Grapholita funebrana

Scientific Name
Grapholita funebrana (Treitschke)

Synonyms:
Carpocapsa funebrana, Cydia funebrana, *Enarmonia funebrana, Endopisa funebrana, Grapholita funebrana, Grapholitha funebrana, Laspeyresia cerasana, Laspeyresia funebrana, Opadia funebrana,* and *Tortrix funebrana.*

Note: *Grapholita funebrana* is often incorrectly referred to as *Cydia funebrana*. The correct generic placement is in *Grapholita* (see Komai (1999) for more details).

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

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

Pest Description
Grapholita funebrana is able to develop on many wild and cultivated stone fruits and other plants in the family Rosaceae. This pest occurs in Europe, the Middle East, and northern Asia with losses of 25 to 100% reported.

The information provided below is from Alford (1978), Bradley et al. (1979), and Whittle (1984).

Eggs: Eggs are deposited singly and measure about 0.7 mm (0.28 in.) across by 0.6 mm (0.24 in.) wide, are lenticular to ovate (flattened and slightly elliptical), and are translucent white, becoming yellow as they mature. When they turn yellow, the egg has a central dome-shape area, circled by a flat ring. Eggs are generally laid during June and July at the base of a fruit stalk, hatching in about 10 days.

Larvae: At their longest, larvae are about 10 to 12 mm (0.39 to 0.47 in.) long. The head is dark brown to black. The prothorax is pale yellow; while the prothoracic plate is pale brown with the posterior margin mottled darker brown. The thoracic legs are pale yellow. The abdomen is translucent white but turns pink dorsally and yellowish ventrally

as the larvae develop through the instars. The pinacula is light brown and inconspicuous. The peritreme is brown and inconspicuous. The anal plate is pale brown with small blackish spots. The anal comb has four to seven prongs with one to three small additional prongs laterally.

Pupae: Pupae are light brown, 6 to 7 mm (0.24 to 0.28 in.) long, and contained in a silken cocoon.

Figure 1. *Grapholita funebrana* adult male. Image courtesy of Todd Gilligan, Colorado State University.

Adults: The average wingspan of an adult (Fig. 1) is 12 to 15 mm (0.47 to 0.59 in.). The forewings are triangular, narrow at the base, dark gray brown becoming clearer towards the apex, turning to an ashy gray spot. At the center of this spot, four small horizontal black dashes are present. Adults have brownish gray hind wings, and the underside of the body and legs is grayish.

Labial palpus, frons fuscous (brownish-gray); also (along with the head) described as ocherous (yellow-orange). Forewing mainly overlaid with fuscous brown except obscure pairs of white interspaces between poorly defined blackish brown costal strigulae; fasciate marking blackish brown, indeterminate except outer edge of sub-basal fascia weak dorsally; discocellular spot minute, indistinct, white; distal area, especially ocellus, irroration (tips of scales) with white or grayish white, similar irroration mediodorsally forms indistinct blotch; ocellus comprising usually four black dots, edged laterally by thick plumbeous stria on inner margin, thinner stria on outer margin; cilia concolorous with wing basally, otherwise gray, with black sub-basal line indented subapically. Hindwing fuscous, lighter basally and along termen, cilia grayish white, fuscous sub-basal line. Simple blackish-gray antennae. Abdomen dark brown. Genitalia with characteristic symmetrical projection on sacculus, and a peg-like projection at the orifice of the aedeagus.

The individual variation in adults of this species is mostly seen in the clarity of the white interspaces on the costa and in the strength of the whitish irroration in the distal and medio-dorsal areas of the forewing.

Biology and Ecology

This pest feeds primarily on stone fruits and many potential wild hosts exist in the United States in the family Rosaceae and has been captured many times at U.S. ports of entry, mostly from fruit in baggage. Adults begin to appear in April or May and can be seen through October. Depending upon the climate, this moth has one to three

overlapping generations per year (Sáringer, 1967). In general, the first generation injures fruit at the end of May through June, and the second generation injures fruit in July and August. In areas where multiple generations per year develop, early season varieties are less susceptible to economic damage than later-maturing fruit (CABI, 2009). Females have a higher reproductive potential in the second and third generations (Bobîrnac, 1958). The moth thrives in climates that have warm January and February temperatures (6°C, 42°F), high precipitation (60 inches/year), and high relative humidity (70 to 78%).

