CAPS pest datasheets provide pest-specific information to support planning and completing early detection surveys.

Cydalima perspectalis

Scientific Name
Cydalima perspectalis (Walker, 1859)

Synonyms:
Diaphania perspectalis (Walker, 1859)
Glyphodes perspectalis (Walker, 1859)
Palpita perspectalis (Walker, 1859)
Phakellura perspectalis Walker, 1859
Neoglyphodes perspectalis (Walker, 1859)
Phacellura advenalis Lederer, 1863
Glyphodes albifuscalis Hampson, 1899

Common Name
Box tree moth, box tree pyralid, box tree caterpillar

Type of Pest
Moth, defoliator

Taxonomic Position
Class: Insecta, **Order:** Lepidoptera, **Family:** Crambidae

Figure 1. *Cydalima perspectalis* adult. Photo by Didier Descouens wikimedia commons (CC-BY-SA-4.0), used with permission.

Figure 2. Adult (brown winged or melanic). Photo by Szabolcs Sáfián, University of West Hungary, Bugwood.org (CC-BY-SA-4.0), used with permission.

Pest Recognition
This section describes characteristics of the organism and symptoms that will help surveyors recognize possible infestations/infections in the field, select survey sites, and collect symptomatic material. For morphological descriptions, see the Identification/Diagnostic resources on the AMPS pest page on the CAPS Resource and Collaboration website.

Pest Description

Adults have average wing spans of 4 to 4.5 cm (1 $^{9}/_{16}$ to 1 $^{3}/_{4}$ in) (Gutue et al., 2014). Adults are nocturnal. During the day, they rest on the undersides of leaves (Brua, 2013). *Cydalima perspectalis* has two color forms. The most common form has white wings with dark brown borders (Fig. 1; Hizal et al., 2012; Korycinska and Eyre, 2010), while the melanic form has solid brown wings with a white streak or spot on each forewing

