EPPO Datasheet: *Grapholita inopinata*

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IDENTITY

[more photos...]

Preferred name: *Grapholita inopinata*
Authority: (Heinrich)
Taxonomic position: Animalia: Arthropoda: Hexapoda: Insecta: Lepidoptera: Tortricidae
Other scientific names: *Cydia inopinata* (Heinrich), *Grapholita cerasana* Kozhanchikov, *Laspeyresia prunifoliae* Kozhanchikov
Common names: Manchurian codling moth, Manchurian fruit moth
[view more common names online...]
EPPO Categorization: A2 list
[view more categorizations online...]
EU Categorization: A1 Quarantine pest (Annex II A)
EPPO Code: CYDIIN

Notes on taxonomy and nomenclature

The species *Laspeyresia prunifoliae* described by Kozhanchikov in 1953 from Buryatiya Republic (Russia) was synonymized with *Grapholita inopinata* (Heinrich) (see Danilevsky, 1958). Another species, *Laspeyresia cerasana* described by the same author was synonymized with *Grapholita funebrana* (Treitschke) (see Danilevsky, 1958). Some specimens from the type series of *L. cerasana* corresponded to *G. inopinata*, therefore in some of the literature *L. cerasana* is listed under the name of *G. inopinata*.

HOSTS

Apples are the main hosts (Danilevsky & Kuznetsov, 1968). *G. inopinata* damages both wild and cultivated apples (Danilevsky & Kuznetsov, 1968). *Malus baccata (*synonym *M. pallasiana)* is the main host in Asian part of Russia (Danilevsky & Kuznetsov, 1968; Lopatina, 1978). Far Eastern apple species such as *M. mandshurica*, *M. prunifolia* and *M. spectabilis* are also appropriate hosts (Danilevsky & Kuznetsov, 1968). *M. mandshurica* can be difficult to distinguish from *M. baccata* (Koropachinskiy & Vstovskaya, 2012). Both are wild species that are also used for landscaping. *M. baccata* is easy to cross with *M. domestica* and it serves as a rootstock for cultivated apples in high-latitude regions due to its resistance to disease and tolerance to cold (Chen *et al.*, 2019). Apple varieties with leaves that are densely covered by woolly hairs are avoided by this pest (Kolmakova, 1958; Danilevsky & Kuznetsov, 1968). *G. inopinata* also attacks pears and other species in the same subfamily (Amygdaloideae) (Danilevsky & Kuznetsov, 1968). According to Takizawa (1936), *C. inopinata* has been reared artificially on some Far Eastern *Prunus* spp.

Host list: *Chaenomeles japonica*, *Crataegus cuneata*, *Crataegus*, *Eriobotrya japonica*, *Malus baccata*, *Malus domestica*, *Malus mandshurica*, *Malus prunifolia*, *Malus spectabilis*, *Malus toringo*, *Malus*, *Pyrus bretschneideri*, *Pyrus communis*, *Pyrus pyrifolia*, *Pyrus ussuriensis*, *Pyrus*

