



Australian Government

**Department of Agriculture,
Water and the Environment**

Department Risk Analysis

**Application to add sterile *Cydia pomonella* (Codling Moth) to the
Environment Protection and Biodiversity Conservation Act 1999 *List
of Specimens taken to be Suitable for Live Import***

October 2020

Introduction

Purpose of the proposed import

The purpose of the application is to allow the importation of 'sterile' *Cydia pomonella* (Codling Moth) by the Tasmanian Department of Primary Industries, Parks, Water and Environment to assess the feasibility of using sterile moths to control wild Codling Moth populations that are damaging commercial apple orchards. When strategically released in large numbers the sterile moths of both sexes to seek out and mate with wild Codling Moths, resulting in either unfertilised eggs or sterile progeny and an overall reduction in damage.

Background

Under s.303EC of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), the responsible Minister may amend the *List of Specimens taken to be suitable for live import* (Live Import List) by including a specimen on the list. There are two parts to the list - Part 1 comprises specimens that can be imported without a permit under the EPBC Act. Part 2 comprises specimens that require a permit under the EPBC Act to be imported. Import conditions may be applied to the species listed on Part 2, such as 'for research only' and 'high security facilities only'. Additional conditions may also be applied when the permit for import is issued.

Before amending the Live Import List, the Minister must consult with appropriate agencies and other persons, and consider a report assessing the potential environmental impacts of the proposed amendment. When submitting an application to the department to amend the Live Import List, all applicants are required to provide an accompanying report that addresses specific terms of reference. The department undertakes a risk assessment using the information in the applicant's report and any other sources of relevant information. The department also considers comments and information received through the public consultation process (including states and territories). The application and accompanying report for the proposed import of sterile *Cydia pomonella* was released for public comment in April 2020.

Biology and Ecology of *Cydia pomonella*

Description

Cydia pomonella is believed to have originated in Europe or the Mediterranean, were introduced to the Americas in the mid 1700's and are now found in Europe, Asia, Africa, North and South America, islands of the Pacific and Australia.

Cydia pomonella is a small moth with a wingspan of 15 - 20mm and is grey in colour with lighter grey wavy lines across the wings, and a distinctive copper patch at the tip of the wings (Figures 1 and 2). Male and female moths can be distinguished by genitalia. *C. pomonella* caterpillars grow to 20mm long and are coloured from pale yellow to light brown with dark brown spots (Figure 3).



Figure 1. Male

Figure 2. Female

Walker, K. (2006) Codling moth (*Cydia pomonella*) Updated on 11/25/2011 10:34:41 AM Available online: PaDIL - <http://www.padil.gov.au>. (From application).



Figure 3. Late instar larva

LepIntercept - An identification resource for intercepted Lepidoptera larvae by Todd M. Gilligan and Steven C. Passoa Identification Technology Program (ITP), Fort Collins, CO. Last updated February 2014. (From application).

Taxonomy

Family: Tortricidae

Genus: *Cydia*

Species: *Cydia pomonella* (Linnaeus, 1758)

Taxonomic reference: Linnaeus, C. (1758). *Systema Naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis*. Editio decima, reformata [10th revised edition], vol. 1: 824 pp. Laurentius Salvius: Holmiae.

Synonyms: *Phalaena pomonella* Linnaeus, 1758, *Carpocapsa pomonella* (Linnaeus, 1758), *Carpocapsa pomonana* (Treitschke, 1830), *Enarmonia pomonella* (Linnaeus, 1858), *Laspeyresia pomonella* (Linnaeus, 1858).

Common Names: Codling Moth

Life cycle

The entire lifecycle of the Codling Moth can be completed in 40-60 days enabling several generations in a single season if the conditions are suitable. Adults live for 8-18 days (Jones & Wiman, 2008), can fly up to 11km (Schumacher et al, 1997) and can mate within a day of emerging from their pupa.

