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

Grapholita funebrana

Figure 1. *Grapholita funebrana* adult female (Gilligan and Epstein, 2014).

Scientific Name
Grapholita funebrana (Treitschke, 1835)

Synonym(s):
Cydia funebrana (Treitschke)
Grapholitha funebrana Treitschke, 1835
Laspeyresia funebrana (Treitschke)

Common Names
Plum fruit moth, prune moth, red plum maggot

Type of Pest
Moth, borer

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

Notes on taxonomy and nomenclature: *Grapholita funebrana* is often referred to in older literature as *Cydia funebrana*. However, the current accepted generic placement is in *Grapholita* (Komai, 1999).

Pest Recognition
An identification tool can be found at
https://idtools.org/id/leps/tortai/Grapholita_funebrana.htm

Pest Description

Figure 2. Larva of *Grapholita funebrana*. Photo: https://www.ages.at/en/plant/plant-health/pests-from-a-to-z/plum-fruit-moth

Eggs: Eggs are deposited singly and measure about 0.7 mm by 0.6 mm. When hatched, they are flat, oval, and white/transparent. As they mature, they become yellow and two black spots corresponding to the eyes of the larva become visible (Bovey, 1937; Rauleder, 2002; Whittle, 1984).

Larvae: Larvae develop inside the fruit. They generally have four instars, although up to five instars have been reported in Germany, and possibly three in the coastal area of the Black Sea (Sáringer, 1967; Sáringer and Deseo, 1968; Baker, 1963; Popova, 1991; Rauleder, 2002). Young larvae are translucent white and range from 0.06 in. to 0.2 in., while last instar larvae are bright pink and approximately $^{1}/_{4}$ to $^{1}/_{2}$ inches long (Bovey, 1937; Baker, 1963). The larva passes through a red-ring phase and later to a black-head phase (Baker, 1963; Rauleder, 2002) (**Fig. 2**). This pest overwinters in the prepupal stage (i.e., a non-feeding period between the last larval instar and the pupal stage) in a cocoon within crevices, beneath the bark, at the base of the tree, or in the soil (Popova, 1971; Rauleder, 2002).

Pupae: Pupae are light brown, approximately $^{1}/_{4}$ to $^{1}/_{3}$ inches long and contained in a silken cocoon. Pupae can be found under the bark or other crevices, or on the ground (Dickler, 1991; Tosheva-Tsvetkova, 1960).

Adults: Adults are dark brown and small, with an average wingspan between $^{1}/_{2}$ to $^{3}/_{5}$ in.

Identification of *G. funebrana* can be difficult but several characteristics of the adult wings can be used to recognize this pest in field settings. The first (anterior) pair of wings are dark brown, triangular, and narrow at the base. Typically, whitish stripes (striae) are visible between the basal and central areas towards the inner (posterior) margin of the wing, and whitish areas and thinner stripes are also visible towards the outer (costal) margin (Alford, 1978; Bovey, 1937). The wing color is darker at the basal and central areas and becomes clearer towards the outer (apical) margin turning to a gray spot. At the center of this spot, four small horizontal dark stripes are visible. The second (posterior) pair of wings are brownish gray, and the underside of the body and legs is grayish (**Fig. 1**) (Alford, 1978; Dickler, 1991; Gilligan and Epstein, 2014).

Symptoms

- Larvae bore into fruits after hatching, moving through the pulp to the seed (**Fig. 4**). Entrance holes are later sealed with fruit skin tissue and excrement bound

together with silk. Tunnels inside the fruit are filled with frass and the pulp around the stone is eaten (Popova, 1971; Whittle, 1984). In apple, larvae sometimes produce fine mining tunnels under the fruit skin before they bore into the fruit (Rauleder, 2002).

- Larval feeding also causes 'gummosis' (fluid exuding from the entrance hole) (**Fig. 3**). First generation larvae may cause a bluish discoloration on fruits and fruit drop (Noma et al., 2010; Böhm, 1948; Dickler, 1991; Rauleder, 2002). In the latter part of the season, when fruits are fully-grown, infested fruits tend to ripen prematurely (Dickler, 1991).