GEOGRAPHICAL DISTRIBUTION

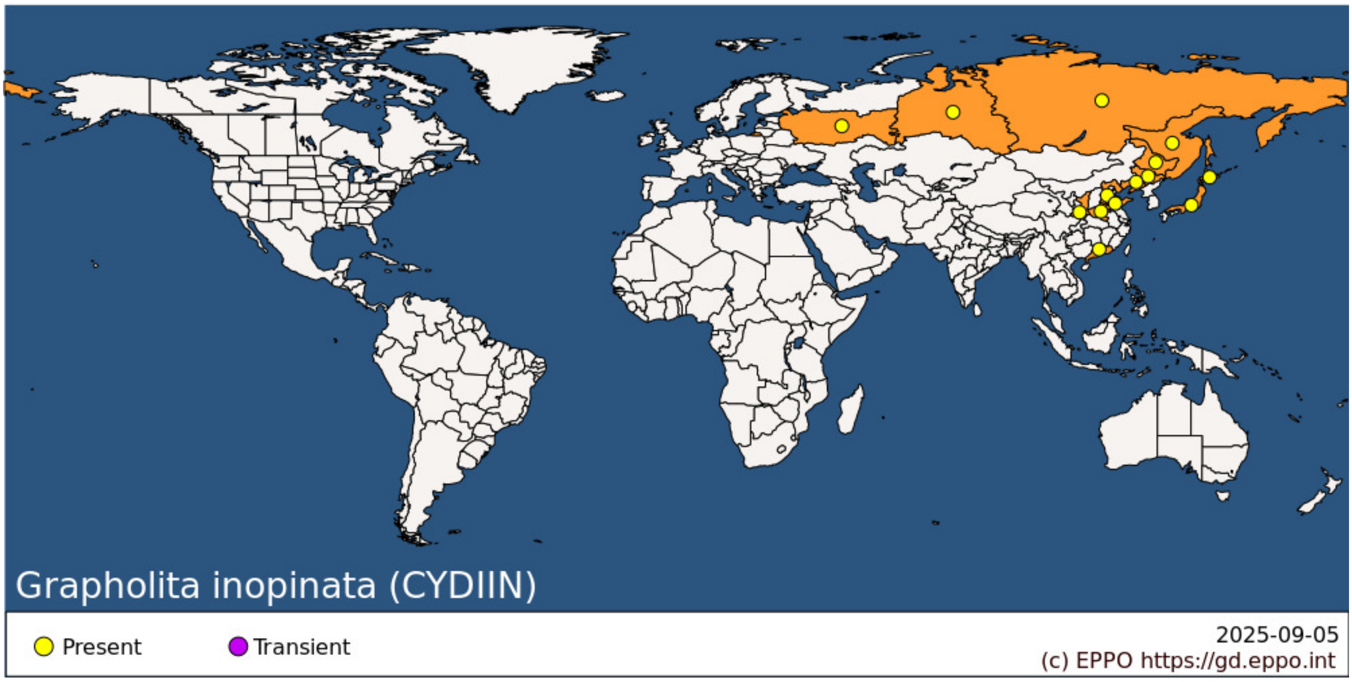
Grapholita inopinata's range covers a large territory of East Asia with the climate varying from subtropical in Southern China to continental in Siberia (Danilevsky & Kuznetsov, 1968).

In China the species is widely distributed across the eastern part of the country (Biosecurity Australia, 2010) but detailed reports are only available from a limited number of provinces: Liaoning Heilongjiang, Jilin Henan Hebei, Shandong and Guangdong.

The presence in the Korean peninsula is debated: Varshalovich (1966) mentioned that apples imported from ‘Korea’ to Russia contained larvae whose chaetotaxy corresponded to *G. inopinata*, however Bae & Park (1997) consider that *G. inopinata* is absent from South Korea and Byun *et al.* (2012) consider that it is absent from North Korea.

In Japan, the species is found in Northern Honshu (Tanake *et al.* 2005) and Hokkaido (Mizukos, 2006).

In Russia, the species is native in the Russian Far East: Primorsky krai, Amurskaya oblast, Yevreyskaya avtonomnaya oblast, Khabarovsky krai (up to Komsomosk-on-Amur as the northernmost point) (Tikhonov, 1962; Danilevsky & Kuznetsov, 1968; Gibanov & Sanin, 1971). In Eastern Siberia, it occurs in Transbaikalia (Buryatiya Republic and Zabayakalsky krai) (Lopatina, 1978). So far, it has not been found in Irkutsk oblast. In the 2010s, *G. inopinata* was detected in the area of Krasnoyarsk (on the eastern and the western banks of the River Yenisei) and further south in the area around Minusinsk and in the Khakassiya Republic (Akulov & Kirichenko, 2014). The presence of the species further west, i.e. in Western Siberia, at least in regions bordering Krasnoyarsk krai, is considered highly likely (Akulov & Kirichenko, 2014).



EPPO Region: Russian Federation (the) (Central Russia, Eastern Siberia, Far East, Western Siberia)
Asia: China (Guangdong, Hebei, Heilongjiang, Henan, Jilin, Liaoning, Shaanxi, Shandong), Japan (Hokkaido, Honshu)

