

Crop Protection Compendium

Selected sections for: *Epiphyas postvittana* (light brown apple moth)

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Datasheet Type(s): Pest

Identity

Preferred Scientific Name

Epiphyas postvittana Walker

Preferred Common Name

light brown apple moth

Other Scientific Names

Archips postvittanus Walker
Austrotortrix postvittana Walker
Cacoecia postvittana Walker
Teras postvittana Walker
Tortrix postvittana Walker

International Common Names

English

apple leafroller, Australian leafroller, light-brown apple moth

French

pyrale brun pâle de la pomme

EPPO code

TORTPO (*Epiphyas postvittana*)

Taxonomic Tree

Domain: Eukaryota
 Kingdom: Metazoa
 Phylum: Arthropoda
 Subphylum: Uniramia
 Class: Insecta
 Order: Lepidoptera
 Family: Tortricidae
 Genus: *Epiphyas*
 Species: *Epiphyas postvittana*

Summary of Invasiveness

E. postvittana is a small, bell-shaped moth, whose caterpillars feed on a very wide range of plants. The eggs, larvae and pupae can be associated with plant material and readily transported. The pest status of this insect in horticultural crops is very significant. It is native to Australia and was distributed to New Zealand, Hawaii, New Caledonia and the UK with apples [*Malus domestica*] or other plant material in the late 1800s. It has since spread throughout lowland New Zealand, and in recent years has spread through southern parts of the UK, and Ireland. In Hawaii, it appears to be confined to altitudes above 1100 m, and can largely be considered a pest of temperate regions.

Notes on Taxonomy and Nomenclature

This species is one of a number of Australian species of *Epiphyas* (under revision: M Horak, CSIRO, Australia, personal communication, 2007), although it is the one with the greatest pest status. Related species with pest status include *Epiphyas pulla* in Western Australia and *Epiphyas xyloides* in Tasmania. It is a member of the Archipini, which includes more than 500 species with worldwide distribution.

Description

Light brown apple moth adults are highly sexually dimorphic and variable in wing pattern and colour, although a lighter, diamond-shaped area extending from behind the head to approximately one-third of the body length is typically visible at rest. Male forewing length ranges from 6-10 mm, compared with 7-13 mm in females (Thomas, 1975a). Males tend to have a higher contrast in colouration than females, although the level of contrast varies.

First instar larvae are approximately 1.6 mm long, and final instar larvae range from 10 to 20 mm in length. The body of a mature larva is green with a darker green central stripe and two side stripes. The first larval instar has a dark-brown head; all other instars have a light-fawn head and prothoracic plate. Overwintering larvae are typically darker.

Pupae are green after pupation, but become brown within 1 day.

Distribution

In Australia, *E. postvittana* is present in Tasmania, New South Wales, Victoria, South Australia, and Western Australia. It is widespread throughout New Zealand on many weedy hosts including gorse (*Ulex europaeus*) and broom (*Cytisus scoparius*) (Suckling et al., 1998). It is commonly present in gardens and unsprayed horticultural crops, as well as on woody weeds and many trees. It is present above 1100 m, on Hawaii on introduced *Rubus* and gorse [*Ulex europaeus*], although it was not found recently on Oahu or Maui in pheromone trap surveys (E Jang, USDA-ARS, USA, personal communication, 2007).

According to Suckling and Brockerhoff (2010), "several publications cite the presence of LBAM in New Caledonia, but this could not be verified (C. Mille, personal communication)". Despite numerous and recent trapping surveys (between the end of 2008 and the beginning of 2009) in La Foa, *E. postvittana* was not caught and has been described as 'not confirmed' for New Caledonia. Surveys elsewhere in New Caledonia are required for further confirmation of its distribution status [C Mille, Institut Agronomique néo-Calédonien, La Foa, New Caledonia, personal communication, 2011].

NHM in the distribution table refers to specimens held in the Natural History Museum, London, UK.

Distribution Table

The distribution in this summary table is based on all the information available. When several references are cited, they may give conflicting information on the status. Further information may be available for individual references and this is displayed in the Distribution Table Details report which can be selected in the Report tab of the datasheet.

Country	Distribution	Last Reported	Origin	First Reported	Invasive	References	Notes
NORTH AMERICA							
USA	Restricted distribution		Introduced		Invasive	EPPO, 2009	
-California	Present, no further details		Introduced		Invasive	USDA-APHIS, 2007	
-Hawaii	Present, no further details		Introduced	1800s	Invasive	Carter, 1984; UK CAB International, 1992; Higgins, 1917; EPPO, 2009; NHM, 1937	Above 1100 m
EUROPE							
Ireland	Restricted distribution		Introduced	1990s	Invasive	Porter, 2001	
Portugal							
-Azores	Present, no further details					Hummer et al., 2009	
Sweden	Present, no further details					Svensson, 2009	
United Kingdom	Restricted distribution		Introduced	1930s	Invasive	Carter, 1984; UK CAB International, 1992; Aldford, 1984; EPPO, 2009	
-England and Wales	Restricted distribution		Introduced		Invasive	Winter, 1985; Cross, 1996; Porter, 2001; EPPO, 2009	
OCEANIA							
Australia	Restricted distribution		Native			Carter, 1984; UK CAB International, 1992; EPPO, 2009	
-New South Wales	Present, no further details		Native			MacQuillan, 1976; Thwaite, 1978; UK CAB International, 1992; EPPO, 2009	
-New South Wales	Present, no further details					Dondale, 2000; MacQuillan, 1976; Thwaite, 1978; UK CAB International, 1992; EPPO, 2009	
-Queensland	Present, no further details		Native			McLachlan, 1970; UK CAB International, 1992; EPPO, 2009	
-South Australia	Present, no further details		Native			Madge, 1972; Carver, 1978; UK CAB International, 1992; EPPO, 2009	
-Tasmania	Present, no further details		Native			MacQuillan, 1976; Terauds et al., 1978; UK CAB International, 1992; EPPO, 2009	
-Victoria	Present, no further details		Native			Bruzzese, 1980; Danthanarayana &, 1983;	

-Western Australia	Present, no further details	Introduced	Invasive	UK CAB International, 1992; EPPO, 2009 Dumbleton, 1940; UK CAB International, 1992; EPPO, 2009	
New Caledonia	Absent, reported but not confirmed	Introduced	Not invasive	Carter, 1984; UK CAB International, 1992; EPPO, 2009	Not found in surveys between the end of 2008 and beginning of 2009 in La Foa
New Zealand	Present, no further details	Introduced 1800s	Invasive	Carter, 1984; Armstrong & Suckling, 1990; Suckling et al., 1990; UK CAB International, 1992; EPPO, 2009 ; NHM, 1950 [Wellington]	Widespread in North and South Islands

History of Introduction and Spread

The most detailed information on the spread of this moth comes from the UK, where amateur entomologists have monitored its spread over recent decades (Porter, 2001). *E. postvittana* showed good evidence of recent geographic range expansion in England (Porter, 2001), where, after being confined to the south-east of the UK for a long time, it has been observed to spread during the past 20 years.

It has been present in Hawaii for over 100 years. It has not colonised areas at sea level, but remains above 1100 m, according to recent surveys.

It is unclear how long it has been in California, USA, but at least since 2005, and probably earlier. In 2005, the first specimen was caught by light trap, but the trapping programme revealed widespread populations very quickly from March 2007 onwards, as over 30,000 pheromone traps were deployed by the California Department of Food and Agriculture, USA. Thousands of moths have since been trapped. An eradication programme is underway in 13 counties of California. Aerial spraying of a micro-encapsulated sex pheromone has been conducted, despite public objections. Over US\$ 20 million had been spent on regulatory, quarantine and other aspects of the programme in 2007.

