



This presentation is about the Light Brown Apple Moth, an invasive pest posing an economic and environmental threat to New York.

Light Brown Apple Moth

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Enhanced First Detector Training for New York State

Light brown apple moth

Epiphyas postvittana



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UC Agriculture and Natural Resources blog

Light brown apple moth

Epiphyas postvittana

- Potential impact
- Pathways
- Identification and life cycle
- Hosts
- Damage
- Scouting—signs and symptoms
- What to do if you suspect you find it
- Resources

Light brown apple moth

Epiphyas postvittana

- Native to Australia
- First mainland U.S. detection was in CA in 2007 (however it was found in HI in 1896)
- Pest of ornamental plants, crops and plantation trees



Photos: (Top) - Todd Gilligan, CSU, Bugwood.org #5482456; (Bottom) - Department of Primary Industries and Water, Tasmania Archive, Bugwood.org #5385954

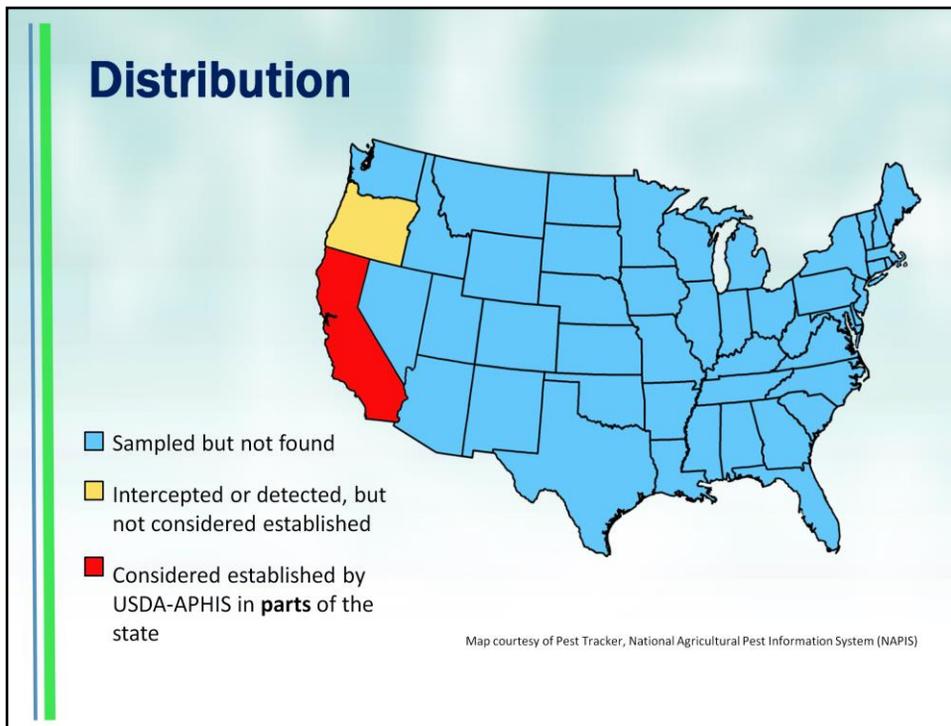
Light Brown Apple Moth (LBAM) is native to Australia, but has long been established in New Zealand, New Caledonia, Hawaii and the United Kingdom. They have been present in California since 2007. On February 6, 2007 a private citizen near Berkeley caught two light brown apple moths in a blacklight trap.

This species is an economic pest of fruit and ornamental crops and of managed forests. The population and geographic distribution of LBAM continues to expand in California, and New York growers are concerned about the potential for this pest to become established here in the state.

Information sources:

Brown, J. W. 2007. Discovery of light brown apple moth in North America. *Torts* 8: 2.

Plant Epidemiology and Risk Analysis Laboratory, Center for Plant Health Science and Technology. 2009. APHIS Draft Response to Petitions for the Reclassification of Light Brown Apple Moth [*Epiphyas postvittana* (Walker)] as a Non-Quarantine Pest. United States Department of Agriculture Animal and Plant Health Inspection Service Plant Protection and Quarantine.



They were originally a pest of apples in Australia, and moved around the world with the global commodities trade on plants, such as apples, stone fruit and cut flowers.

The first detection of LBAMs in the continental United States was in Alameda County, California (near Berkley) in 2006, although the specimens were not determined to species until 2007. Presently, 25 of California's 58 counties are under some form of quarantine or observation for LBAM.

New York growers are concerned that the moth will hitchhike on lettuce, cut flowers, or strawberries imported from California.

