Lobesia botrana

Scientific Name

Lobesia botrana Denis & Schiffermüller, 1776

<u>Synonyms:</u>
Phalaena vitisana Jacquin, 1788
Olindia rosmarinana Millière, 1866

Common Name(s)

European grapevine moth, grape fruit moth, grape leaf-roller, grape vine moth, grape moth, vine moth

Figure 1. Adult male of *Lobesia botrana* (Todd Gilligan, Colorado State University).

Type of Pest

Moth

Taxonomic Position

Class: Insecta, **Order:** Lepidoptera, **Family:** Tortricidae

Reason for Inclusion in Manual

CAPS Target: AHP Prioritized Pest List - 2003 through 2009;
PPQ Program Pest

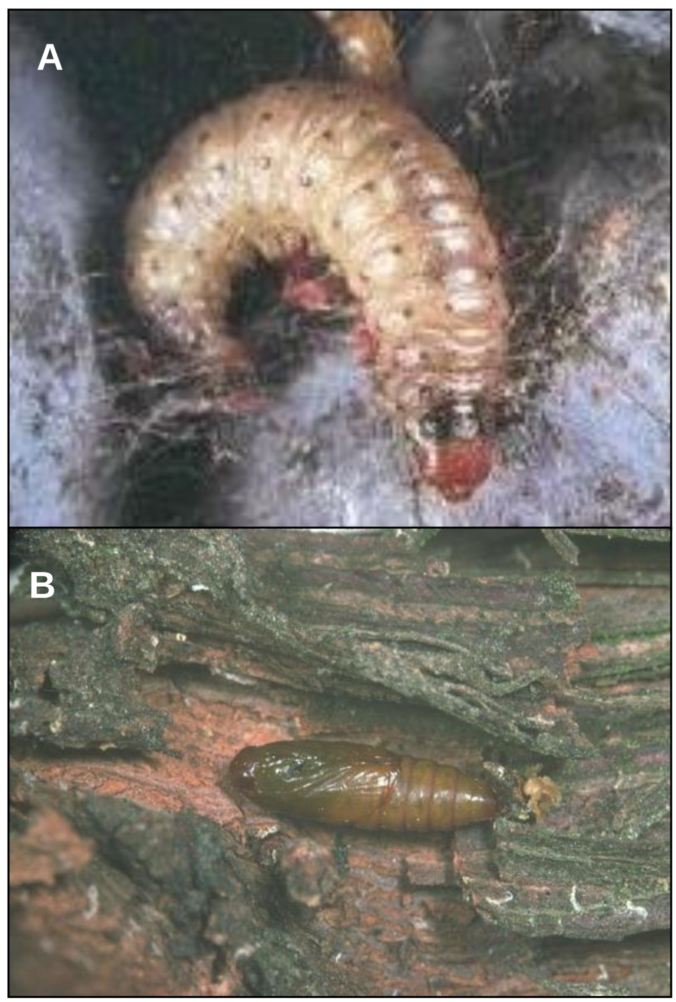

Figure 2. Larva (A) and pupa (B) of *L. botrana* (Instituto Agrario S. Michele All' Adigen, HYPPZ Zoology).

Pest Description

European grapevine moth (EGVM) is primarily a pest on the flowers and fruit of grape vines, but the moth has been known to infest stone fruit trees, privet, and olives as well. Survey for this pest in stone fruit, privet, and olives is important because, in general, these secondary hosts flower before grapes; and *L. botrana* can be found on these earlier hosts before moving over to grapes, its preferred host.

<u>Eggs:</u> The egg of *L. botrana* is of the so-called 'flat type' with the long axis

horizontal and the micropyle at one end. Eggs are elliptical, flattened, and slightly convex. The egg measures about 0.65 to 0.90 mm x 0.45 to 0.75 mm. Freshly laid eggs are pale yellow, later becoming light gray and translucent with iridescent glints (opalescent). The chorion is macroscopically smooth but presents a slight polygonal reticulation in the border and around the micropyle (CABI, 2009; Gilligan et al., 2011).

