

A new host plant for *Cameraria ohridella* Deschka & Dimić, 1986 (Lepidoptera: Gracillariidae)

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Abstract

The article deals with the study of host plants of *Cameraria ohridella* Deschka & Dimić, 1986, especially focusing on Belarus findings. For the first time, *Acer saccharinum* L., is recorded as a host plant. The cases of damaging other plants by this species as well as relationships of Gracillariidae with the plant family Sapindaceae are summarized.

Keywords: Lepidoptera, Gracillariidae, *Cameraria ohridella*, host plant, Sapindaceae, *Acer saccharinum*, Belarus.

Una nueva planta nutricia de *Cameraria ohridella* Deschka & Dimić, 1986 (Lepidoptera: Gracillariidae)

Resumen

El artículo trata del estudio de las plantas nutricias de *Cameraria ohridella* Deschka & Dimić, 1986, centrándose especialmente en los hallazgos de Bielorrusia. Por primera vez se registra *Acer saccharinum* L., como planta nutricia. Se resumen los casos de daños causados a otras plantas por esta especie, así como las relaciones de Gracillariidae con la familia de plantas Sapindaceae.

Palabras clave: Lepidoptera, Gracillariidae, *Cameraria ohridella*, planta nutricia, Sapindaceae, *Acer saccharinum*, Bielorrusia.

Introduction

An unknown leaf miner was first found in large numbers on *Aesculus hippocastanum* L. (Sapindaceae) in the vicinity of Lake Ohrid in 1984 (Simova-Tošić & Filov, 1985). Then, based on new collections near Lake Ohrid, it was described as a new species *Cameraria ohridella* Deschka & Dimić, 1986, which was the closest to the North American species *Cameraria aesculisella* (Chambers, 1871) (Deschka & Dimiè, 1986; Kenis et al. 2003), which is also trophically associated with the genus *Aesculus*, but with other local species: *Aesculus glabra* Willd., *A. flava* Sol., *A. pavia* L. (Braun, 1908; De Prins & De Prins, 2006-2022).

Careful studies of herbarium collections of horse chestnut from the Balkan Peninsula, collected in the period from 1737 (Lack, 2002) to 1981, allowed to establish that the miner lived in Europe at least since 1879 (08-XI-1879, Mikro Chorio, Mt. Chelidoni, Greece) (Lees et al. 2011). Damage by *C. ohridella* found in herbarium collections, related to the 19th century, indicates the presence of this pest

in Greece, and from the first half of the 20th century - in Bulgaria (1928) and Albania (1928) (Lees et al. 2011).

The expansion of *C. ohridella* into southern and central Europe began in the 1980s. In 1987 the horse-chestnut leaf miner was found in Serbia (Petkovic, 1989), in 1989 in Austria (Puchberger, 1990) and Croatia (Maceljiski, 1995). After that, the phyllophage spread to other European countries (Roginsky et al. 2014; De Prins & De Prins, 2006-2022).

A prerequisite for the successful invasion of the horse-chestnut leaf miner was the spread of *Aesculus hippocastanum* (introduction into landscaping) across European countries in the 16th-19th centuries (Kosayev, 1973; Prada et al. 2010; Ravazzi & Caudullo, 2016; Walas, 2021).

Horse chestnut is the main food plant for caterpillars of *C. ohridella* (Walczak et al. 2017). However, in the conditions of the secondary range, the horse-chestnut leaf miner was also recorded on other plants of other families (Heitland et al. 2005; Krivosheina & Ozerova, 2020).

