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Data Sheets on Quarantine Pests

Rhagoletis pomonella

IDENTITY

Name: *Rhagoletis pomonella* (Walsh)
Synonyms: *Trypeta pomonella* Walsh
Taxonomic position: Insecta: Diptera: Tephritidae
Common names: Apple maggot, apple maggot fly (English)
Mouche de la pomme (French)
Notes on taxonomy and nomenclature: Many pre-1966 records of *R. pomonella* refer to *R. cornivora* Bush (on *Cornus*, Cornaceae), *R. mendax* Curran (on Ericaceae) and *R. zephyria* Snow (on *Symphoricarpos*, Caprifoliaceae); true *R. pomonella* is associated with Rosaceae. *R. pomonella* is one of a complex of closely related species, distinguishable into allozyme frequency groups (Berlocher et al., 1993).
Bayer computer code: RHAGPO
EPPO A1 list: No. 41
EU Annex designation: I/A1

HOSTS

Apples (*Malus pumila*) are now the principal host, but the natural host plants in North America are *Crataegus* spp. *R. pomonella* has moved onto apple as this crop was introduced throughout North America. There are also records on other rosaceous fruit crops, such as other *Malus* spp. and some *Prunus* spp. Larvae have been found in pears (*Pyrus communis*), but no adults emerged (Bush, 1966). Wild or ornamental rosaceous hosts include *Amelanchier*, *Aronia*, *Cotoneaster*, *Crataegus* and *Rosa*. Alldred & Jorgensen (1993) recorded *R. pomonella* in Utah (where it has recently been introduced) from field-infested apricots (*Prunus armeniaca*), cherries (*P. avium* and *P. cerasus*) and *P. americana*, as well as various ornamental and wild Rosaceae; cherries are its main cultivated hosts in Utah (Jones *et al*., 1989). In Colorado (Kroening *et al*., 1989), introduced *R. pomonella* has remained on wild *Crataegus* and has not become a pest in commercial apple orchards. Records on Ericaceae refer to *R. mendax* (EPPO/CABI, 1996b), while records on Solanaceae (*Lycopersicon esculentum* - tomatoes) are almost certainly erroneous. In the EPPO region, apples are the main host threatened, with the possibility of survival on a range of other widely distributed wild or ornamental Rosaceae.

GEOGRAPHICAL DISTRIBUTION

EPPO region: Absent.
Asia: A record from Afghanistan (Ullah, 1988) is almost certainly an error.
North America: Canada (Manitoba, New Brunswick, Nova Scotia, Ontario, Prince Edward Island, Quebec, Saskatchewan), Mexico, USA (eastern and central states: Arkansas, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, North Carolina,

North Dakota, Nebraska, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, South Carolina, South Dakota, Texas, Vermont, Virginia, Wisconsin, West Virginia; recently established in Oregon, from where it has spread to California, Colorado, Utah and south-eastern Washington; AliNiazee & Brunner, 1986).
Central America and Caribbean: Costa Rica (doubtful record).
South America: Colombia (doubtful record).
EU: Absent.
Distribution map: See CIE (1989, No. 48) and also AliNiazee & Penrose (1981), AliNiazee & Westcott (1986), Foote *et al.* (1993).

BIOLOGY

Eggs are laid below the skin of the host fruit and hatch after 3-7 days. The larvae usually feed for 2-5 weeks, except for those in winter apples which develop over a period of several months. Pupariation is in the soil under the host plant and this is the normal overwintering stage. However, some adults may emerge within the same summer and a few may even pass two to four winters before emerging. Adults may live for up to 40 days under field conditions (Christenson & Foote, 1960). Populations from apple and from hawthorn may be different races (Luna & Prokopy, 1995), 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). 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 also done when introduced into western USA). However, as McPheron *et al.* (1988) have suggested for *R. pomonella* introduced into Utah, newly introduced populations may have a narrow genetic base and a more limited host range than the species as a whole (see also Hosts).

DETECTION AND IDENTIFICATION

Symptoms

Attacked fruit will be pitted by oviposition punctures, around which some discoloration usually occurs.

Morphology

R. pomonella is very difficult to separate on morphological criteria from *R. mendax* (EPPO/CABI, 1996b) and should be referred to a specialist (Bush, 1966). It is, however, easy to separate by reference to its hosts. The following description applies to both.