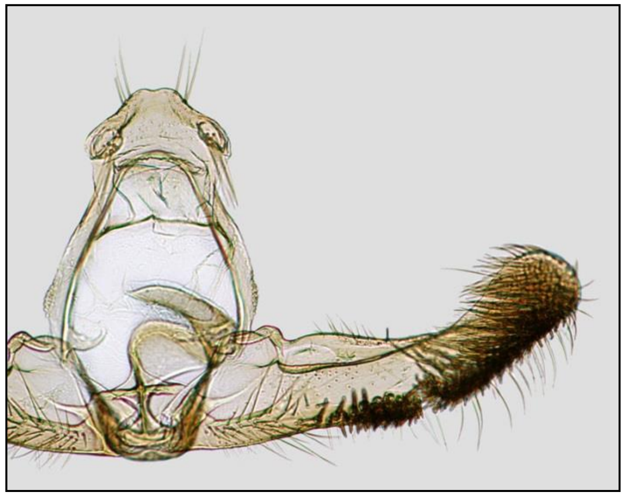

Figure 3. Male genitalia of *L. botrana* (Todd Gilligan, Colorado State University).

<u>Larvae:</u> From Gilligan and Epstein (2012):

"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."

Figure 4. Female genitalia of *L. botrana* (Todd Gilligan, Colorado State University).

<u>Pupae:</u> Female pupae are larger (5 to 9 mm; approx. $^{3}/_{16}$ to $^{3}/_{8}$ in) than males (4 to 7 mm; approx. $^{3}/_{16}$ to $^{5}/_{16}$ in). Freshly formed pupae are usually cream or light brown but also light green or blue, but a few hours later become brown or deep brown (Fig. 1B). Cast pupal skins, are somewhat unusual in retaining a greenish tint on the anterior abdominal segments. Pupal age may be estimated as a function of tegument transparency and coloring (CABI, 2009).

<u>Adults:</u> From Gilligan and Epstein (2012):

“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.

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; cornuti absent. Female genitalia are characterized by a long, slender ductus bursae that is undifferentiated from the corpus bursae and an elongate signum”.

For an in depth description of pest stages, see Gilligan et al. (2011).

Biology and Ecology

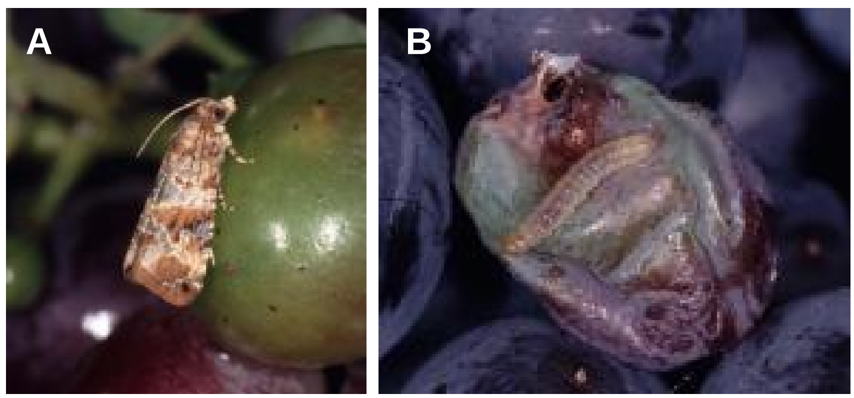

Figure 5. Adult on grape fruit (A) and larvae feeding inside a grape (B) (Michael Breuer. http://www.bio-pro.de/de/region/freiburg/magazin/01476/index.html).

The first flight of adults occurs in spring when daily average air temperature is above the minimal threshold temperature of 10°C (50°F) for 10 to 13 days. The second flight period begins in summer (USDA, 1985). In Israel, adults appear in the vineyard when grapevines flower. Adults are hard to discover during the day and may be noticed only when they take flight after being disturbed. They fly at dusk whenever the temperature is above 12°C (54°F), but rainfall and wind will reduce flight. Adults usually prefer hot, dry places protected from wind so they fly mainly between the first rows of grapevines close to windbreaks and on slopes facing the sun (Avidov and Harper, 1969).

Within a day or two of mating, females begin to oviposit on the blossoms, leaves, and tender twigs of the grapevine. The female lays 300 or more eggs singly or in groups of two or three at a rate of more than 35 per day. During rearing experiments under laboratory conditions in Czechoslovakia, the optimum temperatures for oviposition were from 20 to 27°C (68 to 81°F) (Gabel, 1981). First generation eggs are laid on the flower buds or pedicels of the vine while second generation eggs are laid on individual grapes (USDA, 1985) (Fig. 5A). Eggs hatch in 5 to 10 days or 75 degree-days above a 10°C (50°F) threshold (Gilligan et al., 2011).