Egg laying starts two days after emergence regardless of whether the female has mated (Vickers, 1997) but those eggs laid prior to mating will not hatch. Most eggs will be laid two days after mating and continue to be laid in lower numbers until the female dies – after approximately 14 days. Fecundity and fertility are highest if the female mates within two days of emergence, but longevity is highest if the female is unmated (Vickers, 1997). The age of the male Codling Moth has no impact on the fecundity or fertility of the female. Eggs are generally laid on the tree from the which the female hatched. Optimal humidity for egg laying is 75 per cent and eggs may be laid on fruit, twigs and leaves. Up to 300 may be laid by each female over four to seven days (Wearing & Ferguson, 1971) but the average is 50-60. The eggs are 1-1.2mm in size, white and shaped like a convex lens. They are laid with a sticky mass which acts like a glue to hold them in place. The caterpillar hatches after 5-12 days depending on conditions.

The pale yellow caterpillar is 2mm long on hatching and grows through five instar phases to be 18-20mm long and reddish in colour. When ready to pupate – after 28 to 35 days – the caterpillar will either spin a spider-like silk thread and lower itself to the ground or crawl down the tree trunk. Once it has selected its place to pupate, either under a rock or clod of soil, in a crack or ditch in the ground, the caterpillar will spin a cocoon which will provide it with protection from the rain and other external factors (Geier, 1964).

If the conditions are not suitable for pupation the caterpillars can enter a period of diapause by entering a state of decreased metabolism (Wearing et al. 2001). They can stay in this state for over a year until the temperature and humidity rise to a favourable range.

Codling Moths will emerge from their cocoon as adults after 11 days to mate and continue the cycle.

Diet

Adult *C. pomonella* have never been recorded feeding on ripe fruit in nature (Wenninger & Landolt, 2011). Apple and pear are the main host plants for Codling Moth, but it has also been shown to develop on walnut, quince, apricot, peach, almond, maize, sweet cherry and Japanese plum. There is no evidence that Codling Moths can maintain populations in orchards of peach, sweet cherry or almond (Barnes, 1991), but they can survive on a diet of apple leaves (Pszczolkowski et al, 2002). The caterpillars bore into the fruit leaving a silk thread which binds with scraps of skin and pulp to seal the opening. Once in the centre of the fruit the caterpillar bites into the seeds halting the growth of the fruit and causing it to ripen prematurely and providing the caterpillar with the nutrients it needs. A caterpillar will feed in this way for 23-27 days but only on one or two fruit.

Climate

Humidity levels and climate are very important to the viability and fitness of *C. pomonella*. Optimal conditions for growth are 32°C and 75 per cent humidity. Humidity of less than 20 per cent or at 100 per cent can hinder pupation. Temperatures of below 0°C will render the caterpillars completely inactive however they will return to normal when the temperature rises.

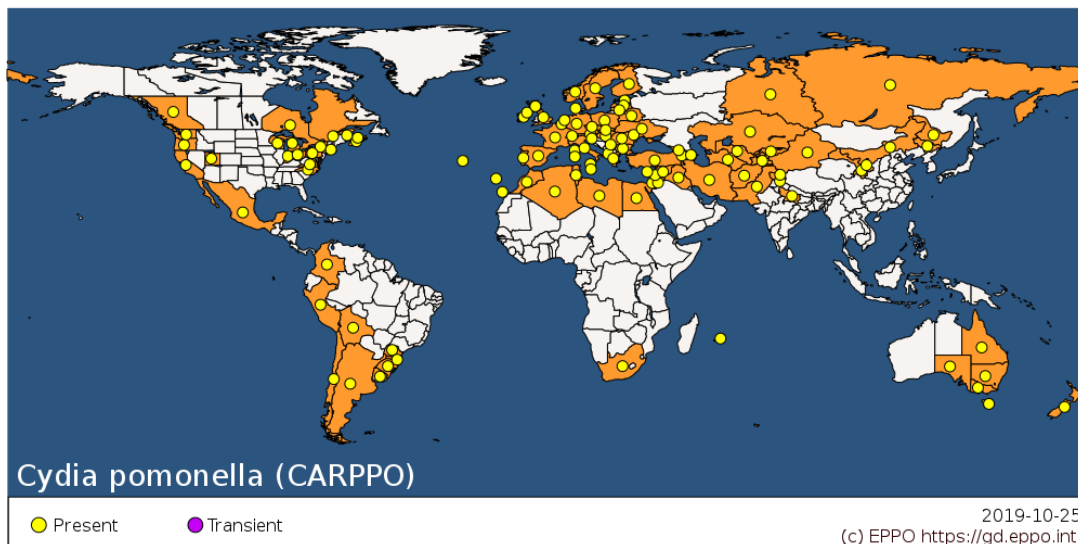
Environment

C. pomonella can survive in all climates where its target fruit trees survive including altitudes as high as 1500m.

The critical lower temperature threshold for development and growth is 9-10°C, with optimal growth temperatures being between 15-27°C and the upper threshold being 30-34°C (Howell and Neven, 2000).