Habitat

In its native Australia, this species is thought to have evolved in association with *Acacia* and other evergreen species (Danthanarayana, 1975). *E. postvittana* has colonized a wide range of orchard and other habitats in both Australia and New Zealand. It is present in pine forests on understorey perennial weeds, on willows and other plants along stream and river margins, in coastal areas, and on a wide range of garden plants. It appears to have had limited success in penetrating native forest vegetation in New Zealand (DM Suckling, HortResearch, Lincoln, Canterbury, New Zealand, personal communication, 1995-96).

Habitat List

Category	Habitat	Presence	Status
Littoral	Coastal areas	Secondary/tolerated habitat	Productive/non-natural
Terrestrial-managed	Buildings	Secondary/tolerated habitat	Productive/non-natural
	Cultivated / agricultural land	Secondary/tolerated habitat	Productive/non-natural
	Disturbed areas	Secondary/tolerated habitat	Productive/non-natural

	Managed forests, plantations and orchards	Principal habitat	Productive/non-natural
	Managed grasslands (grazing systems)	Secondary/tolerated habitat	Productive/non-natural
	Protected agriculture (e.g. glasshouse production)	Secondary/tolerated habitat	Productive/non-natural
	Rail / roadsides	Secondary/tolerated habitat	Productive/non-natural
	Urban / peri-urban areas	Secondary/tolerated habitat	Productive/non-natural
Terrestrial-natural/semi-natural	Riverbanks	Secondary/tolerated habitat	Productive/non-natural
	Scrub / shrublands	Secondary/tolerated habitat	Productive/non-natural

Hosts / Species Affected

E. postvittana has a very wide host range, with 73 listed from Australia (Danthanarayana, 1975; Geier and Brieze, 1981), and over 250 from New Zealand (Thomas, 1989; Dugdale and Crosby, 1995).

Danthanarayana et al. (1995) have suggested that the better performance of *E. postvittana* on herbaceous rather than woody plants suggests that it primarily evolved as a feeder on the former. Mo et al. (2006) reported development of this species on *Citrus* spp.

In Australia, capeweed [*Phyla nodiflora* or *Arctotheca calendula*], curly dock [*Rumex crispus*] and plantain [*Plantago major*] are important hosts. In New Zealand, important perennial weed hosts are gorse (*Ulex europeus*) and broom (*Cytisus scoparius*), and in several regions it has been commonly recorded on annual weeds (*Rumex obtusifolius* and *Plantago* spp.), shelter and amenity trees (*Salix* spp. and *Populus* spp.) (Suckling et al., 1998). It has readily colonised the native *Acacia koa* (koa) in Hawaii, USA, along with gorse and other species, and there are also new host records from California, USA. The ecological host range in the existing geographic range has yet to be fully compiled, but it is clearly highly polyphagous.

Detoxification enzyme profile and expression of insecticide resistance is affected by larval host plant (Robertson et al., 1990), as is developmental rate (Danthanarayana, 1975; Tomkins et al., 1989). The larval and adult host plant preferences appear to be independent of each other (Foster and Howard, 1999). The molecular biology of the larval midgut, which can affect host range, has also been examined (e.g. Simpson et al., 2007).

A 1970s survey in New Zealand, conducted by DSIR Entomology Division Horticulture Group, in conjunction with horticultural advisors, returned the following results (Wearing, 2000):

- Exotic host plants: 88 (very common); 78 (common); 166 (occasional); 332 (grand total).
- New Zealand native or endemic host plants: 3 (very common); 16 (occasional); 19 (grand total).

Larval development was not confirmed on all of the 'occasional' hosts.

The host plants recorded in the New Zealand survey were summarised by family (Wearing, 1999) and are included in the host list of this datasheet.

Host Plants and Other Plants Affected

Plant name	Context
Acacia (wattles)	Unknown
Acacia baileyana (cootamundra wattle)	Unknown
Acacia longifolia (golden wattle)	Unknown
Acacia riceana	Unknown

Actinidia chinensis (Chinese gooseberry)	Main
Carmichaelia	Unknown
Cassia corymbosa	Unknown
Chaenomeles japonica (Japanese quince)	Unknown
Chrysanthemum morifolium (chrysanthemum (florists'))	Main
Citrus	Main
Clanthus puniceus	Unknown
Cotoneaster	Main
Cotoneaster coriaceus	Unknown
Cotoneaster frigidus	Unknown
Crataegus (hawthorns)	Main
Crataegus monogyna (hawthorn)	Unknown
Crataegus rhipidophylla (Midland hawthorn)	Unknown
Cydonia oblonga (quince)	Unknown
Cytisus multiflorus	Unknown
Cytisus scoparius (broom)	Unknown
Diospyros (malabar ebony)	Main
Duchesnea indica (India mockstrawberry)	Unknown
Eriobotrya japonica (loquat)	Unknown
Eucalyptus (Eucalyptus tree)	Main
Feijoa sellowiana (Horn of plenty)	Main
Fragaria ananassa (strawberry)	Unknown
Fragaria moschata	Unknown
Genista (broom)	Unknown
Hardenbergia violacea	Unknown
Humulus lupulus (hop)	Main
Jasminum (jasmine)	Main
Kerria japonica (Japanese kerria)	Unknown
Laburnum anagyroides (laburnum)	Unknown
Lathyrus (Vetchling)	Unknown
Ligustrum vulgare (privet)	Main
Litchi chinensis (lichi)	Main
Lotus corniculatus (bird's-foot trefoil)	Unknown
Lotus uliginosus (greater lotus)	Unknown
Lupinus (lupins)	Unknown
Lupinus albus (white lupine)	Unknown
Lupinus angustifolius (lupin)	Unknown
Lupinus arboreus (tree lupin (UK))	Unknown
Lupinus luteus (yellow lupin)	Unknown
Malus baccata (siberian crab apple)	Unknown
Malus domestica (apple)	Main
Medicago lupulina (black medick)	Unknown
Medicago sativa (lucerne)	Main
Melilotus albus (Bokhara clover)	Unknown
Parthenocissus inserta	Unknown
Persea americana (avocado)	Main
Phaseolus vulgaris (common bean)	Unknown
Photinia glabra	Unknown
Pinus (pines)	Main

Pinus radiata (radiata pine)	Main
Pisum sativum (pea)	Unknown
Populus (poplars)	Main
Prunus amygdalus	Unknown
Prunus armeniaca (apricot)	Main
Prunus avium (sweet cherry)	Unknown
Prunus campanulata (taiwan cherry)	Unknown
Prunus cerasifera (myrobalan plum)	Unknown
Prunus cerasus (sour cherry)	Unknown
Prunus domestica (plum)	Unknown
Prunus laurocerasus (cherry laurel)	Unknown
Prunus persica (peach)	Main
Prunus persica var. nucipersica (nectarine)	Unknown
Prunus serrulata (Japanese flowering cherry)	Unknown
Pyracantha angustifolia (Narrow-leaf firethorn)	Unknown
Pyrus (pears)	Main
Pyrus communis (European pear)	Unknown
Pyrus pyrifolia (Oriental pear tree)	Unknown
Pyrus ussuriensis (amur pear)	Unknown
Rhamphiolepis umbellata (Yedda hawthorne)	Unknown
Ribes (currants)	Main
Rosa (roses)	Main
Rosa canina (Dog rose)	Unknown
Rosa rubiginosa (sweet briar)	Unknown
Rubus (blackberry, raspberry)	Main
Rubus fruticosus (blackberry)	Unknown
Rubus idaeus (raspberry)	Unknown
Rubus occidentalis (black raspberry)	Unknown
Rubus parvus	Unknown
Senna multiglandulosa	Unknown
Solanum tuberosum (potato)	Main
Spiraea arguta	Unknown
Trifolium (clovers)	Main
Trifolium arvense	Unknown
Trifolium campestre (Hop trefoil)	Unknown
Trifolium dubium (yellow suckling clover)	Unknown
Trifolium fragiferum (strawberry clover)	Unknown
Trifolium pratense (purple clover)	Unknown
Trifolium repens (white clover)	Unknown
Trifolium subterraneum (subterranean clover)	Unknown
Trifolium tomentosum	Unknown
Ulex europaeus (gorse)	Unknown
Vaccinium (blueberries)	Main
Vicia faba (broad bean)	Main
Vicia faba var. major (broad bean)	Unknown
Vicia sativa (common vetch)	Unknown
Vicia villosa	Unknown
Vitis (grape)	Wild host
Vitis vinifera (grapevine)	Main

[Wisteria](#)

Unknown

[Wisteria sinensis \(purple wisteria\)](#)

Unknown

Growth Stages

Post

-

harvest

Symptoms

Larval nests are typically seen as leaves webbed together, or attached to fruit. Fruit surface feeding is common within larval nest sites. On apples [*Malus domestica*], older skin damage has a cork-like appearance, and may be small (5 mm) or larger areas, depending on larval instar and feeding duration. Feeding sites on other fruits are similar.

