

New observations and notes of *Prays citri* Millière, 1873 in Hungary (Lepidoptera: Praydidae)

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Abstract. The paper presents new data on observations of *Prays citri* Millière, 1873 in Hungary. It is found in large glass houses and in grass gardens. Professionals working there had not recognized the species. The author identified it by genital examination. In his opinion, the species may be present in several private nurseries where citrus fruits are kept in containers during the growing season and then moved to a warm place to escape winter frosts. Many citrus shipments arrive in Hungary from Mediterranean countries, so it is important to monitor *Prays citri* and organise its control. The study is illustrated with 17 figures.

Keywords. New records, citrus flower moth, biology, distribution, Hungary.

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Introduction

In Hungary, three species of the genus *Prays* Hübner, 1825 are at present (Pastoralis & Buschmann 2018): *P. fraxinella* (Bjerkander, 1784), *P. ruficeps* (Heinemann, 1854) and *P. citri* Millière, 1873). The first two species are indigenous to the Hungarian fauna, while *P. citri* was introduced to Hungary (Takács *et al.* 2018). *P. citri* was first captured in a sex phero-mone trap set in a fallow field near the Vala Valley Rest Area (Kajászó) on the M7 (E71) mo-torway (EOV: 627060; 218348 | 47.18315N | 18.44388E) (Takács *et al.* 2018), which was de-ployed on 15 April 2017 and operated until 4 May 2017. A total of 10 *P. citri* specimens were caught. The study aimed at detecting the presence of insect species not native to our country, accompanying seedling consignments imported from abroad. According to Attila Takács (pers. comm. 2022), he is not aware of any new sites or specimens of *P. citri* observed in the last five years.

In mid-February 2022, a light trap at the ELTE (= Eötvös Loránd University) Botanic Garden (1083 Budapest, Illés u. 25. | 47.48395N; 19.08561E) collected more than 50 very worn specimens near the citrus trees. As unknown, unidentified specimens, Attila Haltrich and György Zsigó sent them to me (Pécs, Pannon Institute) for identification. Following mounting and genital examination, it was clearly established that a second occurrence of *P. citri* had been detected in Hungary, only 41 km east of the first occurrence (Kajászó). A photograph of a mined lemon tree leaf showing presumed damage was received along with the specimens (Figure 14), but clearly this was not caused by *P. citri*, as it primarily infests the flowers of citrus fruits. Subsequently, Attila Haltrich and György Zsigó surveyed the flowering citrus in the ELTE Botanical Garden on 13.03.2022 and found numerous damaged flowers with larvae of another species; adult moths were flying continuously and present in the light trap for two months after the first sighting (mid-February 2022 and were shown to be

Phyllocnistis citrella. This species has been previously detected in Hungary (Katona *et al.* 2020), but this is only the second record.

Results

The species of the genus *Prays* are very like *Atemelia torquatella*, with some apomorphic similarities: r4 and r6 stalked in the forewing, m3 and cux fused in the hindwing; head without a longitudinal seam, characteristic formation of the VIII sternite. Pierce & Metcalfe (1935) emphasized that they are not to be classified among the Yponomeutids and show closer relationships to *Scythris* Hübner, 1825 (see Friese 1960).

Prays citri Millère, 1873

Acrolepia citri Millière, 1873 | *Lépidoptères nouveaux de France. – Petites nouvelles entomologiques* 5 (77): 310. | Locus typicus: Corsica.

References. Arambourg & Pralavorio 1978; Abo-Sheaasha & Agamy 2004; Agassiz *et al.* 2013; El-Metwally *et al.* 2010; Friese 1960; Huemer 2016; Morena *et al.* 1990; Seliger & Hemmersbach 2018; Pastorális & Buschmann 2018; Takács *et al.* 2018.

