Rhagoletis cerasi

Scientific Name
Rhagoletis cerasi (Linnaeus, 1758)

Synonyms:
Musca cerasi Linnaeus,
Rhagoletis cerasi f. obsoleta Hering,
Rhagoletis cerasi ssp. *fasciata*, Rohdendorf,
Rhagoletis cerasi obsoleta Hering,
Rhagoletis obsoleta Hering,
Spilographa cerasi,
Tephritis cerasi,
Trupanea cerasi,
Trypeta signata Meigen,
Urophora cerasorum Dufour,
Urophora liturata Robineau-Desvoidy

Figure 1. Female *Rhagoletis cerasi* on cherry (Photo © OPIE/Rémi Coutin)

Common Name(s)
European cherry fruit fly, cherry fruit fly, cherry maggot

Type of Pest
Fruit fly

Taxonomic Position
Class: Insecta, **Order:** Diptera, **Family:** Tephritidae

Reason for Inclusion
Suggestion from CAPS Community

Pest Description
Larvae: Three instars, with the final instar measuring 5 to 6 mm (approx. $^{3}/_{16}$ to $^{1}/_{4}$ in.) long (Katsoyannos, 2008). The body is whitish and translucent (Alford, 2007).

Pupae: Pupae are 3 to 4 mm (approx. $^{1}/_{8}$ to $^{3}/_{16}$ in.) long and 2 mm (approx. $^{1}/_{16}$ in.) in diameter; pale yellowish brown (Alford, 2007; Daniel and Grunder, 2012). The larvae pupate 2 to 5 cm ($^{13}/_{16}$ to 2 in.) deep in the soil under the host plant (Daniel and Grunder, 2012).

Adults: "Average length of female 4.6 mm (approx. $^{3}/_{16}$ in.), of male 3.4 mm (approx. $^{1}/_{8}$ in.). Mostly black. Head yellowish except posteriorly. Apex of antenna sharply pointed dorsally. Thorax mostly black, postpronotum (= humeral callus) and notopleural stripes whitish. Scutellum mostly whitish except base of sides, with 2 pairs of marginal bristles. Postnotum black. Legs with femora black, tibiae and tarsi yellowish. Wing slightly longer

than body, about 4.8 mm (approx.$^{3}/_{16}$ in.) in female, about 4.0 mm (approx.$^{3}/_{16}$ in.) in male. Wing crossed by 4 large and 1 small (intercalary) dark, distinct bands, the apical and subapical bands fused anteriorly, and the medial band isolated. Abdomen blackish, hind margin of segments yellowish. Female with tubular ovipositor sheath and thin elongate, piercing ovipositor apically. Male with tiny genital complex, coiled aedeagus (Hendel 1927)" (USDA, 1983).

Biology and Ecology

Rhagoletis cerasi adults emerge late May to early July and are active in sunny, hot, dry conditions (Alford, 2007). Adults must feed to mature sexually (Boller and Prokopy, 1976) and can be found feeding on aphid honeydew and other sugary excretions from plants (Alford, 2007; Katsoyannos, 2008). Upon emerging, males establish territories on fruit and begin emitting a volatile sex pheromone to attract virgin females (Boller and Prokopy, 1976; Katsoyannos, 2008). Females begin mating approximately 4 days after emerging (Katsoyannos, 1982) and begin ovipositing in 7 to 13 days, mainly on mid and late ripening fruit varieties (Katsoyannos, 2008). Females prefer to oviposit into fruits that are in full sun, so flies often aggregate in the sunniest parts of the tree (Daniel and Grunder, 2012). Females begin laying eggs in mid-June and insert them individually beneath the skin of ripening fruit (Alford, 2007). Females can lay 30 to 200 eggs; usually one per fruit (Daniel and Grunder, 2012). Once a female has laid eggs, she will rub her ovipositor over the fruit surface depositing pheromones on the fruit; the pheromones deter other females from ovipositing on the same fruit (Katsoyannos, 1975). The average life span of *Rhagoletis cerasi* is four to seven weeks, with adults living two to four weeks (Bush, 1992; Daniel and Grunder, 2012).