[Found in: New Zealand, 1891; Hawaii, 1896; England, 1936; New Caledonia, 1968; France, 2004; California, 2007]

Information sources:

Espinosa, A. and A. C. Hodges. 2009. *Epiphyas postvittana*. Bugwood Wiki. Accessed 28 July 2013.

Plant Epidemiology and Risk Analysis Laboratory, Center for Plant Health Science and Technology. 2009. APHIS Draft Response to Petitions for the Reclassification of Light Brown Apple Moth [*Epiphyas postvittana* (Walker)] as a Non-Quarantine Pest. United States Department of Agriculture Animal and Plant Health Inspection Service

Plant Protection and Quarantine.

Identification: eggs

- 20–50 laid on upper surface of leaf or fruit
- 0.84–0.95 mm long
- Pale white to green
 - Black or brown when parasitized



Photos: (Top) Todd Gilligan, CSU Bugwood.org #5495358; (bottom) Department of Primary Industries and Water, Tasmania Archive, Bugwood.org #5385952

Each egg is approximately 0.04 inches (0.84 to 0.95 mm) long. They are white to light green in color and appear flat with a pebbled-like surface. They are laid in small overlapping rafts of twenty to fifty eggs at a time. As eggs mature they turn paler yellow-green. They will also turn black or brown when parasitized.

Information sources:

Lewis, C. and A. C. Hodges. 2013. Light Brown Apple Moth. UF & FDACS/DPI. Featured Creatures # EENY-469

Espinosa, A. and A. C. Hodges. 2009. *Epiphyas postvittana*. Bugwood Wiki. Accessed 28 July 2013.

Identification: larva & pupa

Positive ID best with
molecular methods
But experts can ID
morphologically, IF the
sample is a good one...



Photos: (Left) Department of Primary Industries and Water, Tasmania Archive, Bugwood.org #5385959; (Right) - Todd Gilligan, CSU, Bugwood.org #5495362

Leafroller moths are very difficult to tell apart, as many of them have the same general appearance. Newly hatched larvae are pale green in color and 2 mm in length. As they mature their color deepens and their length increases up to 20 mm.

First instar larvae are about 1.5-2 mm long and have dark brown heads. The other instars have a light brown head and a greenish-brown region behind the head with no markings.

Mature larvae are 10 to 18 mm in length with a green body and a darker green central stripe and two side stripes. The body hairs are whitish. They pupate in a thin-walled silken cocoon webbed between two leaves. The pupa measures between 10 and 15 mm in length and will turn from green to brown as it matures.

Information sources:

Espinosa, A. and A. C. Hodges. 2009. *Epiphyas postvittana*. Bugwood Wiki. Accessed 28 July 2013.

Identification: adults

- About 1cm in length
- Broad, brownish, slightly overlapping wings, pattern extremely variable
- Thin antennae
- If microscope available
 - Forward facing palps with tiny terminal segment
 - Proboscis free of scales



Photos: Top - Julieta Brambila, USDA 2011; Bottom - Natasha Wright, FDACS 2008

Adult's are approximately 0.4 inches (1 cm) long, with a wingspan between 0.6 and 1.3 cm, females being slightly larger than males.

They have a yellowish-brown to dark brown body color with overlapping brown forewings of varying shades and mottled pale brown-gray hind wings. Additionally, light brown apple moths are sexually dimorphic, and the females are differentiated by a dark mark located on the hind margin of each forewing. Many tortrid moths look similar to LBAM and LBAM wing patterns are extremely variable so wing pattern should not be used in identification.

The adult moths have whip-like antennae, forward-facing palpi, and no scales on the proboscis.

Information sources:

Danthanarayana, W. 1975. The Bionomics, distribution and host range of the light brown apple moth, *Epiphyas Postvittana* (Walk.) (Tortricidae). *Australian Journal of Zoology* 23: 419-437.

Espinosa, A. and A. C. Hodges. 2009. *Epiphyas postvittana*. Bugwood Wiki. Accessed 28 July 2013.

Lewis, C. and A. C. Hodges. 2013. Light Brown Apple Moth. UF & FDACS/DPI. Featured Creatures # EENY-469.

Identification: adults

- ID requires expert species level confirmation by dissection of genitalia or molecular methods
- Highly variable forewing coloration & pattern
 - NOT a reliable diagnostic tool



Photos: Todd Gilligan, CSU, Bugwood.org #5482458

Identification of light brown apple moths requires expert confirmation as they may exhibit color variation and be difficult to distinguish from other small brown moths. As seen in these images, the brown shade and pattern of the forewings is highly variable, and cannot be used as a diagnostic character.

