (Morgan) Cockerell; *Aspidiotus mangiferae* Cockerell; *Chrysomphalus dictyospermatis* Lindinger; *Chrysomphalus castigatus* Mamet.

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

Parlatoria pergandii Comstock: *Parlatoria sinensis* Maskell; *Parlatoria proteus* v. *pergandii* (Cockerell) Cockerell; *Parlatoria pergandii* (Cockerell) Hunter; *Parlatoria pergandii* (Cockerell) Lindinger; *Syngenaspis pergandei* (Cockerell) MacGillivray.

Parlatoria ziziphi (Lucas): *Coccus zizyphus* Lucas; *Parlatoria zizyphus* (Lucas).

Unaspis yanonensis (Kuwana): *Chionaspis yanonensis* Kuwana; *Prontaspis yanonensis* (Kuwana)

Host(s):

Chrysomphalus dictyospermi: *Areca catechu* (betelnut palm); *Citrus aurantiifolia* (lime); *Citrus aurantium* (sour orange); *Citrus maxima* (pummelo); *Citrus* x *paradisi* (grapefruit); *Citrus sinensis* (navel orange); *Citrus unshiu* (satsuma); *Cocos nucifera* (coconut); *Howea forsteriana* (paradise palm); *Mangifera indica* (mango); *Musa paradisiaca* (plantain); *Olea europaea* subsp. *europaea* (olive); *Palmae*; *Persea americana* (avocado); *Plumeria* (frangipani); *Rosa* (roses); *Solanum melongena* (aubergine); *Syzygium malaccense* (malay-apple); *Taxus baccata* (English yew); *Zingiber* (ginger).

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

Parlatoria pergandii: *Asparagus setaceus* (asparagus fern); *Citrus aurantiifolia* (lime); *Citrus limon* (lemon); *Citrus maxima* (pummelo); *Citrus reticulata* (mandarin); *Citrus sinensis* (navel orange); *Citrus x paradisi* (grapefruit); *Citrus*; *Malus pumila* (apple); *Prunus* (stone fruit); *Prunus domestica* (damson).

Parlatoria ziziphi: *Parlatoria ziziphi* has been recorded on several species of Citrus and other Rutaceae such as *Severinia buxifolia* and *Murraya paniculata*. *Campnosperma brevipetiolata*; *Citrus* spp.; *Citrus aurantium* (bergamot orange, bitter orange, marmalade orange, seville orange, sour orange); *Citrus reticulata* (clementine, mandarin, mandarin orange, satsuma orange, tangerine, tangor); *Cocos nucifera* (coconut, coconut palm); *Mangifera indica* (mango); *Nipa* spp.; *Nipa fruticans*.

Unaspis yanonensis: Only attacks *Citrus* spp. In Japan, it is found on all types of citrus except for specific Japanese hybrids known as Natsudaidi and *Citrus junos* (Ohkubo, 1980). *Citrus* spp., *Citrus limon* (lemon), *Citrus x paradisi* (grapefruit), *Citrus reticulata* (mandarin), *Citrus sinensis* (navel orange), *Citrus unshiu* (satsuma).

Distribution:

Chrysomphalus dictyospermi: Algeria; Angola; Argentina; Australia; Azerbaijan; Bahamas; Benin; Bermuda; Brazil; Bulgaria; Cameroon; Caroline Islands; Canary Islands; Cape Verde; Chile; China; Colombia; Congo, Cook Islands; Costa Rica; Ivory coast, Cuba; Dominican Republic; Easter Island; Ecuador; Egypt; Ethiopia; Federated states of Micronesia; Fiji; France; French Polynesia; Georgia (Republic); Greece; Guadeloupe; Guatemala; Guinea; Guyana; Honduras; India; Indonesia; Iraq; Iran; Israel; Italy; Jamaica; Johnston Island; Kenya; Kiribati; Laos; Lebanon; Libya; Madagascar; Malaysia; Mali; Malta; Marshall Islands; Mauritius; Mexico; Morocco; Myanmar; New Caledonia;

Nicaragua; Niger; Nigeria; Norfolk Island; Northern Mariana Islands; Panama; Papua New Guinea; Paraguay; Peru; Philippines; Portugal; Puerto Rico; Réunion; Samoa; Sao Paulo; Senegal; Sierra Leone; Solomon Islands; Somalia; Spain; South Africa; Sri Lanka; Sudan; Sumatra; Suriname; Syria; Tanzania; Thailand; Togo; Tonga; Trinidad and Tobago; Tunisia; Turkey; Turkmenistan; Tuvalu; Uganda; Ukraine; United Kingdom; Uruguay; USA; USSR; Venezuela; Vietnam; Yugoslavia; Zambia; Zimbabwe (CABI, 2004).

Lepidosaphes gloverii: Algeria; Argentina; 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; 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, 2004).

Parlatoria pergandii: Algeria; Argentina; Australia; Brazil; Cameroon; China; Cook Islands; Cuba; Dominican Republic; Egypt; El Salvador; Eritrea; Federated states of Micronesia; France; Greece; Guatemala; Honduras; India; Indonesia; Iran; Israel; Italy; Jamaica; Japan; Libya; Malta; Mexico; Morocco; Nicaragua; Nigeria; Norfolk Island; Pakistan; Peru; Philippines; Puerto Rico; Samoa; Senegal; Seychelles; Sierra Leone; Singapore; Somalia; South Africa; Spain; Syria; Tanzania; Thailand; Togo; Trinidad and Tobago; Tunisia; Turkey; USA (Alabama, California, Florida, Louisiana, Mississippi, South Carolina, Texas).