Eggs hatch in one to two weeks (Alford, 2007). Larvae feed on pulp around the pit for approximately four weeks (USDA, 1983; Alford, 2007). Larvae then move to the soil where they pupate beneath the surface (Alford, 2007) underneath the host trees (Fletcher, 1989). One generation occurs annually (Alford, 2007). *Rhagoletis cerasi* overwinter in the pupal stage, which may last from one to three winters (Alford, 2007). Adult emergence in this genus "is closely synchronized with the fruiting period of their hosts" (Fletcher, 1989). Dispersal flights may occur when all suitable fruits are either destroyed, harvested, or marked by another female. Females typically disperse first and

Figure 2. Damage on cherry caused by larval exit holes of *R. cerasi* (Photo © OPIE/Rémi Coutin)

are followed by the males. Experimentally, dispersal distance is between 100 and 500 m (approx. 328 and 1640 ft), but laboratory studies have demonstrated that the flies can cover up to 3 km (approx. 1.9 miles) in 24 hours if there is no place to land (Daniel and Grunder, 2012).

Rhagoletis cerasi was thought to comprise two geographic races due to differences in host fidelity and unidirectional sterility between the races (Boller, 1989). The 'southern' race, found in mainland Europe, is a pest of cherry (*Prunus* spp.). The 'northern' race, found in countries north and east of Switzerland, attacks honeysuckle (*Lonicera* spp.) (Alford, 2007). Adults typically oviposit in the same host species they emerged from but will shift to the alternate host when the preferred host in unavailable (Daniel and Grunder, 2012). Mating between males of the 'southern' race and females of the 'northern' race result in low egg hatch; whereas, the reverse ('northern' males crossed with 'southern' females) results in normal fertility levels (Boller, 1989). The unidirectional sterility is due to differences in the *Wolbachia* bacterium present in the populations. *Wolbachia* is maternally inherited, and the wCer2 strain, common in the southern European population, causes unidirectional cytoplasmic incompatibility with the northern population (Arthofer et al., 2009; Riegler and Stauffer, 2002).

Damage

Fruit damaged by the larvae of *R. cerasi* often rots; heavy infestations can reduce marketable yields (Alford, 2007). Damaged cherries darken and commonly fall off of the tree (Daniel and Grunder, 2012). Mature fruit may have soft spots or an off-color, wilted, or shriveled appearance (USDA, 1983). Exit holes left by mature larvae are visible (Fig. 2) (USDA, 1983). Fruit processors may reject consignments of infested harvested cherries (Alford, 2007).

Pest Importance

Rhagoletis cerasi is considered a serious pest of sweet cherry in Europe (Alford, 2007; Daniel and Grunder, 2012). Ripening cherries can be destroyed by this species shortly before harvest (USDA, 1983); and without proper control, infestation can reach 100% (Daniel and Grunder, 2012). From 1983 to 1992, the susceptibility of some sweet cherry cultivars was accessed in Cacak (western Serbia); this species was observed "causing more damage in mid-early and late sweet cherry cultivars" (Stamenkovic et al., 1996). Sour cherries are also infested to a lesser degree; without proper control, infestation reaches 30% (Olszak and Maciesiak, 2004).

If infestations are above 4% for table and canning cherries, they may be used for distillation which can tolerate higher limits of infestation (USDA, 1983). However, this can reduce the market prices by up to 50% (USDA, 1983).

If *Rhagoletis cerasi* becomes established in the United States it may seriously affect external markets such as New Zealand and Australia. The resulting quarantines might cause lower prices and economic losses for growers (W. Gould, personal communication, 2016).

Blueberry maggots (*Rhagoletis mendax*) have caused problems for canned blueberries because the larvae float to the top of the syrup on canning causing consumer rejections (W. Gould, personal communication, 2016). Canned cherries may have a similar problem. Blueberry growers in the eastern United States use a number of control methods including pesticides to lower populations (W. Gould, personal communication, 2016).

