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Department of Agriculture, Fisheries and Forestry

Biosecurity

Final Risk Analysis Report for the release of *Eueupithecia cisplatensis* for the biological control of Parkinsonia (*Parkinsonia aculeata*)

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Cover image: *Eueupithecia cisplatensis* feeding on *Parkinsonia aculeata* (Courtesy: Dr Tim Heard, CSIRO Ecosystem Sciences).

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Figure 1 Map of Australia

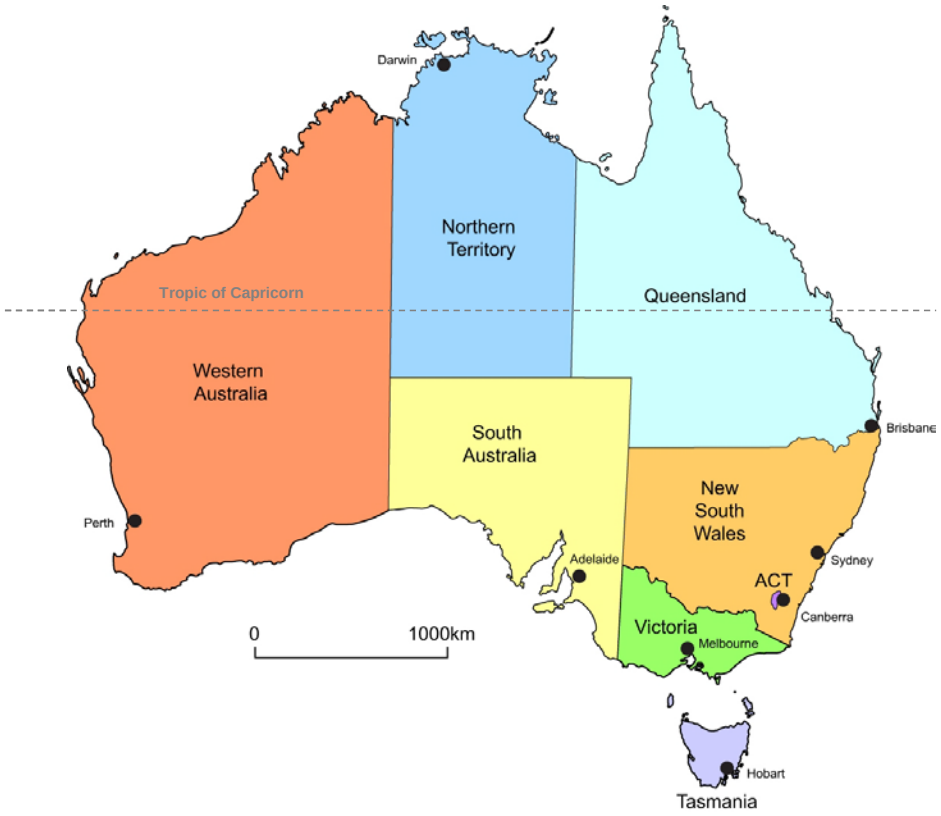
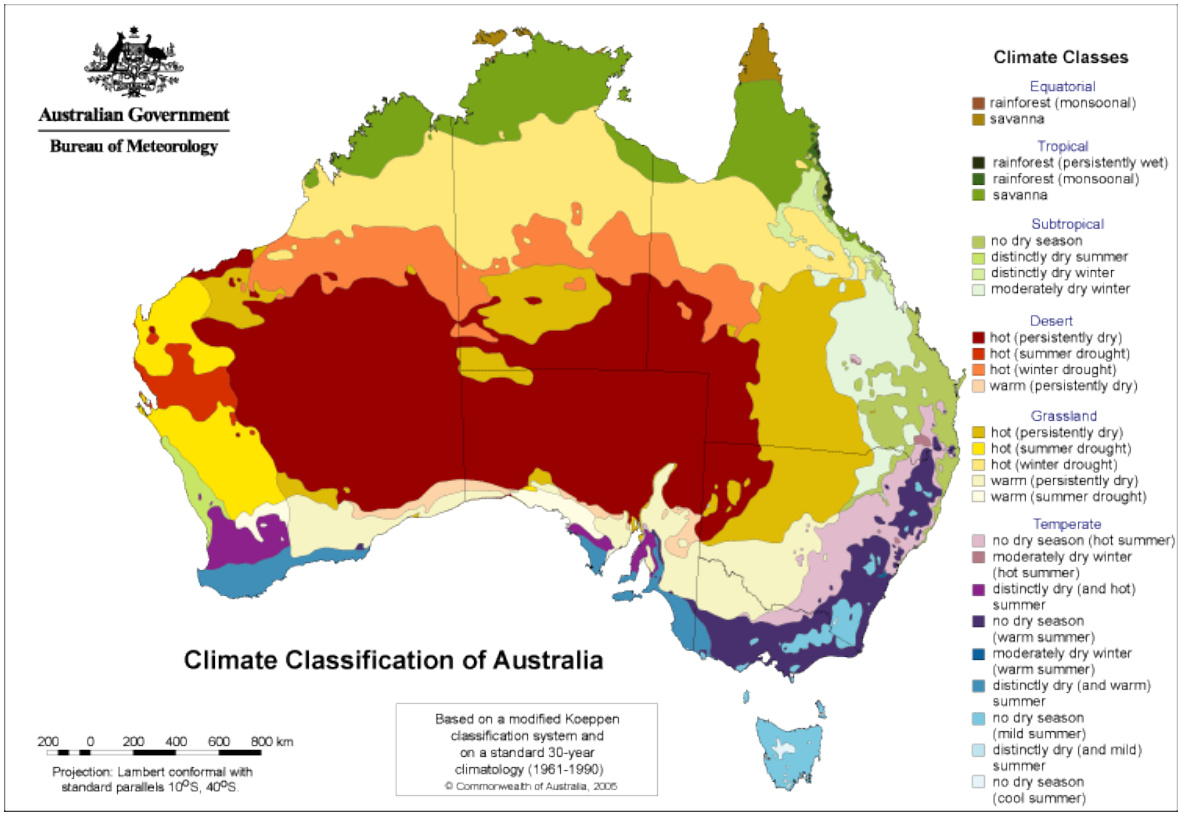


Figure 2 A guide to Australia's bio-climate zones



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 risk analysis finalises an application from CSIRO Ecosystem Sciences to release the geometrid moth *Eueupithecia cisplatensis* for the biological control of Parkinsonia (*Parkinsonia aculeata*). In accordance with the IRA handbook 2011, this risk analysis has been undertaken as a non-regulated analysis of existing policy.

This final risk analysis report recommends that the biological control agent should be released, subject to standard quarantine conditions associated with the import and release of biological control agents.

The report takes into account stakeholders' comments on the April 2012 draft risk analysis report. Comments were received from 7 stakeholders.

The Department of Sustainability, Environment, Water, Population and Communities (DSEWPC) also has an approval process for the import and release of biological control agents under the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*. There has been consultation with DSEWPC prior to the release of this report and it has endorsed the findings of this report.

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

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 Biosecurity, hereafter referred to as DAFF Biosecurity, by technical and scientific experts with consultation with appropriate scientific specialists. Consultation with stakeholders also occurs. DAFF Biosecurity 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 CSIRO Ecosystem Sciences to release a biological control agent (Appendix A). The biological control agent, *Eueupithecia cisplatensis* is a leaf defoliating caterpillar proposed for the biological control of Parkinsonia (*Parkinsonia aculeata*) (Leguminosae: Caesalpinioideae). 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 Biosecurity 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*.

Plants that are considered weeds are sometimes considered to have value. For example, as ornamental species, traditional medicine, feed for stock etc. Consideration of the benefits and therefore any concerns about eradication of the target weed species are out of scope of this analysis.

DAFF Biosecurity will not commence an assessment to release a biological control agent unless the target has been approved by an appropriate government body. *Parkinsonia aculeata* was approved as a target for biological control in Australia by The Australian Weeds Committee in 1983.

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 Biosecurity 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 18 April 2012, Biosecurity Advice (BA) 2012/08 informed stakeholders of the release of a draft risk analysis report for the release of *Eueupithecia cisplatensis* for the biological control of Parkinsonia (*Parkinsonia aculeata*). The draft report was also released at this time for a 60-

day stakeholder consultation period that closed on 18 June 2012. Written submissions received from 7 stakeholders were considered.

The Department of Sustainability, Environment, Water, Population and Communities also has an approval process for the import and release of biological control agents under the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*. There has been consultation with DSEWPC prior to the release of this report and it has endorsed the findings of this report.

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 Biosecurity 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 environment 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 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

Compilation of the host test list, followed an acceptable methodology. Host specificity testing was sufficiently extensive and included three methods:

- surveys of plant use in the native range
- testing of larval development on cut plant material in Argentina, and
- testing of larval development on live plant species in Australia.

The above processes are important in establishing confidence that the outcomes of the host testing indicate all possible off-target effects.

Results of host specificity testing

Of the plant species tested, significant feeding and the ability to complete a life cycle, only occurred on the target species, *Parkinsonia aculeata*. Adult emergence of 3% was also recorded on *Parkinsonia praecox* during testing in Argentina, however this species is not present in Australia. Host testing was carried out in Argentina on 27 legume plant species and in Australia on 40 legume plant species. Host testing was in the form of no-choice larval development tests. The applicant states in their report (Appendix A) that "our larvae died rather than feed on all test plant species except *P. aculeata*".