Adult moths are most active at night (resting during the day high in the tree canopy) when temperatures reach (18 to 22°C) (64 to 72°F). Females live longer than males (11 days compared to 8 days, on average). Females are also much more abundant (proportionally) than males as the year progresses (Popova, 1971; Rauleder, 2002). Most mating occurs about two hours before dawn, and females prefer to mate about 10 feet above the ground (Charmillot and Blaser, 1982).

Figure 2. Fruit showing the sticky exudate formed when the larvae of the plum fruit moth enters a fruit. Photos courtesy of Magnus Gammelgaard Nielson (http://www.plante-doktor.dk/blommevikler.htm) and R. Coutin (OPIE).

Beginning in May (when the temperature has reached at least (14°C, 57°F), eggs from the first generation are laid singly or in small groups (three to nine) on the sunny side and at the base of fruit stalks, on fruit surfaces, or on the underside of leaves in the afternoon and evening hours (Touzeau, 1972; Whittle, 1984). Eggs hatch in five to 10 days (mostly five to seven days) and the larvae chew into fruit, usually near the stem. Before feeding, the larvae seal up the entrance hole with deposits of chewed fruit skin bound with silk. In general, larval mortality is high in each generation, either through parasitism, competition, and/or failure to establish within the fruit. Larval feeding causes gummosis (fluid exuding from the entrance hole) (Fig. 2), a premature color change, and/or fruit drop. Larvae feed throughout the fruit, traveling from the outer part to the pit region (Fig. 3), and have been seen feeding on multiple fruit, but usually do not. After 15 to 25 days, larvae complete their development, leaving a large exit hole and find a

place to pupate under bark or other crevices, including on the ground and in the soil. In regions where two or three generations per year develop, these moths overwinter as larvae; where only one generation completes development, this moth overwinters as pupae.

Photoperiod is the main cause for the onset of diapause (temperature and host ripeness do not influence diapause). The light conditions crucial for diapause are perceived during the first half of larval development (second and third instar), and the threshold is likely between 15 to 17 hours of daylight, unless the length of the days are still getting longer (Sáringer, 1967, 1970).

Some orchard-wide pheromone releases for mating disruption have seen success, but not all. It seems that some isolation from other wooded areas is necessary to control *G. funebrana* with pheromones (Charmillot et al., 1982). Male trapping over a period of years also seems to reduce fruit damage by up to 84% (Koltun and Yarchakovskaya, 2006).

