

Tortricid target pest species

Part 2: Tortricinae

Taxonomic Workshop for Early Detection of
Important Tortricidae and Other Lepidopteran
Agricultural and Silvicultural Pests

UMass Amherst 15-17 July 2013



Todd M. Gilligan, Ph.D.

Colorado State University

Department of Bioagricultural Sciences and Pest Management

1177 Campus Delivery

Fort Collins, Colorado 80523 USA

tgilliga@gmail.com / tgilliga@rams.colostate.edu

Pest Tortricidae of Importance to the U. S.

Genus	species	Author	Common name	Status	Region	List
<i>Adoxophyes</i>	<i>orana</i>	(Fischer von Röslerstamm)	summer fruit tortrix	primary target	Palearctic	1, 2
<i>Archips</i>	<i>podana</i>	(Scopoli)	fruit tree tortrix	primary target	Palearctic	1
<i>Archips</i>	<i>xylosteanus</i>	(Linnaeus)	golden variegated leafroller	primary target	Palearctic	1, 2
<i>Crociosema</i>	<i>aporema</i>	(Walsingham)	bean shoot moth	primary target	S. America	1, 3
<i>Epiphyas</i>	<i>postvittana</i>	(Walker)	light brown apple moth	primary target	Australia	1, 3
<i>Eupoecilia</i>	<i>ambiguella</i>	(Hübner)	vine moth/grape berry moth	primary target	Palearctic	1
<i>Grapholita</i>	<i>funebrana</i>	(Treitschke)	plum fruit moth	primary target	Palearctic	1, 3
<i>Lobesia</i>	<i>botrana</i>	(Denis & Schiffermüller)	grape berry moth	primary target	Palearctic	1, 3
<i>Thaumatotibia</i>	<i>leucotreta</i>	(Meyrick)	false codling moth	primary target	Africa	1, 2
<i>Tortrix</i>	<i>viridana</i>	Linnaeus	European/green oak leafroller	primary target	Palearctic	1, 3
<i>Acleris</i>	<i>comariana</i>	(Lienig & Zeller)	strawberry tortrix	secondary target	Holarctic	
<i>Archips</i>	<i>crataegeana</i>	(Hübner)	brown oak tortrix	secondary target	Palearctic	
<i>Archips</i>	<i>fuscocupreanus</i>	Walsingham	apple tortrix	secondary target	Oriental	
<i>Argyrotaenia</i>	<i>ljungiana</i>	(Thunberg)	grape tortrix	secondary target	Palearctic	1
<i>Clepsis</i>	<i>spectrana</i>	(Treitschke)	cyclamen tortrix	secondary target	Palearctic	
<i>Cryptaspasma</i>	n. sp.	Gilligan & Brown - in press	avocado moth	secondary target	C. America	
<i>Cryptophlebia</i>	<i>illepida</i>	(Butler)	koa seedworm	secondary target	Hawaii	
<i>Cryptophlebia</i>	<i>ombrodelta</i>	(Lower)	litchi fruit moth	secondary target	Aust./Hawaii	
<i>Cryptophlebia</i>	<i>peltastica</i>	(Meyrick)	litchi moth	secondary target	Africa	
<i>Cydia</i>	<i>coniferana</i>	(Saxesen)	pine resin moth	secondary target	Palearctic	
<i>Cydia</i>	<i>fabiovra</i>	(Meyrick)	pod moth	secondary target	S. America	
<i>Cydia</i>	<i>splendana</i>	(Hübner)	chestnut tortrix/acorn moth	secondary target	Palearctic	1
<i>Enarmonia</i>	<i>formosana</i>	(Scopoli)	cherry bark tortrix	secondary target	Palearctic	3
<i>Leguminivora</i>	<i>glycinivorella</i>	(Matsumura)	soybean pod borer	secondary target	Oriental	1, 3
<i>Pammene</i>	<i>fasciana</i>	(Linnaeus)	chestnut leafroller	secondary target	Palearctic	1
<i>Pandemis</i>	<i>cerasana</i>	(Hübner)	barred fruit tree tortrix	secondary target	Palearctic	
<i>Pandemis</i>	<i>heparana</i>	(Denis & Schiffermüller)	dark fruit tree tortrix	secondary target	Palearctic	
<i>Proeulia</i>	spp.	[various]	leafrollers	secondary target	Chile	1

Major tortricid pests threatening U.S. agriculture, grouped as primary and secondary target species. Region specifies the native region of each species.

List specifies inclusion in an official USDA list: 1 = OPIS; 2 = CAPS 2012 Top 50; 3 = CAPS Other

Tortricid target pest species

Olethreutinae (Part 1)		Tortricinae (Part 2)	
<i>Cydia latiferreana</i> *	(Walsingham)	<i>Adoxophyes orana</i>	(Fischer von Röslerstamm)
<i>Cydia splendana</i>	(Hubner)	<i>Archips podana</i>	(Scopoli)
<i>Cydia pomonella</i> *	(Linnaeus)	<i>Archips xylosteana</i>	(Linnaeus)
<i>Grapholita funebrana</i>	(Treitschke)	<i>Archips fuscocupreanus</i>	Walsingham
<i>Grapholita molesta</i> *	(Busck)	<i>Choristoneura fumiferana</i> *	(Clemens)
<i>Grapholita packardi</i> *	(Zeller)	<i>Choristoneura rosaceana</i> *	(Harris)
<i>Grapholita prunivora</i> *	(Walsingham)	<i>Epiphyas postvittana</i>	(Walker)
<i>Thaumatotibia leucotreta</i>	(Meyrick)	<i>Eupoecilia ambiguella</i>	(Hübner)
<i>Enarmonia formosana</i>	(Scopoli)	<i>Tortrix viridana</i>	Linnaeus
<i>Lobesia botrana</i>	([Denis & Schiffermuller])	* = non-target	

Adoxophyes orana

Tortricidae: Tortricinae: Archipini

- ***Adoxophyes orana* (Fischer von Röslerstamm)**
 - summer fruit tortrix, apple peel tortrix, [smaller tea tortrix]
 - Major pest of fruit crops throughout its range. Most economic loss is caused by damage to apple and pear. Larvae are highly polyphagous.
 - A European native, this species is widely distributed throughout Europe and several countries in Asia (China, Japan, and Korea)

Adoxophyes orana

Adult recognition

- FWL: 7.0-8.5 mm(male); 8.0-11.0 mm (female)
- Forewings are pale yellowish brown with brown to dark brown fasciate markings. Males are smaller with brighter markings and a forewing costal fold; females are larger, darker, and have duller markings.
- Adults may appear similar to species in other genera such as *Choristoneura* and *Clepsis*. Two species of *Adoxophyes* are present in the U.S.: *A. furcatana* and *A. negundana*. A genitalic dissection can be used to confirm identity.
- Another very similar species, *Adoxophyes honmai*, is a pest of tea in Asia. Molecular diagnostics may be required to reliably separate different species of *Adoxophyes* originating from Asia.