Establishment

C. pomonella originated in Europe and the Mediterranean and is now established in 80 countries in temperate regions of all major continents including Europe, Asia, Africa, North and South America and Australia as well as islands of the Pacific (CABI, 2020, EPPO, 2019).



Map 1 - Present range of *C. pomonella* (EPPO, 2019)

Reason for Import

Cydia pomonella cause damage to the fruit of apple, walnut, quince, apricot, peach, almond, maize, sweet cherry and Japanese plum. All damage from Codling Moths is due to the larval stages of the moth's lifecycle. The Tasmanian Department of Primary Industries, Parks, Water and Environment proposes to assess the feasibility of using sterile adult moths to control wild Codling Moth populations in approximately 100-150ha of commercial apple orchards over several apple growing regions in Tasmania and South Australia. Successful trials leading to use of sterile moths could potentially deliver many beneficial economic, social and environmental outcomes including reduced volumes of damaged fruit and reduced need for the application of insecticides.

Only *C. pomonella* individuals that have been sterilised using gamma radiation (Horner, 2016) under the ‘sterile insect technique’ (SIT) are to be imported. The optimum dose of radiation (150 Gy (gray – a unit of ionizing radiation dose)) (Horner et al, 2016) has been shown to sterilize the moths enough to ensure sterility or inherited sterility whilst maintaining enough fitness and competitiveness to allow them to seek out and mate with wild moths.

The result will be either sterile eggs which don’t hatch or sterile progeny which may complete a lifecycle (including feeding on fruit) but will produce sterile eggs, leading to a further reduction in the numbers of larvae feeding on fruit.

The initial project will assess the feasibility of releasing approximately 2,500 moths per hectare per week between November and February each year – initially during the feasibility study then potentially as part of an ongoing area-wide management system.

Importation of sterilised *C. pomonella* would also be subject to an importation approval by the department under the *Biosecurity Act 2015* (Commonwealth).

Disease transmission

Imported moths are derived from clean, factory culture with a strict quality control system in place, to ensure the population is free of parasitoids and pathogens. The proponent states that ‘sterile insects have now been included in the International Standard for Phytosanitary Measures 3 – Guidelines for the export, shipment import and release of biological control agents and other beneficial organisms (ISPM3). Sterile organisms are considered to be beneficial organisms in ISPM 3 and were specifically included to help facilitate the transnational shipment of such organisms. Any import of sterile Codling Moths will be conducted in accordance with ISPM 3, relevant IAEA (International Atomic Energy Agency) guidelines (Dyck, 2010) and subject to approval by the Department of Agriculture, to ensure any risks are mitigated and that assurance systems are in place’.

Related Live Import listings

44 species of moth are listed on Part 1 of the Live Import List (see below). These species do not require an import permit.

| Taxon | Common Name |
|------------------------------------|--|
| Class: Insecta | |
| <i>Actinotia hyperici</i> | Pale-shouldered Purple Cloud Moth |
| <i>Agonopterix ulicetella</i> | Gorse Soft Shoot Moth, Gorse Shoot-tip Moth |
| <i>Apanteles scutellaris</i> | brachonid moth |
| <i>Apanteles subandinus</i> | brachonid moth |
| <i>Aplocera plagiata</i> | St John’s Wort Inchworm, Defoliating Moth |
| <i>Arcola malloi</i> | Alligator Weed Stem-borer Moth |
| <i>Bembecia chrysidiformis</i> | Fiery Clearwing Moth, Clearwing Dock Moth |
| <i>Bombyx mori</i> | Mulberry Silkworm, Mulberry Silk Moth |
| <i>Bradyrrhoa gilveolella</i> | Rush Skeletonweed Root-feeding Moth |
| <i>Bucculatrix ivella</i> | Groundsel Leaf-perforator Moth, Groundsel Leaf-mining Moth |
| <i>Cactoblastis spp.</i> | Cactus Moths, Nopal Moths |
| <i>Carmenta ithacae</i> | Mexican Clearwing Stem-boring Moth |
| <i>Carmenta mimosa</i> | Mimosa Stem-boring Moth |
| <i>Chamaesphecia mysiniiformis</i> | Horehound Clearwing Moth |

