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Thaumatotibia leucotreta and *Epiphyas postvittana* found in Italy, invasive pests in Europe (Lepidoptera Tortricidae)

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Abstract

The paper reports observations on the distribution, host plants, morphology, and biology related to the false codling moth *Thaumatotibia leucotreta* (Meyrick) and the light brown apple moth *Epiphyas postvittana* (Walker), two invasive tortricid pests recently intercepted in Italy. Because the eggs, larvae, and pupae can be associated with fruit and plant material, as well as readily transported, vigilance and early detection methods are critical to minimise the probability of these species' introduction and establishment in Southern Europe.

Key words: Lepidoptera Tortricidae, *Thaumatotibia leucotreta*, *Epiphyas postvittana*, invasive pests, Italy.

Introduction

This paper reports observations on the distribution, host plants, morphology, and biology related to *Thaumatotibia leucotreta* (Meyrick 1913) and *Epiphyas postvittana* (Walker 1863), two invasive tortricid pests recently found in Italy. The first moth is an important pest to control because it is highly polyphagous on wild and cultivated plants in Africa; the second is very harmful to apples, citrus fruits, and grapes in Australia and New Zealand. The information provided is relevant for anyone involved in the identification, exclusion, detection, and control of these pest species.

Thaumatotibia leucotreta (Meyrick 1913)

Material examined. 3 adults, January 14, 2022, obtained from larvae infesting mandarins imported from Eritrea, Africa.

T. leucotreta, known as the false codling moth (FCM) in Africa, is an important tortricid pest to control because it is highly polyphagous on fruit and cultivated plants. Larvae are reported to feed on more than 50 species of plants in 30 families (van der Geest *et al*., 1991; Gilligan *et al*., 2011). The species is a serious citrus pest in southern and central Africa. Larvae feed within the fruit and often show little external sign of attack. Feeding damage can also lead to the development of secondary infections mediated by fungi and bacteria.

T. leucotreta is widely distributed throughout sub-Saharan Africa and has been reported in approximately 40 countries on the continent. It is not considered established outside of Africa, although it is commonly intercepted during quarantine inspections in various European countries (CABI, 2022). In trade destined to the EU, it is most often intercepted on *Capsicum* spp., *Citrus* spp., *Solanum melongena* L., and *Rosa* spp. (European Plant Protection Organization, EPPO, 2019).

The insect was added to the EPPO A2 List because it was locally present in Israel where it was found in 1984 on macadamia nuts (Proteaceae) (EPPO, 2013). It is listed in the EU categorisation as an A1 quarantine pest - Annex II A (EPPO, 2023).

In 2009, *T. leucotreta* was detected in the Netherlands on glasshouse-grown *Capsicum chinense* Jacq. and was subsequently eradicated (CABI, 2022). In the last few years, the insect has occasionally been intercepted in Finland, Sweden, Denmark, the United Kingdom, Belgium, Germany, France, and Spain (Agassiz *et al*., 2013; EPPO, 2013; Rogard, 2015; Haslberger and Segerer, 2016).

The finding on January 14, 2022, was the second detection of the pest in Italy after an interception of infested navel oranges (*Citrus sinensis* L. Osbeck), the fruit arrived at the port of Leghorn from South Africa (Mazza *et al*., 2014).

At USA ports of entry, the false codling moth is one of the most commonly intercepted tortricids on pepper (*Capsicum annuum* L.) and eggplant (*Solanum melongena* L.) (Venette *et al*., 2003; Gilligan *et al*., 2011; EPPO, 2019).

Morphological characters

Adults. Male adult specimens (figure 1A) are 7-8 mm, whereas females are 9-10 mm, the wingspan can range between 15-20 mm. Head, thorax, and abdomen are dark brown. The forewing is dark greyish brown, patterned with reddish brown and black speckles, and the most distinctive features of the complex pattern are darker marks in the apical region and a small white discal spot. The hindwing is dark greyish brown. Males are easily distinguished by a semicircular pocket of opalescent scales at the distal end of vein CuA2 and tufts of modified scales on the hind tibia.