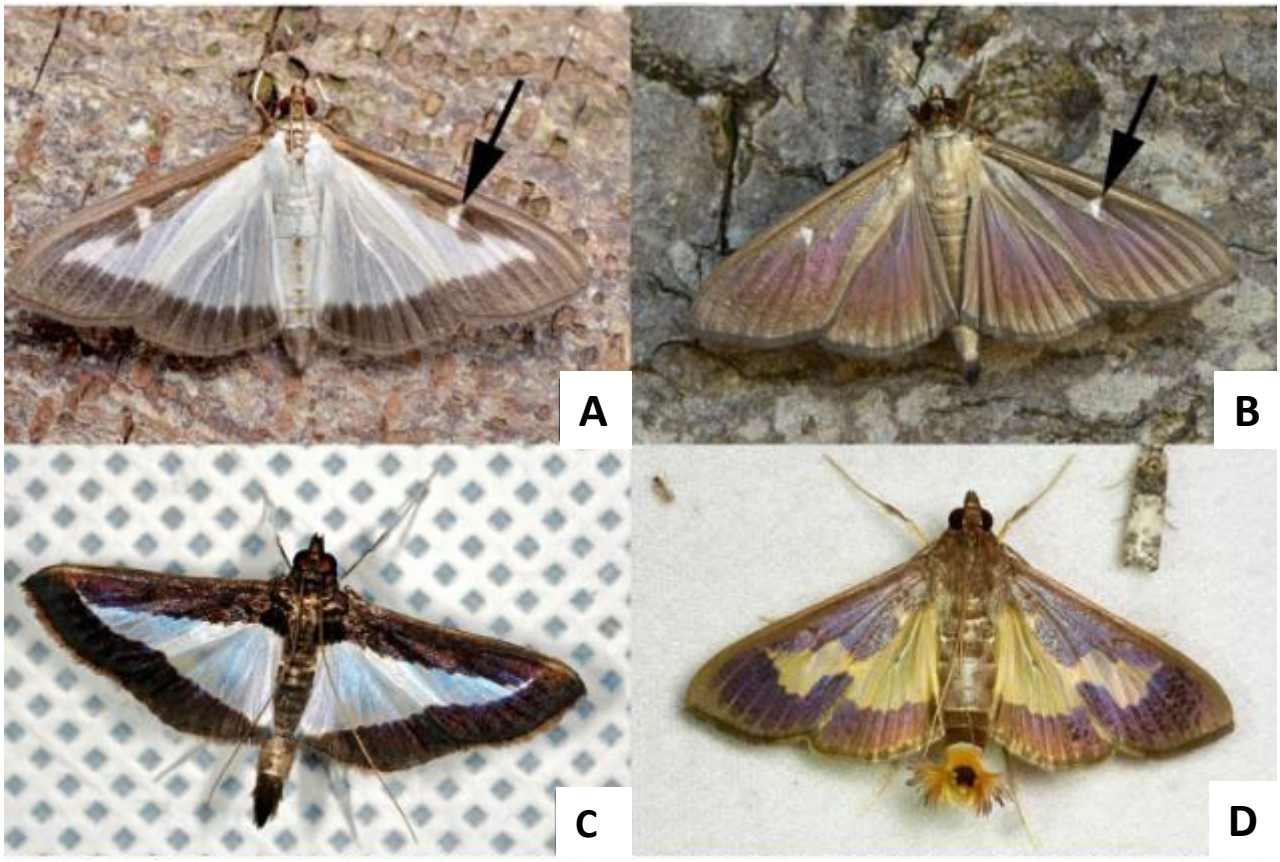

Figure 3. a) *Cydalima perspectalis* adult, arrow marks white spot on forewing (Russia), - b) *Cydalima perspectalis* adult (melanic form), arrow marks white spot on forewing (UK), - c) *Diaphania hyalinata* (Belize), - d) *Diaphania nitidalis* (Ecuador). Photo credits (CC BY-NC 2.0): Vlad Proklov, flickr (Figs. 3a – b), Bernard Dupont, flickr (Fig. 3c), Andreas Kay, flickr (Fig. 3d).

(Fig. 2; Korycinska and Eyre, 2010). Both forms have a distinctive white dot or mark in the middle of each forewing (Fig. 3a, b); this is the most diagnostic wing character and can be used to separate this species from similar moths in other genera (e.g. *Diaphania*) (Fig. 3c, d). In addition, the brown and white portions of the wings in both forms are iridescent, giving a golden sheen to the brown portions and a purple sheen to the white portions (Fig. 3a, b) (Korycinska and Eyre, 2010). Males of *C. perspectalis* have more extensive brown coloration and tufts at the end of the abdomen than females (Brua, 2013).

Larvae that are newly hatched are greenish yellow with black head capsules and two rows of black dorsal spots. As the larvae mature, their bodies become greener, and black, white, and dark green stripes appear along the length of the body (Fig. 4; Korycinska and Eyre, 2010). Larvae are quite colorful and may stand out during a visual survey in *Buxus* (boxwood). Fully grown larvae can reach 4 cm ($1^1/_2$ in) in length before pupation (Korycinska and Eyre, 2010). They use silk to join leaves together to overwinter as larvae and to pupate (Albert, 2009). Signs of feeding by *C. perspectalis* larvae include silk and greenish black frass on the host leaves (Fig. 5) and frass and leaf fragments on the ground around the base of the plant (Gutue et al., 2014). Early

Figure 4. *Cydalima perspectalis* larva. Photo by Didier Descouens (CC-BY-SA-4.0), used with permission.

Figure 5. *Cydalima perspectalis* frass. Photo by Walter Schön (http://www.schmetterling-raupe.de), used with permission.

instars feed on leaves in groups, while later instars spread out and feed alone, consuming the entire leaf (Fig. 6; Göttig and Herz, 2017).

Easily Mistaken Species

Many colorful lepidopteran larvae resemble *C. perspectalis*, but no Crambidae species in the United States are feeding specialists on *Buxus*.

Several domestic and exotic foliage-feeding moths in Crambidae and other families look similar to *C. perspectalis* as adults (Appendix). Some species of *Diaphania* Hübner have wing patterns that are similar to *C. perspectalis*. The moths are smaller on average than *C. perspectalis* (forewing length up to 1.5cm), but size by itself should not be trusted if small specimens of *C. perspectalis* are encountered.