Adoxophyes orana

Adult recognition

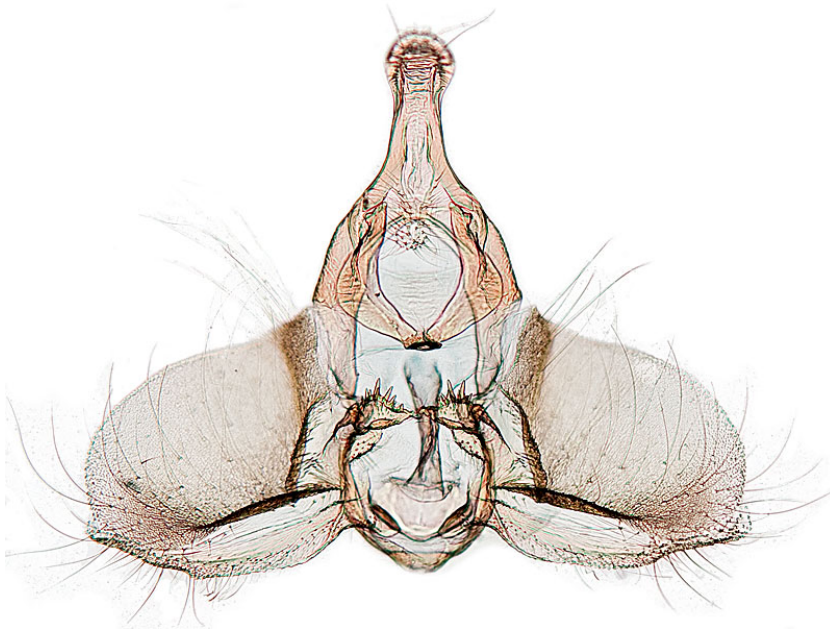
- Typical wing pattern (male)



Adoxophyes orana

Adult recognition

- Male and female genitalia
 - Male genitalia are distinguished by reduced socii, a well developed gnathos, a rounded valva, and transtilla with a spiny basal lobe.
 - Female genitalia have a long ductus bursae and a hooklike signum in the rounded corpus bursae.



Adoxophyes orana

Biology

- Larvae vary in body color. Head and prothoracic shield are black in early instars and become brown to yellowish brown in later instars. Legs are unmarked.
- Larvae are difficult to distinguish from other Archipini and are generally not identifiable to species based only on morphology.
- Larvae are highly polyphagous and have been recorded feeding on the leaves and fruits of plants in more than 17 families. Economically important hosts include: apple, cherry, peach, pear, plum, rose, blackberry, citrus, lychee, raspberry, oak, cotton, hops, and many others. Most economic loss occurs in apple and pear.



Adoxophyes orana

- Beeke, H. and D. J. De Jong. 1991. Identification of Larvae and Pupae, pp. 65-76. In L. P. S. van der Geest and H. H. Evenhuis [eds.], Tortricid Pests: Their Biology, Natural Enemies, and Control. World Crop Pests, Vol. 5. Elsevier, Amsterdam.
- Bradley, J. D., W. G. Tremewan and A. Smith. 1973. British Tortricoid Moths - Cochylidae and Tortricidae: Tortricinae. The Ray Society, London, England.
- Crop Protection Compendium. 2007 Edition. CAB International, Wallingford, UK, 2007.
- Davis, E. E., S. French and R. C. Venette. 2005. Mini risk assessment: summer fruit tortrix moth, *Adoxophyes orana* (Fischer von Roslerstamm, 1834) (Lepidoptera: Tortricidae). USDA - CAPS Pest Risk Assessment.
- Lee, S. Y., H. Park, K. S. Boo, K.-T. Park and S. Cho. 2005. Molecular identification of *Adoxophyes honmai* (Yasuda) (Lepidoptera: Tortricidae) based on mitochondrial COI gene sequences. Molecules and cells. 19: 391-397.
- Meijerman, L. and S. A. Ulenberg. 2000. Arthropods of Economic Importance: Eurasian Tortricidae. Arthropods of Economic Importance series. ETI/ZMA.
- Sakamaki, Y. and T. Hayakawa. 2004. Specific differences in larval and pupal characters of Japanese species of *Adoxophyes* (Lepidoptera, Tortricidae). Applied Entomology and Zoology. 39: 443-453.
- Yasuda, T. 1998. The Japanese species of the genus *Adoxophyes* Meyrick (Lepidoptera, Tortricidae). Transactions of the Lepidopterological Society of Japan. 49: 159-173.
- Zhou, J.-H., H.-G. Qui and W.-J. Fu. 1997. Summer fruit tortrix *Adoxophyes orana* should be classified as two subspecies (Lepidoptera: Tortricidae: Tortricidae). Entomotaxonomia. 19: 130-135.

Archips spp.

Tortricidae:Tortricinae:Archipini

- ***Archips podana* (Scopoli)**
 - fruit tree tortrix
- ***Archips xylosteana* (Linnaeus)**
 - apple leaf roller, brown oak tortrix
- ***Archips fuscocupreanus* Walsingham**
 - apple tortrix

Archips podana

Tortricidae: Tortricinae: Archipini

- ***Archips podana* (Scopoli)**
 - fruit tree tortrix
 - *Archips podana* is considered a major pest of apple and pear in parts of Europe. Larvae are moderately polyphagous and feed on a variety of deciduous trees and shrubs (mainly Rosaceae).
 - *Archips podana* is distributed throughout Europe. It has been introduced into the Pacific Northwest where it is present in Washington and British Columbia.

Archips podana

Adult recognition

- FWL: 10.0-12.0 mm
- Males are pale purplish brown with a dark brown basal patch and well defined median fascia. Females are pale brown to purplish brown with darker reticulate markings. The hindwing in both sexes is gray basally and yellowish orange apically; the yellowish orange coloration is usually more pronounced in the female. Dark forms of both sexes exist, where the entire forewing is overlaid with purplish-gray scaling. Males have a forewing costal fold.
- Other similar species of *Archips* with yellowish orange apical shading on the hindwing include *A. oporana* and *A. rosana*, but the amount of shading is much greater in most *A. podana* individuals. Female *A. podana* may be confused with female *Choristoneura rosaceana*, which has similar markings on the forewing and hindwing.



Archips podana

Adult recognition

- Typical wing pattern (male)



Archips podana

Adult recognition

- Male and female genitalia
 - Male genitalia are characterized by a well developed uncus, reduced socii, rounded valva, and a well defined sacculus ending in a point.
 - Female genitalia are characterized by a long ductus bursae with cestum and a single signum in the rounded corpus bursae.