The European grapevine moth is a polyvoltine species (CABI, 2009). The number of generations in a given area is fixed by photoperiod together with temperature, acting on diapause induction and development rate, respectively. Short-day photophases (between 8 and 12 h) during the larval stage induce diapause in larvae that will be later expressed in pupae. The moth achieves two generations in northern cold areas and usually three generations in southern temperate areas, although this general latitudinal pattern is often modified by the altitude-derived gradient and/or microclimatic conditions in a given area. Thus the number of generations has a broader range, reported as one generation in Romania (Filip, 1986) to four generations (often partial) in Spain, Greece, Crete, Italy, and former Yugoslavia (Coscollá, 1997 and references therein). Five generations have been reported in Turkmenistan (Rodionov, 1945).

First generation larvae feed on bud clusters or flowers and spin webbing around them (glomerules) (Fig. 6) before pupating inside the web or under the rolled leaf. Second generation larvae enter an unripened grape (Fig. 4B) and feed before pupating inside the grape. Larvae of the third generation, the most damaging, feed on ripening grapes, migrating from one to another and spinning webs. The third generation larvae leave the fruit and shelter under the bark, among dead leaves, or between clods of earth, where they pupate before overwintering. Few of these larvae pupate before harvest, and many are gathered with the grapes. Larval development is completed in approximately 20 to 28 days or 170 degree days for larvae feeding on flowers and 225 degree-days for larvae feeding on berries (Gilligan et al., 2011). Pupae complete development in approximately 12 to 14 days, or 130 degree-days, for non-diapausing individuals (Gilligan et al., 2011).

Moth activity (*i.e.*, flight, feeding, calling, mating, and egg-laying) is principally displayed at dusk, although some activity can also occur at daybreak or at any time on cloudy days. Water availability is necessary for adults to reach their potential reproductive output (Torres-Vila et al., 1996).

Damage

Grape: On grape inflorescences, neonate (first generation) larvae firstly penetrate single flower buds. Symptoms are not evident initially because larvae remain protected by the top bud. Later, when larval size increases, each larva agglomerates several flower buds with silk threads forming glomerules visible to the naked eye (Fig. 6), and the larvae continue feeding while protected inside. Larvae usually make one to three glomerules during their development. Despite hygienic

Figure 6. Glomerules of *L. botrana* (EFAPO-ES).

behavior of larvae, frass may remain adhering to the glomerules. On grapes (summer generations), larvae feed externally and when berries are a little desiccated, they penetrate them, bore into the pulp, and remain protected by the berry peel (Fig. 5B). Larvae secure the pierced berries to surrounding ones by silk threads in order to avoid falling. Each larva directly damages several berries (one to six). If conditions are suitable for fungal or acid rot development, a large number of berries near the damaged berry may be also affected. Damage is variety-dependent; generally it is more severe on grapevine varieties with dense grapes because this increases both larval infestation and rot development. On both inflorescences and grapes, several larvae may co-exist in a single reproductive organ. Larval damage on growing points, shoots, or leaves is unusual.

Figure 7. Damage by *L. botrana* (HYPPZ Zoology).

Larval feeding on the buds or flowers webs them and prevents further growth. If heavy flower damage occurs during the first moth generation, the affected flowers will fail to develop and yield will be low. Damage by summer larvae of the second and third generation results in many nibbled berries, which later shrivel. The berries may be eaten either partly (leading to rot) or completely (leaving only empty skins at the tip of the bunch). Sometimes berries drop, and only the stalks remain (USDA, 1985).

Stone fruit: Documentation on damage to stone fruits is limited, as most information is available on grape. This moth can cause damage to the flowers and the fruit of stone fruit hosts.

Pest Importance

The European grapevine moth is a serious pest in the warm vine-growing countries where it is normally found. Larvae feed on flower buds, developing berries, and most destructively, on the ripening fruit of grape. The primary damage to grape berries attracts other insects and predisposes the fruit to fungal infection. Larval boring in grapes may promote a number of fungal rots (CABI, 2009). Loss of up to one-third of the vintage has been reported in areas of the Soviet Union, Syria, and Yugoslavia. Losses in Israel sometimes reach 40 to 50 percent among table grapes and up to 80 percent or more for wine grapes. Further loss is due to the time and labor spent in cleaning the grape bunches. When infestations are heavy, the work days spent in cleaning the fruit account for 30 to 40 percent of the time of those involved in harvesting (USDA, 1985).

