Australian Government

Department of Agriculture, Fisheries and Forestry

Draft Risk Analysis Report for the release of *Mastrus ridens* for the biological control of codling moth (*Cydia pomonella*)

April 2013

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The *Draft Risk Analysis Report for the release of Mastrus ridens for the biological control of codling moth (Cydia pomonella)* is available via daff.gov.au/ba.

Cover image: *Mastrus ridens* female approaching *Cydia pomonella* larvae (Courtesy: Greg Lefoe, DPI Victoria)

Submissions

This draft risk analysis (RA) report has been issued to give all interested parties an opportunity to comment and draw attention to any scientific, technical, or other gaps in the data, misinterpretations and errors. Any comments should be submitted to DAFF within the comment period stated in the related Biosecurity Advice on the Department of Agriculture, Fisheries and Forestry website. The draft RA report will then be revised as necessary to take account of the comments received and a final RA report will be released at a later date.

Comments on the draft RA report should be submitted to:

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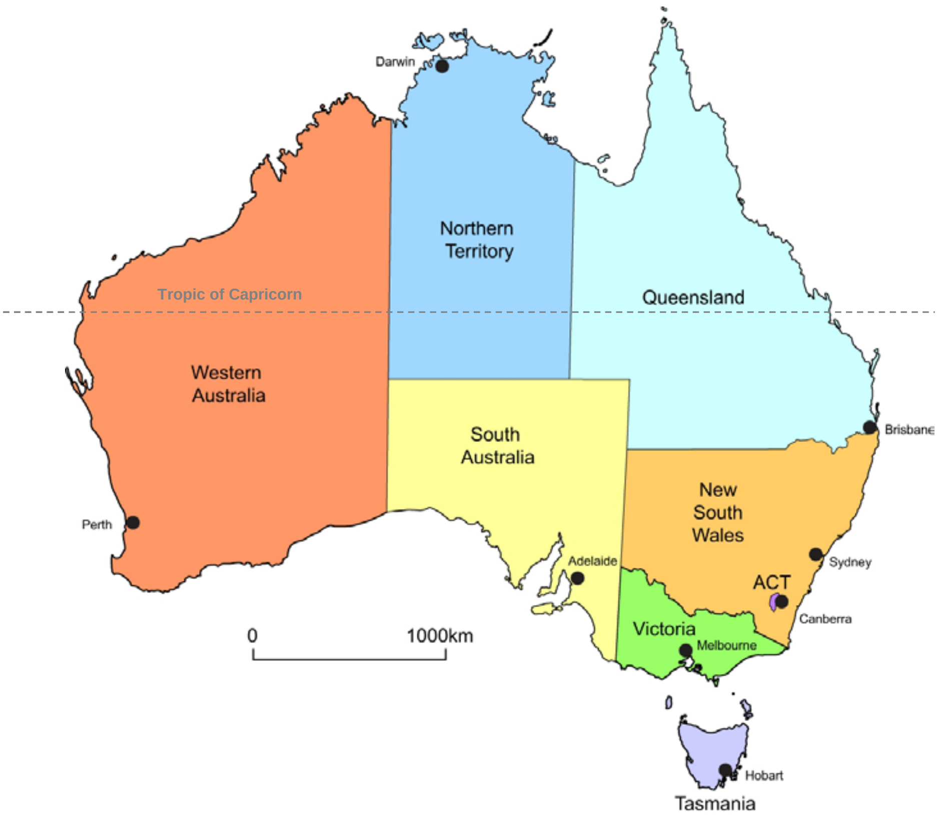

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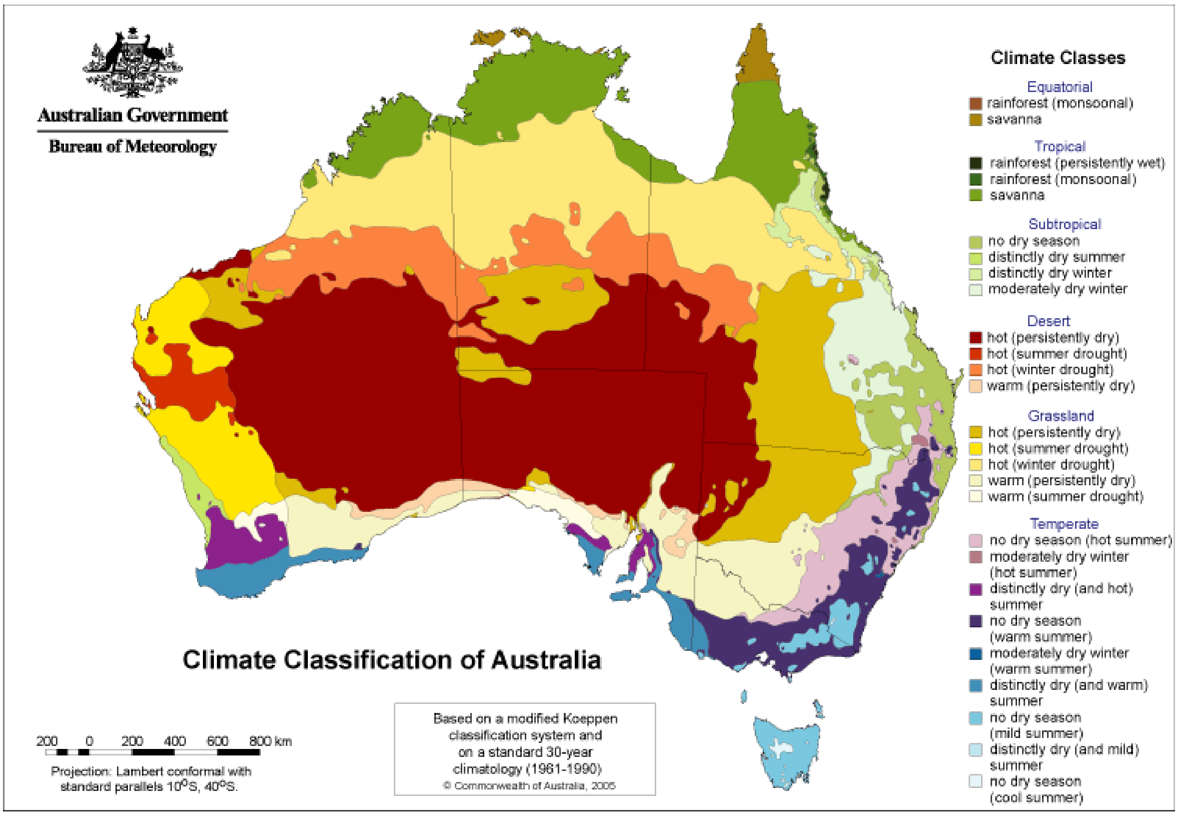

Acronyms and abbreviations

Term or abbreviation	Definition
ALOP	Appropriate level of protection
APPD	Australian Plant Pest Database (Plant Health Australia)
BCA	Biological Control Agent
CABI	CAB International, Wallingford, UK
CMI	Commonwealth Mycological Institute
DAFF	Australian Government Department of Agriculture, Fisheries and Forestry
FAO	Food and Agriculture Organization of the United Nations
IPC	International Phytosanitary Certificate
IPM	Integrated Pest Management
IPPC	International Plant Protection Convention
ISPM	International Standard for Phytosanitary Measures
NPPO	National Plant Protection Organization
NSW	New South Wales
NT	Northern Territory
Qld	Queensland
RA	Risk Analysis
Tas.	Tasmania
Vic.	Victoria
WA	Western Australia
WTO	World Trade Organisation

Abbreviations of units

Term or abbreviation	Definition
ºC	degree Celsius
ºF	degree Fahrenheit
kg	kilogram
km	kilometre
m	metre
µ	micrometre (one millionth of a metre)
ml	millilitre
mm	millimetre
ppm	parts per million
s	second

Summary

This draft risk analysis assesses an application from DPI Victoria to release the ichneumonid wasp *Mastrus ridens* for the biological control of codling moth (*Cydia pomonella*). In accordance with the IRA handbook 2011, this risk analysis has been undertaken as a non-regulated analysis of existing policy.

The draft report proposes that the biological control agent should be released, subject to standard quarantine conditions associated with the import and release of biological control agents.

The draft report has identified no significant off-target effects or potential consequences that would be associated with the release of *Mastrus ridens*. The risk is estimated to be negligible, which meets Australia's appropriate level of protection (ALOP).

A preliminary draft of this report was distributed to state and territory departments of primary industry and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) through the Plant Health Committee (PHC). Comments received via this consultation process were incorporated into the draft risk analysis report. All comments endorsed the preliminary draft and its recommendations.

This draft report contains details of the risk assessment for potential off-target effects associated with the proposed release of *Mastrus ridens* and DPI Victoria's application (Appendix A) in order to allow interested parties to provide comments and submissions to DAFF within the consultation period.

1 Introduction

1.1 Australia's biosecurity policy framework

Australia's biosecurity policies aim to protect Australia against the risks that may arise from exotic pests[1] entering, establishing and spreading in Australia, thereby threatening Australia's unique flora and fauna, as well as those agricultural industries that are relatively free from serious pests.

Risk analysis is an important part of Australia's biosecurity policies. It enables the Australian Government to formally consider the risks that could be associated with proposals to release a new organism into Australia. If the risks are found to exceed Australia's appropriate level of protection (ALOP) then release will not be allowed.

Successive Australian Governments have maintained a conservative, but not a zero risk, approach to the management of biosecurity risks. This approach is expressed in terms of Australia's ALOP, which reflects community expectations through government policy and is currently described as providing a high level of protection aimed at reducing risk to a very low level, but not to zero.

Risk analyses for biological control agents are undertaken within the Department of Agriculture, Fisheries and Forestry, hereafter referred to as DAFF, by technical and scientific experts with consultation with appropriate scientific specialists. Consultation with stakeholders also occurs. DAFF provides recommendations for animal and plant quarantine policy to Australia's Director of Animal and Plant Quarantine (the Secretary of the Australian Government Department of Agriculture, Fisheries and Forestry). The Director, or delegate, is responsible for determining whether or not release of a biological control agent can be permitted under the *Quarantine Act 1908*, and if so, under what conditions.

[1] A pest is any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products (FAO 2007b).

1.2 This risk analysis

1.2.1 Background

An application has been submitted by The Department of Primary Industries Victoria to release a biological control agent (Appendix A). The biological control agent, *Mastrus ridens* (Hymenoptera: Ichneumonidae) is a parasitoid wasp proposed for the biological control of codling moth (*Cydia pomonella*) (Lepidoptera: Tortricidae). The applicant has followed the steps outlined in the Biosecurity Guidelines for the Introduction of Exotic Biological Control Agents for the Control of Weeds and Plant Pests (http://www.daff.gov.au/ba/reviews/biological_control_agents/protocol_for_biological_control_agents).