Archips podana

Biology

- Mature larvae are approximately 15-20 mm in length. The abdomen is pale green to pale gray with pale conspicuous pinacula. The head is reddish brown. The prothoracic shield is reddish brown anteriorly and shaded with black posteriorly. Thoracic legs are brown or black.
- Larvae of *A. podana* are similar to those of many other Archipini.
- Larvae are moderately polyphagous and have been recorded feeding on a variety of deciduous trees and shrubs. Economically important hosts include: apple, pear, blackberry, raspberry, cherry, plum, blueberry, and others.



Archips xylosteana

Tortricidae: Tortricinae: Archipini

- ***Archips xylosteana* (Linnaeus)**
 - apple leaf roller, brown oak tortrix, variegated golden tortrix
 - Pest of fruit trees in Europe, causing damage to buds, new foliage, and fruitlets.
 - *Archips xylosteana* is distributed throughout Europe, Asia (China, Iran, Japan, Kazakhstan, Korea, Siberia, Turkey), and northern Africa (Algeria). It was first discovered in North America (Newfoundland, Canada) in 2005.

Archips xylosteana

Adult recognition

- FWL: 7.0-10.0 mm (male); 9.0-11.0 mm (female)
- Forewing ground color is pale pinkish brown. Forewing markings are dark reddish brown and include a basal patch, a well-defined median fascia that is narrow at the costa and broadened at the dorsum, and a costal spot. Hindwings are grayish brown and lack extensive yellowish orange apical shading. Males have a forewing costal fold.
- Adult *A. xylosteana* may appear similar to other *Archips*, including: *A. betulana*, *A. crataegana*, *A. grisea*, *A. magnoliana*, *A. oporana*, *A. podana*, and *A. rosana*. Most *A. xylosteana* individuals lack the extensive yellowish orange apical shading on the hindwing that is present in *A. podana* and *A. rosana*.



Archips xylosteana

Adult recognition

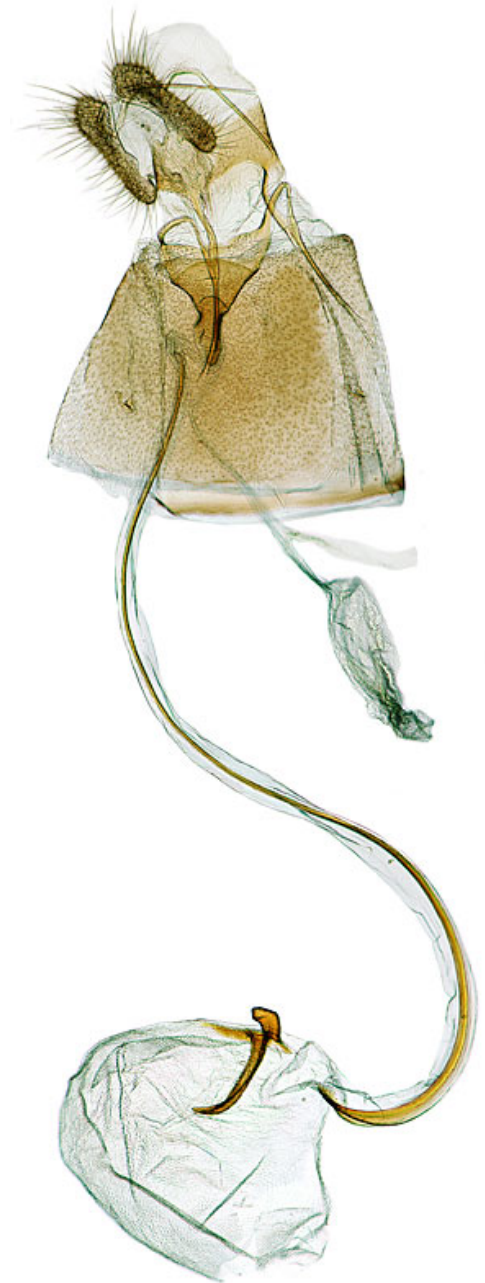
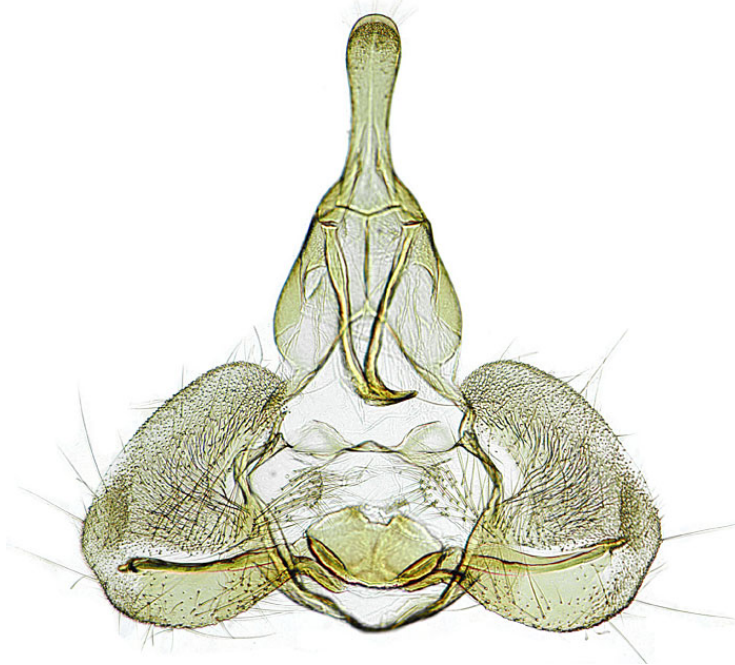
- Typical wing pattern



Archips xylosteana

Adult recognition

- Male and female genitalia
 - Male genitalia are characterized by a large, parallel-sided uncus, rounded valva, and well defined sacculus with a short projection.
 - Female genitalia are characterized by a very long ductus bursae with cestum and a signum in the round corpus bursae.



Archips xylosteana

Biology

- Mature larvae are greenish gray to whitish gray. The head and prothoracic shield are black or dark brown and are separated by a white line. Thoracic legs are dark brown or black.
- Larvae of *A. xylosteana* are similar to those of many other Archipini.
- Larvae are moderately polyphagous and have been recorded feeding on a variety of deciduous trees and shrubs. Economically important hosts include: apple, cherry, raspberry, pear, oak, and others.



Archips fuscocupreanus

Tortricidae: Tortricinae: Archipini

- ***Archips fuscocupreanus* Walsingham**
 - apple tortrix
 - Important pest of apple in East Asia
 - Larvae are highly polyphagous and feed on plants in more than 23 families
 - A native of East Asia, *Archips fuscocupreanus* has been introduced to the northeastern United States (Connecticut, Massachusetts, New Jersey, New York, and Rhode Island) and Pacific Northwest (Washington).

Archips fuscocupreanus

Adult recognition

- FWL: 7.0-9.5 mm (male); 8.0-12.5 mm (female)
- Forewing color is dull brown with dark-brown to reddish-brown markings. Pattern expression can vary between individuals, but the median fascia is complete from costa to dorsum. Hindwings are brownish gray. Males have a forewing costal fold.
- Some individuals resemble *Archips xylosteana*, but the two species can be separated by the broader costal fold and continuous median fascia (from costa to dorsum) in *A. fuscocupreanus*.
- Other *Archips* species, including *Archips crataegana*, *Archips grisea*, and forms of *Archips podana* and *Archips rosana*, can appear similar to *A. fuscocupreanus*. A genitalic dissection can be used to confirm identity.