Adults can only be reliably identified using genital dissection or molecular methods. Tools for diagnosing the light brown apple moth and related western U.S. leafrollers are available at <http://keys.lucidcentral.org/keys/v3/LBAM/lucid.html>.

If you see a moth that meets the description, please contact your local NPDP diagnostic lab or state department of agriculture, especially if you are experiencing unusual pest outbreaks and notice moths or larvae similar to LBAM.

Information sources:

Espinosa, A. and A. C. Hodges. 2009. *Epiphyas postvittana*. Bugwood Wiki. Accessed 28 July 2013.

Lewis, C. and A. C. Hodges. 2013. Light Brown Apple Moth. UF & FDACS/DPI. Featured Creatures # EENY-469.

Similar species



*Argyrotaenia
velutinana*
Redbanded leafroller

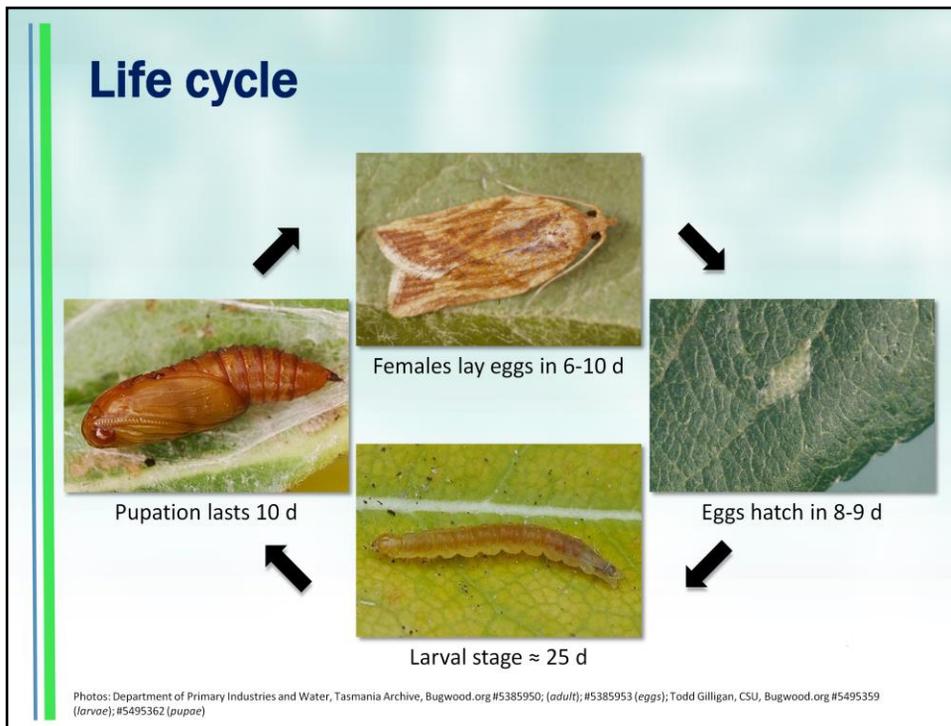


*Choristoneura
rosaceana*
Obliquebanded
leafroller



Photos: (left) redbanded leafroller, Mark Dreiling, Bugwood.org, #5460673; (right) obliquebanded leafroller

LBAM is a member of the Tortricidae family of moths and includes many pest species. In North America there are approximately 1200 species of tortricids. Most tortricid moths are small and brown with a wingspan of approximately 10-30 mm. Two similar, native tortricid moths include the redbanded leafroller and the obliquebanded leafroller which are also pests of apple.



In warmer climates, there can be four or five overlapping generations per year; whereas in colder climates they may be limited to two generations per year.

Egg masses are laid on the leaves, young stems, or fruit of plants, and contain 2 to 170 slightly overlapping eggs. Eggs hatch after 5 to 30 days depending on temperature. LBAM has 5 to 6 larval instars, which can take from three to five weeks to grow through. Cold temperatures slow larval development and overwintering occurs between the 2nd and 4th larval instars.

Larvae pupate in a thin-walled silken cocoon webbed between two leaves. The pupal stage will last between 3 and 8 weeks.

Females mate and begin to lay eggs 6 to 10 days after emerging from her cocoon, and will continue for about 21 days. A female usually lays around 300 eggs in a lifetime, but is capable of producing up to 1,500 eggs.

