EPPO Datasheet: *Rhagoletis pomonella*

Last updated: 2020-09-18

IDENTITY

Preferred name: *Rhagoletis pomonella*
Authority: (Walsh)
Taxonomic position: Animalia: Arthropoda: Hexapoda: Insecta: Diptera: Tephritidae
Other scientific names: *Spilographa pomonella* (Walsh), *Trypeta pomonella* Walsh, *Zonosema pomonella* (Walsh)
Common names: apple fruit fly, apple maggot, apple maggot fly, railroad worm
view more common names online...
EPPO Categorization: A1 list
view more categorizations online...
EU Categorization: Quarantine pest ((EU) 2019/2072 Annex II A)
EPPO Code: RHAGPO



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Notes on taxonomy and nomenclature

Rhagoletis pomonella belongs to the *R. pomonella* species group that comprises *R. pomonella*, *R. mendax*, *R. zephyria*, and *R. cornivora* (Bush 1966) and an undescribed 'flowering dogwood fly' (Xie *et al.*, 2008).

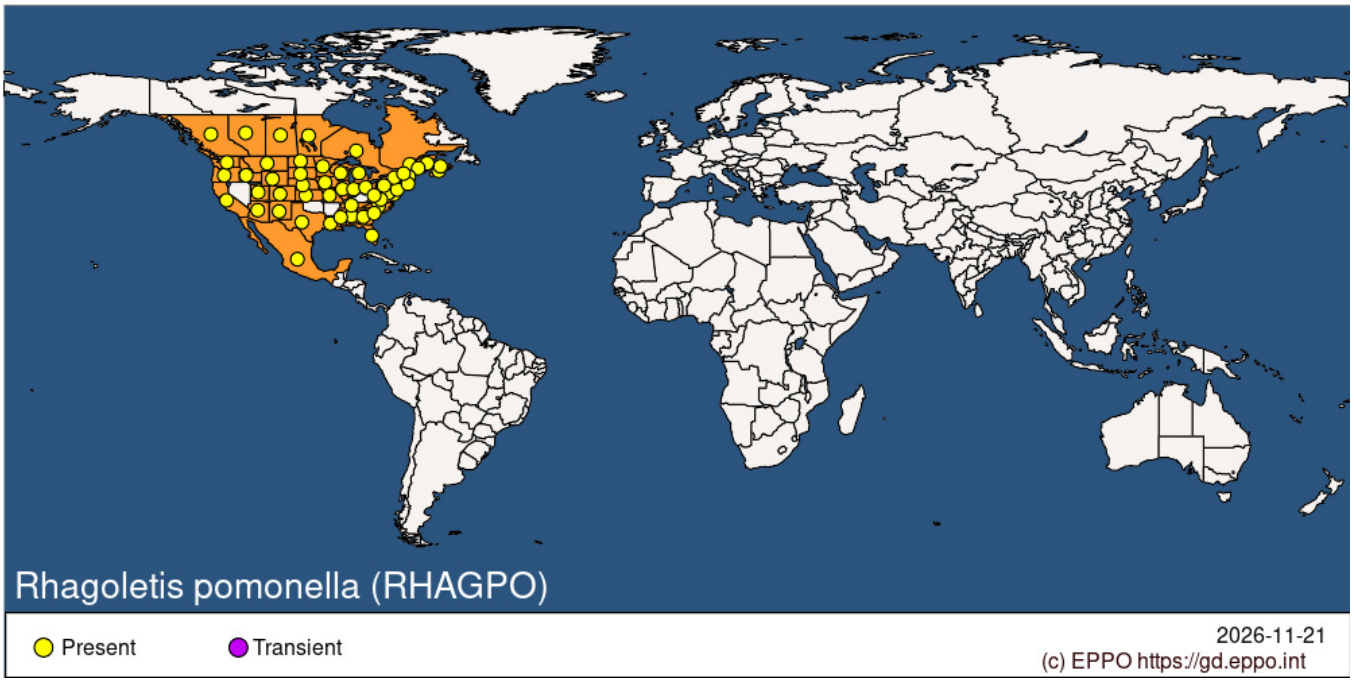
HOSTS

Apples (*Malus domestica*) are the principal cultivated host, but the ancestral host plants are various species of hawthorns (*Crataegus* spp.). *Rhagoletis pomonella* moved onto apple after this crop was introduced into North America around 1850. There are >60 plant taxa, all in the Rosaceae family, attacked by the fly, with at least 34 belonging to *Crataegus* (Yee & Norrbom, 2017; Yee & Goughnour, 2019). In addition to apple, seven other commonly cultivated plants are also natural hosts, although these are rare hosts, with the infestations seeming to occur on wild growing plants and only in parts of the fly's range. These hosts are apricot (*Prunus armeniaca*) (Lienk, 1970), sweet cherry (*Prunus avium*) (Allred & Jorgensen, 1993), sour cherry (*Prunus cerasus*) (Shervis *et al.*, 1970), European plum (*Prunus domestica*) (Yee & Goughnour, 2006), peach (*Prunus persica*) (Yee & Goughnour, 2016), common pear (*Pyrus communis*) (Prokopy & Bush, 1972), and Asian pear (*Pyrus pyrifolia*) (Yee & Goughnour, 2006). Records of *Amelanchier*, *Aronia melanocarpa*, *Cornus*, *Cydonia*, *Solanum*, *Symphoricarpos*, and *Vaccinium* as *R. pomonella* hosts are unsubstantiated and some are probably erroneous (Yee & Norrbom, 2017). In the EPPO region, apples are the main host threatened, and the fly may also survive on a range of other widely distributed wild or ornamental Rosaceae.

Host list: *Aronia arbutifolia*, *Cotoneaster apiculatus*, *Cotoneaster integerrimus*, *Cotoneaster lacteus*, *Crataegus aestivalis*, *Crataegus castlegarensis*, *Crataegus crus-galli*, *Crataegus cuprina*, *Crataegus douglasii*, *Crataegus flabellata*, *Crataegus flava*, *Crataegus gracilior*, *Crataegus greggiana*, *Crataegus holmesiana*, *Crataegus laevigata*, *Crataegus macracantha*, *Crataegus macrosperma*, *Crataegus marshallii*, *Crataegus mexicana*, *Crataegus mollis*, *Crataegus monogyna*, *Crataegus okennonii*, *Crataegus opaca*, *Crataegus pentagyna*, *Crataegus pinnatifida*, *Crataegus punctata*, *Crataegus rivularis*, *Crataegus rosei*, *Crataegus scabrida*, *Crataegus viridis*, *Crataegus* × *cogswellii*, *Crataegus*, *Malus domestica*, *Malus floribunda*, *Prunus americana*, *Prunus angustifolia*, *Prunus armeniaca*, *Prunus avium*, *Prunus cerasifera*, *Prunus cerasus*, *Prunus domestica*, *Prunus emarginata*, *Prunus mahaleb*, *Prunus persica*, *Prunus salicina*, *Prunus umbellata*, *Prunus virginiana*, *Pyracantha angustifolia*, *Pyracantha coccinea*, *Pyrus communis*, *Pyrus pyrifolia*, *Rosa rugosa*, *Rosa virginiana*, *Sorbus aucuparia*, *Sorbus scopulina*