Archips fuscocupreanus

Adult recognition

- Typical wing pattern



Archips fuscocupreanus

Adult recognition

- Male and female genitalia



Archips fuscocupreanus

Biology

- *Archips fuscocupreanus* completes one generation per year, with adults present in mid-June through mid-July in the northeastern U.S.
- Females lay black egg masses on the trunks and limbs of trees. The eggs overwinter, and first instar larvae hatch the following spring.
- Early instars feed on young leaves. Later instars construct a shelter by webbing together leaves and consume leaves, flowers, and occasionally fruit.
- Pupation occurs in webbed leaves.

Archips spp.

- Beeke, H. and D. J. De Jong. 1991. Identification of Larvae and Pupae, pp. 65-76. In L. P. S. van der Geest and H. H. Evenhuis [eds.], Tortricid Pests: Their Biology, Natural Enemies, and Control. World Crop Pests, Vol. 5. Elsevier, Amsterdam.
- Bradley, J. D., W. G. Tremewan and A. Smith. 1973. British Tortricoid Moths - Cochylidae and Tortricidae: Tortricinae. The Ray Society, London, England.
- Crop Protection Compendium. 2007 Edition. CAB International, Wallingford, UK, 2007.
- Davis, E. E., R. C. Venette and E. M. Albrecht. 2006. Oak commodity based survey reference. USDA - CAPS Commodity Reference Guide.
- Hoebeke, E. R., A. G. Wheeler, Jr. and J. W. Brown. 2008. *Archips xylosteana* (L.) (Lepidoptera: Tortricidae), a Palearctic leafroller new to North America. Proceedings of the Entomological Society of Washington. 110: 789-795.
- LaGasa, E. H., P. Hertzog, D. Bowden and B. Fair. 2003. *Archips podana* (Scopoli) (Lepidoptera: Tortricidae) host survey 2002 - Northwest Washington occurrence of an Old World tree-fruit pest new to the United States. Plant Protection Division, Washington State Department of Agriculture. WSDA PUB 080.
- Maier, C. T. 2003. Distribution, hosts, abundance, and seasonal flight activity of the exotic leafroller, *Archips fuscocupreanus* Walsingham (Lepidoptera: Tortricidae), in the northeastern United States. Annals of the Entomological Society of America. 96: 660-666.
- Maier, C. T. and V. C. Mastro. 1998. Discovery, abundance, and distribution of the exotic apple tortrix, *Archips fuscocupreanus* Walsingham (Lepidoptera: Tortricidae), in the northeastern United States. Proceedings of the Entomological Society of Washington. 100: 545-552.
- Razowski, J. 2002. Tortricidae of Europe, Vol. I, Tortricinae and Chlidanotinae. Frantisek Slamka, Slovakia. 247 pp.
- Yasuda, T. 1975. The Tortricinae and Sparganothinae of Japan (Lepidoptera: Tortricidae). Part II. Bulletin of the University of Osaka Prefecture, Series B. 27: 79-251.

Choristoneura spp.

Tortricidae:Tortricinae:Archipini

- ***Choristoneura fumiferana** (Clemens)**
 - eastern spruce budworm
 - Complex of several species
- ***Choristoneura rosaceana** (Harris)**
 - oblique banded leaf roller

* = non-target

Choristoneura spp.

- ***Choristoneura fumiferana* (Clemens) [complex]**
 - One of the most destructive native insects in the northern spruce and fir forests of eastern North America
 - *Abies balsamea* (balsam fir) and *Picea* (spruce) are preferred hosts. Larvae may also feed on *Larix* (tamarack), *Pinus* (pine), and *Tsuga* (hemlock).
 - Eastern North America (and northern U.S. and Canada)
- ***Choristoneura rosaceana* (Harris)**
 - Larvae are highly polyphagous and feed on the leaves or fruits of a wide variety of plants (more than 25 families). Preferred hosts appear to be woody plants and members of the family Rosaceae.
 - Not currently considered a serious economic threat in North America. There have been populations of *C. rosaceana* reported as being resistant to insecticides.
 - Widespread in North America

Choristoneura rosaceana

Adult recognition

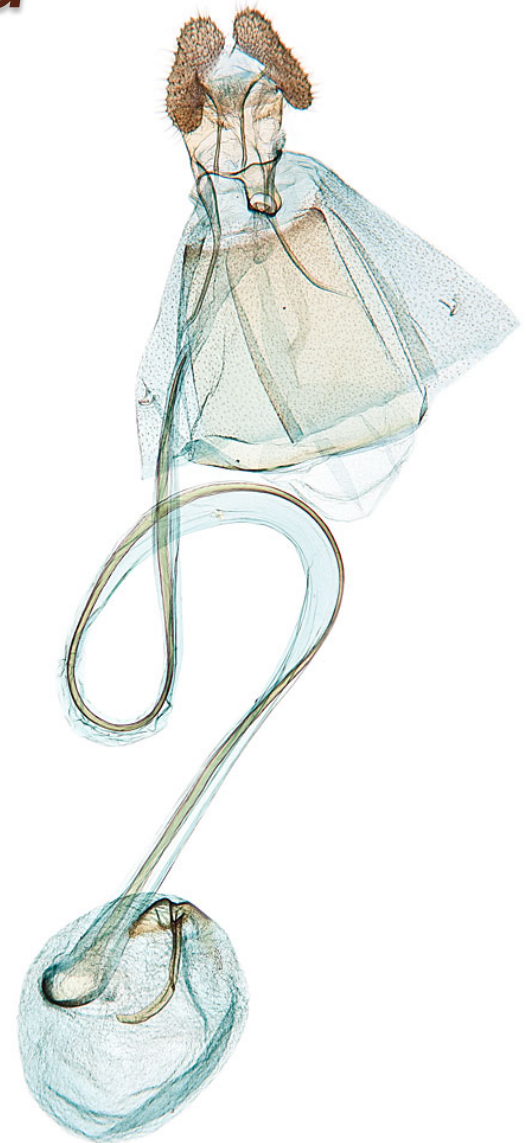
- FWL: 7.5-11 mm (male); 11.5-14 mm (female)
- Forewing pattern is variable, but the majority of individuals have three fasciae that are variably expressed from costa to dorsum. The costal margin is sinuate, giving resting individuals a classic "bell-shaped" appearance. The distal half of the hindwing is white in males and yellowish in females. Males have a forewing costal fold.
- Adults are similar to other species of *Choristoneura*. Many species of *Pandemis* have a similar wing pattern but male *Pandemis* do not have a forewing costal fold.