Known Hosts

This species has a narrow host range, comprised of cherry (*Prunus* spp.) and honeysuckle (*Lonicera* spp.). The population found in mainland Europe is a pest of cherry (*Prunus* spp.). The population found in countries north and east of Switzerland, attacks honeysuckle (*Lonicera* spp.) (Alford, 2007).

Major hosts

Lonicera alpigena (alpine honeysuckle), *Lonicera tatarica* (tatarian honeysuckle), *Lonicera xylosteum* (dwarf honeysuckle), *Lonicera* spp. (honeysuckle), *Prunus avium* (sweet cherry), *P. cerasus* (sour cherry), *P. cerasus* var. *semperflorens* (allsaints cherry), *P. mahaleb* (mahaleb cherry), and *P. serotina* (black cherry) ((USDA, 1983; Boller et al., 1998; Jaastad, 1998; Kovanci and Kovanci, 2006; Daniel and Grunder, 2012).

Minor hosts

Symphoricarpos albus (snowberry) and *S. rivularis* (garden snowberry) (USDA, 1983; Boller et al., 1998; Jaastad, 1998).

Pathogens or Associated Organisms Vectored

This pest is not currently known to vector any pathogens or other associated organisms.

Known Distribution

Asia: Armenia, Azerbaijan, Georgia (Republic of), Iran, Kazakhstan, Kyrgyzstan, Tajikistan, Turkey, Turkmenistan, and Uzbekistan; **Europe:** Andora, Austria, Belgium, Britain, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece (including Crete), Hungary, Italy, Latvia, Lithuania, Moldova, Netherlands, Norway, Poland, Portugal, Romania, Russia, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, and Ukraine (Boller et al., 1976; Neuenschwander et al., 1982; USDA, 1983; White and Elson-Harris, 1992; Jaastad, 1994, 1998; Kovanci and Kovanci, 2006; Barić et al., 2007; Stamenković et al., 2012; CABI, 2015).

Pathway

The United States does not allow cherry (*Prunus avium*) from areas where this species is known to occur (FAVIR, 2016). Sweet cherry (*Prunus avium*) fruits may be imported into all U.S. ports from Argentina, Australia (including Tasmania), Canada, Chile, and New Zealand (FAVIR, 2016). South Africa may export to ports within the continental United States (FAVIR, 2016). The Republic of Korea and Japan (except for Amami, Bonin, Ryukyu, Tokara, and Volcano Islands) may export to Guam and the Northern Mariana Islands (FAVIR, 2016). Cherries from Mexico have specific import

requirements: Cherries grown in fruit fly free areas of Mexico may be exported to all U.S. ports; if grown outside of fruit fly free areas may export to North Atlantic ports only, with cold treatment (FAVIR, 2016).

However, this species has been intercepted 115 times at U.S. ports of entry since 1988, with 58 of the interceptions occurring since 2000 (AQAS, 2016). All interceptions occurred at airports on *Prunus* spp. fruit found in passenger baggage (AQAS, 2016). The most common interceptions originated from material carried from France (19), Germany (15), Italy (13), Poland (9), and Romania (8) with the most common destinations being California (12), Florida (12), Georgia (7), Illinois (23), and Texas (10) (AQAS, 2016).

Its introduction into Crete was believed to have occurred through the importation of infested cherries. It may have been further dispersed in Crete through the transport of pupae in used crates to cherry growing areas in the mountains (Neuenschwander et al., 1982).

Potential Distribution within the United States

This genus is found throughout the Holarctic Region and in temperate parts of the Neotropical Region (Fletcher, 1989). *Rhagoletis cerasi* is not known to be present in the United States (USDA CPHST, 2016b).

Sweet and tart cherry is found in the highest density towards the Pacific Coast (California, Oregon, and Washington), the northeastern United States (Maryland, New York, and Pennsylvania), and other states such as Colorado, Michigan, New Mexico, and Utah (USDA CPHST, 2016a). A recent combined host density map for *Rhagoletis cerasi* developed by USDA-APHIS-PPQ-CPHST (Fig. 3) identifies areas of high host acreage based on the combined acreage of sweet cherry and tart cherry.