On the basis of the work presented in Appendix A it is concluded that the probability of off-target effects is: **VERY 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 the 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. Host testing was carried out in Argentina on 27 legume plant species and in Australia on 40 legume plant species. Of all the plant species tested, only the two parkinsonia *species* were able to support pupation and adult emergence (*P. praecox* only recorded 3% adult emergence). During no-choice testing in Argentina and Australia, no feeding (other than on the target plant) was recorded on any plant species tested. The target organism *Parkinsonia aculeata* is the only naturalised parkinsonia *species* in Australia and there are no indigenous species of this group present in Australia.
Other aspects of the environment	**Impact score**: A There is no known evidence of any negative impact caused by *E. cisplatensis* within its native range.
Indirect	
Eradication, control etc.	**Impact score**: A *Eueupithecia cisplatensis* is proposed for release for the biological control of the weed parkinsonia and testing has shown it to be very host specific. As it is host specific on parkinsonia, 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 *Eueupithecia cisplatensis* is host specific to the weed parkinsonia and is not a pest of crop plants. Therefore impacts on domestic trade would not be expected.
International trade	**Impact score**: A *Eueupithecia cisplatensis* is host specific to the weed parkinsonia and is not a pest of crop plants. Therefore impacts on international trade would not be expected.
Environmental and non-commercial	**Impact score**: A As the only direct effects of *E. cisplatensis* are on the introduced species *Parkinsonia aculeata*, this species is not likely to have any negative indirect environmental or non-commercial effects. Reduction of the weed parkinsonia is unlikely to have any deleterious indirect effects on the environment. Indirect effects are likely to be positive.

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 **very 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. Recommendation on release

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

5. Stakeholder responses to draft risk analysis report

Written submissions were received from 7 stakeholders. All stakeholders supported the release of *Eueupithecia cisplatensis* into the Australian environment;

- Queensland Department of Agriculture, Fisheries and Forestry (Jack Noye, Director-General)
- Department of Primary Industries Victoria (Hugh Millar, Executive Director, Biosecurity Victoria)
- New South Wales Department of Primary Industries (Bruce Christie, Executive Director Biosecurity NSW & John Hosking, Senior Entomologist)
- Tasmania Department of Primary Industries, Parks, Water & Environment (Andrew Bishop, Manager - Biosecurity & Plant Health)
- Western Australia Department of Agriculture and Food (DAFWA) and Department of Environment and Conservation (DEC) (Rob Delane, Director General, DAFWA)
- Northern Territory Department of Resources (Stephen West, Chief Plant Health Manager)
- Department of Primary Industries and Regions SA (Greg Baker, Principal Entomologist, South Australian Research & Development Institute (SARDI))

Therefore the risk analysis has not been altered from the draft recommendation to release *Eueupithecia cisplatensis.*

Appendices

A. Application to release the defoliating caterpillar *Eueupithecia cisplatensis* (Lepidoptera: Geometridae) for the biological control of the weed *Parkinsonia aculeata* (Leguminosae: Caesalpinioideae)

B. Pest risk analysis methodology

C. Biosecurity Framework

Appendix A Application to release the defoliating caterpillar *Eueupithecia cisplatensis* (Lepidoptera: Geometridae) for the biological control of the weed *Parkinsonia aculeata* (Leguminosae: Caesalpinioideae)

Application to release the defoliating caterpillar *Eueupithecia cisplatensis* (Lepidoptera: Geometridae) for biological control of the weed *Parkinsonia aculeata* (Leguminosae: Caesalpinioideae)

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Figure 1 Eight larvae, seven green one brown, of *Eueupithecia cisplatensis* on a damaged Parkinsonia leaf, most of the pinnules have been removed from the leaves and rasping of the leaf surface is visible on the leaf at the bottom

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1. Summary

Parkinsonia aculeata (Leguminosae: Caesalpinioideae) is a shrub or tree from the Americas that can form dense thorn thickets that impact negatively on both environment and the pastoral industry in rangeland Australia. It is recognised as one of twenty worst weeds in Australia (Thorp and Lynch 2000) and has been declared in all states and territories. The Australian Weed Committee approved *P. aculeata* as a target for biological control in Australia in 1983 (Donnelly 2000).

The defoliating caterpillar, *Eueupithecia cisplatensis* Prout, has been identified as a potential biocontrol agent of *P. aculeata*. Preliminary studies on its biology and host specificity made in Argentina, in the field and in laboratory conditions, strongly indicated fidelity to *P. aculeata*. It was then imported into an Australian quarantine where testing was completed on a broad range of plant species, particularly native Australian caesalpinioids, selected on the basis of phylogeny. Excluding *P. aculeata*, a total of 67 plant species were tested, 40 in Australia and 27 in Argentina.

This species has proven to be entirely host specific to *P. aculeata*. In laboratory tests, full development to adult occurs consistently on *P. aculeata* with a high rate of success (average of 61% in Argentina and 56% in Australia). But no development past the first instar occurred on any test plant species with the exception of was the closely related *Parkinsonia praecox* on which a very low rate of development (3%) was measured. No feeding occurred on any test plant species other than *P. praecox* and hence no damage was observed on non-target species. However, even *P. praecox* was not found to be used by *E. cisplatensis* in the field in the native range.

We conclude that the level of risk associated with releasing *Eueupithecia cisplatensis* into the Australian environment is acceptable and that it will potentially be an effective biological control agent for *P. aculeata*. We seek permission for its release in Australia.

2. Information on target species, *Parkinsonia aculeata*

2.1. Taxonomy

2.1.1. Botanical name

Parkinsonia aculeata L.

2.1.2. Common name

The plant is usually referred to as parkinsonia in Australia and Mexican palo verde and retama in the American literature. However, overseas it has many local names, including Jerusalem thorn, blue palo verde, horse bean tree, sessaban and Barbados flower fence (Hawkins 2001).

2.1.3. Relationships

Parkinsonia aculeata belongs to the family Leguminosae, subfamily Caesalpinoideae, tribe Caesalpinieae. Relationships of the monophyletic Leguminosae to other Angiosperms is still unclear with several families having been proposed as related, but more recent and well supported studies place Surianaceae and Polygalaceae as sister groups (Woyciechowski 2003). Relationships between caesalpinioid genera of the Leguminosae are also unresolved (Herendeen 2003), but the *Peltophorum* group, to which *Parkinsonia* belongs, is strongly supported as monophyletic. The *Peltophorum* group includes *Peltophorum*, *Parkinsonia*, *Delonix*, *Colvillea* and *Schizolobium* (Haston *et al*. 2005). The only member of the *Peltophorum* group native to Australia is *Peltophorum pterocarpum.* The genus *Parkinsonia* is considered to be congeneric with the paraphyletic Central American genus *Cercidium* (Hawkins *et al.* 2007). *Parkinsonia aculeata* is the only *Parkinsonia* species known to have naturalized in Australia. *Parkinsonia aculeata* is easily delimited morphologically from all other *Parkinsonia* species (Hawkins 2001); however, considerable intra-specific genetic variation occurs across its distribution in the native range. More information on the relationships is given in the section “The test plant list”.

2.2. Description

P. aculeata is readily identified in Australia by its smooth, green bark, very distinctive pendulous leaves with minute, easily-shed pinnules, bright yellow, five-petalled flowers, and pods which are straw-coloured when mature and contain 1-11 seeds (Figure 2). Adults typically grow to 5-7 m tall and wide (van Klinken *et al*. 2009a).

a)

b)

c)

d)

e)

Figure 2. *Parkinsonia aculeata* in Australia: leaves (pinnae and pinnules) and thorns (a); flowers b); mature pods c) adult plant in flower d); large infestation in wetlands of the Queensland Gulf Region (e). (Source: Nathan March, Biosecurity Queensland).

2.3. Distribution

2.3.1. Native Range

Parkinsonia aculeata is native to the Neotropics. Species level and infra-specific phylogenies have been reconstructed using three chloroplast gene regions, and amplified fragment length polymorphism markers (Hawkins *et al*. 2007). Several genetically distinct populations of *P. aculeata* have been identified across the Americas: (1) northern and western Mexico, south-

western USA and Cuba; (2) eastern and southern Mexico and south-eastern USA; (3) Venezuela; (4) Central America; and (5) Argentina. The Argentine lineage (5) is estimated to have diverged from other lineages (1-4) c. 9.1 million years ago, and the northern Mexico lineage (1) from the Mesoamerican-Venezuelan lineages (2-4) c. 5.2 million years ago (both pre-dating formation of the Isthmus of Panama) (Hawkins *et al*. 2007). Additional divergent populations may exist in South America, but these have not been analysed genetically.

2.3.2. Australian Range

The distribution of *P. aculeata* has been mapped nationally on a 50 x 50 km grid, mainly through existing distributional records held by state departments and through expert knowledge (Figure 3). When considered at that grid scale, *P. aculeata* is now estimated to be present on over 3.3 million ha of Australia, although densities are very low throughout most grid cells (van Klinken et al 2009a).

Most infestations occur across semi-arid and semi-humid Australia, especially in central and north Queensland, the Barkly Region and the Victoria River District of the Northern Territory, and the Kimberley and Pilbara Regions of Western Australia. Although it is widespread in these regions, dense patches are associated primarily with flood-outs, water infrastructure (such as “turkey nests”), water courses and the edges of seasonally-flooded fresh-water wetlands. Elsewhere in Australia records are mostly of isolated plants, or relatively restricted, scattered infestations (van Klinken et al 2009a).

The potential distribution in Australia is much greater than the current. Much of northern and eastern Australia is probably climatically suitable for *P. aculeata*, provided adequate soil moisture is available, with conditions being optimal in Central Queensland (van Klinken et al 2009a). On the broad scale *P. aculeata* has probably naturalized in the majority of suitable catchments. Within catchments *P. aculeata* is generally very sparsely and/or locally distributed, but there is little doubt that *P. aculeata* will continue to spread through the wetter habitats within its current range. Special efforts are currently underway to prevent its spread into Cape York Peninsula, the Lake Eyre and Murray Darling basins in Queensland and the blue-bush (*Maireana* spp.) swamps in the Barkly Tablelands (Deveze 2004).

Climate change is expected to result in a southward extension of highly suitable areas in eastern Australia as a result of reduced cold stress (van Klinken et al 2009b). Also, in south-west Australia it is expected that there will be improved growing conditions and reduced cold-wet stress. Reduced rainfall is expected to result in the northern (tropical) interior becoming less suitable, while increased rainfall is expected to increase the suitability of much of Australia.