Parlatoria ziziphi: Algeria; Argentina; Bangladesh; Barbados; Brazil; Cambodia; Cameroon; Central African Republic; China; Colombia; Congo; Cuba; Cyprus; Dominica; Dominican Republic; Egypt; Eritrea; Ethiopia; France; Gambia; Georgia; Ghana; Greece; Guam; Guatemala; Guinea; Guyana; Haiti; India; Indonesia; Iran; Israel; Italy; Ivory Coast; Jamaica; Japan; Korea; Laos; Lebanon; Liberia; Libya; Malaysia; Mali; Malta; Mauritius; Micronesia; Morocco; Myanmar; New Zealand; Nigeria; Pakistan; Panama; Peru; Philippines; Portugal; Puerto Rico; Russian Federation; Saudi Arabia; Senegal; Sierra Leone; Singapore; South Africa; Spain; Sri Lanka; Syria; Thailand; Togo; Trinidad and Tobago; Tunisia; Turkey; USA (Florida [Fasulo & Brooks, 1997], Hawaii, Mississippi); Venezuela; Vietnam (CABI, 2004).

Unaspis yanonensis: China; Fiji; France; Italy; Japan; and Korea (CABI, 2004).

Biology: Most armoured scales are very small (2-4 mm long) and their body is covered with 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, well-developed legs and lack mouthparts (they do not feed). Adult females are elongate-oval (Williams & Watson, 1988). Nymphs are active only during the first instar (or crawler) stage and may travel some distance to a new plant where 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 movement and by wind.

In cooler regions during winter, development of all scales progresses very slowly up to the adult stage for females and up to the 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.

Armoured scales do not produce honeydew, but their feeding can damage fruit or cause leaf drop. They inject toxins into plant tissues and at high populations can cause tree death. These species are polyphagous and are often found in large numbers on leaves. Scales feed on foliage, fruit, twigs and the bark of the trunk (Timmer & Duncan, 1999). Leaves are the preferred feeding sites but fruit and branches are also attacked (Fasulo & Brooks, 2001). Most scales settle on upper leaf surfaces and the lower surfaces only become infested at very high population densities (Fasulo & Brooks, 2001).

Many scale species have shown an ability to adapt to new hosts and new environments (McClure, 1983). Adult female scales are sedentary. They attach to vegetative plant surfaces as nymphs, insert their mouthparts into vascular plant tissue and begin secreting protective armour. Eggs are laid beneath the female and remain there until they hatch. Crawlers move from the female and search the plant surface for a suitable point of attachment. Although crawlers may wander for a time, they usually settle and become attached to a vegetative surface within hours of leaving the female. Crawlers may be distributed by wind, or by a range of mechanical or biological vectors including propagation material, plantation equipment and personnel. Short-range transfer of scales is generally attributed to the movement of crawlers, either through their own efforts or by vectors. Long-range movement of scales occurs when gravid females are transferred *in situ* with the vegetative material upon which they are feeding. Short-range dispersal would occur readily by wind (Willard, 1974).

The depletion of plant sap reduces host vigour and foliage and fruit may be discolored with yellow streaking and spotting. Heavy infestations cause chlorosis of foliage and stems, premature dropping of leaves, moderate to severe defoliation, dieback of twigs and branches, stunting and distortion of fruit, spots on fruit and premature fruit drop. Severe infestations can drastically affect plant vigour and may even kill the plant (Fasulo & Brooks, 2001). For a short period after hatching, the first instars are attracted to light and move upwards towards the apical twigs or onto the fruit, especially if leaf fall has occurred.

Chrysomphalus dictyospermi is polyphagous. Eggs hatch 1 to 24 hours after being layed. The mobile nymphs settle in less than 24 hours and undergo their first moult 8 days later. The second and final nymphal instar stages last about 13 days. Three generations usually occur each year. A fourth may occur in the advent of warm autumn climatic conditions. Mobile nymphs initially settle on the upper surfaces of old leaves and later on new shoots and young fruits. Heavily infested leaves dry up and fall, branches wilt and infested fruit is deformed. Individuals have difficulty surviving in winter (HYPPZ, 2003).

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

The spread of *Parlatoria* spp. depends on relative humidity and temperature (Gerson, 1980). They do not spread well under low relative humidity and high temperatures. Australia has a wide range of climate and many areas are suitable for the establishment and spread of these scale insects. *Parlatoria pergandii* populations establish on limbs and trunks, but can be widely distributed on a tree. Adults and nymphs feed on leaves, stems and fruit, which can sometimes lead to fruit drop. Chaff scales are often associated with gumming, flaking and splitting of 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* in the Cook Islands (Walker & Dietz, 1979).

Parlatoria ziziphi females lay from 8 to 20 eggs (Fasulo & Brooks, 1997). Females feeding on fruit lay more eggs than those feeding on branches or foliage. Eggs hatch in 5–12 days and larvae pass through nymphal stages over 23–35 days (Sweilem *et al*., 1984). Depending upon the region of the world, there are from three to seven generations per year and each generation may take 30–93 days to develop. In colder weather, the time required is much longer (Fasulo & Brooks, 1997). All stages of development can be found throughout the year. Population density appears to be significantly and positively influenced by temperature and negatively influenced by relative humidity and rainfall, although the latter was not found to be significant by El Bolok *et al*. (1984a). Highest population densities are usually observed in the lowest part of a tree (El Bolok *et al*., 1984b). Leaves are the preferred feeding sites but fruit and branches are also attacked (Fasulo & Brooks, 1997). Generally, scales firmly attach to the fruit so that they cannot easily be removed, causing rejection in most fresh fruit markets. Most scales settle on the upper leaf surfaces and the lower surfaces only become infested at very high population densities (Fasulo & Brooks, 1997).