According to published data, *C. ohridella* eggs were found on the following plant species: *Aesculus hippocastanum* L., *A. turbinata* Blume, *A. flava* Sol. in Hope, *A. pavia* L., *A. glabra* Willd., *A. sylvatica* W. Bartram, *A. indica* (Wall. Ex Camb.) Hook., *A. californica* (Spach) Nutt., *A. assamica* Griff., *A. chinensis* Bunge var. *wilsonii*, *A. parviflora* Walter (D'Costa et al. 2013), *Acer pseudoplatanus* L., *A. campestre* L., *A. platanoides* L., *Fraxinus excelsior* L., *Prunus avium* L., *Ligustrum vulgare* L., *Euonymus europaeus* L., *Carpinus betulus* L., *Fagus sylvatica* L., *Cornus sanguinea* L., *Tilia platyphyllos* Scop., *Lonicera xylosteum* L., *Corylus avellana* L. (Péré et al. 2010). In Ukraine, the leaf miner colonized the *Parthenocissus quinquefolia* (L.) Panch., which curled along the horse chestnut. However, the identified larvae did not complete their development (survived to 5th instar) (Zerova et al. 2007). Notably, a single record of leaf mines on *Corylus avellana* was on trees close to heavily infested horse chestnuts and all larvae within mines had died in Germany (Friese et al. 2004); so, this plant cannot be regarded as a normal host for *C. ohridella* (Straw & Tilbury, 2006).

Other species and forms of horse chestnuts have different levels of resistance to damage by the horse-chestnut leaf miner (Freise et al. 2003): on *Aesculus chinensis* Bunge, larvae die when they reach the last instars; on *A. indica*, *A. californica*, and hybrids of *A. x carnea*, larvae die at stages 1-2 instar. Also, hybrids *A. x bushii* Schneid., *A. x dallimorei* Seally, *A. x dupontii* Sarg., *A. x glaucescens* Sarg., *A. x plantierensis* André, *A. x woelintzense* Koehne (Gregor et al. 1998; Freise et al. 2003; Hellrig, 2001; Straw & Tilbury, 2006).

Caterpillars were found to successfully develop to adults on several species of the genus *Aesculus*: *A. hippocastanum* (Simova-Tošić & Filov, 1985; Deschka & Dimić, 1986; Heitland et al. 2005; Walczak et al. 2017), *A. glabra* (Freise et al. 2003; Walczak et al. 2017), *A. octandra* (Freise, et al. 2004; Schmidt, 2019), *A. carnea* (Straw & Williams, 2013), *A. parviflora* (Freise & Heitland, 1999), *A. pavia* (Freise et al. 2004), *A. turbinata* (Backhaus et al. 2002; Heitland et al. 2005; Krivosheina & Ozerova, 2020). Near *Aesculus* plantings severely damaged by the horse-chestnut leaf miner, colonization, and development of larvae to imago on *Acer pseudoplatanus* (Skuhřavý, 1999; Freise et al. 2004; Péré et al. 2010), *Acer platanoides* (Skuhřavý, 1999; Heitland et al. 2005; Gregor et al. 1998; Krivosheina & Ozerova, 2020) is noted. Damage levels of *Acer* sp. can be as high as on horse chestnut (Péré et al. 2010). Based on the results of studies in 2020-2021, several records of the development of *Cameraria ohridella* larvae on *Acer pseudoplatanus* were established in 2 out of 30 surveyed localities in Southern Russia. Caterpillars were found within the leaf-mines, cases of pupation of the chestnut miner moth were also noted. It remains unclear to the authors whether *Cameraria ohridella* can colonize maple species originating from other regions - East Asia and North America (Kirichenko et al. 2023).

The horse-chestnut leaf miner was first noted in 2003 in Belarus (Gninenko & Orlinski, 2004). It is assumed that the species could have entered the country in 2000 (Roginsky et al. 2016). Conducted by A. S. Roginsky research in the period from 2013 to 2019 in the regions of Belarus made it possible to identify a number of its host plants: *Aesculus hippocastanum*, *Aesculus hippocastanum* cv. *Baumanii*, *Aesculus pavia* (Roginsky, 2020). However, this work does not provide findings of damage to maple (*Acer* sp.) leaves by the horse-chestnut leaf miner.

There are up to three full generations of the chestnut moth are recorded in Belarus (Roginsky & Buga, 2020; Roginsky, 2022). At the same time, 2 generations are noted in the Northern region of introduction of horse chestnut trees, and 3 generations in the Southern region. The emergence of adults in the Southern region of introduction usually occurred in the following periods: May-June, August-September, October (Roginsky, 2022).