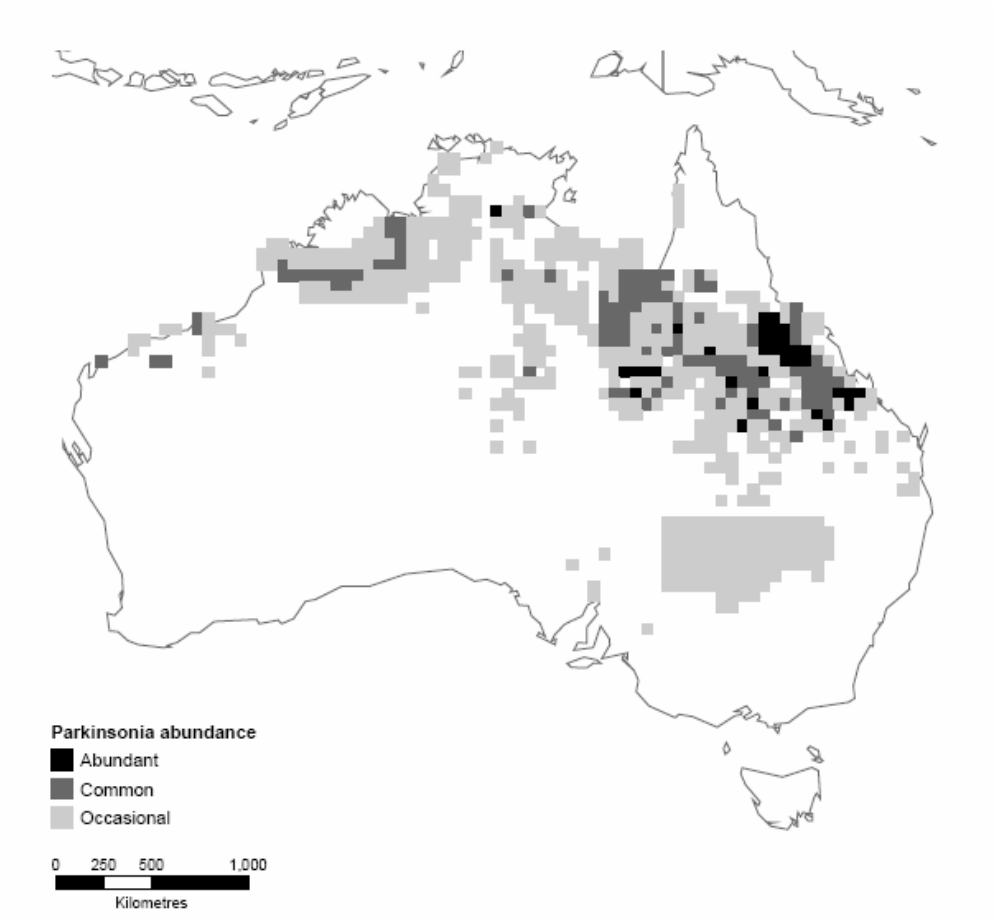

Figure 3. Current distribution and abundance of *P. aculeata* in Australia. Source: Queensland Biosecurity.

2.4. Ecology

Parkinsonia aculeata has an outstanding ability to survive and grow under a wide range of environmental conditions (Hughes 1989). This includes arid regions to wet-dry tropical regions, with annual rainfall typically ranging between 250 and 1400 mm. Plants probably rarely live more than 20-30 years (van Klinken et al. 2009a). They can produce large numbers of seeds, which are mostly dispersed either by flood waters within floating pods, or become incorporated into the seed bank under or adjacent to parent trees. Seeds are hard-seeded and are released from dormancy by "wet heat" (van Klinken and Flack 2005; van Klinken et al. 2006; 2008). Populations are typically very dynamic as a result of often rare major recruitment events and a wide range of mortality factors, including dieback putatively caused by a suite of soil-borne pathogens (Toh et al. 2008; Diplock et al. 2006, 2008; Toh 2009; van Klinken et al. 2009a), severe frosts, fires, and browsing by macropods or sheep (van Klinken et al. 2009a). In fact most of the 23 initially healthy populations monitored across Australia since 1999-2000 have subsequently declined in adult density, and local extinctions are probably common (van Klinken et al. 2009a). Browsing by sheep, goats and other livestock (generally not cattle) is likely to be an important factor preventing invasions in other countries.

2.5. Importance

Parkinsonia aculeata is an example of a plant that is both weedy and beneficial; however, in Australia its negative aspects far outweigh any actual or potential benefits.

2.5.1. Beneficial

Parkinsonia aculeata is widely used as an ornamental in dry areas throughout the Americas because of its spectacular bright yellow flowers; however, it is not generally considered to produce particularly valuable or high quality products (Hawkins 2001). Uses include hedges, windbreaks, shade, fuel (firewood and charcoal), paper-making and low quality fodder (Hawkins 2001). Although wood can be used for carpentry, it is brittle and of dubious durability (Stewart *et al*. 1992). *Parkinsonia aculeata* has been used in folk medicine (Barbosa and Prado 1991). Leaves, when made into an infusion, are considered in some areas to have medicinal and antiseptic properties and the infusion has been used to treat fevers, epilepsy and vomiting (Stewart *et al*. 1992, Hawkins 2001). Raw seeds have been used as a food source by humans in Mexico, children have been reported to eat flowers and seeds in West Africa, and seeds have been investigated as a minor food source in India (Hawkins 2001).

The fodder value of *P. aculeata* pods and foliage varies, and reports range from it being rarely eaten by livestock or wildlife (Everitt 1983) to being a potentially important fodder tree (MacDicken and Brewbacker 1984, Stewart *et al*. 1992, Hawkins 2001). It appears to be consumed by cattle only in times of shortage (Stewart *et al*. 1992), such as late in the dry season (Anon 1972, Deveze 2004, p. 35, 45); however, it is browsed by sheep, goats and camels and, in some parts of the world, branches are lopped during dry periods to feed sheep and goats (Hawkins 2001).

Parkinsonia aculeata has been introduced pantropically, primarily as an ornamental, hedging and fodder tree (Stewart *et al*. 1992, Woods 1988, Hawkins 2001). In addition, its tolerance to drought, waterlogging and saline conditions has meant that it has often been promoted for rehabilitation and as a multi-purpose tree, particularly in harsh, degraded or marginal land (Hughes 1986, Hawkins 2001). It has been used for reforestation programs in several countries, including India, Sudan and Cape Verde (Hughes 1989) and continues to attract attention as a candidate for the reforestation of degraded environments. However, its usefulness can be limited by its weedy tendencies (Hughes 1989). In Australia *P. aculeata* appears to have been planted mainly as an ornamental and shade tree.

2.5.2. Detrimental

Most of the detrimental effects of *P. aculeata* stem from its propensity to form dense, thorny, impenetrable thickets along drainage lines, depressions, ephemeral wetlands and, to a lesser extent, uplands across a large part of Australia. These are of both of environmental and economic significance.

The greatest environmental impact is probably through the exclusion of the herbaceous layer (van Klinken 2006). *Parkinsonia aculeata* trees are relatively shallow-rooted, but they may shorten the duration that ephemeral water bodies hold water. Dense patches are rarely greater than 1 ha so impacts on biodiversity are likely to be localised and limited to the infestation site (van Klinken 2006). At greatest risk are climatically suitable mesic habitats in arid and semi-arid regions, such as wetlands on the Barkly Tablelands (Northern Territory), wetlands

and gorges in the Pilbara Region (Western Australia) (van Klinken 2006) and waterbird habitats of national significance across its potential distribution (Humphries *et al*. 1991).

In production systems *P. aculeata* can also replace pasture, but existing infestations probably do not occur at a sufficient scale to cause significant and widespread reductions in carrying capacities (van Klinken 2006). Thicket formation does, however, interfere with stock management, impedes stock access to water, makes the maintenance of water points difficult and provides refuge for feral pigs (Deveze 2004). Both the formation and control of thickets may also exacerbate erosion problems (Wilson and Miller 1987). Thorns may injure hooves of animals and affect leisure and recreational activities, while its flowers are known to cause hay fever (Wilson and Miller 1987; Deveze 2004).

Although *P. aculeata* is already widespread in Australia, existing infestations are not yet of sufficient scale to cause substantial production losses at the property scale or to cause catchment or regional scale environmental impacts. Most of the direct costs are related to increased property management costs, especially in relation to mustering, accessing water points and maintaining vehicle tyres, and on-ground control work to prevent *P. aculeata* from becoming a more serious problem. Costs to Australia will increase dramatically if *P. aculeata* continues to spread and thicket formation continues. However, actual and potential impacts have not been quantified.

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

Parkinsonia aculeata has been declared in all states and territories other than Victoria, Tasmania and the Australian Capital Territory (Deveze 2004). In Queensland it is classified as a Class 2 declared pest (landholders must take reasonable steps to keep land free of the weed; it is also prohibited to introduce, feed, keep, release, take for commercial use, supply or transport). In the Northern Territory the species is classified as Category B (growth and spread to be controlled). In Western Australia it is declared as P1 (prevention of trade, sale or movement), P2 (eradicate) or P4 (contain) according to districts. In New South Wales it is declared in Category W1 (presence must be notified to the local control authority and the weed must be fully and continuously suppressed and destroyed). In South Australia *P. aculeata* is notifiable throughout the state, and plants must be destroyed.

2.7. When the target species was approved for biological control

The Australian Weed Committee approved *P. aculeata* as a target for biological control in Australia in 1983 (Donnelly 2000).

3. Information on the potential agent *Eueupithecia cisplatensis*

3.1. Taxonomy

Eueupithecia cisplatensis Prout 1910 (family Geometridae) (Figure 4), identified by Geometridae specialist Dr. Axel Hausmann (Bavarian State Collection of Zoology, Munich, Germany).