BIOLOGY

The biology of *G. inopinata* is somewhat similar to that of *Cydia pomonella* (Akulov & Kirichenko, 2014). *G. inopinata* overwinters as pronymph in silk cocoons under the bark close to the bases of the main trunk (Gibanov & Sanin, 1971), in the soil or among dead leaves (Danilevsky & Kuznetsov, 1968). In colder regions, in Siberia, larvae overwinter in the leaf litter (Kolmakova, 1958). Overwintering in cocoons in fruit crates was also recorded (Gibanov & Sanin, 1971). Larvae are cold resistant and can withstand temperatures down to -41°C (Lopatina, 1978). Pupation occurs during the following spring and moths start emerging about one month later. In Transbaikalia, the first adults were documented to emerge in June (Lopatina, 1978). Unlike other related fruit-boring moths, the *G. inopinata* adults can remain active during daytime (Danilevsky & Kuznetsov, 1968). The period of emergence, flight and oviposition is protracted lasting up to 2 months in Transbaikalia (Kolmakova, 1958). Eggs are laid on the fruit surface (Tikhonov, 1962; Lopatina, 1978), and rarely on the lower side of leaves (Kolmakova, 1958). In Transbaikalia, up to 15 eggs per fruit were recorded; one female produces from 16 to 40 eggs (Lopatina, 1978). In the Russian Far East, the fecundity can reach 170 eggs per female (Kolmakova, 1958). Larvae hatch in 6-10 days (Tikhonov, 1962; Lopatina, 1978) and tunnel into the fruit at the point where the eggshell adjoins the fruit surface. For some time, the eggshell remains attached to the fruit protecting the entrance hole (Lopatina, 1978). The larva feeds in a chamber under the skin and later goes deeper to eat the surrounding fruit pulp, and moves to the core to consume seeds (Lopatina, 1978). Usually, one larva is present in a fruit (Lopatina, 1978), rarely 3-5 larvae per fruit (Wu & Huang, 1955). In Transbaikalia, larvae develop for 6-8 weeks and leave fruits in late August-September to overwinter (Gibanov & Sanin, 1971; Lopatina, 1978). There is only one generation per year in the Russian Far East and Siberia (Gibanov & Sanin, 1971; Akulov & Kirichenko, 2014). In Manchuria, there are two generations flying in May-June and August-September (Takizawa, 1936) which occur slightly earlier in Guangdong (Kondo & Miyahara, 1930). Larval development takes about 16 days for the first generation and 27 days for the second. The generations can overlap resulting in the presence of larvae in fruits during the whole season (Danilevsky & Kuznetsov, 1968).

DETECTION AND IDENTIFICATION

Symptoms

In apples, the young larva eats out a flat chamber under the fruit skin before moving to the fruit core (Kolmakova, 1958); the damaged area is recognizable as a reddish brown spot on the fruit surface (Wu & Huang, 1955). In small fruits, older larvae eat the seeds but not the seed coat (Lopatina, 1978). In large fruits, larvae feed upon the flesh and do not reach the seeds (Wu & Huang, 1955). Severely damaged fruits are deformed (Wu & Huang, 1955; Kolmakova, 1958). Damaged fruits are reported to contain frass (Danilevsky & Kuznetsov, 1968; Akulov & Kirichenko, 2014). However, according to Lopatina (1978) in Transbaikalia the fruits damaged by *G. inopinata* were free of frass because larvae did not cover the entrance hole with silk and frass spilled out through it. In apple cultivars known under the general name Reinette, which are widely distributed in Siberia, damaged fruits can remain on trees during whole winter together with intact fruits (Lopatina, 1978).

Morphology

Eggs

About 0.7 mm in diameter, round slightly flattened, white darkening to pinkish-brown (Kolmakova, 1958) or light-green (Lopatina, 1978).

Larva

The larva of *G. inopinata* is similar to that of *G. funebrana* (Akulov & Kirichenko, 2014; Akulov *et al.*, 2014). Matured larvae reach 10 mm length. They are pinkish with one red stripe on each segment dorsally and with red spots laterally (often missing in pupating larvae and in ethanol-preserved specimens); the head is brownish (Lubarskaya, 1964; Akulov & Kirichenko, 2014). The main morphological features of *G. inopinata* larvae are (1) a short seta on the mid-abdominal segments (the seta length is not longer than the distance from the stigma to the base of this seta), (2) the location of setae on the abdominal segments on separate shields, (3) the abdominal legs with 20–30 hooks, (4) the anal crest with 4-5 teeth. Larval chaetotaxy is detailed and illustrated in Akulov & Kirichenko (2014).

Pupa

The pupa has a broad band of numerous small spines on the first abdominal segment. The young pupa is light yellow, and darkens while maturing; the fully developed pupa is black (Lopatina, 1978).