1.2.2 Scope

This report assesses the risk associated with the release of a biological control agent into the Australian environment. The primary risk with a release of this nature is the possibility of unwanted off-target effects on other species already present in Australia. DAFF assesses the risk under the *Quarantine Act 1908*. A parallel process operates for the assessment of biological control release applications, with the Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) also making a ruling under the *Environment Protection and Biodiversity Conservation Act 1999*.

DAFF will not commence an assessment to release a biological control agent unless the target has been approved by an appropriate government body. However, there are some weed and insect biological control programs which pre-existed the current target approval process. DAFF accepts these weed/insect targets do not require approval under the current process. *Cydia pomonella* is a well documented pest of numerous fruit crops in Australia, and has been the target of several biological control programs in the past.

1.2.3 Contaminating pests

There are organisms that may arrive with imported biological control agents. These organisms may include parasitoids, mites or fungi. DAFF considers these organisms to be contaminating pests that could pose sanitary and phytosanitary risks. Should this application to release be approved, these risks will be addressed by existing operational procedures that apply to the importation and final release of biological control agents. These procedures include detailed examination of imported material, confirmation of identity and breeding through one generation before release. For this reason contaminating pests are outside the scope of this risk analysis.

1.2.4 Consultation

On 2 January 2013 a preliminary draft of this report was distributed to state and territory departments of primary industry and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) through the Plant Health Committee (PHC). Comments received via this consultation process were incorporated into the draft risk analysis report. All comments endorsed the preliminary draft and its recommendations.

1.2.5 Next steps

In order to provide a formal opportunity for stakeholder consultation this draft RA report will be open for comment for a 30 day period. This draft RA report gives stakeholders the opportunity to comment and draw attention to any scientific, technical, or other gaps in the data, misinterpretations and errors. The process includes:

- DAFF will consider submissions received on the draft RA report and may consult informally with stakeholders. DAFF will revise the draft RA report as appropriate.
- DAFF will then prepare a final RA report, taking into account stakeholder comments.
- The report will be distributed to the proposer and registered stakeholders and the documents will be placed on the DAFF website.

2 Method for analysis

Biological control agents (BCA) intended for release are deliberately introduced, distributed, aided to establish and spread. Therefore it would be inappropriate to assess the probability of entry, establishment and spread using the processes described in ISPM 11 (FAO 2004). This BCA RA will focus only on off-target effects, as this is the only concern with regard to the release of biological control agents.

2.1.1 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.

3 Assessment of off-target risks

This section sets out the assessment of off-target risks that could be associated with the release of the biological control agent. As appropriate the methods followed those used for pest risk analysis (PRA) by DAFF in accordance with the International Standards for Phytosanitary Measures (ISPMs), including ISPM 2: *Framework for Pest Risk Analysis* (FAO 2007) and ISPM 11: *Pest Risk Analysis for Quarantine Pests, including analysis of environmental risks and living modified organisms (FAO 2004).* The methodology for a commodity-based PRA is provided in Appendix B.

The risk relevant to release of a biological control agent consists of the combination of the probability of off-target consequences on non-target species and the potential magnitude of the consequences of any off-target impacts.

3.1 Stage 1: Initiation

Initiation commences when the applicant provides a submission proposing the release of the biological control agent.

The risk analysis area is defined as all of Australia given that once released there will be no control of spread of the agent other than environmental constraints related to the biology of the organism.

3.2 Stage 2: Risk assessment

This assessment evaluates the probability of off-target effects and the potential economic and environmental consequences of these effects.

3.2.1 Assessment of the probability of off-target effects

Given that the proposal is for deliberate release then the probability of entry, establishment and spread is assumed to be certain and therefore the assessment relates to the host specificity of the proposed agent.

A qualitative likelihood is assigned to the estimate of probability of off-target effects. Six descriptors are used: high; moderate; low; very low; extremely low; and negligible. Definitions of each descriptor are given in Appendix B, Table 1.1.

Appendix A gives details provided by the proponent of the host specificity testing that was carried out.

Host specificity testing methodology

Mastrus ridens (Horstmann 2009) (syn. *M. ridibundus* Gravenhorst) has been released as a biological control agent against *Cydia pomonella* in the USA (1998), Argentina (2003) and Chile (2006). In June 2012 *Mastrus ridens* was also approved for release in New Zealand. All released insects are descended from one founding colony collected in Kazakhstan in 1994. This lineage is also proposed as the source for the insects to be released in Australia. To date, no reports of significant off-target effects have been reported from any country in which this insect has been released.

Overseas 15 Lepidoptera species have been tested as potential non-target hosts for *M. ridens*. Of these, *Argyroploce chlorosaris*, *Ctenopseustis obliquana*, *Cydia prunivora* and *C. succedana* were occasionally attacked and supported the development of some larvae to adulthood. However the average number of attacks and of *M. ridens* larvae reaching maturity on these non-target hosts was significantly lower than that on codling moth for all non-target species tested. None of the four attacked non-target hosts are present in Australia, nor are any known species from the genera *Argyroploce* or *Ctenopseustis* present. Two species present in Australia have also been tested, the native macadamia nut borer *Cryptophlebia ombrodelta*, and *Grapholita* (*Aspila*) *molesta*, an introduced pest of fruit; neither of these species were attacked by *Mastrus ridens*.

These host specificity tests were conducted following accepted protocol. Pairs of *M. ridens* adults were confined to either codling moth larvae or alternate host larvae in no-choice tests. The survival rate of these exposed larvae was compared to a control group of larvae not exposed to *M. ridens.* The number of parasitoids emerging from exposed host pre-pupae was also monitored.

Two native but undescribed *Cydia* species are recorded in Australia, one from northern Queensland, and one from the Australian Capital Territory. Neither of these species were tested due to unavailability of live cultures. While *M. ridens* is unlikely to survive in northern Queensland due to the tropical climate, codling moth is well established in the ACT and the climate would be suitable for *M. ridens.* Although the ability of *M. ridens* to parasitize these native *Cydia* or other untested native moth species is unknown, several factors are considered below which indicate the probability of this occurring to be very low.

Results of host specificity testing

Mastrus ridens was shown to be significantly more likely to parasitise codling moth larvae placed on an apple tree than codling moth larvae placed on other plants or substrates, indicating that host searching is more likely to take place on fruit trees in an orchard environment. *Mastrus ridens* has also been demonstrated to be attracted to a mix of volatile chemicals released by pupating codling moths. Codling moths are known only to attack fruit trees and walnuts, therefore it appears likely that *M. ridens* will only be found in environments with fruit trees and most likely in environments in which codling moth is present.

Mastrus ridens females probe potential host larvae and if found suitable sting these larvae prior to oviposition. The criteria for *M. ridens* females to recognise and sting a potential host appear to be very specific. Even under no-choice conditions in a restricted environment *M. ridens* did not recognise and sting the larvae of any moth species present in Australia other than the target codling moth. The sting injects a mixture of chemicals which paralyse but do not kill the target host. The paralysed but still living larvae are likely the most suitable food source for developing parasitoid larvae. Non-target hosts may have a different reaction to these toxins and are killed outright by the sting. Researchers have attributed the low success rate of *M. ridens* development on non-target hosts to mortality of the non-target pre-pupae. All non-target species tested have supported a greatly reduced level of *M. ridens* development in comparison to codling moth. This is also consistent with *M. ridens* being host specific

While *M. ridens* did attack the two overseas *Cydia* species tested, this occurred in no-choice tests under artificial conditions. While the rate of attack on *C. prunivora*, an overseas pest of fruit trees, was not given, development of *Mastrus ridens* on this host was characterised as abnormal. The rate of attack on *C. succedana* a species released in some countries for biological control of gorse, was characterised as “occasional” and subsequent parasitoid survival and development on attacked larvae of this host was low. This suggests that *M. ridens* is highly specialized to the host codling moth; it is probable that the native *Cydia* species would be similarly unacceptable and unsuitable for *M. ridens* as the non-target *Cydia* species overseas.

The frequency of *M. ridens* attacks on codling moth is density dependent; more hosts are attacked when present at higher population densities (Bezemer & Mills 2001). Most native Australian Olethreutine moth larvae are not polyphagous and native moth genera are typically associated with particular plant groups (Horak 2006). It is likely that the population density of the codling moth will be much higher as a pest in an orchard monoculture than the population density of a native moth species in a native habitat with a diversity of plants. Therefore attack rates outside of orchard environments are expected to be lower than attack rates within an infested orchard.

It is important to note that the reduced attack rate and development of *M. ridens* on non-target hosts does not ensure all non-target hosts will not experience an impact from the parasitoid. If *M. ridens* is at a high local population density associated with a large local population of codling moth the parasitoid could still attack and kill non-target hosts. While the number of non-target attacks may represent a small fraction of the attacks compared to those on codling moth, there may still be an impact on the non-target host population. However the host specificity results do provide assurance that any potential non-target impacts will occur only in localities with fruit trees and codling moth present. Furthermore *M. ridens* will be unable to maintain its population in the absence of the codling moth, and the overall abundance of *M. ridens* will decline if codling moth populations decline.

Overall, whatever impact *M. ridens* might have on non-target hosts is expected to be very small, localised in fruit tree areas with very high codling moth populations and persist only as long as codling moth populations are high. As no potential non-target species has been identified in Australia, the likelihood of even localised impacts are considered to be low.

On the basis of the work presented in Appendix A it is concluded that the probability of off-target effects is: **LOW** (the event is very unlikely to occur).

3.2.2 Assessment of potential consequences to off-target species

The potential consequences of the off-target effects of this biological control agent have been assessed using the same methodology (Appendix B) as used in the import risk analyses for pests that may be associated with imported produce.

Criterion	**Estimate and rationale**
Direct	
Plant life or health	**Impact score**: A – Indiscernible. *Mastrus ridens* is a parasitoid of pupating *Cydia pomonella* larvae; all life stages except the adult stage are completed on or near the host larvae. The only known direct interaction of *M. ridens* with plants occurs when adults feed on nectar.
Other aspects of the environment	**Impact score**: B – minor significance at the local level Overall, the likelihood of significant non-target impacts on other insect species appears to be very low. There may be some very low levels of non-target stings within orchards that have high levels of *C. pomonella*. However these are very unlikely to have an effect on populations of native species. Given the apparent restriction of *M. ridens* to searching in orchard environments and it's attraction to codling moth larvae it is unlikely to encounter native hosts. Given *M. ridens* level of host specificity it is very unlikely to be able to successfully parasitise any off-target hosts it may encounter.
Indirect	
Eradication, control etc.	**Impact score**: A *Mastrus ridens* is proposed for release for the biological control of codling moth and testing has shown it to be very host specific. As it is host specific on codling moth, and does not affect other economic or environmental attributes, it would be extremely unlikely to meet criterion for eradication. Therefore, the need for eradication and or control is not anticipated.
Domestic trade	**Impact score**: A *Mastrus ridens* is host specific on codling moth, and does not attack any plants or beneficial insects. Therefore, impacts on domestic trade would not be expected.
International trade	**Impact score**: A *Mastrus ridens* is host specific on codling moth, and does not attack any plants or beneficial insects. Therefore, impacts on international trade would not be expected.
Environmental and non-commercial	**Impact score**: A The only direct effects *Mastrus ridens* is anticipated to have is on populations of the introduced codling moth, which in turn only attacks introduced fruit trees. A reduction in the population of codling moth is unlikely to have any negative indirect effects on the environment.