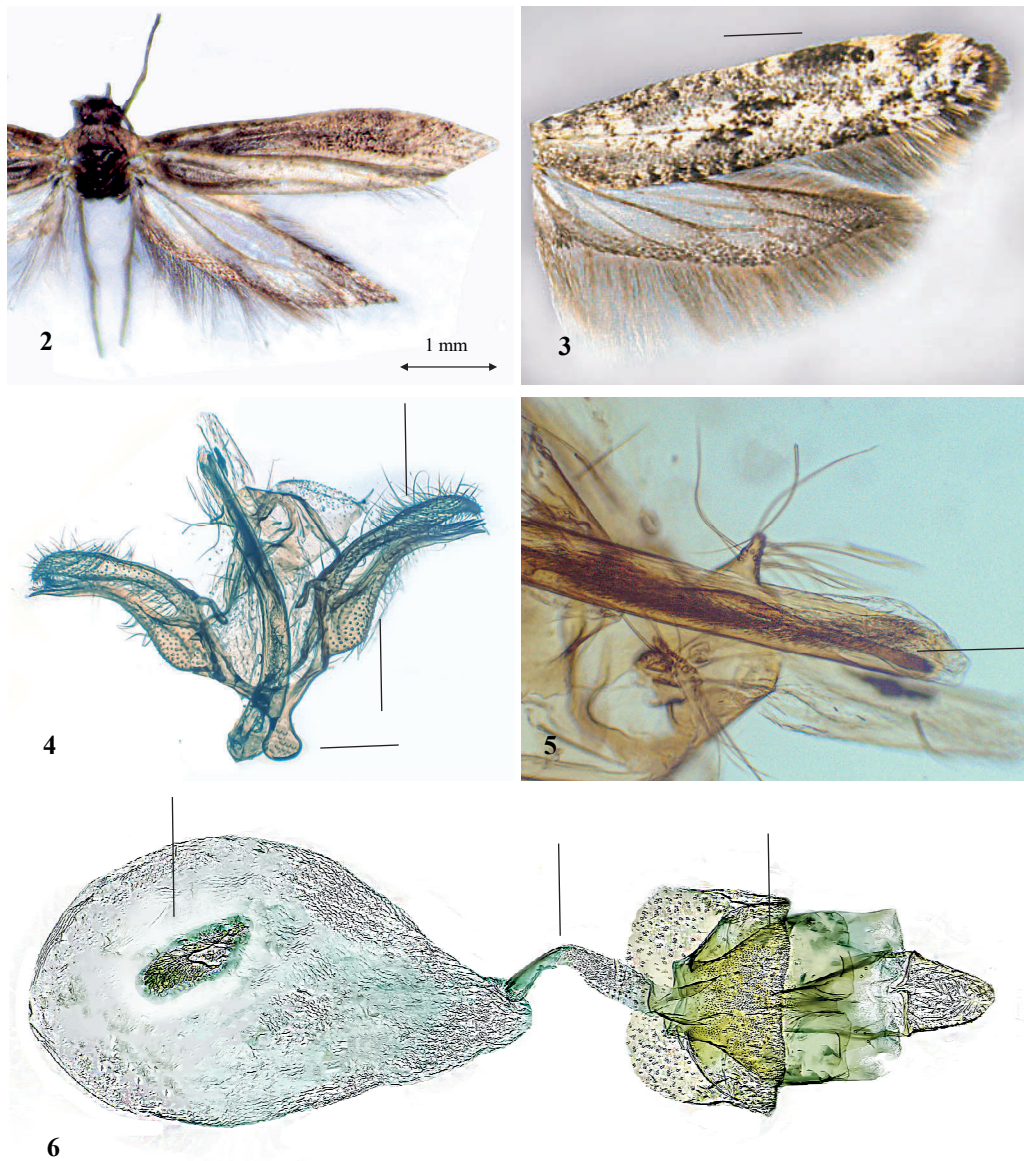
Examined material. 57 adult specimens and 8 larvae | Budapest, ELTE Botanical Garden (=füvészkert), 1083 Budapest, Illés u. 25. | 47.48395N; 19.08561E | in coll. Pannon Intézet, Pécs. | 3 larvae in Pécs, University of Pécs, Botanical Garden, Ifjúság útja 6. | 46.077328N; 18.205831E.

Diagnosis. Wingspan 10-12 mm. Head grey brown. Antennae just over half length of forewing. Forewings grey brown with many darker spots. Hindwings grey, margin smudged with black, and the dorsum marked with two oblong spots also black.