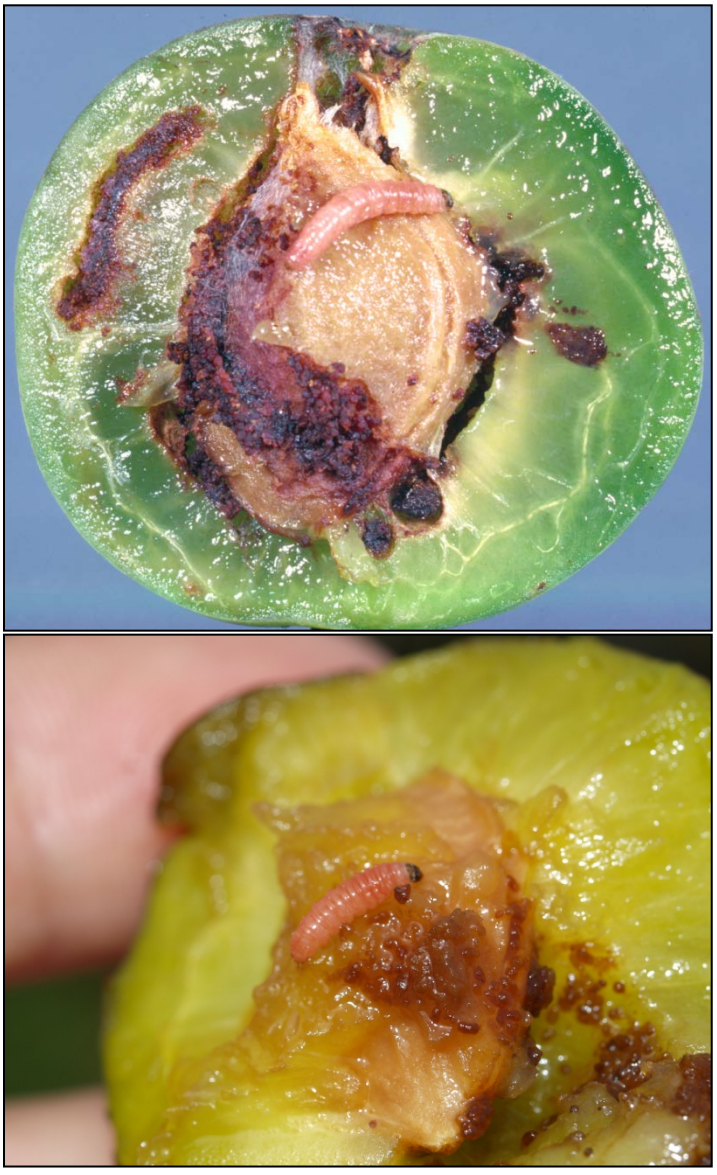

Figure 3. Larva of the plum fruit moth feeding within an unripened and ripened plum. Notice most of the damage occurring near the pit. Photos courtesy of R. Coutin (OPIE) and Magnus Gammelgaard Nielson, respectively. http://www.plante-doktor.dk/blommevikler.htm.

Fenoxycarb (a juvenile hormone mimic) and diflubenzuron (a chitin formation inhibitor) have been used as a control for this moth. These chemicals are used most often at the beginning of the egg laying period. In the Czech Republic, once a degree day value of 290°C is reached, pheromone traps should be monitored. Once a marked flight wave is noticed, these ovicides should be sprayed. The chemicals have shown success controlling the summer (second) generation of *G. funebrana* with only one treatment (Kocourek et al., 1995). It is also been recommended that fenoxycarb should not be

used without a chemical rotation. Organophosphorous insecticides and diflubenzuron (2 to 3 treatments per generation) have also been used to control *G. funebrana (*Andreev and Kutinkova, 2010). Azinphos-methyl at 6.3 g *a.i.* per acre applied at least twice at 14-day intervals was effective at killing larvae in field studies in England. Carbaryl, dimethoate, fenthion and methyl parathion have also seen success in Europe on these larvae (Vernon, 1971).The pyrethrins cypermethrin, bensultap and λ-cyhalothrin were successful against this pest (Tălmaciu et al., 2006).

Symptoms/Signs

Larvae bore into fruits after hatching. Entrance holes, however, are barely visible. Holes at the base of fruit near the stalks and fruit exudates (Fig. 2) that include frass are good diagnostic observations. The feeding activity of the larvae in young fruits usually damages sap vessels near the peduncle, causing a color change in the fruit from green to violet and fruit drop. In the latter part of the season, when fruits are fully-grown, infested ones can be easily detected as they tend to ripen earlier. If you suspect a *G. funebrana* infection, cut the fruit to expose the larvae tunneling in the pulp near the seed (Fig. 3). Finally, inspect and look for cocoons in crevices in the bark of trees, on main branches, on root collars, or even in fruit containers (Whittle, 1984).

Pest Importance

The plum fruit moth is an important pest of plums throughout northern Europe. Yield losses of 40 to 95% have been reported. Total loss has been recorded on the Black Sea coast. Severe losses are more commonly related to the 2nd and 3rd generations, and in regions with warmer summers. In Denmark, this moth prefers cherry to plum (Whittle, 1984, and references therein).

Known Hosts

This pest feeds primarily on stone fruits and wild hosts that exist in the family Rosaceae.

Major hosts: *Prunus* spp. (stone fruit), *P. armeniaca* (apricot), *P. avium* (sweet cherry, gean), *P. cerasifera* (myrobalan plum), *P. cerasus (*sour cherry), *P. domestica* (plum), *P. instititia* (damson plum), *P. japonica* (Japanese plum), *P. persica* (peach), and *P. spinosa* (blackthorn/sloe).

Minor hosts: *Castanea sativa* (chestnut)**,** *Juglans regia* (English walnut), *Malus domestica* (apple), *M. sylvestris* (crabapple), *Prunus dulcis* (almond), and *Pyrus communis* (pear).