Adult

Wingspan is 10-11 mm (Akulov & Kirichenko, 2014). Colour variously described as dark-brown with metallic lead-blue lines on the forewing (Danilevsky & Kuznetsov, 1968) or dark-grey with some purple lustre (Takizawa, 1936); top of the forewings with black dot, the outer edge of the forewings with unclear speculum with 3-4 black dots inside it; the hindwings are greyish-brown, somewhat paler than forewings (Akulov & Kirichenko, 2014). The habitus is similar to *Grapholita tenebrosana*, but genitalia are different (Wu & Huang, 1955). Male genitalia of *G. inopinata* are well described in Danilevsky & Kuznetsov (1968) and further detailed in Akulov & Kirichenko (2014). Valva relatively short and wide, curved at the middle. The cuculus large, more than a half of the valva length; its lower angle forms a small projection near the sacculus. The transverse fold separating the lower part of the cuculus from the main part of the valva is absent. Aedeagus is ½ length of valva, almost straight, very thin in distal part. Cornuti absent. The scales of coremati broadly lanceolate. The adult is illustrated in Wu & Huang (1955), Danilevsky & Kuznetsov (1968), forewing venation in Takizawa (1936) and Wu & Huang (1955), male genitalia in Danilevsky & Kuznetsov (1968) and Akulov & Kirichenko (2014).

Detection and inspection methods

Eggs can be spotted on fruit surface or on leaves using a magnifying glass. However, given the small size of eggs and their inconspicuous appearance, they can be easily overlooked; thus, it is not an effective measure for detection.

Apple fruits damaged by young larvae turn reddish brown in the damaged area. Fruits that are suspected to be infested can be cut into halves for further inspection. After harvest, non-invasive approaches, such as electromagnetic energy-based technologies, X-raying, thermography etc. were shown to be efficient to detect damage caused by larvae of fruit pests inside the fruits (larval tunnels, darkening of damaged area, frass etc.) in a short time for large number of fruits (Ekramirad *et al.*, 2016). These methods might also be effective for *G. inopinata* given their rapidity and the possibility to process many fruits. Fruits damaged by larvae that already vacated the fruits for pupation carry distinguishable signs – reddish-brown spots with dark harden (corked) exit hole that can be easily spotted at visual inspection (Akulov & Kirichenko, 2014). Li *et al*. (2011) provide a simple field key to distinguish 14 species of fruit boring insect pests (including *G. inopinata*) for northern China based on the host fruit, the age of the fruit, the position of the bore and recognisable pest features.

Adults of *G. inopinata* are attracted to the original pheromone synthesized for this species (Tanaka *et al.*, 2007), but they are also effectively attracted to the synthetic pheromone of *G. molesta* as the main component, (Z)-8-dodecenyl acetate, is common to both (Tanaka *et al.*, 2005; Akulov & Kirichenko, 2014). The attractiveness of *G. molesta* pheromone to *G. inopinata* was documented in field surveys in Japan in a low-density population (Tanaka *et al.*, 2005) and in Siberia (Russia) in a high-density population (Akulov & Kirichenko, 2014; Akulov *et al.*, 2014). In the latter case, 6323 out of 6949 moth individuals (i.e. 91%) captured in pheromone traps with *G. molesta*'s pheromone were *G. inopinata* (Akulov *et al.*, 2014).

Light trapping is not appropriate as adults seem not to be attracted to light (Lopatina, 1978).

PATHWAYS FOR MOVEMENT

G. inopinata can disperse locally by adult flight; the maximal distance that adults can cover is, however, not defined. In international trade, the species might be carried as larvae in fresh fruit or as larvae and pupae. in fruit crates. It can also be accidently introduced with planting material (carrying fruits and leaves with eggs or larvae). The species has not yet been intercepted in the EU (EFSA, 2018) but trade from infested areas has been minimal.

PEST SIGNIFICANCE

Economic impact

The damage caused by *G. inopinata* is rather similar to that of the pan-European *Cydia pomonella*. Both species occur in the Far East of Russia, where *C. pomonella* damages a larger proportion of apples than *G. inopinata*, though the latter remains a significant pest, damaging up to 35% of the apple crops in Khabarovsky krai (Kuznetsov, 1986) and up to 65% in Yevreyskaya avtonomnaya oblast (Lubarskaya, 1964). Damage from *G. inopinata* can reach 100% on apples in Transbaikalia (Kolmakova, 1958; Lopatina, 1978). Noticeable damage can also be caused to apple cultivars which are widely planted as ornamentals in urban areas and as orchard trees with edible fruits in private gardens in Siberia (Akulov & Kirichenko, 2014).