GEOGRAPHICAL DISTRIBUTION

R. pomonella is native to Eastern North America and Mexico and is present in most of North America, from Mexico to Southern provinces of Canada.



North America: Canada (Alberta, British Columbia, Manitoba, New Brunswick, Nova Scotia, Ontario, Prince Edward Island, Québec, Saskatchewan), Mexico, United States of America (Alabama, Arizona, California, Colorado, Connecticut, Delaware, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oregon, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, Washington, West Virginia, Wisconsin, Wyoming)

BIOLOGY

Eggs are laid below the skin of the host fruit and hatch after 3-7 days in July to September. The larvae usually feed for 2-5 weeks, except in winter apples, in which development may take much longer. Pupariation occurs in summer: larvae fall onto the soil under the host plant, and normally overwinter as pupae before adults eclose the following summer. However, some adults may emerge within the same summer (Porter, 1928; Hall, 1937) and a few pupae may even pass two or more winters before forming adults (Dean & Chapman, 1973). Adults may live for up to 40 days under field conditions (Christenson & Foote, 1960). In eastern North America, populations from apple and from hawthorn are genetically distinct host races (Feder *et al*., 1988), the apple race having evolved from a common form since the introduction of apple into North America, or from a pre-existing race with different host preferences (Carson, 1989; Luna & Prokopy, 1995). In either case, *R. pomonella* shows intraspecific variation in relation to host preference and has demonstrated its capacity to move onto new hosts, as it has done after introduction into western USA (AliNiazee & Westcott, 1986; Cha *et al*., 2012). Introduced populations of *R. pomonella* in western North America have lower genetic diversity than populations in eastern North America (McPheron *et al*., 1988; Sim *et al*., 2017), but this does not appear to reduce the fly's propensity to attack diverse rosaceous plants in non-native regions.

DETECTION AND IDENTIFICATION

Symptoms

Attacked fruit are pitted by oviposition punctures, around which some discoloration usually occurs. When feeding, larvae damage the flesh of the fruit.

Morphology

Rhagoletis pomonella adults can be separated from other members of its complex using morphological traits, such as wing shape, ovipositor (aculeus) length, and male genitalia shape (Pickett, 1937; Bush, 1966; Yee *et al*., 2011). It is easy to separate adult *R. pomonella* from other related species by a combination of morphological characters and host fruit.