Material and methods

The material for the work carried out in 2021-2022 was collections from surveys of green stands in regional cities of Belarus in order to identify new alien species and monitor populations of previously discovered representatives of the Gracillariidae family. Collected damaged leaf blades of woody plants were placed in plastic Zip-Lock bags for temporary storage. Some of the collected leaves were placed in plastic containers with a lid (176x123x50 mm) in order to breed adults, the rest of the material was herbarized according to the standard methods (Skvortsov, 1977). When collecting leaves from the lower crown, the percentage of population of the lower crown of plants was considered (the ratio of the number of damaged leaf blades to undamaged ones). The collected herbarium material was scanned using a flatbed scanner (300 dpi), the resulting image was analyzed by using the ImageJ program to determine the length and area of the damage (Sinchuk et al. 2016). Identification of pests by damaged leaves was carried out using specialized keys (Ellis, 2001-2020), identification of adults - using guides (Nel & Varenne, 2014; Doorenweerd et al. 2014). Plants were identified by their vegetative organs (Sary, 2008; Valyagina-Malyutina, 2012).

During the collection of materials, damaged leaf blades of the silver maple *Acer saccharinum* (figure 1A) were found in Brest (Belarus), in the park of culture and recreation, N52.093287, E23.674656, collected on 18-VIII-2021 (leg. A. V. Sinchuk, N. V. Sinchuk), on 19-VIII-2022 (leg. A. V. Sinchuk). Phytopathological collection (the herbarium of damaged leaves and insects) is kept in the personal collection of A. V. Sinchuk. The distance from the infested horse chestnut (figure 1B) was less than 100 m.

In order to consider the morphometric indicators of individual damage by the chestnut leaf moth on the leaves of *Aesculus hippocastanum* and *Acer saccharinum* in the city park in Brest, plants were selected that were in the same microclimatic conditions, in the same insolation, and the samples were taken at the same time in 2021-2022.

Results

According to the results of an inspection of green stands, single mines of a chestnut mining moth were found on the leaf blades of a silver maple.

The natural (native) range of *Acer saccharinum* L. is located in the eastern part of North America (Fedoruk, 1972; Gelderen et al. 1994). Silver maple was introduced into Europe in 1725 (Fedoruk, 1985; Gelderen et al. 1994; Hillier & Coombes, 2003). In Belarus, this species has been used in green stands since about 1850 (arboretum of the Belarusian State Agricultural Academy) (Fedoruk, 1972; Fedoruk, 1985). Currently, the plant cadaster indicates the presence of 29 populations on a total area of 6.5 ha. Most of the habitats were noted in the Brest, Minsk, and Vitebsk regions (figure 3) (Maslovsky et al. 2019). In some cases, we noted the growth of *Acer saccharinum* next to *Aesculus hippocastanum*.

In 2021, we identified three mines (figure 2A) on three leaf blades. In two, the death of larvae, presumably at the third and fourth instars was noted (possibly due to the gradual drying of the tissues of the leaf blades). In the third leaf mine, a pupa was found, from which the adult was hatched (figure 2B). In 2022, three damaged leaf blades with pupae were found on the same plant. The development of larvae of the first generation of the phytophage on horse chestnut in 2021 was already noted in June. Whereas the occurrence of the first-generation imago on *Acer saccharinum* was noted only in August. Considering the timing of the emergence of three generations of chestnut moth adults from *Aesculus*

hippocastanum (from June to November), in the conditions of the Southern region of the introduction of woody plants (Roginsky, 2022), it is possible for *A. saccharinum* to have two moth generations (August–November).

In 2021–2022 only isolated damages of *C. ohridella* were found on *Acer saccharinum*. At the same time, it should be noted that the population of the lower crown of horse chestnut under the same conditions in 2021 exceeded 95 % of the leaves of the lower crown, in 2022 this figure did not exceed 70 %.

The density (number) of mines on horse chestnut per leaf blade in 2022 decreased compared to 2021, which may be due to the autumn harvesting of foliage in the park. Even under such conditions, mining of the leaves of *Acer saccharinum* is noted, and adaptation of the chestnut moth to a new host plant is expected.

For comparison, it was analyzed the size and area of damages made by the chestnut moth on the leaves of the common horse chestnut and silver maple.

The work of Polish researchers (Łaszczycza et al. 2021) notes the variation in the dimension of individual leaf damage by horse-chestnut mining moth, which changes under the influence of environmental factors. We also note the variation in the size of damages on different types of host plants in representatives of the family Gracillariidae (Sinchuk & Buga, 2016; Sinchuk & Sinchuk, 2021).