The life span of an adult LBAM is 2 to 3 weeks, depending on temperature and host plant availability. Major flight periods occur during September-October, December-January, February-March, and April-May. First Detectors might see the moth flying at these times.

Information sources:

Lewis, C. and A. C. Hodges. 2013. Light Brown Apple Moth. UF & FDACS/DPI. Featured Creatures # EENY-469

Espinosa, A. and A. C. Hodges. 2009. *Epiphyas postvittana*. Bugwood Wiki.
Accessed 28 July 2013.

Host plants

Generalist

- Wide range of unrelated hosts
- Serious pest of stone and pome fruits
- Adds 1.3% to management costs
- Untreated, can result in 70% crop loss

Larva on young apples



Photos: Department of Primary Industries and Water, Tasmania Archive, Bugwood.org #5385957

LBAMs are extremely polyphagous herbivores, feeding on well over 2,000 species of plants in 121 separate families. They appear to prefer herbaceous plants to woody perennials, but will utilize whatever hosts are available. In particular, they are a serious pest of stone and pome fruit in Australia and New Zealand.

In addition to economically important crops and nursery stock, this moth also jeopardizes over 70 species, subspecies, or varieties of native plants that are in danger of extinction.

For a full list – http://www.cdfa.ca.gov/plant/factsheets/LBAM_HostList.pdf

Information sources:

Anonymous. 2008. "LBAM Host List". California Department of Food and Agriculture. Sacramento, CA.

Plant Epidemiology and Risk Analysis Laboratory, Center for Plant Health Science and Technology. 2009. APHIS Draft Response to Petitions for the Reclassification of Light Brown Apple Moth [*Epiphyas postvittana* (Walker)] as a Non-Quarantine Pest. United States Department of Agriculture Animal and Plant Health Inspection Service Plant Protection and Quarantine.

Host plants

New York hosts would include:

- Apples, pears, peaches, plums, cherries, grapes
- Strawberries, blueberries
- Cabbage, corn, tomatoes, peppers
- Oaks, willow, poplar, walnut
- Roses, chrysanthemums



Photos: (top) UC Agriculture and Natural Resources blog; (bottom) larva on grape.

New York hosts include: apple, blueberry

For a full list – http://www.cdfa.ca.gov/plant/factsheets/LBAM_HostList.pdf

Information sources:

Anonymous. 2008. "LBAM Host List". California Department of Food and Agriculture. Sacramento, CA.

Plant Epidemiology and Risk Analysis Laboratory, Center for Plant Health Science and Technology. 2009. APHIS Draft Response to Petitions for the Reclassification of Light Brown Apple Moth [*Epiphyas postvittana* (Walker)] as a Non-Quarantine Pest. United States Department of Agriculture Animal and Plant Health Inspection Service Plant Protection and Quarantine.

Damage

- Leaf-roller moth (construct tent)
- Feed on underside of leaves
- Scar exterior surface of fruit
- Older larvae burrow into fruit



Photos: Department of Primary Industries and Water, Tasmania Archive, Bugwood.org #5385955; #5385954

As “leafroller” moths, the larvae will web leaves together to hide from predators, and then feed safely inside these tents. The "leaf rolls", or nests, that larvae construct damages leaves and fruit surfaces. Additional damage is caused directly by feeding on buds and leaves and when older larvae tunnel into the flesh of the fruit. This deforms the host plant, reduces growth rate, and renders fruit unmarketable.

A USDA quantitative analysis estimated that in high risk areas, light brown apple moths could cause over \$118 million in damages, due to direct effects on apple, grape, orange, and pear crops of the country, and also through widespread international and domestic trade restrictions.

Information sources:

Lewis, C. and A. C. Hodges. 2013. Light Brown Apple Moth. UF & FDACS/DPI, Featured Creatures # EENY-469.

Irvin N. 2009. Light Brown Apple Moth. Center for Invasive Species Research. Accessed 28 July 2013.

USDA-APHIS-PPQ. 2009. Economic Analysis: Risk to U.S. Apple, Grape, Orange and Pear Production from the Light Brown Apple Moth, *Epiphyas postvittana* (Walker). Animal and Plant Health Inspection Service. Accessed 28 July 2013.

