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Notes on the navel orangeworm, *Amyelois transitella* (Walker) (Lepidoptera Pyralidae) in Europe, a potential Union quarantine pest

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Abstract

Navel orangeworm, *Amyelois transitella* (Walker) (Lepidoptera Pyralidae), satisfies the criteria that are within the remit of the European Food Safety Authority (EFSA) to assess this species as a potential Union quarantine pest. *A. transitella* occurs in North, Central and South America. This species has been cited as present in Italy, Austria and Germany; however, no records was found, and it may also refer to an interception, the pest does not seem to be established in Europe. Should *A. transitella* arrive in the EU, the availability of hosts and occurrence of potentially suitable climates would be conducive for establishment. Because of the economic importance of this species, morphological characters, biological notes and seasonal ecology are reported.

Key words: navel orangeworm, *Amyelois transitella*, pest risk, EU quarantine.

Introduction

Navel orangeworm, *Amyelois transitella* (Walker) (Lepidoptera Pyralidae), is a primary pest of almonds, pistachios, and walnuts in California. Larvae of *A. transitella* cause direct damage to the nut, burrowing into the kernel and contaminating it with frass and webbing, and adult females may introduce fungi during oviposition that produce aflatoxin, a known human carcinogen that is heavily regulated both domestically and in key foreign markets. *A. transitella* is endemic to much of the lower latitudes in the Americas, and is not known to occur outside the Americas. Despite its common name, *A. transitella* is not a serious pest of citrus (Wilson *et al*., 2020) (figure 1).

Adults of *A. transitella* were first trapped in southern California in 1942 and were reported throughout the 1940s feeding on walnuts, dates, and dried figs. With the development of the pistachio industry in the 1970s, the navel orangeworm was soon noted as a pest of this new crop as well. For all of these crops, *A. transitella* is primarily considered an in-field pest, but it can also occur in wild populations (Lara-Villaron *et al*., 2017).

Distribution

North America: USA (Alabama, Arizona, California, Florida, Georgia, Louisiana, North Carolina, Oklahoma, Texas, Washington) (Heinrich, 1956).

Central America and Caribbean: Cuba, Costa Rica, Dominican Republic, Guatemala, Mexico, Panama (Heinrich, 1956).

South America: Brazil (AQIS, 1999); Argentina (USDA, 2015); Colombia, Guyana, Peru (Heinrich, 1956).

Other records: Canada, mentioned by Biosecurity Queensland (2011), but no other record was found. Korea, intercepted on fresh oranges (first case) and walnuts (in the past) from the USA (Hong *et al.*, 2012). Australia, a pest of concern and is subject to alerts (Biosecurity Queensland, 2011; NSW, 2012).

Navel orangeworm is not included in EU Commission Implementing Regulation 2019/2072. Potential entry pathways for *A. transitella* exist, such as plants for planting and fruit. The pest is not known to be present in the European Union (EU) territory, although it has been intercepted in Italy (Trematerra, 1988) and Austria (Essl and Rabitsch, 2002).

A. transitella is also recorded as present in Germany according to Fauna Europaea (Nuss, 2012; de Jong *et al.*, 2014); however, no record was found, and it may also refer to an interception. Consequently, the pest was considered absent from the EU, with some doubt (DROPSA, 2022).

Should *A. transitella* arrive in the EU, the availability of hosts and occurrence of potentially suitable climates would be conducive for establishment. Should this species become established in the EU, yield and quality losses in citrus, nuts, stone and pome fruit production is anticipated.

A. transitella satisfies the criteria that are within the remit of European Food Safety Authority (EFSA) to assess this species as a potential Union quarantine pest (Bragard *et al*., 2021).

The purpose of this note is to provide information about *A. transitella* because of the economic importance of this species and the limited attention in the entomological literature about this new pest introduction in Europe. Here, I report and illustrate morphological characters (especially the diagnostic male and female genitalia), a few biological notes, and seasonal ecology of *A. transitella*.

Morphology, biology and ecology

Adults of *A. transitella* are grey, measuring approximately 9-10 mm with a wingspan of 19-20 mm. The forewings are predominantly silver-grey, marked with irregular black patterning. The patterns show considerable variation, but often take the form of irregular, wavy black

Figure 1. *A. transitella* damages: on walnuts (**A** and **B**); on pistachios (**C** and **D**); on orange fruit (**E** and **F**). (Credits: P. Trematerra; C. Burks; K.J. Hong).

transverse lines and distal dots. The hindwings are a uniform white to dusky grey. There are lighter and darker forms, and adult size can vary considerably (figures 2, 3).

Eggs of *A. transitella* at oviposition are creamy white but develop a reddish-orange hue as they mature. They are typically oviposited directly onto overripe, damaged, cracked, or mummied fruits/nuts. Though on occasion they may be found on adjacent leaves or stems (Wade, 1961; Wilson *et al*., 2020).