Egg

The egg is white, smooth, and elongated and about 0.73 mm long. The anterior end terminates in a small papilla while the posterior end is rounded (Dean and Chapman, 1973).

Larva

There are three larval instars. Larvae are whitish or creamy, legless, maggot-like and the last instar is about 7 mm long. See Phillips (1946), Kandybina (1977) and Berg (1979).

Adult

Adult females average about 5.2 mm in length with a wingspan of 9.3 mm while males average 3.9 mm in length with a wingspan of 7.5 mm (Dean and Chapman 1973).

Head: Three pairs of frontal setae; genae usually less than one-quarter eye height; ocellar setae long, usually similar in length and strength to orbital setae; two pairs of orbital setae; 1st flagellomere usually with a small antero-apical point.

Thorax: Scutum predominantly black, with two or four longitudinal bars of tomentum that form grey stripes, with dorsocentral setae based close to a line between the anterior supra-alar setae; scutum with dorsocentral setae and presutural supra-alar setae; anatergite without long pale hairs, at most with a fine pubescence; scutellum marked black at sides and in base half, with basal and lateral black areas broadly joined, flat and with four marginal setae (one basal and an apical pair).

Wing: The apical part of the wing has a distinctive F-shaped band that is similar to those of other members of the *R. pomonella* complex or species group. Vein Sc abruptly bent forward at nearly 90°, weakened beyond this bend and ending at subcostal break; vein R1 with dorsal setulae; vein R4+5 usually without dorsal setulae, except sometimes at the base of the vein (except in some aberrant individuals); apex of vein M meeting C with a distinct angle; cup extension short, never more than one-fifth as long as vein A1+Cu2, and vein CuA2 straight along anterior edge of cup extension; cell cup always considerably broader than half depth of cell bm, and usually about as deep as cell bm. Cells r1 and r2+3 without any markings between the discal and preapical crossbands; preapical crossband (the band which covers the dm-cu crossvein) running obliquely from a point on the discal crossband near the r-m crossvein, so that it is almost parallel to the apical crossband; apical crossband separated from vein C leaving a hyaline margin at least across the apices of veins R2+3 and R4+5. Length 2-4 mm.

Abdomen: Predominantly black; female with an ovipositor that is shorter than the wing length, and straight.

Detection and inspection methods

Traps already in use within the EPPO region for *Rhagoletis cerasi* should be suitable for detecting any invasion of North American *Rhagoletis* spp. They capture both sexes and are based on visual, or visual plus odour, attraction. They are coated with sticky material. Traps are usually either flat-surfaced and coloured yellow to elicit a supernormal foliage response, or spherical and dark-coloured to represent a fruit, with colour contrast being a cue. Traps that combine both foliage and fruit attraction can also be used. The odour comes from protein hydrolysate or other substances emitting ammonia, such as ammonium carbonate or ammonium acetate. For *R. pomonella* in eastern North America, synthetic apple volatiles are also very effective attractants (Reissig *et al*., 1985), although ammonia is consistently more attractive than synthetic fruit volatiles for *R. pomonella* in the Pacific Northwest of the USA (Yee *et al*., 2014). Due to a combination of attractiveness and ease of use, sticky yellow panels baited with

ammonium carbonate are used in annual *R. pomonella* detection surveys in Washington state, conducted in abandoned or wild apple and hawthorn trees (Yee *et al*., 2012). In Washington state (USA), a commercial orchard is considered threatened if an adult fly is found with one-half-mile (about 800 m) of the orchard. Apples in a threatened orchard must be inspected before its apples are transported into or through a pest-free area (Washington State Department of Agriculture, 2019).

As surveys should be carried out in all the EU member countries, a pest survey card was prepared by the European Food Safety Authority (EFSA, 2020) to assist EU Member States in planning their annual survey activities.

PATHWAYS FOR MOVEMENT

Adult flight and the transport of infested fruits are the major means of movement and dispersal to previously uninfested areas. In general, *Rhagoletis* spp. fly short distances (relative to some tropical fruit flies). However, *R. pomonella* has been recorded moving up to 100 m in the presence of hosts and up to 1.5 km when released away from an orchard (Fletcher, 1989). Individual flies can disperse or have the ability to potentially fly 0.2-4.5 km (free flight: Maxwell & Parsons, 1968; tethered flight: Sharp, 1978). In international trade, the major means of dispersal to previously uninfested areas is the transport of fruits containing live larvae. There is also a risk from the transport of puparia in soil or packaging with plants that have borne fruit. In Washington state, certain soils and growing media as well as municipal and green waste are regulated as part of the apple maggot quarantine because there are concerns that waste and soil could harbour *R. pomonella* puparia which could then be spread into commercial apple-growing regions (Washington State Department of Agriculture, 2020).

