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State of horse-chestnut, *Aesculus hippocastanum* L., in Lithuania: diseases and pest damages

Vilija Snieškienė[1],

Ligita Baležentienė[2],

Antanina Stankevičienė[1]

[1] *Kaunas Botanical Garden of Vytautas Magnus University, Ž. E. Žilibero 6, LT-46324 Kaunas, Lithuania*

[2] *Aleksandras Stulginskis University, Akademija, LT-53341 Kaunas distr., Lithuania*

Commonly used ornamental tree *Aesculus hippocastanum* has been successfully used for planting for a long time in Lithuania. Data of the state of *A. hippocastanum* were assessed in 55 cities and settlements of the country during 1992–2009. The changing state of *A. hippocastanum* was recorded to begin to deteriorate in 1995–1997 when the species was affected by fungi diseases caused by *Guignardia aesculi, Erysiphe flexuos* and *Schizophyllum commune*. Horse-chestnut leafminer *Cameraria ohridella* has been the most harmful pest over all territory of Lithuania since 2005–2007. Effectiveness of natural predators and different means for *C. ohridella* control as well as for spread of fungal diseases were analyzed and discussed.

Key words: environment, *Aesculus hippocastanum*, diseases, pests

INTRODUCTION

Aesculus hippocastanum L. is attributed to *Sapindaceae family* and *Hippocastanoideae* subfamily. This species originated from the south of Balkan peninsula, in Northern Greece and Southern Bulgaria. *A. hippocastanum* was brought from Constantinople to Western Europe in late 16th – early 17th century (Küstler, 1999). There are no exact records about the beginning of introduction of *A. hippocastanum* in Lithuania. Initially, they were grown in parks of manor houses, and later on this species has spread because of favourable climatic conditions. Currently *A. hippocastanum* is a common ornamental plant in green areas of Lithuanian cities. These ornamental trees are grown in parks, squares, on roadsides, near country-houses. *A. hippocastanum* is not the main ornamental species in city greeneries as together with *Acer negundo* L. and *A. platanoides* L. this species makes about 20% of all tree species used for city greening (Snieškienė et al., 1999). Thus *A. hippocastanum* is used quite rarely.

The state of *A. hippocastanum* has been sufficiently good for a long time owing to tolerable climatic conditions and low damage by disease agents and harmful pests. However, the situation has changed during the last years and the state of *A. hippocastanum* became deteriorating. Phytopathological state of *A. hippocastanum* worsened a few years ago in neighbouring countries located to the west and south of Lithuania. The causes of the impairment are both biotic (new disease agents and pests appeared over short time) and abiotic (climate change). Due to climate change cold-limited pest species may be able to extend their geographic range northwardly (Jepsen et al., 2008). There have been observed changes in the distribution of many species in the northern hemisphere owing to unusually hot summers. Moreover, increase in atmospheric CO_2 as well as shifts (usually downward) in precipitation and, particularly, increase in temperature alter plant phenology, influence herbivore growth and abundance, and indirectly affect the abundance of prey / hosts for natural pathogens/pests (Thomson et al., 2010). Despite the economic importance of the pest and pathogens which represent a key component of the horse-chestnut environment, species variation in pest / disease resistance remains poorly examined.

The aim of this study was to assess the state of *A. hippocastanum* during the period of 1992–2009 in Lithuania taking into consideration diseases and pest damages.

MATERIALS AND METHODS

The state of *A. hippocastanum* was checked and assessed every July during 1992–2009 in cities of Lithuania (Vilnius, Kaunas, Panevėžys, Šiauliai, Klaipėda, Marijampolė, etc). Due to the wide spread of *Cameraria ohridella* the state of *A. hippocastanum* started (2004) to be assessed over the en-

* Corresponding author. E-mail: ligita.balezentiene@asu.lt

tire territory of Lithuania in 55 cities and settlements. For detailed analysis, *A. hippocastanum* trees growing in three streets, two squares and one park of Kaunas city (middle Lithuania) were chosen. The state of approximately 1000 trees was assessed. *A. hippocastanum* trees were observed starting from leaves' emergence stage in spring till their fall, and the state of trunks was assessed during the leafless period.