| Taxon | Common Name |
|---------------------------------------|--|
| <i>Chiasmia assimilis</i> | Prickly Acacia Geometrid Moth |
| <i>Coccidiphaga scitula</i> | Scale-feeding Noctuid Moth |
| <i>Cochylis atricapitana</i> | Ragwort Crown-boring Moth, Ragwort Leaf-boring Moth |
| <i>Comostolopsis germana</i> | Bitou Bush Tip Moth |
| <i>Cuphodes profluens</i> | Prickly Acacia Tip-boring Moth |
| <i>Dialectica scalariella</i> | Paterson's Curse Leaf-miner Moth, Echium Leaf-miner Moth |
| <i>Epiblema strenuana</i> | Parthenium Stem-galling Tortricid Moth |
| <i>Eublemma respersa</i> | Scotch Thistle Leaf-boring Noctuid Moth |
| <i>Euclasta gigantealis</i> | Rubber Vine Pyralid Moth |
| <i>Eueupithecia cisplatensis</i> | a geometrid moth |
| <i>Eueupithecia vollonoides</i> | A geometrid moth |
| <i>Evippe spp.</i> | Leaf-tying Gelechiid Moths |
| <i>Haimbachia infusella</i> | pyralid moth |
| <i>Hellinsia balanotes</i> | Groundsel Plume Moth |
| <i>Hypocosmia pyrochroma</i> | Cat's Claw Leaf-tying Pyralid Moth |
| <i>Leuciris fimbriaria</i> | Mimosa Foliage-feeding Geometrid Moth |
| <i>Leucoptera spartifoliella</i> | Twig-mining Moth, Broom Lyonetiid Moth |
| <i>Lioplacis elliptica</i> | Broom Twig-miner Moth |
| <i>Macaria pallidata</i> | Mimosa Leaf-feeding Looper Moth |
| <i>Neurostrota gunniella</i> | Mimosa Stem-mining Moth |
| <i>Niphograpta alboguttalis</i> | Water Hyacinth Stem-borer Moth |
| <i>Oidaematophorus lacteodactylus</i> | Stem-borer Pterophorid Moth |
| <i>Platphalonidia mystica</i> | Parthenium Stem-boring Moth |
| <i>Prochoerodes truxaliata</i> | Groundsel Bush Geometrid Moth |
| <i>Pyramidobela spp.</i> | Leaf-rolling Ethmiine Moths |
| <i>Samea multiplicalis</i> | Salvinia Stem-borer Moth |
| <i>Tortrix spp.</i> | Fruit-feeding Tortrix Moths |
| <i>Tyria jacobaeae</i> | Cinnabar Moth |
| <i>Wheeleria spilodactylus</i> | Horehound Plume Moth |
| <i>Xubida infesellus</i> | Water Hyacinth Stem-borer Moth |

31 species of moth are listed on Part 2 of the Live Import List and do require an import permit. All but two have to meet the conditions 'Eligible non-commercial purpose only, excluding household pets. High security facilities only'.

| Taxon | Common Name | Conditions for Import |
|------------------------------------|--|--|
| Class: Insecta | | |
| <i>Apotoforma rotundipennis</i> | Mimosa Leaf-tying Tortricid Moth | Eligible non-commercial purpose only, excluding household pets. High security facilities only. |
| <i>Chiasmia inconspicua</i> | Kenyan Geometrid Moth, Leaf-feeding Looper Caterpillar | |
| <i>Cometaster pyrula</i> | Prickly Acacia Leaf-feeding Caterpillar, Cutworm Moth | |
| <i>Cremastobombycia lantanella</i> | Lantana Leaf-miner Gracillariid Moth | Eligible non-commercial purpose only, excluding household pets. High security facilities only. |
| <i>Ctenopseustis obliquana</i> | Brown-headed Leaf-roller Tortricid Moth | Eligible non-commercial purpose only, excluding household pets. High security facilities only. |
| <i>Ectaga garcia</i> | Lantana Leaf-rolling Moth | Eligible non-commercial purpose only, excluding household pets. High security facilities only. |
| <i>Ephestia kuhniella</i> | Mediterranean Flour Moth | Eligible non-commercial purpose only, excluding household pets. High security facilities only. |
| <i>Ethmia bipunctella</i> | Viper's Bugloss Ethmiid Moth | Eligible non-commercial purpose only, excluding household pets. High security facilities only. |