Diaphania hyalinata (melonworm) (Fig. 3c) and *D. nitidalis* (pickleworm) (Fig. 3d) have wing patterns similar to the white phenotype of *C. perspectalis*. Melonworm is distributed widely across eastern North America, and it has also been recorded in southern California. Adults have white, semi-transparent wings with black margins (Capinera, 2005a) and lack the white spot in the middle of the forewing that is present in all forms of *C. perspectalis*. Pickleworm is also distributed across eastern North America. Adults have purplish brown wings with pale yellow to tan, semi-transparent centers (Capinera, 2005b). Melonworm and pickleworm only infest cucurbit (Capinera, 2005a; 2005b).

Other *Diaphania* are found in the United States, including *D. infimalis* (Florida) and *D. elegans* (Texas). Although these species are black and white, similar to melonworm, none of the *Diaphania* found in the United States have the distinctive white spots on the forewing that are present in *C. perspectalis* (Capinera, 2005a; 2005b).

Commonly Encountered Non-targets

A few common genera of Spilomelinae may be attracted to the *C. perspectalis* pheromone lure. In addition, the *C. perspectalis* pheromone may attract some *Diaphania* species.

Figure 6. *Cydalima perspectalis* damage. Photo by Ferenc Lakatos, University of Sopron, Bugwood.org (CC BY-NC 3.0 US), used with permission.

Biology and Ecology

Cydalima perspectalis produces one to five generations per year in native and introduced areas (Göttig and Herz, 2017; Maruyama and Shinkaji, 1987; Nacambo et al., 2014; Nagy et al., 2017; Park, 2008; She and Feng, 2006). The number of generations varies depending on the temperature and accumulation of developmental degree-days (DD) (Nacambo et al., 2014). In China, one to five generations per year have been observed (She and Feng, 2006), while in Germany, Russia, and South Korea, only two generations per year have been recorded (Göttig and Herz, 2017; Park, 2008). In northwestern Switzerland, there are two generations; the overwintering generation needs an average of 518 DD to complete its development, while the summer generation needs 430 DD (Nacambo et al., 2014).

Adult emergence time varies with location. Wang (2008) recorded that in China, the first generation emerges in mid-May, the second in early July, the third in late September, and the fourth in late November. In Japan, adults of the overwintering generation begin to emerge in mid-May, the second generation starts to emerge in late July, and the third in late August (Maruyama and Shinkaji, 1987). In northwestern Switzerland, the first adults emerge in late June and peak in July, and the second generation of adults begins to emerge in mid to late August and is present until early October (Nacambo et al., 2014).

After mating and dispersing, adult females lay clusters of five to 20 eggs on the undersides of boxwood leaves (Fig. 7) (Göttig and Herz, 2017). They can lay between six and 491 egg clusters in their lifetime (Leuthardt and Baur, 2013). Eggs take between three and 15 days to hatch, with earlier hatching occurring at higher temperatures (Maruyama and Shinkaji, 1987). The average time from egg to adult is about 40 days (Korycinska and Eyre, 2010).

Figure 7. *Cydalima perspectalis* egg mass. Photo by Walter Schön (http://www.schmetterling-raupe.de),used with permission.

Larvae typically go through five to seven instars, depending on the host and temperature (Maruyama and Shinkaji, 1991). Leuthardt and Baur (2013) observed five to seven instars for the summer generations, while the overwintering generation had three to seven instars. Average development time of larvae from egg hatch to pupation at 22–24 °C (71.6-75.2 °F) ranged from 16 to 24 days (Leuthardt and Baur, 2013).

Cydalima perspectalis larvae enters obligatory diapause and overwinters in silk shelters constructed between 2 or more leaves (Nacambo et al., 2014). Diapause can begin between the second and fifth instars, but most overwinter as fourth instars in Japan (Maruyama and Shinkaji, 1991) and as third instars in Europe (Nacambo et al., 2014). Diapause begins when daylight decreases to 12–14 hours (Maruyama and Shinkaji, 1991; Nacambo et al., 2014). To terminate diapause, a cold period of 1.5 to 2 months is required (Nacambo et al., 2014). The lower threshold temperature for larval, egg, and pupal stage development of nondiapausing individuals is about 8.4 °C (47 °F), 10.9 °C (52 °F), and 11.5 °C (53 °F), respectively (Nacambo et al., 2014). Once diapause ends, larvae leave their shelters, continue to feed, and eventually pupate. In northwestern Switzerland, larvae require on average 322 DD to complete larval development after diapause and another 122 DD as a pupa to complete development (Nacambo et al., 2014).

