Tortricid target pest species
Part 1: Olethreutinae

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

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Pest Tortricidae of Importance to the U. S.

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

Cydia spp.

Tortricidae: Olethreutinae: Grapholitini

- ***Cydia splendana* (Hubner)**
  - chestnut fruit tortrix, acorn moth
- ***Cydia latiferreana** **(Walsingham)**
  - filbertworm
- ***Cydia pomonella** **(Linnaeus)**
  - codling moth

* = non-target

Cydia spp.

- ***Cydia splendana* (Hubner)**
  - Important pest of chestnut (*Castanea sativa*). Other preferred hosts include *Quercus*, *Fagus*, and *Juglans*.
  - Widely distributed thoughout Europe (records from Asia are likely of *Cydia kurokoi*).
- ***Cydia latiferreana* (Walsingham)**
  - Can be a pest of cultivated filberts, hazelnuts, and almonds.
  - Widely distributed across North America and northern Mexico.
- ***Cydia pomonella* (Linnaeus)**
  - The most widely distributed and important pest of apple, pear, and walnuts in the world. Other larval hosts include almond, apricot, fig, macadamia, nectarine, peach, plum, prune, and quince.
  - Found in nearly all temperate pome fruit-growing regions of the world. It is notably absent from Japan and Korea.

Cydia splendana

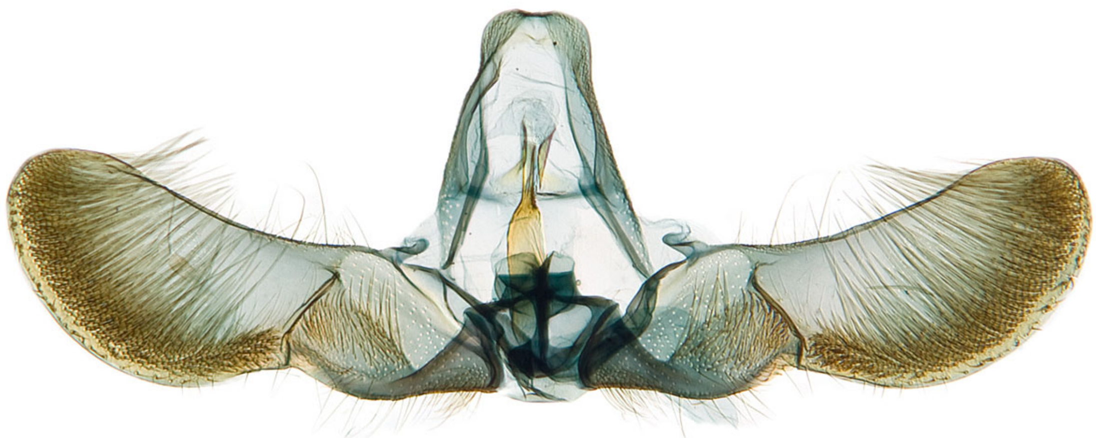
Adult recognition

- FWL: 6.5-10.5 mm
- Forewings are light gray to gray. The distal one-third of the wing is marked with a dark-brown to black subtriangular patch that surrounds the purplish ocellus. Hindwings are dark grayish brown.
- Adults may appear similar to those of other *Cydia* species. *Cydia kurokoi* is very similar but only occurs in Asia. *Cydia fagiglandana* is darker overall and lacks a well-defined purplish ocellus. *Cydia pomonella* is a more uniform gray and the ocellus is edged with gold or copper scales. A genitalic dissection can be used to confirm identity of the species listed here.

Cydia splendana

Adult recognition

- Male and female genitalia



Cydia splendana

C. splendana *C. fagiglandana* *C. pomonella*

Cydia splendana

Biology

- *Cydia splendana* completes a single annual generation.
- Adults are present in June to July in Central and Northern Europe and August to September in Southern Europe.
- Females lay eggs singly on young fruit or on leaves near fruit.
- Early instars tunnel into fruit and feed inside and a single fruit generally supports one larva.
- Larval-infested fruit drop to the ground early.
- Overwintering occurs as a late instar lava under bark or in the soil.
- Pupation occurs the following spring.

Cydia splendana

Larval morphology

- Late instar larvae are approximately 13-15 mm in length with a whitish gray-green to pale-yellow abdomen. The head is yellowish brown and the prothoracic shield is paler than the head and weakly sclerotized. An anal comb is absent.
- Other tortricid *Castanea* (chestnut) pests include
  - *Cydia fagiglandana* (Europe to central Asia)
  - *Cydia glandicolana* (Asia, possibly Russia)
  - *Cydia kurokoi* (Asia)
  - *Fibuloides aestuosa* (Asia)
  - *Pammene fasciana* (Europe)

- Brown and Komai (2008) provide a description and key to larvae of these species. *Cydia splendana* larvae can be distinguished by the following characters: whitish abdomen with concolorous pinacula; distance between V setae on A9 slightly to conspicuously greater than those on A8; number of crochets on prolegs less than 18; anal comb absent.
  - **Brown, J.W. and Komai, F. 2008. Key to larvae of *Castanea*-feeding Olethreutinae frequently intercepted at U.S. ports-of-entry (Lepidoptera : Tortricidae). Tropical Lepidoptera Research. 18(1): 2-4.**

Cydia latiferreana

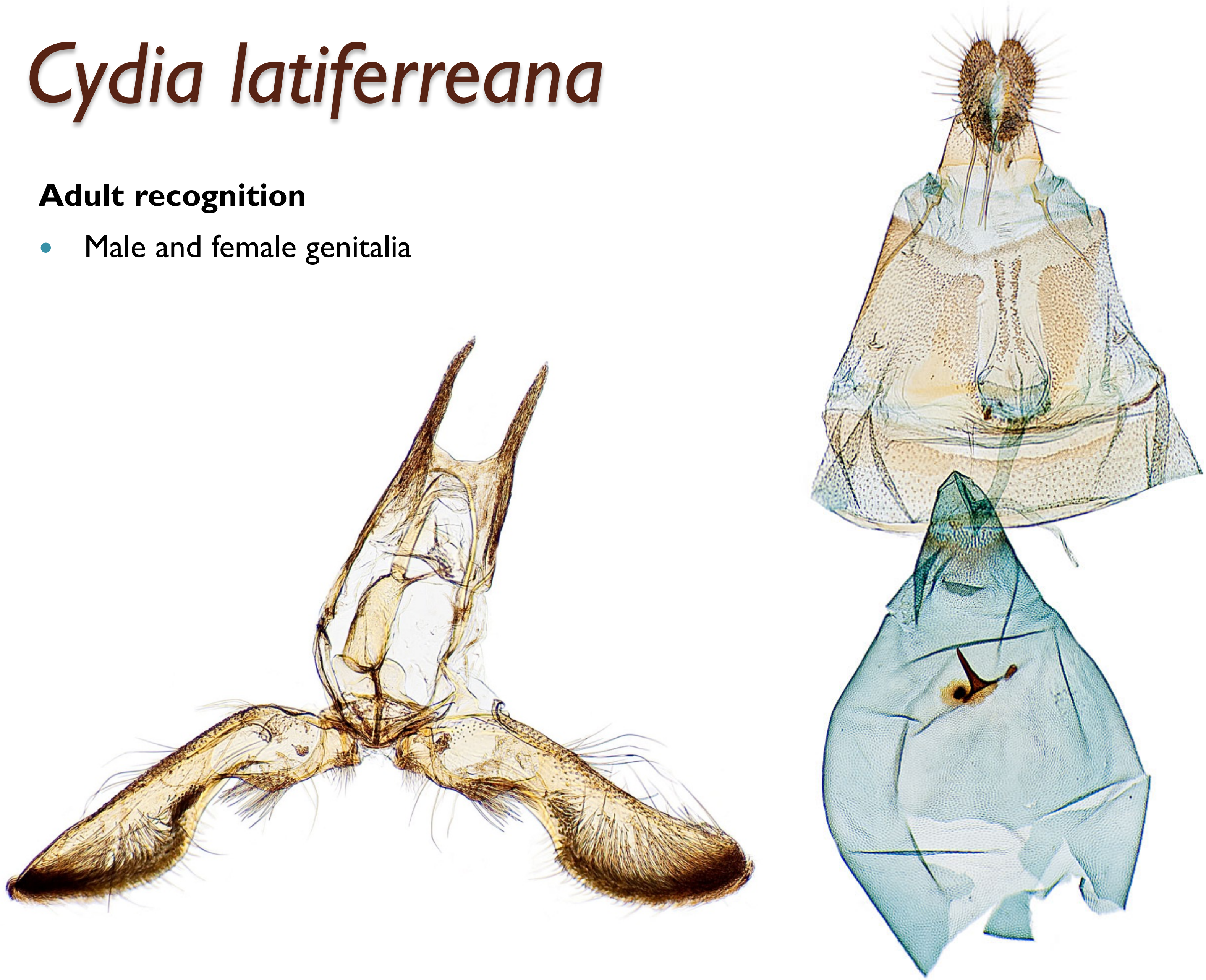
Adult recognition

- FWL: 6.0-9.5 mm
- Adult forewing color is extremely variable and ranges from pale tan to orange red to dark brown. Most individuals are marked with two metallic transverse bands that run from costa to dorsum.
- Male genitalia are equally variable. Heinrich (1926) designated seven different forms (type A-G) based on variation in the dorsally projecting extensions of the tegumen and lateral projection off the aedeagus. The different forms are somewhat geographically isolated, and are assumed to constitute a species complex, although there have been no conclusive studies that demonstrate this to be the case.