The analysis of the morphometric parameters of individual leaf mines, however, showed that the length and areas of individual mines formed by *C. ohridella* larvae on *A. hippocastanum* and *A. saccharinum* have differences (Table).

Table. Dimensional characteristics of the damage to the leaves of *Aesculus hippocastanum* and *Acer saccharinum*

Damage parameters	<i>Aesculus hippocastanum</i> (min.-max)		<i>Acer saccharinum</i> (min.-max)	
	2021*	2022*	2021**	2022**
Length, cm	1.35–2.60	1.34–2.07	0.82–1.59	1.21–1.83
Area, cm ²	1.38–2.31	0.59–1.41	0.36–0.88	0.60–0.7

* n=10, ** n=3

Discussion

Plants of the genus *Aesculus* are exceptional host plants for the Gracillariidae family. In total, three miner species trophically associated with horse chestnut are known: *Cameraria aesculisella* (Chambers, 1871), *Cameraria ohridella* Deschka & Dimić, 1986 (De Prins & De Prins, 2006–2022) and *Caloptilia aesculi* Liao, Ohshima & Huang, 2019, recently described in China (Liao et al. 2019).

It should be noted that other representatives of the Sapindaceae family (a total of 16 genera of plants of the Sapindaceae world flora are associated with Gracillariidae, but, in the majority, with the genus *Acer*) serve as host plants mainly for moths from the genera *Phyllonorycter* (subfamily Lithocolletinae) and *Caloptilia* (subfamily Gracillariinae). However, in general, relatively few species of Gracillariidae are trophically associated with this family (71 registrations out of more than 2000 in the world database Gracillariidae.net) (De Prins & De Prins, 2006–2022). Therefore, described cases of silver maple infestation by horse-chestnut leaf miner in the secondary areas can serve as example of a return to co-evolutionarily related host plants.

Among others there are representatives of the subfamilies Acrocercopinae (eight species from the Oriental and Afrotropical biogeographical regions) and Ornixolinae (four species from the Australian and Oriental regions, associated mainly with cultivated Sapindaceae plants), as well as one South African species of the genus *Stomphastis*. But, obviously, the diversity of such relationships is not fully appreciated, and there are many species of Gracillariidae in the world fauna, known (but without an established host plant) or not yet discovered, that can be related to Sapindaceae.

In the conditions of natural range (North America), feeding and development of larvae of

Cameraria aceriella (Clemens, 1859) and *C. saccharella* (Braun, 1908) were noted on *Acer saccharinum*. There are no specialized pests of the genus *Cameraria* for *Acer saccharinum* in the literature. In Europe, feeding on this maple species (among others) is reported for the larvae of *Phyllonorycter geniculella* (Ragnot, 1874) in Germany and *Caloptilia hemidactylella* ([Denis & Schiffemüller], 1775) in Poland (De Prins & De Prins, 2006-2022). In Ukraine (Kyiv), feeding on silver maple of two gracillariid species is reported: *Caloptilia rufipennella* (Hübner, 1796), *Phyllonorycter acerifoliella* (Zeller, 1839) (Lisovyi et al. 2017). These phytophages have not been recorded on the silver maple in Belarus.

Conclusion

As a result of the study, the facts of feeding the horse chestnut mining moth with leaf blades of the silver maple *Acer saccharinum* and the full development of one generation of this phytophage on it, *Acer saccharinum* was first recorded as a host plant of *C. ohridella* in the conditions of the southern region of its introduction in Belarus. It is necessary to continue monitoring in Belarus the damage caused by this leaf miner to the leaves of various maple species, in particular, silver maple (*Acer saccharinum*), in order to identify whether the miner will develop a new host plant in the future, or whether this is an accidental event.

