EPPO Datasheet: *Epitrix papa*

Last updated: 2020-07-24

IDENTITY

Preferred name: *Epitrix papa*
Authority: Orlova-Bienkowskaja
Taxonomic position: Animalia: Arthropoda: Hexapoda: Insecta: Coleoptera: Chrysomelidae
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EPPO Categorization: A2 list
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EU Categorization: Emergency measures
EPPO Code: EPIXPP

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Notes on taxonomy and nomenclature

Flea beetles are classified by some authors in a separate subfamily (Alticinae) of the family Chrysomelidae, but others place the group in a tribe (Alticini) of the subfamily Galerucinae. The genus *Epitrix* Foudras comprises to date 162 described flea beetle species worldwide (Bienkowski & Orlova-Bienkowskaja, 2017), and many undescribed species (Deczynski, 2016). The majority of the described *Epitrix* species are of American origin (Döberl, 2000) and most are native to the neotropics (Deczynski, 2016). A few *Epitrix* species are associated with potato, such as the north American species *Epitrix tuberis* (tuber flea beetle), *E. cucumeris* (potato flea beetle), *E. similaris* (no common name), *E. subcrinita* (western potato flea beetle) (Gentner, 1944), and the south American species *E. yanazara*, *E. ubaquensis* and *E. hilariana rubia* (collectively named 'pulguilla saltona') (Alcázar, 1997).

Epitrix papa Orlova-Bienkowskaja was initially misidentified in 2009 as the North-American species *E. similaris* (Doguet, 2009; Boavida & Germain, 2009) but in 2015 was found to be a new species, following a taxonomic revision of the described Holarctic *Epitrix* species (Orlova-Bienkowskaja, 2015). Consequently, the data published prior to 2015 on the Portuguese and Spanish flea beetle *E. similaris*, in fact relate to *E. papa*.

In Portugal, *E. papa* is often found together with *E. cucumeris* and reported collectively as *Epitrix* spp. given the impossibility of distinguishing the species in the field.

HOSTS

E. papa is associated with solanaceous hosts, as is the case for all other *Epitrix* species, the adults feeding on the foliage and the larvae on the roots (Doguet, 1994). The adults of *E. papa* may feed temporarily on plants from other botanical families when they do not have access to their solanaceous hosts, but no records exist on the possibility of larval development on non-solanaceous plants.

The most economically important host for *E. papa* is potato (*Solanum tuberosum*). In Portugal *E. papa* has also been observed on aubergine crops (*Solanum melongena*) but damage on this crop is not important and only leaves are affected (Boavida *et al.*, 2013). Other solanaceous host plants include common weeds such as black nightshade (*Solanum nigrum*), jimsonweed (*Datura stramonium*) (Boavida *et al.*, 2013) and cutleaf nightshade (*Solanum triflorum*) (Boavida & Germain, 2009). All these secondary host plant species are important food sources for the survival of *E. papa* populations when potato is not available (Boavida *et al.*, 2019), and the same applies to plants from different botanical families where the adults may feed temporarily, such as *Chenopodium* sp. (Amaranthaceae) recorded by Oliveira *et al.* (2008).