Unaspis yanonensis attacks fruits, leaves and small branches but not large branches or trunks. Only the second and third generations are found on fruit (Ohkubo, 1980). Attacks on branches and leaves lead to leaf fall, and possibly to complete dieback. Leaves and branches begin to die back at a density of 1.1 females per leaf (Ohkubo, 1980), while a density of 8 females per leaf in spring is likely to lead to complete dieback of the tree within the year (Ohgushi & Nishino, 1968). This species has three generations per year (Nohara, 1962). The fertilised adult female overwinters. Each generation has two population peaks and the duration of these is affected by day length and temperature. In Japan, the third generation is only seen in southern regions (Ohkubo, 1980). This pest survives best in shade and at high temperatures the natural mortality is high on the upper parts of trees. In France, attacks are mainly observed on the north side of trees, the south side remaining practically free from the pest (Bénassy & Pinet, 1972). This scale has a low dispersal potential. In common with other diaspidids, the main dispersal stage of this scale is the first instar, which may be naturally dispersed by wind and animals. Internationally, it is carried on citrus plants for planting or on citrus fruits.

Economic importance: Scale insects are major citrus pests and being small are difficult to detect by inspection, 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.

Attacked fruits lose their commercial value because of the feeding punctures of the pest (Ohkubo, 1980). *Parlatoria* scales have been reported causing serious damage in East Java on varieties of *Citrus nobilis* where shoots and leaves were attacked (Kalshoven & Van der Laan, 1981).

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2.1.7 Whiteflies

Aleurothrixus floccosus (Maskell) [Hemiptera: Aleyrodidae] – Woolly whitefly
Parabemisia myricae (Kuwana) [Hemiptera: Aleyrodidae] – Bayberry whitefly

Synonym(s):

Aleurothrixus floccosus (Maskell): *Aleurodes floccosa* Maskell; *Aleurothrixus howardi* (Quaintance) Quaintance & Baker; *Aleyrodes horridus* Hempel; *Aleyrodes howardi* Quaintance; *Aleurothrixus horridus* (Hempel) Quaintance & Baker. *Aleurothrixus howardi* (Quaintance) Quaintance & Baker.

Parabemisia myricae (Kuwana): *Bemisia myricae* Kuwana.

Hosts:

Aleurothrixus floccosus (Maskell): *Anacardium occidentale* (cashew); *Annona reticulata* (custard apple); *Baccharis genistelloides*; *Bougainvillea* sp.; *Cicca acida* (karmay); *Citrofortunella microcarpa* (calamondin); *Citrus aurantiifolia* (key lime, lime, sour lime); *Citrus aurantium* (bergamot orange, sour orange); *Citrus decumana*; *Citrus limon* (lemon); *Citrus maxima* (pummelo, shaddock); *Citrus reticulata* (mandarin, mandarin orange); *Citrus sinensis* (navel orange, orange, sweet orange, Valencia orange); *Citrus x nobilis* (king mandarin, king orange); *Citrus x paradisi* (grapefruit); *Coccoloba uvifera* (Jamaican kino, sea grape); *Coffea arabica* (Arabian coffee, arabica coffee); *Dieffenbachia* sp. (dumb cane); *Diospyros kaki* (Chinese persimmon, persimmon); *Eugenia uniflora* (Brazil cherry, Florida cherry); *Ficus* spp. (fig); *Gloriosa superba* (flame lily, glory lily); *Guaiacum officinale* (lignum vitae); *Licania tomentosa*; *Lucuma caimito*; *Malpighia glabra* (Barbados cherry); *Mangifera indica* (mango); *Manilkara zapota* (sapodilla); *Parquetina nigrescens*; *Phoradendron* sp.; *Plumeria* sp. (frangipani); *Pouteria campechiana* (eggfruit); *Psidium guajava* (guava); *Sida rhobifolia* (Queensland hemp); *Solanum melongena* (aubergine, eggplant); *Spondias lutea*, *Spondias purpurea* (red mombin); *Triplaris surinamensis* (CABI, 2004).

Parabemisia myricae (Kuwana): *Acer* sp. (maple); *Camellia sinensis* (tea); *Carya illinoensis* (pecan); *Chiococca alba* (snowberry); *Citrus limon* (lemon); *Citrus* spp.; *Cydonia oblonga* (quince); *Diospyros kaki* (persimmon); *Elaeocarpus serratus* (Ceylon olive); *Ficus carica* (fig); *Ficus* sp. (fig) *Lamium* sp. (deadnettle); *Laurus nobilis* (bay, laurel, sweet bay); *Lycopersicon esculentum* (tomato); *Maclura pomifera* (Osage orange);

Maesa japonica; *Malva neglecta* (mallow); *Malus communis*; *Mercurialis annua* (annual mercury); *Morella rubra* (Chinese arbutus); *Morus alba* (white mulberry); *Morus* sp. (mulberry); *Myrtus communis* (true myrtle); *Parthenocissus quinquefolia* (Virginia creeper); *Persea americana* (avocado); *Polygonum* sp. (knotgrass); *Prunus avium* (cherry); *Prunus domestica* (plum); *Prunus mume* (Japanese apricot); *Prunus persica* (peach); *Prunus salicina* (Japanese plum); *Prunus triflora*; *Psidium guajava* (guava); *Punica granatum* (pomegranate); *Pyrus communis* (pear); *Quercus acutissima* (sawthorn oak); *Quercus serrata* (Oak); *Rhododendron* sp. (azalea, rhododendron); *Rosa* sp. (rose); *Rubus* sp. (blackberry, raspberry); *Salix babylonica* (weeping willow); *Salix gracilistyla* (rose-gold pussy willow); *Salix* spp. (willow); *Solanum nigrum* (common nightshade); *Sonchus* sp. (sow thistle); *Vitis* spp. (grape) (Hamon *et al*., 1990; Luo & Zhou, 1997; Mound & Halsey, 1978; Uygun *et al*., 1990).