Male genitalia (figure 1B) are characterised by a rounded tegumen, large rounded valvae, and a tapered phallus that is upcurved distally. Female genitalia (figure 1C) are characterised by a semicircular sterigma, narrow ductus bursae, and large rounded corpus bursae with a pair of signa.

Egg. Eggs are flat and oval shaped with a granulated surface. They are white to cream coloured when initially laid, and then change to a reddish colour before the black head capsule of the larvae becomes visible under the chorion.

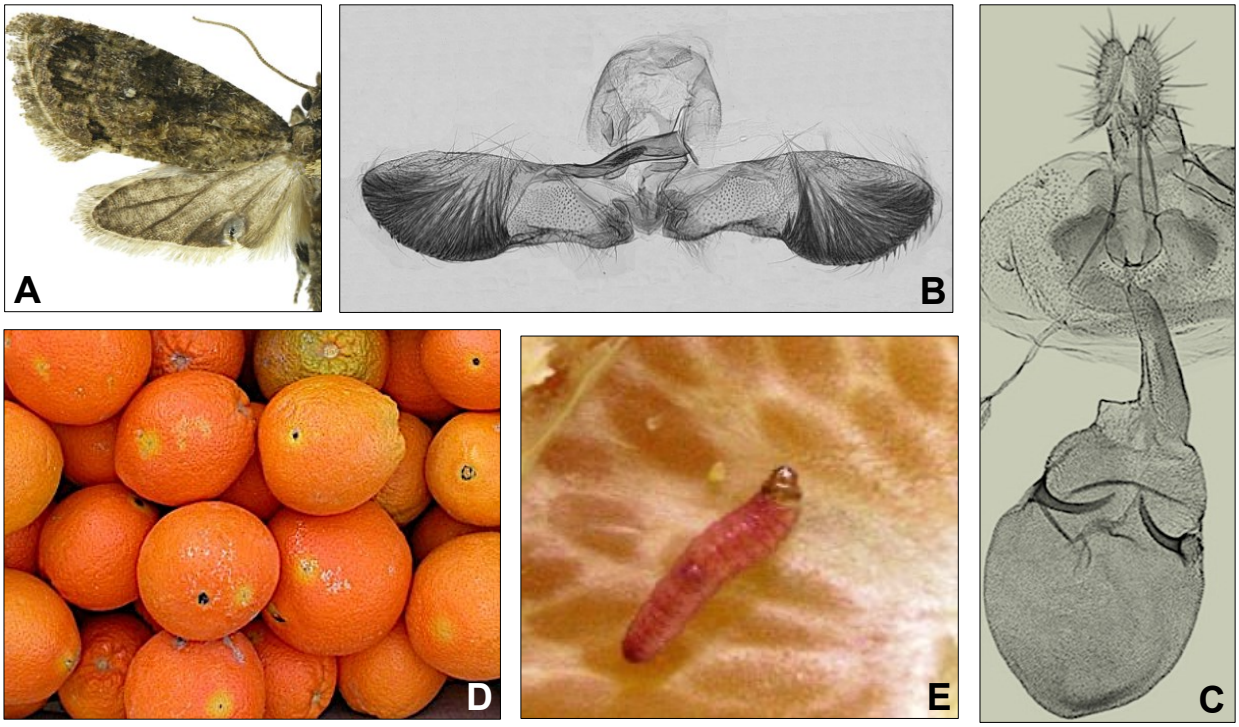

Figure 1. *Thaumatotibia leucotreta*: adult male (**A**); male genitalia (**B**); female genitalia (**C**); fruits of citrus damaged (**D**); larva in fruit of citrus (**E**).

Larva. The body length of mature larvae (figure 1E) is 15 mm. The head is yellowish brown to brown, and the body is pinkish or orange-red in the final instar, showing a paler shade below the spiracular line. The prothoracic and anal plates are brown (for chaetotaxy see Komai, 1999).

Pupa. The body length of pupa is 6-10 mm. They are pale yellowish-brown to reddish-brown, inside a lightly woven silk.