Vectoring of *Botrytis cinerea* by larvae has been shown in grapes [*Vitis vinifera*], with up to 13% of berry damage (by weight) caused as a result (Bailey, 1997).

List of Symptoms / Signs

Fruit

lesions: scab or pitting

Leaves

webbing

Biology and Ecology

Life Cycle

The number of annual generations of light brown apple moth (LBAM) varies with latitude within its range. There is considerable overlap between generations, with development driven by temperature and larval host plant. The highest rate of population increase was on *Plantago lanceolata* [buckhorn], followed by *Rumex crispus* [curly dock], apples (*Malus domestica* cv. Granny Smith) and *Trifolium repens* [white clover] (Danthanarayana et al., 1995).

There is no winter resting stage, although overwintering larvae tend to develop slowly, with a lower threshold of development for all stages of 7.5°C and an upper threshold of 31°C (Danthanarayana, 1975). In Australia, the number of generations varies from three to four, with three in most areas (Wearing et al., 1991).

In New Zealand, four overlapping generations are completed annually in the north (38°S), with major flight periods occurring during September-October, December-January, February-March, and April-May (Thomas, 1975b). Three generations are typically observed annually in the Southern North Island and Northern South Island (40°S). In Canterbury (43°S), Otago (45°S) and Southland (47°S), the number of complete generations is reduced to two.

Eggs are typically laid in clusters of 3-150 on the upper surface of leaves, and take 8 days at 20°C to hatch (longer at cooler temperatures). These give rise to the first generation of larvae. There are five (male) or six (female) larval instars (Thomas, 1975b).

The rate of larval development is much slower during winter. The majority of larvae overwinter in prolonged phases of the second, third and fourth instars. During this period they normally feed on

herbaceous plants and shrubs. Re-invasion of apples and other fruit crops takes place during October-December, when moths from the overwintered larval generation start oviposition (Thomas, 1975b).

Larval development rate varies with temperature, season and host plant (Danthanarayana, 1975; Tomkins et al., 1989).

Longer distance dispersal is typically achieved by adults (Geier and Brieese, 1980; Suckling et al., 1994), although larval dispersal occurs by ballooning.

Air Temperature

Parameter	Lower limit	Upper limit
Mean maximum temperature of hottest month (°C)	0	32
Mean minimum temperature of coldest month (°C)	7	0

Means of Movement and Dispersal

Accidental Introduction

E. postvittana is reported as being spread with plant material, including apple trees [*Malus domestica*], from Australia to New Zealand and the UK. It has probably spread within the UK with nursery stock. Within New Zealand, it may have spread naturally since the 1800s.

Pathway Vectors

Vector	Notes	Long Distance	Local	References
Consumables (food on cruise ships etc.)	Eggs or larvae on fruit (rare)	Yes		
Plants or parts of plants	Eggs, larvae or pupae on foliage	Yes		

Plant Trade

Plant parts liable to carry the pest in trade / transport	Pest stages	Borne internally	Borne externally	Visibility of pest or symptoms
Flowers, Inflorescences, Cones, Calyx	eggs; larvae; pupae	No	No	Pest or symptoms usually visible to the naked eye
Fruits (inc. pods)	eggs; larvae	No	No	Pest or symptoms usually visible to the naked eye
Growing medium accompanying plants	larvae; pupae	Yes	No	Pest or symptoms usually visible to the naked eye
Leaves	eggs; larvae; pupae	No	Yes	Pest or symptoms usually visible to the naked eye
Seedlings, Micropropagated plants	eggs; larvae; nymphs; pupae	No	Yes	Pest or symptoms usually visible to the naked eye

Plant parts not known to carry the pest in trade / transport

Bark
Bulbs, Tubers, Corms, Rhizomes
Roots

Stems (above ground), Shoots, Trunks, Branches

True seeds (inc. grain)

Wood

Notes on Natural Enemies

Briese et al. (1980) reported resistance to a nucleopolyhedrosis virus (MacCollom and Reed, 1971), which was probably one of the first examples of virus-resistance in insects. The virus genome has been sequenced (Caradoc-Davies et al., 2001; Hyink et al., 2002).

Natural enemies

Natural Enemy	Type	Life Stages	Specificity	References	Biological Control in	Biological control on
Apanteles demeter	Parasite	Larvae				
Australoglypta latrobei	Parasite	Larvae			New Zealand	apples
Bacillus thuringiensis kurstaki	Pathogen					
Bacillus thuringiensis thuringiensis	Pathogen					
Brachymeria lasus	Parasite					
Brachymeria phya	Parasite	Pupae			New Zealand	apples
Brachymeria teuta	Parasite	Pupae			New Zealand	apples
Dolichogenidea tasmanica	Parasite	Larvae			New Zealand	apples etc
Eriborus epiphyas	Parasite			Paull C, Austin AD, 2006		
Glabridorsum stokesii	Parasite	Pupae			New Zealand	apples etc
Goniozus jacintae	Parasite	Pupae				
Goniozus mandibulatus	Parasite					
Nucleopolyhedrosis virus	Pathogen	Larvae				
Trichogramma carverae	Parasite				Victoria	
Trichogramma funiculatum	Parasite	Eggs				
Trichogrammatoidea bactrae fumata	Parasite					
Trigonospila brevifacies	Parasite	Larvae			New Zealand	apples etc
Voriella uniseta	Parasite	Larvae/Pupae			New Zealand	apples
Xanthopimpla rhopaloceros	Parasite	Pupae			New Zealand	apples etc

Impact Summary

Category	Impact
Economic/livelihood	Negative
Environment (generally)	Negative

Impact: Economic

Losses in Australia are estimated to be of the order of AU\$ 21 million per annum from a range of industries (RW Sutherst, CSIRO Entomology, Indooroopilly, Queensland, Australia, personal communication), but there has been no similar estimation in other countries for this species alone. In New Zealand, several tortricids cost fruit export growers NZ\$ 35 million per annum in control costs, including monitoring. The economic cost of *E. postvittana* in grapes [*Vitis vinifera*] in Australia and New Zealand has not been estimated, although one to two sprays may be used each season. Approximately 1000 ha of mating disruption occurs in Australia (H Senoh, Shin Etsu Fine Chemicals, Tokyo, personal communication, 2007).

Risk and Impact Factors**Invasiveness**

- Capable of securing and ingesting a wide range of food
- Fast growing
- Has a broad native range
- Has high genetic variability
- Has high reproductive potential
- Highly adaptable to different environments
- Invasive in its native range
- Is a habitat generalist
- Pioneering in disturbed areas
- Proved invasive outside its native range
- Tolerant of shade
- Tolerates, or benefits from, cultivation, browsing pressure, mutilation, fire etc

Impact outcomes

- Host damage
- Negatively impacts agriculture

Impact mechanisms

- Herbivory/grazing/browsing

Uses List**General**

- Laboratory use
- Research model

Diagnosis

Larval keys exist for a range of tortricids (Dugdale et al., 2005). Several DNA methods have been used for species identification (Sin et al., 1995; Armstrong et al., 1997; Gleeson et al., 2000).