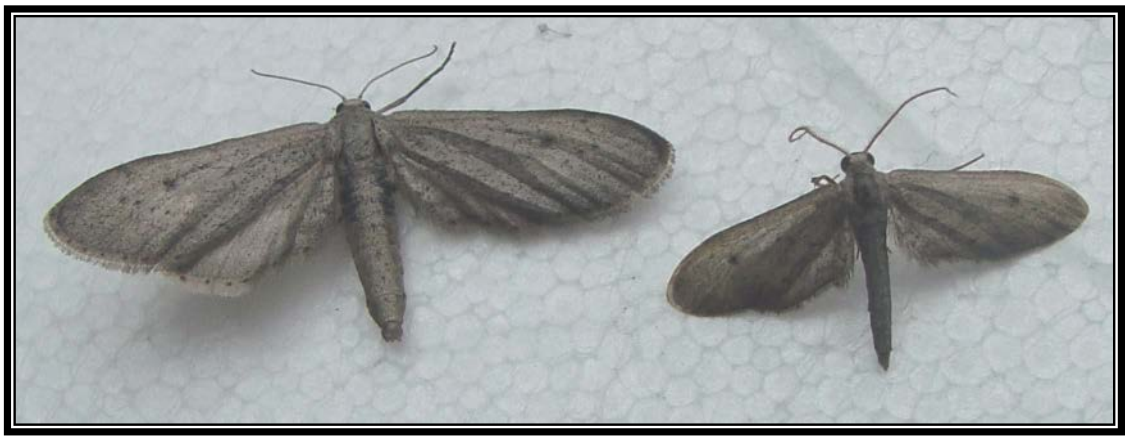

Figure 4. *Eueupithecia cisplatensis*, female left and male right

Eueupithecia cisplatensis is placed into subfamily Sterrhinae, tribe Sterrhini (see Differential diagnosis below). The Geometridae and all recognized subfamilies are monophyletic (Sihvonen et al. 2011). Also the phylogeny of the Sterrhinae subfamily revealed good support for the subfamily Sterrhinae and the tribe Sterrhini (Sihvonen and Kaila 2004). The tribe Sterrhini consists of approximately 825 species distributed in the following genera: *Anthometra, Arcobara, Brachyglossina, Cleta, Emmiltis, Epicleta, Euacidalia, Eueupithecia, Eumacrodes, Eupithecidia, Idaea, Limeria, Lobocleta, Lophophleps, Odontoptila, Protoproutia, Ptychamalia* and *Tineigidia* (Sihvonen and Kaila 2004).

Parsons et al. (1999) included only one species (*E. cisplatensis*) in the genus *Eueupithecia*. However, Dr Axel Hausmann recently identified a second cryptic species. This species shows striking differences in female and male genitalia and CO1 gene sequence (Table 1). The CO1 barcode gene differs by 4%, an amount that normally indicates another species. But no significant and constant differential features in colour or pattern of adults or larvae have been found. The second species is less common than *E. cisplatensis* and is so far only known from the north western Salta Province of Argentina. Further work is needed to confirm that this second species has not previously been described under the closely related *Euacidalia* genus, the latter including 12 described neotropical and nearctic species.

All testing in Australia was conducted on a pure colony of *E. cisplatensis*, as confirmed by genitalia dissections. Many provenances were used for Argentinean testing. All insects subsampled for identification were *E. cisplatensis*, although it is possible that a small number of undetected individuals of the new species could have been present among the test material.

Table 1. Differential features between the two *Eueupithecia* species collected on *Parkinsonia aculeata*.

	E. cisplatensis	*Eueupithecia* new species
Female genitalia	Length of corpus bursae 1.6 mm, posterior 1/2 sclerotized, slightly folded only	Length of corpus bursae 2 mm, posterior ¾ strongly sclerotized and strongly folded laterally.
Male genitalia	Aedeagus with large basal cornutus (half length of aedeagus) and a smaller, but stout, hook-shaped cornutus at tip. Aedeagus slender, width 0.15 mm.	Aedeagus with one cornutus only. Aedeagus very broad, width 0.4 mm.
Size of adults	On average smaller, wingspan 15-20 mm	On average larger, wingspan 20-25 mm

3.2. Description

The following is a description of the genus *Eueupithecia* obtained by Dr Axel Hausmann (pers. comm. 2011):

Tongue very short. Palpi very small, tapering, last two segments narrow, length 0.6 times diameter of eye in male, 0.8-1.0 times diameter of eye in female. Frons black, flat, smoothly scaled. Antennae filiform, in female with scarce and very short ciliation, in male ciliate-fasciculate, cilia strongly curved, length 2.5 times width of flagellum. Male hindtibia shortened, without spurs, with weak pencil. Female frenulum developed as a long, single stout bristle, appressed without retinaculum in the fold of the anal vein of the forewing (unknown in any other Geometridae, all other female geometrids have a brush of setae, if they have a frenulum). Hindwing Sc+R1 and Rs+M1 with long anastomosis, ca 2/3 length of cell. M2 much closer to M1 than to M3. Forewing with one single areole. Fore- and hindwing elongate and very narrow, discal spots conspicuous, postmedial line dotted. Hindwings of both sexes with setose lobes at the inner termen. Tympanum with ansa narrow at base, dilated at centre, rounded at tip.

Male genitalia: Small. Uncus single, digitiform. Valvae simple, long spatulate. Saccus very small. Aedeagus with cornuti. Sternum A8 simple, without latero-posterior appendages (cerata).

Female genitalia: Ovipositor with additional ventrolateral ovipositor-lobes. Apophyses fine, comparatively short. Ductus bursae very short. Corpus bursae with posterior part strongly sclerotized. Signum absent.

Synapomorphies: Female frenulum; hindwing anastomosis (Sc, Rs+M1).

Differential diagnosis: Genitalic features (male: uncus, valvae, saccus, cornuti, absence of appendages from sternum A8; female: ovipositor-lobes, sclerotisation of corpus bursae, absence of signum) clearly indicating a position in the tribe Sterrhini. The structure of female frenulum is unique in Geometridae and allows separation from *Idaea*. An isolated lineage of genus *Eueupithecia* with position between Cyllopodini and Semaeopus resulting from COI NJ analysis of neotropical Sterrhinae, but when excluding the (variable) third codon position, the genus falls within the clusters of the tribe Sterrhini. Tympanum is typical for Sterrhinae. The long hindwing anastomosis an extremely rare character in Sterrhinae (but characteristic for

Larentiinae). The asymmetric position of hindwing median veins also unusual for Sterrhinae (characteristic for Geometrinae). The eremic species *Idaea volloni* in external appearance and in the long anastomosis of hindwing veins Sc and Rs+M1 (very unusual in Sterrhinae) very similar to *Eueupithecia*, but female frenulum developed as a brush of setae and genitalia of both sexes completely different. The great external similarity, therefore, is probably just a convergence.

Remarks: Both the long vein-anastomosis in the hindwing and the modified female frenulum may be an advantage for wing stability and flight in moths with long and narrow wings.

3.3. Brief biology of the agent

Experiments were conducted in Argentina in controlled environment chambers at 25±1°C and 60±5% relative humidity, with a 14:10 L:D photoperiod. Cultures of *E. cisplatensis* were established in the laboratory from 50 larvae collected in February 2009 on *P. aculeata* plants growing near La Plata, Buenos Aires Province (60 km south of Buenos Aires city).

Newly hatched larvae were fed bouquets of freshly excised leaves of *P. aculeata* and reared individually in 0.5-liter plastic jars with perforated lids and moist tissue paper. Head capsule width was measured to establish the number and the duration of larval instars. The duration of the pupal stage was also recorded.

Adult longevity and fecundity were estimated from eight pairs of newly emerged *E. cisplatensis*. Each pair was kept in 3-litre plastic jars with moist tissue paper containing bouquets of excised fresh leaves of *P. aculeata*. Every day, bouquets were replaced and eggs removed and counted. A replicate ended when the female died; if the male died first it was replaced. For each replicate, the pre-oviposition period, total number of eggs and longevity of females were recorded.

Brown cylindrical eggs, approximately 0.3 mm in length, are usually laid individually or in strings on the leaflets (Figure 5). The eggs hatch and larvae begin to feed about 5 days after eggs were laid. Body colour of larvae changes progressively from light brown-greenish in the early instars to green-purple in the later instars (Figure 6) mimicking leaf rachises and young shoots. As larvae develop, they eat most of the pinnules and parts of the rachises. The reduced number of prolegs results in the larvae progressing with a looping motion, hence the common name loopers.

Figure 5. Strings of brown eggs of *Eueupithecia cisplatensis* on *Parkinsonia aculeata* leaf.

Figure 6. Two larvae of *Eueupithecia cisplatensis* on *Parkinsonia aculeata* leaf

Life stage duration. *E. cisplatensis* undergoes four larval instars. No overlapping was found in head capsule width ranges, therefore they can be used to distinguish the instars (Table 2). Larval mortality was greater during the first and second instars and the survival to the adult stage was 42 %. The duration of the stages was approximately: 5 days for eggs, 17 days for larvae, and 4 days for pupae.

