Ecological characteristics of horse chestnut (*Aesculus hippocastanum* L.) plantings of the city of Orel

A.P. Tyapkina[1,*], *Zh.G.* Silaeva[2], *L.L.* Kiseleva[1], *N.A.* Shiryaeva[2] and *E.A.* Parakhina[3]

[1] Orel State University named after I.S. Turgenev, city of Orel, Russia
[2] Orel State Agrarian University named after N.V. Parakhin, city of Orel, Russia
[3] Peoples' Friendship University of Russia, city of Moscow, Russia

Abstract. Today, the leading factors of deterioration of woody plants in natural and artificial ecosystems are pests and pathogens. Monitoring and control of populations of known pest species and pathogens is an urgent task of modern ornamental plant raising. The purpose of the work was to characterize the state of *Aesculus hippocastanum* L. plantings at the objects of landscape architecture of the city of Orel for damage by the chestnut miner *Cameraria ohridella* Deshka et Dimic. Plantings of *A. hippocastanum* L. were examined at four landscaping sites of the Sovetsky district of the city of Orel. The plantings were assessed visually, according to the condition of the crown and the damage to the leaves of the horse chestnut with a periodicity of 17 days. As a result of the study, it was shown that most of the damaged woody plants were found in the City Park of Culture and Recreation, to a lesser extent - on Victory Boulevard, where preventive stem injections were carried out. As the main measures to combat the chestnut mining moth in urban conditions, systematic pruning of species, stem injections, replacement of species with resistant species and varieties are recommended*: A. carnea, A. glabra, A. indica.*

1 Introduction

The problems of deterioration of tree plantations in the city of Orel have been discussed by experts for a long time [1-4]. The leading factors of deterioration of woody plants in natural and artificial ecosystems are pests and pathogens. Monitoring and control of populations of known pest species and pathogens, early detection, and accurate identification of new harmful organisms, study of ways of their spread and adaptation to woody plants – these and other tasks require the involvement of modern scientific approaches.

Biological invasions – migration of biological objects (plants, animals) outside their natural habitats - are the provoking factors of mass damage and affect to tree plantations. An example of such infestations is the chestnut mining moth (chestnut miner *Cameraria ohridella* Deshka et Dimic), noted on the territory of our country in 2003 in the Kaliningrad

* Corresponding author: angelikpt@mail.ru

region [5]. In 2009, the pest was found in the Rostov region, and in 2010, individual mines were found on individual trees of horse chestnut in the city of Krasnodar [6].

Until recently, horse chestnut (*Aesculus hippocastanum* L.) was widely used in urban landscaping in the European part of Russia and the CIS countries and was one of the most valuable decorative tree species. This species was planted for landscaping streets, parks, squares, educational institutions, courtyard spaces, etc. The value of this is not only its decorativeness, but also its resistance to adverse environmental conditions.

The purpose of the work is to assess the condition of horse chestnut (*Aesculus hippocastanum* L.) plantings on the landscape architecture objects of the city of Orel.

2 Materials and Methods

Cameraria ohridella Deshka et Dimic. belong to order Lepidoptera, suborder Microlepidoptera, midget moths family Gracellaridae, genus Samegagia. The moth overwinters in the imago stage. The flight of butterflies begins in late spring – first half of summer, females lay eggs one at a time on the adaxial side of the leaf plates, mainly near the conductive veins. The female covers each egg with a viscous transparent substance that dries over the egg and forms a film. Butterflies of the first generation lay eggs on the leaves of the lower part of the crown, mainly of senile and sub-senile trees. Butterflies of the second generation lay eggs on the leaves of both the lower and middle parts of the crown. By the time of the second generation flight, the lower leaves are eaten by the caterpillars of the first generation. Hatched caterpillars gnaw through the epidermis at the point of contact of laid egg and leaf surface and penetrate into the columnar tissue, gnawing out a cavity in it - a "mine" (this process is called mining). At first, the mines are small, in the form of brown spots. As the caterpillars grow and they eat the parenchymes, the mines become larger, acquire an arbitrary shape. These formations soon merge, forming an extensive brown spot [7].

Numerous mines lead to defoliation of chestnut leaves and loss of decorative effect of the whole tree. In addition to the deterioration of the tree appearance, the normal processes of vital activity of trees are disrupted. Damaged crowns lose a significant part of the photosynthetic apparatus, which as a result leads to the weakening of trees and loss of stability, disruption of carbohydrate metabolism and metabolism, insufficient accumulation of plastic and energy substances. These negative factors can lead to partial or complete tree freezing in winter.