Choristoneura rosaceana

Adult recognition

- Male and female genitalia



Choristoneura rosaceana

Biology

- Adults are present in late June through July and again in late August through September; 1-2 generations per year.
- Eggs are laid in flat masses on the upper side of leaves. Egg masses may contain 200-900 individual eggs and are covered by the female with a waxy substance.
- First instar larvae hatch in 5-12 days and crawl to a protected location on the underside of leaves, in the buds, or under the calyx of a fruit.
- Young larvae may also disperse to other hosts by ballooning in the wind on a silk thread.
- Later instar larvae construct tubular shelters by webbing leaves.
- Larvae typically complete six instars, and second or third instars may overwinter in the fall and complete development in late May to mid-June.
- Pupation occurs in the final feeding shelter and lasts approximately 10-12 days.

Choristoneura rosaceana

Larval morphology

- Last instar larvae are green to yellowish green and 25-30 mm long.
- The head is black to light brown.
- The prothoracic shield varies from completely shaded (black or brown), to partially shaded, to having no shading (body color).
- The thoracic legs are dark brown to black.
- Due to their variable markings, *Choristoneura rosaceana* larvae are difficult to separate from those of many other Archipini.



Choristoneura freemani / *fumiferana*

Nomenclature

- It is difficult (or impossible?) to separate many of the Pinaceae-feeding *Choristoneura* using only morphology
- These names include: *C. fumiferana*, *C. retiniana*, *C. freemani*, *C. biennis*, *C. orae*, *C. carnana*, *C. lambertiana*, *C. pinus*, *C. spaldingiana*
- We will refer to the common eastern North American species as *C. fumiferana*, although this species is also present in the West
- We will refer to the common western North American species as *C. freemani* (formally *C. occidentalis*)
 - *C. freemani* is the replacement name for *C. occidentalis* (Razowski 2008)
 - *C. occidentalis* now refers to a species that only occurs in Africa
 - Here is the detailed explanation for reference:
 - Walsingham described *Cacoecia occidentalis* from Gambia (West Africa) in 1891. Freeman described *Choristoneura occidentalis* (western spruce budworm) from Klickitat Co., Washington in 1967. Brown (2005) transferred *Cacoecia occidentalis* to *Archips* in the World Catalogue of the Tortricidae. Razowski (2008) determined that the African *occidentalis* belongs in *Choristoneura*; because the African species is the senior (oldest) name, the North American *C. occidentalis* became a junior homonym. To solve this problem, Razowski (2008) proposed *Choristoneura freemani* as a replacement name for the North American *C. occidentalis*. As these are valid taxonomic changes consistent with the Code of the International Commission on Zoological Nomenclature, the correct scientific name for the western spruce budworm is *C. freemani*.

Choristoneura freemani / *fumiferana*

Adult recognition

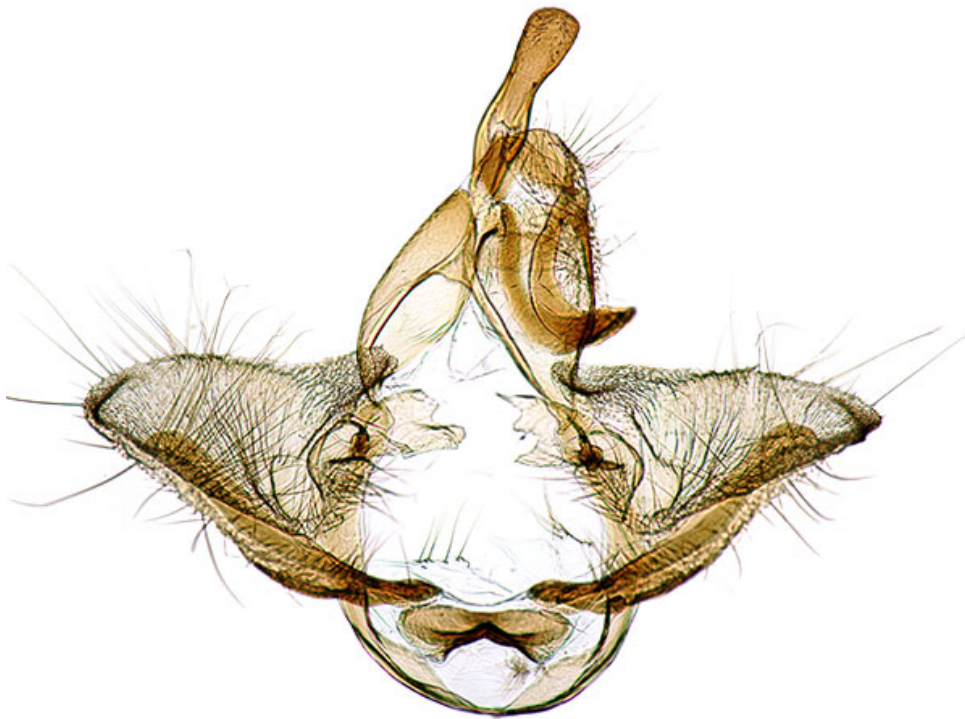
- FWL: 11-17 mm
- Forewing color varies from gray to reddish to orange with variable mottled markings. It is difficult to separate species based on forewing color or pattern.
- Males lack a forewing costal fold.



Choristoneura freemani / *fumiferana*

Adult recognition

- Male and female genitalia
 - Male genitalia are characterized by pliable (weakly sclerotized) valvae and a spatulate uncus
 - Female genitalia are characterized by a long ductus bursae and single signum

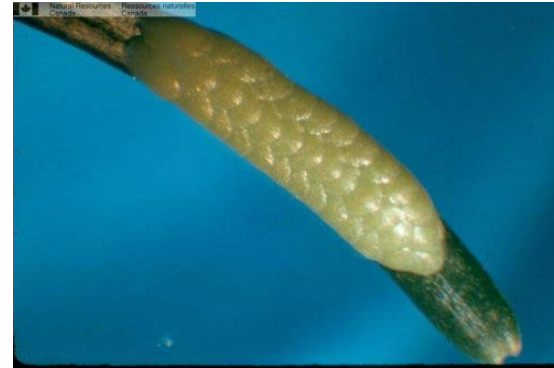


Choristoneura freemani / *fumiferana*

Biology

- Females lay eggs in a shingle-like fashion on the underside of needles in midsummer. Eggs hatch in about 10 days.
- The larvae molt once, then hibernate for the winter on rough bark surfaces in the canopy and down the trunk.
- In the spring, larvae re-emerge and begin to tunnel into older foliage, or float away on silken threads. After about two weeks, they move on to expanding buds and finish with the new foliage.
- Larvae spin webbing among the needles of expanding shoots, and feed until disturbed or the shoot is completely destroyed. When feeding on new foliage early in the summer, budworms construct a shelter by binding the needles together at the tips with webbing. They retreat to this shelter when disturbed.
- Six larval instars are completed.
- In midsummer, they pupate either in their feeding webs or in other webs in the foliage.
- Extensive dispersal occurs during outbreak periods. Passive wind dispersal may occur in the first larval instar in late summer, or in the second larval instar in early spring aided by their habit of spinning down on long threads. Dispersal may also occur as adults. International movement is only likely to occur on plants or cut foliage of hosts, carrying first-instar hibernating larvae (EPPO Data Sheet).