Cydia latiferreana

Adult recognition

- Male and female genitalia



Cydia latiferreana

Biology

- Multiple generations over most of its range – adults may be present March to November in southern locations with reduced flight periods in the North.
- Larvae feed within the acorns, nuts, and burrs of *Quercus* (oak), *Fagus* (beech), *Corylus* (hazelnut and filbert), and *Castanea* (chestnut).
- Overwintering occurs in the soil or leaf litter, and pupation occurs the following spring.
- Larvae have also been reported to infest oak galls produced by cynipid wasps.

Larval morphology

- Last instar larvae are approximately 12-15 mm in length
- Abdomen is whitish-gray abdomen
- Head is yellowish brown
- Prothoracic shield is pale brown with faint dark mottling
- Anal comb is absent

Cydia pomonella

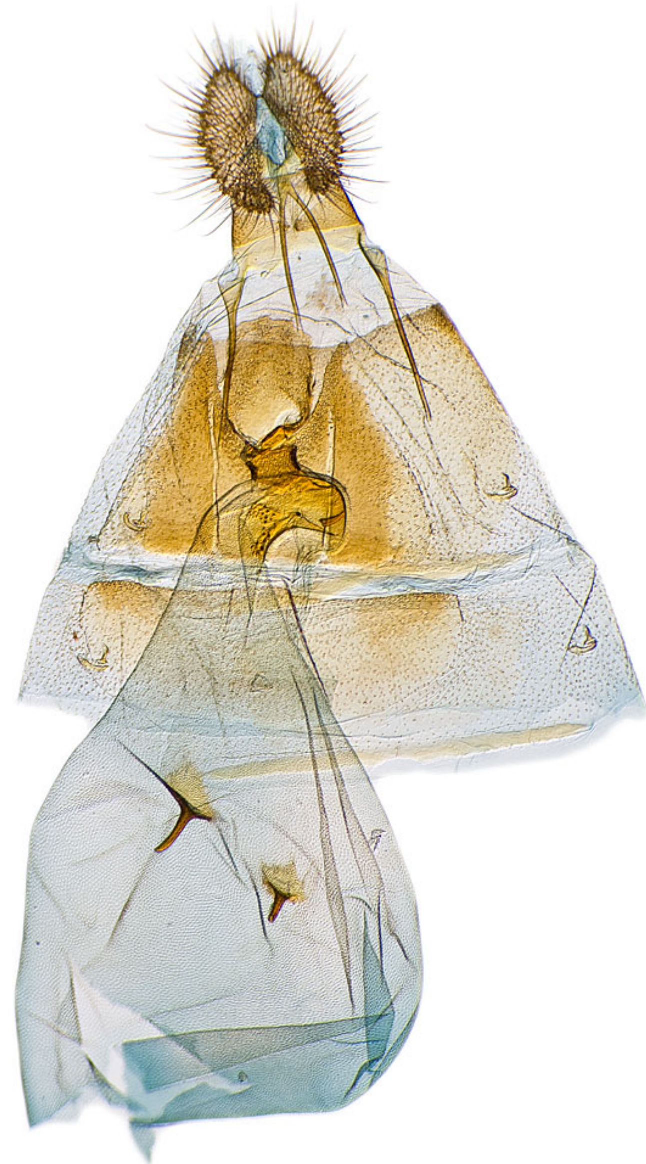
Adult recognition

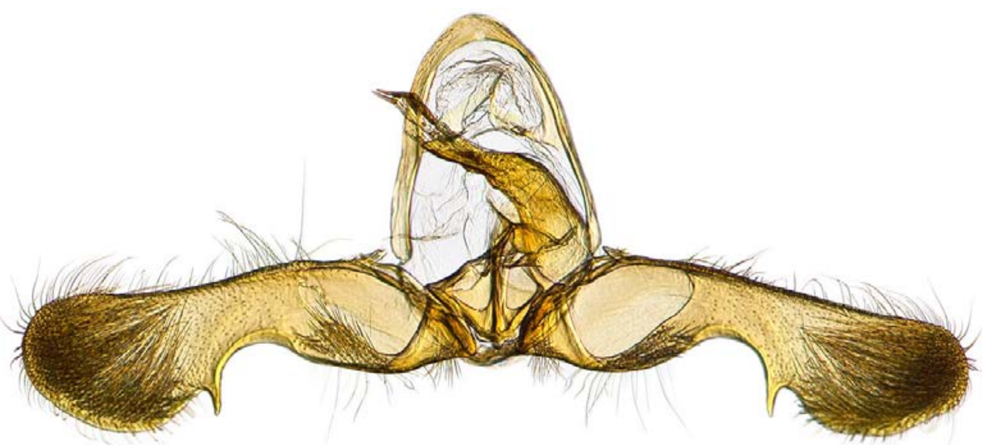
- FWL: 6.5-11.0 mm
- Forewings are gray with silvery striations. The ocellus is dark purplish brown and is edged with metallic gold or copper scales. Hindwings are grayish brown and males have a fold along the base of the cubital vein that contains a hair pencil with long black sex scales.
- Adults may appear similar to dark individuals of *Cydia splendana*. *Cydia pomonella* can be separated from *C. splendana* by the metallic scales surrounding the ocellus and the hair pencil on the male hindwing. A genitalic dissection can be used to confirm identity.

Cydia pomonella

Adult recognition

- Male and female genitalia
  - Male genitalia are characterized by a ventrally projecting spur at the base of the cucullus.
  - Female genitalia are characterized by a short sclerotized ductus bursae.





Cydia pomonella

Biology

- *Cydia pomonella* completes 2-4 generations per year.
- In North America, adults are present in many locations from April through September.
- Females lay eggs singly on fruits, stems, or leaves of the host.
- Larvae tunnel into fruit to feed on the seeds. Larval damage to fruit is characterized by entry and exit holes, rot that surrounds larval feeding areas, and frass accumulation.
- Mature larvae exit the fruit and create a cocoon under tree bark or in leaf litter; overwintering occurs as a prepupa.

Cydia pomonella

Larval morphology

- Late instar larvae are approximately 15-19 mm in length
- Abdomen is whitish or pale-yellow with moderately large pinacula
- Head is yellowish brown and may be mottled or unmarked
- Prothoracic and anal shields are yellowish brown with distinct mottling (usually)
- An anal comb is absent
- Larvae may appear similar to those of other Grapholitini, especially other *Cydia* and *Grapholita*. *Cydia pomonella* can be separated from most *Grapholita* by the absence of an anal comb. Larvae of *Cydia splendana* are similar but lack the mottling on the prothoracic and anal shields. Molecular diagnoses may be necessary to positively identify some individuals or early instars.

Cydia spp.

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Grapholita spp.

Tortricidae: Olethreutinae: Grapholitini

- ***Grapholita funebrana* (Treitschke)**
  - plum fruit moth, red plum maggot
- ***Grapholita molesta** * **(Busck)**
  - oriental fruit moth
- ***Grapholita packardi** * **(Zeller)**
  - cherry fruit worm
- ***Grapholita prunivora** * **(Walsingham)**
  - lesser apple worm

* = non-target

Grapholita spp.

- ***Grapholita funebrana* (Treitschke)**
  - One of the most important lepidopteran pests of fruit in Europe. Larvae can cause significant damage to apricot, cherry, peach, plum, and other *Prunus* species.
  - A native of Europe, *Grapholita funebrana* has spread to most other fruit-growing regions of the Palearctic. It is currently present from Europe and northern Africa across Asia Minor and Central Asia to China, Korea, and Japan.
- ***Grapholita molesta* (Busck)**
  - An important pest of stone-fruit crops throughout the world. Most economic damage occurs in peach and nectarine, or when other fruit crops are grown adjacent to peach.
  - *Grapholita molesta* is thought to be native to northwest China. It is currently widely distributed on all continents where stone-fruit is grown.