In our country *C. ohridella* Deshka et Dimic is a quarantine facility that poses a threat to *A. hippocastanum* L. not only by the loss of the decorativeness of the whole plant, but also by the violation of vital processes in trees, which leads to their weakening, loss of productivity, partial drying of the crowns, and possible death.

We have studied four objects of landscape architecture of the Sovetsky district of the city of Orel, on which the horse chestnut grows: the arboretum of the Orel SAU, Victory Boulevard, L.N. Gurtyev Garden Square, the City Park of Culture and Recreation.

Table 1. Characteristics of landscape architecture objects

Object	Brief description	Number of horse chestnut specimens, pcs.
Arboretum of the Orel SAU	Located on Generala Rodina Street. On the territory adjacent to the object there are residential buildings, private sector, suburban areas, and garages. The area is 4.7 hectares. The terrain is smooth.	159
Victory Boulevard	Located between the Oktyabrskaya Str. and	66

	Leskova Str. The relief is smooth without significant differences. The length is about 400 m.	
L.N. Gurtyev Garden Square	It is located in the square of Pionerskaya, Saltykova-Shchedrina, Oktyabrskaya, and Gurtyeva streets. The area is 2.84 hectares. The terrain is smooth.	50
City Park of Culture and Recreation	It is located on M. Gorky Street, on two virtually isolated from each other sites with a weakly expressed pedestrian and visual interconnection. The central part of the park is located on the left bank of the Oka River, mainly has a calm terrain with a slope in the south-east direction. The area is 14.5 hectares.	106

The plantings were assessed visually, according to the condition of the crown and the damage to horse chestnut leaves. The first observations were made on July 5, 2021, followed 17 days later.

The general condition of chestnut plantations was assessed according to the A.I. Vorontsov et al. [8] scale, modified by S.A. Tribel and O.N. Gamanova [9].

Assessment of damage to the crown and leaves of horse chestnut by chestnut mining moth was carried out according to a scale developed by S.A. Tribel and O.N. Gamanova[9].

3 Results and Discussion

Assessment of the state of *A. hippocastanum* L. specimens on the objects of landscape architecture is shown below (Table 2).

Table 2. Number of trees (as a percentage) in the corresponding categories of conditions at the greening facilities of the city of Orel in 2021.

Place of growth	Number of trees in % in the corresponding categories				
	Healthy	Weakened	Severely weakened	Shrinking	Dead
Arboretum of the Orel SAU	0.00	60.00	40.00	0.00	0.00
Victory Boulevard	0.00	100.00	0.00	0.00	0.00
L.N. Gurtyev Garden Square	0.00	0.00	67.00	23.00	0.00
City Park of Culture and Recreation	0.00	0.00	50.00	50.00	0.00

Relatively young chestnut trees grow in the arboretum of the Orel SAU, which are subjected to seasonal pruning, as a result of which the moth cannot go through the entire development cycle on the leaves, and the visible degree of leaf and crown damage is reduced or practically absent. Measures to protect horse chestnut from moths were not carried out on the arboretum territory.

Victory Boulevard is the place where the injection treatment of trees against chestnut miner was carried out in May 2019. This has had a good effect and the 40-year-old trees are in satisfactory sanitary and decorative condition. Nevertheless, it is too early to talk about the effectiveness of intra-stem injections: according to the data of the Municipal Unitary

Enterprise "Zelenstroy", which serves the facility, the treatment was carried out at the facility for only one year and not a full cycle.

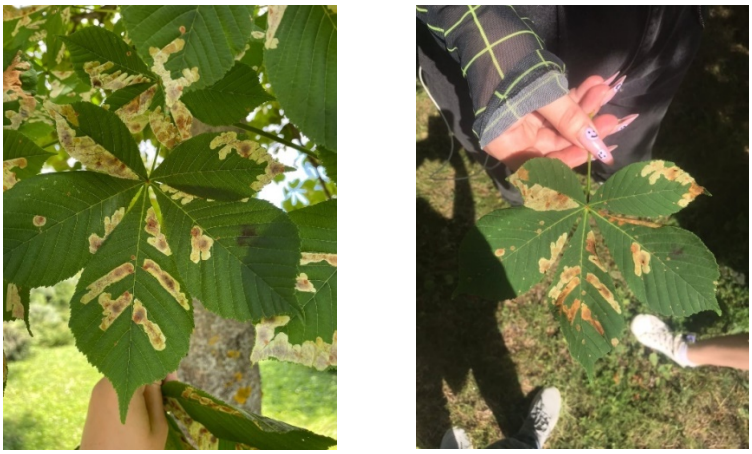
On the territory of the L.N. Gurtyev Garden Square, shrinking trees account for 23% of the studied number of species, which negatively affects the decorativeness of the entire park. Agrotechnical measures and measures to protect horse chestnut from miner were not carried out.