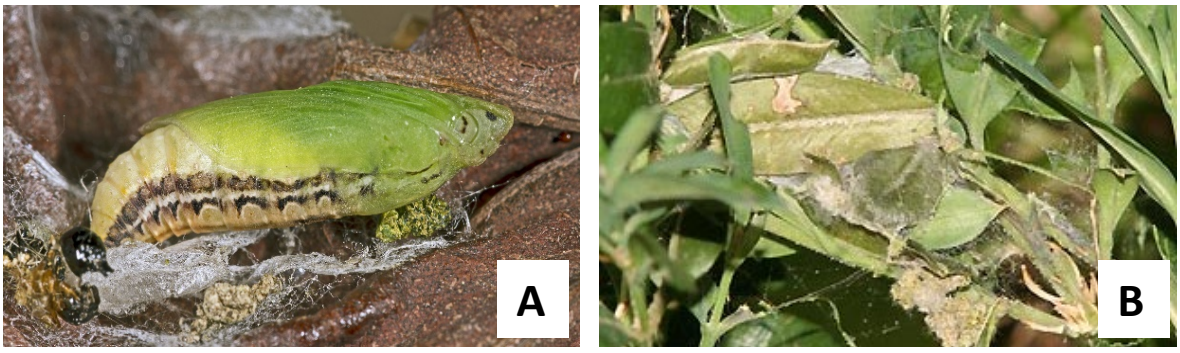

Figure 8. *Cydalima perspectalis* pupa (A), and pupa housing (B). (Source: (A) Didier Descouens, wikimedia commons (CC-BY-SA-4.0), (B) Walter Schön (http://www.schmetterling-raupe.de), used with permission).

Cydalima perspectalis pupates on the host in cocoons of silk and green leaves that are still attached to the host plant (Fig. 8; Korycinska and Eyre, 2010). The pupal stage lasts an average of 10 days at 25 °C (77 °F) (Maruyama and Shinkaji, 1991; Park, 2008), and 15–18 days at 20 °C (68 °F) (Maruyama and Shinkaji, 1991).

Known Hosts

Cydalima perspectalis is primarily a pest of nurseries and landscaped areas. Its preferred hosts are boxwoods, both wild and horticultural varieties (Leuthardt and Baur, 2013). In its native range, it also feeds on *Euonymus alatus* (burningbush), *E. japonicus* (Japanese spindletree), *Ilex chinensis* (purple holly), and *Murraya paniculata** (orange jessamine) (Wan et al., 2014; Wang et al., 2013). *Cydalima perspectalis* can also complete its life cycle on orange jessamine and purple holly (Liu et al., 2007; Qi, 2003; Wang, 2008; Zhang and Wang, 2012); however, the extent of damage to these hosts and the *Euonymus* species listed has not been described or does not have an economic impact. In Europe, *C. perspectalis* is reported to have moved to *Rubus plicatus* (plaited-leaved bramble), *Ruscus aculeatus* (butcher's-broom), and *Ruscus colchicus* in areas where boxwood has been eliminated by *C. perspectalis* feeding (Matsiakh et al., 2018).

Ligustrum sinense (Chinese privet) is reported to be a host, but the record is questionable because it is only supported by observations of adults being present on the plant (Zhang et al., 2008).

The host list below includes cultivated and wild plants that 1) are infected or infested by the pest under natural conditions, 2) are frequently described as major, primary, or preferred hosts, and 3) have primary evidence for feeding and damage documented in the literature. Plants are highlighted in bold if they are commercially produced and the pest causes economically significant damage.