Scouting for LBAM

Scouting

- Look for rolled leaves and silk nests



Photos: (top) USDA via Shane58 Flickr; (bottom) Clement via Flickr

Scouting for LBAM

Scouting

- Look for rolled leaves and silk
- Look for signs of the pest, egg masses, visible larvae, visible adults



Photos: (top) LBAM larva, USDA Hungry Pests; LBAM adult, Reeves, Flickr

Scouting for LBAM

Scouting

- Look for rolled leaves and silk
- Look for signs of the pest, egg masses, visible larvae, visible adults
- Damaged fruit



Photos: (top) Department of Primary Industries and Water, Tasmania Archive, Bugwood.org #5385954; (bottom) USDA Hungry Pests.



Pheromone trap

Monitoring

The USDA eradication program

- Traps baited with LBAM lure
 - Sterile males
 - Quarantines
 - Ground based & aerial treatments
 - Bio-controls

Photos: Julieta Brambila, USDA 2011

Millions of dollars have already been spent to prevent the spread of this pest. The USDA initiated an eradication program in 2007 and it is anticipated to continue until 2015.

The program emphasizes:

- (1) rigorous moth trapping and detection program throughout California and other at risk states, including the southeastern U.S.
- (2) releasing sterile male LBAMs through the use of the sterile insect technique
- (3) applying ground-based treatments to control infestations around leading edges and in densely-affected areas (i.e. commercial nurseries) to reduce artificial/mechanical spread
- (4) rigorous enforcement of quarantines,
- (5) use of aerial treatments in unoccupied areas only when necessary.

Some alternative methods that have also been proposed include the use of pheromone traps and biological controls, such as *Trichogramma platerni* and *Trichogramma pretiosa* wasps.

Information sources:

Irvin N. 2009. Light Brown Apple Moth. Center for Invasive Species Research. Accessed 28 July 2013.

Jones, D. 2009. Vigilance urged after moth find. San Jose Mercury News - Central Coast. Accessed 23 April 2013.

What to do if you suspect you find LBAM

Light brown apple moth is a regulated pest not known to be established in the state of New York, however, NY has a suitable climate for establishment and plenty of hosts are available so...

- If you find signs of a pest which looks like light brown apple moth
- Take a quality sample and send it to the Cornell Insect Diagnostic Lab.
- If it is confirmed to be light brown apple moth, the lab will notify the appropriate stakeholders and a sample will go out to the national identifier for this pest for official confirmation.

Light brown apple moth is a regulated pest not known to be established in the state of New York however, because New York has a climate which would allow this pest to establish, the state is considered to be at risk.

Questions?



Enhanced First Detector Training for New York State

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Danthanarayana, W. 1975. The Bionomics, distribution and host range of the light brown apple moth, *Epiphyas Postvittana* (Walk.) (Tortricidae). *Australian Journal of Zoology* 23: 419-437.

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Gilligan, TM and ME Epstein. 2009. "LBAM ID, Tools for diagnosing light brown apple moth and related western U. S. leafrollers (Tortricidae: Archipini)". Colorado State University, California Department of Food and Agriculture, and Center for Plant Health Science and Technology, USDA, APHIS, PPQ.

Irvin N. 2009. Light Brown Apple Moth. Center for Invasive Species Research. Accessed 28 July 2013.

Jones, D. 2009. Vigilance urged after moth find. *San Jose Mercury News - Central Coast*. Accessed 23 April 2013.

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National Agricultural Pest Information System (NAPIS). Purdue University. "Survey Status of Light Brown Apple Moth - *Epiphyas postvittana* (All years)." Published: 08/06/2013. <http://pest.ceris.purdue.edu/map.php?code=ITBUBPA&year=alltime>. Accessed: 08/06/2013.

Plant Epidemiology and Risk Analysis Laboratory, Center for Plant Health Science and Technology. 2009. APHIS Draft Response to Petitions for the Reclassification of Light Brown Apple Moth [*Epiphyas postvittana* (Walker)] as a Non-Quarantine Pest. United States Department of Agriculture Animal and Plant Health Inspection Service Plant Protection and Quarantine.

Suckling, DM and EG Brockerhoff. 2010. "Invasion biology, ecology, and management of the light brown apple moth (Tortricidae)". *Annual Reviews of Entomology*. 55:285–306.

USDA-APHIS-PPQ. 2009. Economic Analysis: Risk to U.S. Apple, Grape, Orange and Pear Production from the Light Brown Apple Moth, *Epiphyas postvittana* (Walker). Animal and Plant Health Inspection Service. Accessed 28 July 2013.

USDA. 2008. "Treatment program for light brown apple moth in California. Environmental Assessment, February 2008." 46 pp.