Grapholita spp.

- ***Grapholita packardi*** **(Zeller)**
  - Larvae feed on many common fruit crops in the families Rosaceae and Ericaceae. It is possible that hawthorn (Crataegus) is the native host.
  - *Grapholita packardi* is widely distributed in eastern North America. It is also present in the Pacific Northwest (Washington and British Columbia) and likely other fruit-growing regions of the West.
- ***Grapholita prunivora*** **(Walsingham)**
  - Larvae feed on common stone fruit crops in the family Rosaceae. These include *Malus*, *Prunus*, and *Pyrus*.
  - *Grapholita prunivora* is found throughout southern Canada and the continental U.S.; it is absent from the far southern U.S.

Grapholita funebrana

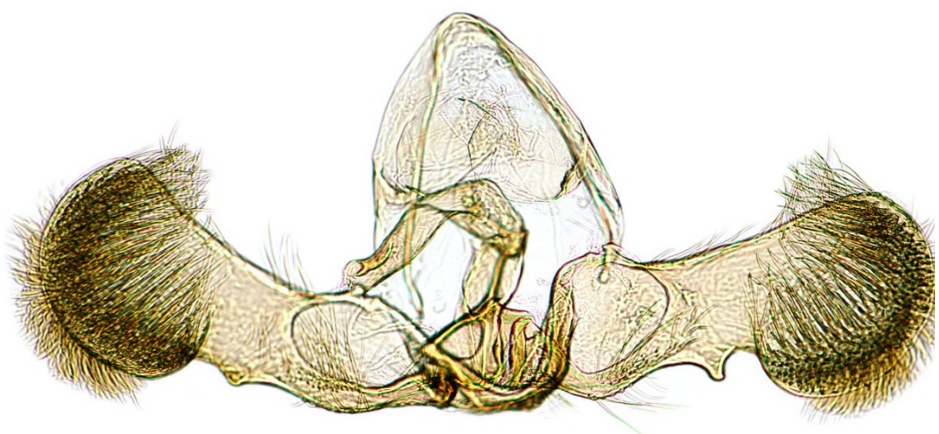
Adult recognition

- FWL: 4.0-7.5 mm
- Forewings are grayish brown with indistinct silvery-gray markings on the dorsum and around the poorly-defined ocellus. Hindwings are brown.
- Adults are similar to other species of *Grapholita*, including *Grapholita molesta* and *Grapholita tenebrosana*; a genitalic dissection may be necessary to confirm species identity, especially if individuals are recovered from sticky traps. In *G. molesta*, males lack the thornlike projection off the ventral margin of the valva and the female sterigma is laterally elongate with small posterolateral projections. In *G. tenebrosana*, the male valva is more elongate with the anal angle sharply pronounced and the female sterigma is large with triangular lateral lobes.

Grapholita funebrana

Adult recognition

- Male and female genitalia
  - Male genitalia are characterized by a thornlike projection off the ventral margin of the valva.
  - Female genitalia are characterized by a rounded sterigma, an irregular sclerite in the ductus bursae, and two long, curved, thornlike signa in the corpus bursae.



Grapholita funebrana

Biology

- *Grapholita funebrana* completes 1-3 generations per year; two generations are most common over most of its range.
- Adults are present from late May to September.
- First generation females lay eggs singly on fruitlets. Second generation females lay eggs near the base of maturing fruit.
- Larvae tunnel into the fruit and feed inside. Last instar larvae bore out of the fruit and overwinter in a cocoon spun on tree bark or in the soil.
- Pupation occurs the following spring.
- Larvae of the second generation cause the most damage to fruits such as plum that mature in mid- to late summer.

Grapholita funebrana

Larval morphology

- Late instar larvae are approximately 9-12 mm long
- Abdomen is bright reddish-pink
- Head is dark brown and the prothoracic shield is yellowish brown
- Anal shield is light brown with dark mottling
- Anal comb is present with 4-10 small teeth
- Early instars are whitish with a black head and prothoracic shield
- Larvae may appear similar to those of many other species of *Grapholita* and *Cydia*. Other species of *Grapholita* cannot be reliably separated from *G. funebrana* based solely on larval morphology. Chen and Dorn (2009) provide a molecular assay to distinguish *G. funebrana* larvae from similar species.

Grapholita molesta

Adult recognition

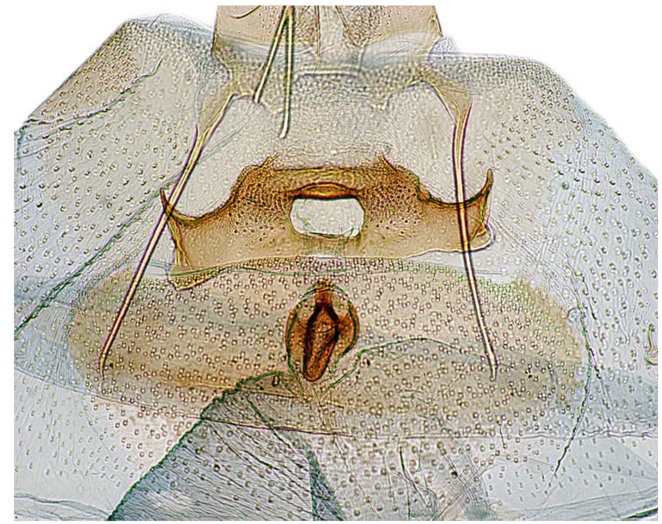
- FWL: 5.0-6.5 mm
- Forewings are dull grayish brown with a row of black dots near the apex and termen.
- Adults are similar to other species of *Grapholita*, including *G. funebrana*, *G. libertina*, *G. tenebrosana*, and several others. A genitalic dissection may be necessary to confirm species identity, especially if individuals are recovered from sticky traps. Males of *G. funebrana* can be distinguished by the thornlike projection off the ventral margin of the valva, which is lacking in *G. molesta*.
- Synthetic pheromones are not species-specific, and *G. molesta* lures will attract other species of *Grapholita*, including *G. funebrana*.

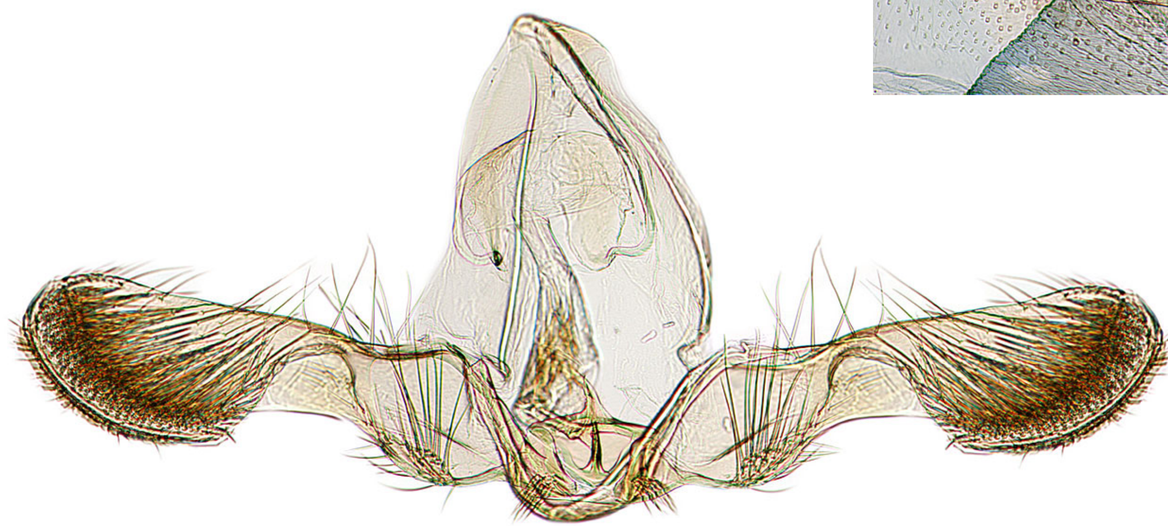


Grapholita molesta

Adult recognition

- Male and female genitalia
  - Male genitalia are characterized by an elongate valva with rounded cucullus.
  - Female genitalia are characterized by rectangular lateral extensions of the sterigma with sharply pointed posterolateral projections.