Distribution:

<u>*Aleurothrixus floccosus* (Maskell):</u> Algeria; Angola; Argentina; Bahamas; Barbados; Belize; Benin; Brazil; Chile; Colombia; Congo; Costa Rica; Cuba (EPPO, 1999); Cyprus (NHM, 1997); Dominica; Dominican Republic; Ecuador; Egypt; El Salvador; France; French Polynesia (EPPO, 1999); Gambia (Bink-Moenen, 1983); Guadeloupe; Guyana; Haiti; India; Israel; Italy; Jamaica (EPPO, 1999); Japan (NHM, 1998); Kenya (Bink-Moenen, 1983); Lebanon (EPPO, 1999); Malawi (NHM, 1995); Malta (Mifsud, 1997); Mauritius (Bink-Moenen, 1983); Mexico; Morocco (EPPO, 1999); Niger (Bink-Moenen, 1983); Nigeria; Panama; Paraguay; Peru; Philippines (EPPO, 1999); Portugal (Magalhaes, 1980); Puerto Rico; Réunion; Singapore; Spain; Suriname; Tanzania; Togo; Trinidad and Tobago; Tunisia (EPPO, 1999); United Kingdom (Malumphy, 1995); USA (California, Florida, Hawaii, Texas); Zambia: (EPPO, 1999).

<u>*Parabemisia myricae* (Kuwana):</u> Algeria (Berkani & Dridi, 1992); China (Luo & Zhou, 1997); Croatia (Zanic *et al*., 2000); Cyprus (CABI/EPPO, 1997); Egypt (IIE, 1992); Greece (Michalopoulos, 1989); Hong Kong (Hamon *et al*., 1990); Israel (IIE, 1992); Italy (Rapisarda *et al*., 1990); Ivory Coast (IIE, 1992); Japan (IIE, 1992); Lebanon (Aslam, 1995); Malaysia (Mound & Halsey, 1978); Papua New Guinea (CABI/EPPO, 1997); Portugal (Franco *et al*., 1996); Spain (IIE, 1992); Taiwan (IIE, 1992); Tunisia (Chermiti *et al*., 1993); Turkey (IIE, 1992); USA (California, Florida [Hamon *et al*., 1990], Hawaii [USDA, 1978]); Venezuela (Chavez & Alvaro-Chavez, 1985); Venezuela (Hamon *et al*., 1990); Vietnam (Waterhouse, 1993).

Biology:

Females of *Aleurothrixus floccosus* prefer completely expanded young leaves for oviposition. Females lay between 53–178 eggs either singly, in small groups, a circle, a partial circle, or in concentric rings. Eggs are usually deposited on the underside of mature leaves and inserted into leaf tissues. The species has also been reported as living on the underside of young leaves and ovipositing both there and on fruit (Reuther *et al*., 1989). The female inserts her mouthparts into the leaf underside and then rotates while depositing eggs (Onillon & Abbassi, 1973).). The first larval stage is light green while subsequent stages are brown with a wide fringe of shiny, white, waxy plates. Adults are yellow, sluggish and seldom fly (Reuther *et al*., 1989). This pest has 4-6 generations per year, with hibernation of the various nymphal stages during the winter. The number of generations per year is very dependent on ambient climatic parameters. At constant temperatures of 17°C, 22°C, 27°C and 30°C it was shown that development from egg stage to adult stage took 80 days, 45 days, 30 days and 28 days, respectively. At higher temperatures, death rates of eggs and nymphs are very high and at lower temperatures development is slower.

There are 4 nymphal instar stages. As the nymph grows, it secretes a white, waxy and powdery substance that covers the body. Nymphs are active only during the first instar (or crawler) stage, becoming sessile for the remaining nymphal (larval) instars. Pupae are usually covered by white wax threads, which are very conspicuous on heavily infested leaves. 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. This pest is spreading on many plant species. It is mainly transported via infested plant material. Thus, it is recommended that phytosanitary measures should be enforced to limit further spread of the insect.

Reproduction of *Parabemisia myricae* is by primarily by parthenogenesis and males occur only exceptionally (Uygun *et al*., 1990). Adults fly morning and evening, redistributing themselves within a crop and locating leaves suitable for feeding and oviposition (Meyerdirk & Moreno, 1984). In citrus groves in Turkey, Uygun *et al*. (1990) noted that at low population densities, oviposition occurs on very young, actively growing citrus foliage, which have not yet completely unfolded. Fully expanded (mature) leaves may be chosen later, but old leaves are never chosen. At high population densities oviposition may also take place on young fruits and shoots (Uygun *et al*., 1990). Females live for up to 6 days and produce an average of 70 eggs. Eggs are 0.17-0.23 mm in length, are white when newly laid, but turn blackish during the course of development (Walker & Aitken, 1985). Eggs are deposited either singly, in circles or half circles along leaf margins and on the veins. Nymphs are active only during the first instar (or crawler) stage, becoming sessile for the remaining nymphal (larval) instars. Length ranges from 0.25-0.65 mm over the 3 larval instar stages. A waxy secretion surrounds larvae. This species hibernates in the larval stage or in the puparium. During warm weather, some adults may emerge and even oviposit in the winter. However, complete development from egg to adult never occurs during winter. The life cycle takes about 24 days at 60 ± 5% R.H. There are 7-8 generations per year. Whitefly occurrence is enhanced by high humidity. The developmental threshold temperature is 10.2°C and the optimum development temperature is 25-26°C.

High population densities cause direct damage to plants by sucking nutrients from young leaves and excreting honeydew onto the fruit and leaves, leading to sooty mould growth that interferes with photosynthesis (Uygun *et al*., 1990; Walker & Aitken, 1985). Direct and indirect feeding damage caused by *P. myricae* can result in defoliation of trees (Rose *et al*., 1981). Other types of feeding damage include discolouration and deformations in very young leaves. Heavy infestations can result in premature leaf drop, especially during periods of dry weather.