In Northeast China, *G. inopinata* was reported to cause a higher impact on apple orchards than *G. molesta* in the past (Kondo & Miyahara, 1930). However, in the last decade, many more scientific articles have been published on *G. molesta* than on *G. inopinata* in Chinese. Inadequately managed orchards can lose up to 50% of apple fruits due to fruit boring insects including *G. inopinata* (Kondo & Miyahara, 1930; Hang *et al.*, 2000, Fan *et al*., 2019). The pest also causes damage in pear orchards (Biosecurity New Zealand, 2009).

In Japan, *G. inopinata* seems not to be a pest of an economic importance as it is recorded rarely compared to other fruit boring pests (Tanaka *et al.*, 2005; Mizukos, 2006).

G. inopinata is a quarantine pest in a number of countries worldwide and its presence may therefore restrict import markets (Biosecurity Australia, 2010; Biosecurity New Zealand, 2009).

Control

No recent data on control has been found in the literature. In the last century, insecticides used on the hatching larvae helped protect up to 98% of fruits, as documented in the Russian Far East (Gibanov & Sanin, 1971). The use of insecticides in the period when larvae have already entered the fruits (with the eggshell still attached to the fruit protecting the entrance hole) is not efficient (Lopatina, 1978). Aerial insecticide treatments of orchards during the period of adult emergence was also practiced (Lubarskaya, 1964).

Mechanical methods were also applied in the past. The removal of old semi-detached bark from the lower part of the main trunk, where larvae can overwinter, in autumn, as well as double ploughing leaf litter and soil between the rows of apple trees during the pupation period of *G. inopinata* caused a significant reduction in the number of emerged adults the next season (Gibanov & Sanin, 1971).

In China, fruits are bagged during the growing season to protect them from a range of fruit borers including *G. inopinata* (Biosecurity Australia, 2010; EFSA, 2018; Fan *et al.*, 2019).

Mass-trapping of *G. inopinata* can be done with the use of sticky traps supplied with the specific pheromone as is done for *C. pomonella* (Jaffe *et al.*, 2018).

In Manchuria (China), the parasitoids from the genera *Phaedroctonus* and *Mesochorus* (Ichneumonidae) were reared from *G. inopinata* larvae (Takizawa, 1936). Furthermore, two parasitoids of larvae are listed for *G. inopinata*: *Nemeritis* sp. and *Campoplex grapholithae* (the latter also attacks pupae) (CABI, 2021). In Transbaikalia (Russia), eggs were heavily parasitized by *Trichogramma embryophagum* (Trichogrammatidae) (Kolmakova, 1965). A parasitoid, *Trichogramma sibiricus* reared from eggs of *G. inopinata* in Transbaikalia was described (Sorokina, 1981), but no data was provided on its efficiency to control the pest. Overall, there is no information on biological control measures as such.

Phytosanitary risk

Apples and pears are important crops in the EPPO region. Considering the current range of the pest, it is likely that *G. inopinata* could establish and spread if it was introduced in EPPO countries where it is not yet present, and cause damage. Integrated Pest Management (IPM) is applied for apples and pears in the EPPO region and measures applied against similar pests (e.g. *Cydia pomonella*) may limit the impact of *G. inopinata* but IPM programmes need to be modified to adapt them to *G. inopinata* (e.g. the timing of application of insecticides).

PHYTOSANITARY MEASURES

Fruits of *Malus* and *Pyrus* from countries where *G. inopinata* occurs should be found free from the pest. This can be achieved if the fruits come from a pest-free area; or by monitoring orchards during production and applying control measures or bagging fruits during the growing season, and inspecting the fruit before export. It should be also ensured that fruit crates are free of pupating larvae and/or pupae. Plants for planting of these genera from East Asia should not carry fruits and leaves and be free from soil. Overwintering pupae are unlikely to be in the bark of young plants.

Additional possible measures could include the use of ionization to kill the pest in fruits; the treatment of fruits in controlled atmosphere (modified gas atmosphere, temperature and pressure conditions), as well as use of cultivars resistant to the pest (EFSA, 2018).

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Datasheet history

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