Acrolepia Citri.

Envergure 12 mill. — Très-voisine pour la coupe d'ailes de l'Assectella, Z., et de la Vesperella, Z. (Smilaxella, Mill.) Les ailes sont allongées, d'un aspect gris foncé et luisant. Les supérieures sont rectangulaires, à fond blanchâtre, aspergées d'atomes noirs et traversées par une bande diagonale très-obscur, laquelle présente vers son milieu un signe noir en forme de < couché, dont la pointe se projette extérieurement. La côte est maculée de noir et le bord interne marqué de deux taches oblongues également noires. Les ailes inférieures sont unicolores. Le dessous est gris, cependant les nervures sont bien indiquées en noir. Thorax et abdomen concolores.

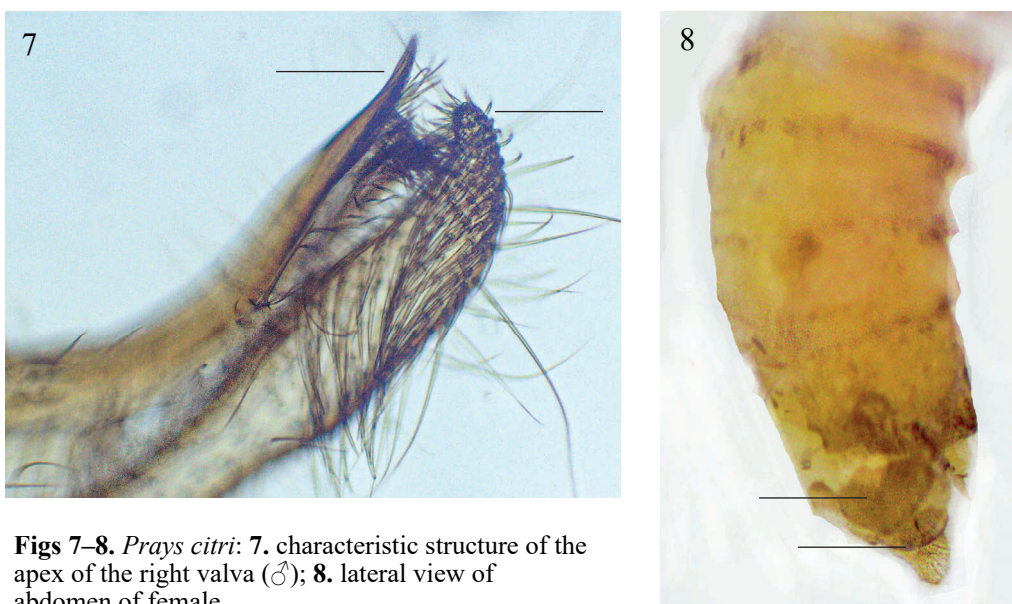
Fig. 1. Citation of original description by Millière 1873 (extracts from the text)



Figs 2-6. *Prays citri*: **2.** ♀ adult, Budapest; **3.** pattern of the right wings (enlarged); **4.** ♀ genitalia, gen. prep. Fazekas I. No. 3509; **5.** magnification of tip of aedeagus, sign indicating the long cornutus; **6.** ♀ genitalia, gen. prep. Fazekas I. No. 3510.

Male genitalia. Costa of valva slightly curved, lateral margin concave; sacculus strong, cucullus with a cleft and a branch; vinculum well developed, drumstick-like. Aedeagus long, slightly curved, cornutus rod-like.

Female genitalia. Ostium bursae broad, sclerotized; ductus bursae short, corpus bursae pear-shaped, with a large jug-shaped signum.



Figs 7–8. *Prays citri*: 7. characteristic structure of the apex of the right valva (♂); 8. lateral view of abdomen of female.

Bionomics. *Prays citri* is an important pest of citrus in parts of the Mediterranean, from Portugal, Spain, Italy and Greece to Turkey and the Middle East. The preferred main food plants are *Citrus aurantiifolia*, *C. limon*, *C. medica*, *C. reticulata*, and to some extent *C. sinensis*. It also feeds on various species of Rutaceae and Sapotaceae (*Manilkara zapota*, *Casimiroa edulis*) and Oleaceae (*Ligustrum lucidum*).