Biology

Eggs of *T. leucotreta* are laid singly or in small groups on developing fruits, and newly hatched larvae bore through the skin to feed on the flesh (figures 1D and 1E). Fruit often has a distinct sunken brown patch on the skin marking the entry point of the larvae, but it is not always obvious. In their natural habitat, last instar larvae leave the fruits or boll, drop from the host plant, and pupate in silken cocoons amongst debris or in cracks in the ground. *T. leucotreta* is a polyvoltine species; as many as 10 generations are possible per year in South Africa (EPPO, 2013).

Prevention and control

Visual inspection of plant materials may be used to detect eggs, larvae, and adults of *T. leucotreta.* Eggs will commonly be found on fruits, foliage, and occasionally on branches. Larvae in fruits and berries can affect fruit development at any stage, causing premature ripening and fruit drop, as well as secondary infection by fungi.

For early detection surveys of adults in stone fruit, fields in close proximity to high-risk areas such as citrus should be monitored utilising pheromone traps. Males of *T. leucotreta* are attracted to a blend of (*E*)-8-dodecenyl acetate and (*Z*)-8-dodecenyl acetate (El-Sayed, 2023). As prevention, the sanitation, removal and destruction of dropped fruit and infected hosts are important.

Chemical control of the species is difficult due to the highly polyphagous, internal feeding larvae. Control of false codling moth in South Africa is achieved through an Integrated Pest Management (IPM) combination of chemical control, mating disruption, attract-and-kill approaches, natural enemies, and sterile insect techniques (Adom *et al*., 2021; CABI, 2022).

Epiphyas postvittana (Walker 1863)

Material examined. 4 males, Bernalda (Metaponto area, Matera), 19 September 2022, in pheromone traps for *Platynota stultana* Walsingham (Lepidoptera Tortricidae), leg. P. Trematerra.

E. postvittana, the light brown apple moth (LBAM), is a polyphagous species that is an important pest to control on apples, citrus fruits, and grapes in Australia and New Zealand. The moths scar fruit and attack many other plants, including strawberries and pears as well as other horticultural crops. It is also considered a pest of some conifers (CABI, 2022).

E. postvittana was introduced in the United Kingdom in the 1930s (Baker, 1968), from where it may have colonised Ireland (Bond, 1998), as well as northwest France in 2000 (Cosson, 2009), while scattered records exist from the Netherlands (Wolschrijn and Kuchlein, 2006) and Sweden (Svensson, 2009). More recently, it has been recorded in the extreme south of Spain (Cadiz) by Gaona *et al*. (2020) and in Portugal mainland (at Sintra, near Lisbon) by Marabuto (2022). New Caledonia and Hawaii

have also been colonised (Danthanarayana, 1975), as well as California (Varela *et al*., 2008; Brown *et al*., 2010) and the Azores (Vieira and Karsholt, 2010; Pérez Santa-Rita *et al*., 2018).

Light brown apple moth has been recorded from more than 545 plant species in 121 families and 363 genera (Brockerhoff *et al*., 2011; CABI, 2022; EPPO, 2023), although larvae prefer herbaceous plants over woody ones. The larvae feed on the leaves, shoots, flowers, and fruit of its hosts, but most economic damage is caused by lesions on the surface of the fruit in contact with the leaves, which cause scarring and provide sites for secondary infections and rot development.

In our case, we found the males of *E. postvittana* in pheromone traps for monitoring of *P. stultana*, baited with a mixture of (*E*)(*Z*)-11-tetradecenyl acetate, in an area where local agriculture products include fruits, vegetables, and the Aglianico grape used to produce the wine of the same name.

E. postvittana has a potential economic importance (EPPO, 2022). The diffusion of the species and the discovery in Italy proves his climatic suitability of Southwestern Europe and in particular of the western coastal areas of the continent for the establishment of the species.

Morphological characters

Adult (figure 2A). Wingspan 19 mm male, 24 mm female. Head, thorax and abdomen rust-brown. The colour varies from rust-brown to pale yellow with brown to dark brown markings, sometimes reticulated with brown. Males are more variable than females. Cilia light reddish brown. Hindwing grey with cilia paler. The female colour is comparatively uniform, with a poorly defined median fascia and more speckled appearance than in males.