The horse chestnut in the city park of culture and recreation is most damaged by a mining moth (Table 3).

On the studied objects of landscape architecture, it was noted that the leaves of affected trees bloom with a delay of 6-7 days, compared with healthy species. At the same time, their aboveground mass gain decreases, the size of leaves, the intensity of flowering, the size of fruits and seed nuts decreases. If in healthy trees the size of seed nuts is 3-5 cm in diameter, then in damaged trees there is a decrease in diameter by 2 times and it does not exceed 1.8 – 2.3 cm, while there is a significant decrease in the number of fruits.

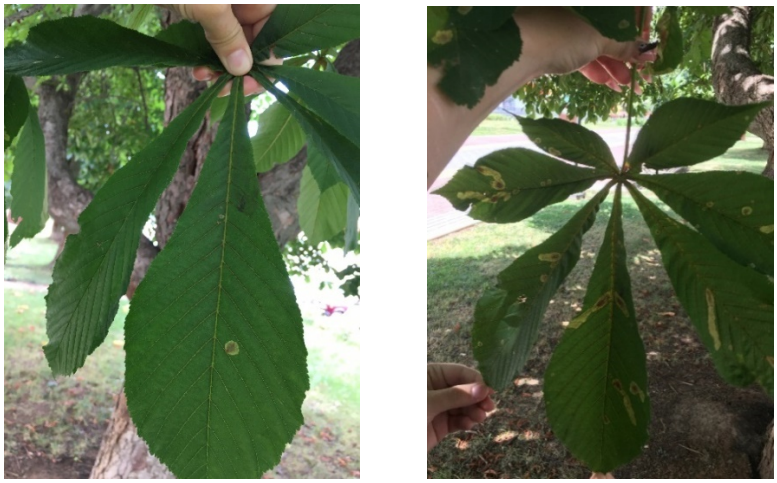
Table 3. Assessment of the condition of horse chestnut crown and leaves.

No.	Object name	Assessment of tree crown condition, score	Assessment of damage to tree leaves, score
1	OSAU Arboretum	5.01±0.79	4.04±0.82
2	Victory Boulevard	7.89±0.76	2.15±0.74
3	L.N. Gurtyev Garden Square	3.87±0.73	6.04±0.84
4	City Park of Culture and Recreation	3.03±0.64	7.56±0.79



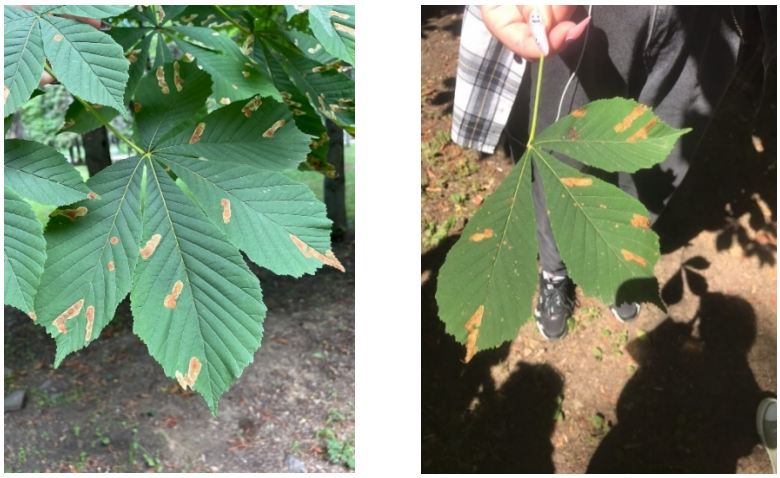
a) b)

Fig. 1. Arboretum of the Orel State Agrarian University: a) – degree of damage on July 5, b) – the degree of damage on July 22



a) b)

Fig 2. Victory Boulevard: a) – degree of damage on July 5, b) – degree of damage on July 22.



a) b)

Fig. 3. L.N. Gurtyev Garden Square: a) – degree of damage on July 5, b) – degree of damage on July 22.

a) b)

Fig. 4. City Park of Culture and Recreation: a) – degree of damage on July 5, b) – degree of damage on July 22.