Based on this assessment the potential consequences of off-target effects are: **NEGLIGIBLE.**

3.2.3 Estimating the off-target risk of release of the biological control agent.

The estimate of probability of off-target effects of **low** are combined with the estimate of potential consequences of **negligible** to provide an estimate of risk of **NEGLIGIBLE**.

The estimate of risk is the result of combining the probability of off-target effects with the outcome of overall potential consequences. Probabilities and consequences are combined using the risk estimation matrix shown in Appendix B, Table 1.5.

A risk estimate of '**negligible'** achieves Australia's appropriate level of protection.

4. Draft recommendation on release

Given that the estimate of risk is negligible it is proposed that this biological control organism should be released subject to standard conditions to ensure that the released material is free of other organisms.

5. References

Bezemer TM & Mills NJ (2001) Host density responses of *Mastrus ridibundus*, a parasitoid of the codling moth, *Cydia pomonella*. *Biological Control* 22, 169–175.

Horak M (2006) Olethreutine moths of Australia (Lepidoptera: Tortricidae*). Monographs on Australian Lepidoptera*, Volume 10.

Appendices

A. Application for the release of *Mastrus ridens* for the biological control of codling moth (*Cydia pomonella*).

B. Pest risk analysis methodology

C. Biosecurity Framework

Appendix A Application for the release of *Mastrus ridens* for the biological control of codling moth (*Cydia pomonella*)

Application for the release of *Mastrus ridens* (Hymenoptera: Ichneumonidae) for the biological control of codling moth *Cydia pomonella* (Lepidoptera: Tortricidae)

June 2012

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Agent name

Phylum: Arthropoda
Class: Insecta
Order: Hymenoptera
Family: Ichneumonidae
Subfamily: Cryptinae
Genus: Mastrus
Species: ridens (Horstmann 2009)

Note: previous documentation referred to this agent as *M. ridibundus* (Gravenhorst).

A brief biology of the agent

Mastrus ridens is a synovigenic, gregarious, idiobiont, ectoparasitoid of pre-pupal cocooned codling moth. Adult parasitoids are black and several millimetres long. Females can parasitize up to 4 codling moth larvae per day, with a single larva supporting the development of a maximum of ten parasitoids (Sandanayaka et al. 2011).

M. ridens actively searches for the codling moth, eavesdropping on pheromones produced by codling moth cocoons (Jumean et al. 2005). *Mastrus ridens* parasitizes cocooned larvae by paralysing the prey and laying an egg onto the host. Parasitoid larvae then develop and feed externally on the host, eventually killing it (Devotto et. al. 2010).

The native range of the agent

M. ridens is native to central Asia, the probable natural range of codling moth (Mills 2005, Horstmann 2009). Surveys of codling moth parasitoids in this region resulted in the collection of *M. ridens* from Kazakhstan between 1994 and 1998 (Mills 2005). *M. ridens* from those collections were reared in quarantine in the USA and subsequently approved for release in that country (Hennessey 1995, Mills 2005).

Related species to the agent and a summary of their host range

M. ridens belongs to the large family Ichneumonidae. Ichneumonids are minute to very large gregarious parasitoids of insects and spiders, and in Australia are most diverse in the cooler, wetter southeast of the continent (CSIRO 1991).

The proposed source(s) of the agent

The *M. ridens* culture tested in quarantine at DPI Frankston was obtained from Plant and Food Research (PFR) New Zealand's quarantine culture. The New Zealand culture was obtained from Argentina, following importation to that country from the USA (Sandanayaka et al. 2011, Devotto et al. 2010). If approved for release, *M. ridens* will be mass-reared at DPI Tatura from the DPI Frankston quarantine culture or re-imported from New Zealand.

The current status of the target species in Australia, including a summary of the economic and environmental losses caused by the target and the expected benefits resulting from the control of the target species

Phylum:	Arthropoda
Class:	Insecta
Order:	Lepidoptera
Suborder:	Glossata
Superfamily:	Tortricoidea
Family:	Tortricidae
Subfamily:	Olethreutinae
Tribe:	Grapholitini
Genus:	Cydia (Hübner)
Species:	pomonella (Linnaeus)

Common name: codling moth

Native range and, if determinable, possible centre of origin

Codling moth is thought to originate from wild apple, *Malus* spp., in central Asia (Mills 2005). Its spread to various parts of the world has been facilitated by trade of commercially grown apples.

Australian and overseas distribution

Codling moth was introduced into Australia in the 1850s and spread north from Tasmania onto the mainland. It has now established itself as a direct pest of apples, pears and nashi in Victoria, NSW, Queensland, and South Australia. It is known not to be established in Western Australia because several incursions have been successfully eradicated and there is an active surveillance program.

With some exceptions it is now established in most temperate pome fruit growing regions of the world (Willett et al. 2009, Figure 1).

Figure 1: Distribution of codling moth and host plants (from Willett et al. 2009).

1. Pest status

Codling moth has numerous fruit crop hosts including apple, pear, plum and walnut. It is the most damaging pest of apple and pear production in the world, including major Australian apple and pear growing regions (Hetherington 2009). Quarantine, surveillance and eradication measures have prevented establishment of the pest in Western Australia (Hetherington 2009).

Damage is caused by 'stings', shallow feeding areas on the surface of fruit, and by larval tunnelling. Newly-hatched larvae chew through the fruit skin and bore their way to the core. The presence in fruit of one or more holes plugged with frass (excrement) is characteristic of attack by codling moth. The larvae enter the fruit through the sides, stem end, or calyx end, and a syrupy substance may exude from the holes as the fruit matures. Damage can lead to premature ripening and fruit drop.

Codling moth is the principal insect pest of pome fruit in Victoria, the largest apple and pear producing State in Australia, and can damage almost the entire crop if not controlled (Williams 2000). Control of codling moth impacts on almost all other pest programs in pome fruit orchards since the chemicals commonly used to control codling moth have adverse effects on beneficial insect and mite species, which contribute to biological control of other pests. As a result, regular seasonal chemical control programs are often required for control of minor pests. Integrated pest management (IPM) programs have been developed to manage codling moth but the tools available have lower individual efficacy than chemical pesticides against codling moth. Carryover of high populations of hibernating (diapaused) larvae from one season to the next result in emergence of large numbers of moths in spring and these overwhelm control methods based on softer chemicals and/or pheromone based mating disruption (Hetherington 2009).

Whether and when the target species was approved for biological control, and the proposing organisation

A biological control program was planned for codling moth in Australia as early as 1903 when *Liotryphon caudatus* was considered for introduction (Johnston 1928, Waterhouse and Sands 2001). It is not certain whether this agent was subsequently introduced. The first known introduction of a biological control for codling moth occurred in 1928 when *Trichogramma minutum* was released in Queensland and New South Wales (Wilson 1960). Surveys at release sites in 1929 recovered small numbers of *T. minutum*. In 1964 *Ascogaster quadridentatus* was introduced from Canada (Clausen 1978), however establishment of *A. quadridentatus* was not confirmed.

Invertebrate pests not previously targeted for biological control must now be approved as a target by the relevant ministerial committee. This is a relatively recent requirement for invertebrate pests, and only one new target has been approved to date. For weeds, the process of target approval by the Australian Weeds Committee has been in place for some time. However the Australian Weeds Committee recognised that where biological control programs pre-existed the process, approval of that target was assumed. Exceptions can occur if it is determined that the public interest in the target has changed over time.

Following consultation with the Department of Agriculture Fisheries and Forestry (DAFF), it was determined that codling moth meets the criteria for a pre-existing biological control target where the public interest in controlling the pest has not diminished over time (Tara Dempsey, DAFF, pers. comm.), therefore approval of codling moth as a target for biological control is assumed.

The agent's potential for control of the target

Mills (2005) analysed a stage-structured model for codling moth, and identified the second-instar and cocoon as the stages vulnerable to parasitism where the greatest impact on codling moth populations could be achieved. He therefore argued that in addition to narrow host -range, the selection of biological control agents for codling moth should focus on parasitoids where:

(i) there is an absence of antagonistic interactions between parasitoid species,

(ii) greater than 30% parasitism is observed in the natural range, and

(iii) parasitoids target the second instar and cocoon stages.

Mills (2005) survey of *M. ridens* in Kazakhstan orchards found maximum parasitism levels of more than 40%. In addition to meeting this and the other criteria proposed by Mills, *M. ridens* also responds positively to patches of higher host density, has a short generation time, and produces a greater number of female offspring per host attacked than other codling moth parasitoids. For these reasons Mills (2005) considered *M. ridens* a priority for introduction to the USA. *M. ridens* has established readily in the USA and parasitism of overwintering cocoons has reached up to 70% in some unsprayed orchards (Mills 2005).

M. ridens was subsequently released in South America in Argentina (2003) and Chile (2006) (Devotto et al. 2010). In Argentina, *M. ridens* was collected 4km from release sites a few weeks after release (Devotto et al. 2010). The successful establishment and rapid dispersal of *M. ridens* are seen as desirable traits in area-wide management programs for codling moth (Devotto et al. 2010).

M. ridens has recently undergone host-range testing in New Zealand, where an application for its release has been submitted (Pipfruit NZ Inc. 2011). If approved for release, *M. ridens* is expected to make a considerable contribution to the biological control of codling moth in New Zealand by reducing codling moth populations on host trees outside orchards (Pipfruit NZ Inc. 2011). *M. ridens* has similar potential in Australia through a reduction in (i) overwintering codling moth populations, (ii) codling moth populations in organic orchards, and (iii) infestations on host trees outside sprayed orchards.

Non-target organisms at risk from an agent

Kuhlmann et al. (2006) highlighted the following considerations when selecting non-target species for host-specificity testing:

(1) *Ecological similarities* between the target and non-target species,

(2) *Phylogenetic/taxonomic affinities* or relatedness of non-target species to the target (see Table 1), and

(3) *Safeguard considerations* such as the possible inclusion of beneficial insects (including other biological control agents) and endangered species.

However Kuhlmann et al. (2006) also recognised the difficulties associated with collecting, rearing, and testing multiple insect species for arthropod biological control tests. They proposed filters to remove species whose attributes do not overlap with those of the target species (Figure 2). Charles and Dugdale (2011) utilised this approach in the selection of non-target species for host-specificity testing of *M. ridens* in New Zealand.