Grapholita molesta

Biology

- *Grapholita molesta* completes 3-7 annual generations; the exact number depends on temperature (latitude).
- In middle North America, adults are present from early May to late September. In southern locations, adults may be present year-round.
- Females lay eggs singly on smooth surfaces of the host plant, which usually includes leaves, shoots, and twigs.
- Early instars tunnel into shoots or pedicels. Later instars continue feeding in shoots or tunnel into fruit.
- The final instar leaves the fruit or shoot and constructs a cocoon on the tree or in leaf litter.
- Larvae complete 4-5 instars.
- Overwintering occurs as a prepupa and pupation occurs in the spring for the overwintering generation.
- Larval damage is characterized by dead and wilting shoots and injured fruit. Injured fruit may fall early and is more prone to secondary infection by fungus.

Grapholita molesta

Larval morphology

- Last instar larvae are approximately 10-12 mm in length
- Abdomen is pinkish with large pale pinacula
- Head and prothoracic shield are yellowish brown
- Anal shield is light brown without mottling
- Anal comb is present with ca. 5 teeth
- Early instars are assumed to be whitish with a black head and prothoracic shield
- Larvae may appear similar to those of many other species of *Grapholita* and *Cydia*. *Cydia pomonella* larvae can be separated from *G. molesta* by the absence of an anal fork. Other species of *Grapholita* cannot be reliably separated from *G. molesta* based solely on larval morphology. Chen and Dorn (2009) provide a molecular assay to distinguish *G. molesta* larvae from similar species.

Grapholita packardi

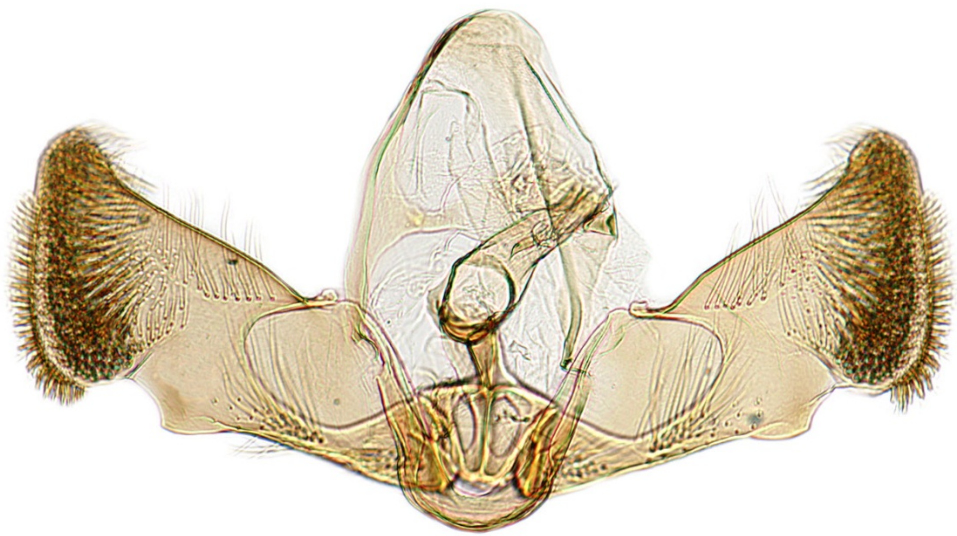
Adult recognition

- FWL: 3.5-5.0 mm
- Adults range in color from light to dark. Light individuals have silvery striae and darker contrasting fasciae while dark individuals lack a well-defined forewing pattern. Males have a conspicuous patch of dark sex scales on the dorsal surface of the hindwing.
- Dark individuals may appear similar to *Grapholita molesta*, but are generally much smaller. In western North America, *Grapholita libertina* is similar in appearance to dark *G. packardi* in both forewing pattern and male genitalia, but *G. libertina* males lack a patch of dark sex scales on the hindwing.

Grapholita packardi

Adult recognition

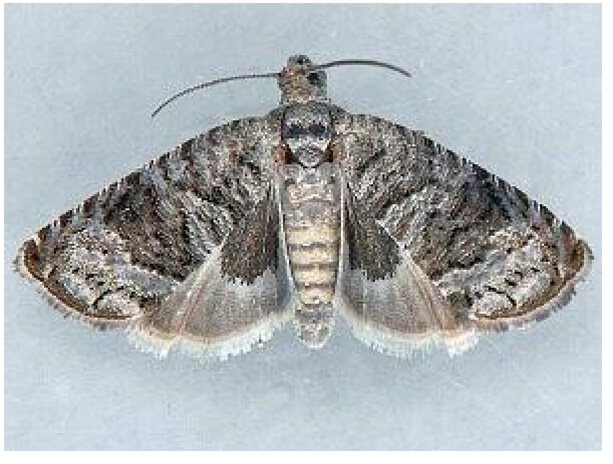
- Male and female genitalia
  - Male genitalia are characterized by the unconstricted valval neck, which is nearly as wide as the cucullus.
  - Female genitalia are characterized by a triangular ostium.



Grapholita packardi

Biology

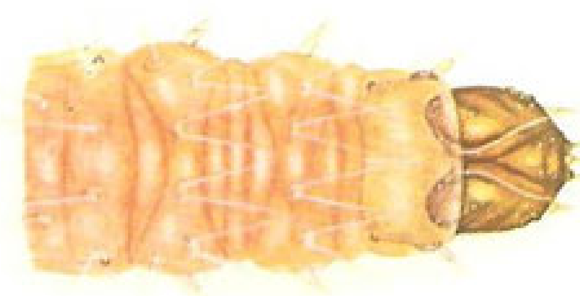
- *Grapholita packardi* completes 2-3 generations per year.
- Adults are present in May and June.
- Females lay eggs singly on terminal shoot leaves.
- Larvae feed inside the shoots or fruit.
- Overwintering occurs on the host in a cocoon and pupation occurs the following spring.
- Larval damage is characterized by injured fruit, early fruit drop, and/or stunted or dead shoots.



Grapholita packardi

Larval morphology

- Late instar larvae are approximately 8-9 mm in length
- Abdomen is pale-reddish with moderately large pinacula
- Head is yellowish brown with darker mottling
- Prothoracic and anal shields are brown
- Anal comb is present with 4-6 teeth
- Larvae may appear similar to those of many other species of *Grapholita* and *Cydia*.
    - *Cydia pomonella* larvae can be separated from *G. packardi* by the absence of an anal fork and their larger size.
    - Larvae of *Grapholita molesta* are similar but generally larger.
    - Larvae of *G. packardi* and *G. prunivora* are very similar, although the pinacula on the 8th and 9th abdominal segment are more prominent in *G. packardi*, and the abdomen of *G. prunivora* is more reddish, especially in preserved specimens.



Grapholita prunivora

Adult recognition

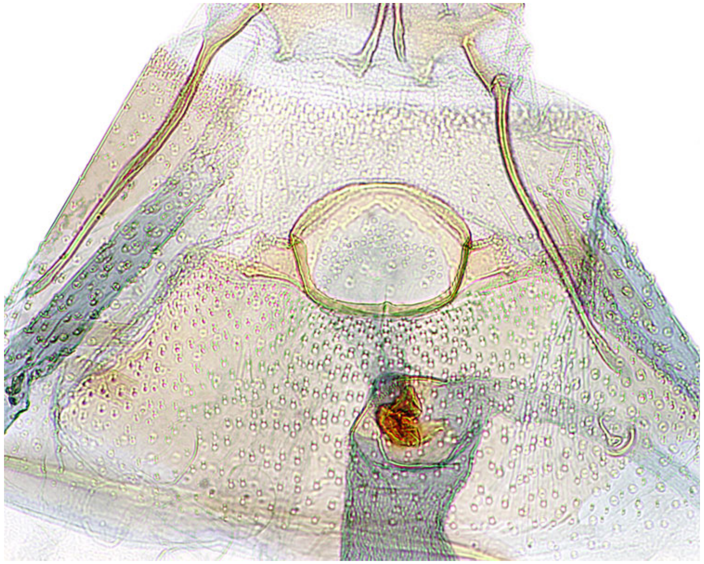
- FWL: 4.0-5.5 mm
- Forewing pattern is distinctive with pale-yellow costal strigulae, silvery striae, a line of yellow scales preceeding the black terminal line, and a well-developed ocellus with 3-4 black dashes.
- This is one of the smallest North American tortricids. Fresh specimens are unlikely to be confused with any other species; worn specimens can be dissected to confirm identity.