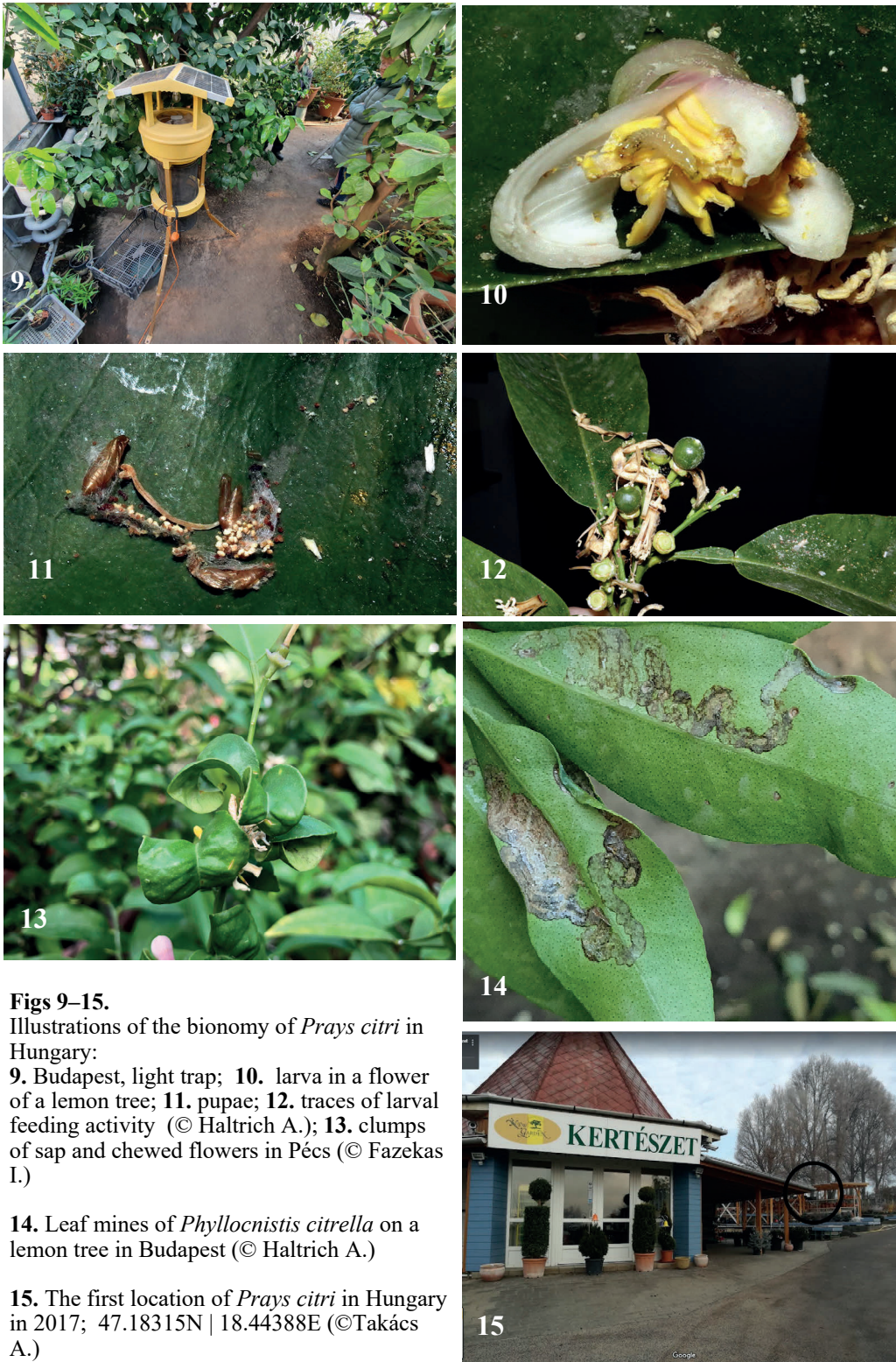
Up to 3–6 generations are produced each year. Females lay oval, whitish, ~0.2 mm eggs on flower buds or in flowers. The number of eggs varies from 50 to 160, but even larger numbers have been observed. Larvae light grey, green, or brown, reaching 4–5.5 mm long at the last larval stage. Larval development takes about two weeks, depending on temperature. Some larvae burrow into the fruit but die there. Necrotic lesions develop at the site of these tiny boring marks, causing a reduction in the quality of the citrus fruit. The greenish, brownish pupae are found in damaged flowers, between leaves and even on fruit. The pupal stage lasts for 6–8 days.