Preferred Hosts

Buxus balearica (Balearic boxwood), *Buxus bodinieri* (Bodinier's Boxwood), *Buxus colchica* (Georgian box), *Buxus harlandii* (Harland's box), *Buxus megistophylla*, ***Buxus microphylla*** (boxwood), ***Buxus microphylla* var. *japonica*** (Japanese boxwood), *Buxus rugulosa* (syn.: *Buxus sinica* var. *parvifolia*), ***Buxus sempervirens***[*] (common box), *Buxus sinica* (Chinese box), *Buxus sinica* var. *aemulans*, and ***Buxus sinica* var. *insularis*** (Korean boxwood) (Brua, 2013; Leuthardt and Baur, 2013; Maruyama and Shinkaji, 1991; Wan et al., 2014)

Pest Importance

In 2014, boxwood made up 15 percent of broadleaf evergreen sales in the United States, and the estimated value was $126 million (USDA-NASS, 2015). *Cydalima perspectalis* can cause heavy defoliation of boxwood plants if populations are left unchecked (Burjanadze et al., 2019). Defoliation can kill the plant (Kawazu et al., 2007; Kenis et al., 2013; Leuthardt and Baur, 2013; Nacambo et al., 2014; Van der Straten and Muus, 2010). Larvae have been observed feeding on the bark (Nacambo et al.,

[*] Host present in the United States (NRCS, 2019)

2014), which can cause branches or the entire plant to die (Leuthardt and Baur, 2013). *Cydalima perspectalis* feeding damage to boxwood can lower the value of the plants because of defoliation and dieback (Korycinska and Eyre, 2010). Plants lost to *C. perspectalis* damage in a cemetery in Basel, Switzerland [valued at $2.7 million] would cost $1.4 million to replace (Leuthardt, 2013).

Defoliation of wild boxwood plants can reduce plant diversity and alter the composition of ground cover and understory vegetation (Kenis et al., 2013; Korycinska and Eyre, 2010; Mitchell et al., 2018). A review conducted by Mitchell et al. (2018) found that 63 species, such as fungi and invertebrates, could be at risk for local extinction if natural boxwood stands in Europe are lost. The impacts on vertebrate wildlife are unknown but could include ecosystem effects, such as changes in water quality and increased erosion and flooding (Mitchell et al., 2018).

Cydalima perspectalis is not listed as a harmful organism by any country (PExD, 2020), but is considered reportable/actionable in the United States (PestID, 2020).

Pathogens or Associated Organisms Vectored

This species is not known to be associated with pathogens or other organisms.

Known Distribution

Africa: Algeria (Haddad et al., 2020); **Asia:** China, India, South Korea, Japan (Leuthardt and Baur, 2013; Mally and Nuss, 2010; Park, 2008); **Europe:** Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Denmark, England, France, Georgia, Germany, Greece, Hungary, Italy, Liechtenstein, Lithuania, Luxembourg, Malta, Netherlands, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, Spain, Switzerland, Turkey, and Ukraine (Agius, 2018; Brua, 2013; Bury et al., 2017; Gutue et al., 2014; Hizal et al., 2012; Leuthardt et al., 2010; Matsiakh et al., 2018; Nagy et al., 2017; Paulavičiūtė and Mikalauskas, 2018; Perez-Otero et al., 2014; Santi et al., 2015; Strachinis et al., 2015; Wan et al., 2014); **North America:** Canada (Ontario) (NAPPO, 2019)

Pathway

The main method of natural dispersal for *C. perspectalis* is adult flight. Based on limited published research, adults can travel between 5 and 10 km (3.1–6.2 miles) per year (The Food and Environment Research Agency, 2010). A likely pathway for human-assisted introductions of *C. perspectalis* is through the movement of infested host materials, specifically boxwood. It is speculated that *C. perspectalis* was introduced to Europe through the importation of infested plants (Van der Straten and Muus, 2010). In 2018, it was detected in North America for the first time on *Buxus* spp. in three residential areas in Ontario, Canada. The method of introduction is not known. Live boxwood plants, including cut flowers and greenery are Not Authorized Pending Pest Risk Analysis (NAPPRA) for importation into the United States from all countries except Canada. Artificially dwarfed Chinese boxwood plants are approved for importation from Canada and China under the Plants in Growing Media Program; however, China has no approved facilities for certification (USDA, 2018).

Minor hosts such as *Murraya* plants are prohibited from entry into the United States from any country, while *Ligustrum* spp. from European countries and Canada are prohibited pending pest risk analysis (USDA, 2018).