Detection and Inspection

Pheromone traps have been widely used for detection and monitoring of populations of this species, since the identification of the sex pheromone (Bellas et al., 1983). A range of applications were reported by

Suckling (1993), including insecticide resistance monitoring, insecticide spray reduction, and sample collection for population studies. Pheromone traps were proposed for use in the biosecurity detection of *E. postvittana* in the USA, in combination with codling moth lures, because there is no cross-talk between these species (Schwalbe and Maestro, 1988). This was apparently not adopted. Bradley et al. (1998) reported the use of traps with a spray threshold for insect growth regulator timing. Shoot tip assessment has also been used on apples [*Malus domestica*] and other crops. Suckling et al. (1998) used time searches for alternative host plants to study the host range. Egg sampling and pheromone trapping is conducted in Australian vineyards (Somers and Quirk, 2005). Trapping of females using fermenting port wine has also been used (Suckling et al., 1994).

Similarities to Other Species/Conditions

E. postvittana is similar to *Epiphyas pulla* and *Epiphyas liadelpa*.

Geier and Springett (1976) reported possible hybridization based on demographic characteristics. The larvae are similar to larvae of other leafrollers, which may be present (for example in New Zealand, *Planotortrix octo*, *Planotortrix excessana*, *Ctenopseustis obliquana* and *Ctenopseustis herana*). Dugdale et al. (2005) reported on keys to many species.

Prevention and Control

Regulatory Control (plant quarantine and certification)

Live larvae are not permitted on fruit exported between countries.

Cultural Control and Sanitary Methods

Removal of mummified fruits in older apple varieties was previously recommended (Wearing et al., 1991). Mowing and grazing of the orchard understorey can help to reduce the pest pressure, along with removal of weedy hosts. Development of orchard understoreys based on resistant legume plants has been examined, but no resistant plant material has been found (Burnip and Suckling, 1997).

Host-Plant Resistance

Natural resistance is not known in many host plants, although some obscure apple cultivars showed weak resistance (Wearing et al., 2003). Transgenic apples expressing Bt toxins were previously under development in several countries (Suckling et al., 1996). Resistance management of transgenic apples expressing Bt toxins has been investigated using mating disruption through modelling (Caprio and Suckling, 1995; Caprio and Suckling, 1997).

Biological Control

Predation by arthropods (including spiders) is a key factor in the population ecology of this species, and a wide range of biological control agents is present in Australia (Danthanarayana, 1983). Parasitoids were introduced from Australia to New Zealand for classical biological control (Thomas, 1989). Several species are routinely encountered, with the most abundant being *D. tasmanica* on both berryfruit (Charles et al., 1996) and a range of weeds found near apple orchards (Suckling et al., 1998). The success of this parasitoid is affected by the host plant (DM Suckling, Hortresearch, New Zealand, personal communication, 2008).

Innundative release of native egg parasitoids (*Trichogramma*) has been proposed in Australia (Glen and Hoffman, 1997).

Chemical Control

A range of insecticides have been tested and are effective on various crops. These include organophosphates (azinphos-methyl, chlorpyrifos), carbamates (carbaryl), insect growth regulators (tebufenozide, lufenuron), spinosad, indoxacarb, and Bt. Resistance to organophosphates and carbamates was described from a limited area of New Zealand (Suckling and Khoo, 1993). Bt efficacy is variable to poor

on grapes (Bailey et al., 1996) and apples (Suckling et al., 1993), although on *Actinidia chinensis* it is reported to give good control of tortricids (McKenna et al., 1995).

Early Warning Systems

The pheromone (Bellas et al., 1983) was proposed as an early warning system for the arrival of this species in the USA (Schwalbe and Mastro, 1988). A survey was conducted in 2005 in California, and none were caught (D Lance, USDA-CPHST, USA, personal communication, 2007). However, in 2007 there was confirmation of an established population in California over a large area. Either the insect spread incredibly fast, including via human assisted-transport, or the surveillance missed something.

Field Monitoring/Economic Threshold Levels and IPM Programmes

Pheromone trapping was the basis of the now superseded New Zealand "Window" programme to remove pre-Christmas organophosphates (Suckling et al., 1988). More recently, the accumulated pheromone trap catch inside apple blocks was reported as the basis for application of the selective larvicide tebufenozide by Bradley et al. (1998), in New Zealand's Integrated Fruit Production for apples. It can be important to take other sources of the insect into account, including the understory (Rogers et al., 2003).

IPM has been developed for Australian pears (Barrass and Brown, 1993), apples (Thwaite, 1997) and grapes (Bailey et al., 1997), where it has used day degree accumulation for phenology prediction of this insect (Madge and Stirrat, 1991). Peach IPM is also under development in New Zealand (Lo et al., 1995).

In Australian vineyards, moth trapping, and larval and egg sampling are recommended (Somers and Quirk, 2005). They stated that "trapping of moths provides information on peak times of moth emergence and egg laying, but numbers of moths caught are not good predictors of the size of subsequent [*E. postvittana*] populations".

Trap types should be placed within the canopy and checked at least once a week between budburst and harvest. Pheromone traps should be arranged in a grid pattern consisting of three to five traps within each vineyard. One pheromone cap should be changed each week on a 3- to 5-week rotation (depending on the number of traps used) to minimise the effects of enhanced attractiveness of new caps.

Inspections of shoots, leaves and bunches should be timed in conjunction with moth trapping counts. Egg masses and young larvae will be most abundant shortly after the times of peak moth trap counts, and monitoring should be conducted at this time for the best results.

The shoots, leaves and bunches are monitored at different times of the year, depending on their availability and the likelihood of *E. postvittana* presence. Monitoring must be conducted in a manner that ensures the vineyard is adequately checked. Monitoring should be conducted across the entire vineyard either systematically or randomly so that there is no conscious bias in which vines are monitored.

Pheromonal Control

Mating disruption using sex pheromones has been used for the management of insecticide resistance of this species in apples in New Zealand (Suckling et al., 1990), as well as for low-residue fruit in apple IPM (Suckling and Shaw, 1995). A considerable amount of background work on the response of this insect to sex pheromones released from Shin Etsu polyethylene tubing dispensers has been done, including the use of field electroantennogrammes to study plume structures (Suckling and Angerilli, 1996; Karg and Suckling, 1997; Suckling and Karg, 1997). Apple foliage was discovered to act as a sink and source of attractive pheromone (Karg et al., 1994), and was shown to influence mating disruption (Suckling et al., 1996).

The atmospheric concentration required for trap shut-down and prevention of wing fanning, as surrogates for mating disruption, was estimated using a partially validated Lagrangian model (Suckling et al., 1999a, b). The estimated atmospheric concentration required to prevent catch to 105 µg lures was 10 ng/m³. The concentration required to prevent wing fanning was 70 ng/m³.

Also trials in Australia recently demonstrated effective mating disruption in citrus orchards (Mo et al., 2006). Other formulations, including aerosols, have been examined in New Zealand (Suckling et al., 2006). Sprayable pheromone has been applied aerially in California.

Pheromone biosynthesis has been elucidated (e.g. Foster, 2001).

RNA interference with pheromone reception has been examined (Turner et al., 2006), and olfactory receptors have also been identified recently (Newcomb et al., 2006), offering leads for the future.

Postharvest Treatments

A range of treatments have been examined, but few have reached commercialization.

On apples, hot water treatment (Jones et al., 1996) and high temperature controlled atmosphere storage have been used (Lay-Yee et al., 1997). Hot water treatment (Jones et al., 1996) and high temperature have also been used for nectarines (Birtles et al., 1991), while on apricots (Whiting et al., 1997), pears (Chervin et al., 1997) and persimmons (Dentener et al., 1996; 1997), controlled atmosphere and cold storage, high temperature and controlled atmosphere and heat and cold have been used, respectively.