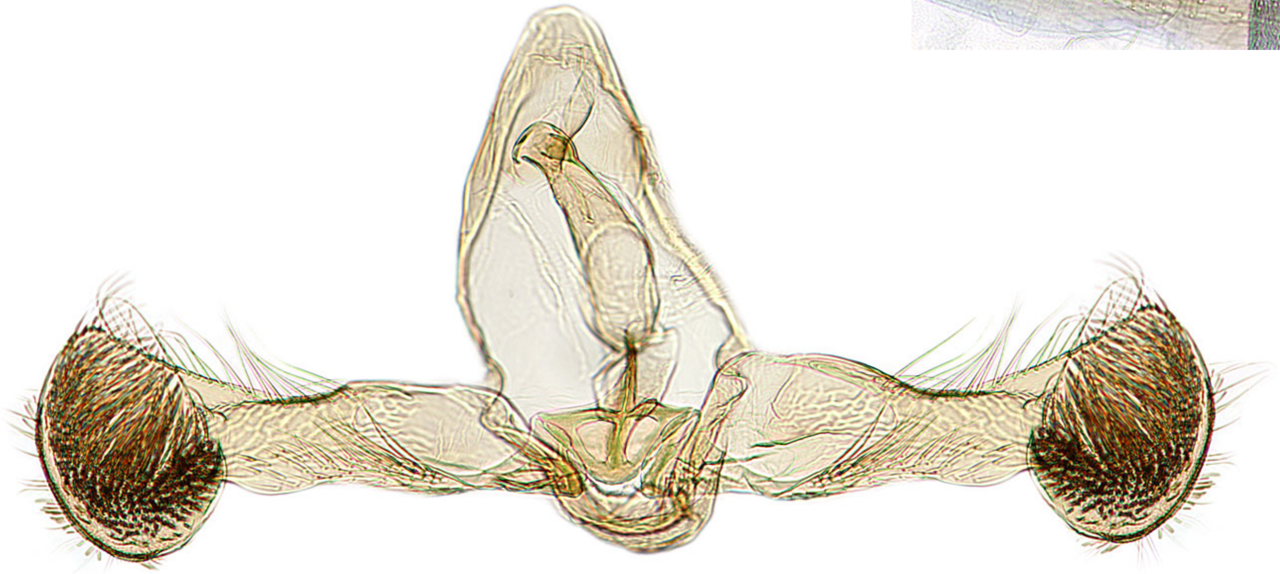


Grapholita prunivora

Adult recognition

- Male and female genitalia
  - The male valva is characterized by the angular apex and evenly rounded anal angle of the cucullus.
  - Female genitalia are characterized by a ringlike sterigma with weakly sclerotized lateral extensions.





Grapholita prunivora

Biology

- *Grapholita prunivora* completes two annual generations over much of its range.
- Adults are present in May to June and again in August.
- Females lay eggs singly on young fruits or on the upper surface of leaves.
- Larvae tunnel into the fruit at the calyx end and feed inside.
- In apple, larvae may feed directly under the skin of the fruit, creating a blotchy mine.
- Overwintering occurs as a mature larva and pupation occurs in the spring.

Grapholita prunivora

Larval morphology

- Late instar larvae are approximately 7.5-9.5 mm in length
- Abdomen is pale-reddish abdomen with moderately large pinacula
- Head is yellowish brown with darker mottling
- Prothoracic and anal shields are brown; the prothoracic shield may have some dark posterolateral markings
- Anal comb is present with 4-6 teeth
- Larvae may appear similar to those of many other species of *Grapholita* and *Cydia*.
  - *Cydia pomonella* larvae can be separated from *G. prunivora* by the absence of an anal fork and their larger size.
  - Larvae of *Grapholita molesta* are similar but generally larger.
  - Larvae of *G. packardi* and *G. prunivora* are very similar, although the pinacula on the 8th and 9th abdominal segment are more prominent in *G. packardi*, and the abdomen of *G. prunivora* is more reddish, especially in preserved specimens.

Grapholita spp.

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Thaumatotibia leucotreta

Tortricidae: Olethreutinae: Grapholitini

- ***Thaumatotibia leucotreta* (Meyrick)**
  - false codling moth (FCM)
  - In Africa, false codling moth is a serious pest of citrus (*Citrus* L.), cotton (*Gossypium* L.), and avocado (*Persea americana* Mill.).
  - It has also been reported causing serious damage to corn (*Zea mays* L.), guava (*Psidium guajava* L.), macadamia (*Macadamia integrifolia* Maiden & Betche), mango (*Mangifera indica* L.), peach (*Prunus persica* (L.) Batsch), and other horticultural crops.
  - Larvae are highly polyphagous and have been recorded feeding on more than 50 species of plants in over 30 families.
  - *Thaumatotibia leucotreta* is widely distributed across Africa and has been reported from approximately 40 countries on the African continent.
  - It is not considered established outside of Africa although it is commonly intercepted during quarantine inspections in Europe.

Thaumatotibia leucotreta

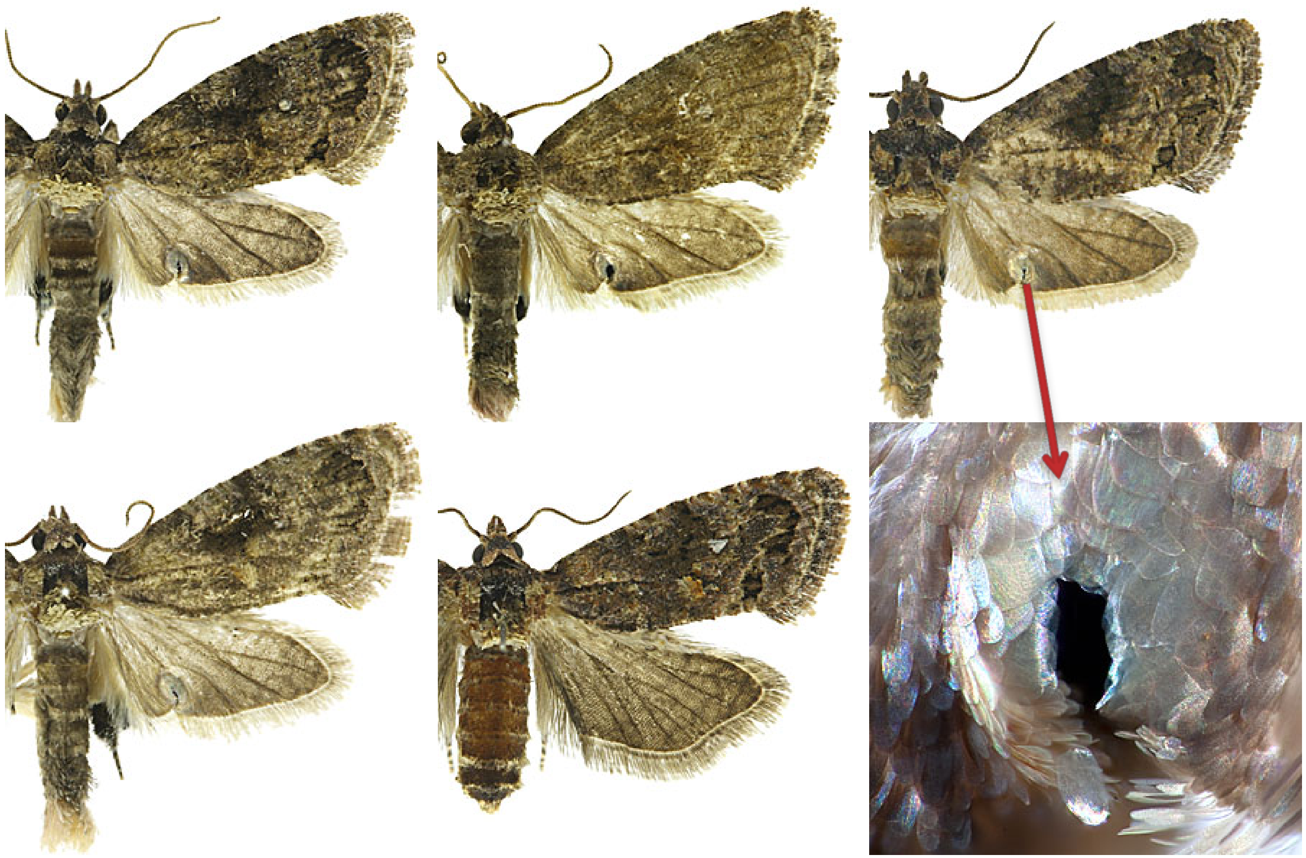
Adult recognition

- FWL: 7.0-8.0 mm (male); 9.0-10.0 (female)
- Adults of *T. leucotreta* are sexually dimorphic, and the two sexes differ in overall size, wing shape, and male secondary sexual characters. Male forewings are triangular with an acute apex, while female forewings are more elongate with a rounded apex. Both sexes exhibit a combination of the same forewing pattern elements: a small white dot near the end of the discal cell; a patch of raised, usually rust or orange colored scales near the middle of the wing; a distinct "question-mark-shaped" band of dark scales along the termen; and a semicircular band of dark scales in the middle of the costa.
- Males are easily distinguished by a semicircular pocket of opalescent scales at the distal end of vein CuA2 on the hindwing, tufts of modified scales on the hind tibia, and an enlargement of the inner apical spur on the hind tibia. Males lack a forewing costal fold.