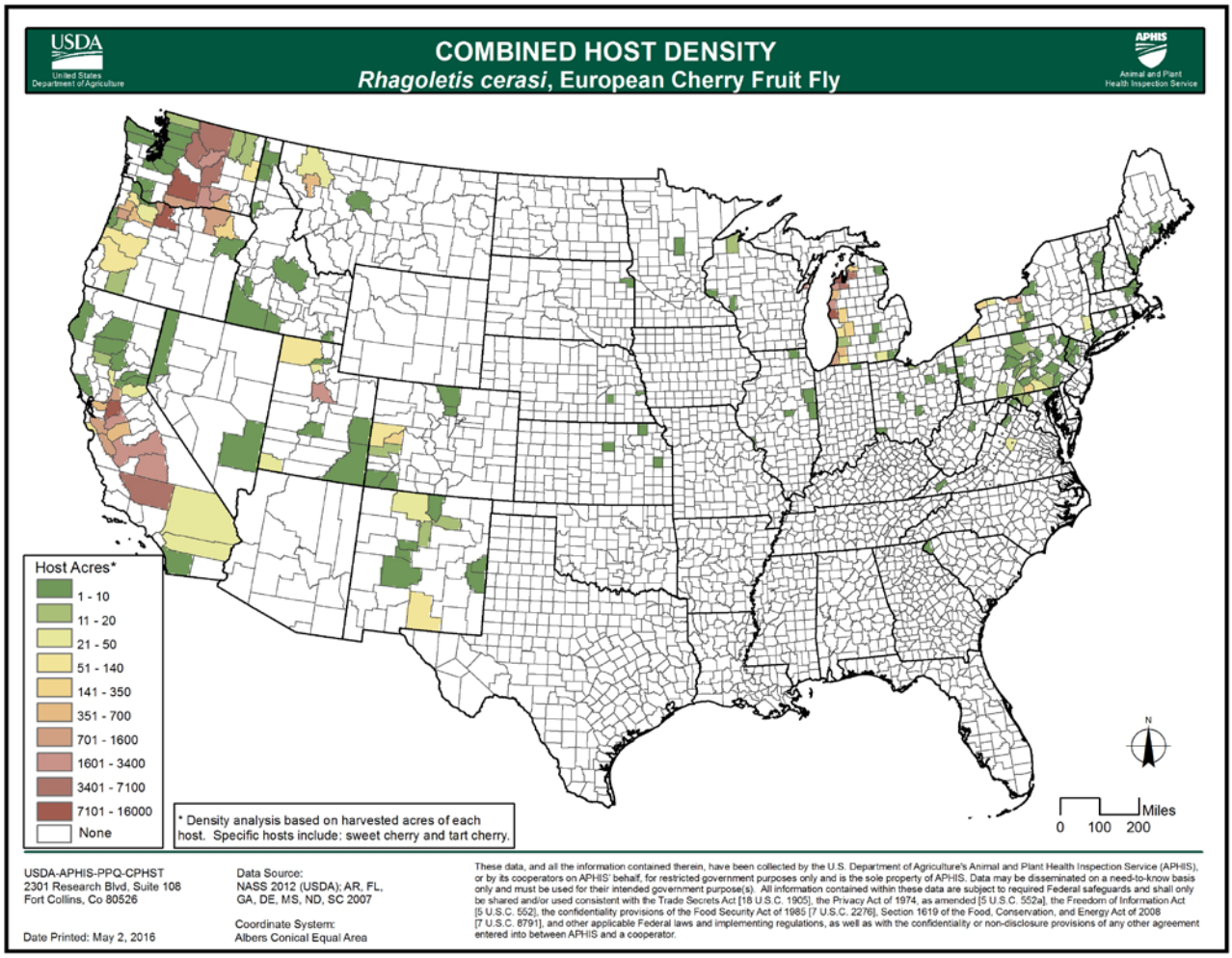

Figure 3. Combined Host Density Map for *Rhagoletis cerasi* within the continental United States. Values represent combined host acreage low to high (sweet cherry and tart cherry). Map courtesy of USDA-APHIS-PPQ-CPHST.