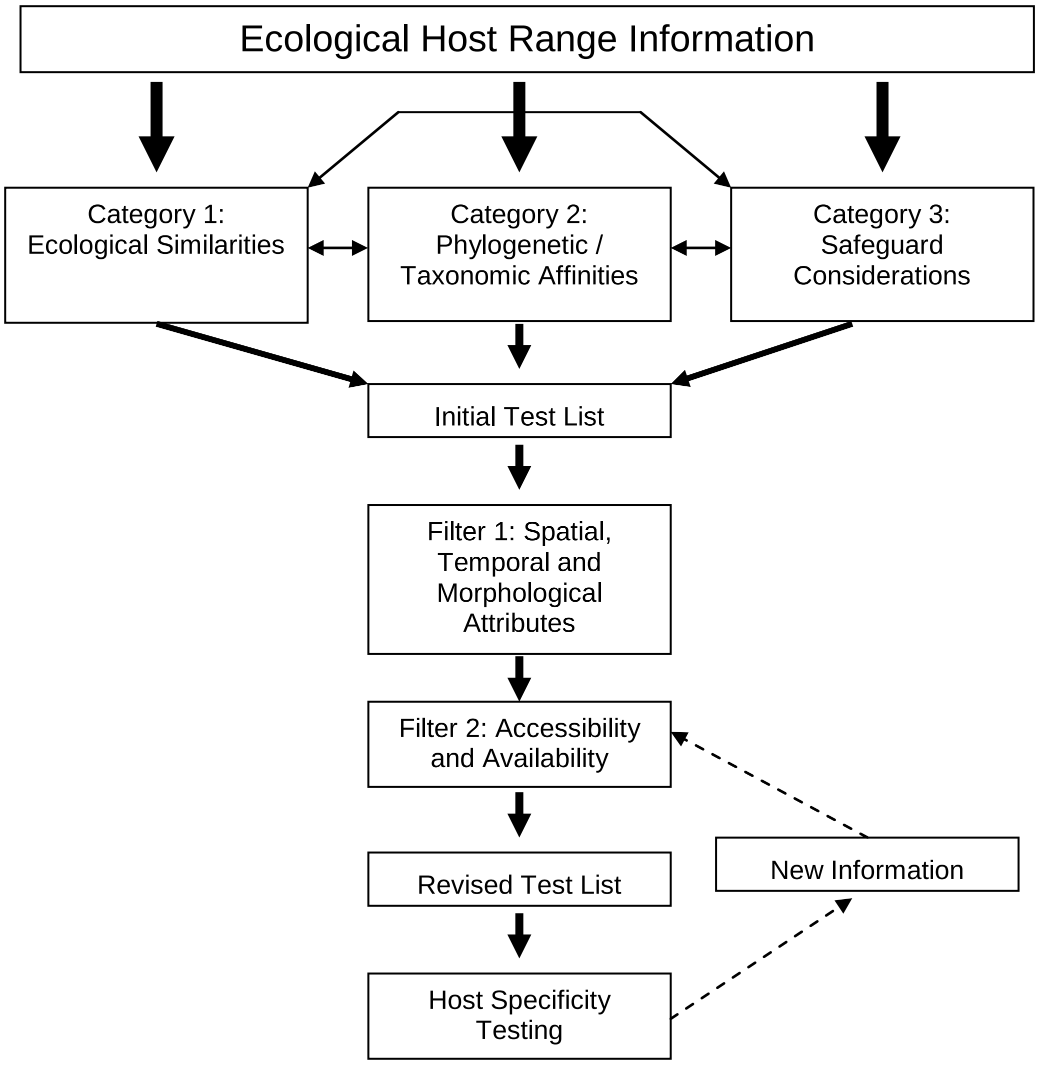

Figure 2: Selecting non-target species for host-specificity testing (from Kuhlmann et al. 2006)

When considering Australian Grapholitini for host-specificity testing, important determinants for inclusion or non-inclusion were geographic distribution, habitat, accessibility and availability. In some cases, where potential test species occur in temperate regions, little or nothing is known of their host plant or biology (Table 1). Many Australian species were therefore excluded because they (i) have a northern tropical distribution, or (ii) occur in dry and arid parts of Australia, or (iii) do not occur in orchards or modified habitats. However in the case of (iii), non-target species may be at risk if they occurred in a habitat that was attractive to dispersing *M. ridens*. Importantly though, Jumean (2005) demonstrated that dispersing *M. ridens* adults are strongly attracted to the complex 11-component species-specific aggregation pheromone produced by newly spun codling moth cocoons. Therefore, dispersing *M. ridens* will firstly fly to a habitat occupied by cocooned codling moth larvae, before landing and searching for a suitable host (codling moth does not develop on native plants, Geier 1963). Host plant chemical cues or visual stimuli may also play a role in attracting *M. ridens* to apple over other habitats (see page 18).

After arriving at a suitable habitat, *M. ridens* switches from to flight to walking in its search for host cocoons. New Zealand researchers studied the functional morphology of the *M. ridens* antenna and ovipositor, and it's close-range searching behaviour when exposed to codling moth and five non-target test species (Pipfruit NZ Inc. 2011). These studies showed that *M. ridens* was only attracted to codling moth cocoons (Pipfruit NZ Inc. 2011). When non-target species were accidentally encountered in small arena tests, steps in the host examination, acceptance, guarding and oviposition behaviours were terminated before parasitism in most cases. However some of these individuals were parasitised, and produced abnormal offspring. They were not considered suitable hosts though, as it was argued that *M. ridens* would not encounter these species normally because they are not attractive to *M. ridens*, and even if accidentally encountered and parasitised *M. ridens* could not maintain a population on the non-target species (Pipfruit NZ Inc. 2011).

Based on these considerations, and further information from overseas research, four exotic species (including codling moth) and three native species were selected for host-specificity testing:

Cydia pomonella
Cydia succedana
**Cydia* sp.
Grapholita (Aspila) molesta
Cryptophlebia ombrodelta
**Thaumatotibia zophophanes*
**Epiblema strenuana*

*This list was further modified due to availability constraints:

- Dr. Marianne Horak (CSIRO) and Yu Ning Su were consulted for further information on the native *Cydia* spp.,however collections were not possible. .
- *T. zophophanes* was not available for testing.
- *E. strenuana*, a weed biological control, was initially included as a 'safeguard species'. Host plants were grown, and Dr. Dhileepan Kunjithapatham of DPI Queensland conducted several field surveys during 2011. However *E. strenuana* could not be collected from the field in Queensland or Victoria.

C. succedana, an important test species given its relatedness to codling moth and potential as a biological control for gorse in south eastern Australia, was tested at PFR New Zealand (Pipfruit NZ Inc. 2011). Host-specificity testing of *G. molesta* was also conducted at PFR New Zealand (Pipfruit NZ Inc. 2011). The Australian Grapholitine *C. ombrodelta* underwent host-specificity testing at DPI Frankston.

Related Australian native and introduced species

Horak (2006) recognised four genus-groups of the tribe Grapholitini:

2. *Loranthacydia*-group: based on a single genus which is endemic to Australia. Recorded from all Australian states and territories except Victoria, Tasmania and the ACT.
3. *Dichrorampha*-group: which includes one genus in Australia, *Pammenemima*, recorded from the Northern Territory and Queensland.
4. *Cydia*-group: comprising six genera including *Cydia*. All except *Lathronympha* are represented in Australia. Two genera, *Apocydia* and *Notocydia*, are endemic.
5. *Grapholita*-group: strongly concentrated in the old world. Ten genera in Australia, three of which are endemic.

The Cydia- and Grapholita- groups are summarised in Table 1.

Three species of *Cydia* occur in Australia; codling moth and two unnamed native species. The gorse pod moth *Cydia succedana*, a potential weed biological control agent, has not been released in Australia but has undergone host-range testing in DPI Frankston's quarantine laboratory.

Apart from codling moth, the tribe Grapholitini also contains the important exotic pest oriental fruit moth *Grapholita (Aspila) molesta.*

Epiblema strenuana (stem-galling moth) was introduced for the biological control of parthenium and belongs to the sub-family Olethreutinae.

Table 1. Summary of Australian Grapholitini (*Cydia*- and *Grapholita*-groups) from Horak (2006)

Genus (E=endemic)	Australian distribution	Biological/host records
	***Cydia*-group**	
Cydia	Native spp. northern Queensland and the ACT. *C. pomonella* recorded from all states except NT and WA.	Represented in Australia by two unnamed native species and the introduced pome fruit pest *C. pomonella*. Only one host record for a native *Cydia* reared from sticky hop bush *Dodonaea viscosa* (Sapindaceae) in Canberra. Many plant families including Fagaceae, Fabaceae and Rosaceae recorded as larval hosts overseas. *Cydia succedana* is being considered as a potential biological control for gorse (pending approval for release from quarantine).
Apocydia (E)	All mainland states except Victoria and Sth Australia. One specimen from Tas.	Monotypic genus. *A. pervicax* occurs through diverse climatic range, however nothing known of the biology of this species.
Notocydia (E)	Drier regions: WA, NT, Qld and NSW.	Larvae collected in Qld from *Senna* sp. Seed pods. Reared from dried *Senna* flowers in NT.
Fulcrifera	Carnarvon WA, NT, and south to Yeppoon, Qld.	Larvae are borers of Fabaceae overseas. No information on biology of Australian species is known.
Leguminivora	Qld; from Brisbane to Cairns	Mostly associated with Fabaceae overseas. No information on biology of Australian species is known.
	***Grapholita*-group**	
Gymnandrosoma	Only known from four *G. gonomela* males collected in Adelaide, SA; and a single male of an unnamed species from WA.	Very little known of the biology of Australian species. *G. gonomela* individuals collected in Adelaide were “dislodged from *Banksia* sp.” which suggests *Banksia* as a foodplant. Overseas the genus are borers of fruit and nuts.
Cryptophlebia	NT, WA, Qld, NSW	Nine species found in Australia, including four named species. Diverse host range overseas but mostly Fabaceae. In Australia *C. ombrodelta* is a pest of Macadamia, and has been reared from a variety of other hosts.
Grapholita		
Subgenus *Grapholita*	*compositella*-group restricted to northern Australia. *conficitana*-group (E) occurs	Two species-groups known in Australia, one of which is endemic. Known host plants in Australia belong to Fabaceae. *G. zapyrana* reared on seed of native