Table 2. Life stage duration and larval head capsules width of *Eueupithecia cisplatensis* on *Parkinsonia aculeata.*

Stage	**n**	**Life stage duration (days)**		**Mortality (%)**	**Cumulative survival (%)**	**Head capsule width (mm)**	
		Mean ± SD	Range			Mean ± SD	Range
Larva 1st instar	43	5 ± 0.24	2-8	35	100	0.26 ± 0.01	0.23-0.26
Larva 2nd instar	28	3 ± 0.46	1-14	21	65	0.42 ± 0.03	0.33-0.42
Larva 3rd instar	22	4 ± 0.21	2-7	5	51	0.68 ± 0.0	0.62-0.72
Larva 4th instar	21	5 ± 0.28	3-9	0	49	1.04 ± 0.06	0.91-1.11
Larva total	21	17 ± 3.1	13-27	61	49	-	-
Prepupa	21	2 ± 0.11	1-2	0	49	-	-
Pupa	21	3 ± 0.11	3-15	14	49	-	-
Adult	18	4 ± 0.11	1-13	-	42	-	-

Female longevity and fecundity. Preoviposion period was 1.8 ± 0.6 days (mean ± SD; n = 6), fecundity was 78.8 ± 62.7 eggs (mean ± SD; n = 8) and the longevity of females was 6.9 ± 3.6 days (mean ± SD; n = 8) (Table 3). The female of pair n° 4, laid a total of 36 green coloured eggs. Previous observations indicate that occasionally, virgin females may lay a few similar green eggs, which never hatch. Based on these observations, we consider these green eggs to be unfertile. The rest of the pairs laid brown fertile eggs.

Table 3. Fecundity and female survival of *Eueupithecia cisplatensis* on *Parkinsonia aculeata*

N° of replicates (pairs)	**Female longevity (days)**	**Preoviposition period (days)**	**N° of eggs**
1	9	3	140
2	13	2	79
3	8	1	168
4	7	2	36[a]
5	2	-	0
6	7	2	117
7	7	1	90
8	2	-	0
Average	6.9	1.8	78.8

[a] green infertile eggs

Adult females are bigger than male, with a wider abdomen. The morphology of the antennae also shows sexual dimorphism: pectinate in the male and simple in the female (Figure 4).

Natural enemies. Two species of *Conura* (Hymenoptera: Chalcidoidea) emerged from cocoons, and probably parasitised the larvae.

3.4. Native range of the agent

Known from field surveys from Argentina and Paraguay only.

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

The genus *Eueupithecia* has only one member other than *E. cisplatensis*, which is yet to be described (see above). A study of the biology and host specificity of the latter is planned but as yet little is known except that we suspect it is also a specialist on *P. aculeata*. It is unknown which of the 18 genera in the tribe Sterrhini are closest to *Eueupithecia* (A. Hausmann, pers.comm.), so we are not in a position to summarize the host range of the related species. Preliminary analysis shows that the 825 species distributed in 18 genera in the tribe Sterrhini show a broad spectrum of host specificity, from extreme specialists to generalists.

3.6. The proposed source of the agent

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Cultures of the genetic material from Argentina that has been tested in Australian quarantine will be maintained and released if permission is granted.

3.7. Possible interactions with existing biological control programs (of same or related targets and other targets)

Three insect species have been released in Australia for biocontrol of *P. aculeata*. *Rhinacloa callicrates* (a sap-sucking mirid) and *Mimosestes ulkei* (a seed-feeding bruchid) were released in Queensland in 1993 (Julien and Griffiths 1998) and the Northern Territory in 1989 (Donnelly 2000) and 1994 (Flanagan *et al*. 1996), respectively. A third insect from Argentina, the seed-feeding bruchid *Penthobruchus germaini* Pic., was identified from the literature as a potential agent and was released in Australia from 1995 (Briano *et al*. 2002). *Rhinacloa callicrates* has established in Central Queensland but has never been observed to reach damaging densities there and did not establish in the Kimberley (Donnelly 2000). *Mimosestes ulkei* has established at relatively few sites and, where measured, the seed mortality rates have been low (Donnelly 1998, Lockett *et al*. 1999). It has not been reported in the past several years. In contrast, *Penthobruchus germaini* established easily, and dispersed readily (van Klinken and Flack 2008). *Penthobruchus germaini* passes through several generations a year, and oviposits primarily on pods on the tree (Briano *et al.* 2002, van Klinken 2005, van Klinken and Flack 2008). However, seed consumption rates were relatively low during a national survey conducted between 2000 and 2004 (van Klinken 2005, van Klinken and Flack 2008), and the agent is therefore unlikely to be causing any population-level impacts. Studies showed that beetle populations were unable to track sudden seasonal fluctuations in pod supply, resulting in a lag-phase between seed availability and beetle numbers. Also, high egg parasitism (10-70%) by a trichogrammatid wasp (*Uscana* sp.), is likely to be a key regulating factor through its effect on egg survival, and indirectly on adult densities. Existing agents therefore do not appear to be having a significant impact.

The proposed agents feed on vegetation tissue and therefore it is unlikely that they will interact with the existing agents.

3.8. The agent's potential for control of target

Leaf feeding by larvae of Geometridae reduces the total photosynthetic area of the plant causing reduction in vigour, growth rate and seed production. In the laboratory the larvae are voracious feeders and completely strip potted plants of all foliage. As the leaves of *P. aculeata* are undamaged in Australia, the potential for impact on the plant is great.

Geometrids have been used successfully in weed biocontrol programs. *Comostolopsis germana* damages shoot tips of bitou bush, *Chrysanthemoides monolifera,* in Australia (Adair and Scott 1989; Adair and Edwards 1996). It is widely established and causes obvious damage to bitou bush. *Aplocera plagiata* established on St John's wort (*Hypericum perforatum*) in Canada and USA but not in Australia (Julien and Griffiths 1998). The Geometridae *Chiasmia inconspicua* and *Chiasmia assimilis* from Kenya, were released in 2000 for biocontrol of *Acacia nilotica* in Queensland. *Chiasmia assimilis* is showing signs of damage to its host in coastal areas of Queensland - particularly the Bowen/Ayr region and is completely defoliating some plants which may lead to reduced flowering and pod production. *Macaria pallidata* and *Leuciris fimbriaria* were released in Australia for control of *Mimosa pigra*. Both have established and *Macaria pallidata* is inflicting heavy damage on the target plant.

3.9. Information on non-target organisms at risk from an agent

Our thorough host specificity testing (see below), predicts that no non-target plant species are at risk because the host range of *E. cisplatensis* is confined to *P. aculeata*.

3.10. Information and results of any other assessments undertaken on the species

None known. This is the first time that this insect has been assessed for biocontrol or any other purpose.

3.11. Report of host specificity testing

3.11.1. Introduction

The host specificity of *E. cisplatensis* was tested using three methods: 1 Surveys of plant use under natural condition in the native range; 2 Tests of larval development on cut plant material in Argentina; and 3 Tests of larval development on living plant species in Australian quarantine. All tests delivered the same result: complete specificity to one plant species, *P. aculeata*. Low rates of pupation were observed on another Parkinsonia species (P. praecox), but that species does not occur in Australia. Each of these tests is considered separately below. But first we discuss the test list which applies to the two latter tests.

3.11.2. The test plant list

The plant list for the Australian plants consists of 40 species from the legume family, in addition to *P. aculeata*. In addition, another 27 legume plant species were tested in Argentina. The list presented here was compiled according to the modern methods, primarily using

degrees of phylogenetic separation, based on published phylogenies (Bruneau et al. 2008, and references therein). This is discussed further below and presented in Table 4.

- The genus *Parkinsonia: Parkinsonia aculeata* is the only *Parkinsonia* species known to have naturalized in Australia and so no other species could be tested. Note, however, that *Parkinsonia praecox* was available in Argentina and was tested there.
- The group *Peltophorum* is a strongly supported monophyletic group that includes *Peltophorum, Parkinsonia, Delonix, Colvillea* and *Schizolobium* (Haston *et al*. 2005). The only member of the *Peltophorum* group native to Australia is *Peltophorum pterocarpum* which is on the list. *Peltophorum dubium* was also tested in Argentina. Also ornamental member of the group that are exotic to Australia was tested to help define the host range, including *Colvillea racemosa* in Australia and *Schizolobium parahybum* and *Delonix regia* in Argentina.
- The tribe Caesalpinieae is represented in Australia by *Erythropleum chlorostachys*, which was tested. There are several native *Caesalpinia* species which could not be obtained and so were replaced by *Caesalpinia pulcherrima* and *Caesalpinia ferrea*. The genus *Gleditsia* is represented in Australia by the exotic *Gleditsia triacanthos*, which was tested in Argentina, along with *Gleditsia amorphoides* in Argentina. The genus *Haematoxylum* is represented in Australia by the exotic *Haematoxylum campechianum*, which could not be obtained.
- The subfamily Caesalpinioideae. In addition to the tribe Caesalpinieae (above), members of the tribes Cassieae, Cercideae and Detarieae occur in Australia. Representatives of all these groups were included on the test list (Table 4 and 5).
- Fourteen species representing eleven of the tribes of the subfamily Papilionoideae were included.
- Nineteen species representing the three tribes of the subfamily Mimosoideae were tested. This subfamily contains the large and important tribe and genus *Acacia*. All of the sections of this important genus were represented (Tables 3 and 4) except Lycopodiifoliae which are very difficult to obtain and grow in cultivation.
- The legume family belongs to the Order Fabales. Traditionally this order contained only the Leguminosae, considered an isolated family. However a novel hypothesis in which the order Fabales contains also the families Quillajaceae, Surianaceae and Polygalaceae is emerging from recent molecular phylogenies (Stevens 2001 onwards). There is scant morphological support for these relationships (Bello et al. 2009). The Quillajaceae are a small family known only from temperate South America. Surianaceae is mostly Australian with two species of *Cadellia,* one species of *Guilfoylia,* one species of *Suriana* and three *Stylobasium* species. Polygalaceae contains several species of *Comesperma, Polygala* and *Salomonia*. Due to the high specificity of the insect being tested, the doubts over the relationships and the lack of morphological similarity, we did not include any non-legume species on the list.