Newly hatched larvae of *A. transitella* are reddish-orange, but become pinkish-orange or cream. Body coloration is influenced by diet. Larvae pass through 5 to 6 instars and will reach a length of 13-19 mm before pupation. Larvae enter the nut shortly after hatching and will remain inside until they reach the pupal stage. Mature larvae can be differentiated from other nut-boring lepidopterans by the presence of an enlarged crescent-shaped sclerotization on each side of the mesothorax at the base of the SD1 seta (figure 3).

Pupae are dark brown in coloration, 7.25-12 mm long (figure 3), and are typically encased within silk cocoons. *A. transitella* pupates either within the infested nut or outside of the shell. Pupae lack a longitudinal ridge on the head and thorax and a pair of short, thorn-like projections on each segment of the abdomen found in *Ectomyelois ceratoniae* (Zeller) (Lepidoptera Pyralidae) (figure 3C, on right side).

A. transitella is polyphagous on a variety of fruits and nuts, including: *Citrus* sp., *Citrus limon*, *Citrus x paradisi*, *C. sinensis*, *Vitis vinifera*, *Acacia farnesiana*, *Brachychiton* sp., *Carya illinoensis*, *Ceratonia siliqua*, *Coffea* sp., *Cydonia oblonga*, *Eriobotrya japonica*, *Ficus* sp., *Forchhammeria* sp., *Genipa americana*, *Gleditsia triacanthos*, *Heteromeles arbutifolia*, *Juglans regia*, *Malus*

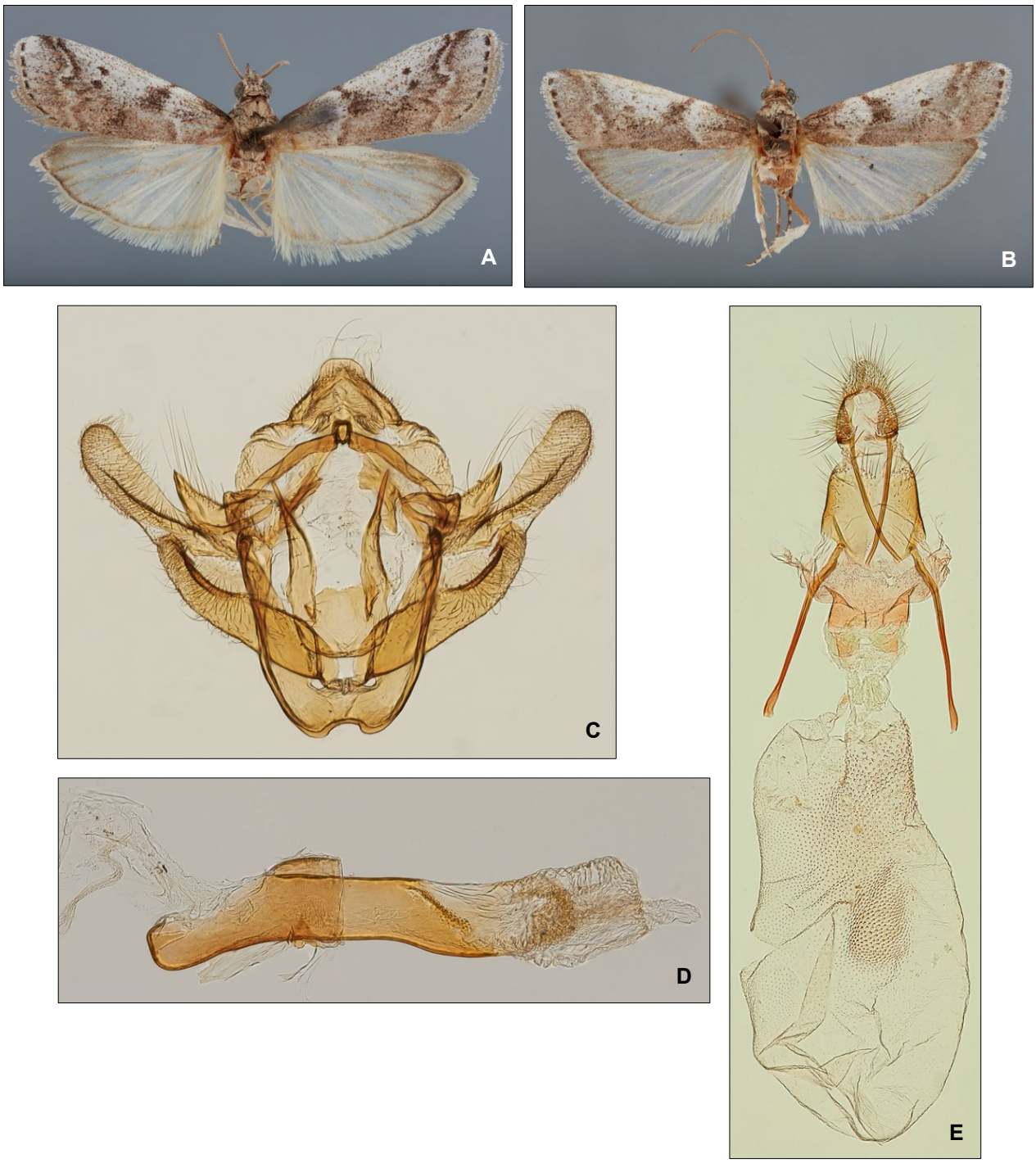

Figure 2. *A. transitella*: adult male (**A**); adult female (**B**); male genitalia (**C**); phallus (**D**); female genitalia (**E**). (Credits C-E: A.M. Solis).