| Taxon | Common Name | Conditions for Import |
|----------------------------------|---|--|
| <i>Ethmia distigmatella</i> | Viper's Bugloss Ethmiid Moth | Eligible non-commercial purpose only, excluding household pets. High security facilities only. |
| <i>Ethmia terminella</i> | Viper's Bugloss Ethmiid Moth | Eligible non-commercial purpose only, excluding household pets. High security facilities only. |
| <i>Euclasta whalleyi</i> | Rubber Vine Leaf-feeding Moth | Eligible non-commercial purpose only, excluding household pets. High security facilities only. |
| <i>Isturgia disputaria</i> | Prickly Acacia Looper Moth | Eligible non-commercial purpose only, excluding household pets. High security facilities only. |
| <i>Isturgia presbitaria</i> | Prickly Acacia Looper Moth | Eligible non-commercial purpose only, excluding household pets. High security facilities only. |
| <i>Isturgia pulinda</i> | geometrid moth | Eligible non-commercial purpose only, excluding household pets. High security facilities only. |
| <i>Itame varadaria</i> | Groundsel Bush Geometrid Moth | Eligible non-commercial purpose only, excluding household pets. High security facilities only. |
| <i>Melipotis indomita</i> | Indomitable Melipotis Cutworm Moth | Eligible non-commercial purpose only, excluding household pets. High security facilities only. |
| <i>Meskea horor</i> | Spinyhead Sida Gall-forming Moth | Eligible non-commercial purpose only, excluding household pets. High security facilities only. |
| <i>Nephele densoi</i> | Hawk Moth | Eligible non-commercial purpose only, excluding household pets. High security facilities only. |
| <i>Oidaematophorus beneficus</i> | Hamakua Pamakani Plume Moth | Eligible non-commercial purpose only, excluding household pets. High security facilities only. |
| <i>Phidotricha insularella</i> | Mimosa Pyralid Moth | Eligible non-commercial purpose only, excluding household pets. High security facilities only. |
| <i>Platyptilia isodactyla</i> | Ragwort Plume Moth | Eligible non-commercial purpose only, excluding household pets. High security facilities only. |
| <i>Plutella xylostella</i> | Diamond-back Moth, Cabbage Moth | Eligible non-commercial purpose only, excluding household pets. High security facilities only. |
| <i>Prasinocyma nereis</i> | Prickly Acacia Geometrid Moth | Eligible non-commercial purpose only, excluding household pets. High security facilities only. |
| <i>Psigida walkeri</i> | Mimosa Citheroniid Moth | Eligible non-commercial purpose only, excluding household pets. High security facilities only. |
| <i>Rhodometra sacraria</i> | Vestal Caterpillar, Geometrid Moth | Eligible non-commercial purpose only, excluding household pets. High security facilities only. |
| <i>Semiothisa assimilus</i> | geometrid moth | Eligible non-commercial purpose only, excluding household pets. High security facilities only. |
| <i>Semiothisa cyda</i> | Mesquite Looper Geometrid Moth | Eligible non-commercial purpose only, excluding household pets. High security facilities only. |
| <i>Sesamia grisescens</i> | Sugarcane-borer Moth | Eligible non-commercial purpose only, excluding household pets. High security facilities only. |
| <i>Sesquialtera ridicula</i> | South African Geometrid Moth | Eligible non-commercial purpose only, excluding household pets. High security facilities only. |
| <i>Tarachidia candefacta</i> | Olive-shaded Bird-dropping Noctuid Moth | Eligible non-commercial purpose only, excluding household pets. High security facilities only. |
| <i>Xenoecista pallidata</i> | geometrid moth | Eligible non-commercial purpose only, excluding household pets. High security facilities only. |

Conservation status

Cydia pomonella is not listed on the International Union for Conservation of Nature's Red List of Threatened Species or the *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES) appendices.