The degree of tree damage was estimated according to the method used by A. Žiogas et al. (2006) with a slight adaptation. The categories of tree state were evaluated within 5-grade scale (Table 1).

After the assessment of tree state, the average damage grade was estimated, employing a modified procedure applied in agriculture and forestry (Šurkus, Gaurilčikienė, 2002) according to the formula:

$$V = \frac{\sum_{i=1}^{5}(n_i \cdot b_i)}{N},$$

where V – average grade of damage; n_i – number of plants damaged to the same grade and the sum of products of the i-th grade; b_i – the numeric value of the i-th grade; N – number of checked plants.

Pathogens were identified based on the symptoms of diseases and fungi morphological features (Butin, 1983; Hudson, 1987; Braun, 1995; Braun, Takamatsu, 2000). Insect pests were identified according to Deschka and Dimic (1986).

Statistical analysis was done using MicroSoft Exel 2003.

RESULTS

In Lithuania the state of *A. hippocastanum* was quite good and stable till 1997. Later it began to change obviously with causes varying year to year. In Lithuania, like in Europe, every few years a new either pathogenic fungus or pest damaging horse-chestnut trees appeared (Figs. 1 and 2).

A. hippocastanum leaves injured by leaf blotch disease caused by *Guignardia aesculi* (Peck) Stew. (anamorpha *Phyllosticta sphaeropsoidea* Ellis & Everk. (syn. *Phyllostictina sphaeropsoidea* (Ellis & Everk.) Petr., *Asteromella aesculicola* (Sacc.) Petr.) have been recorded since 1998

Table 1. **Assessment scale of chestnut tree damage**

Damage degree	Characteristics	Point
Relatively healthy	Leaf defoliation up to 10%, crown characteristic for the trees with no external signs of weakening	1
Weakened	Trees with slightly open crown; reduced increment; 11–25% of leaves, branches or trunks are damaged or dead	2
Weak	Open crown; highly reduced increment or its absence; 26–50% of leaves, branches or trunks are damaged or dead	3
Dying	Crown is extremely open; 51–80% of leaves, branches or trunks are damaged	4
Dead leaves, fresh deadwood	81–100% of leaves, branches or trunks are damaged. Recently dead trees	5