According to some observations, the larvae can cause 15–70% to >90% damage to flowers, resulting in significant yield losses.

The females move from flower to flower (or bud to bud) and deposit 1–3 eggs on each, laying about 100 or more eggs. The emerging larvae bore into these structures, wherein they feed and produce abundant webbing that ties the flowers together. There is much overlap of the several generations during summer and autumn. Females attract males by a pheromone that is produced at night. The moths, which are weak fliers, tend to remain in the same area (http://www.agri.huji.ac.il/mepests/pest/Prays_citri/).

According to Moore & Kirkman (2014) in South Africa it was shown that the first generation of *P. citri* in spring attacks lemon blossoms and it is the second generation that develops on fruit, leading to blemishing of fruit and possibly even crop reduction.

According to Abo-Sheaesha & Agamy (2004) the egg parasitoid *Trichogramma evanescens* (Westwood) (Trichogrammatidae) is very effective in controlling the species. Several bacteria of the genus *Bacillus* have infected the pest in Egypt and an application of a commercial product of *Bacillus thuringiensis* reduced larval infestations by about 60–75%. According to El-Metwally *et al.* (2010) three species of entomopathogenic bacteria were isolated identified and tested on larvae (CFM= citrus flower moth). Statistical analysis indicated that *B. sphaericus* had the highest pathogenicity to CFM, while *Bacillus subtilis* ranked second in the order of activity, *B. thurengiensis* had the lowest entomopathogenic properties.



Figs 9–15.

Illustrations of the bionomy of *Prays citri* in Hungary:

9. Budapest, light trap; **10.** larva in a flower of a lemon tree; **11.** pupae; **12.** traces of larval feeding activity (© Haltrich A.); **13.** clumps of sap and chewed flowers in Pécs (© Fazekas I.)

14. Leaf mines of *Phyllocnistis citrella* on a lemon tree in Budapest (© Haltrich A.)

15. The first location of *Prays citri* in Hungary in 2017; 47.18315N | 18.44388E (©Takács A.)

Morena *et al.* (1990) examined the parasites of *P. citri* in Spain and identified the following species and wrote the following: “The parasitoids of *P. citri* were determined in the laboratory at 22–24°C, 60–70% RH and LD 16:8 using eggs, larvae and pupae collected in a lemon growing area of Spain. The braconids *Phanerotoma bilinea*, *P. dentata*, *Microchelonus rimatus*, *Habrobracon* [*Bracon*] sp. and *Choeras* sp. were found parasitising the pest for the first time. Two established parasitoids (*Bracon laetus* and *Ageniaspis fuscicollis*) were also observed. A new hyperparasitoid of *B. laetus* (*Gyrinophagus* sp.) was also established. *Heteropelma* sp. and *Choeras* sp. were found parasitising the tortricid *Cacoecimorpha pronubana* and the geometrid *Gymnoscelis pumilata* [*G. rufifasciata*]”.

From the obtained results, it can be concluded that the highest activity of *Prays citri* has been recorded when mean temperature was 18.4 and 16.4°C (during the first and second seasons, respectively). These results are supported by Burgio *et al.* (1974) who found that the maximum number of laid eggs was obtained at 20°C. According to statistical analysis of the present study, mean temperature and relative humidity had relatively low effects on *P. citri* population. Mineo *et al.* (1980) reported that climatic and cultural factors had considerable effects on *P. citri* activity in Sicily. With respect to wind speed, there was insignificantly positive and negative correlation between *P. citri* and the changes of mean wind speed during the first and second years of study. According to Jonason *et al.* (2014) flight activity of micro moths is markedly affected by wind speed with no flight occurring above at wind speeds greater than 10km/hr. Wind speeds above 8km/hr reduce the moth flight activity.