Thaumatotibia leucotreta

Adult recognition

- The semicircular pocket of scales on the hindwing can be used to separate *T. leucotreta* males from all other tortricids.

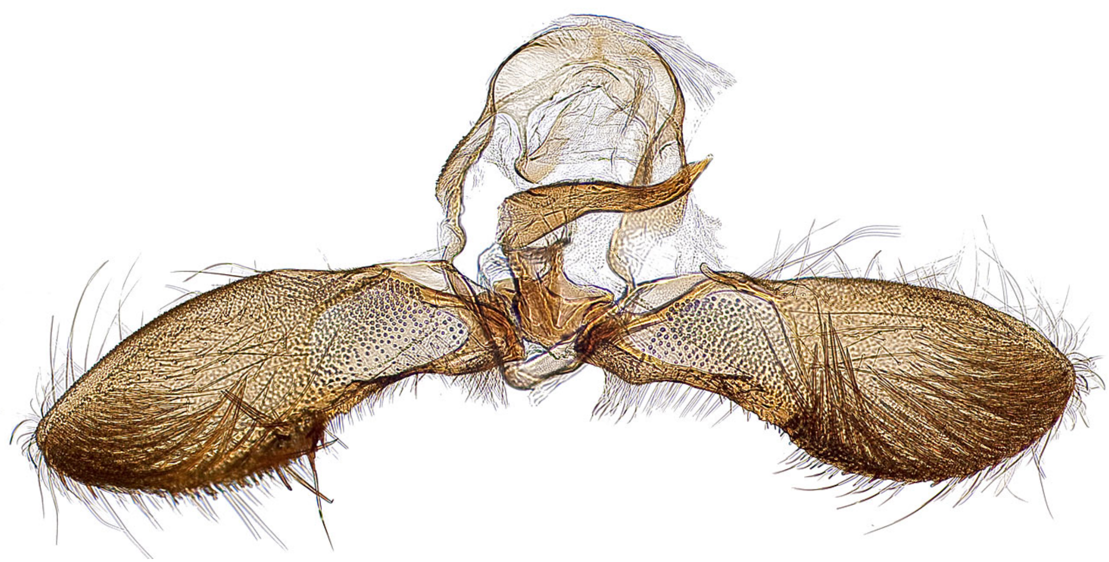


Thaumatotibia leucotreta

Thaumatotibia leucotreta

Adult recognition

- Male and female genitalia
  - Male genitalia are characterized by a rounded tegumen lacking an uncus or socii, large rounded valvae, and a tapered aedeagus that is upcurved distally.
  - Female genitalia are characterized by a semicircular sterigma, narrow ductus bursae, and large rounded corpus bursae with a pair of thorn-shaped signa.

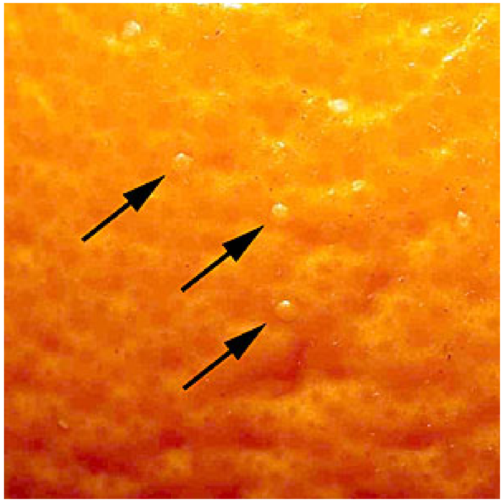


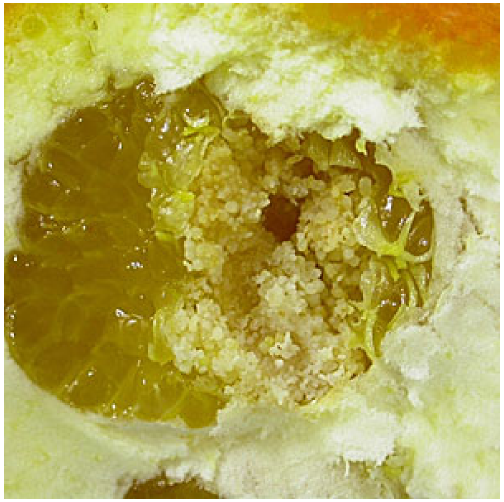
Thaumatotibia leucotreta

Biology

- *Thaumatotibia leucotreta* is not known to diapause, and development is continuous with adults present year-round. As many as 10 generations are possible per year in South Africa. The absence of a diapause may lead to host shifts and varied developmental rates in times of drought or when preferred host plants are unavailable.
- Females deposit eggs singly or in small groups on the surface of smooth fruit. A single female may produce between 87-456 eggs in her lifetime (with a maximum of 799).
- On fruit, larvae tunnel into the pith or feed beneath the surface. On cotton, larvae mine the wall of the boll and later move into the center of the boll to feed on the seeds.
- Larvae complete five instars. Last instar larvae exit the fruit or boll, drop from the host plant, and pupate in a silken cocoon in the soil, under leaf litter, or in bark crevices.
- Larvae cause significant damage by feeding directly on fruit or bolls. Feeding in citrus fruit can result in premature ripening and fruit drop as well as secondary infection by fungi. Larval feeding in cotton results in secondary infection by fungus and bacteria, causing rotting of the bolls. Feeding in avocado fruit results in lesions on the fruit and secondary infection by bacteria and fungi.
- Chemical control of this species is difficult due to the highly polyphagous, internal feeding larvae, and crop losses can be as high as 10-20% during serious citrus infestations. Control of false codling moth in South Africa is achieved through a combination of chemical control, mating disruption, attract and kill, natural enemies, and sterile insect technique (SIT).

Thaumatotibia leucotreta






Thaumatotibia leucotreta

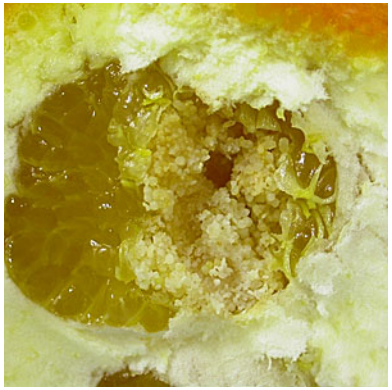
Larval morphology

- Last instar larvae are approximately 12-18 mm long with a yellowish brown to dark brown head and prothoracic shield. The abdomen is orange to pink with large pinacula that are darker than body color.
- Larvae can be distinguished by the following combination of characters:
  - L pinaculum on T1 enlarged, extending beneath and beyond (posterad of) spiracle
  - D1 and SD1 on A9 on same pinaculum, separate from D2
  - L group on A9 trisetose
  - Anal comb present with 2-10 teeth (the anal comb may be greatly reduced in some individuals)
- Other larval characters include:
  - SD2 on A1-8 highly reduced or appearing absent
  - SV groups on A1, 2, 7, 8, 9 with 3:3:2:2:1 setae
  - Spiracle on A8 displaced posterad of SD pinaculum
  - D2 setae on A9 on shared mid-dorsal "saddle" pinaculum
  - V setae on A9 slightly further apart than those on A8.
- Larval characters listed here are not completely diagnostic, and *T. leucotreta* larvae are difficult to separate from those of Cochylini and some *Cryptophlebia*, which can share the same set of character states (e.g., enlarged L-pinaculum on A9, spiracle on A8 displaced posterad, anal comb present). Two possible distinguishing features are SV counts of 3:3:2:2:2 and a bisetose L-group on A9 in many Cochylini. See next slide for *Cryptophlebia-Thaumatotibia* comparison.