Known vectors (or associated organisms)

This insect has been associated with *Monilinia fructigena* (brown rot) and *Botrytis cinerea* (gray mold) (listed as *Molina fructigens* and *M. cinerea*) (Kostarev, 1914).

Known Distribution

Asia: Armenia, Azerbaijan, China, Republic of Georgia, Iran, Japan, Kazakstan, Kyrgyzstan, Syria, Tajikistan, Turkey, Turkmenistan, and Uzbekistan. **Africa:** Algeria.

South America: Argentina. **Europe:** Albania, Austria, Belgium, Bosnia, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Romania, Russia, Slovakia, Spain, Sweden, Switzerland, Ukraine, and the United Kingdom (Whittle, 1984; CABI, 2009).

Potential Distribution within the United States

Surveys should be focused where the greatest risk for establishment occurs. A recent risk analysis by USDA-APHIS-PPQ-CPHST indicates that most states in the United States have a low to moderate risk rating for *G. funebrana* establishment based on host availability and climate within the continental United States.

Survey

CAPS-Approved Method*: The CAPS approved method is a trap and lure combination. The trap type is a wing trap.

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

1) Wing Trap Kit, Paper
2) Wing Trap Kit, Plastic

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

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

Lure Placement: Placing lures for two or more target species in a trap should never be done unless otherwise noted here.

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

Literature-Based Methods: Delta trap, Pherocon 1C, or Traptest traps with a rubber septa lure have been used to trap *Grapholita funebrana*. The lure is composed of five compounds, 1) Z,8-12:AC, 2) E,8-12:AC, 3) Z,8-14:AC, 4) Z,10-14:AC, and 5) 14:AC (Venette et al., 2003). These five compounds were identified in the proportions 100:1:30:5:2 in female sex gland extracts of *Grapholita funebrana*, accompanied by saturated acetates from 12 to 20 carbons with tetradecyl acetate predominating (Guerin et al., 1986). The principal components were reported to be Z8-12Ac ("Funemone") and E8-12Ac.

Traps with "Funemone" (*cis*-8-dodecenyl acetate) lures can be placed about 19.68 m (6 ft.) off the ground. These need to be replaced every six weeks and monitored every week. Three to 5% of the *trans* isomer helps in attracting more male moths.

Monitoring with sex pheromones along the edges of fields, rather than in the center, is recommended. Pheromones to detect *G. funebrana* can be placed in the same traps with pheromones of *Cydia pomonella* or *Lymantria dispar* without adverse side effects (Schwalbe and Mastro, 1988). Spatial modeling in Italy has shown some behavioral changes throughout the growing season. During the first flight period, adults aggregate, building up high local densities. During the subsequent one to two flight periods, high rates of dispersal occur along prominent landscape features, such as ravines (Sciarretta et al., 2001). Using pheromone traps to determine population density has given mixed results, and is not seen as reliable as other methods. Pheromone traps also are not species specific, catching many other tortricid species, including males of *G. molesta*.

Key Diagnostics/Identification

CAPS-Approved Method*: Morphological. This species can be identified by examining the male and female genitalia.

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

Literature-Based Methods:

Adults of *Grapholita funebrana* are most similar to those of *G. molesta* and *G. tenebrosana*. Genitalia illustrations for all species described here can be found in Razowski (2003).

Grapholita molesta is commonly distributed throughout the United States. It is morphologically very similar to *G. funebrana* and the two species share the same host plants and female pheromones. *Grapholita molesta* can be separated from *G. funebrana* by the absence of a thorn-like projection off the valva in the male and the laterally elongate sterigma with small posterolateral projections in the female.

Grapholita tenebrosana is distributed across Europe to Asia Minor and Siberia. It is not known to occur in North America. Adults can be separated from *G. funebrana* by the elongate valva with a sharply developed anal angle in the male and the large sterigma with triangular lateral lobes in the female.

Larvae may appear similar to those of many other species of *Grapholita* and *Cydia. Cydia pomonella* larvae can be separated from *G. funebrana* by the absence of an anal fork. 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 using a polymerase chain reaction-restriction fragment length polymorphism (PCR-RFLP) analysis.

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. *Grapholita funebrana* is included in this tool.

Easily Confused Pests

This pest may be easily confused with *G. molesta*, which is common and widespread in North America. The two species are similar morphologically, share the same host plants, and are attracted to the same female pheromone.

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