For cut flowers, phosphine and controlled atmospheres have been used (Karunaratne et al., 1997).

References

- [Aldford DV, 1984. A colour atlas of fruit pests their recognition, biology and control. London, UK: Wolfe Publishing Ltd, 152 pp.](#)
- APPPC, 1987. Insect pests of economic significance affecting major crops of the countries in Asia and the Pacific region. Technical Document No. 135. Bangkok, Thailand: Regional Office for Asia and the Pacific region (RAPA).
- [Armstrong KF, Cameron CM, Frampton ER, Suckling DM, 1997. Aliens at the border and cadavers in the field: a molecular technique for species identification. Proceedings of the Fiftieth New Zealand Plant Protection Conference, Lincoln University, Canterbury, New Zealand, 18-21 August, 1997., 316-321; 18 ref.](#)
- [Armstrong KF, Suckling DM, 1990. Correlation of azinphosmethyl resistance with detoxication enzyme activity in the light brown apple moth *Epiphyas postvittana* \(Lepidoptera: Tortricidae\). Pesticide Biochemistry and Physiology, 36\(3\):281-289.](#)
- [Bailey P, 1997. Lightbrown apple moth \[*Epiphyas postvittana*\] control options for the 1997/8 season. Australian & New Zealand Wine Industry Journal, 12\(3\):267-268, 270.](#)
- [Bailey P, Baker G, Caon G, 1996. Field efficacy and persistence of *Bacillus thuringiensis* var. *kurstaki* against *Epiphyas postvittana* \(Walker\) \(Lepidoptera: Tortricidae\) in relation to larval behaviour on grapevine leaves. Australian Journal of Entomology, 35\(4\):297-302; 5 ref.](#)
- [Bailey PT, Ferguson KL, McMahon R, Wicks TJ, 1997. Transmission of *Botrytis cinerea* by lightbrown apple moth larvae on grapes. Australian Journal of Grape and Wine Research, 3\(2\):90-94; 9 ref.](#)
- [Barrass I, Brown D, 1993. Integrated control and cost reduction in pear orchards of the Goulburn Valley, Australia. Acta Horticulturae, No. 347:307-313; 6 ref.](#)
- [Bellas TE, Bartell RJ, Hill A, 1983. Identification of two components of the sex pheromone of the moth *Epiphyas postvittana* \(Lepidoptera, Tortricidae\). Journal of Chemical Ecology, 9\(4\):503-512](#)
- [Berry JA, 1997. *Meteorus pulchricornis* \(Wesmael\) \(Hymenoptera: Braconidae: Euphorinae\), a new record for New Zealand. New Zealand Entomologist, 20:45-48; 9 ref.](#)
- [Birtles DB, Waddell BC, Maindonald JH, 1991. High temperature disinfestation of nectarines: lightbrown apple moth larvae. In: Proceedings of the Forty Fourth New Zealand Weed and Pest Control Conference. Palmerston North, New Zealand: New Zealand Weed and Pest Control Society Inc., 61-65](#)

Bradley SJ, Walker JTS, Wearing CH, Shaw PW, Hodgeson AJ, 1998. In: Proceedings of the 51st New Zealand Plant Protection Conference. Rotorua, New Zealand: New Zealand Plant Protection Society, 173-178.

[Briese DT, Mende HA, Grace TDC, Geier PW, 1980. Resistance to a nuclear polyhedrosis virus in the light-brown apple moth *Epiphyas postvittana* \(Lepidoptera: Tortricidae\). Journal of Invertebrate Pathology, 36 \(2\):211-215](#)

Brown JW, Epstein ME, Gilligan TM, Passoa SC, Powell JA, 2010. Biology, Identification, and history of the light brown apple moth, *Epiphyas postvittana* (Walker) (Lepidoptera: Tortricidae: Archipini) in California: An example of the importance of local faunal surveys to document the establishment of exotic insects. American Entomologist, 56(1):34-43.

[Bruzzese E, 1980. The phytophagous insect fauna of *Rubus* spp. \(Rosaceae\) in Victoria, a study on the biological control of blackberry \(*Rubus fruticosus* L. agg.\). Journal of the Australian Entomological Society, 19 \(1\):1-6](#)

[Burnip GM, Suckling DM, 1997. Evaluation of legumes for development of leafroller-free orchard understoreys. Proceedings of the Fiftieth New Zealand Plant Protection Conference, Lincoln University, Canterbury, New Zealand, 18-21 August, 1997., 420-424; 15 ref.](#)

Caprio M, Suckling DM, 1997. Resistance management in the 21st century: An entomologist's point of view. Proceedings of the 50th New Zealand Plant Protection Conference. Rotorua, New Zealand: New Zealand Plant Protection Society, 307-315.

[Caprio MA, Suckling DM, 1995. Mating disruption reduces the risk of resistance development to transgenic apple orchards: simulations of the lightbrown apple moth. Proceedings of the Forty Eighth New Zealand Plant Protection Conference, Angus Inn, Hastings, New Zealand, August 8-10, 1995., 52-58; 22 ref.](#)

[Caradoc-Davies KMB, Graves S, O'Reilly DR, Evans OP, Ward VK, 2001. Identification and in vivo characterization of the *Epiphyas postvittana* Nucleopolyhedrovirus ecdysteroid UDP-glucosyltransferase. Virus Genes, 22\(3\):255-264.](#)

[Carter DJ, 1984. Pest Lepidoptera of Europe with special reference to the British Isles. Dordrecht, Netherlands: Dr. W. Junk.](#)

[Carver M, 1978. A new subgenus and species of *Trichogramma* Westwood \(Hymenoptera: Chalcidoidea\) from Australia. Journal of the Australian Entomological Society, 17\(1\):109-112](#)

[Charles JG, Walker JTS, White V, 1996. Leafroller phenology and parasitism in Hawkes Bay, New Zealand, canefruit gardens. New Zealand Journal of Crop and Horticultural Science, 24\(2\):123-131; 19 ref.](#)

[Chervin C, Kulkarni S, Kreidl S, Birrell F, Glenn D, 1997. A high temperature/low oxygen pulse improves cold storage disinfestation. Postharvest Biology and Technology, 10\(3\):239-245; 22 ref.](#)

[Cross JV, 1996. A pheromone trap survey of tortricid moths \(Lepidoptera: Tortricidae\) in apple orchards in England subject to different insecticide management. Entomologist, 115\(3/4\):168-180; 14 ref.](#)

[Danthanarayana W, 1975. The bionomics, distribution and host range of the light brown apple moth, *Epiphyas postvittana* \(Walk.\) \(Tortricidae\). Australian Journal of Zoology, 23\(3\):419-437](#)

[Danthanarayana W, 1983. Population ecology of the light brown apple moth, *Epiphyas postvittana* \(Lepidoptera: Tortricidae\). Journal of Animal Ecology, 52\(1\):1-33](#)

[Danthanarayana W, Farrugia D, Gauld ID, 1977. Studies on the biology and systematic position of a new species of ichneumonid parasitising the light brown apple moth, *Epiphyas postvittana* \(Walker\) \(Lepidoptera: Tortricidae\), in Australia. Bulletin of Entomological Research, 67\(4\):607-617](#)

[Danthanarayana W, Gu H, Ashly S, 1995. Population growth potential of *Epiphyas postvittana*, the lightbrown apple moth \(Lepidoptera: Tortricidae\) in relation to diet, temperature and climate. Australian Journal of Zoology, 43\(4\):381-394](#)

[Dentener PR, Alexander SM, Lester PJ, Petry RJ, Maindonald JH, McDonald RM, 1996. Hot air treatment for disinfestation of lightbrown apple moth and longtailed mealy bug on persimmons. Postharvest Biology and Technology, 8\(2\):143-151; 25 ref.](#)

[Dentener PR, Bennett KV, Hoy LE, Lewthwaite SE, Lester PJ, Maindonald JH, Connolly PG, 1997. Postharvest disinfestation of lightbrown apple moth and longtailed mealybug on persimmons using heat and cold. Postharvest Biology and Technology, 12\(3\):255-264; 26 ref.](#)

[Dondale CD, 2000. A network of spiders. Biodiversity , 1\(2\):2-6.](#)

Dugdale JS, Crosby T, 1995. BUGS database of leafrollers and their host plants. Auckland, New Zealand: Landcare Research, Mt. Albert Research Centre.