On grapes (summer generations), indirect damage is usually more important than direct, at least in the event of less severe attacks. Thus global damage may appear of little importance if it is evaluated exclusively as weight loss (direct damage) because greater damage is due to rot-derived reduction in quality (indirect damage). Larval boring in grapes may promote a number of fungal rots, especially *Botrytis cinerea* (Fig. 8) (Fermaud and Le Menn, 1989; CABI, 2009).

Figure 8. Discolored, shriveled berries caused by Botrytis bunch rot (left), and *Botrytis cinerea* sporulating on grape berries (right) (P. Sholberg, Agriculture & AgriFood Canada).

Known Host

This pest feeds primarily on the flowers and fruit of grapes. However, *L. botrana* demonstrates a curious behavior of feeding on many different plant families (approximately 27), but only a few species within each family are suitable. Grape cultivars with prolonged blossoming or late-ripening berries are usually more heavily infested than short-flowering or early ripening varieties (Avidov and Harper, 1969). *Lobesia botrana* exhibits an oviposition preference for privet and certain grape cultivars, such as ‘Cabernet Sauvignon’ (Maher et al., 2000, 2001).

Major hosts

Vitis vinifera (grape) and *Vitis* spp.

Minor hosts

Actinidia chinensis (kiwi), *Clematis vitalba* (traveler’s joy), *Coffea* spp. (coffee), *Daphne odora* (winter daphne), *Dianthus* spp. (carnation), *Diospyros kaki* (persimmon), *Diospyros virginiana* (persimmon), *Hypericum calycinum* (Aaron’s beard), *Hordeum vulgare* (barley), *Malus pumila* (apple), *Medicago sativa* (alfalfa), *Olea europaea* subsp. *europaea* (olive), *Prunus* spp., *Prunus avium* (sweet cherry), *Prunus domestica* (plum), *Prunus dulcis* (almond), *Prunus persica* (peach/nectarine), *Prunus salicina* (Japanese plum), *Prunus spinosa* (blackthorn), *Punica granatum* (pomegranate), *Pyrus communis* (pear), *Ribes* spp. (currant), *Ribes nigrum* (blackcurrant), *Ribes rubrum* (red currant), *Ribes uva-crispa* (gooseberry), *Rosa* spp. (rose), *Rubus fruticosus* (European blackberry), and *Solanum tuberosum* (potato).

Wild hosts
Arbutus unedo (arbutus), *Berberis* spp. (barberry), *Berberis aquifolium* (Oregon-grape), *Berberis vulgaris* (European barberry), *Clematis vitalba* (old man's beard), *Cornis* spp. (dogwood), *Cornus alba* (dogwood), *Cornus mas* (cornelian cherry), *Cornus sanguinea* (dogwood), *Cucumis sativus* (cucumber), *Daphne gnidium* (spurgeflax daphne), *Galium mollugo* (smooth bedstraw), *Hedera helix* (ivy), *Lamium amplexicaule* (henbit), *Ligustrum vulgare* (privet), *Lonicera tatarica* (Tatarian honeysuckle), *Lonicera xylosteum* (fly honeysuckle), *Menispermum canadense* (common moonseed), *Parthenocissus quinquefolia* (Virginia creeper), *Rhus glabra* (smooth sumac), *Rosmarinus officinalis* (rosemary), *Rubus* spp. (blackberry), *Rubus caesius* (dewberry), *Rubus dumetorum* (European dewberry), *Silene vulgaris* (bladder campion), *Syringa vulgaris* (lilac), *Tanacetum vulgare* (tansy), *Thymelaea hirsuta* (thymelaea), *Trifolium pratense* (red clover), *Urginea maritima* (red squill), *lantana* (wayfaring tree), and *Ziziphus jujuba* (common jujube) (Hoenisch, n.d.; USDA, 1985; reviewed in Gilligan and Epstein, 2012).