Table 4. Numbers of test plant species in the taxonomic groups of the Leguminosae whether native or exotic to Australia and the number tested in Australian and Argentina

				Number of species:			
Subfamily	**Tribe**	**Group**	**Section**	**Native**	**Exotic**	**Tested Aust.**	**Tested Arg.**
Caesalpinioideae	Caesalpinieae	Peltophorum (*Parkinsonia*)		0	1	1	2
Caesalpinioideae	Caesalpinieae	Peltophorum (not *Parkinsonia*)		1	4	4	3
Caesalpinioideae	Caesalpinieae	Caesalpinia		10	2	2	3
Caesalpinioideae	Caesalpinieae	Dimorphandra		1	0	1	0
Caesalpinioideae	Caesalpinieae	Umtiza		0	1	0	2
Caesalpinioideae	Cassieae			81	15	9	2
Caesalpinioideae	Cercideae			7	1	2	1
Caesalpinioideae	Detarieae			4	2	4	0
Mimosoideae	Acaciae		Botrycephalae			1	1
Mimosoideae	Acaciae		Juliflorae			2	1
Mimosoideae	Acaciae		Phyllodineae			1	0
Mimosoideae	Acaciae		Plurinerves			1	0
Mimosoideae	Acaciae		Acacia			1	3
Mimosoideae	Ingeae					2	1
Mimosoideae	Mimoseae					2	3
Papilionoideae	Aeschynomeneae					1	0
Papilionoideae	Bossiaeeae					1	0
Papilionoideae	Desmodieae					1	0
Papilionoideae	Mirbelieae					1	0
Papilionoideae	Phaseoleae					1	2
Papilionoideae	Robinieae					1	0
Papilionoideae	Tephrosieae					1	0
Papilionoideae	Vicieae					1	0
Papilionoideae	Dalbergiae					0	2
Papilionoideae	Galegeae					0	1
Papilionoideae	Milletieae					0	1

After considering phylogeny, the test plant species were selected with regards to the biogeographic overlap with the target or the likely final distribution of the agent within the framework of phylogenetic separation. The concept of testing safeguard species of distant phylogenetic relatedness (Wapshere, 1974) has become redundant in most contexts, as such species do not contribute to the determination of host range (Briese and Walker, 2002; Briese, 2003; 2005). While preferential selection of economic or rare and threatened test plant species can be a useful criterion, providing they pass other selection criteria, systematically testing them is not relevant for risk analysis (Sheppard et al., 2005). As there is no plant on which congeners of the agent have been previously found to feed and reproduce, then this aspect did not result in inclusion of any further species. Taking all these factors into account, we arrived at the test list (Table 5). Such a relatively long list was considered necessary due to the size, diversity and importance of the legume plant family.

Table 5. The complete list of plant species subject to non-choice larval development host specificity tests in Australia and Argentina.

Subfamily	Tribe	group	Section	Genus/species	Tested
Caesalpinioideae	Caesalpinieae	Peltophorum		*Parkinsonia aculeata*	Argentina
Caesalpinioideae	Caesalpinieae	Peltophorum		*Parkinsonia aculeata*	Australia
Caesalpinioideae	Caesalpinieae	Peltophorum		*Parkinsonia praecox*	Argentina
Caesalpinioideae	Caesalpinieae	Peltophorum		*Peltophorum dubium*	Argentina
Caesalpinioideae	Caesalpinieae	Peltophorum		*Peltophorum pterocarpum*	Australia
Caesalpinioideae	Caesalpinieae	Caesalpinia		*Caesalpinia ferrea*	Australia
Caesalpinioideae	Caesalpinieae	Caesalpinia		*Caesalpinia gilliesii*	Argentina
Caesalpinioideae	Caesalpinieae	Caesalpinia		*Caesalpinia paraguariensis*	Argentina
Caesalpinioideae	Caesalpinieae	Caesalpinia		*Caesalpinia pulcherrima*	Australia
Caesalpinioideae	Caesalpinieae	Peltophorum		*Colvillea racemosa*	Australia
Caesalpinioideae	Caesalpinieae	Peltophorum		*Delonix regia*	Argentina
Caesalpinioideae	Caesalpinieae	Dimorphandra		*Erythrophleum chlorostachys*	Australia
Caesalpinioideae	Caesalpinieae	Umtiza		*Gleditsia amorphoides*	Argentina
Caesalpinioideae	Caesalpinieae	Umtiza		*Gleditsia triacanthos*	Argentina
Caesalpinioideae	Caesalpinieae	Caesalpinia		*Pterogine nitens*	Argentina
Caesalpinioideae	Caesalpinieae	Peltophorum		*Schizolobium parahybum*	Argentina
Caesalpinioideae	Cassieae			*Cassia brewsteri*	Australia
Caesalpinioideae	Cassieae			*Ceratonia siliqua*	Australia
Caesalpinioideae	Cassieae			*Chaemacrista mimosoides*	Australia
Caesalpinioideae	Cassieae			*Chaemacrista nomane*	Australia
Caesalpinioideae	Cassieae			*Labichea lanceolata*	Australia
Caesalpinioideae	Cassieae			*Petalostylis labicheoides*	Australia
Caesalpinioideae	Cassieae			*Senna artemisioides*	Australia
Caesalpinioideae	Cassieae			*Senna corymbosa*	Argentina
Caesalpinioideae	Cassieae			*Senna glutinosa*	Australia
Caesalpinioideae	Cassieae			*Senna notabilis*	Australia
Caesalpinioideae	Cassieae			*Senna spectabilis*	Argentina
Caesalpinioideae	Cercideae			*Barklya syringifolia*	Australia
Caesalpinioideae	Cercideae			*Bauhinia forficata*	Argentina
Caesalpinioideae	Cercideae			*Bauhinia hookeri*	Australia
Caesalpinioideae	Detarieae			*Cynometra ramiflora*	Australia
Caesalpinioideae	Detarieae			*Intsia bijuga*	Australia
Caesalpinioideae	Detarieae			*Maniltoa lenticillata*	Australia
Caesalpinioideae	Detarieae			*Schotia brachypetala*	Australia
Caesalpinioideae	Detarieae			*Tamarindus indica*	Australia
Papilionoideae	Aeschynomeneae			*Aeschynomene americana*	Australia
Papilionoideae	Bossiaeeae			*Hovea acutifolia*	Australia
Papilionoideae	Dalbergiae			*Geoffroea decorticans*	Argentina
Papilionoideae	Dalbergiae			*Tipuana tipu*	Argentina
Papilionoideae	Desmodieae			*Desmodium tortuosum*	Australia
Papilionoideae	Galegeae			*Sesbania virgata*	Argentina
Papilionoideae	Millettieae			*Lonchocarpus nitidus*	Argentina
Papilionoideae	Mirbelieae			*Pultenaea villosa*	Australia
Papilionoideae	Phaseoleae			*Cajanus cajan*	Australia
Papilionoideae	Phaseoleae			*Erythrina crista-galli*	Argentina
Papilionoideae	Phaseoleae			*Wisteria sinensis*	Argentina
Papilionoideae	Robinieae			*Sesbania cannabina*	Australia

			Millettia (=Pongamia) sp. McIlwraith	Australia
Papilionoideae	Tephrosieae			
Papilionoideae	Vicieae		*Vicia faba*	Australia
Mimosoideae	Acaciae	Acacia	*Acacia aroma*	Argentina
Mimosoideae	Acaciae	Acacia	*Acacia bidwillii*	Australia
Mimosoideae	Acaciae	Acacia	*Acacia caven*	Argentina
Mimosoideae	Acaciae	Botrycephalae	*Acacia dealbata*	Argentina
Mimosoideae	Acaciae	Botrycephalae	*Acacia decurrens*	Australia
Mimosoideae	Acaciae	Juliflorae	*Acacia disparrima*	Australia
Mimosoideae	Acaciae	Juliflorae	*Acacia julifera*	Australia
Mimosoideae	Acaciae	Juliflorae	*Acacia longifolia*	Argentina
Mimosoideae	Acaciae	Plurinerves	*Acacia melanoxylon*	Australia
Mimosoideae	Acaciae	Botrycephalae	*Acacia oshanesii*	Australia
Mimosoideae	Acaciae	Phyllodineae	*Acacia salicina*	Australia
Mimosoideae	Acaciae	Acacia	*Acacia visco*	Argentina
Mimosoideae	Ingeae		*Archidendron lucyi*	Australia
Mimosoideae	Ingeae		*Enterolobium contortisiliquum*	Argentina
Mimosoideae	Ingeae		*Pararchidendron pruinosum*	Australia
Mimosoideae	Mimoseae		*Anadenanthera colubrina var. cebil*	Argentina
Mimosoideae	Mimoseae		*Dichrostachys cinerea*	Australia
Mimosoideae	Mimoseae		*Leucaena leucocephala*	Australia
Mimosoideae	Mimoseae		*Prosopis alba*	Argentina
Mimosoideae	Mimoseae		*Prosopis chilensis*	Argentina

3.11.3. Surveys of plant use under natural condition in the native range

On three field trips to northern Argentina, over the summer of 2009/10 and 2010/11, eight sites in the provinces of Corrientes, Entre Ríos, Formosa, Salta and Chaco with populations of *P. aculeata* and four co-occurring legume species were sampled for presence of insects by beating foliage over a one square metre sheet (Figure 7). Immature insects were held in plastic containers and provided fresh leaves until the emergence of adults. Voucher specimens of plants and insects collected are maintained at the USDA-ARS-SABCL.

Along the eight sites visited, a total of 391 larvae of *E. cisplatensis* were collected on *P. aculeata* and reared to adult. No *E. cisplatensis* larvae were collected on any of the other surveyed *Acacia*, *Prosopis* or *Parkinsonia* species (Table 6). It is particularly instructive that *E. cisplatensis* was not found even on the conspecific *Parkinsonia praecox.* At the same sites, this species was consistently collected on *P. aculeata*. It is possible that some of the adults reared in this experiment belong to the recently newly identified cryptic species. This only has the effect of reducing the replication obtained for *E. cisplatensis* but not of changing the conclusion. In addition, larvae of *Melipotis acontioides* (Guenee) (Lepidoptera: Noctuidae) and *Macaria* sp. (Lepidoptera: Geometridae) were collected (Table 6).

