

# The Developmental Stages Passage of *Cameraria ohridella* under the Damage to *Aesculus hippocastanum* L. may be Affected by Lighting Conditions

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Trees that retain a high decorative value for a long time, are resistant to adverse conditions of the urban environment, create a comfortable sanitary, ecological and psychological environment and form the green areas esthetic appearance. For urban landscaping, an assortment of woody plants resistant to anthropogenic factors is optimal to be used, which include linden, ash, maple, elm, including different types of horse chestnut. Horse chestnut *Aesculus hippocastanum* L. is the most adapted to urban conditions.<sup>1,2</sup> This species has high decorative qualities, sustainable and is used in landscaping cities in many countries of central and northern Europe. In the last years of the XXth and the beginning of the XXIst, it has become one of the most popular woody plants in landscaping facilities in central Russia and is widely used in urban and private landscaping. Recently, the horse chestnut has been threatened with massive damage and shrinkage as a result of the harmful activity of the invasive Ohrid chestnut leaf miner (*Cameraria ohridella* Deschka&Dimič). Due to the numerous brown fragments of the epidermis formed by mines, the leaves lose their decorative performance and become variegated. At the end of the season, sometimes a month before the end of the growing season, all damaged leaves turn brown, curl, and die off. Trees damaged by the Ohrid miner are massively deprived of their natural seasonal decorative effect.

The objective of this investigation was to assess the effect of crown illumination on the development of *Cameraria ohridella* Deschka&Dimič larvae and pupae on old-growth horse chestnut trees *Aesculus hippocastanum* L.

## MATERIALS AND METHODS

Sampling was carried out in the last decade of September in clear sunny weather from the lower branches of two European horse chestnut trees: 1) "light" latitude 55.70674094; longitude 37.52081841 (altitude 189m above sea level), illumination at 13.00 on a clear day ranges from 15000 to 25000 lux); 2) "shadow" latitude 55.70464027, longitude 37.52375811 (altitude 200 m above sea level), illumination at 1300 on a clear day is from 1300 to 2400 lux) (defined using Google map service). For analysis, fully formed leaves with characteristic lesions (no leaves without damage were observed neither in the lower part of the crown, nor on other higher-located branches). Three independent samples were taken with 10 damaged leaves in each sample (small leaves, leaves with deformations or those with obvious asymmetries were not used).

The selected leaves were brought to the laboratory and photographed. Next, the upper epidermis was removed in the sites of mines formed by the caterpillars. As with the discovery of pupae in the cavity of mines, they were photographed at the site of detection. The larvae and pupae that formed cocoons were photographed directly in them, after which they were extracted and taken into account according to the ontogenesis stage.

The collected caterpillars were located in mines occupying different sites and contained larvae of different ages on the same plant leaf both on a tree located "in the shade" and on a tree located "in the light". Caterpillars of the early stages of development were grayish-green in color and were transparent. By the end of development, the caterpillars increased in size and became darker (Fig. 2), which is typical for this species and corresponds to the data of other authors.<sup>3,5</sup>

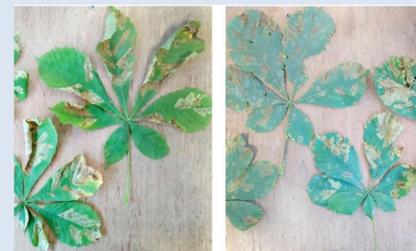
## RESULTS AND DISCUSSION

In our study, the caterpillars and pupae of the miner were studied on the leaves of a horse chestnut growing in different light conditions. Thus, the total number of injuries (before accounting for caterpillars and pupae) on the leaves of chestnut growing in the light was the same. However, a larger number of caterpillars on the leaves of chestnut growing in the shade were found compared to the pupae number (Fig. 1). Damage by the Ohrid miner occurred sequentially and was represented by injuries due to the deposition of eggs on the surface of leaves by moths of the first and second generation. At the same time, in September, feeding caterpillars of different ages may still be found in the parenchyma of unsealed leaves, which are likely to form a cocoon and pupate only in October. This may be caused by the peculiarities of the development of the pest in the weather conditions of the region, since a longer growing season and acceptable temperatures in the region of detection (Macedonia) and southern Europe indicate the maintenance of 4-5 generations during the season. While in the conditions of Moscow, central Russia and eastern Kazakhstan, the development of no more than two full-fledged generations is characteristic.