Pathogens or Associated Organisms Vectored

It has been shown that the nutritional alteration of berries caused by *Botrytis cinerea* may enhance female fecundity of *L. botrana* (Savopoulou-Soultani and Tzanakakis, 1988). Larval boring in grapes may promote a number of fungal rots including *Alternaria*, *Aspergillus*, *Cladosporium*, *Penicillium*, *Rhizopus*, and especially *Botrytis cinerea*.

Known Distribution

Africa: Algeria, Egypt, Eritrea, Ethiopia, Kenya, Libya, and Morocco; **Asia:** Armenia, Azerbaijan, Republic of Georgia, Iran, Iraq, Israel, Japan[1], Jordan, Kazakhstan, Lebanon, Syria, Tajikistan, Turkey, Turkmenistan, and Uzbekistan; **Europe:** Albania, Austria, Belgium, Bulgaria, Cyprus, Czech Republic, France (including Corsica), Germany, Greece (including Crete), Hungary, Italy (including Sardinia and Sicily), Lithuania, Luxembourg, Macedonia, Malta, Moldova, Montenegro, Poland, Portugal, Romania, Russia, Serbia, Slovakia, Slovenia, Spain, Sweden[2], Switzerland, Ukraine, and the United Kingdom; **South America:** Argentina and Chile (CIE, 1974; CABI, 2007; SENASCA, 2010; Shahini et al., 2010; Aarvik, 2011; EPPO, 2012).

In 2008, the first report of *L. botrana* in Western Hemisphere occurred in Chile (Gonzalez, 2008). In March 2010, the Argentinean National Service for Agrifood Health and Quality reported *L. botrana* in Argentina at locations in the Maipu Department, Mendoza Province, close to the Chilean border (SENASCA, 2010).

North American records from the mid- to late- 1800s are misidentifications of *Paralobesia viteana* (Kearfott, 1904), a native North American grape-feeding tortricid that is extremely similar in morphology to *L. botrana* (Gilligan et al., 2011).

[1]Records of *L. botrana* in Japan are thought to be misidentifications (CABI, 2014).

[2]Records of *L. botrana* in Sweden are considered incidental (CABI, 2014).

Pathway

This species could be introduced as larvae or pupae on infested propagation material, including table grapes for consumption, from areas where it is known to occur (CABI, 2014). This species has been occasionally intercepted at U.S. ports of entry. There are 24 records in the AQAS system (queried June 10, 2014). All of the interceptions except one occurred in baggage on plant material (fruit, leaves or seeds) for consumption (AQAS, 2014, queried June 10, 2014).

This species is already present in parts of California. Although this is a program pest, natural spread through adult flight could potentially occur, as well as spread through human-mediated movement.

Potential Distribution within the United States

On September 15, 2009, *Lobesia botrana* was detected in commercial vineyard in Napa County, California. Since 2010, the moth has been detected and a quarantine is in place for portions of 10 counties (Fresno, Mendocino, Merced, Napa, Nevada, San Joaquin, Santa Clara, Santa Cruz, Solano, and Sonoma) in California. In March 2012, *L. botrana* was declared eradicated from Fresno, Mendocino, Merced, and San Joaquin counties leaving only, Napa, Nevada, Santa Clara, Santa Cruz, Solano, and Sonoma under quarantine.

For more information on the current status of this species in the United States, see the USDA-APHIS Program Page.

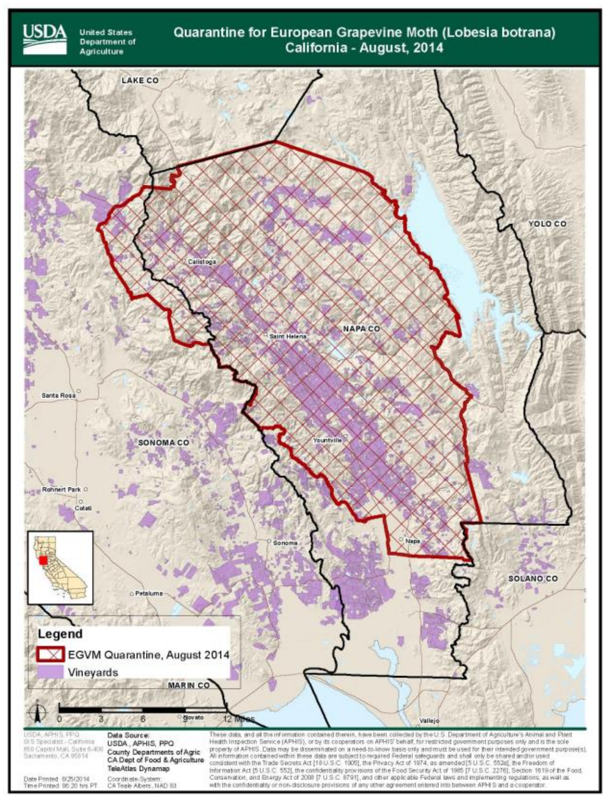

Figure 9. Quarantine map for *Lobesia botrana* in California, August 2014 (USDA, 2014).