Figure 3. Fruit showing the sticky exudate formed when the larvae of the plum fruit moth enters a fruit (Photo: Magnus Gammelgaard Nielson, http://www.plante-doktor.dk/blommevikler.htm and R. Coutin, OPIE).

Figure 4. Larva of the plum fruit moth feeding within an unripe (left) and ripe (right) plum. Notice most of the damage occurring near the pit (Photo: R. Coutin, OPIE and Magnus Gammelgaard Nielsen, http://www.plante-doktor.dk/blommevikler.htm).

Easily Mistaken Species

Adults of *Grapholita funebrana* are similar to those of *G. molesta* (Busck, 1916) and *G. tenebrosana* (Duponchel, 1843) **(Fig. 5 and 6)**. The most reliable method of distinguishing *G. funebrana* from other easily mistaken species is by examining the genitalia (Chambon

and d'Aguilar, 1974, cited by Alford, 1978). Genitalia illustrations for these species can be found in Razowski (2003) and Gilligan and Epstein (2014).

Figure 5. *Grapholita molesta* adult male (Gilligan and Epstein, 2014)

Grapholita molesta is common throughout the United States. It is morphologically very similar to *G. funebrana* and the two species share some of the same host plants (e.g., *Prunus* spp.). *Grapholita molesta* prefers apple and peach, while *G. funebrana* prefers plum (Baker, 1963; Ellis and Hull, 2013; Whittle, 1984). Further, the two species are attracted to the same female sex pheromone (Gilligan and Epstein, 2014). Two characteristics can be used to distinguish these two species: (1) the arrangement of the muscle origins within the dorsal group of hairs ('setae') on the abdominal segments, and (2) the hairs dorsal to the claws on the thoracic legs (Baker, 1963).

Figure 6. *Grapholita tenebrosana* adult male. Photo: http://www2.nrm.se/en/svenska_fjarilar/c/cydia_tenebrosana.html

Grapholita tenebrosana is distributed across Europe to Asia and Siberia (Olenici et al., 2007) and is not known to occur in North America. It can be distinguished from *G. funebrana* by the dark-brown segmented appendages on the lower lip (labial palpi) and the front of the head (frons), and the whitish freckle in the distal (portion farthest from the body) and medio-dorsal areas of the forewing in *G. funebrana* (Bradley et al., 1979, cited by Whittle, 1984).

Commonly Encountered Non-targets

The approved survey method for *G. funebrana* is trapping. The approved lure is the *Grapholita funebrana* lure. A commonly encountered non-target in the United States is *G. molesta,* although it is likely that other *Grapholita* species are also attracted by this lure (Guerin et al., 1986; Rauleder, 2002; Gilligan and Epstein, 2014).

Biology and Ecology

Eggs are laid singly or in small groups of 2-3. Three to nine eggs are laid on average on a single fruit, usually at the base of fruit stalks, on fruit surfaces, or on the underside of the leaves (Böhm, 1948; Touzeau, 1972; Whittle, 1984). Eggs generally hatch in 3–6 days, although they can hatch in up to 18 days depending on the temperature, and larvae tunnel into the fruit (Bovey, 1937; Popova, 1971; Rauleder, 2002; Vernon, 1971; Whittle, 1984). Larvae complete their development in 15-17 days at 90-91°F under bark or other crevices, on the ground, or in the soil (Bovey, 1937; Popova, 1971; Whittle, 1984). The duration of the pupal stage is 7-14 days, although in the overwintering generation it can last 21- 56 days, and the adult lifespan is 7-16 days (Mashkovich, 1930; Popova, 1971; Tosheva-Tsvetkova, 1960).

In most of its distribution, where this species has multiple generations, adults from overlapping generations can be seen from early May through August-September (Alford, 1978; Böhm, 1948; Popova, 1971; Sáringer, 1967; Vernon, 1971). Females are more abundant than males as the year progresses (Popova, 1971; Rauleder, 2002). During their lifetime, females lay on average 40-80 eggs (Böhm, 1948; Bovey, 1937; Rauleder, 2002), although an egg-laying capacity of 100-200 eggs per female in the second generation has also been reported (Bobirnac, 1958).