Survey

Approved Methods for Pest Surveillance*:

The CAPS-approved method is a trap and lure combination. The trap is a yellow sticky card with the “lure,” protein hydrolysate casein, embedded in the adhesive. As there are also un-baited sticky cards, be sure to order the product “Sticky Card, Yellow, Baited” available through the PPQ Trap and Lure Ordering Database.

In addition, adding the synthetic food attractant, ammonium acetate, can increase trap captures. Note, in the previous version of this datasheet, it was thought that the “Sticky Card, Yellow, Baited” product also had the ammonium acetate imbedded in the sticky card. This was not the case. For 2016 surveys, ammonium acetate may be added to the trap as a separate lure. Please contact Brian Kopper (contact information below) for information on product availability.

Therefore, two trap and lure combinations are approved: 1) the yellow sticky card with imbedded protein hydrolysate (Sticky Card, Yellow, Baited) or 2) the baited yellow sticky card with the ammonium acetate lure (Sticky Card, Yellow, Baited + Ammonium Acetate Lure). Contact Brian Kopper for assistance ordering the ammonium acetate lure.

IPHIS Survey Supply Ordering System Product Names:

1) Sticky Card, Yellow, Baited

Time of year to survey

Traps should be in place before the end of May, and trapping should continue for three months.

Trap and lure placement

The ammonium acetate lure is in a patch form. Patches should be attached to the yellow sticky cards at the top or bottom of the card in a manner that does not cover a large portion of the sticky surface.

Traps should be placed around the perimeter of sweet cherry orchards. Traps should be placed in the middle section of the tree canopy on the outside edge of the tree with the yellow surface of the trap facing outward.

Trap servicing

Traps should be inspected weekly, if possible, but at least every two weeks. The trap and lure should be replaced every 4 weeks. Because yellow sticky cards capture many kinds of non-target insects, the traps need to be inspected and cleaned regularly, particularly in windy or dusty areas. If traps become too covered in dust, the traps will not be as effective.

Before planning a *R. cerasi* survey, it is IMPERATIVE that you work with the PPQ National Operations Managers for CAPS and Fruit Flies for guidance in planning your survey (see contact information below).

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IMPORTANT: Do not place lures for two or more target species in a trap unless otherwise recommended.

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

Literature-Based Methods:

Trapping: The International Atomic Energy Agency (IAEA) Trapping Guidelines for Area-wide Fruit Fly Programmes (2003) recommends trapping male and female *R. cerasi* by using ammonium salts in 1 of 3 different traps, yellow panel, Rebell ® Yellow Traps, or red spheres. Trap density per km^2 is given and depends on both type of area (production area, marginal, urban, or points of entry) and scenario (monitoring or detection) (IAEA, 2003).

Katsoyannos et al. (2000) found that the Rebell ® Yellow Traps with a slow release formulation of ammonium acetate attached to the lower part of the trap was the most effective of all treatments tested, including the McPhail trap. The Rebell trap is a patented trap that "consists of two yellow plastic, sticky-coated rectangles (15 by 20 cm) that cross each other to form a two dimensional trap" (Katsoyannos et al., 2000).

Key Diagnostics/Identification

Approved Methods for Pest Surveillance*:

Morphological. *Rhagoletis cerasi* can be distinguished from the *Rhagoletis* species present in North America by the combination of its predominantly blackish body and its wing pattern, which includes an intercalary band, a small band on the anterior margin near the midlength, and a complete, unforked apical band. The native cherry-infesting species, including *R. cingulata* (cherry fruit fly), *R. indifferens* (western cherry fruit fly), and *R. fausta* (black cherry fruit fly), lack the intercalary band and have the apical band forked or broken into a posterior branch and an apical spot (Fig. 4) (USDA, 1983; White & Elson-Harris, 1992; Foote et al., 1993).

Any suspect positive samples should be sent to an expert in the family Tephritidae for definitive identification.

For additional guidance, see the keys in Foote, Blanc and Norrbom (1993).