Measures have been developed and applied to combat and protect horse chestnut from mining moths: biological methods of protection (for example, trichogram larvae, many species of birds consider chestnut miner as an element of the diet, etc.); chemical (the use of insecticides unsafe for human health, as well as the use of stem injections, pheromone traps), mechanical (sanitary pruning, harvesting, and removal of leaves).

In our opinion, one of the ways to combat the mining moth is timely pruning of chestnuts. One example is the chestnut plantings on the Koltsevaya Str. of the city of Orel. The trees at this facility are in good condition, the crown and leaves are not damaged. According to our observations, no special agrotechnical measures were carried out, except for sanitary pruning and removal of fallen leaves (Fig.5).

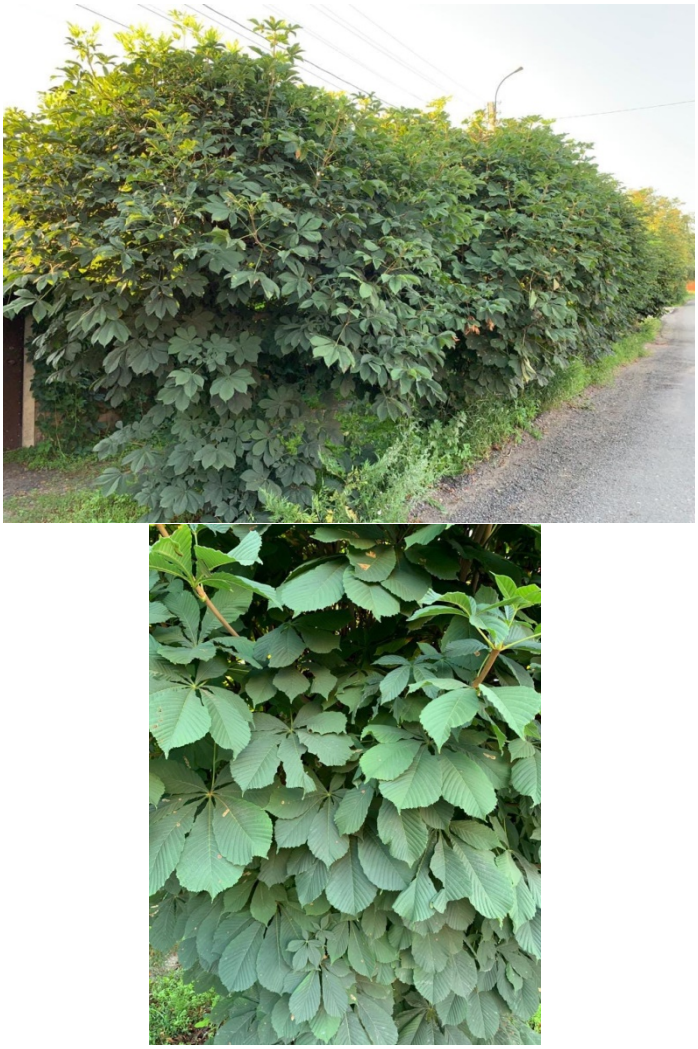


Fig. 5. Horse chestnut on Koltsevaya Street, city of Orel (August 10, 2021).

Currently, the use of systemic insecticides of 1 and 2 hazard classes, which are extremely dangerous and highly dangerous for humans, remains a highly effective, but not always justified, from the point of view of ecology and human health, method of chestnut moth combating. Among them there are systemic insecticides Aktellik, Iskra, Imidakloprid. At the same time, a promising direction in modern plant protection is the restriction of the use of pesticides and their replacement with biological products, organisms-agents of biological control of pests and pathogens, increasing the resistance of woody plants [10].

In several European countries, horse chestnut is replaced at landscape architecture sites by other species and hybrid forms of chestnut of the genus Aesculus, resistant to miner damage: *A. carnea, A. glabra, A. indica* [11].

4 Conclusions

Thus, analyzing the accumulated domestic and foreign data, as well as because of the conducted research, the following conclusions can be drawn:

1. On the studied objects of landscape architecture of the city of Orel, horse chestnut is systematically susceptible to damage by miner *Cameraria ohridella* Deshka et Dimic. Most of the diseased trees were noted in the City Park of Culture and Recreation, to a lesser extent - on Victory Boulevard, where preventive stem injections were carried out.

2. It was found that the leaves of damaged trees bloom with a delay of 6-7 days, compared with healthy species. A decrease in the growth rate of aboveground mass was noted, the size of leaves, the intensity of flowering, the size of fruits and seed nuts decreased.

3. As the main measures to combat the chestnut mining moth in urban conditions, systematic pruning of species, stem injections, replacement of species with resistant species and varieties are recommended.

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