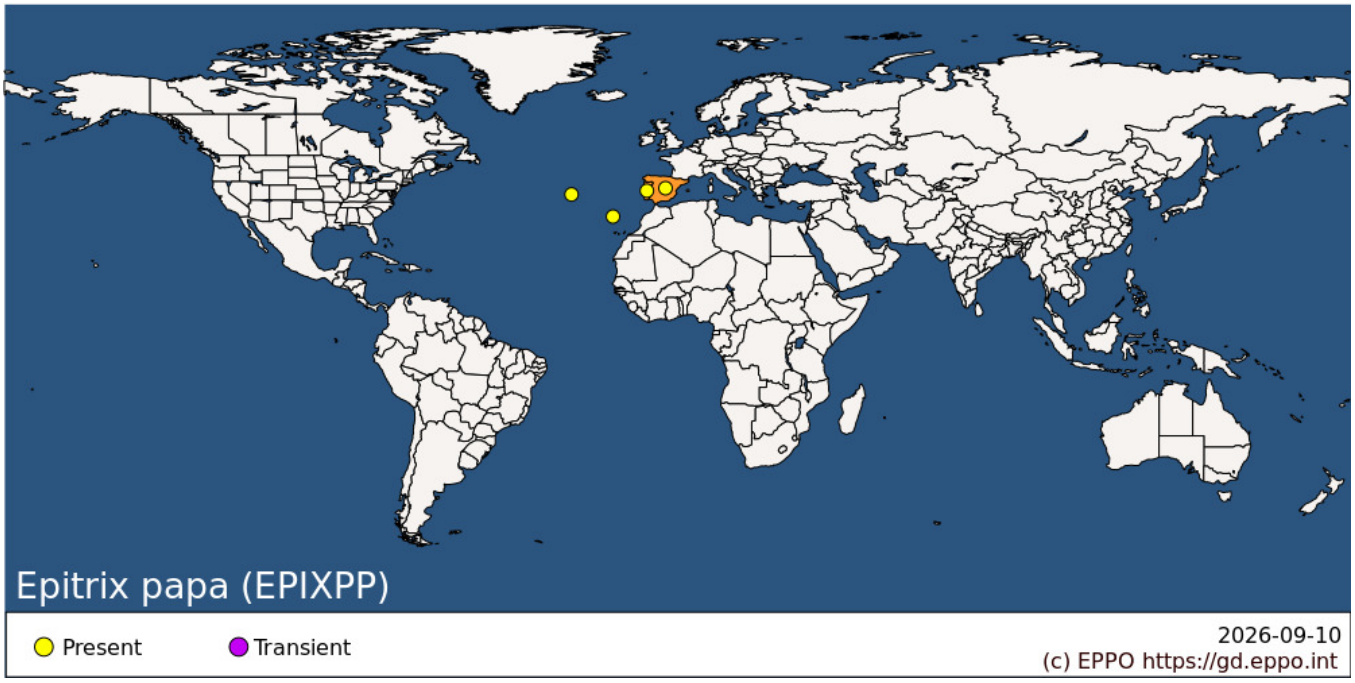
However, these different host plant species are not equally suitable for the multiplication of *E. papa*, as demonstrated in laboratory experiments. In these experiments, *E. papa* produced the highest number of offspring on potato and on

black nightshade, followed by aubergine and jimsonweed, with the lowest number of offspring produced on tomato (*Solanum lycopersicum*), and no reproduction on sweet pepper (*Capsicum annuum*) (Boavida *et al.*, 2013).

Host list: *Chenopodium sp.*, *Datura stramonium*, *Solanum lycopersicum*, *Solanum melongena*, *Solanum nigrum*, *Solanum triflorum*, *Solanum tuberosum*

GEOGRAPHICAL DISTRIBUTION

The origin and native distribution of *E. papa* are unknown (Orlova-Bienkowskaja, 2015). In Portugal, *E. papa* is supposed to have been introduced around 2004 in the North of Portugal (Oporto), but remained unnoticed until 2008, when it was detected in two important potato cropping zones in the centre of Portugal (Centro and Lisboa e Vale do Tejo) (Oliveira *et al.*, 2008; Boavida & Germain, 2009). In Spain, *E. papa* was first detected in 2008 in Galicia, close to the Portuguese border (Boavida & Germain, 2009).



EPPO Region: Portugal (mainland, Azores, Madeira), Spain (mainland)

BIOLOGY

The life cycle of *E. papa* is similar to those of the economically important American tuber flea beetle species, *E. tuberis* and *E. yanazara* (Hoerner & Gillette, 1928; Hill & Tate, 1942; Alcázar, 1997). The adults overwinter in and around the fields where they developed, buried in the soil or under leaf litter and other debris. They become active at the end of winter, when the temperature warms up, leave their winter refuges and start feeding on alternative host plant species available, until the potato plants develop. The emergence of the overwintered adults is gradual, and may start in early March (Boavida *et al.*, 2019) or later in April (MAPAMA, 2017) depending on the climate. When they find a potato plantation, the overwintered adults settle on the potato plants, feed, and mate. After a pre-oviposition period, the female lays eggs below the soil surface, close to the stems of the potato plants. After the eggs hatch, the larvae move to the roots for feeding. When fully-grown, larvae stop feeding, move away from the root zone, to build a pupation chamber with soil particles in which the insect transforms into an adult. After emerging from the soil, the adults of the first generation feed on the foliage of the potato or other host-plants and multiply, to produce the second generation.