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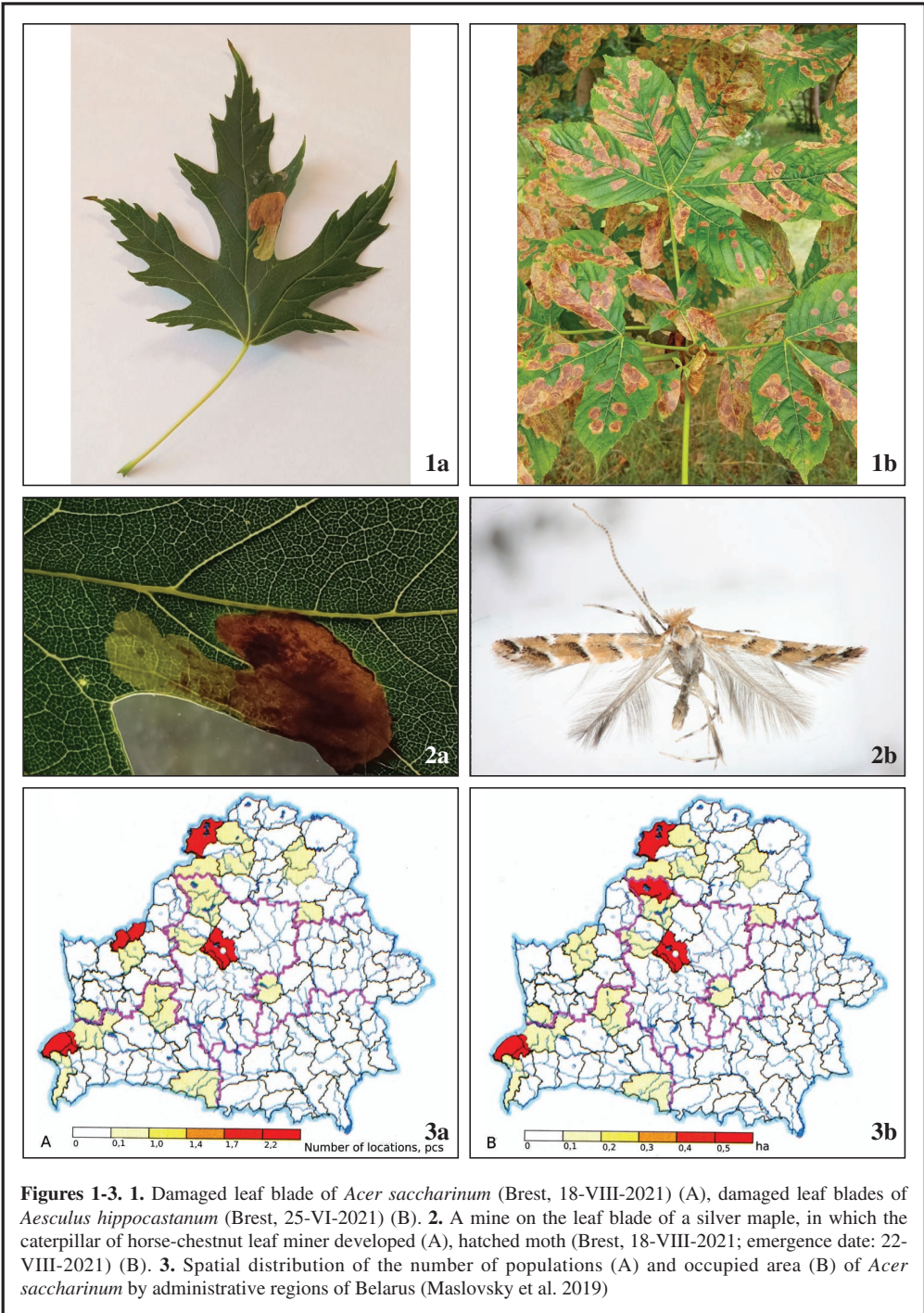
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Figures 1-3. 1. Damaged leaf blade of *Acer saccharinum* (Brest, 18-VIII-2021) (A), damaged leaf blades of *Aesculus hippocastanum* (Brest, 25-VI-2021) (B). 2. A mine on the leaf blade of a silver maple, in which the caterpillar of horse-chestnut leaf miner developed (A), hatched moth (Brest, 18-VIII-2021; emergence date: 22-VIII-2021) (B). 3. Spatial distribution of the number of populations (A) and occupied area (B) of *Acer saccharinum* by administrative regions of Belarus (Maslovsky et al. 2019)