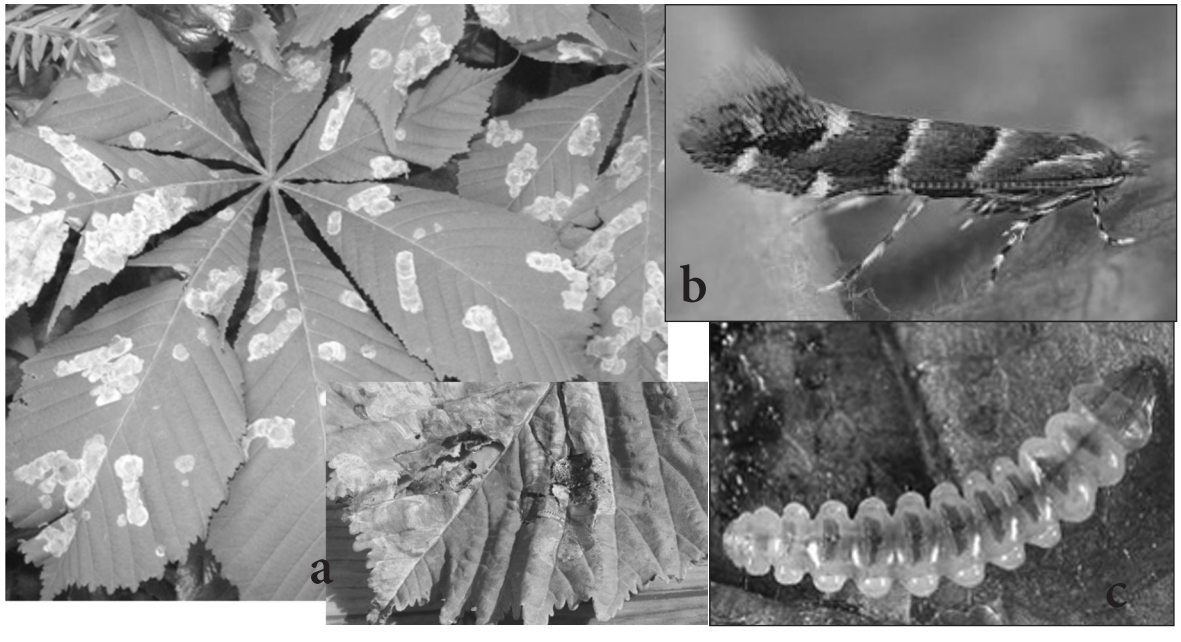

Fig. 1. *Cameraria ohridella* stages on *Aesculus hippocastanum* (a – damaged leaves of *Aesculus hippocastanum*, b – moth and c – larvae)