	in all states.	*Glycine* spp. in the ACT (CSIRO).
Subgenus *Aspila*	*A. dysaethria* – northern Qld. *A. molesta* – Vic, Tas, SA, NSW, ACT and Qld.	*A. dysaethria* is a native for which there is no host or biological information. *A. molesta* (oriental fruit moth) is an introduced pest of stone and some pome fruits.
Parapammene	Northern Australia, Bathurst (NSW), and ACT.	In Australia there is one named (*P. dyserasta*) and four unnamed species. Undescribed species reared from *Dodonaea viscosa* capsules in ACT.
Acanthoclita	Mostly northern wetter areas of NT and northeast Qld. One unidentified species recorded on east coast from Richmond (NSW) to Toowoomba (Qld).	At least six unidentified species and one named species, *A. trichograpta*, from Australia. No information on biology of Australian species is known. Overseas species are primarily leafrollers and all recorded from Fabaceae.
Centroxena	NT and northern Qld	Insufficient material to describe any species.
Microsarotis	NT and northern Qld.	Two species known from Australia; one unnamed species with a few specimens from Darwin, and *M. sanderyi* (collected with light trap in Qld).
Pammenopsis	Widely scattered across tropical northern Australia.	One species, *P. barbata*, known in Australia. No host information known.
Commoneria (E)	NE Qld only.	One named (*C. cyanosticha*) and one unnamed species from Australia. *C. cyanosticha* reared from fruit of *Parinari nonda* near Cairns.
Ixonympha (E)	Qld, Vic, SA, WA and NT	Mistletoe seed
Archiplebia (E)	Qld, NT, WA, and SA. *A. rutilescens* northern Australian distribution; *A. endophaga* and the unnamed species occurring south from Broome and South Australian mallee.	Endemic, with two named species, *A. rutilescens and A. endophaga*, and one unnamed species. *A endophaga* reared from larvae feeding on *Acacia* pods. *A. rutilescens* reared from larva feeding on "fruit" in Qld. Generally found in arid, semi-arid or seasonally dry locations.
Thaumatotibia	Darwin, NT; Cape York, Qld; and northern NSW as far south as Allyn River (north of Newcastle).	Larvae are fruit borers with broad host range. Three species known from Australia; *T. zophophanes*, *T. aclyta*, and an unnamed species. In Qld *T. zophophanes* is a pest of macadamia and avocado.

Copies of any references referred to in the application

See attachments

Information and results on any other similar assessments undertaken on the species

M. ridens has been approved for release in the USA, Argentina, and Chile (Hennessey et al. 1995, Devotto 2010). Research into the host-range of *M. ridens* has been conducted at the PFR New Zealand quarantine laboratories (Pipfruit NZ Inc. 2011).

Information on all other relevant Commonwealth, State and Territory legislative controls of the target species

n/a

Report of host-specificity testing

a. Small arena no-choice black box test for C. ombrodelta

Aim: Determine if *M. ridens* will parasitise the Australian native macadamia nutborer *Cryptophlebia ombrodelta*.

Method and materials:

Codling moth larvae and *M. ridens* adults were obtained from the laboratory culture at DPI Frankston. *C. ombrodelta* larvae were reared at the Wollongbar Primary Industries Institute, NSW, and shipped overnight to DPI Frankston. Pre-pupal larvae of the test species were placed in a small arena (glass tube, 25mm diameter x 100mm, with lid) with a pair of *M. ridens* adults. Prior to the experiment, individual parasitoid pupae were placed in plastic tubes until emergence and kept separated until use.

Test species:
Target (host) – codling moth *C. pomonella* (CM)
Non-target – macadamia nutborer *C. ombrodelta* (MNB)
Parasitoid – *M. ridens* (MR)

Positive control: target (host) species
Negative control: target and non-target species without *M. ridens*

Treatments:
CM (single codling moth larva only)
MNB (single macadamia nutborer larva only)
CM + MR (single codling moth larva plus single virgin male and female *M. ridens* adults)
MNB + MR (single macadamia nutborer larva plus single virgin male and female *M. ridens* adults)

For each treatment twenty cocooned MNB or CM larvae (each in a single corrugated cardboard flute) were placed into their individual arenas with a pair of *M. ridens* adults (unmated female and male). After 48 hours the *M. ridens* adults were removed from the tube, and the tubes with larvae were maintained at 23C, 16hours light for one week, after which the number of larvae parasitized by *M. ridens* was recorded. The test was repeated three times.

Behavioural observations: detailed observation was not conducted at this stage, however *M. ridens* activity was observed during the first hour to ensure any lack of attack on the non-target was not due to poor condition of *M. ridens* adults.

Parameters measured:
1. Number of hosts parasitised and not parasitised
2. Host suitability for parasitoid (attack versus development)

Results

C. ombrodelta larvae were not parasitised by *M. ridens* (Table 2). There were no significant differences in survival of MNB larvae in tubes with or without MR. The rate of parasitism in

CM larvae (positive control) averaged 73% and 1-6 parasitoid larvae were produced per parasitised codling moth larva.

Table 2: Parasitism of macadamia nut borer *C. ombrodelta* (MNB) and codling moth *C. pomonella* (CM) larvae by *Mastrus ridens* (MR) in small arena no-choice test.

Treatments	No. of individuals tested	No. alive after one week	No. parasitised	No. of MR emerged	MR emerged / host larva	Rate of parasitism (%)
CM larva only	60	57	-	-	-	-
MNB larva only	60	42*	-	-	-	-
CM larva + MR	60	-	44	139	3.16	73
MNB larva + MR	60	35*	0	0	0	0

* means not significantly different at p=0.05

b. *Ability of M. ridens to locate and parasitise cocooned codling moth larvae on alternate hosts*

Aim: To determine whether host plant influences the ability of *M. ridens* to locate and parasitise codling moth larvae.

Method and Materials:

An insect tent (2m x 2m x 2m) was set up in the quarantine glass house to investigate whether host plant influences the ability of *M. ridens* to locate and parasitise codling moth (CM) larvae. Treatments were placed in each corner of the tent as follows:

1. Potted apple tree (approx 2m high) + CM larvae,
2. Plastic tree of similar size and structure to the apple tree + CM larvae,
3. Gorse bush + CM larvae
4. CM larvae only presented on a 1cm diameter stick (control)

The experiment was conducted at 25^0C under a 16 hour light: 8 hour dark photoperiod and at approximately 60% RH.

A cardboard sheet (1m high) encircled the outside of the tent to provide a consistent background, and only the canopy of each treatment was silhouetted.

6 pairs of *M. ridens* adults were released in the centre of the tent after overnight acclimatization in a container inside the tent. 3 codling moth larvae, cocooned in corrugated cardboard and refrigerated for at least 7 days, were presented in each treatment.

After 48 h the CM larvae were removed from the cardboard and placed in plastic containers in the CT room (23^0C; 16 hour light and 8 hour dark) for *M. ridens* adult emergence.

The treatments (apple, gorse, artificial tree, control) were moved anticlockwise one step for each position (A, B, C and D) and the experiment was repeated 4 times. *M. ridens* adults and codling moth larvae were replaced with fresh insects after each rotation.

Results and discussion

There was a significant difference in the number of codling moth larvae parasitised between treatments (p-value = 0.00256), with the rate of parasitism higher on the apple tree (91.7%) compared to all other treatments. Parasitism on gorse (41.7%) was not significantly different to the artificial tree (25%) or control (25%). Jumean (2005) found that an 11-component aggregation pheromone produced by codling moth cocoons was highly attractive to *M. ridens*, but was only active during the first three days after cocoon spinning. Cocoons more than seven days old are less attractive, especially over long-distances. More *M. ridens* adults emerged from larvae parasitised on the apple tree than on gorse, the artificial tree, or the control, suggesting that host plant chemical cues may also play a role in attracting dispersing *M. ridens* to a suitable host habitat.

Table 3: Parasitism of codling moth (CM) larvae presented on alternate hosts in a tent experiment. Figures followed by the same letter are not significantly different.

Host 'plant'	No. CM larvae tested	No. CM larvae parasitised	No. M. ridens emerged	% parasitism
Apple tree	12	11a	41	91.7
Artificial tree	12	3b	8	25
Gorse bush	12	5b	10	41.7
Control (stick)	12	3b	8	25

Overseas host records, including literature and discussions with experts

Codling moth is the only recorded host of *M. ridens* in its native range (Mills 2005, Horstmann 2009). Host specificity testing was conducted as part of an Environmental Assessment for *M. ridens* prior to its introduction to the USA (Hennessey et al. 1995, Table 4).

Table 4: Host-specificity testing conducted for *M. ridens* in the USA prior to approval for release (Hennessey et al. 1995)

Family	Test Species	Result
Tortricidae	*Cydia pomonella*	Host
	C. prunivora	Abnormal development
	Archips rosana	No parasitism
	Argyrotaenia citrana	No parasitism
	Choristoneura rosaceana	No parasitism
	Pandemis chondrillana	No parasitism
Gelechiidae	*Anarsia lineatella*	No parasitism
Hyponomeutidae	*Hyponomeuta malinella*	No parasitism
Pyralidae	*Amyelois ttransitella*	No parasitism
	Anagasta kuehniella	No parasitism
	Ephestia cantella	No parasitism
	Eurrhypara urticara	No parasitism

Although *M. ridens* is not known to function as a hyper-parasite, Hennessey et al. (1995) nevertheless tested *M. ridens* against six hymenopteran natural enemies of lepidopterous pests. No hyper-parasitism occurred.

Subsequent field surveys following establishment of *M. ridens* in the USA and in South America have not identified any other hosts (Nick Mills, University of California, pers. comm., Devotto et al. 2010)

Host specificity tests undertaken in New Zealand found *M. ridens* only recognises codling moth as a suitable host (Pipfruit NZ Inc. 2011). G. (A). *molesta* and *C. succedana* were tested in New Zealand host-range testing and were not found to be at risk (Pipfruit NZ Inc. 2011).

Risk evaluation to non-target species

Research in Australia and overseas has demonstrated that the ecological host range of *M. ridens* is restricted to codling moth. Codling moth is the only known host of *M. ridens* from field surveys conducted in the parasitoid's native range and introduced ranges in North America and South America (Mills 2005, Devotto et al. 2010). Dispersing *M. ridens* are only attracted to habitats containing cocooned codling moth larvae, and once in that habitat, are strongly attracted to codling moth cocoons but not cocoons of other species (Pipfruit NZ Inc. 2011). *M. ridens* recognise the chemicals associated with codling moth cocoons, and the absence of those chemicals means that non-target cocoons are not recognised by *M. ridens* as being present (Pipfruit NZ Inc. 2011). In the laboratory in small arena tests no larvae of the native Australian Grapholitine *C. ombrodelta* were parasitised. In New Zealand and USA small arena tests some non-target larvae were parasitised, but those non-target larvae that were parasitised were killed rather than paralysed by the parasitoid sting, and so offspring either starved to death, or were very small and ecologically unfit (Pipfruit NZ Inc. 2011).

Hoddle (2004) suggested that "non-target impacts and habitat infiltration can be significantly reduced by selecting ichneumonid and braconid parasitoids with narrow host breadths and high levels of habitat fidelity". *M. ridens* meets these criteria. Based on these studies it is believed that, if released, *M. ridens* would not pose a significant risk to Australian tortricid fauna, and would become an important biological control against an economically damaging pest.