RISK ASSESSMENT

Assessing the risk of the potential of introducing a new organism into the environment involves assessing the risk of it becoming established and spreading and the likely impacts if establishment occurred.

There are no accepted risk assessment models that can be used to calculate the establishment risk of invertebrates in Australia. Bomford (2008) found that for vertebrates, the level of risk can be assumed in accordance with the four key factors of establishment success. These factors are:

- Propagule pressure – the release of large numbers of animals at different times and places enhances the chance of successful establishment
- Climate match – introduction to an area with a climate that closely matches that of the species' original range
- History of establishment elsewhere – previous successful establishment
- Taxonomic group – belonging to a family or genus which has a high establishment success rate.

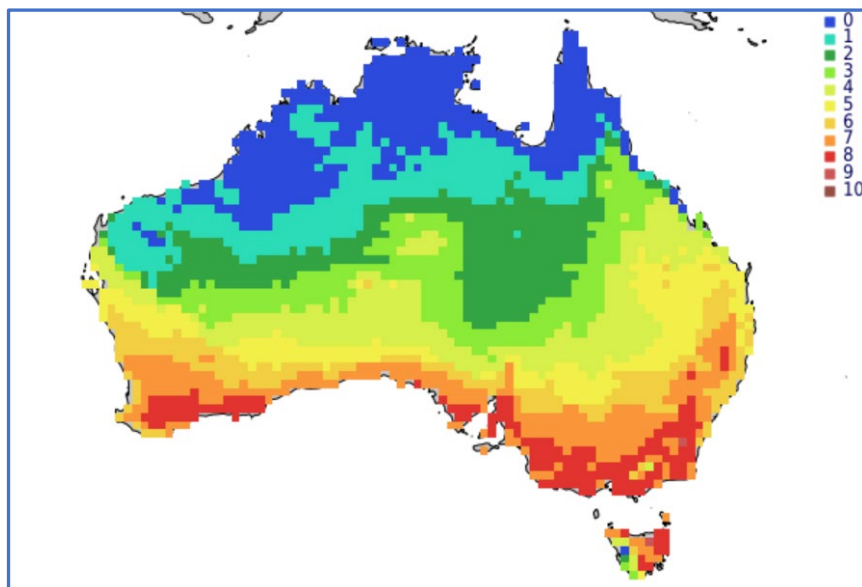
Although these factors apply to vertebrates, they have been used as a guide for this risk assessment of *C. pomonella*. In addition, using the information compiled from research into the above factors for *C. pomonella* the potential impacts of establishment of feral populations can also be assumed.

Propagule pressure – the release of large numbers of animals at different times and places

Codling Moths are already well established in the fruit orchards of southern Australia and are either damaging fruit or require the use insecticides to control their numbers. The release of large numbers (~2500 per ha) of sterile moths is expected to reduce the overall numbers of moths in the subsequent generation as the resultant eggs will either be unfertilised or contain sterile offspring, it will not be possible for the sterile moths released in a 'sterile insect technique' (SIT) program to establish separate and independent breeding colonies, or to contribute any genetic material to a wild breeding population.

Climate match – introduction to an area with a climate that closely matches that of the species’ original range

Codling moths could be expected to survive in the areas coloured yellow, orange and red on the Climatch map (Map 2) below:



Map 2. Potential range of *C. pomonella* in Australia (Climatch, 2020).

The Climatch map shows most of southern Australia is suited to *C. pomonella*. The current extent of Codling Moth in Australia roughly matches the Climatch map except for Western Australia.

History of establishment elsewhere – previous successful establishment

C. pomonella originated in Europe and the Mediterranean and is now established in 80 countries in temperate regions of all major continents including Europe, Asia, Africa, North and South America and Australia as well as islands of the Pacific (Map 1, CABI, 2020).