Male genitalia (figure 2B) are distinctive: spatulate uncus; reduced socii; short valve with a broad sacculus; membranous lobe on the apex of the valve (the most diagnostic feature); phallus with 2-4 deciduous cornuti. Female genitalia (figure 2C) have simple sterigma; long, straight ductus bursae which is 2/3 or more the length of the abdomen; and corpus bursae with a single, hook-shaped signum (Gilligan and Epstein, 2009).

Egg. Eggs of *E. postvittana* are flat and broadly oval; are regularly overlapped, shingle-like (imbricate) laid on upper surface of leaves. When newly laid, the eggs are light green, pale yellow to white and translucent; the embryos become visible as incubation proceeds (Peterson, 1965).

Larva (figure 2E). First-third instars larvae have dark head and light-coloured body; succeeding instars have body pale yellowish green darker dorsally, than fully grown larvae. The head, prothoracic shield, legs, and anal plate are greenish pale brown. Mature larvae range from 10 to 20 mm in length (for chaetotaxy see Brown *et al*., 2010).

Pupa. The pupa of *E. postvittana* is greenish brown initially and turns reddish-brown to dark brown when fully hardened. The average length of pupa is 8 to 10 mm.

Biology

E. postvittana completes 2-4 generations annually over much of its range, depending on temperature and latitude. The upper and lower temperature thresholds for development in laboratory studies are 7.5 and 31 °C; 20 °C is the optimum for development (Danthanarayana, 1975).