Any evidence to reveal laboratory artefacts in behaviour or development

n/a

Possible interactions, including conflict-of-interest with existing biological control programs

Codling moth hosts a number of predators and parasitoids in Australia. These natural enemies occasionally cause high mortality of codling moth, but none have reduced its pest status in Australia (Waterhouse and Sands 2001).

C. succedana (gorse pod moth) has been tested as a potential biological control for gorse*, Ulex europaeus*, in Australia. It is anticipated that an application for its release from quarantine will be submitted in 2012. *C. succedana* was included in host-specificity testing in New Zealand (where it is established) and was not found to be a suitable host for *M. ridens* (Pipfruit NZ Inc. 2011).

M. ridens has no observed hyperparasitism potential (Hennessey et al. 1995), and adults are not likely to compete with native species for floral food resources (Pipfruit NZ Inc. 2011).

Information on where, when and how initial releases will be made

If approved for release, *M. ridens* will be mass-reared at DPI Tatura and initially released at selected sites in apple growing regions of Victoria. Establishment, dispersal and impact assessments will be conducted by DPI (Vic). Following establishment in the field, further releases can be conducted in other pome fruit areas.

Information on whether this species has established feral populations, and if so, where those populations are

n/a

Information on, and the results of, any other environmental risk assessments undertaken on the species both in Australia and overseas.

See previous sections

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Appendix B Method for pest risk analysis

In accordance with the International Plant Protection Convention, the technical component of a plant import risk analysis (IRA) is termed a pest risk analysis (PRA). DAFF has conducted this PRA in accordance with the International Standards for Phytosanitary Measures (ISPMs), including ISPM 2: *Framework for Pest Risk Analysis* (FAO 2007) and ISPM 11: *Pest Risk Analysis for Quarantine Pests, including analysis of environmental risks and living modified organisms (FAO 2004).*

A PRA is 'the process of evaluating biological or other scientific and economic evidence to determine whether a pest should be regulated and the strength of any phytosanitary measures to be taken against it'(FAO 2009). A pest is 'any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products'(FAO 2009).

Quarantine risk consists of two major components: the probability of a pest entering, establishing and spreading in Australia from imports; and the consequences should this happen. These two components are combined to give an overall estimate of the risk.

Unrestricted risk is estimated taking into account the existing commercial production practices of the exporting country and that, on arrival in Australia, DAFF will verify that the consignment received is as described on the commercial documents and that its integrity has been maintained.

Restricted risk is estimated with phytosanitary measure(s) applied. A phytosanitary measure is 'any legislation, regulation or official procedure having the purpose to prevent the introduction and spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests'(FAO 2009).

A glossary of the terms used is provided at the back of this IRA report.

PRAs are conducted in three consecutive stages.

Stage 1: Initiation

Initiation identifies the pest(s) and pathway(s) that are of quarantine concern and should be considered for risk analysis in relation to the identified PRA area.

The initiation point for this PRA was the receipt of a technical submission from the National Plant Protection Organisation (NPPO) for access to the Australian market for the commodity. This submission included information on the pests associated with the production of the commodity, including the plant part affected, and the existing commercial production practices for the commodity.

The pests associated with the crop and the exported commodity were tabulated from information provided by the NPPO of the exporting country and literature and database searches.

For this PRA, the 'PRA area' is defined as Australia for pests that are absent, or of limited distribution and under official control. For areas with regional freedom from a pest, the 'PRA area' may be defined on the basis of a state or territory of Australia or may be defined as a region of Australia consisting of parts of a state or territory or several states or territories.

For pests that had been considered by DAFF in other risk assessments and for which import policies already exist, a judgement was made on the likelihood of entry of pests on the commodity and whether existing policy is adequate to manage the risks associated with its import. Where appropriate, the previous policy has been adopted.

Stage 2: Pest risk assessment

A pest risk assessment (for quarantine pests) is: 'the evaluation of the probability of the introduction and spread of a pest and of the likelihood of associated potential economic consequences'(FAO 2009).

In this PRA, pest risk assessment was divided into the following interrelated processes:

Pest categorisation

Pest categorisation identifies which of the pests identified in Stage 1 require a pest risk assessment. The categorisation process examines, for each pest, whether the criteria in the definition for a quarantine pest are satisfied. A 'quarantine pest' is 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, as defined in ISPM 5: *Glossary of phytosanitary terms (FAO 2009).*

The pests identified in Stage 1 were categorised using the following primary elements to identify the quarantine pests for the commodity being assessed:

- identity of the pest
- presence or absence in the PRA area
- regulatory status
- potential for establishment and spread in the PRA area
- potential for economic consequences (including environmental consequences) in the PRA area.

The results of pest categorisation are set out in the Appendices. The quarantine pests identified during pest categorisation were carried forward for pest risk assessment and are listed in the document.

Assessment of the probability of entry, establishment and spread

Details of how to assess the 'probability of entry', 'probability of establishment' and 'probability of spread' of a pest are given in ISPM 11 (FAO 2004). A summary of this process is given below, followed by a description of the qualitative methodology used in this IRA.

Probability of entry

The probability of entry describes the probability that a quarantine pest will enter Australia as a result of trade in a given commodity, be distributed in a viable state in the PRA area and subsequently be transferred to a host. It is based on pathway scenarios depicting necessary steps in the sourcing of the commodity for export, its processing, transport and storage, its use in Australia and the generation and disposal of waste. In particular, the ability of the pest to survive is considered for each of these various stages.

The probability of entry estimates for the quarantine pests for a commodity are based on the use of the existing commercial production, packaging and shipping practices of the exporting country. Details of the existing commercial production practices for the commodity are set out in Section 3. These practices are taken into consideration by DAFF when estimating the probability of entry.

For the purpose of considering the probability of entry, DAFF divides this step of this stage of the PRA into two components:

- **Probability of importation**: the probability that a pest will arrive in Australia when a given commodity is imported
- **Probability of distribution**: the probability that the pest will be distributed, as a result of the processing, sale or disposal of the commodity, in the PRA area and subsequently transfer to a susceptible part of a host.

Factors considered in the probability of importation include:

- distribution and incidence of the pest in the source area
- occurrence of the pest in a life-stage that would be associated with the commodity
- volume and frequency of movement of the commodity along each pathway
- seasonal timing of imports
- pest management, cultural and commercial procedures applied at the place of origin
- speed of transport and conditions of storage compared with the duration of the lifecycle of the pest
- vulnerability of the life-stages of the pest during transport or storage
- incidence of the pest likely to be associated with a consignment
- commercial procedures (e.g. refrigeration) applied to consignments during transport and storage in the country of origin, and during transport to Australia.

Factors considered in the probability of distribution include:

- commercial procedures (e.g. refrigeration) applied to consignments during distribution in Australia
- dispersal mechanisms of the pest, including vectors, to allow movement from the pathway to a host
- whether the imported commodity is to be sent to a few or many destination points in the PRA area
- proximity of entry, transit and destination points to hosts
- time of year at which import takes place
- intended use of the commodity (e.g. for planting, processing or consumption)
- Risks from by-products and waste.

Probability of establishment

Establishment is defined as the ‘perpetuation for the foreseeable future, of a pest within an area after entry’ (FAO 2004). In order to estimate the probability of establishment of a pest, reliable biological information (lifecycle, host range, epidemiology, survival, etc.) is obtained from the areas where the pest currently occurs. The situation in the PRA area can then be compared with that in the areas where it currently occurs and expert judgement used to assess the probability of establishment.

Factors considered in the probability of establishment in the PRA area include:

- availability of hosts, alternative hosts and vectors
- suitability of the environment
- reproductive strategy and potential for adaptation
- minimum population needed for establishment
- cultural practices and control measures.

Probability of spread

Spread is defined as ‘the expansion of the geographical distribution of a pest within an area’ (FAO 2004). The probability of spread considers the factors relevant to the movement of the pest, after establishment on a host plant or plants, to other susceptible host plants of the same or different species in other areas. In order to estimate the probability of spread of the pest, reliable biological information is obtained from areas where the pest currently occurs. The situation in the PRA area is then carefully compared with that in the areas where the pest currently occurs and expert judgement used to assess the probability of spread.

Factors considered in the probability of spread include:

- suitability of the natural and/or managed environment for natural spread of the pest
- presence of natural barriers
- potential for movement with commodities, conveyances or by vectors
- intended use of the commodity
- potential vectors of the pest in the PRA area
- potential natural enemies of the pest in the PRA area.

Assigning qualitative likelihoods for the probability of entry, establishment and spread

In its qualitative PRAs, DAFF uses the term ‘likelihood’ for the descriptors it uses for its estimates of probability of entry, establishment and spread. Qualitative likelihoods are assigned to each step of entry, establishment and spread. Six descriptors are used: high; moderate; low; very low; extremely low; and negligible (Table 1.1). Descriptive definitions for these descriptors and their indicative probability ranges are given in Table 1.1. The indicative probability ranges are only provided to illustrate the boundaries of the descriptors. These indicative probability ranges are not used beyond this purpose in qualitative PRAs. The standardised likelihood descriptors and the associated indicative probability ranges provide guidance to the risk analyst and promote consistency between different risk analyses.

Table 1.1 Nomenclature for qualitative likelihoods

Likelihood	Descriptive definition	Indicative probability (P) range
High	The event would be very likely to occur	0.7 < P ≤ 1
Moderate	The event would occur with an even probability	0.3 < P ≤ 0.7
Low	The event would be unlikely to occur	0.05 < P ≤ 0.3
Very low	The event would be very unlikely to occur	0.001 < P ≤ 0.05
Extremely low	The event would be extremely unlikely to occur	0.000001 < P ≤ 0.001
Negligible	The event would almost certainly not occur	0 ≤ P ≤ 0.000001

The likelihood of entry is determined by combining the likelihood that the pest will be imported into the PRA area and the likelihood that the pest will be distributed within the PRA area, using a matrix of rules (Table 1.2). This matrix is then used to combine the likelihood of entry and the likelihood of establishment, and the likelihood of entry and establishment is then combined with the likelihood of spread to determine the overall likelihood of entry, establishment and spread.

For example, if the probability of importation is assigned a likelihood of 'low' and the probability of distribution is assigned a likelihood of 'moderate', then they are combined to give a likelihood of 'low' for the probability of entry. The likelihood for the probability of entry is then combined with the likelihood assigned to the probability of establishment (e.g. 'high') to give a likelihood for the probability of entry and establishment of 'low'. The likelihood for the probability of entry and establishment is then combined with the likelihood assigned to the probability of spread (e.g. 'very low') to give the overall likelihood for the probability of entry, establishment and spread of 'very low'.