Taxonomic group – belonging to a family or genus which has a high establishment success rate

C. pomonella belongs in the family Tortricidae, also known as the tortrix or leaf roller moths, which includes many species that are considered invasive and are actively managed to reduce economic impact on agricultural crops. They include but are not limited to:

| No. | Common name/species name | Distribution |
|-----|--|--|
| 1 | Light brown apple moth (<i>Epiphyas postvittana</i>) | Native to Australia – pest in NZ, Hawaii, New Caledonia and the UK |
| 2 | Peach moth (<i>Cydia molesta</i>) | Known to be in Australia |
| 3 | Oriental fruit moth (<i>Grapholita molesta</i>) | Known to be in Australia |

| No. | Common name/species name | Distribution |
|-----|---|----------------------------------|
| 4 | Summer fruit tortrix moth (<i>Adoxophyes orana</i>) | Not yet known to be in Australia |
| 5 | Fruit tree tortrix moth (<i>Archips podana</i>) | Not yet known to be in Australia |
| 6 | Rose leaf roller (<i>Archips rosana</i>) | Not yet known to be in Australia |
| 7 | <i>Argyrotaenia ljugiana</i> , a pest on vines, maize, and fruit trees | Not yet known to be in Australia |
| 8 | Plum fruit moth (<i>Cydia funebrana</i>) | Not yet known to be in Australia |
| 9 | Pea moth (<i>Cydia nigricana</i>) | Not yet known to be in Australia |
| 10 | Chestnut and acorn moth (<i>Cydia splendana</i>) | Not yet known to be in Australia |
| 11 | False codling moth (<i>Thaumatotibia (Cryptophlebia) leucotreta</i>) | Not yet known to be in Australia |
| 12 | European grapevine moth (<i>Lobesia botrana</i>) | Not yet known to be in Australia |
| 13 | Hemp borer (<i>Grapholita delineana</i>) | Not yet known to be in Australia |
| 14 | Cherry fruitworm (<i>Grapholita packardi</i>) | Not yet known to be in Australia |
| 15 | Barred fruit tree tortrix moth (<i>Pandemis cerasana</i>) | Not yet known to be in Australia |
| 16 | Grape berry moth (<i>Paralobesia viteana</i>) | Not yet known to be in Australia |
| 17 | Long-palped tortrix (vine leaf roller) (<i>Sparganothis pilleriana</i>) | Not yet known to be in Australia |
| 18 | Bud moth (<i>Spilonota ocellana</i>) | Not yet known to be in Australia |
| 19 | Spruce budworm (<i>Genus Choristoneura</i>) | Not yet known to be in Australia |

A full assessment of the disease risks of *C. pomonella* would be undertaken by the Department of Agriculture, Water and the Environment under the *Biosecurity Act 2015* should the specimen be added to the Live Import List.

Risk summary and mitigation measures

Codling moth is a pest species in Australia. The intention of this application is for sterile *C. pomonella* to be imported and released in large numbers to lower the impact of existing wild Codling Moth populations on commercial fruit orchards by reducing the numbers of viable offspring. As the moths will be sterile as a result of being irradiated, they will not be able to

establish separate and independent breeding colonies, or to contribute any genetic material to the wild breeding population.

As the moths will be raised and radiated in a secure facility the risk of them carrying disease or parasites is negligible. The sterile adult Codling Moths would also need to meet any conditions applied by the department as part of their import conditions under the *Biosecurity Act*.

Comments on the proposal to import *Cydia pomonella*

The department undertook consultation with relevant ministers (or their delegates), government agencies and the public from 9 April to 8 May 2020. The department received no responses.

A second consultation round was undertaken from 6 to 26 August 2020 with state and territory government agencies only, via the GovTEAMS website. The department received no responses.

On 15 September 2020 Plant Health Australia, at the department's request, circulated the department's risk assessment to its members with comments, invited by 30 September 2020. Members include Apple and Pear Australia, the Australian Walnut Industry Association and Summerfruit Australia. No comments were received.

Conclusion

The department has undertaken a risk analysis and reviewed the available information on *Cydia pomonella* with regards to the proposed amendment to include this species on the Live Import List.

The department concludes that the release of sterilised *Cydia pomonella* poses negligible risk to the Australian environment. Accordingly, the department recommends that **sterilised *Cydia pomonella*** be **added to Part 1 of the Live Import List**.