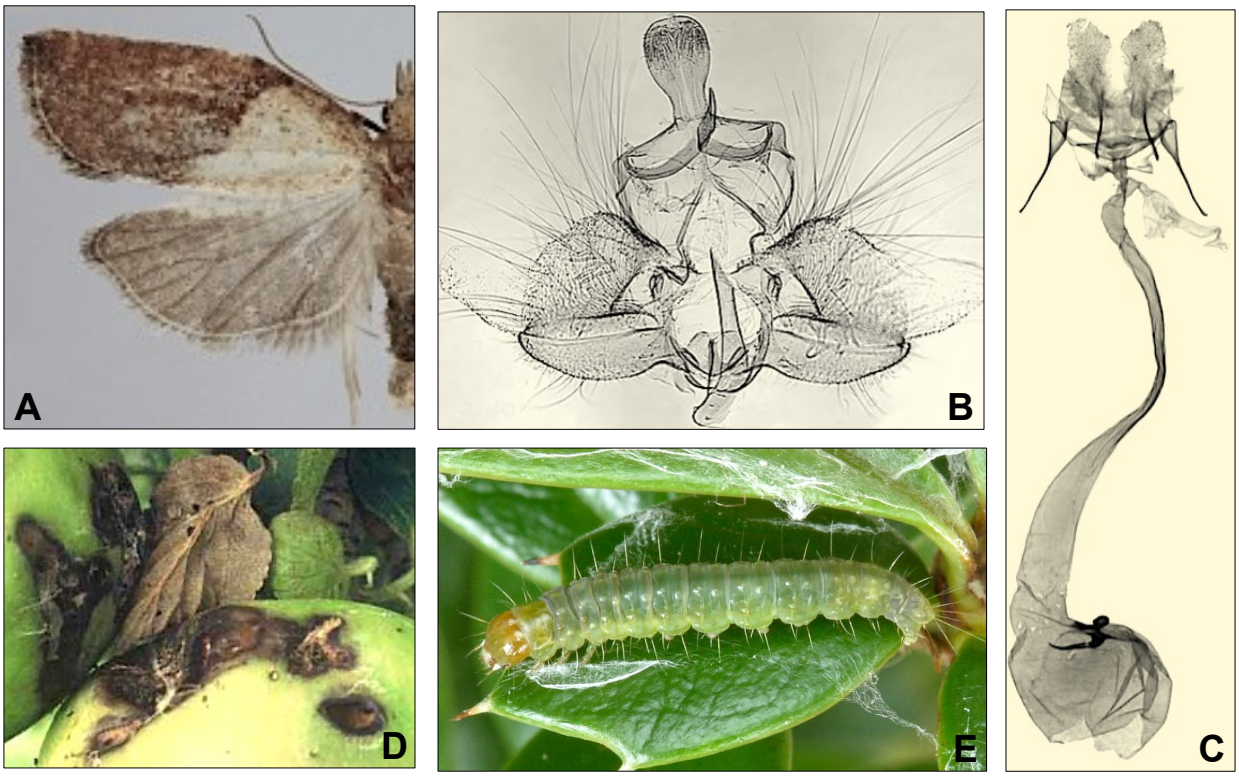

Figure 2. *Epiphyas postvittana*: adult (**A**); male genitalia (**B**); female genitalia (**C**); damaged fruit (**D**); larva (**E**).

Eggs are deposited on smooth surfaces of host plant foliage, including leaves, stems, and fruit. Early instars feed on the undersides of leaves within a silk chamber. Late instars may fold individual leaves, create a nest of several leaves webbed together, or web leaves to fruit and feed on the surface of the fruit (figures 2D-E). Larvae on deciduous trees and shrubs feed as long as leaves remain on the host plant and then drop to the ground, where they may feed on understory vegetation or survive in leaf litter. Pupation occurs in the larval nest, and metamorphosis takes about 10 days at 20 °C (Danthanarayana, 1975). Feeding by leafroller larvae damages grape bunches and makes them susceptible to *Botrytis cinerea* Pers. disease.

Prevention and control

Inspections of shoots, leaves, and bunches should be timed in conjunction with moth trapping counts. Pheromone traps lured with (*E*)11-tetradecenyl acetate and (*E*)9(*E*)11-tetradecenyl acetate can be used to survey for *E. postvittana* males (El-Sayed, 2023), whereas trapping of females using fermenting red wine has also been used.

IPM measures, including insecticide applications (chlorpyrifos, carbaryl, tebufenozide, lufenuron, spinosad, indoxacarb, and *Bacillus thuringiensis*) or mating disruption and lure and kill are used for control in Australia and New Zealand. Biological control agents have been introduced into New Zealand with considerable success in reducing background populations in some horticultural regions (Suckling *et al*., 2012).

A range of postharvest treatments have been examined, but few have reached commercialisation.

Removal of mummified fruits in older apple varieties was previously recommended.

Conclusions

Recently, the interception and presence of *Amyelois transitella* (Walker) (Lepidoptera Pyralidae) and *Platynota stultana* Walsingham (Lepidoptera Tortricidae) have been reported in Italy and in other European countries (Trematerra, 2022; Trematerra and Colacci, 2022).

Although the ultimate effect of *T. leucotreta* and *E. postvittana* in Italy has yet to be realised, these moths have not become established in the agriculturally important territories; and armed with accurate information on their distribution, morphology, detection, and control, prospects for its management appear optimistic.

Confirmation of *T. leucotreta* and *E. postvittana* is by morphological identification. Many European tortricids could be confused with them. Identification requires dissection of genitalia. In fact, *T. leucotreta* can be confused with many *Cydia* spp. including *C. pomonella* (L.) because of similar appearance and damage. *E. postvittana* presents great variation in the wing pattern and it is difficult to differentiate from another species in the family Tortricidae, such as *Pandemis heparana* (Denis et Schiffermuller 1775). Diagnostic kit based on molecular biology techniques are also available to identify the two tortricids (Barr *et al.*, 2011).

This study documents the importance of faunal surveys and suggests that positive and negative data should be used in combination to determine accurately where and when exotic species become established. Their presence would not only represent new pests that could inflict considerable damage to agricultural crops and ornamental plants, but could result in quarantine regulations that would adversely affect agricultural exports to trading partners.

Because the eggs, larvae, and pupae can be associated with plant material and readily transported, vigilance and early detection methods are critical to minimise the probability of these species' introduction and establishment in Southern Europe.

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