Table 1.2 Matrix of rules for combining qualitative likelihoods

	High	**Moderate**	**Low**	**Very low**	**Extremely low**	**Negligible**
High	High	Moderate	Low	Very low	Extremely low	Negligible
Moderate		Low	Low	Very low	Extremely low	Negligible
Low			Very low	Very low	Extremely low	Negligible
Very low				Extremely low	Extremely low	Negligible
Extremely low					Negligible	Negligible
Negligible						Negligible

Time and volume of trade

One factor affecting the likelihood of entry is the volume and duration of trade. If all other conditions remain the same, the overall likelihood of entry will increase as time passes and the overall volume of trade increases.

DAFF normally considers the likelihood of entry on the basis of the estimated volume of one year's trade. This is a convenient value for the analysis that is relatively easy to estimate and allows for expert consideration of seasonal variations in pest presence, incidence and behaviour to be taken into account. The consideration of the likelihood of entry, establishment and spread and subsequent consequences takes into account events that might happen over a number of years even though only one year's volume of trade is being considered. This difference reflects biological and ecological facts, for example where a pest or disease may establish in the year of import but spread may take many years.

The use of a one year volume of trade has been taken into account when setting up the matrix that is used to estimate the risk and therefore any policy based on this analysis does not simply apply to one year of trade. Policy decisions that are based on DAFF's method that uses the estimated volume of one year's trade are consistent with Australia's policy on appropriate level of protection and meet the Australian Government's requirement for ongoing quarantine protection. Of course, if there are substantial changes in the volume and nature of the trade in specific commodities then DAFF has an obligation to review the risk analysis and, if necessary, provide updated policy advice.

In assessing the volume of trade in this PRA, DAFF assumed that a substantial volume of trade will occur.

Assessment of potential consequences

The objective of the consequence assessment is to provide a structured and transparent analysis of the likely consequences if the pests or disease agents were to enter, establish and spread in Australia. The assessment considers direct and indirect pest effects and their economic and environmental consequences. The requirements for assessing potential consequences are given in Article 5.3 of the SPS Agreement (WTO 1995), (FAO 2009)and ISPM 11 (FAO 2004).

Direct pest effects are considered in the context of the effects on:

- plant life or health
- other aspects of the environment.

Indirect pest effects are considered in the context of the effects on:

- eradication, control, etc
- domestic trade
- international trade
- environment.

For each of these six criteria, the consequences were estimated over four geographic levels, defined as:

- **Local**: an aggregate of households or enterprises (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 or territory, such as 'Far North Queensland').
- **Regional**: a geographically or geopolitically associated collection of districts in a geographic area (generally a state or territory, although there may be exceptions with larger states such as Western Australia).
- **National**: Australia wide (Australian mainland states and territories and Tasmania).

For each criterion, the magnitude of the potential consequence at each of these levels was described using four categories, defined as:

- **Indiscernible**: pest impact unlikely to be noticeable.

- **Minor significance**: expected to lead to a minor increase in mortality/morbidity of hosts or a minor decrease in production but not expected to threaten the economic viability of production. Expected to decrease the value of non-commercial criteria but not threaten the criterion's intrinsic value. Effects would generally be reversible.
- **Significant**: expected to threaten the economic viability of production through a moderate increase in mortality/morbidity of hosts, or a moderate decrease in production. Expected to significantly diminish or threaten the intrinsic value of non-commercial criteria. Effects may not be reversible.
- **Major significance**: expected to threaten the economic viability through a large increase in mortality/morbidity of hosts, or a large decrease in production. Expected to severely or irreversibly damage the intrinsic 'value' of non-commercial criteria.

Values were translated into a qualitative impact score (A–G)[2] using Table 1.3.

Table 1.3 Decision rules for determining the consequence impact score based on the magnitude of consequences at four geographic scales

Impact score	Local	District	Region	Nation
G	Major significance	Major significance	Major significance	Major significance
F	Major significance	Major significance	Major significance	Significant
E	Major significance	Major significance	Significant	Minor significance
D	Major significance	Significant	Minor significance	Indiscernible
C	Significant	Minor significance	Indiscernible	Indiscernible
B	Minor significance	Indiscernible	Indiscernible	Indiscernible
A	Indiscernible	Indiscernible	Indiscernible	Indiscernible
	Geographic scale			

The overall consequence for each pest is achieved by combining the qualitative impact scores (A–G) for each direct and indirect consequence using a series of decision rules (Table 1.4). These rules are mutually exclusive, and are assessed in numerical order until one applies.

[2] In earlier qualitative IRAs, the scale for the impact scores went from A to F and did not explicitly allow for the rating 'indiscernible' at all four levels. This combination might be applicable for some criteria. In this report, the impact scale of A-F has changed to become B-G and a new lowest category A ('indiscernible' at all four levels) was added. The rules for combining impacts in Table 1.4 were adjusted accordingly.

Table 1.4 Decision rules for determining the overall consequence rating for each pest

Rule	The impact scores for consequences of direct and indirect criteria	Overall consequence rating
1	Any criterion has an impact of ‘G’; or more than one criterion has an impact of ‘F’; or a single criterion has an impact of ‘F’ and each remaining criterion an ‘E’.	Extreme
2	A single criterion has an impact of ‘F’; or all criteria have an impact of ‘E’.	High
3	One or more criteria have an impact of ‘E’; or all criteria have an impact of ‘D’.	Moderate
4	One or more criteria have an impact of ‘D’; or all criteria have an impact of ‘C’.	Low
5	One or more criteria have an impact of ‘C’; or all criteria have an impact of ‘B’.	Very Low
6	One or more but not all criteria have an impact of ‘B’, and all remaining criteria have an impact of ‘A’.	Negligible

Estimation of the unrestricted risk

Once the above assessments are completed, the unrestricted risk can be determined for each pest or groups of pests. This is determined by using a risk estimation matrix (Table 1.5) to combine the estimates of the probability of entry, establishment and spread and the overall consequences of pest establishment and spread. Therefore, risk is the product of likelihood and consequence.

When interpreting the risk estimation matrix, note the descriptors for each axis are similar (e.g. low, moderate, high) but the vertical axis refers to likelihood and the horizontal axis refers to consequences. Accordingly, a ‘low’ likelihood combined with ‘high’ consequences, is not the same as a ‘high’ likelihood combined with ‘low’ consequences – the matrix is not symmetrical. For example, the former combination would give an unrestricted risk rating of ‘moderate’, whereas, the latter would be rated as a ‘low’ unrestricted risk.

Table 1.5 Risk estimation matrix

Likelihood of pest entry, establishment and spread	Negligible	Very low	Low	Moderate	High	Extreme
High	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	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Negligible risk	Very low risk

Consequences of pest entry, establishment and 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 1.5 marked 'very low risk' represents Australia's ALOP.

Stage 3: Pest risk management

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

The conclusions from pest risk assessment are used to decide whether risk management is required and if so, the appropriate 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. The guiding principle for risk management is to manage risk to achieve Australia's ALOP. The effectiveness of any proposed phytosanitary measure (or combination of measures) is evaluated, using the same approach as used to evaluate the unrestricted risk, to ensure it reduces the restricted risk for the relevant pest or pests to meet Australia's ALOP.

ISPM 11 (FAO 2004) 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 entry of the pest.

Examples given of measures commonly applied to traded commodities include:

- options for consignments – e.g., inspection or testing for freedom from pests, 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 – if no satisfactory measure can be found.

Risk management measures are identified for each quarantine pest where the risk exceeds Australia's ALOP. These are presented in the 'Pest Risk Management' section of the report.

Appendix C Biosecurity framework

Australia's biosecurity policies

The objective of Australia's biosecurity policies and risk management measures is the prevention or control of the entry, establishment or spread of pests and diseases that could cause significant harm to people, animals, plants and other aspects of the environment.

Australia has diverse native flora and fauna and a large agricultural sector, and is relatively free from the more significant pests and diseases present in other countries. Therefore, successive Australian Governments have maintained a conservative, but not a zero-risk, approach to the management of biosecurity risks. This approach is consistent with the World Trade Organization's (WTO's) Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement).

The SPS Agreement defines the concept of an 'appropriate level of protection' (ALOP) as the level of protection deemed appropriate by a WTO Member establishing a sanitary or phytosanitary measure to protect human, animal or plant life or health within its territory. Among a number of obligations, a WTO Member should take into account the objective of minimising negative trade effects in setting its ALOP.

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

Consistent with the SPS Agreement, in conducting risk analyses Australia takes into account as relevant economic factors:

- the potential damage in terms of loss of production or sales in the event of the entry, establishment or spread of a pest or disease in the territory of Australia
- the costs of control or eradication of a pest or disease and
- the relative cost-effectiveness of alternative approaches to limiting risks.

Roles and responsibilities within Australia's quarantine system

Australia protects its human[3], animal and plant life or health through a comprehensive quarantine system that covers the quarantine continuum, from pre-border to border and post-border activities.

Pre-border, Australia participates in international standard-setting bodies, undertakes risk analyses, develops offshore quarantine arrangements where appropriate, and engages with our neighbours to counter the spread of exotic pests and diseases.

At the border, Australia screens vessels (including aircraft), people and goods entering the country to detect potential threats to Australian human, animal and plant health.

The Australian Government also undertakes targeted measures at the immediate post-border level within Australia. This includes national co-ordination of emergency responses to pest and disease incursions. The movement of goods of quarantine concern within Australia's

[3] The Australian Government Department of Health and Ageing is responsible for human health aspects of quarantine.

border is the responsibility of relevant state and territory authorities, which undertake inter- and intra-state quarantine operations that reflect regional differences in pest and disease status, as a part of their wider plant and animal health responsibilities.

Roles and responsibilities within the Department

The Australian Government Department of Agriculture, Fisheries and Forestry (DAFF) is responsible for the Australian Government's animal and plant biosecurity policy development and the establishment of risk management measures. The Secretary of the department is appointed as the Director of Animal and Plant Quarantine under the Quarantine Act 1908 (the Act).

DAFF takes the lead in biosecurity and quarantine policy development and the establishment and implementation of risk management measures across the biosecurity continuum, and;

- conducts risk analyses, including IRAs, and develops recommendations for biosecurity policy as well as providing quarantine policy advice to the Director of Animal and Plant Quarantine
- develops operational procedures, makes a range of quarantine decisions under the Act (including import permit decisions under delegation from the Director of Animal and Plant Quarantine) and delivers quarantine services
- coordinates pest and disease preparedness, emergency responses and liaison on inter- and intra-state quarantine arrangements for the Australian Government, in conjunction with Australia's state and territory governments.

Roles and responsibilities of other government agencies

State and territory governments play a vital role in the quarantine continuum. DAFF works in partnership with state and territory governments to address regional differences in pest and disease status and risk within Australia, and develops appropriate sanitary and phytosanitary measures to account for those differences. Australia's partnership approach to quarantine is supported by a formal Memorandum of Understanding that provides for consultation between the Australian Government and the state and territory governments.