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

Easily Confused Species

Rhagoletis cerasi is similar to *R. berberidis*, which is currently not found in the United States; keys to differentiate adults of *R. cerasi* and *R. berberidis* and other Eurasian species can be found in Merz (1994), Korneyev and Merz (1997), and Kutuk and Ozaslan (2006). There are three *Rhagoletis* species found in North America that infest cherries: *R. cingulata* (cherry fruit fly), *R. indifferens* (western cherry fruit fly), and *R. fausta* (black cherry fruit fly) (USDA, 1983). *Rhagoletis cerasi* adults can be distinguished from these other species by their wing patterns; the three species of

Rhagoletis present in the United States that attack cherries lack the intercalary band and have a forked apical band or an apical spot (USDA, 1983; White & Elson-Harris, 1992; Foote et al., 1993). There are two species of *Rhagoletis* in the United States that have intercalary bands, *R. basiola* and *R. meigenii*; however, these species do not look very similar to *R. cerasi* (W. Gould, personal communication, 2016).

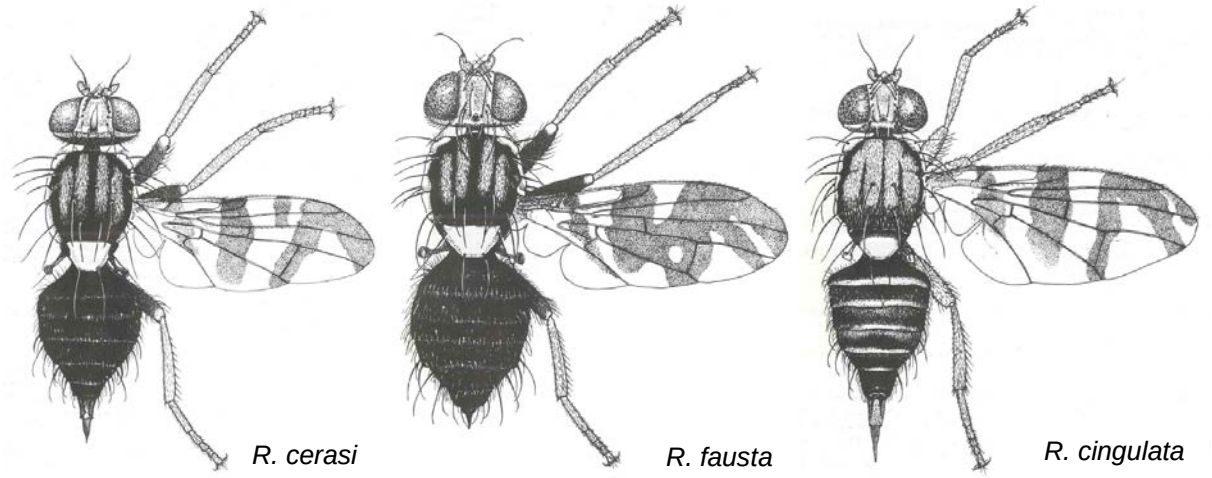

Figure 4. Body and wing pattern of adult female European cherry fruit fly (*R. cerasi*), black cherry fruit fly (*R. fausta*), and cherry fruit fly (*R. cingulata*) (White & Elson-Harris, 1992)

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May 2016: Complete update performed. 2017 Version posted to CAPS website.
July 2011: Final datasheet posted to CAPS website.

Revisions

May 2016
1) Revised the **Pest Description** section.
2) Revised the **Biology and Ecology** section. Added current research and explanation for unidirectional cytoplasmic incompatibility
3) Revised the **Pest Importance** section.
4) Revised the **Damage** section.
4) Revised the **Known Hosts** section.
5) Revised the **Known Distribution** section.
6) Added the **Pathway** section.
7) Revised the **Potential Distribution within the United States** section. Added a newly created map for the "Combined Host Density Map for *Rhagoletis cerasi* within the continental United States."
8) Revised the **Survey** section. Added new trap and lure combinations in coordination with the PPQ Fruit Fly Cross Functional Working Group.
9) Revised the **Key Diagnostics/Identification** section. Section reviewed by subject matter experts.
10) Added photos to **Easily Confused Species** section. Section reviewed by subject matter experts.

Reviewers

May 2016
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