[Dugdale JS, Gleeson D, Clunie LH, Holder PW, 2005. A diagnostic guide to Tortricidae encountered in field surveys and quarantine inspections in New Zealand: morphological and molecular characters \[ed. by Dugdale JS, Gleeson D, Clunie LH, Holder PW\]. Wellington, New Zealand: MAF Biosecurity Authority, 163 pp.](#)

[Dumbleton LJ, 1940. *Toririx postvittana* Walk. and its Parasites in Australia. New Zealand Journal of Science and Technology, Section A, 21\(6\):322A-336A pp.](#)

EPPO, 2009. PQR database. Paris, France: European and Mediterranean Plant Protection Organization. www.eppo.org.

[Farrugia D, 1981. Three new Australian species of *Goniozus* Foerster \(Hymenoptera: Bethyridae\), and *G. antipodum* Westwood redescribed. Bulletin of Entomological Research, 71\(2\):317-322](#)

[Follas G, Welsh R, Bland S, Patterson TM, 1994. Lufenuron - an insect growth inhibitor for the control of leafrollers in apples and kiwifruit. In: Proceedings of the Forty Seventh New Zealand Plant Protection Conference, Waitangi Hotel, New Zealand, 9-11 August, 1994. Rotorua, New Zealand: New Zealand Plant Protection Society, 341-345](#)

[Foster SP, 2001. Fatty acyl pheromone analogue-containing lipids and their roles in sex pheromone biosynthesis in the lightbrown apple moth, *Epiphyas postvittana* \(Walker\). Journal of Insect Physiology, 47 \(4/5\):433-443.](#)

[Foster SP, Howard AJ, 1999. Adult female and neonate larval plant preferences of the generalist herbivore, *Epiphyas postvittana*. Entomologia Experimentalis et Applicata, 92\(1\):53-62.](#)

[Geier PW, Briese DT, 1980. The light-brown apple moth, *Epiphyas postvittana* \(Walker\): 4. studies on population dynamics and injuriousness to apples in the Australian Capital Territory. Australian Journal of Ecology, 5\(1\):63-93](#)

Geier PW, Briese DT, 1981 The light-brown apple moth, *Epiphyas postvittana* (Walker); a native leafroller fostered by European settlement. In: Kitching RL, Jones RE, eds. The Ecology of Pests. Some Australian Case Histories. Melbourne, Australia: CSIRO.

[Geier PW, Springett BP, 1976. Population characteristics of Australian leafrollers \(*Epiphyas* spp., Lepidoptera\) infesting orchards. Australian Journal of Ecology, 1\(3\):129-144](#)

[Gleeson D, Holder P, Newcomb R, Howitt R, Dugdale J, 2000. Molecular phylogenetics of leafrollers: application to DNA diagnostics. In: New Zealand Plant Protection Volume 53, 2000. Proceedings of a conference, Commodore Hotel, Christchurch, New Zealand, 8-10 August 2000 \[ed. by Zydenbos SM\] Rotorua, New Zealand: New Zealand Plant Protection Society, 157-162.](#)

[Glenn DC, Hoffmann AA, 1997. Developing a commercially viable system for biological control of light brown apple moth \(Lepidoptera: Tortricidae\) in grapes using endemic Trichogramma \(Hymenoptera: Trichogrammatidae\). Journal of Economic Entomology, 90\(2\):370-382; 46 ref.](#)

[Higgins JE, 1917. The litchi in Hawaii. Bulletin Hawaii Agricultural Experimental Station, 44:1-21.](#)

[Hummer K, Williams R, Mota J, 2009. Pests of blueberries on São Miguel, Açores, Portugal. Acta Horticulturae \[Proceedings of the Ninth International Vaccinium Symposium, Corvallis, Oregon, USA, 13-16 July 2008.\], No.810 \(Vol 1\):287-292. <http://www.actahort.org>](#)

[Hyink O, Dellow RA, Olsen MJ, Caradoc-Davies KMB, Drake K, Herniou EA, Cory JS, O'Reilly DR, Ward VK, 2002. Whole genome analysis of the Epiphyas postvittana nucleopolyhedrovirus. Journal of General Virology, 83\(4\):957-971.](#)

[Jones VM, Waddell BC, 1996. Hot water treatment of lightbrown apple moth eggs on apples and nectarines. Proceedings of the Forty Ninth New Zealand Plant Protection Conference, Quality Hotel Rutherford, Nelson, New Zealand, 13-15 August, 1996., 71-74; 6 ref.](#)

[Jones VM, Waddell BC, Maindonald JH, 1995. Comparative mortality responses of three tortricid \(Lepidoptera\) species to hot water. Journal of Economic Entomology, 88\(5\):1356-1360; 10 ref.](#)

[Karg G, Suckling DM, 1997. Polyethylene dispensers generate large-scale temporal fluctuations in pheromone concentration. Environmental Entomology, 26\(4\):896-905; 33 ref.](#)

[Karg G, Suckling DM, Bradley SJ, 1994. Absorption and release of pheromone of Epiphyas postvittana \(Lepidoptera: Tortricidae\) by apple leaves. Journal of Chemical Ecology, 20:1825-1841.](#)

[Karunaratne C, Moore GA, Jones R, Ryan R, 1997. Phosphine and its effect on some common insects in cut flowers. Postharvest Biology and Technology, 10\(3\):255-262; 24 ref.](#)

[Lay-Yee M, Whiting DC, Rose KJ, 1997. Response of 'Royal Gala' and 'Granny Smith' apples to high-temperature controlled atmosphere treatments for control of Epiphyas postvittana and Nysius huttoni. Postharvest Biology and Technology, 12\(2\):127-136; 24 ref.](#)

[Lester PJ, Dentener PR, Petry RJ, Alexander SM, 1995. Hot-water immersion for disinfestation of lightbrown apple moth \(Epiphyas postvittana\) and longtailed mealy bug \(Pseudococcus longispinus\) on persimmons. Postharvest Biology and Technology, 6\(3/4\):349-356](#)

[Lo PL, Bohm VF, Walker JTS, Manktelow DW, 1995. Monitoring pests of peaches in Hawke's Bay to reduce insecticide applications. Proceedings of the Forty Eighth New Zealand Plant Protection Conference, Angus Inn, Hastings, New Zealand, August 8-10, 1995., 107-110; 4 ref.](#)

[MacCollom GB, Reed EM, 1971. A nuclear polyhedrosis virus of the light brown apple moth, Epiphyas postvittana. Journal of Invertebrate Pathology, 18\(3\):337-343.](#)

[MacQuillan MJ, 1976. Insecticides for control of light brown apple moth and codling moth in Australia. Australian Journal of Experimental Agriculture and Animal Husbandry, 16\(78\):135-139.](#)

[Madge DG, Stirrat SC, 1991. Development of a day-degree model to predict generation events for lightbrown apple moth Epiphyas postvittana \(Walker\) \(Lepidoptera: Tortricidae\) on grapevines in Australia. Plant Protection Quarterly, 6\(1\):39-42](#)

[Madge PE, 1972. Pest management in an apple orchard. Experimental Record of the Department of Agriculture, South Australia, No. 6:35-37.](#)