Depending on the nature of the good being imported or proposed for importation, DAFF may consult other Australian Government authorities or agencies in developing its recommendations and providing advice.

As well as a Director of Animal and Plant Quarantine, the Act provides for a Director of Human Quarantine. The Australian Government Department of Health and Ageing is responsible for human health aspects of quarantine and Australia's Chief Medical Officer within that Department holds the position of Director of Human Quarantine. DAFF may, where appropriate, consult with that Department on relevant matters that may have implications for human health.

The Act also requires the Director of Animal and Plant Quarantine, before making certain decisions, to request advice from the Environment Minister and to take the advice into account when making those decisions. The Australian Government Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) is responsible under the *Environment Protection and Biodiversity Conservation Act 1999* for assessing the environmental impact associated with proposals to import live species. Anyone proposing to import such material should contact DSEWPC directly for further information.

When undertaking risk analyses, DAFF consults with DSEWPC about environmental issues and may use or refer to DSEWPC's assessment.

Australian quarantine legislation

The Australian quarantine system is supported by Commonwealth, state and territory quarantine laws. Under the Australian Constitution, the Commonwealth Government does not have exclusive power to make laws in relation to quarantine, and as a result, Commonwealth and state quarantine laws can co-exist.

Commonwealth quarantine laws are contained in the *Quarantine Act 1908* and subordinate legislation including the Quarantine Regulations 2000, the Quarantine Proclamation 1998, the Quarantine (Cocos Islands) Proclamation 2004 and the Quarantine (Christmas Island) Proclamation 2004.

The quarantine proclamations identify goods, which cannot be imported, into Australia, the Cocos Islands and or Christmas Island unless the Director of Animal and Plant Quarantine or delegate grants an import permit or unless they comply with other conditions specified in the proclamations. Section 70 of the Quarantine Proclamation 1998, section 34 of the Quarantine (Cocos Islands) Proclamation 2004 and section 34 of the Quarantine (Christmas Island) Proclamation 2004 specify the things a Director of Animal and Plant Quarantine must take into account when deciding whether to grant a permit.

In particular, a Director of Animal and Plant Quarantine (or delegate):

- must consider the level of quarantine risk if the permit were granted, and
- must consider whether, if the permit were granted, the imposition of conditions would be necessary to limit the level of quarantine risk to one that is acceptably low, and
- for a permit to import a seed of a plant that was produced by genetic manipulation – must take into account any risk assessment prepared, and any decision made, in relation to the seed under the Gene Technology Act, and
- may take into account anything else that he or she knows is relevant.

The level of quarantine risk is defined in section 5D of the *Quarantine Act 1908*. The definition is as follows:

> reference in this Act to a *level of quarantine risk* is a reference to:
>
> (a) the probability of:
>
> (i) a disease or pest being introduced, established or spread in Australia, the Cocos Islands or Christmas Island; and
>
> (ii) the disease or pest causing harm to human beings, animals, plants, other aspects of the environment, or economic activities; and
>
> (b) the probable extent of the harm.

The Quarantine Regulations 2000 were amended in 2007 to regulate keys steps of the import risk analysis process. The Regulations:

- define both a standard and an expanded IRA,
- identify certain steps, which must be included in each type of IRA,
- specify time limits for certain steps and overall timeframes for the completion of IRAs (up to 24 months for a standard IRA and up to 30 months for an expanded IRA),
- specify publication requirements,
- make provision for termination of an IRA, and
- allow for a partially completed risk analysis to be completed as an IRA under the Regulations.

The Regulations are available at www.comlaw.gov.au.

International agreements and standards

The process set out in the *Import Risk Analysis Handbook 2011* is consistent with Australia's international obligations under the SPS Agreement. It also takes into account relevant international standards on risk assessment developed under the International Plant Protection Convention (IPPC) and by the World Organisation for Animal Health (OIE).

Australia bases its national risk management measures on international standards where they exist and when they achieve Australia's ALOP. Otherwise, Australia exercises its right under the SPS Agreement to apply science-based sanitary and phytosanitary measures that are not more trade restrictive than required to achieve Australia's ALOP.

Notification obligations

Under the transparency provisions of the SPS Agreement, WTO Members are required, among other things, to notify other members of proposed sanitary or phytosanitary regulations, or changes to existing regulations, that are not substantially the same as the content of an international standard and that may have a significant effect on trade of other WTO Members.

Risk analysis

Within Australia's quarantine framework, the Australian Government uses risk analyses to assist it in considering the level of quarantine risk that may be associated with the importation or proposed importation of animals, plants or other goods.

In conducting a risk analysis, DAFF:

- identifies the pests and diseases of quarantine concern that may be carried by the good
- assesses the likelihood that an identified pest or disease would enter, establish or spread
- assesses the probable extent of the harm that would result.

If the assessed level of quarantine risk exceeds Australia's ALOP, DAFF will consider whether there are any risk management measures that will reduce quarantine risk to achieve the ALOP. If there are no risk management measures that reduce the risk to that level, trade will not be allowed.

Risk analyses may be carried out by DAFF's specialists, but may also involve relevant experts from state and territory agencies, the Commonwealth Scientific and Industrial Research Organisation (CSIRO), universities and industry to access the technical expertise needed for a particular analysis.

Risk analyses are conducted across a spectrum of scientific complexity and available scientific information. An IRA is a type of risk analysis with key steps regulated under the Quarantine Regulations 2000. DAFF's assessment of risk may also take the form of a non-regulated analysis of existing policy or technical advice. Further information on the types of risk analysis is provided in the *Import Risk Analysis Handbook 2011*.

Glossary

Term or abbreviation	Definition
Additional declaration	A statement that is required by an importing country to be entered on a phytosanitary certificate and which provides specific additional information on a consignment in relation to regulated pests (FAO 2009).
Appropriate level of protection (ALOP)	The level of protection deemed appropriate by the Member establishing a sanitary or phytosanitary measure to protect human, animal or plant life or health within its territory (WTO 1995).
Area	An officially defined country, part of a country or all or parts of several countries (FAO 2009).
Area of low pest prevalence	An area, whether all of a country, part of a country, or all parts of several countries, as identified by the competent authorities, in which a specific pest occurs at low levels and which is subject to effective surveillance, control or eradication measures (FAO 2009).
Biological Control Agent (BCA)	A natural enemy, antagonist or competitor, or other organism, used for pest control (FAO 2009).
Certificate	An official document which attests to the phytosanitary status of any consignment affected by phytosanitary regulations (FAO 2009).
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) (FAO 2009).
Control (of a pest)	Suppression, containment or eradication of a pest population (FAO 2009).
DAFF	The Department of Agriculture, Fisheries and Forestry, responsible for Australia's biosecurity policies.
Endangered area	An area where ecological factors favour the establishment of a pest whose presence in the area will result in economically important loss (FAO 2009).
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 (FAO 2009).
Establishment	Perpetuation, for the foreseeable future, of a pest within an area after entry (FAO 2009).
Fresh	Living; not dried, deep-frozen or otherwise conserved (FAO 2009).
Host range	Species capable, under natural conditions, of sustaining a specific pest or other organism (FAO 2009).
Import permit	Official document authorising importation of a commodity in accordance with specified phytosanitary import requirements (FAO 2009).
Import risk analysis	An administrative process through which quarantine policy is developed or reviewed, incorporating risk assessment, risk management and risk communication.
Infestation (of a commodity)	Official document authorising importation of a commodity in accordance with specified phytosanitary import requirements (FAO 2009).
Inspection	Official visual examination of plants, plant products or other regulated articles to determine if pests are present and/or to determine compliance with phytosanitary regulations (FAO 2009).
Intended use	Declared purpose for which plants, plant products, or other regulated articles are imported, produced, or used (FAO 2009).
Interception (of a pest)	The detection of a pest during inspection or testing of an imported consignment (FAO 2009).
International Standard for Phytosanitary Measures (ISPM)	An international standard adopted by the Conference of the Food and Agriculture Organization, the Interim Commission on phytosanitary measures or the Commission on phytosanitary measures, established under the IPCC (FAO 2009).
Introduction	The entry of a pest resulting in its establishment (FAO 2009).
Lot	A number of units of a single commodity, identifiable by its homogeneity of composition, origin etc., forming part of a consignment (FAO 2009).
National Plant Protection Organization (NPPO)	Official service established by a government to discharge the functions specified by the IPPC (FAO 2009).
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 (FAO 2009).

Term or abbreviation	Definition
Pathway	Any means that allows the entry or spread of a pest (FAO 2009).
Pest	Any species, strain or biotype of plant, animal, or pathogenic agent injurious to plants or plant products (FAO 2009).
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 (FAO 2009).
Pest free area (PFA)	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 (FAO 2009).
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 (FAO 2009).
Pest free production site	A defined portion of a place of production in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this conditions is being officially maintained for a defined period and that is managed as a separate unit in the same way as a pest free place of production (FAO 2009).
Pest risk analysis (PRA)	The process of evaluating biological or other scientific and economic evidence to determine whether an organism is a pest, whether it should be regulated, and the strength of any phytosanitary measures to be taken against it (FAO 2009).
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 (FAO 2009).
Pest risk management (for quarantine pests)	Evaluation and selection of options to reduce the risk of introduction and spread of a pest (FAO 2009).
Phytosanitary certificate	Certificate patterned after the model certificates of the IPPC (FAO 2009).
Phytosanitary measure	Any legislation, regulation or official procedure having the purpose to prevent the introduction and/or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests (FAO 2009).
Phytosanitary regulation	Official rule to prevent the introduction and/or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests, including establishment of procedures for phytosanitary certification (FAO 2009).
Polyphagous	Feeding on a relatively large number of hosts from different genera.
PRA area	Area in relation to which a pest risk analysis is conducted (FAO 2009).
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 (FAO 2009).
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 (FAO 2009).
Restricted risk	Risk estimate with phytosanitary measure(s) applied.
Spread	Expansion of the geographical distribution of a pest within an area (FAO 2009).
SPS Agreement	WTO Agreement on the Application of Sanitary and Phytosanitary Measures (WTO 1995).
Stakeholders	Government agencies, individuals, community or industry groups or organizations, whether in Australia or overseas, including the proponent/applicant for a specific proposal, who have an interest in the policy issues.
Systems approach(es)	The integration of different risk management measures, at least two of which act independently, and which cumulatively achieve the appropriate level of protection against regulated pests (FAO 2009).
Unrestricted risk	Unrestricted risk estimates apply in the absence of risk mitigation measures.

References

FAO (2004) *International Standards for Phytosanitary Measures (ISPM) no. 11: pest risk analysis for quarantine pests including analysis of environmental risks and living modified organisms*. Secretariat of the International Plant Protection Convention, Food and Agricultural Organization of the United Nations, Rome, Italy.

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