Larva

See Phillips (1946), Kandybina (1977), Berg (1979).

Adult

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: 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 *R. cerasi* should be suitable for monitoring any invasion of North American *Rhagoletis* spp. They capture both sexes and are based on visual, or visual plus odour, attraction. They are coated in sticky material. Traps are usually either flat-surfaced and coloured fluorescent yellow to elicit a supernormal foliage response, or spherical and dark-coloured to represent a fruit; traps which combine both foliage and fruit attraction can also be used. The odour comes from protein hydrolysate or other substances emitting ammonia, such as ammonium acetate; for *R. pomonella* synthetic apple volatiles are also very effective attractants (Reissig *et al.*, 1985). See Boller & Prokopy (1976) and Economopoulos (1989) for a discussion of these traps.

MEANS OF MOVEMENT AND DISPERSAL

Adult flight and the transport of infected fruits are the major means of movement and dispersal to previously uninfected areas. In general, *Rhagoletis* spp. are not known to fly more than a short distance; 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). 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 which have already fruited.

PEST SIGNIFICANCE

Economic impact

R. pomonella, which primarily attacks apples, is the most serious fruit-fly pest in North America, except for introductions of *Ceratitis capitata* (EPPO/CABI, 1996a).

Control

Control procedures already established in the EPPO region for *R. cerasi* are similar to those used against the North American pest species and could therefore be implemented against any outbreak of those species within the EPPO region. Upon detection, fallen and infected fruit must be removed and destroyed. If possible, wild and abandoned host trees should also be destroyed. Boller & Prokopy (1976) note that systemic organophosphates, such as dimethoate, are highly effective against most species, killing eggs, larvae and adults. Recently, Belanger *et al.* (1985) discussed the use of pyrethroids, but these were only of use when pest activity was low. More environmentally acceptable techniques have been tried; namely bait sprays (insecticide plus ammonia source) which can be applied as a spot treatment; soil application of insecticide to destroy pupae; juvenile hormone analogues which can be 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 is now generally recommended for apple pests in North America

(Prokopy *et al*., 1990). Monitoring to facilitate IPM of *R. pomonella* and other apple pests can be facilitated by computer programs such as Bugwatch (Yee & Yee, 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. Biological control has so far not been successful (Boller & Prokopy, 1976; Wharton, 1989), and Van Driessche *et al*. (1987) concluded that, out of 15 apple pests, *R. pomonella* was one of only two for which biological control had no potential. It has been noted that if *R. pomonella* spreads to British Columbia, Canada, the control measures required against it will conflict with the integrated pest management (IPM) of other apple pests (F.L. Banham, pers. comm.) and this may also be a problem if it reaches the EPPO region.

Phytosanitary risk

The EPPO A1 quarantine list category "non-European Trypetidae" (OEPP/EPPO, 1983) was originally "*R. pomonella* and other non-European Trypetidae", which indicates the importance attached to this species. Indeed, all EPPO's original documentation concerned only *Rhagoletis* spp. in North America; the tropical tephritids were added to the data sheet only at a late stage. Thus, the temperate fruit flies are the obvious direct quarantine pests for the EPPO region. *R. pomonella* has also shown its capacity to spread, on apple, from its original range in eastern North America, to western states of the USA. Canada considers it as an internal quarantine pest (absent from the fruit-producing areas of British Columbia). There are no European fruit flies on *Malus*, and *R. pomonella* is in itself the most important of the group in North America, so it is also much the most significant quarantine pest for the EPPO region. *R. pomonella* is also of quarantine significance for COSAVE and OIRSA.

PHYTOSANITARY MEASURES

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. EPPO recommends that such 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, but specific treatment schedules have mostly not been developed for *Rhagoletis* spp., since there is no need for them in North America. Schedules developed for other fruit flies on apples will probably be adequate, e. g. treatment in transit by cold treatment (e.g. 13, 15 or 17 days at 0.5, 1 or 1.5°C, respectively) (USDA, 1994). Ethylene dibromide was previously widely used as a fumigant but is now generally withdrawn because of its carcinogenicity; methyl bromide is less satisfactory, damaging many fruits and reducing their shelf life, but treatment schedules are available for apple (e.g. 32 g/m^3 for 2 h at 21-29.5°C; USDA, 1994).

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 carry fruits. Such plants may indeed be prohibited importation.

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