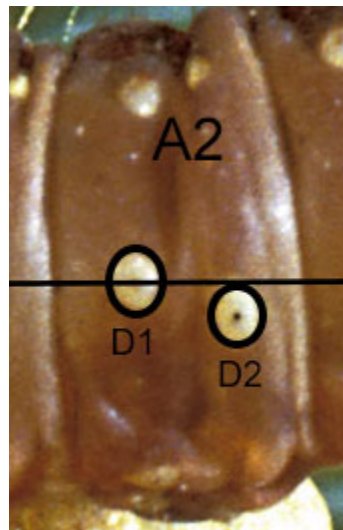
Choristoneura freemani / *fumiferana*



Choristoneura freemani / *fumiferana*

Larval morphology

- It is not possible to separate many of the Pinaceae-feeding *Choristoneura* based on larval morphology.
- The head is brown to black, the prothoracic shield is brown to black, may be variably mottled.
- The abdomen is brown (greenish to reddish to dark brown). Pinacula are large, conspicuous, and lighter than body color.
- An anal comb is present.
- According to Stehr (1987), Pinaceae-feeding *Choristoneura* can be separated from some other tortricids by the D2 pinacula on A1-3, which has its mesal margin at the same level as the D1 setal base.



Choristoneura spp.

- Carriere, Y., J. P. Deland and D. A. Roff. 1996. Obliquebanded leafroller (Lepidoptera: Tortricidae) resistance to insecticides: among-orchard variation and cross-resistance. *Journal of Economic Entomology*. 89: 577-582.
- Chapman, P. J. and S. E. Lienk. 1971. Tortricid fauna of apple in New York (Lepidoptera: Tortricidae); including an account of apple's occurrence in the state, especially as a naturalized plant. Spec. Publ. Geneva, NY: New York State Agricultural Experiment Station. 122 pp.
- Chapman, P. J., S. E. Lienk and R. W. Dean. 1968. Bionomics of *Choristoneura rosaceana*. *Annals of the Entomological Society of America*. 61: 285-290.
- Davidson, A. G. and R. M. Prentice. 1968. Growth and Utilization of Poplars in Canada, pp. 118-119. Departmental Publication No. 1205. Department of Forestry and Rural Development, Ottawa, Canada.
- EPPO. [no date]. Data sheets on quarantine pests: *Choristoneura fumiferana*. Prepared by CABI and EPPO. 3 pp.
- Furniss, R. L. and V. M. Carolin. 1977. Western forest insects, pp. 168-173. Miscellaneous Publication No. 1339. Forest Service, USDA, Washington, USA.
- Freeman, T. N. 1958. The Archipinae of North America (Lepidoptera: Tortricidae). *The Canadian Entomologist Supplement* 7 (Vol. 90): 1-89.
- Powell, J. A. 1964. Biological and taxonomic studies on tortricine moths, with reference to the species in California. *University of California Publications in Entomology*. Vol. 32. 317 pp.
- Powell, J. A. and P. A. Opler. 2009. *Moths of western North America*. University of California Press, Berkeley. 369 pp.
- Prebble, M. L. and V. M. Carolin. 1967. Important forest insects and diseases of mutual concern to Canada, the United States and Mexico, pp. 75-80. Department of Forestry and Rural Development, Ottawa, Canada.
- Stehr, F. W. 1987. *Immature Insects, Volume I*. Kendall/Hunt, Dubuque, Iowa. 754 pp.
- USDA [no author]. 1979. *A guide to common insects and diseases of forest trees in the Northeastern United States*, p. 61. Forest Service, USDA, Washington, USA

Epiphyas postvittana

Tortricidae: Tortricinae: Archipini

- ***Epiphyas postvittana* (Walker)**

- light brown apple moth (LBAM)
- *Epiphyas postvittana* is a polyphagous pest on pome and stone fruits and other horticultural crops. It has been recorded from more than 500 plant species in 121 families and 363 genera, although larvae prefer herbaceous plants over woody ones.
- A native of Australia, *E. postvittana* occurs in all apple-growing areas of that country. It has been introduced into Tasmania, New Zealand and Hawaii. In Europe, it has been present in the United Kingdom since the mid-1930s and is intermittently recorded from continental Europe, most recently in the Netherlands and Sweden. It was first discovered in California in 2006 but has not established elsewhere in North America.

Epiphyas postvittana

Adult recognition

- FWL: 5.0-11.5mm (male); 5.5-12.5mm (female)
- Forewings of both sexes are light brown to pale yellow with brown to dark-brown markings.
- Males are more variable than females, although in most males the basal half of the forewing is lightly marked, the median fascia is well defined, and there is a dark mark on the costa distal to the median fascia.
- In California, males tend to be of three phenotypes; the form with solid dark markings on the distal half of the forewing is the most uncommon.
- Males have a forewing costal fold.
- The female forewing color is more uniform, with a poorly defined median fascia and an overall mottled or speckled appearance. Most females have a dark mark on the dorsum of each forewing and two dark spots on the posterior of the thorax.
- The hindwing in both males and females is mottled with dark scales, although this pattern is usually more evident in females.