pumila, *Phoenix dactylifera*, *Pistacia vera*, *Pithecellobium flexicaule*, *Prunus*, *Prunus armeniaca*, *P. domestica*, *P. dulcis*, *Punica granatum*, *Pyrus communis*, *Yucca* sp., *Ziziphus* sp. (AQIS, 1999; Wilson *et al*., 2020).

In the USA, this species has 4-6 generations a year and is variable depending on climate. For example, in California, *A. transitella* can have 3 to 4 generations per year, with more generations in the warmer southern San Joaquin Valley and fewer generations in the cooler northern Sacramento Valley. Detailed information on biology and management of the navel orangewormin California was compiled by Wilson and Burks (2019).

The navel orangeworm, *A. transitella*, may be confused with the carob moth, *E. ceratoniae*, that is also present in the EU. The two species have overlapping niches in Mediterranean climates and the latter is a pest of carob, date, fig, citrus and various dried fruits seeds and nuts. The two species can be differentiated based on genitalia, larval, and pupal characteristics (see Carter, 1984; Heinrich, 1956; Solis, 1999).

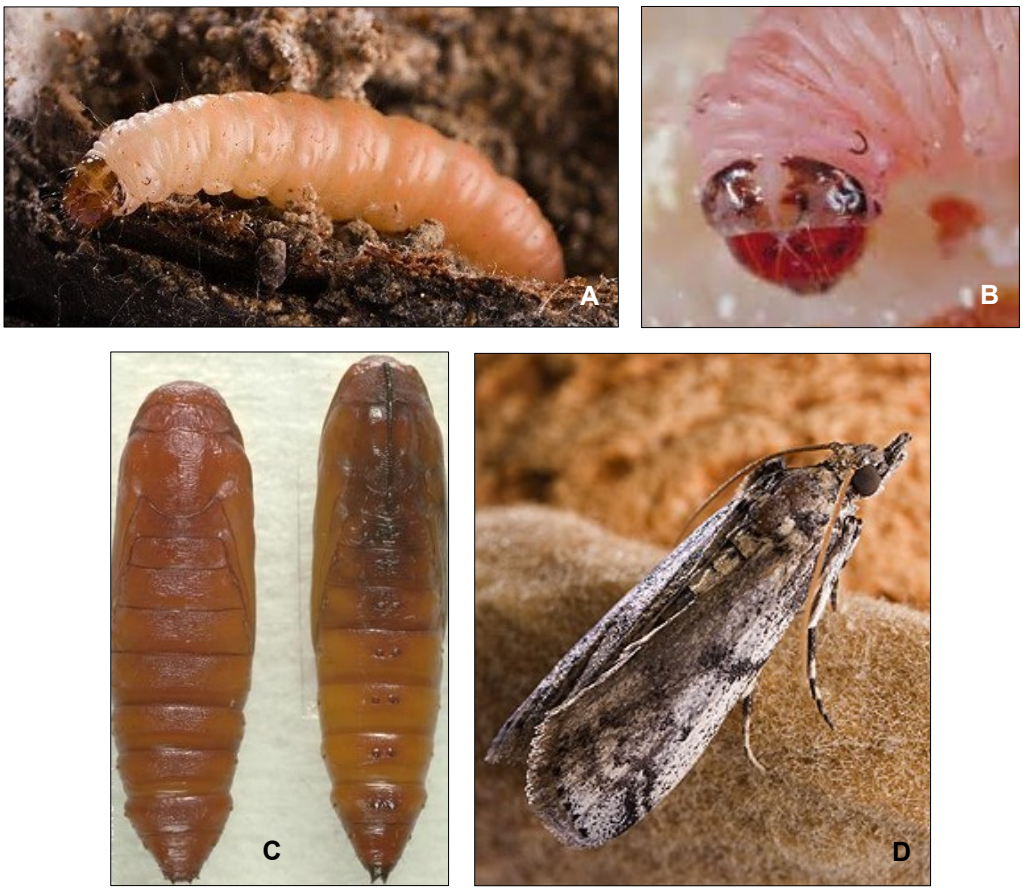

Figure 3. *A. transitella*: mature larva (**A**); larva: head and mesothorax (**B**); pupae on the left, *E. ceratoniae* on the right (**C**); adult (**D**). (Credits: J.K. Clark; P. Greb).

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