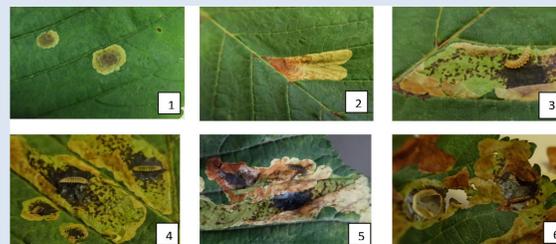
Also, a comparison was made of the number of caterpillars on a late stage of development collected from plants growing in different light conditions (Fig. 3). Significant differences were found between the studied options during the study. Thus, it is obvious that the number of caterpillars at a late stage of development was higher on the leaves of the horse chestnut under shading conditions (1.6 times) (Fig. 3). A large number of un-pupated older caterpillars feeding on plants growing in shaded conditions may be associated with a change in the chemical composition of secondary metabolites and due to unfavorable conditions (temperature, insolation, distribution of secondary metabolites).

The cut leaves were analyzed for the degree of infestation with chestnut miner. The common horse chestnut was found to be damaged severely by the miner, since the lesions were pronounced and occupied a large leaf area (Fig. 4).

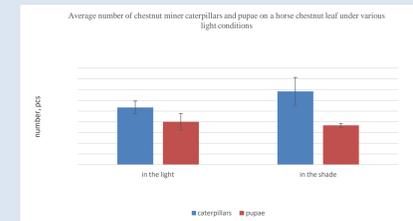
In both cases, damage to chestnut leaves by caterpillars was dynamic; both caterpillars at an early stage of development and pupae were noted (Fig. 5).



**FIGURE 4.** Degree of infestation with chestnut miner, 1 - light, 2 - shadow.



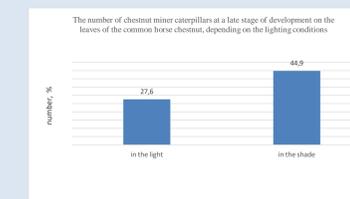
**FIGURE 5.** Dynamics of the mines formation by the chestnut miner 1-2 - mines, 3-4 - caterpillars of the early stage of development, 5 - caterpillar of the late stage of development, 6 - pupa.



**FIGURE 1.** Average number of chestnut miner caterpillars and pupae on a horse chestnut leaf under various light conditions.



**FIGURE 2.** Caterpillars of the chestnut miner. 1 - an early age caterpillar of an early age, 2 - a caterpillar on late stage of development.



**FIGURE 3.** The number of chestnut miner caterpillars at a late stage of development on the leaves of the common horse chestnut, depending on the lighting conditions.

Thus, it can be assumed that the location of the tree in the light or in the shade insignificantly affects the degree of damage in the presence of pest moths; the differences are noticeable only in the ratio of the number of larvae of different ages and pupae. The reasons for the differences may be associated with a change in the level of hormones responsible for the passage of ontogenesis, both in connection with a change in the quality indicators of nutrition, and abiotic factors associated with lighting, temperature, humidity, gas composition, sensitivity to the intensity or light wavelength.

## SUMMARY

There is a clear difference in the speed and quality of the stages of ontogenesis passage, depending on the lighting conditions. This suggests that when monitoring this pest development and selecting methods to combat the Ohrid miner, it is necessary to take into account the location of the tree and the degree of illumination of the place of its growth.

## ACKNOWLEDGMENTS

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