References:

- Barnes, MM, Van der Geest, LPS and Evenhuis, HH 1991. 'Codling moth occurrence, host race formation and damage'. In: *Tortricid Pests, Volume 5, 1st Edition, Their Biology, Natural Enemies and Control*.
- Bloem, S., Carpenter, J.E., Blomefield, T.L. and Harrison, C., 2010. Compatibility of codling moths *Cydia pomonella* (Linnaeus)(Lepidoptera: Tortricidae) from South Africa with codling moths shipped from Canada. *Journal of applied entomology*, 134(3), pp.201-206.
- Blomefield, T.L., Bloem, S. and Carpenter, J.E., 2010. Effect of radiation on fecundity and fertility of codling moth *Cydia pomonella* (Linnaeus)(Lepidoptera: Tortricidae) from South Africa. *Journal of Applied Entomology*, 134(3), pp.216-220.
- Bomford, M 2008. 'Risk assessment models for establishment of exotic vertebrates in Australia and New Zealand'. *Invasive Animals Cooperative Research Centre, Canberra*.
- Dyck, V.A. 2010. Rearing codling moth for the sterile insect technique. In *FAO Plant Production and Protection Paper*, Food and Agriculture Organization of the United Nations (FAO): Rome, Italy, p. 197.
- Geier, P.W., 1964. Population dynamics of codling moth, *Cydia pomonella* (L)(Tortricidae), in the Australian Capital Territory. *Australian journal of Zoology*, 12(3), pp.381-416.
- Jones V.P. and Wiman N.G. 2008. 'Longevity of the adult codling moth, *Cydia pomonella*, and the oblique banded leafroller, *Choristoneura rosaceana*, in Washington apple orchards'. *Journal of Insect Science* 8: 14. doi:10.1673/031.008.1401
- Horner, R.M., Walker, J.T.S., Rogers, D.J., Lo, P.L. and Suckling, D.M., 2016. Use of the sterile insect technique in New Zealand Benefits and constraints. *New Zealand Plant Protection*, 69, pp.296-304.
- Howell, J.F. and Neven, L.G., 2000. Physiological development time and zero development temperature of the codling moth (Lepidoptera: Tortricidae). *Environmental Entomology*, 29(4), pp.766-772.
- Pszczolkowski, M.A., Matos, L.F., Zahand, A. and Brown, J.J., 2002. Effect of monosodium glutamate on apple leaf consumption by codling moth larvae. *Entomologia experimentalis et applicata*, 103(1), pp.91-98.
- Schumacher, P, Weyeneth, A, Weber, DC and Dorn, S. 1997. 'Long flights in *Cydia pomonella* L.(Lepidoptera: Tortricidae) measured by a flight mill: influence of sex, mated status and age'. *Physiological Entomology*, 22(2), pp.149-160.
- Vickers, R.A., 1997. Effect of delayed mating on oviposition pattern, fecundity and fertility in codling moth, *Cydia pomonella* (L.)(Lepidoptera: Tortricidae). *Australian Journal of Entomology*, 36(2), pp.179-182.
- Walker, K 2006. Codling moth (*Cydia pomonella*) Updated on 11/25/2011 10:34:41 AM Available online: PaDIL - <http://www.padil.gov.au>.
- Wearing, CH and Ferguson, AM 1971. 'Variation in the fecundity of *Carpocapsa pomonella*'. *New Zealand Journal of Science* 14: 233-237.

Wearing, CH, Hansen, JD, Whyte, C, Miller, CE and Brown, J 2001. 'The potential for spread of codling moth (Lepidoptera: Tortricidae) via commercial sweet cherry fruit: a critical review and risk assessment'. *USDA Systematic Entomology Laboratory* 7.
<https://digitalcommons.unl.edu/systementomologyusda/7>

Wenninger, EJ and Landolt, PJ 2011. 'Apple and sugar feeding in adult codling moths, *Cydia pomonella*: effects on longevity, fecundity, and egg fertility'. *Journal of Insect Science* 11: 161.

Websites:

CABI. 2019. 'Invasive Species Compendium'. Wallingford, UK: CAB International.
www.cabi.org/isc. <https://www.cabi.org/isc/datasheet/11396#todistributionDatabaseTable>

EPPO, 2019. The European and Mediterranean Plant Protection Organization.
<https://gd.eppo.int/taxon/CARPPPO>

ISPM3, 2017. International Standard for Phytosanitary Measures 3 – Guidelines for the export, shipment import and release of biological control agents and other beneficial organisms.
https://www.ippc.int/static/media/files/publication/en/2017/05/ISPM_03_2005_En_2017-05-23_PostCPM12_InkAm.pdf