Use the PPQ Commodity Import and Export manuals listed below to determine 1) if host plants or material are allowed to enter the United States from countries where the organism is present and 2) what phytosanitary measures (e.g., inspections, phytosanitary certificates, post entry quarantines, mandatory treatments) are in use. These manuals are updated regularly.

Plants for Planting Manual: This manual is a resource for regulating imported plants or plant parts for propagation, including buds, bulbs, corms, cuttings, layers, pollen, scions, seeds, tissue, tubers, and like structures.
https://www.aphis.usda.gov/import_export/plants/manuals/ports/downloads/plants_for_planting.pdf

Cut Flowers and Greenery Import Manual: This manual is a resource for regulating imported fresh, cut plants used for decoration and for protecting plants from extinction due to trade.
https://www.aphis.usda.gov/import_export/plants/manuals/ports/downloads/cut_flower_imports.pdf

Treatment Manual: This manual provides information about treatments applied to imported and domestic commodities to limit the movement of agricultural pests into or within the United States.
https://www.aphis.usda.gov/import_export/plants/manuals/ports/downloads/treatment.pdf

Potential Distribution within the United States

The climate in the native and introduced areas for *C. perspectalis* includes Plant Hardiness Zones 4 through 9 (SAFARIS, 2019), which encompasses much of the continental United States. Hosts for *C. perspectalis* (boxwood and orange jessamine) are found in the eastern and southeastern portions of the United States (NRCS, 2019). In addition, there are major *Buxus* propagative production areas on the west coast (Washington, Oregon, northern California) and east coast (Maryland down to South Carolina) (Bilderback et al., 1997).

Survey and Key Diagnostics

Approved Methods for Pest Surveillance*:

For the current approved methods and guidance for survey and identification, see the Approved Methods for Pest Surveillance (AMPS) pest page on the CAPS Resource and Collaboration website, at https://caps.ceris.purdue.edu/approved-methods.

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Appendix

List of non-target moths that are either similar in size or have a similar wing shape/pattern as *C. perspectalis*.

Species	Color morph	Region
Anania hortulata (Linnaeus, 1758)	White	Eastern United States
Colomychus talis (Grote, 1878)	White	Eastern United States
Cydalima laticostalis (Guenée, 1854)	White	Exotic
Cydalima pfeifferae (Lederer, 1863)	White	Exotic
Desmia ploralis (Guenee, 1854)	Dark	Eastern United States
Diaphania elegans (Möschler, 1890)^	White	Western United States
Diaphania hyalinata (Linnaeus, 1767)^	White	Eastern, Western United States
Diaphania indica (Saunders, 1851)^	White	Eastern United States
Diaphania infimalis (Guenée, 1854)	White	Eastern United States
Diaphania nitidalis (Stoll, 1781)^	White	Eastern, Western United States
Gnophaela aequinoctialis (Walker, 1854)*	White	Western United States
Gnophaela discreta Stretch, 1875*	White	Western United States
Haploa confusa (Lyman, 1887)	White	Eastern United States
Haploa contigua (Walker, 1855)	White	Eastern United States
Haploa lecontei (Guérin-Méneville, 1832)	White	Eastern, Western United States
Heliomata cycladata Grote & Robinson, 1866*	White	Eastern United States
Hemigrotella argenteostriata Barnes & McDunnough, 1918	White	Western United States
Herpetogramma sphingealis Handfield & Handfield, 2011	Dark	Eastern United States
Herpetogramma thestealis (Walker, 1859)^	White	Eastern United States
Norape tenera (Druce, 1897)*	White	Western United States
Palpita atrisquamalis (Hampson, 1912)^	White	Western United States
Palpita magniferalis (Walker, 1861)	Dark	Eastern United States
Palpita vitrealis (Rossi, 1794)	White	Exotic
Polygrammodes langdonalis (Grote, 1877)	White	Eastern United States
Pseudosphex leovazquezae (Pérez & Sánchez, [1986])*	White	Western United States
Xerociris wilsonii (Grote, 1863)	White	Western United States

^ *Likely to be encountered/confused with* C. perspectalis

* *Unlikely to be trapped due to rarity*

Versions

Version	Date	Summary of changes	Authorized
Ver. 1	5/14/2021		Gray

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