Survey

<u>CAPS-Approved Method*:</u>

The CAPS-approved method is a trap and lure combination. The approved trap is a delta trap.

Any of the following Trap Product Names in the IPHIS Survey Supply Ordering System may be used for this target,

Paper Delta Trap, 2 sticky sides, Brown
Paper Delta Trap, 2 sticky sides, Green
Paper Delta Trap, 2 sticky sides, Orange
Paper Delta Trap, 3 sticky sides, Orange

Large Plastic Delta Trap Kits, Red

The Lure Product Name is "*Lobesia botrana* Lure." The lure is effective for 28 days (4 weeks).

IMPORTANT: Do not include lures for other target species in the trap when trapping for this target.

Method notes: The paper delta trap (with 2 sticky sides) has been added as an approved method. Both the large plastic delta trap (red) and the orange paper delta trap (with 3 sticky sides) are acceptable for use and for data reporting. The PPQ Lobesia Program has chosen the 2-sided paper delta trap as the preferred trap for the program. When using the 2-sided trap, the lure should be placed in a lure hanger inside the trap.

The trap color may be decided by the State and does not affect trap efficacy. For the paper delta traps, all of the standard colors used for gypsy moth (brown, green, or orange) are acceptable. Red was the recommended color for the large plastic delta trap as it has been shown to reduce trap catches of non-target (beneficial) insects. Trap color has not been shown to increase or decrease catches of *L. botrana*.

Trap spacing: When trapping for more than one species of moth, separate traps for different moth species by at least 20 meters (65 feet).

Survey Site Selection:
Surveys can occur wherever host material is present. This pest feeds primarily on the flowers and fruits of grapes, so vineyards are a good place to survey.

Time of year to survey:
The first flight of adults occurs in spring when daily average air temperature is above the minimal threshold temperature of 10°C (50°F) for 10 to 13 days. The second flight period begins in summer.

More information on trapping *L. botrana* in the United States can be found on the PPQ Program website.

*For the most up-to-date methods for survey and identification, see Approved Methods on the CAPS Resource and Collaboration Site, at https://caps.ceris.purdue.edu/node/223.

Literature-Based Methods: From Venette et al. (2003)
Trapping: A sex pheromone has been identified that is highly attractive to males. Males are most attracted to a five component blend of (*E*,*Z*)-(7,9)-dodecadienyl acetate, (*E*,*Z*)-(7,9)-dodecadien-1-ol, (*Z*)-9-dodecenyl acetate, (*E*)-9-dodecenyl acetate and 11-dodecenyl acetate in a ratio of 10: 0.5: 0.1: 0.1: 1. Males are slightly less attracted to a three component blend of (*E*,*Z*)-(7,9)-dodecadienyl acetate, (*E*,*Z*)-(7,9)-dodecadien-1-ol,

(*Z*)-9-dodecenyl acetate (ratio of 10:0.5:0.1). Males were still attracted, but much less so, to the main pheromone component (*E*,*Z*)-(7,9)-dodecadienyl acetate. The main pheromone component has been used to disrupt mating as a method of pest control and to monitor the flight period of males. However, this compound is sensitive to sunlight and degrades, becoming non-attractive to *L. botrana* after 60 minutes of exposure to UV radiation.

Pheromone-baited traps (*e.g.*, Pherocon 1C, Zoecon) have been used to monitor male flight activity (Anshelevich et al., 1994) and to make informed treatment decisions in grape production areas. Delta traps catch relatively fewer moths than traps with a more open design, *e.g.,* traptest traps described as "commercial type (Montedison, Milan, Italy), consisting of two triangular plastic roofs in Havana brown; with a sticky area of 9.89 dm^2 [152 in^2]".