- [McKenna CE, Stevens PS, Steven D, 1995. A new *Bacillus thuringiensis* product for use on kiwifruit. Proceedings of the Forty Eighth New Zealand Plant Protection Conference, Angus Inn, Hastings, New Zealand, August 8-10, 1995., 135-138; 5 ref.](#)
- [McLachlan RA, 1970. Grape pest control in Queensland. Queensland Agricultural Journal, 96\(4\):231-235.](#)
- [Mo JianHua, Glover M, Munro S, Beattie GAC, 2006. Development of *Epiphyas postvittana* \(Lepidoptera: Tortricidae\) on leaves and fruit of orange trees. Journal of Economic Entomology, 99\(4\):1321-1326. <http://docserver.esa.catchword.org/deliver/cw/pdf/esa/freepdfs/00220493/v99n4s37.pdf>](#)
- [Mo JianHua, Glover M, Munro S, Beattie GAC, 2006. Evaluation of mating disruption for control of lightbrown apple moth \(Lepidoptera: Tortricidae\) in citrus. Journal of Economic Entomology, 99\(2\):421-426. <http://docserver.esa.catchword.org/deliver/cw/pdf/esa/freepdfs/00220493/v99n2s21.pdf>](#)
- [Newcomb RD, Jordan M, Anderson AR, 2006. Olfactory receptors. US provisional patent application 60745240.](#)
- [Paull C, Austin AD, 2006. The hymenopteran parasitoids of light brown apple moth, *Epiphyas postvittana* \(Walker\) \(Lepidoptera: Tortricidae\) in Australia. Australian Journal of Entomology, 45\(2\):142-156. <http://www.blackwell-synergy.com/servlet/useragent?func=showIssues&code=aen>](#)
- [Porter J, 2001. Range expansion in the lightbrown apple moth *Epiphyas postvittana* \(Walk.\). Atropos, 14:42-46.](#)
- [Robertson JL, Armstrong KF, Suckling DM, Preisler HK, 1990. Effects of host plants on the toxicity of azinphosmethyl to susceptible and resistant light brown apple moth \(Lepidoptera: Tortricidae\). Journal of Economic Entomology, 83\(6\):2124-2129](#)
- [Rogers DJ, Walker JTS, Moen IC, Weibel F, Lo PL, Cole LM, 2003. Understorey influence on leafroller populations in Hawke's Bay organic apple orchards. In: New Zealand Plant Protection, Volume 56, 2003. Proceedings of a conference, Chateau on the Park, Christchurch, New Zealand, 12-14 August 2003 \[ed. by Zydenbos SM\] Rotorua, New Zealand: New Zealand Plant Protection Society, 168-173.](#)
- [Sale PR, Sawden D, Steven D, 1985. Trials with *Bacillus thuringiensis* on kiwifruit 1982-1984. Proceedings, New Zealand Weed and Pest Control Conference, No. 38:162-164; 3 ref.](#)
- [Schwalbe CP, Mastro VC, 1988. Multispecific trapping techniques for exotic-pest detection. Agriculture, Ecosystems and Environment, 21\(1-2\):43-51](#)
- [Shaw MR, 1981. Some parasites \(Hymenoptera\) of *Epiphyas postvittana* \(Walker\) \(Lepidoptera: Tortricidae\) in Cornwall. Entomologist's Gazette, 32\(1\):36-38](#)
- [Simpson RM, Newcomb RD, Gatehouse HS, Crowhurst RN, Chagné D, Gatehouse LN, Markwick NP, Beuning LL, Murray C, Marshall SD, Yauk YK, Nain B, Wang YY, Gleave AP, Christeller JT, 2007. Expressed sequence tags from the midgut of *Epiphyas postvittana* \(Walker\) \(Lepidoptera: Tortricidae\). Insect Molecular Biology, 16\(6\):675-690. <http://www.blackwell-synergy.com/loi/imb>](#)
- [Sin FYT, Suckling DM, Marshall JW, 1995. Differentiation of the endemic New Zealand greenheaded and brownheaded leafroller moths by restriction fragment length variation in the ribosomal gene complex. Molecular Ecology, 4\(2\):253-256](#)
- [Somers T, Quirk L, 2005. Grapevine Management Guide 2005-06. NSW Department of Primary Industries. <http://www.csu.edu.au/nwgic/pages/extension/GrapevineManagementGuide05.pdf>](#)
- [Stevens PS, 1995. Host preferences of *Trichogrammatoidea bactrae fumata* \(Hym.: Trichogrammatidae\) an egg parasitoid of leafrollers \(Lep.: Tortricidae\). Entomophaga, 40\(3/4\):379-385; 17 ref.](#)

[Stevens PS, Steven D, 1994. An insect growth regulator for controlling leafrollers on kiwifruit. Proceedings of the Forty Seventh New Zealand Plant Protection Conference, Waitangi Hotel, New Zealand, 9-11 August, 1994 \[edited by Popay, A. J.\] Rotorua, New Zealand; New Zealand Plant Protection Society, 310-313](#)

Suckling DM, 1993. Sex pheromones: Are they delivering to expectations? In: Corey S, Dall D, Milne W, eds. Pest Control and Sustainable Agriculture. Canberra, Australia: CSIRO, 62-65.

[Suckling DM, Angerilli NPD, 1996. Point source distribution affects pheromone spike frequency and communication disruption of Epiphyas postvittana \(Lepidoptera: Tortricidae\). Environmental Entomology, 25 \(1\):101-108.](#)

Suckling DM, Bockerhoff EG, 2010. Invasion biology, ecology, and management of the light brown apple moth (Tortricidae). Annual Review of Entomology, 55:285-306.

[Suckling DM, Brunner JF, Burnip GM, Walker JTS, 1994. Dispersal of Epiphyas postvittana \(Walker\) and Planotortrix octo Dugdale \(Lepidoptera: Tortricidae\) at a Canterbury, New Zealand orchard. New Zealand Journal of Crop and Horticultural Science, 22\(3\):225-234](#)

Suckling DM, Burnip GM, Gibb AR, Daly JM, Armstrong KF, 2001. Host and host plant influences on the leafroller parasitoid Dolichogenidia tasmanica (Braconidae). Entomologia Experimentalis et Applicata, 100:53-260.

[Suckling DM, Burnip GM, Walker JTS, Shaw PW, McLaren GF, Howard CR, Lo P, White V, Fraser J, 1998. Abundance of leafrollers and their parasitoids on selected host plants in New Zealand. New Zealand Journal of Crop and Horticultural Science, 26\(3\):193-203; 28 ref.](#)

[Suckling DM, Daly JM, Chen X, Karg G, 2006. Field electroantennogram and trap assessment of aerosol pheromone dispensers to disrupt lightbrown apple moth. Pest Management Science, 63:202-209.](#)

[Suckling DM, Green SR, Gibb AR, Karg G, 1999. Atmospheric pheromone concentrations affect the behaviour of lightbrown apple moth \(Lepidoptera: Tortricidae\) in the orchard. Journal of Chemical Ecology, 25:2011-2025.](#)

[Suckling DM, Green SR, Gibb AR, Karg G, 1999. Predicting atmospheric concentration of pheromone in treated apple orchards. Journal of Chemical Ecology, 25:117-139.](#)

Suckling DM, Karg G, 1997. Mating disruption of the lightbrown apple moth: portable electroantennogram equipment and other aspects. In: Carde RT, Minks AK, eds. Insect Pheromone Research: New Directions. New York, USA: Chapman & Hall, 411-420.

[Suckling DM, Karg G, Bradley SJ, 1996. Apple foliage enhances mating disruption of light-brown apple moth. Journal of Chemical Ecology, 22\(2\):325-341.](#)

[Suckling DM, Khoo JGI, 1993. Cline in frequency of azinphosmethyl resistance in light brown apple moth \(Lepidoptera: Tortricidae\). Journal of Economic Entomology, 86\(5\):1308-1316](#)

[Suckling DM, Markwick NP, Wigley PJ, Frater C, Chilcott CN, Maindonald J, 1996. Response to purified Cry IB protein in lab-wild type crosses of lightbrown apple moth. Proceedings of the Forty Ninth New Zealand Plant Protection Conference, Quality Hotel Rutherford, Nelson, New Zealand, 13-15 August, 1996., 64-70; 21 ref.](#)

[Suckling DM, Shaw PW, 1995. Large-scale trials of mating disruption of lightbrown apple moth in Nelson, New Zealand. New Zealand Journal of Crop and Horticultural Science, 23\(2\):127-137](#)

Suckling DM, Shaw PW, Brown B, 1993. Efficacy of Bt, carbaryl and pyrethrum against lightbrown apple moth. Proceedings of the Forty Sixth New Zealand Plant Protection Conference. Rotorua, New Zealand: New Zealand Plant Protection Society, 141-145.