PEST SIGNIFICANCE

Economic impact

Rhagoletis pomonella is a serious quarantine pest of apples in North America, potentially restricting export of commercial apples to many markets and requiring various management measures to prevent its spread into commercial orchards in the western USA (Washington State Department of Agriculture, 2020). These measures could be also relevant if the fly invades the EPPO region. Commercial apple crops in Washington state have never been infested by *R. pomonella* larvae (Washington State Department of Agriculture, 2020), but the fly is a continual threat to orchards and export markets. It was estimated that if it were allowed to spread, it could cost the economy of Washington approximately 510 to 557 million USD per year (Galinato *et al*., 2018).

Control

Control procedures already established in the EPPO region for *R. cerasi* are similar to those used against North American *Rhagoletis* pests and could therefore be implemented against any outbreak of those species within the EPPO region. Upon detection, fallen and infested fruit must be removed and destroyed. If possible, wild and abandoned host trees should also be removed. In North America, degree-days can be used to accurately predict first emergence of *R. pomonella* (UC IPM, 2019) to time insecticide treatments against adults. Various organophosphate, pyrethroid, spinosyn, neonicotinoid, mitochondrial complex, and diamide insecticides are fair, good, to excellent for controlling *R. pomonella* (Wise, 2019). More environmentally acceptable techniques than using broad-spectrum insecticides in high volume sprays have been studied. These include bait sprays (insecticide plus ammonia, sugar source) such as GF-120 (Yee, 2007), which can be applied as a spot treatment or lower volume spray; soil application of insecticide to destroy pupae; juvenile hormone analogues applied to the soil (Boller & Prokopy, 1976); pesticide-coated red spheres suspended on apple trees, which visually attract adult *R. pomonella* (Duan & Prokopy, 1995). An IPM approach has been recommended for apple pests in North America (Prokopy *et al*., 1990). Averill & Prokopy (1987) demonstrated that the application of the oviposition deterrent pheromone of *R. pomonella* deterred oviposition for up to 3 weeks, provided it was not rain-washed. Research on biological control was done in 1970s-1980s and was not successful (Boller & Prokopy, 1976; Wharton, 1989), and Van Driesche *et al.* (1987) concluded that, out of 15 apple pests, *R. pomonella* was one of only two for which biological control had no potential. Recent work has shown some efficacy of nematodes for killing *R. pomonella* (Usman *et al.*, 2020).

Phytosanitary risk

Rhagoletis pomonella has shown its capacity to spread, probably via infested apples, from its original range in eastern North America, to western states of the USA as well as to British Columbia in Canada (Canadian Food Inspection Agency, 2019). EFSA (2019), based on Kumar *et al*., (2016), determined that most parts of Southern and Central Europe are highly favourable for the establishment of *R. pomonella*, and this corresponds to the area where apples are cultivated. Apple is a very important crop in the EPPO region. *R. pomonella* is one of the most important fruit flies in North America and is likely to cause high yield losses if it is introduced into the EPPO region. As there are no European fruit flies on *Malus*, specific control measures would need to be developed in the EPPO region.

PHYTOSANITARY MEASURES

R. pomonella has been listed as one of the 20 EU priority pests in 2019 (EU, 2019).

Consignments of apples from countries where *R. pomonella* occurs should be inspected for symptoms of infestation and those suspected should be cut open in order to look for larvae. Fruits should come from an area where *R. pomonella* does not occur, or from a place of production found free from the pest by regular inspection for 3 months before harvest. Fruits may also be treated. Cold treating apples at 3.3°C for ≥90 days or at 0°C for ≥40 days is an effective and accepted way to kill *R. pomonella* larvae in the USA (Washington State Department of Agriculture, 2019). USDA (2020) recommends as a possible treatment irradiation of fruit at 60 Gy.

Plants of host species transported with roots from countries where *R. pomonella* occurs should be free from soil, or the soil should be treated against puparia, and should not bear fruits. Such plants may indeed be prohibited from importation. There are strict regulations and restrictions for movement of municipal waste and soil in Washington state, USA, as well as signage to inform travellers that transport of homegrown fruit outside of fly quarantine areas is illegal (Washington State Department of Agriculture, 2020).

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Datasheet history

This datasheet was first published in the EPPO Bulletin in 1983, and in the two editions of 'Quarantine Pests for Europe' in 1992 and 1997, as well as in 2020. It is now maintained in an electronic format in the EPPO Global Database. The sections on 'Identity', ‘Hosts’, and 'Geographical distribution' are automatically updated from the database. For other sections, the date of last revision is indicated on the right.

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