Figure 7. USDA-ARS-SABCL researchers Marcelo Parisi and Fernando Mc Kay beating *P. aculeata* plants in northern Argentina

Table 6. Number of *Eueupithecia cisplatensis* and other Lepidoptera on various legume plants species from surveys of plant use under natural condition in the native range in Argentina

Date	**Locality**	**Province**	**Surveyed plant species**	**Beats**	***Eueupithecia cisplatensis***	***Melipotis acontioides***	***Macaria sp.***	**Unidentified Geometridae**
2009-12-03	RN° 14, Pucheta	Corrientes	*Parkinsonia aculeata*	50	44	0	0	0
2009-12-03	RN° 14, Cuatro Bocas	Corrientes	*Parkinsonia aculeata*	32	43	0	0	0
2009-12-03	RN° 14, Mocoretá	Corrientes	*Parkinsonia aculeata*	17	13	0	0	0
2009-12-03	RN° 14, Chajarí	Entre Ríos	*Parkinsonia aculeata*	46	195	0	0	0
2009-12-04	RN° Concepción del Uruguay	Entre Ríos	*Parkinsonia aculeata*	30	35	0	0	0
2010-03-20	RN° 81, 60 km NW Juarez	Salta	*Parkinsonia aculeata*	10	24	-	5	0
2010-09-26	RN° 81, 60 km NW Juarez	Salta	*Parkinsonia aculeata*	15	2	20	0	0
2010-03-23	RN° 95, near Fortín Lavalle	Chaco	*Parkinsonia aculeata*	10	35	-	0	0
2010-03-19	RN° 81, 8 km S Pozo d Mortero	Formosa	*Parkinsonia praecox*	10	0	-	29	0
2010-03-20	RN° 81, 60 km NW Juarez	Salta	*Parkinsonia praecox*	3	0	-	12	0
2010-09-26	RN° 81, 60 km NW Juarez	Salta	*Parkinsonia praecox*	10	0	15	0	0
2009-12-03	RN° 14, Pucheta	Corrientes	*Prosopis affinis*	2	0	0	0	2
2009-12-03	RN° 14, Cuatro Bocas	Corrientes	*Prosopis affinis*	8	0	2	0	3
2009-12-04	RN° Concepción del Uruguay	Entre Ríos	*Prosopis affinis*	4	0	0	0	0
2010-03-23	RN° 95, near Fortín Lavalle	Chaco	*Prosopis ruscifolia*	10	0	-	0	0
2009-12-03	RN° 14, Pucheta	Corrientes	*Acacia caven*	10	0	9	0	0
2009-12-03	RN° 14, Mocoretá	Corrientes	*Acacia caven*	5	0	1	0	0
2009-12-03	RN° 14, Chajarí	Entre Ríos	*Acacia caven*	10	0	1	0	0
2009-12-04	RN° Concepción del Uruguay	Entre Ríos	*Acacia caven*	5	0	0	0	0
2010-03-23	RN° 95, near Fortín Lavalle	Chaco	*Acacia caven*	10	0	-	0	0

3.11.4. Tests of larval development in Argentina

Laboratory no-choice larval survival was evaluated on 28 species of Leguminosae in the subfamilies Caesalpinioideae and Mimosoideae (Table 7). Plants were selected on the basis of taxonomic relatedness to *P. aculeata* and availability. The plants were a mix of species native to Argentina and introduced from other countries including two species of Australian *Acacia*. Experiments were carried out in controlled environmental chambers (25±2°C: 60-80% RH; 16:8 L:D).

In each replicate, 10 newly emerged larvae were placed in 0.7-liter plastic containers with perforated lids and moist tissue paper. The larvae were fed bouquets of freshly excised leaves of the test plant species, with their petioles inserted in small recipients filled with water. The bouquets were replaced every 48-72 hours as needed. Feeding damage and larval mortality were recorded daily until adult emergence. The various test plant species and the control plant (*P. aculeata*) were tested using insects of five different provenances (Table 7). Usually 10 replicates were performed for each plant species, although fewer were done for some plant species (last column in Table 7).

Table 7. The number of replicates of each plant species tested with the various provenances of *Eueupithecia cisplatensis* in Argentina

	The number of replicates (in table body) tested with the various provenances (in column header)					
Test plants	1*	2*	3*	4*	5*	Total
Order Fabales						
Family Fabaceae						
Sub Family Caesalpinioideae						
Tribe Caesalpinieae						
Group Peltophorum						
Parkinsonia aculeata	5	6	2	5	3	21
Parkinsonia praecox	10					10
Peltophorum dubium		3		6	1	10
Schizolobium parahybum	3				2	5
Delonix regia	4	1			5	10
Group Caesalpinia						
Caesalpinia gilliesii		3		6	1	10
Caesalpinia paraguariensis		10				10
Pterogine nitens		2	8			10
Group Umtiza						
Gleditsia amorphoides		2		7	1	10
Gleditsia triacanthos		10				10
Tribe Cassiae						
Senna corymbosa		3		6	1	10
Senna spectabilis		3		6	1	10

Test plants	The number of replicates (in table body) tested with the various provenances (in column header)					
	1*	2*	3*	4*	5*	Total
Tribe Cercideae						
Bauhinia forficate		3		6	1	10
Sub Family Mimosoideae						
Tribe Acaciae						
Acacia aroma	7	3				10
Acacia caven		1		8	1	10
Acacia visco		4		5	1	10
Acacia dealbata	10					10
Acacia longifolia	10					10
Tribe Ingeae						
Enterolobium contortisiliquum		5			5	10
Tribe Mimoseae						
Anadenanthera colubrina var. *cebil*			6			6
Prosopis alba		4		5	1	10
Prosopis chilensis	10					10
Sub Family Papilionoideae						
Tribe Dalbergiae						
Geoffroea decorticans	10					10
Tipuana tipu		10				10
Tribe Galegeae						
Sesbania virgata		4				4
Tribe Phaseoleae						
Erythrina crista-galli		10				10
Wisteria sinensis		4				4
Tribe Millettieae						
Lonchocarpus nitidus		10				10

*Detail on the various provenances used: 1. Plants tested in Jan 2010 with northern populations (Corrientes and Entre Ríos); 2. Plants tested in Oct 09 with northern populations (Formosa and Salta); 3. Plants tested in Nov 09 northern populations (Formosa and Salta); 4. Plants tested in Feb-Apr 09 with southern populations (La Plata, Buenos Aires); 5. Plants tested in Sep 2009 with northern populations (Formosa and Salta)

Voucher specimens at USDA-ARS-SABCL: 1♀ + 2♂ (Chajarí, Entre Ríos province); 6♂ (RN°14, km 455, Corrientes province); 4♀ + 5♂ (La Plata, Buenos Aires province); 1♂ + 1♀ (Yuchán, Salta Province).

Eueupithecia cisplatensis was able to complete larval development only on *P. aculeata* and *P. praecox*, with 61% and 3% of adult emergence recorded, respectively (Table 8). Larvae exposed to the other tested species died between 2-4 days of initiation of testing. No feeding occurred on any test plant species other than *P. praecox* and hence no damage was observed on non-target species.

Table 8. Results of no-choice larval survival tests on *Eueupithecia cisplatensis* in Argentina

Test plants	Replicates	Pupation (%)	Adult emergence (%)
Order Fabales			
Family Leguminosae			
Sub Family Caesalpinioideae			
Tribe Caesalpinieae			
Group Peltophorum			
Parkinsonia aculeata	**21**	**70 (20-100)**	**61 (20-100)**
Parkinsonia praecox	**10**	**6 (0-30)**	**3 (0-10)**
Peltophorum dubium	10	0	0
Schizolobium parahybum	5	0	0
Delonix regia	6	0	0
Group Caesalpinia			
Caesalpinia gilliesii	10	0	0
Caesalpinia paraguariensis	10	0	0
Pterogine nitens	10	0	0
Group Umtiza			
Gleditsia amorphoides	10	0	0
Gleditsia triacanthos	10	0	0
Tribe Cassiae			
Senna corymbosa	10	0	0
Senna spectabilis	10	0	0
Tribe Cercidae			
Bauhinia forficata	10	0	0
Sub Family Mimosoideae			
Tribe Acaciae			
Acacia aroma	10	0	0
Acacia caven	10	0	0
Acacia visco	10	0	0
Acacia dealbata	10	0	0
Acacia longifolia	10	0	0
Tribe Ingae			
Enterolobium contortisiliquum	10	0	0
Tribe Mimosae			
Anadenanthera colubrina var. *cebil*	6	0	0
Prosopis alba	10	0	0
Prosopis chilensis	10	0	0
Sub Family Papilionoideae			
Tribe Dalbergiae			
Geoffroea decorticans	10	0	
Tipuana tipu	10	0	0
Tribe Galegeae			
Sesbania virgata	4	0	0
Tribe Phaseoleae			
Erythrina crista-galli	10	0	0
Wisteria sinensis	4	0	0
Tribe Millettieae			
Lonchocarpus nitidus	10	0	0

3.11.5. Tests of larval development on living plants in Australian quarantine

3.11.5.1. Details on the quarantine facility and methods of containment

Initial studies were conducted in the Quarantine Insectary at CSIRO Long Pocket Laboratories, Indooroopilly, Brisbane. This was an AQIS approved facility (Approval Number is: Q0174, with classes of goods 95.4 Quarantine Insectary and 6.1 Closed Quarantine Facility for Medium Risk Nursery Stock). Precautions included HEPA air filtering, negative air pressure, filtering and chlorine treatment of waste water, air lock entrances, autoclaving or fumigation of waste materials.

On 2 March 2011, the colony was moved to our new premises, the Queensland EcoSciences Precinct QC3 Quarantine Facility for Containment of Arthropod and Pathogen Agents for Weed Biocontrol, situated at the EcoSciences Precinct, 41 Boggo Rd, Dutton Park, Brisbane, 4102. This is an AQIS approved facility, QAP No: Q2140, QC level: 5.3 and QIC level 7.3. All necessary movement permits were obtained. Precautions include double glazing of glasshouses, HEPA air filtering, negative air pressure, filtering and heat treatment of liquid waste, air lock entrances, autoclaving or fumigation of solid waste.