New localities in Hungary

1. Budapest, Eötvös Loránd University) Botanic Garden, 1083 Budapest, Illés u. 25. | 47.48395N; 19.08561E); The first Hungarian Botanical Garden was founded in 1771 by the predecessor of Eötvös Loránd University. It was moved to its present premises more than 150 years ago and in 1960 it became a National Nature Reserve. The Botanical Garden contains about 7, 000 species and varieties of plants. The orangery built in the 19th century and the greenhouse restored in 1984 are the home of the tropical and sub-tropical plants.

2. Pécs, University of Pécs, Botanical Garden, Ifjúság útja 6. | 46.077328N; 18.205831E. The park used to be the garden of the Jesuit Pius Grammar School. Following the foundation of the Biology Department at the former Teachers' Training College, its development into a botanical garden was launched in 1952. The garden is under the professional supervision of the Department of Plant Systematics and Geobotany at the Faculty of Sciences, while its financial management belongs to the central financial body of the university. The garden was declared a County Nature Conservation Area in 1989.

Geographical distribution

Prays citri is known throughout the Mediterranean region. It has been observed in South Asia, the Indomalayan Archipelago, Australia, South Africa. However, its occurrence in Southeast Asia and Australia should be treated with caution, as *Prays citri* can be confused with *P. nephelomima* Meyrick, 1907, *P. endocarpa* Meyrick, 1919.

Prays citri has spread throughout the Mediterranean following the planting citrus trees [see in www.cabi.org]: Cyprus, Greece, Malta, Italy (regional), Sicily, Sardinia, Corsica (= locus typicus!), Balearic Islands, France (restricted to the south), Spain, Portugal, Canary Islands, Azores and Madeira (see map). It has also been reported from Albania, Austria, Croatia, Denmark, England, Hungary, Germany, the Netherlands, Norway, Turkey. It is mainly found in nurseries and herb gardens, but also indoors. The species overwinters in these temperate, heated spaces.