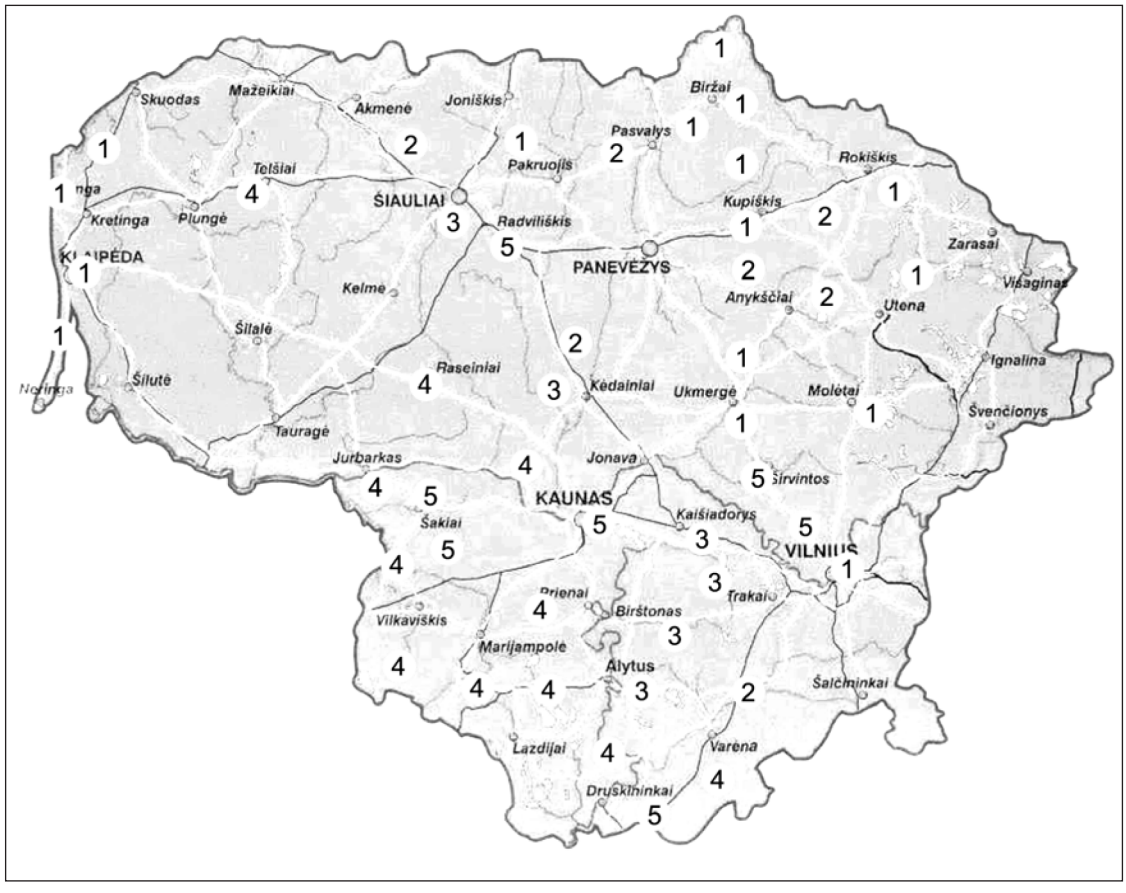

Fig. 2. Spread of *Cameraria ohridella* on *Aesculus hippocastanum* in Lithuania in 2009; 1 to 5 damage degree as indicated in Table 1

(Figs. 3 and 4). It is assumed that the spread of this disease is caused by the following favourable climatic conditions: in springtime when leaves of *A. hippocastanum* unfold ascospores germinate when leaves become dewy for a few hours at least, later fungi spread as conidia, and the most favourable conditions for that is wet and warm weather (Butin, 1983). In Lithuania leaf blotch disease appeared in warm and wet summers of 1998, 2001 and 2003: the average temperature of months of the three summers was 19.1–20.9 °C and the amount of precipitation was 118–144 mm. The following disease symptoms on the leaves were registered: large brown irregularly-shaped spots surrounded by yellow or brownish edge appeared on leaves approximately in the middle of summer, later they quickly expanded and the edge of the leaf started curling up inwards near the spots. Black fruit-bodies were clearly seen in the middle of the spots. Conidia infected the leaves repeatedly throughout all summer and injured leaves fell down before time. Stromata formed at the end of summer and overwintered inside them. In spring fruit-bodies with spores infecting *A. hippocastanum* emerged in stromata (as indicated by Pastircakova, 2004).

For Lithuania a new *A. hippocastanum* disease – powdery mildew caused by *Erysiphe flexuosa* (Peck) U. Braun & S. Takamatsu was recorded in Kaunas, Vilnius and Šiauliai in 2004 (Grigaliunaitė et al., 2004). Cleistothecia (120–160 μm in diameter) of this fungus consist of 3–5 ascos each containing 6–8 unicellular ascospores (Butin, Kehr, 2002). This fungus originated from North America (Braun, 1995) and was named *Uncinula flexuosa* (Ing, Sponer, 2002), however, genetic analysis revealed taxonomic position of this fungus in *Erysiphe* genus (Braun, Takamatsu, 2000). In Europe, the fungus was registered in Germany in 1999 (Ale-Agha et al., 2000) and rapidly spread over other countries (Ing, Sponer, 2002): Switzerland (Zimmermannova-Pastircakova et al., 2002), England (Zimmermannova-Pastircakova et al., 2002), Slovakia (Ale-Agha et al., 2000), Slovenia (Milevoj, 2004), and Hungary (Kiss et al., 2004).

It was ascertained that mildew damaged heavier more luxuriant *A. hippocastanum* trees growing under more favourable conditions as well as pruned trees with large sprouts. *A. hippocastanum* trees growing nearby under the same conditions were not equally resistant to *Erysiphe flexuosa.* Fungus (the causative agent of mildew) affects *A. hippocastanum* in the same way as other powdery mildews do, namely by decreasing assimilation surface of leaves and increasing water loss. This impedes both photosynthesis and