The biology of *E. papa* was studied in the laboratory at different temperatures. The development time from egg to adult was 102 days at 15ºC, 48 days at 20ºC, 34 days at 25ºC and 30 days at 30ºC (Boavida *et al.*, 2019). The mean preoviposition period ranged from 20 to 7 days, the oviposition period from 115 to 44 days, and the females

fecundity from 64 to 190 eggs, at 15ºC and 25ºC respectively.

From these data, a degree-day model of developmental rates as a function of temperature was calculated, allowing an estimation of the lower limit for completion of one *E. papa* generation as 625 degree-days above 8.1 °C (Boavida *et al.*, 2019). Based on this model, three complete generations per year and a partial fourth are possible in most cropping zones of Portugal. The first generation of *E. papa* is expected to develop from egg to adult in a minimum of 7 weeks, and the following generations will develop much faster, in 4-5 weeks. The first generation larvae develop from April to late May, mostly on seed potatoes, small immature tubers and roots of early planted crops, while the larvae of the second generation develop from mid June onwards, hence developing mostly on maturing tubers of mid- and late season crops. The second larval generation is more damaging than the first one, because the second generation larvae are more abundant and also because the feeding wounds caused by the larvae on the maturing tubers in the process of skin suberization are deeper and remain conspicuous until harvest, whereas the lesions caused on small developing tubers are frequently blurred into the skin during the process of tuber growth. The larvae of the third generation develop on alternate hosts from mid August onwards, a period when most of the potato crops have been harvested, and therefore the larvae of this generation do not represent in most cases a threat for potato production.

E. papa adults disperse by flight, jumping and walking.

DETECTION AND IDENTIFICATION

Symptoms

Both larvae and adults have chewing mouthparts. The adults riddle the leaves with small circular holes (1.0-1.5 mm diameter) that produce the characteristic ‘shot-hole’ symptom in the potato foliage, which is common to all flea beetles. The adult insects can be detected on the foliage, and jump promptly when approached. On windy days, they are less active.

The types of tuber injury caused by larval feeding are similar to those caused by *E. tuberis*. The larva may tunnel underneath the skin, producing winding superficial trails, called ‘worm-tracks’ or ‘serpentines’ (Gentner, 1944; Boavida *et al.*, 2013). They may also feed from the outside, burrowing into the flesh, almost at a right angle to the surface, causing a dark splinter full of corky material which mostly penetrates up to 3 mm but may reach 9 mm (Boavida *et al.*, 2013). This type of injury is similar to the one described for *E. tuberis* in the USA as a ‘sliver’ (Gentner, 1944; Morrison *et al.*, 1967). ‘Slivers’ may show on the tuber’s surface as a black point, or a raised rugose elevation in the skin (‘pimples’). Rough skin, and scab-like lesions are sometimes observed in association with the larval attack of *E. papa.* Tuber flea beetle lesions have been claimed to favour the penetration of different pathogens, and Schaal (1934) demonstrated that *E. tuberis* larvae could transmit the common scab fungus (*Streptomyces scabies*) from the soil into the tubers. This may also be the case for *E. papa.*

Morphology

The genus *Epitrix* is a group of small flea beetles with uniform appearance which can be recognized by the presence of elytral punctures arranged into rows, and characteristic rows of erect setae on the intervals (Döberl, 2000; EPPO, 2017). The morphological identification to species is made by specialists, on the basis of the *habitus* and *genitalia* of the adult insects. The identification keys and illustrations presented in EPPO Standard PM 7/109 (2) (EPPO, 2017) and Orlova-Bienkowskaja (2015) allow *E. papa* to be distinguished from the related potato species *E. cucumeris*, *E. tuberis* and *E. subcrinita*.