All staff are experienced quarantine operators who strictly follow AQIS approved guide-lines. A Standard Operating Procedures document for the facility is available upon request. All staff wear overalls, hairnets and booties when entering the laboratories which they remove before leaving the building. Insects are transported to the facility in sealed containers. Containers are unpacked in a specially designed unpacking room. Insects are held in cages in the laboratories, glasshouses or controlled environment rooms. Changes to new containers are done inside a walk-in cage. Method of disposal and treatment of refuse and packaging is by autoclaving or fumigation.

3.11.5.2. Materials and Methods

A shipment of approximately 200 eggs was received in Australian quarantine from a mix of locations in Argentina in February 2010. A colony was established which prospered for four generations from May until July 1010, providing adults which were used for host specificity testing in which between 1 and 4 replicates of 22 plant species were completed. The fifth generation of the lab colony was heavily affected by a *Nosema*-like microsporidian pathogen in August 2010. This invalidated the tests undertaken with this generation. The disease was severe and damaging to the colony, which took until December 2010 to recover following a strict hygiene regimen. The majority of remaining tests were done with the recovered colony in 2011. In April 2011, another shipment of 20 pupae from Argentina was imported and integrated into the quarantine colony to boost the genetic diversity generally and especially of genetic material from the north which was more closely climatically similar to the areas of *P. aculeata* infestation in Australia. The final tests done between June and August of 2011 used this mixed colony.

Laboratory no-choice larval survival was evaluated on 40 species of Leguminosae (Table 9). To obtain larvae for testing, eggs were collected from the colony and held in a petri dish until emergence of the neonate larvae. From these, 50 larvae were counted and placed on the foliage of an individual test plant species growing in a pot (Figure 8). The plants were held for larval development in an aluminium frame cage lined with gauze and measuring 250 x 250 x 800 mm or 250 x 250 x 500 mm depending on the size of the plant. The cages were kept in a quarantine glasshouse to allow plants to maintain good condition. Plants were monitored regularly and extra plants of the same species were added if the larval feeding depleted the original plant. Plants were held for an average of 47 days (range 28 to 69 days), by which time all adults had emerged from the *P. aculeata* control plant.

One *P. aculeata* control plant and a variable number of plants for each other test species were used in each trial. For validity, the survival and development of the immature stages to adult on the control plant had to be confirmed. For immature stage viability, the rate of the eggs that resulted in emerged adults on *P. aculeata* was set at 30%. This figure was somewhat arbitrarily set but allows the exclusion of the one trial where adult survival was low on the control plant. A total of 27 trials were done to complete the tests. For each plant species, different individual plants were used for each replicate throughout all trials. Initial studies showed that leaves of *P. aculeata* of all ages are suitable for larval development and so no special plant requirements were required concerning leaf age.

Figure 8. Andrew White transferring newly hatched larvae of *Eueupithecia cisplatensis* onto a plant during no-choice tests in an Australian quarantine

3.11.5.3. Results

The Australian no-choice tests showed a consistent failure of larvae of *E. cisplatensis* to develop on any plant species other than *P. aculeata* (Table 9). No feeding or damage was observed on any non-target test plant species.

Table 9. Results of laboratory no-choice larval survival tests on *Eueupithecia cisplatensis* in Australian quarantine. A replicate consisted of 50 larvae on one plant in one cage.

Subfamily / Tribe / Group / Section / Genus/species	Replicates	% adult emergence (range)
Caesalpinioideae		
Caesalpinieae		
Peltophorum		
Parkinsonia aculeata	**29**	**56% (34%-86%)**
Peltophorum pterocarpum	4	0
Colvillea racemosa	4	0
Caesalpinia		
Caesalpinia ferrea	4	0
Caesalpinia pulcherrima	4	0
Dimorphandra		
Erythrophleum chlorostachys	4	0
Caesalpinioideae		
Cassieae		
Cassia brewsteri	4	0
Ceratonia siliqua	4	0
Chaemacrista mimosoides	2	0
Chaemacrista nomane	4	0
Labichea lanceolata	4	0
Petalostylis labicheoides	4	0
Senna artemisioides	4	0
Senna glutinosa	4	0
Senna notabilis	4	0
Cercideae		
Barklya syringifolia	4	0
Bauhinia hookeri	4	0
Detarieae		
Cynometra ramiflora	4	0
Intsia bijuga	3	0
Maniltoa lenticillata	4	0
Schotia brachypetala	4	0
Tamarindus indica	4	0
Papilionoideae		
Aeschynomeneae		
Aeschynomene americana	4	0
Bossiaeeae		
Hovea acutifolia	4	0
Desmodieae		
Desmodium tortuosum	4	0
Mirbelieae		
Pultenaea villosa	4	0
Phaseoleae		
Cajanus cajan	4	0
Robinieae		

Subfamily / Tribe / Group / Section / Genus/species	Replicates	% adult emergence (range)
Sesbania cannabina	4	0
Tephrosieae		
Millettia sp. McIlwraith	4	0
Vicieae		
Vicia faba L.	4	0
Mimosoideae		
Acaciae		
Acacia		
Acacia bidwillii	4	0
Botrycephalae		
Acacia decurrens	4	0
Acacia oshanesii	4	0
Juliflorae		
Acacia disparrima	4	0
Acacia julifera	4	0
Plurinerves		
Acacia melanoxylon	4	0
Phyllodineae		
Acacia salicina	3	0
Ingeae		
Archidendron lucyi	4	0
Pararchidendron pruinosum	4	0
Mimoseae		
Dichrostachys cinerea	4	0
Leucaena leucocephala	4	0

3.11.6. Discussion

Three types of methods were applied to evaluate the specificity of this agent. All delivered the same result: total specificity to one plant species, *P. aculeata*. The methods used differed, but complemented and supported each other. The field survey in the native range could only be done on a small number of legume species that could be found coexisting with *P. aculeata*. But this method had the advantage of showing the natural host plant use and is hence very accurate.

The two laboratory tests had the common element that they assessed the larval developmental host range. That is, they evaluated the suitability and acceptability of the test plant species for feeding, growth and progression of larvae to later developmental stages. This is a conservative test in the sense that it is extremely unlikely to under-estimate the host range. If a larva is behaviourally and physiologically able to feed and grow when placed on a food source, then it will do so. For some insect species, these types of tests over-estimate the host range. That is they feed and develop on food sources upon which they would not in nature. The fact that our larvae died rather than feed on all test plant species except *P. aculeata*, proves, to a very high level of confidence, that this insect species will not feed on or damage any other plants species in the field and hence the risks of damage to non-target plants following its release are extremely low.

4. Where, when and how initial release will be made

4.1. Release from quarantine

Eueupithecia cisplatensis is currently being cultured within the quarantine facility at the EcoSciences Precinct, Dutton Park, Brisbane. Specimens of this culture will be deposited with AQIS and the Australian National Insect collection as voucher specimens. Once approval for release is obtained from DAFF and SEWPaC, adults from this culture will be removed from the quarantine after careful inspection to confirm identity and to ensure that no other associated organism such as parasite or pathogen is taken from the quarantine. All requirements imposed by AQIS on the release permit will be followed. Once removed from quarantine, the insects will be placed on *P. aculeata* in non-quarantine glasshouses to initiate a mass-rearing phase.

Should the culture be lost before approvals are granted or any detrimental signs appear as a result of genetic bottlenecks, the insect will be recollected in Argentina and reared through at least one generation in quarantine before being released. Voucher specimens will be submitted to AQIS and ANIC and the identity of the collected material will be confirmed by an authority on the group.

4.2. Distributing in the field

Eueupithecia cisplatensis will be distributed to selected sites throughout the weed's range in Australia. Release sites will be recorded with their GPS coordinates. It is expected that state and territory government departments, community groups such as Landcare, Bushcare and schools may contribute to this distribution. Senior representatives of the Queensland government and the Northern Territory government have already expressed interest in participating in release activities. CSIRO will provide "How to" packages and starter colonies to interested parties.

4.3. Establishment and evaluation

Release sites will be monitored for some years after releases to ascertain whether the insect has established. Should the insect be found to have established, assessments will be made on its effects on the weed.

5. Copies of any references referred to in the application

Copies of the many references cited in this application are available from the author upon request.

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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 Biosecurity 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 Biosecurity 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 Biosecurity 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 Biosecurity when estimating the probability of entry.

For the purpose of considering the probability of entry, DAFF Biosecurity 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 Biosecurity 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	$0.7 < P \leq 1$
Moderate	The event would occur with an even probability	$0.3 < P \leq 0.7$
Low	The event would be unlikely to occur	$0.05 < P \leq 0.3$
Very low	The event would be very unlikely to occur	$0.001 < P \leq 0.05$
Extremely low	The event would be extremely unlikely to occur	$0.000001 < P \leq 0.001$
Negligible	The event would almost certainly not occur	$0 \leq P \leq 0.000001$

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	Very low	Extremely low	Negligible
Low	Very low	Very low	Very low	Extremely low	Extremely low	Negligible
Very low	Extremely low	Extremely low	Extremely low	Extremely low	Negligible	Negligible
Extremely low	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Negligible	Negligible	Negligible	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 Biosecurity 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 Biosecurity'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 Biosecurity 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 Biosecurity 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 Biosecurity 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 Biosecurity 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 Biosecurity 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 Biosecurity 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 2007 (update 2009)* 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 Biosecurity:

- 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 Biosecurity 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 Biosecurity'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 Biosecurity'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 2007 (update 2009)*.

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 Biosecurity	The unit, within the Department of Agriculture, Fisheries and Forestry, responsible for Australia's biosecurity policies. Previously known as Biosecurity Australia and the Australian Quarantine and Inspection Service (AQIS).
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

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