On citrus in California, adult females lay eggs selectively on new, small foliage, often referred to as feather growth (Jeppson, 1989). Eggs, each attached with a supporting pedicel, are laid on both sides of the leaves. On hatching, the nymphs (larvae) feed on the lower surface of the leaves. The larval stages have a clear, wax fringe around the body margin. Complete larval development can occur on green wood (Uygun *et al*., 1990). The life cycle requires 21 days for completion under variable day/night conditions of 21°C to 17.3°C and 65-100% R.H. (Rose *et al*., 1981). Adults primarily feed on leaves, but they also feed and lay eggs on fruit and green angular wood (Rose *et al*., 1981).

Under field conditions in California, *P. myricae* demonstrates a strong preference to oviposit on the actively growing foliar terminals of lemon trees instead of the middle and mature terminals (Walker & Aitken, 1985). Within young terminals, newly laid eggs are concentrated on the apical 5-6 cm where leaves are youngest. When first instars (crawlers) of *P. myricae* were experimentally placed on young, middle and mature leaves, it was found that 49, 35 and 0% successfully developed to the adult stage respectively. Five generations per year have been reported in California (Walker & Aitken, 1985).

In Israel, larvae and adults are found on citrus and avocado trees throughout the winter (Swirski *et al*., 1986). The oviposition rate of *P. myricae* in winter was low, but rose steeply in the spring. The density of larvae on the lower side of leaves was higher than on the upper side. Substantial numbers (45.4%) of larvae survived the winter on avocado trees. Emergence of adults increased at the end of February, reaching a peak in early March, and ceasing at the end of March or beginning of April.

In Turkey, the population development of *P. myricae* was studied on lemon, grapefruit, orange and mandarin in an 8-year-old orchard from January 1986 to July 1987 by Atay & Sekeroglu (1987). Population densities of immatures remained low in 1986 until July and then increased to a peak in mid-September. Immature populations were also low early in 1987 but reached a peak in June-July. The population trends were similar on all food plants, but the number of aleyrodids per leaf was highest on lemon, followed in descending order by grapefruit, orange and mandarin. Larval mortality was high, with only 8-16% of the eggs laid reaching the pupal stage. Adults caught in yellow sticky traps in 1986 showed similar population trends to the larvae, remaining low in numbers early in the season and reaching a peak by September. In 1987, almost no adults were trapped until June, and a slight population increase was observed in July.

In laboratory studies conducted by Uygun *et al*. (1990), the developmental time from egg to adult was 79.7, 41.7, 24.4 and 22 days at 15, 20, 25 and 30°C, respectively. At a fluctuating temperature of 25-35°C, the developmental time was 24.2 days. With increasing relative humidity at 25°C constant temperature, the total developmental time decreased significantly from 26.7 days at 40% R.H. to 20.3 days at 90% R.H. The mortality rate was lowest at 25°C and highest at 30°C. In Cyprus, up to nine generations occur per year (Orphanides, 1991).

In Turkey, Ulusoy *et al*. (1999) studied the effect of 6 citrus and 5 non-citrus host plants on the developmental period of immature stages of *P. myricae*. The developmental time on the citrus host plants from egg stage to adult was found to be 16.1, 16.1, 19.2, 20.0, 24.4 and 29.3 days on lemon, mandarin, grape fruit, sweet-orange, sour-orange and *Poncirus trifoliata*, respectively. The developmental time on the non-citrus host plants was 15.7, 20.4, 20.8, 23.8 and 26.4 days on grapevine, peach, rose, mulberry and pomegranate respectively. The mortality rate during the egg stage was lowest on lemon and rose and was highest on sweet orange and peach. The total mortality rate of all immature stages was lowest on sour orange and grapevine but highest on *Poncirus trifoliata* and peach.

Vector relationship: In Turkey *P. myricae* has been shown to be able to transmit citrus chlorotic dwarf (CCD) (Korkmaz *et al*., 1996). It was not possible to transmit the causal agent mechanically to citrus seedlings or herbaceous plants by leaf-inoculation or by knife cuts, simulating pruning. According to the results, vector transmission appeared to be the primary means of transmission of CCD.

Economic importance: In citrus, damage is caused by whiteflies both directly through sap removal and indirectly through a reduction of photosynthesis resulting from the development of sooty mould growing on honeydew deposits (Reuther *et al*., 1989). *Parabemisia myricae* is considered to be one of the six most injurious whitefly pests (Onillon, 1990). Rose and Rosen (1991) describe it as very damaging to citrus in California. Until biological control was established it was one of the most serious pests of citrus both in Turkey (Sengonca *et al*., 1993) and Israel (Swirski *et al*., 1985). In Florida, *P. myricae* has been recorded as damaging citrus seedlings when the natural balance was disturbed by the use of chemicals that eliminated a parasitoid but not the pest (Hamon *et al*., 1990). In Algeria, it is regarded as a citrus pest (Berkani & Dridi, 1992).

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2.1.8 Citrus pyralid

Cryptoblabes gnidiella (Millière) [Lepidoptera: Pyralidae] – Citrus pyralid

Synonym(s): *Albinia casazzar* Briosi; *Albinia gnidiella* Millière; *Cryptoblabes aliena* Swezey; *Ephestia gnidiella* (Millière).

Hosts: *Cryptoblabes gnidiella* is polyphagous and able to use almost any plant, but it is most often encountered on commercial crops.