Epiphyas postvittana



Epiphyas postvittana

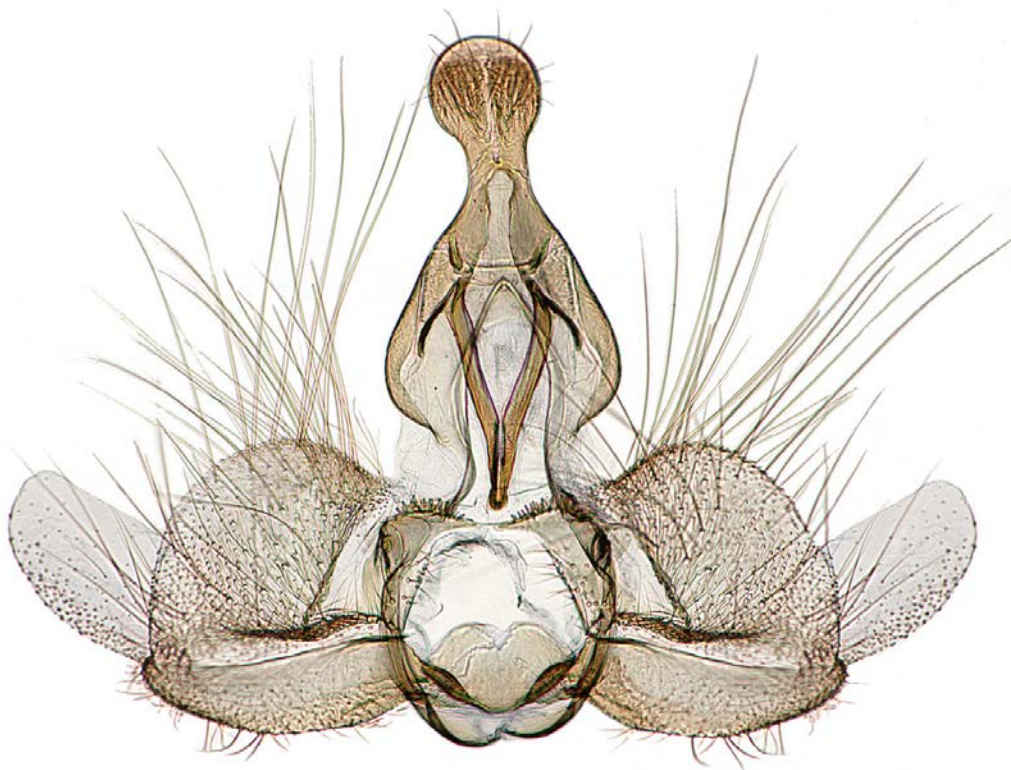
Adult recognition

- Male genitalia are distinctive, and examination of these structures is essential for reliable identification. Males have a combination of the following characters:
 - spatulate uncus; reduced socii; short valva with a broad sacculus; **membranous lobe on the apex of the valve (the most diagnostic feature)**; and an aedeagus with 2-4 deciduous cornuti.
- Female genitalia are typical of many Archipini and females may be difficult to verify based on dissection alone. Females possess a combination of the following characters:
 - simple sterigma; long, straight ductus bursae which is 2/3 or more the length of the abdomen; and corpus bursae with a single, hook-shaped signum.

Epiphyas postvittana

Adult recognition

- Male and female genitalia



Epiphyas postvittana

Biology

- *Epiphyas postvittana* completes 2-4 generations annually over much of its range, depending on temperature and latitude. Populations in California appear to undergo at least four generations and adults are active throughout the year.
- Females deposit eggs in masses on smooth surfaces of host plant foliage, including leaves, stems, and fruit. Egg masses vary from 4 to 150 individual eggs.
- Larvae pass through five or six instars; they can overwinter, but development during cooler months is slower.
- Early instar larvae feed on the undersides of leaves within a silk chamber. Later instars may fold individual leaves, create a nest of several leaves webbed together, or web leaves to fruit and feed on the surface of the fruit.
- Larvae on deciduous trees and shrubs feed as long as leaves remain on the host plant and then drop to the ground, where they may feed on understory vegetation or survive in leaf litter.
- Pupation occurs in the larval nest, and adults eclose in approximately 10 days at 20°C.

Epiphyas postvittana

Larval morphology

- Larvae are generally yellowish green but color may vary with instar and host. Early and mid-instar larvae range from translucent to opaque reddish brown.
- The head of all instars is pale brown and the prothoracic shield is approximately the same color as the rest of the body.
- The head, prothoracic shield, and legs of mid- to late instars are not dark and do not have any dark or contrasting markings.
- The anal shield is pale brownish green and the anal comb is well developed with 7-9 teeth.
- First instar larvae are approximately 1.6 mm long, while last instar larvae are 10-20 mm in length.
- Chaetotaxy is described and illustrated in Brown et al. 2010.

Epiphyas postvittana



Epiphyas postvittana

- Barr, N. B., L. A. Ledezma, J. D. Vasquez, M. E. Epstein, P. H. Kerr, S. Kinnee, O. Sage and T. M. Gilligan. 2009. Molecular identification of the light brown apple moth (Lepidoptera: Tortricidae) in California using a polymerase chain reaction assay of the internal transcribed spacer 2 locus. *Journal of Economic Entomology*. 102(6): 2333-2342.
- Barr, N. B., L. A. Ledezma, R. E. Farris, M. E. Epstein and T. M. Gilligan. 2011. A multiplex real-time polymerase chain reaction assay to diagnose *Epiphyas postvittana* (Lepidoptera: Tortricidae). *Journal of Economic Entomology*. 104(5): 1706-1719.
- Brown, J. W., M. E. Epstein, T. M. Gilligan, S. Passoa and J. A. Powell. 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.
- 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.
- Geier, P. and D. Briese. 1981. The light-brown apple moth, *Epiphyas postvittana* (Walker): a native leafroller fostered by European settlement., pp. 131-155. *In* R. Kitching and R. Jones [eds.], *The Ecology of Pests*. CSIRO, Melbourne, Australia.
- Gilligan, T. M. and M. E. Epstein. 2009. LBAM ID: Tools for diagnosing light brown apple moth and related western U.S. leafrollers (Tortricidae: Archipini). CDROM. Center for Plant Health Science and Technology, USDA, APHIS PPQ, Raleigh, NC.
- Gu, H. and W. Danthanarayana. 1992. Influence of larval rearing conditions on the body size and flight capacity of *Epiphyas postvittana* moths. *Australian Journal of Zoology* 40: 573-581.
- Suckling D. M., J. G. I. Khoo and D. J. Rogers. 1990. Disruption of lightbrown apple moth *Epiphyas postvittana* (Lepidoptera: Tortricidae) trapping in Nelson, New Zealand. *Australian Journal of Zoology* 38: 363-373.
- Suckling, D. M. and E. G. Brockhoff. 2010. Invasion biology, ecology, and management of the light brown apple moth (Tortricidae). *Annual Review of Entomology*. 55: 285-306.
- Tooman, L. K., C. J. Rose, C. Carraher, D. M. Suckling, S. R. Paquette, L. A. Ledezma, T. M. Gilligan, M. Epstein, N. B. Barr and R. D. Newcomb. 2011. Patterns of mitochondrial haplotypes diversity in the invasive pest *Epiphyas postvittana* (Lepidoptera: Tortricidae). *Journal of Economic Entomology*. 104(3): 920-932.
- Wearing C. H., W. P. Thomas, J. W. Dugdale and W. Danthanarayana. 1991. Tortricid pests of pome and stonefruits, Australian and New Zealand species., pp. 453-472. *In* L. P. S. van der Geest and H. H. Evenhuis [eds.], *Tortricid Pests: Their Biology, Natural Enemies, and Control*. World Crop Pests, Vol. 5. Elsevier, Amsterdam.

Eupoecilia ambiguella

Tortricidae: Tortricinae: Cochylini

- ***Eupoecilia ambiguella* (Hübner)**
 - European grape berry moth
 - This species is a serious pest of grape (*Vitis vinifera*) in the Palearctic. Although most economic damage occurs in grape, larvae have been recorded from plants in several families.
 - *Eupoecilia ambiguella* is widely distributed across the Palearctic, where it is more common in cooler and humid climates. It is not considered established outside of Europe and Asia.