Peak egg laying occurs when temperatures are 75-79 °F. Differences in fruit shape and color among plum cultivars affect susceptibility to *G. funebrana* attack (Rizzo et al., 2019). Adult moths rest during the day high in the tree canopy and are more active at night. The majority of the eggs are laid in the afternoon and in the evening (Böhm, 1948; Charmillot et al., 1979; Sziraki, 1984). The largest number of moths are observed when temperatures are 64 to 72°F (Popova, 1971; Rauleder, 2002).

Adults do not feed. During the first flight period, adult males and females aggregate, building up high local densities, although during the subsequent two flight periods, high rates of dispersal occur (Sciarretta et al., 2001). Further, males have been caught in traps placed at distances 984 and 2397 ft away from a pleach plantation, suggesting that this moth can disperse long distances, with irrigation channels and hedgerows serving as ecological corridors for adult movement (Sciarretta et al., 2001; Sziraki, 1984). According to one account, however, adults did not attack plum trees growing 634 ft from an infested orchard (Mashkovich, 1930).

Grapholita funebrana has one to three generations per year across its distribution (Laznik and Trdan, 2013). Two generations are common in central European countries, whereas three generations have been reported in the Black Sea Coast and southern Europe (Popova, 1971; Sáringer, 1967; Sciarretta et al., 2001). Diapause in *G.*

funebrana is mainly influenced by the photoperiod, and the threshold is between 15 to 17 hours of daylight (Sáringer, 1967; Sáringer and Deseo, 1972).

Known Hosts

Grapholita funebrana is known as a pest of cultivated stone fruits and is also commonly found in at least two wild species (Family Rosaceae). Among cultivated plants, it primarily feeds on plum and can also infest apricot, cherry, and peach when plum is not available. Other less common host records include apple, damson plum, pear, and sour cherry (Popova, 1971; Sáringer and Deseo, 1968; Whittle, 1984).

We found no evidence of environmental impacts caused by this pest; however, wild hosts, including blackthorn and cherry plum, could serve as a reservoir for the population.

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

Prunus armeniaca (apricot), *Prunus avium* (sweet cherry), *Prunus cerasifera* (cherry plum), ***Prunus domestica*** **(plum)**, *Prunus persica* (peach), and the wild species ***Prunus spinosa*** **(blackthorn/sloe)** are preferred, although other *Prunus* species can be infested if the primary hosts are not available (Popova, 1971; Sciarretta et al., 2001).

Pest Importance

Grapholita funebrana is an important pest of plums throughout Europe and northern Asia with reported losses of 25 to 100% (Arnaoudov and Andreev, 2002; Koltun and Yarchakovskaya, 2006; Stamenkovic and Milenkovic, 1992). Total loss has been reported on the Black Sea coast, and losses are greater in the coastal areas than at higher altitudes, where the environmental conditions, including temperature and relative humidity, are less favorable for the pest (Popova, 1971). Severe damage is more commonly associated with the second and third generations and late ripening cultivars (Kocourek et al., 1995; Tosheva-Tsvetkova, 1960; Touzeau, 1972).

Plums and prunes are grown throughout the United States. Large scale production is concentrated in California, where the estimated combined value of plum and prune production was $234 million in 2021. Cherries are primarily grown in California, Oregon, and Washington (sweet cherry), and Michigan (sour cherry), and the estimated value, including sweet and sour cherry, was $950 million in 2021 (USDA-NASS, 2022).

Grapholita funebrana is listed as a harmful organism in Brazil, the British Virgin Islands, Canada, Colombia, Ecuador, Egypt, Israel, Japan, Jordan, Mexico, Peru, South Korea, Taiwan, Thailand, and Vietnam (USDA-PCIT, 2023). There may be trade implications with these countries if this moth becomes established in the United States.

Pathogens or Associated Organisms Vectored

Grapholita funebrana is not known to vector any pathogen or other associated organisms. However, its attack may induce the development of pathogenic fungi, including *Monilinia fructigena* and *Botrytis cinerea* (Kostarev, 1914; Touzeau, 1972).