Trap placement:
Traps placed 4 ft. high (1.3 m) are generally more effective than traps placed at only 1 ft. (0.3 m).

When pheromone traps are used, care should be taken to keep foliage away from the entry to the trap (PPQ, 1993).

Visual survey: USDA (1985) suggests visually inspecting for eggs on flower buds or pedicels of vines and grapes. It is preferable to look for larval damage rather than for eggs, because detection of eggs is very tedious and time-consuming, especially under field conditions. Look for webbed bud clusters (glomerules) or flowers where the spring generation larvae feed. Inspect for pupae under rolled leaves in spring. Inspect grapes and look for eggs or damaged berries. Cut open grapes and search for summer generation larvae (Fig. 5) and pupae. Suspect adult specimens should be pinned and labeled for subsequent identification. Submit suspect larvae or pupae in alcohol. For field surveys, Badenhauser et al. (1999) recommended a sample unit of a grapevine. Sample units should be selected at random.

Not recommended: Light traps have been used; however, for CAPS surveys, light traps are not an approved method for this species as they are not species-specific. Feeding traps were largely used in the past before pheromone traps were developed, but may still be useful in particular situations. An earthen or glass pot is baited with a fermenting liquid (fruit juice, molasses, etc.), and the scents produced attract adults, which are then drowned. Practical problems include irregularity in trapping because fermentation strongly depends on seasonal temperature, trap maintenance (lure replenishment and foam elimination), and low selectivity.

A corrugated paper band technique has sometimes been employed to trap and quantify overwintering pupae. Bands are placed around grapevine trunks or primary branches, and diapausing larvae pupate inside. However, this method is only useful in the latter generations, and its reliability is uncertain.

Key Diagnostics/Identification

CAPS-Approved Method*:
Confirmation of *L. botrana* is by morphological identification. Larvae can be keyed out using Gilligan et al. (2008). Identification of adults requires dissection of the male genitalia; use Gilligan et al. (2014).

Specimens can be sorted and screened based on the level of available expertise. Level 1 screening is difficult for small moths and may need to be performed by a trained Lepidopterist. When in doubt distinguishing first level screening characters, forward traps that have passed the sorting requirements to a trained taxonomist. Use Gilligan et al. (2014) for both sorting and screening.

Gilligan, T. M., S. C. Passoa, and M. E. Epstein. 2014. Screening aid: European Grapevine Moth, *Lobesia botrana* (Denis & Schiff.). Identification Technology Program (ITP), USDA-APHIS-PPQ-S&T, Fort Collins, CO. 6 pp. https://caps.ceris.purdue.edu/dmm/540.

A new identification tool, *Tort AI – Tortricids of Agricultural Importance*, is available at http://idtools.org/id/leps/tortai/ from CPHST's Identification Technology Program. This tool contains larval and adult keys, fact sheets, an image gallery, molecular search capacity, and more. *Lobesia botrana* is included in this tool.

*For the most up-to-date methods for survey and identification, see Approved Methods on the CAPS Resource and Collaboration Site, at https://caps.ceris.purdue.edu/node/223.

Easily Confused Species
From Gilligan and Epstein (2012):

"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. *Paralobesia viteana* is not present in California, but at least three species of *Paralobesia* have been recorded from the West Coast (see Gilligan et al. 2011)." *Paralobesia viteana* occurs in the eastern United States and ranges as far west as Colorado.

For additional information, see:
Gilligan, T. M., S. C. Passoa, and M. E. Epstein. 2014. Screening aid: European Grapevine Moth, *Lobesia botrana* (Denis & Schiff.). Identification Technology Program (ITP), USDA-APHIS-PPQ-S&T, Fort Collins, CO. 6 pp. https://caps.ceris.purdue.edu/dmm/540.

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Revisions

October 2014

1) Revised the **Pest Description** section.
2) Revised the **Known Distribution** section.
3) Revised the **Pathway** section.
4) Revised the **Potential Distribution within the United States** section.
5) Added **Figure 10. Quarantine map for *Lobesia botrana* in California**.
6) Revised the **Key Diagnostics/Identification** section. Added Gilligan et al. (2014).
7) Revised the **Easily Confused Species** section. Added Gilligan et al. (2014).

November 2014

1) Revised the **Synonyms** section.
2) Revised the **Pest Description** section.