Eggs

The eggs are elliptical, white, with a reticulate surface, approximately 0.5 mm in length and 0.2 mm in width.

Larva

The newly hatched larva is white in colour, threadlike, and approximately 1.0 mm long. The full-grown larva is white, with the head and thoracic shield light brown, and approximately 5 mm in length.

Pupa

The pupa is pearly white and approximately 2.5 mm long and 1.5 mm wide.

Adult

The adults are small black beetles with a weak bronze reflection, rows of short white hairs along the elytra, 1.7-2.2 mm long. The hind femurs are enlarged, adapted to jumping.

Detection and inspection methods

Detection is made by visual inspection of the foliage of potato or other host plants, looking for shot-hole symptoms and adult flea beetles. On potato, the tubers are inspected visually for symptoms of larval injury (EFSA, 2019). The 'worm-track' type of injury is the most easily recognizable. The 'slivers' are best detected if the potato tubers are peeled with a knife.

The identification of the species requires the collection of insect specimens for analysis. Adult specimens may be collected with a sweep-net or with a mouth aspirator. The larvae are very difficult to detect and collect because of their small size and translucent colour, and also because of their feeding behaviour. When present at potato harvest, some larvae may be hidden inside the 'worm tracks', and others may expose the terminal part of their abdomens protruding outside the tuber, while feeding.

The identification of all *E. papa* stages can be made reliably by non-specialists, using molecular methods (DNA barcoding on cytochrome c oxidase subunit I (COI) gene) (Germain *et al*., 2013; Mouttet *et al.*, 2019). The reference sequences of these species are available in EPPO-Q-bank and BOLD databases.

PATHWAYS FOR MOVEMENT

The origin of *E. papa* and the pathway for its introduction in Portugal are unknown. The adults disperse naturally by flight, walking and jumping, but long distance spread is through the commercial transport of seed or ware potato tubers, when associated with soil and plant debris (EPPO, 2016; 2017).

When potatoes are harvested from an infested field, adults and pupae of *E. papa* may be present in the stubble and soil, and larvae in the tubers. Adult beetles may be carried passively on the surface of potatoes, or with the soil adhering to potato tubers. This possibility would be higher in exports of seed potatoes, because potatoes are not washed. At harvest, larvae present inside well suberized 'worm-tracks' may be transported with the tuber, however no data exists on the possibility of these larvae surviving and completing development. By contrast, larvae feeding outside the tuber escape rapidly and hence will not be transported.

PEST SIGNIFICANCE

Economic impact

The 'worm-track' lesions caused by the larvae of *E. papa* are mostly superficial and do not affect the tuber's quality, but have a marked negative visual impact in certain trade markets, which may result in the rejection or the commercial downgrading of the potato exports (Oliveira *et al.*, 2008; Vernon & Herk, 2017). When present, 'slivers' oblige deeper peeling of the potatoes before consumption, and may cause some production losses. In Canada, a potato lot is commercially downgraded when more than 5% of the tubers are injured by *E. tuberis* (EPPO, 2011). To prevent economic damage, the crops are treated with insecticides, which increases the production costs (Vernon & Herk, 2017). In the countries where *E. papa* is reported, official eradication and containment measures are implemented, which include insecticide treatments targeting specifically *Epitrix* species, and brushing / washing the harvested tubers to remove the pest and the soil (EU, 2018). The related costs represent an additional burden to the crop's production, and the recommended early season insecticide sprays pose a risk to the pollinating fauna.

The reduction of the leaf area by adult feeding is not expected to have an important impact on yield, because it can be compensated for by the fast growth of the potato plants, as demonstrated experimentally by Senanayake *et al.* (1993) for *E. cucumeris*.