Known Distribution

Grapholita funebrana is present in:
Asia: Armenia (Vasilian, 1981), Azerbaijan (Mustafayeva, 2018), China, (Wei-Chun, 1961), Republic of Georgia (Aleksidze, 1981), India (Sharma and Verma, 1987), Iran (Negahban et al., 2016), South Korea (Bae and Park, 1997), Uzbekistan (Akhmedova et al., 2023). **Europe:** Austria (Böhm, 1948), Belarus (Koltun and Yarchakovskaya, 2006), Belgium (van Laer, 2010), Bosnia and Herzegovina (Batinica and Muratovic, 1972), Bulgaria (Arnaoudov and Andreev, 2002), Croatia (Ivić et al., 2012), Czechia (Hrdý et al., 1996), Estonia (Trematerra et al., 2009), France (Touzeau, 1972), Germany (Rauleder, 2002), Hungary (Sáringer and Deseo, 1968), Italy (Sciarretta et al., 2001), Lithuania (Ostrauskas et al., 2010), Moldova (Panuța et al., 2014), Norway (Schøyen, 1917), Poland (Suski and Niemczyk, 1989), Romania (Olenici et al., 2007), Russia (Popova, 1971), Serbia (Stamenkovic and Milenkovic, 1992), Slovakia (Kišacová et al., 2014), Slovenia (Laznik and Trdan, 2013), Spain (Mataix-Gato et al., 1999), Switzerland (Charmillot et al., 1979), Turkey (Özdemir et al., 2005), Ukraine (Yudytska and Klechkovskyi, 2021), United Kingdom (Alford, 1978).

There are unverifiable records of this pest in Albania, Algeria, Cyprus, Denmark, Finland, the Netherlands, Kazakhstan, Kyrgyzstan, Sweden, Syria, Tajikistan, and Turkmenistan (EPPO, 2023).

Pathway

Information on *Grapholita funebrana* pathways of entry is lacking. However, considering the larva completes its development inside fruit (Popova, 1971), this moth is likely to be transported and introduced to new areas on fruit material of its hosts (Noma et al., 2010).

Currently, imported stone fruits (*Prunus* spp.) from all countries are required to be quick frozen (temperature of 20°F or less) and inspected (USDA-APHIS, 2023). Although apple is a rather uncommon host of this pest (Chen and Dorn, 2009; Whittle, 1984), introduction in infested apples is also possible. No imports of fresh apples are allowed from the Netherlands, Belgium, and Germany. Apples imported from France are subject to inspection and an Import Permit is required (USDA-APHIS, 2023).

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.

Agricultural Commodity Import Requirements(ACIR) manual: ACIR provides a single source to search for and retrieve entry requirements for imported commodities. https://acir.aphis.usda.gov/s/

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

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

Considering the ability of *G. funebrana* to survive and reproduce across Plant Hardiness Zones 4 to 9 and based on climate and host availability, all the states with stone fruit production would be affected, although plum and stone fruit production in California would be most at risk. In addition, this pest can thrive on blackthorn, which is present in some Northwestern and Northeastern states, and the state of Tennessee (Takeuchi et al., 2018; USDA-NRCS, 2023).

Survey and Key Diagnostics

Approved Methods for Pest Surveillance*:

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

USDA-APHIS-PPQ-ST staff developed this datasheet. Cite this document as:

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Versions

Datasheet completed (Version 1)

April 2024 (Version 2)

- Datasheet formatted according to the new template.
- Type of pest changed, List of synonyms condensed.
- Larva and adult descriptions re-worded and image of larva added to the **Pest description** section.
- Risk map removed.
- **Known hosts** section revised and ‘minor hosts’ removed.
- Images added to **Easily mistaken species** section.
- **Biology and Ecology** and **Pest Importance** sections re-worded.
- **Known Distribution** revised and updated: India, Croatia, Moldova, Serbia, and Slovenia added.
- **Pathway** section added.
- **Potential distribution in the US** revised and updated.
- Survey recommendations revised and re-worded.

Reviewer(s)

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