Thaumatotibia leucotreta

Larval morphology

- L pinaculum on T1 enlarged, extending beneath and beyond (posterad of) spiracle



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Enarmonia formosana

Tortricidae: Olethreutinae: Enarmoniini

- ***Enarmonia formosana* (Scopoli)**
  - cherry bark tortrix (CBT)
  - Pest of fruit trees in the family Rosaceae; larvae have also been recorded on beech (Fagaceae)
  - Larval damage results in swellings and cankers, and branches or entire trees may be killed
  - Widely distributed from western Europe and northern Africa to Asia Minor, Russia, and Siberia
  - The first North American records are from British Columbia in 1989; it was subsequently found in western Washington in 1991 and has spread to Oregon
  - It is not present in the Northeast

Enarmonia formosana

Adult recognition

- FWL: 7.0-9.0 mm
- Forewings are black with distinctive yellow, orange, and silvery markings and a conspicuous ocellus with alternating black and yellow bands. Hindwings are dark grayish brown with white fringe.
- Adults of *E. formosana* have forewing coloration similar to some *Olethreutes* and related genera (*Syricoris, Pristerognatha*, etc.), although most of these species lack a defined ocellus. In North America, *Eucosmomorpha nearctica* may appear similar, but adults lack the black forewing ground color. A genitalic dissection can be used to easily separate the various genera listed here.
- *Enarmonia formosana* pheromone traps in Washington have captured a wide variety of tortricines and olethreutines as well as moths in other families. Wing pattern is usually sufficient to separate *E. formosana* from non-target species.

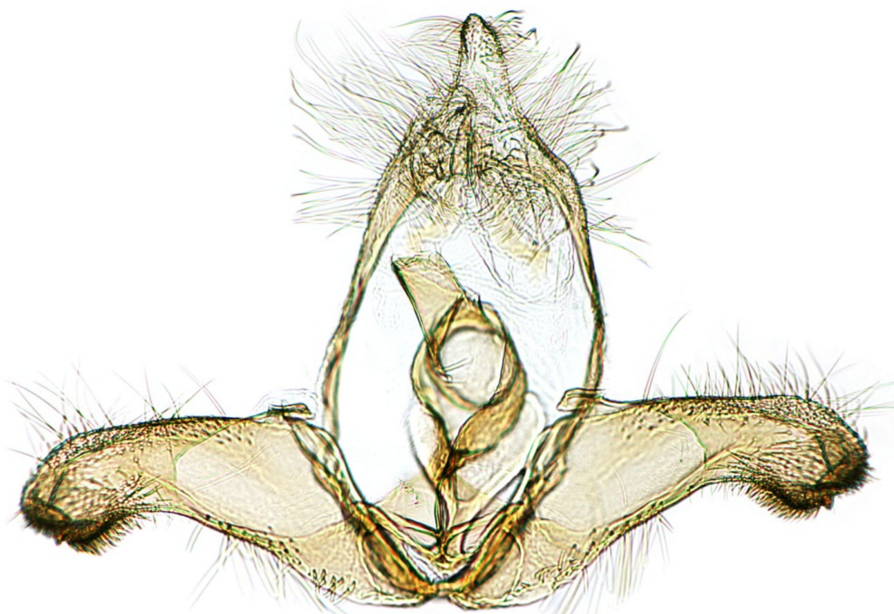
Enarmonia formosana

Adult recognition

Enarmonia formosana

Adult recognition

- Male and female genitalia



Enarmonia formosana

Biology

- *Enarmonia formosana* completes two annual generations; adults are present from May to September
- Females lay eggs singly or in small clusters on tree bark
- Larvae tunnel into the bark and feed under the surface
- Larval damage is characterized by "frass tubes" consisting of fecal pellets, silk, and tree sap, which protrude from larval feeding sites
- Overwintering occurs as a larva and pupation occurs in the larval feeding tunnels close to the surface of the bark or within the frass tubes

Enarmonia formosana

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Lobesia botrana

Tortricidae: Olethreutinae: Olethreutini

- ***Lobesia botrana* ([Denis & Schiffermuller])**
  - European grape vine moth (EGVM) (preferred common name), grapevine moth, grape berry moth
  - The preferred host is *Vitis vinifera* (wine grape) and *L. botrana* is one of the most important pests of grape in the Palearctic. However, larvae are polyphagous and have been recorded feeding on more than 40 species of plants in approximately 20 families (see host list in Gilligan et al. 2011).
  - *Lobesia botrana* is widely distributed in Europe, Central Asia, and parts of Africa. It has been recently discovered in Argentina, Chile, and California.

Lobesia botrana

Adult recognition

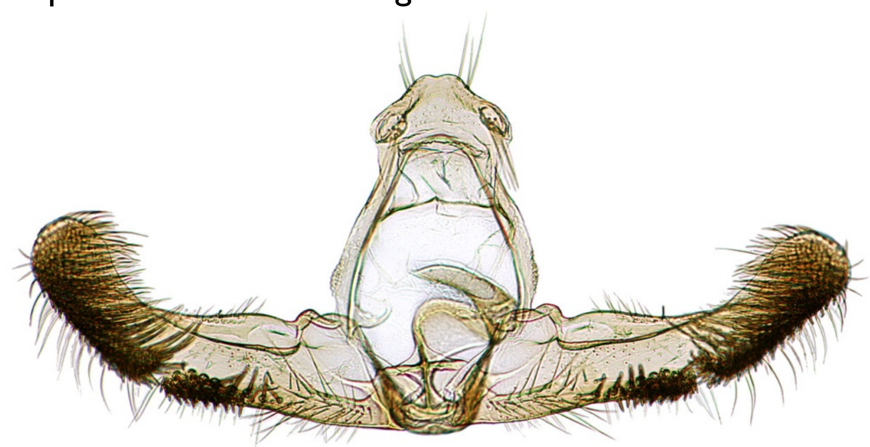
- FWL: 4.5-8.0 mm
- Adults are not sexually dimorphic, although females are generally larger than males. Forewing ground color is cream; the basal one-half of the wing, which is well differentiated by the inner edge of the median fascia, is overlaid with leaden gray, gray-brown, and pale-brown scales forming irregular patches and incomplete fasciae. The dark-brown median fascia is well defined basally, but irregular distally; the distal one-fourth of the wing is paler. The hindwing is whitish with a brown periphery in the male; it is almost complete brown in the female. Males lack a forewing costal fold.




Lobesia botrana

Adult recognition

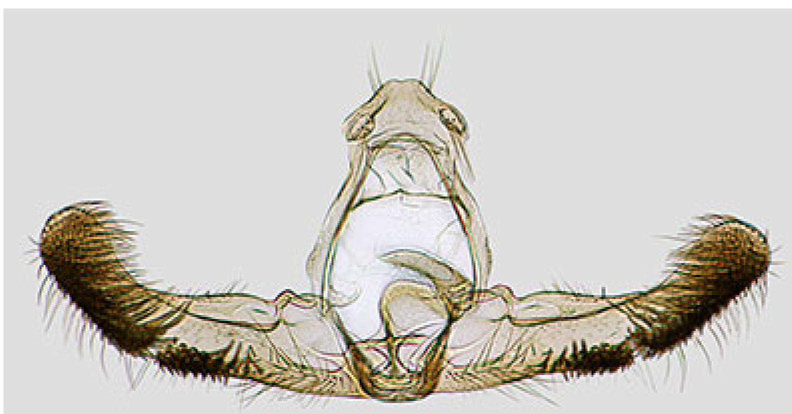
- Male and female genitalia
  - Male genitalia are characterized by the following characters: socii short, lateral, with small tufts of setae; uncus, gnathos, and transtilla absent; valvae long and narrow with row of spines on the ventral magin; cucullus densely setose, separated from sacculus with a distinct gap in the marginal spines; sacculus weakly concave postmedially; aedeagus small.
  - Female genitalia are characterized by a long, slender ductus bursae that is undifferentiated from the corpus bursae and an elongate signum.



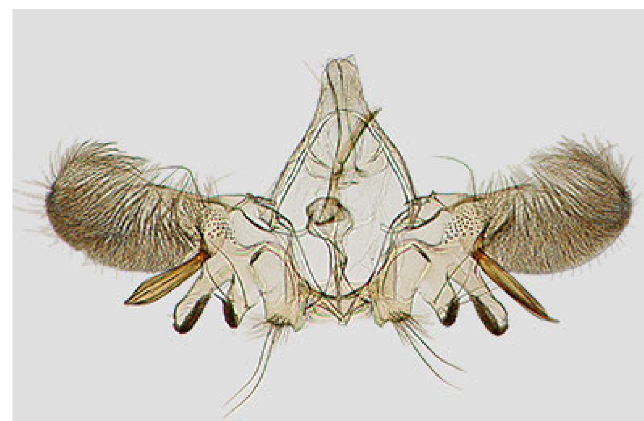
Lobesia botrana

Adult recognition

- *Lobesia botrana* is similar in size and wing pattern to many Nearctic *Paralobesia*, specifically *Paralobesia viteana*, which is a pest of grapes in eastern North America. Adults of *P. viteana* and *L. botrana* cannot be separated by wing pattern; however, the two species are easily separated by genitalia: *P. viteana* has a sclerotized lobe projecting from the base of the male cucullus that is absent in all other Nearctic olethreutines, and the female lacks a signum in the corpus bursae.