[Suckling DM, Walker JTS, Shaw PW, 1990. Reducing insecticide use in pipfruit: Nelson demonstration trials. Proceedings of the Forty Third New Zealand Weed and Pest Control Conference. Palmerston North, New Zealand: New Zealand Weed and Pest Control Society Inc., 306-310.](#)

Suckling DM, Walker JTS, Shaw PW, White V, 1988. Spray less for leafroller control. The Orchardist of New Zealand, November: 21-24.

[Svensson I, 2009. Remarkable records of Microlepidoptera in Sweden during 2008. \(Anmärkningsvärda fynd av smafjärilar \(Microlepidoptera\) i Sverige 2008.\) Entomologisk Tidskrift, 130\(1\):61-72. <http://www.sef.nu/>](#)

[Terauds A, Ireson JE, Rapley PEL, O'Loughlin JB, 1978. Post-harvest disinfestation of apples of the light-brown apple moth Epiphyas postvittana. Australian Journal of Experimental Agriculture and Animal Husbandry, 18\(91\):313-317.](#)

Thomas WP, 1975a. Lightbrown apple moth, Life Cycle Chart. Auckland, New Zealand: Department of Scientific and Industrial Research.

[Thomas WP, 1975b. Additional notes on leaf rollers. Orchardist of New Zealand, 48\(10\):354-355](#)

Thomas WP, 1989. Epiphyas postvittana (Walker), lightbrown apple moth (Lepidoptera: Tortricidae). In: A Review of Biological Control Invertebrate Pests and Weeds in New Zealand 1874 to 1987 [ed. by Cameron, P. J. \Hill, R. L. \Bain, J. \Thomas, W. P.]. Wallingford, UK: CAB International, 187-195.

[Thomson C, Tomkins AR, Wilson DJ, 1993. Activity of oils against lightbrown apple moth \(Epiphyas postvittana\) larvae. Proceedings of the Forty Sixth New Zealand Plant Protection Conference, 10-12 August 1993. Rotorua, New Zealand: New Zealand Plant Protection Society, 67-70](#)

[Thwaite WG, 1978. Light-brown apple moth, Epiphyas postvittana \(Walk.\) \(Lepidoptera: Tortricidae\): flight records for eight seasons at Bathurst, N.S.W. General and Applied Entomology, 10:39-44](#)

Thwaite WG, 1997. Australia's Progress in Apple IPM. A Review of Integrated Pest Management in Australian Apple Orchards. Technical Bulletin NSW Agriculture. 48. Orange, Australia: NSW Agriculture Communications Unit, Research Liaison Officer (Scientific Publications).

[Tomkins AR, Penman DR, Chapman RB, 1989. Effect of temperature and host plant on development of three species of leafrollers \(Lepidoptera: Tortricidae\). New Zealand Entomologist, No. 12:48-54](#)

[Turner CT, Davy MW, MacDiarmid RM, Plummer KM, Birch NP, Newcomb RD, 2006. RNA interference in the light brown apple moth, Epiphyas postvittana \(Walker\) induced by double-stranded RNA feeding. Insect Molecular Biology, 15\(3\):383-391. <http://www.blackwell-synergy.com/servlet/useragent?func=showIssues&code=imb>](#)

[UK CAB International, 1992. Epiphyas postvittana. \[Distribution map\]. Distribution Maps of Plant Pests, June \(2nd Revision\). Wallingford, UK: CAB International. Map 82.](#)

USDA-APHIS, 2007. USDA confirms light brown apple moth in California.
<http://www.aphis.usda.gov/newsroom/content/2007/03/applemoth.shtml>.

[Valentine BJ, Gurr GM, Thwaite WG, 1996. Efficacy of the insect growth regulators tebufenozide and fenoxycarb for lepidopteran pest control in apples, and their compatibility with biological control for integrated pest management. Australian Journal of Experimental Agriculture, 36\(4\):501-506; 18 ref.](#)

[Waddell BC, Dentener PR, Batchelor TA, 1990. Time-mortality response of leafrollers exposed to commercial controlled atmosphere coolstorage. Proceedings of the Forty Third New Zealand Weed and Pest Control Conference. Palmerston North, New Zealand: New Zealand Weed and Pest Control Society Inc., 328-333](#)

[Walker JTS, Baynon GT, White V, 1991. Insect control on apples with RH-5992 a novel insect growth regulator. In: Proceedings of the Forty Fourth New Zealand Weed and Pest Control Conference. Palmerston North, New Zealand: New Zealand Weed and Pest Control Society Inc., 66-69](#)

[Wearing CH, 1999. BugKey. <http://www.hortnet.nz/BugKey>](#)

[Wearing CH, Colhoun K, Attfield B, Marshall RR, McLaren GF, 2003. Screening for resistance in apple cultivars to lightbrown apple moth, *Epiphyas postvittana*, and greenheaded leafroller, *Planotortrix octo*, and its relationship to field damage. *Entomologia Experimentalis et Applicata*, 109\(1\):39-53. <http://www.blackwell-synergy.com/links/doi/10.1046/j.1570-7458.2003.00091.x/abs/>](#)

Wearing CH, Thomas WP, Dugdale JS, Danthanarayana W, 1991. Tortricid pests of pome and stone fruits, Australian and New Zealand species. In: van der Geest LPS, Evenhuis HH, ed. Tortricid pests: their biology, natural enemies and control. World crop pests. Volume 5. Amsterdam, Netherlands: Elsevier, 453-472.

[Whiting DC, Foster SP, Heuvel J van den, Maindonald JH, 1992. Comparative mortality responses of four tortricid \(Lepidoptera\) species to a low oxygen-controlled atmosphere. *Journal of Economic Entomology*, 85\(6\):2305-2309](#)

[Whiting DC, Foster SP, Maindonald JH, 1991. Effects of oxygen, carbon dioxide, and temperature on the mortality responses of *Epiphyas postvittana* \(Lepidoptera: Tortricidae\). *Journal of Economic Entomology*, 84\(5\):1544-1549](#)

Whiting DC, Hoy LE, O'Callaghan M, 1997. Mortality response of lightbrown apple moth to a controlled atmosphere cold storage treatment for apricots. Proceedings of the Fiftieth New Zealand Plant Protection Conference. Rotorua, New Zealand: New Zealand Plant Protection Society, 431-435.

[Whiting DC, O'Connor GM, Heuvel Jvan den, Maindonald JH, 1995. Comparative mortalities of six tortricid \(Lepidoptera\) species to two high-temperature controlled atmospheres and air. *Journal of Economic Entomology*, 88\(5\):1365-1370; 23 ref.](#)

[Winter TG, 1985. A new larval food plant for *Epiphyas postvittana* \(Walker\) \(Lepidoptera: Tortricidae\) in Cornwall. *Entomologist's Gazette*, 36\(1\):1](#)

Contributors

21/12/2007 Updated by:

D Suckling, Hort+Research, PO Box 51, Lincoln 8152, Canterbury, New Zealand

Images

Picture



Title

E. postvittana; adult female
(museum set specimen)

Caption

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E. postvittana; adult male
(museum set specimen)

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E. postvittana; two adults at
rest

E. postvittana; two adults at rest.
Chessington, UK. June 2000.

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E. postvittana; larvae

E. postvittana; larvae. Chessington,
UK. June 2000.

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