Allium sativum (garlic) (Swailem & Ismail, 1972); *Annona muricata* (soursop) (CABI, 2004); *Azolla anabaena* (azolla) (Sasmal & Kelshreshtha, 1978); *Azolla pinnata* (ferny azolla) (Takara, 1981); *Citrus* spp. (Ascher *et al*., 1983; Carter, 1984; Swailem & Ismail, 1972); *Citrus limon* (lemon) (Sternlicht, 1979); *Citrus sinensis* (sweet orange) (Silva & Mexia, 1999); *Coffea* spp. (coffee) (CABI, 2004); *Eleusine corana* (ragi) (Singh & Singh, 1997); *Eriobotrya japonica* (loquat) (Ascher *et al*., 1983); *Ficus carica* (fig) (Carter, 1984); *Gossypium hirsutum* (cotton) (Swailem & Ismail, 1972); *Macadamia ternifolia* (macadamia nut) (Wysoki, 1986); *Malus domestica* (apple) (Carter, 1984); *Mangifera indica* (mango) (Hashem *et al*., 1997); *Mespilus germanica* (medlar) (Carter, 1984); *Morus alba* (mulberry) (CABI, 2004); *Musa* sp. (banana) (Jager & Daneel, 1999); *Myrica faya* (firetree) (Duffy & Gardner, 1994); *Oryza sativa* (rice) (Sasmal & Kulshreshtha, 1978); *Panicum miliacem* (millet panic) (Singh & Singh, 1997); *Paspalum dilatatum* (paspalum) (Yehuda *et al*., 1991/1992); *Pennisetum glaucum* (pearl millet); *Pennisetum typhoideus* (pearl millet) (Kishore, 1991); *Persea americana* (avocado) (Ascher *et al*., 1983); *Phaseolus* sp. (bean) (CABI, 2004); *Prunus domestica* (plum, prune) (Carter, 1984);

Prunus persica (peach) (Carter, 1984); *Punica granatum* (pomegranate) (Carter, 1984); *Ricinus communis* (castor bean) (Singh & Singh, 1997); *Saccharum officinarum* (sugarcane) (CABI, 2004); *Schinus terebinthifolius* (Brazilian pepper tree) (CABI, 2004); *Solanum melongena* (eggplant) (Swailem & Ismail, 1972); *Sorghum vulgare* (sorghum) (Singh & Singh, 1995); *Swietinia macrophylla* (mahogany) (Akanbi, 1973); *Tarchardia lacca* (Yunus & Ho, 1980); *Vaccinium* sp. (blueberry) (Molina, 1998); *Vitis vinifera* (grapevine) (Ascher *et al*., 1983; Carter, 1984; Hashem *et al*., 1997); *Zea mays* (maize) (Swailem & Ismail, 1972).

Distribution: *Cryptoblabes gnidiella* is a cosmopolitan species in warm climates but is unable to survive winters in cooler temperate areas into which it may be imported with produce. Records from the Netherlands, Scandinavian countries (Denmark, Finland, Norway and Sweden) and the United Kingdom are on imported material (Karsholt, 1996). This species is native to the Mediterranean region but has been introduced to Malaysia, New Zealand, Hawaii and parts of tropical and subtropical America (Carter, 1984).

Austria (Karsholt, 1996); Bermuda (CABI, 2004); Egypt (Swailem & Ismail, 1972); France (Karsholt, 1996); Greece (Karsholt, 1996); India (Singh & Singh, 1995) Israel (Yehuda *et al*., 1991/1992); Italy (Karsholt, 1996); Lebanon (CABI, 2004); Liberia (CABI, 2004); Malaysia (Yunus & Ho, 1980); Malta (Karsholt, 1996); Portugal (Karsholt, 1996); New Zealand (Zhang, 1994); Nigeria (Akanbi, 1973); Pakistan (CABI, 2004); Sierra Leone (CABI, 2004); South Africa (Kruger, 1998); Spain (Karsholt, 1996); Thailand (Takara, 1981); Turkey (Karsholt, 1996); Uruguay (CABI, 2004); United States (Hawaii) (Zimmerman, 1958).

Biology: Adult females lay about 100 eggs on the fruit or foliage of host plants. Females have been observed to lay eggs singly or in groups of three on both surfaces of maize leaf (Swailem & Ismail, 1972). Eggs hatch in 4–7 days (Carter, 1984). There are 5 larval instars. Fully-grown larvae measure 11.9 mm long and the duration of the larval period is around 13 days (Carter, 1984). Larvae mainly attack fruit, but also feed on foliage, bark and twigs (Liotta & Mineo, 1964). Larvae often occur in association with infestations by other pests (e.g. with the mealybug *Planococcus citri* on citrus and following attack by the European vine moth, *Lobesia botrana*, on grapes (Carter, 1984)). Pupation takes place on the food plant or on the ground. The moth is attracted to honeydew created by mealybugs (Zimmerman, 1958). There are three or four generations a year in southern Europe and up to five in North Africa (Carter, 1984).

In Israel, this pests overwinters in avocado orchards on fresh or dry fruits remaining on the trees, on leaves infested with *Protopulvinaria pyriformis*, on the weed *Paspalum dilatatum* and on various other plants (Yehuda *et al*., 1991/1992). Yehuda *et al*. (1991/1992) observed five generations in the field, with overwintering moths emerging during March and April to produce a first generation that did not cause any damage to crops. The fifth generation, flying in October to November, established the overwintering population (Yehuda *et al*., 1991/1992).

Silva and Mexia (1999) studied *C. gnidiella* population dynamics in sweet orange groves (*Citrus sinensis*), the importance of damage caused by *C. gnidiella*, and the interspecific association between *C. gnidiella* and the citrus mealybug (*Planococcus citri*) in four groves in the Alagarve, Portugal. Total *C. gnidiella* males captured in each grove showed a similar pattern and the greater percentage of males were trapped during the June–September period (except for the grove Fazenda Grande). It was possible to identify three or four distinct peaks. The results suggested a significant positive association (P = 0.05) between *C. gnidiella* and *P. citri*, supporting the hypothesis of several other authors that a *P. citri* infestation is necessary for attack by *C. gnidiella* in citrus. Even low levels of *C. gnidiella* larval infestation caused serious damage by fruit drop and, consequently a high loss of sweet orange production, mainly in navel cultivars.