Eupoecilia ambiguella

Adult recognition

- Adult FWL: 6.0-7.5 mm
- The forewing is yellow or yellowish orange with a well defined dark brown to black median fascia. Males and females exhibit no sexual dimorphism in wing pattern although females may be slightly larger than males. Males lack a forewing costal fold.
- Adults may be confused with other species of *Eupoecilia* or European Cochylini, although *E. ambiguella* is the only cochyliid commonly associated with grape. A genitalic dissection can be used to confirm the identity of *E. ambiguella* adults.



Eupoecilia ambiguella

Adult recognition

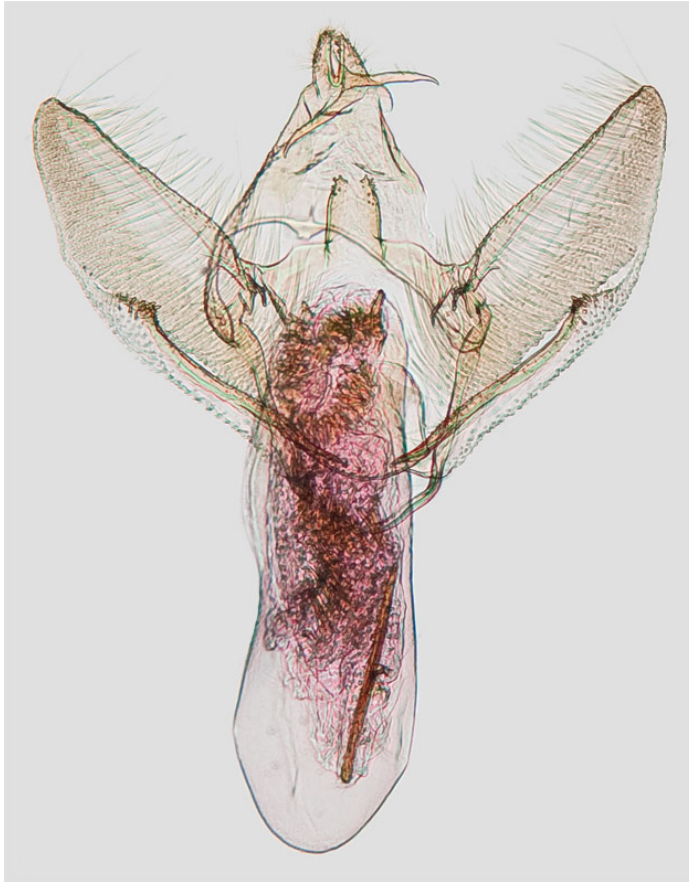
- Typical wing pattern



Eupoecilia ambiguella

Adult recognition

- Male and female genitalia



Eupoecilia ambiguella

Biology & Larva

- Late instar larvae are approximately 10-12 mm in length. The head, prothoracic shield, and legs are dark brown to black. Body color varies from brown to yellow and green. Pinacula are large, conspicuous, and brown. The anal shield is pale brown.
- Economic losses on grape are caused by direct feeding damage and secondary infections. Feeding damage is similar to that of *Lobesia botrana*. Larvae of the first generation cause minor damage by feeding on flower buds, while those of the second generation cause the most damage by feeding on grape berries. The most significant losses are due to secondary infection of feeding sites on berries and clusters by *Botrytis cinerea*. Economic thresholds vary with the type of grape and cultivar.



Eupoecilia ambiguella

- Bradley, J. D., W. G. Tremewan and A. Smith. 1973. British Tortricoid Moths - Cochylidae and Tortricidae: Tortricinae. The Ray Society, London, England.
- EPPO (European and Mediterranean Plant Protection Organization). 2007. PQR, EPPO plant quarantine information retrieval system. Version 4.6 (2007/07) [accessed 28 Feb 2011].
- Gilligan, T. M. and M. E. Epstein. 2011. The European grape vine moth not found in California: *Eupoecilia ambiguella* (Hubner)., pp. 32-34. In Plant Pest Diagnostics Center Annual Report 2010. California Department of Agriculture, Sacramento, CA.
- Meijerman, L. and S. A. Ulenberg. 2000. Arthropods of Economic Importance: Eurasian Tortricidae. Arthropods of Economic Importance series. ETI/ZMA.
- Roehrich, R. and E. Boller. 1991. Tortricids in vineyards, pp. 507-514. In L. P. S. van der Geest and H. H. Evenhuis [eds.], Tortricid Pests: Their Biology, Natural Enemies, and Control. World Crop Pests, Vol. 5. Elsevier, Amsterdam.
- Razowski, J. 2009. Tortricidae (Lepidoptera) of the Palearctic Region, Vol. 2, Cochylini. Frantisek Slamka, Slovakia. 195 pp.

Tortrix viridana

Tortricidae: Tortricinae: Tortricini

- ***Tortrix viridana* Linnaeus**

- European oak leafroller, green oak tortrix
- This species is considered an important forest pest in southern Europe. Outbreaks can cause extensive defoliation of oak trees.
- *Eupoecilia ambiguella* is present in Europe and northern Africa.

Tortrix viridana

Adult recognition

- FWL: 8.0-11.0 mm
- This is the only tortricid species with a uniformly green forewing that varies from bright green to dull pale green. Some individuals have dull yellow forewings, a condition that can also be caused by exposure of individuals to various killing agents and prolonged sunlight.
- Adults of *T. viridana* are unlikely to be confused with any other species of tortricid.



Tortrix viridana

Adult recognition

- Typical wing pattern



Tortrix viridana

Adult recognition

- Male and female genitalia
 - Male genitalia are distinguished by the following characters: uncus absent; socii large; valva sub-rectangular with well developed sacculus.
 - Female genitalia are characterized by broad papillae anales with a patch of flat-headed setae, short apophyses, a long ductus bursae, and a small signum in the corpus bursae.



Tortrix viridana

Biology & Larva

- Mature larvae are approximately 15-20 mm long with a green to gray abdomen. The head varies in color from brown to black and the prothoracic shield varies from near-translucent to black. Darkened pinacula, which are more prominent near the anterior end of the abdomen and on the thorax, serve to separate this species from most North American Tortricidae larvae. Other diagnostic characters include black thoracic legs and an anal comb with eight teeth.
- Oak (*Quercus* sp.) is the primary host and in outbreak conditions *T. viridana* can cause extensive defoliation of oak trees. Defoliation affects tree growth, reproduction, and increases the chances of damage by other insects and frost. This species is regarded as one of the most important tortricid forest pests in southern Europe.



Tortrix viridana

- Bradley, J. D., W. G. Tremewan and A. Smith. 1973. British Tortricoid Moths - Cochylidae and Tortricidae: Tortricinae. The Ray Society, London, England.
- Crop Protection Compendium. 2007 Edition. CAB International, Wallingford, UK, 2007.
- Razowski, J. 2002. Tortricidae of Europe, Vol. I, Tortricinae and Chlidanotinae. Frantisek Slamka, Slovakia. 247 pp.