Lobesia botrana



Paralobesia viteana

Screening for *L. botrana* adults

- The following key was created for the screening and identification of suspect *L. botrana* adults captured in California.

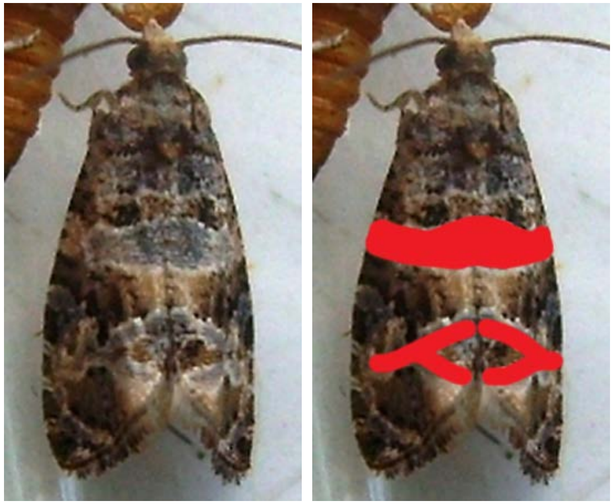
- 1. Abdominal or thoracic tympanum present; antenna pectinate; labial palpi upturned; proboscis scaled or absent; moths not about 4-7mm long – Not *L. botrana*
- 1'. Abdominal and thoracic tympanum absent; antenna simple; labial palpi projecting forward; proboscis not scaled; moths about 4-7mm – Go to 2

- 2. Forewings with prominent median gray bar and outer inverted "Y," both outlined in white, or forewing pattern unknown – Go to 3
- 2'. Forewings without prominent median gray bar and outer inverted "Y" – Not *L. botrana*

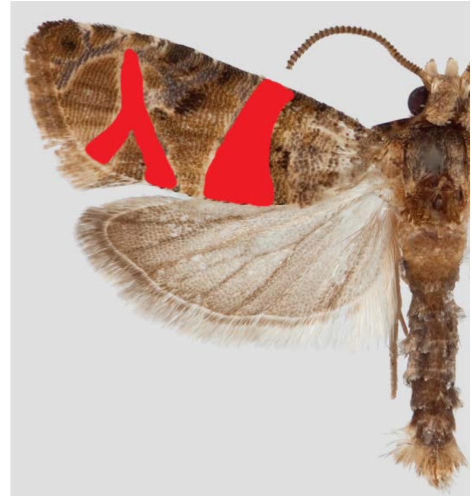
- 3. Males – Go to 4
- 3'. Females – Go to 5

- 4. Male valva with distinctive notch between cucullus and sacculus – *L. botrana* suspect
- 4'. Male valva without distinctive notch between cucullus and sacculus – Not *L. botrana*

- 5. Female with long narrow ductus bursae gradually expanding into corpus bursae, and a large single signum – *L. botrana* suspect
- 5'. Female without a long narrow ductus bursae gradually expanding into corpus bursae, and signum absent or two signa present – Not *L. botrana*

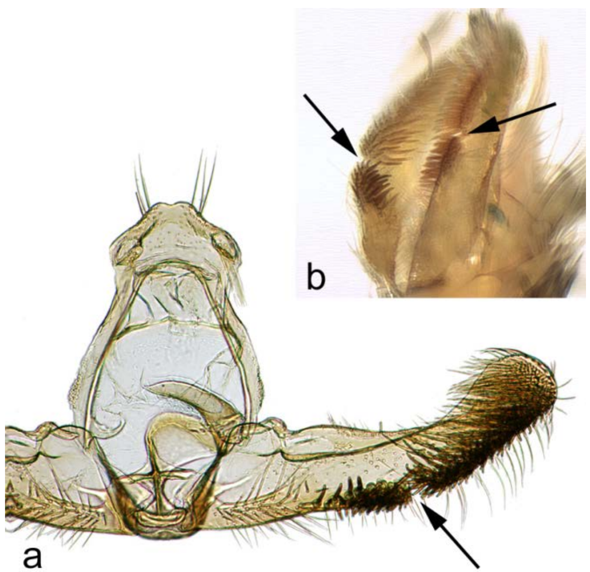


Wing pattern markings on resting adult

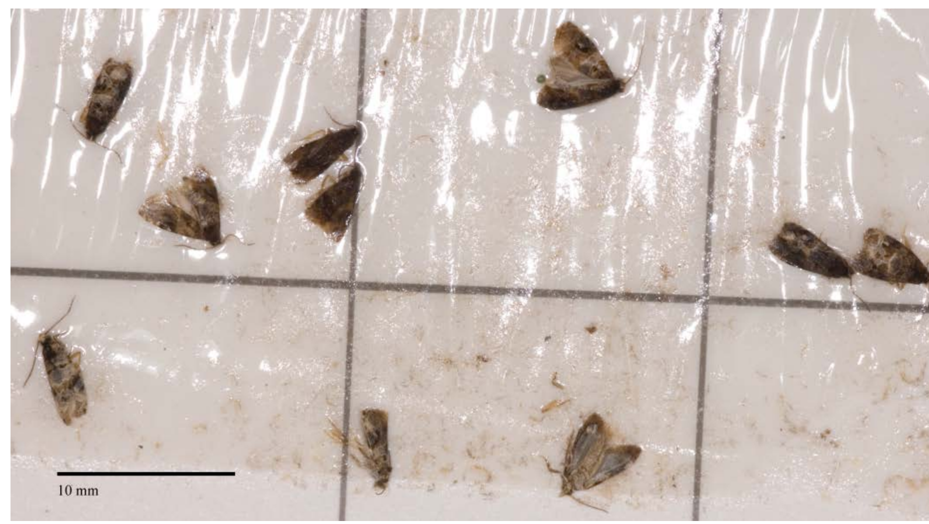


Wing pattern markings on spread adult

Large female signum



Spine gap in male valva



Adults in sticky trap

Lobesia botrana

Biology

- *Lobesia botrana* typically completes three generations in southern Europe, although the number can vary from a single generation in northern Europe to up to five generations in Central Asia.
- Females lay approximately 35 eggs per day, either in groups of 2 or 3 on the buds, pedicels, and flowers, or singly on berries later in the season.
- Eggs hatch in 3-10 days; egg development is dependent on temperature and humidity.
- Larvae complete five instars, with first generation larvae feeding on flowers and buds, second generation larvae feeding within single grape berries, and third and subsequent generation larvae feeding on several grape berries.
- Non-diapausing moths (usually first and second generations) pupate in rolled leaves or inflorescences tied with silk. Diapausing individuals pupate under bark, in the soil, or under leaf litter, and emerge the following spring.
- Damage is caused by larvae feeding on reproductive structures, resulting in yield loss, or by direct injury to grape berries. Secondary infection of larval feeding sites on grapes by fungus (*Botrytis cinerea*) causes the most significant damage.

Lobesia botrana

Larval morphology

- First instar larvae are yellowish green and approximately 1.0 mm in length. The head is black to dark brown, and the paler prothoracic shield is concolorous with the rest of the body.
- Last instar larvae are 10-15 mm long and vary in color from light yellowish green to pale brown. The head is brown to light yellowish brown to honey colored, the antennae and thoracic legs are brown to black, and the prothoracic shield is variably shaded with dark brown to black on the posterior and lateral margins.
- All instars have a dark stemmatal area and genal dash.
- Other diagnostic larval characters include
    - L-pinaculum on T1 horizontal, not extending beneath spiracle
    - SV groups on A1, 2, 7, 8, 9 with 3:3:3:2:2 setae
    - SD2 on A1-8 absent
    - Distance between V setae on A9 approximately 1.5-2.03 the distance between V setae on A8
    - Distance between D1 setae on anal shield equal to the distance between D1 and SD1
    - Anal comb with 5-8 teeth
    - Mandibles without inner teeth or a retinaculum.
- No morphological characters have been identified to reliably separate the larvae of *Paralobesia* and *Lobesia*. Should *Paralobesia* spp. be found in the same location as *L. botrana*, molecular diagnostics may be required to identify larvae found on grape.

Lobesia botrana

Lobesia botrana

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