In India, 9 generations have been reported on hybrid sorghum by Singh & Singh (1995). The pest was active from the end of March to November and overwintered in the pupal stage with the onset of cold weather.

Economic importance: Citrus pyralid is a polyphagous pest of numerous crops and is recorded as a secondary pest in citrus groves, often associated with the attacks of other species (Silva & Mexia, 1999).

In Egypt, it is considered a serious polyphagous pest in fruit orchards, as well as in vegetables and field crops (Hashem *et al*., 1997). It is a pest of avocado, citrus, grape, loquat and pomegranate in the Mediterranean area (Balachowsky, 1972). It is noted to be an important pest of avocado in Israel, of *Azolla*, rice and sorghum in India (Singh & Singh, 1995), and sporadically of maize or other crops in any warm part of the world.

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2.1.9 Citrus flower moth

Prays citri Millière [Lepidoptera: Yponomeutidae] – citrus flower moth

Synonym(s): *Acrolepia citri* (Millière); *Prays citri* (Millière); *Prays nephelomima* Meyrick.

Host(s): *Citrus* is the only known primary host. *Citrus aurantifolia* (lime); *Citrus limon* (lemon); *Citrus paradisi* (grapefruit); *Citrus reticulata* (mandarin, tangerine); *Citrus sinensis* (sweet orange) (Ibrahim & Shahateh, 1984). Other secondary hosts include *Casimiroa edulis* (white sapote) and *Ligustrum lucidum* (glossy privet) (Sinacori & Mineo, 1997).

Part(s) of plant affected: Flower, fruit, leaf (Ibrahim & Shahateh, 1984).

Distribution: *Prays citri* is widespread in the Mediterranean region, where it was probably introduced with some citrus varieties (Balachowsky, 1966; Gomez, 1990; Carvalho & Aguiar, 1997). It is also present in some African countries. According to Common (1990), *P. citri* has not been reported in Australia although seven *Prays* species are endemic in Australia. This moth had previously been reported in Australia by EPPO but was removed for EPPO (2002) because in an authoritative checklist on the genus, *Prays citri* was not included for Australia (Nielsen & Edwards, 1996). Identifications of *Prays citri* on citrus from the east of Turkey, the Middle East, Asia and the Pacific (such as Sri Lanka, Malaysia, Philippines, Pakistan, Fiji and Samoa previously reported by EPPO) are likely to be erroneous as no voucher material has ever been seen and all *P. citri* specimens examined had been misidentified.

Algeria; Cyprus; Egypt (CIE, 1982); Fiji (CABI, 2004); France (CIE, 1982); Greece (Katsoyannos, 1996); India (Carter, 1984); Israel; Italy (CIE, 1982); Japan (Carter, 1984); Lebanon; Libya (CIE, 1982); Malaysia (Yunus & Ho, 1980); Malta; Mauritius; Morocco (CIE, 1982); New Zealand; Pakistan; Philippines (CABI, 2004); Portugal (CIE, 1982); Samoa (CABI, 2004); South Africa; Spain (CIE, 1982); Sri Lanka (CABI, 2004); Syria; Tunisia; Turkey; Zimbabwe (CIE, 1982).

Biology: *Prays citri* attacks the leaves, flowers and developing fruits (Ibrahim & Shahateh, 1984). Lime (*Citrus aurantifolia*) is the most susceptible to the pest, followed by lemon, sweet orange, mandarin and grapefruit (Ibrahim & Shahateh, 1984). Generally, eggs are laid individually on flowers and sometimes on young fruit. Upon hatching, the larvae bore into flowers and small fruits. Cocoons may be found on fruits, flowers and leaves. At 25°C, the complete life cycle takes 20 days. Temperature influences the lifespan of the moth. Experiments show that the female lifespan is greater than 37.2 days at 10°C, while at 26°C it is less than 5 days. Adults have twilight and nocturnal habits. Females begin laying eggs 2-5 hours after mating. Each female lays from 60-156 eggs (Garrido & Ventura, 1993, Carvalho & Aguiar, 1997; Mendonca *et al.*, 1997).

In the Mediterranean region, all stages of the insect may be found throughout the year. The number of generations varies from 3-16, depending on climatic conditions. For example, in Sicily (Italy) there are 11 generations, and in Israel between 8 and 10 generations. Population levels are low in winter and spring and high in summer and autumn. The threshold for development is approximately 10°C, and the first attacks occur in the spring when the temperatures exceed 10°C. Attacks are significant when the trees are in bloom (Jeppson, 1989).

Field observations in Sicily on citrus (especially lemon), indicate that the females lay eggs not only on the flower buds and the developing fruit but also on leaf shoots and larger fruits. The larvae develop successfully, however, only from eggs laid on buds or shoots (Mineo, 1967). The larvae feed not only on reproductive organs, binding them together with silk threads, but also on young fruits. Pupation occurs among damaged flowers or leaves. Separate matings are necessary between each batch of viable eggs laid (Liotta & Mineo, 1963).

In 1978–79 in Sicily, using pheromone traps with capsules containing 160 mµ g of (Z)-7-tetradecenal, Mineo *et al*. (1980) found that males of *P. citri* were caught throughout almost the entire year, being rare only at the end of February and the beginning of March. The highest catches were observed between mid-May and mid-July and between early October and early November. Weekly catches per trap varied greatly according to the location of the trap, from 33 to 1110. Fruit infestation rate was 10–40% in the autumn of 1978, but in 1979 it was 4–16%. Flower infestation was low until April but reached 100% in May and remained very high until the end of June, when the average number of eggs and larvae per flower varied from 6.2 to 7.8. Flower infestation began again in the second half of August and reached 100% in September, with the numbers of eggs and larvae averaging 10 per flower. The relationship of male catches to the degree of infestation is largely influenced by cultural and climatic factors.