Control

There are no published records of efficient natural enemies of *E. papa.*

Without control measures, and with favourable climatic conditions, *E. papa* can multiply rapidly to damaging population levels (Oliveira *et al.*, 2008), in particular in zones with an extended potato growing season, allowing the development of two complete generations in its preferred host (Boavida *et al.*, 2019). In Portugal and Spain, the populations of *E papa* were drastically reduced after the pest was identified and control measures were implemented. The control strategy is based on the IPM program carried out in Canada against *E. tuberis* (Vernon & Herk, 2017). This program combines cultural measures, for reducing the population of overwintered adults, with insecticide treatments. The cultural measures are the cornerstone of the strategy and include the destruction of overwintering places, the rotation with non-solanaceous crops, and when feasible, the adaptation of the planting schedules (Hoerner & Gillette, 1928; Vernon & Herk, 2017). A 3-year potato rotation is recommended to avoid the on-site overwintering of the beetles, together with the destruction of potato culls and volunteers. In Canada, the need for insecticide treatments against the related species *E. tuberis* is decided on the basis of weekly estimations of the population density of the adults on the plants, by visual inspection of the foliage until the plants are 30 cm tall and later with a sweep net (Vernon & Herk, 2017). Based on experience, a national regulatory control system for *Epitrix* species damaging potato tubers was developed (EPPO, 2016). No damage thresholds exist yet for *E. papa* and the mandatory treatments in the demarcated areas of Portugal and Spain stipulated by the Commission Implementing Decision 2012/270/EU of 16 May 2012 (EU, 2018) are recommended to start very early in the season, as soon as the overwintered beetles start colonizing the early potato crops (DGAV, 2018; 2019; MAPAMA, 2019). The negative impact of these early season treatments on beneficial insects can be mitigated if the treatments are directed to specific spots or rows infested by the beetles, avoiding spraying the entire field. Indeed, in well rotated fields the overwintered colonizing beetles tend to settle and feed initially on the border rows of the crop (Cusson *et al.*, 1990).

Phytosanitary risk

The present distribution of *E. papa* in Portugal and Spain indicates that the species could establish in at least the Mediterranean Basin (EPPO, 2011). Distribution models based on climatic variables of the currently known distribution of *E. papa* indicate that the species would not find suitable climatic conditions in northern parts of the EPPO region, namely in Norway (VKM, 2019). However, according to a degree-day model of developmental rates as a function of temperature (Boavida *et al.*, 2019), the area potentially at risk of establishment would be larger, and would include a few regions located in southern Norway (VKM, 2019).

Since *E. papa* can be controlled chemically, its presence could lead to a generalized use of insecticides on potato, rather than the occasionally targeted use against *Leptinotarsa decemlineata*, as at present in most EPPO countries. The problem would arise even more acutely in countries where *L. decemlineata* has not been introduced (EPPO, 2011). Furthermore, the control of *E. papa* could be critical in several EPPO countries, namely in a majority of the EU countries, where insecticides used in North America are no longer authorized.

PHYTOSANITARY MEASURES

The import of seed potatoes from third countries is prohibited in several EPPO Countries, namely in the EU (EU, 2016), but sometimes authorized under derogation procedures, e.g. from Canada into the EU (EU, 2003).

Following the risks identified in a Pest Risk Analysis carried out by EPPO on *Epitrix* species damaging to potato tubers (EPPO 2011), specific requirements related to *E. cucumeris*, *E. papa*, *E. subcrinita* and *E. tuberis* are recommended in the EPPO potato Standard PM 8/1 (EPPO, 2017b) for the international trade of seed (except micropropagative material and minitubers) and ware potatoes. This Standard recommends that seed potatoes should be washed or brushed so that they are free from plant debris and have no more than 0.1% w/w of soil remaining, and

where appropriate subject to transitional arrangements (pest-free area for *E. papa* and origin from a pest-free potato production and distribution system for the pest, according to EPPO Standard PM 3/61 (2) (EPPO, 2019)). For ware potatoes this Standard recommends that either (a) measures as described in EPPO Standard PM 9/22 (EPPO, 2016) for *E. papa* should have been implemented to ensure that there is no risk of spreading this pest, or (b) that there should be absence of plant debris and no more than 0.1% w/w of soil present.

Additional requirements are recommended for soil or growing medium attached to rooted host plants from countries where *E. papa* occurs (removal of soil and growing media, or production in a pest free area, or in a pest-free place under protected conditions, or production under screened greenhouse conditions with appropriate monitoring in the framework of a bilateral agreement) (EPPO, 2011).

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