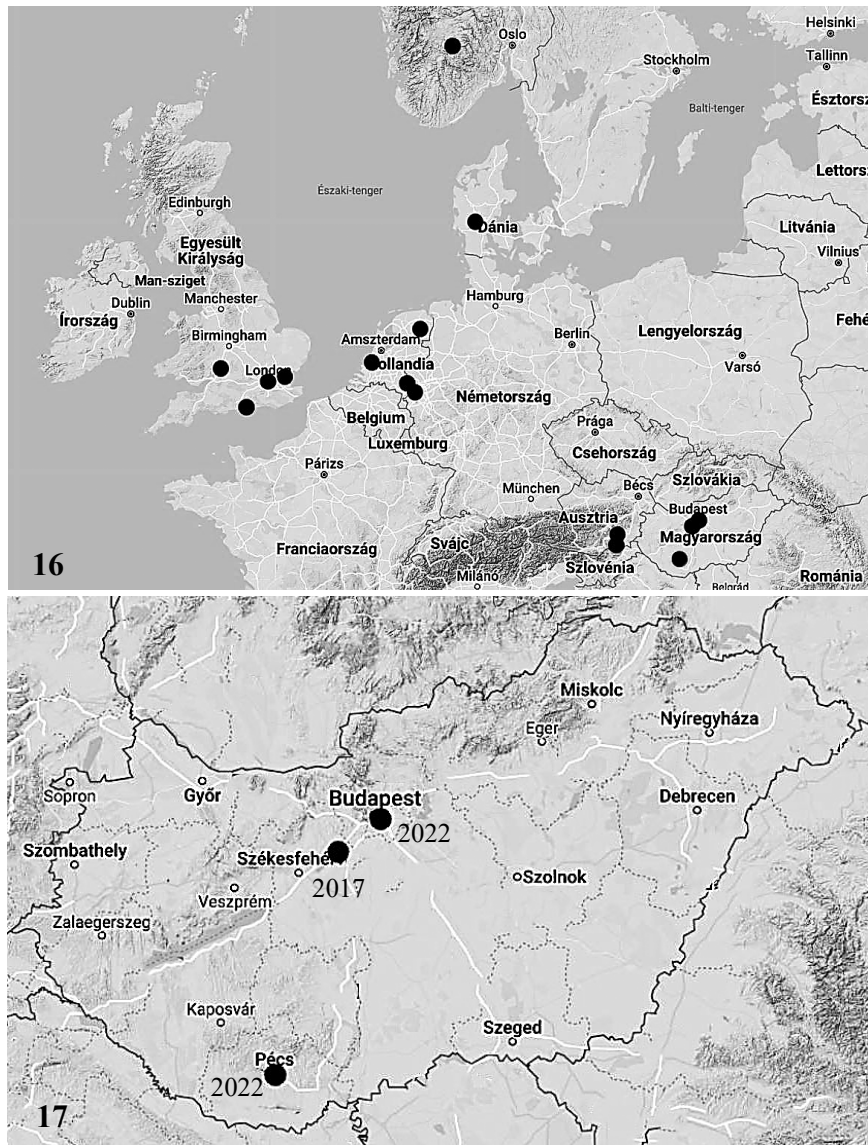


Fig. 16. Observed occurrences of *Prays citri* in Central, Western and Northern Europe (sketch distribution map). Details are described in the text.

Fig. 17. Observed occurrences of *Prays citri* in Hungary, with the year of observation.

Notes

Observations in Central and Western Europe are reported in chronological order (outline) from Denmark (Buhl *et al.* 2001), England (Agassiz *et al.* 2013), Austria (Huemer 2016), Hungary (Takács *et al.* 2018) and Germany (Seliger & Hemmersbach 2018). In Holland, since the first discovery in 1995, the species has been collected a dozen times by the Plant Protec-

tion Service. It is often imported with citrus trees from tropical or Mediterranean areas. In 2010 the species was collected for the first time in the wild in Geulle (Province of Limburg). In 2014 some specimens were collected on a citrus tree indoors in Sleen (Province of Drenthe) and a specimen was reported from Mook (province of Limburg). Incidental, with no evidence of reproduction in the wild. (https://www.nederlandsesoorten.nl/linnaeus_ng/app/views/species/nsr_taxon.php?id=167302 [17.03.2022])

Not surprisingly, animals from these areas are sometimes brought to Central or Northern Europe with the lemon. Thus, Buhl *et al.* (2001) are the first to record Denmark, with reference to introductions: "Four species were first reported as introductions: *Lindera tessellatella*, *Prays oleae*, *Prays citri* and *Sameodes cancellalis*."

Agassiz *et al.* (2013) list the species as an "adventive species", and for England they write: "One specimen London, 2000: (Honey, 2001). Cosmopolitan." At [norfolkmoths.co.uk], you can learn about Britain: "First recorded in London in 2000, the larvae feed within the fruit of *Citrus* sp. causing sufficient damage to make it a serious pest. With several open-network cocoon exuviae (including a dead moth) found at the base of two linden plants at Bressingham Horticultural Centre in 2016 (B. Heckford, S. Beavan. 02.10.2016)".

Interesting is the first record of the species in Austria, reported by Huemer (2016). Huemer. Example ID: TLMF Lep 18197; Series ID: LEATJ622-15 (658 bp). First record from North Tyrol and Austria! Previously unknown from East Tyrol and South Tyrol." On May 11, 2020, Horst Pichler [forum post of May 13, 2020] found a moth in his garden in St. Peter, Graz, Styria - where there are no lemon trees.

Seliger and Hemmersbach (2018) were the first to report on the species in Germany, specifically in North Rhine-Westphalia: the larvae twisted the associated citrus flowers into a ball and pupated in it. A total of 28 moths hatched between 24 October and 10 November 2017. Given the increasing popularity of citrus in recent years, often kept in gardens as tub plants and overwintering in heated rooms, it is very likely that *P. citri* is present in Germany and other central European countries in several locations.

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