Studies conducted in lemon orchards in Sicily found eggs and larvae of this species year round, although they were more abundant in the first 3 weeks of January, from the beginning of May to mid-July, and from the end of August until the end of December (Mineo *et al*., 1980). The results indicate that control of *P. citri* should be affected only when necessary during periods of late flowering, i.e. in May–June or August–September (Mineo, 1993).

Economic importance: Citrus flower moth is a serious pest of citrus in the Mediterranean area. Attacks on *Citrus limon* (lemon) are of particular economic importance. Up to 90% loss in flower production in Spain and 15-70% flower reduction in Portugal have been attributed to *P. citri* (Garrido *et al*., 1984; Mendonca *et al*., 1997). It is also considered an economically important pest in Egypt on lime tree (Ibrahim & Shalateh, 1984).

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2.2 PATHOGENS

2.2.1 Mal secco

Phoma tracheiphila (Petri) Kantachveli & Gikachvili – mal secco; citrus wilt

Synonym(s): *Deuterophoma tracheiphila* Petri; *Bakerophoma tracheiphila* (Petri) Cif.

Host(s): Almost all citrus plants are susceptible to artificial infections of *P. tracheiphila*. In the field, hybrids of citrus, related genera (*Eremocitrus*, *Fortunella*, *Poncirus* and *Severinia*) and other species have different degrees of resistance to the disease (CABI, 2004). Most cultivars of oranges, mandarins (*Citrus deliciosa* and *C. reticulata*) clementines and grapefruits are only occasionally affected (CABI, 2004). However, there are reports indicating that some mandarins (Solel & Salerno, 2000; Palm, 1987) and some of its hybrids (Punithalinghm & Holliday, 1973) and Bergamot, tangelos, and tangors are quite vulnerable (Solel & Salerno, 2000). Infection of grapefruits and sweet orange is rare and usually not severe (Solel & Salerno, 2000). A number of rootstocks such as *C. reshni*, *Poncirus trifoliata* and, to a lesser extent, *C. sinensis* x *P. trifoliata* have been reported to be resistant (CABI, 2004).

Major hosts of mal secco fungus include: *Citrus aurantifolia* (lime), *Citrus aurantium* (sour orange); *Citrus bergamia* (bergamot); *Citrus limon* (lemon), *Citrus medica* (citron); *Citrus*; whereas *Fortunella* (kumquat) and *Poncirus* are minor hosts (CABI, 2004).

Distribution: The presence of *Phoma tracheiphila* in Uganda and Colombia has been reported, but such records are considered doubtful (CABI, 2004). Albania; Algeria; Cyprus; France; Georgia (Republic); Greece; Iraq; Israel; Italy; Lebanon; Southern Russia; Syria; Tunisia; Turkey; Yemen (EPPO, 2002).

Biology: The fungus enters through wounds and penetration through stomata is questioned (Perrotta & Graniti, 1988). Cultivation practices, wind, frost and hail that cause injuries to different organs favor infection by this fungus. Inoculum could be provided both by conidia produced from pycnidia present on withered twigs, and by conidia produced from phialides borne on free hyphae on exposed woody surfaces of the tree or on debris. Inoculum is believed to be waterborne (Solel, 1976). The range of temperature at which infection will occur is considered to be between 14 and 28°C. The optimum temperature for growth of the pathogen and for symptom expression is 20-25°C. The maximum temperature for mycelial growth is 30°C. In the Mediterranean region, infection periods depend on local climatic and seasonal conditions. In Sicily, infections usually occur between September and April (Somma & Scarito, 1986a,b).

The first symptoms appear in spring as leaf and shoot chlorosis, followed by a dieback of twigs and branches. Raised black points within lead-gray or ash-gray areas of withered twigs indicate the presence of pycnidia. The growth of sprouts from the base of the affected branches and suckers from the rootstock are a common response of the host to the disease. Gradually, the pathogen affects the entire tree, which eventually dies. On cutting into the infected twigs, the characteristic salmon-pink or orange-red discoloration of the wood can be seen. This internal symptom is associated with gum production within the xylem vessels (Magnano *et al*., 1992).

Destructive outbreaks of *Phoma tracheiphila* may occur after frost spells and hail storms in spring (Perrotta & Graniti, 1988). In addition to the more common form of mal secco, two different forms of the disease can be distinguished. Mal fulminante is a rapid fatal form of the disease apparently due to root infection. Mal nero is a consequence of chronic infection of the tree leading to a browning of the heartwood. The length of the incubation period may vary according to the season (Grasso & Tirrò, 1984). Conidia produced on the surface of wounds following pruning of infected twigs or branches can provide a source of inoculum for several weeks (Perrotta & Graniti, 1988). The fungus can survive within infected twigs in the soil for more than 4 months (De Cicco *et al*., 1987).

Short-distance dispersal of *Phoma tracheiphila* inoculum is caused by wind and rain (Laviola & Scarito, 1989). Birds and insects are also suspected to be vectors of the disease. Long-distance spread of mal secco occurs through the movement of infected propagative material and plants. *Phoma tracheiphila* has been detected in lemon seeds (Stepanov & Shaluishkina, 1952). There is no evidence that it is seed-borne in other citrus species.

Economic importance: In the Mediterranean region, *P. tracheiphila* is the most destructive fungal disease of lemons. Up to 100% of trees in a lemon orchard of a susceptible cultivar can be affected. In general, injury to the tree through severe cold weather may predispose it to fungal attack. The symptoms of the disease are most severe in spring and autumn. In high summer temperatures, spread of the fungus in the host vascular system ceases and the symptoms do not develop further (Ruggieri, 1953). The disease reduces the quantity and quality of lemon production in the areas where the pathogen is present, and limits the use of susceptible species and cultivars.

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