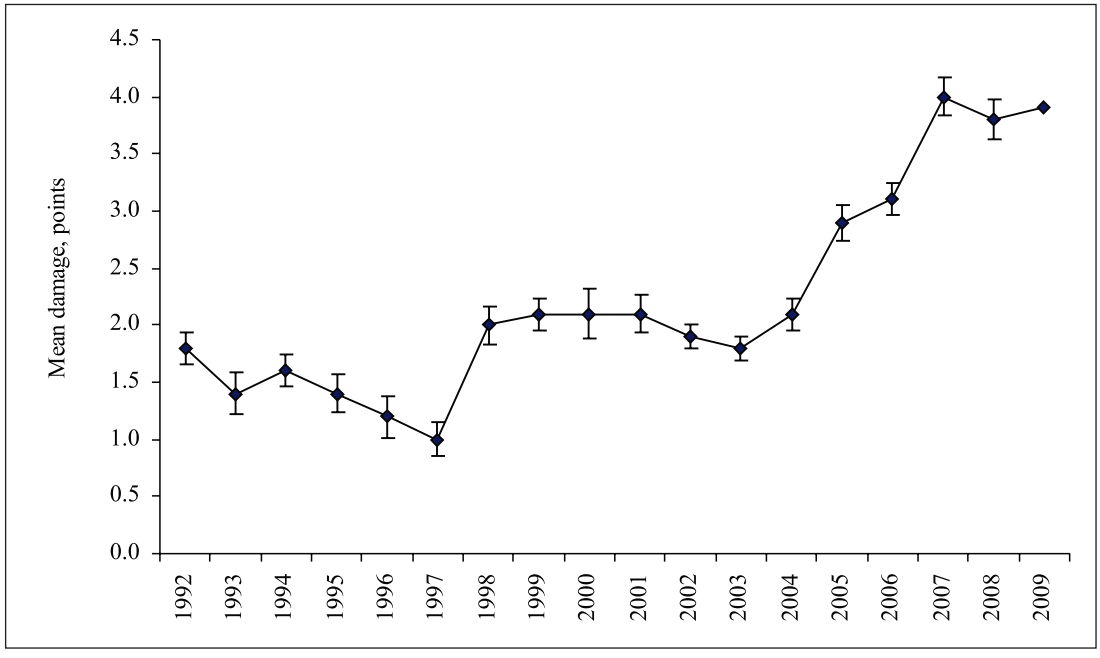

Fig. 3. Dynamics of the horse chestnut-tree damage state in Lithuania during 1992–2009 (mean ± SE)

transpiration, consequently, plant decorativeness decreases. Noticeable, recently spread insect pest *Cameraria ohridella* Deschka and Dimic, and not the diseases became the most harmful factor for horse-chestnut during the last four years in Lithuania (Fig. 3).

For the first time *C. ohridella* was detected on *A. hippocastanum* near Ohrid Lake (Macedonia) in 1984. In 1986 it was described as a new species (Deschka, Dimic, 1986). *C. ohridella* have spread quickly to the north and after a few years appeared in Croatia, Hungary and Romania (see references in Ivinskis, Rimšaitė, 2006). Later (1989) *C. ohridella* emerged in Austria (Sefrova, Lastuvka, 2001) and other European countries: Czech Republic and Germany, 1994 (Heitland, Friese, 2001; Gilbert et al., 2005), Italy, 1997 (Saleo et al., 2003), Poland, 1998 (Labanovski, Soika, 1998), Turkey, 1999, France and Bulgaria, 2000 (Sefrova, Lastuvka, 2001; Gilbert et al., 2005), Sweden, Denmark (Buhl et al., 2003), England (Gilbert et al., 2005) and Ukraine, 2002 (Akimov et al., 2003).

C. ohridella has originated from a temperate climatic zone, thus it is resistant to frost (Buszko, 2006). The speed of the expansion and the abundance of this insect are characteristic for invasive species: since detection in Southern Europe (1984) *C. ohridella* spread into Northern Europe (e. g. Finland) during the three decades.

In Lithuania the first mines of *C. ohridella* on leaves of *A. hippocastanum* were recorded in autumn 2002 in the suburb of the sea town Klaipėda (Forest…, 2007). During 2003–2004 neither *C. ohridella* moths nor mines were found there. In 2005, however, mines were observed already in 14 cities and towns, and the number grew up to 27 in 2006 and 40 in 2007 (Forest…, 2007). Even though J. Buszko (2006) reported *C. ohridella* as an invasive species in Europe, it had spread throughout Lithuania in 2006 as accidental species without establishing reproducing population. In 2006–2007 *C. ohridella* was found in localities close to the Lithuanian–Latvian border.

Different vehicles (long-distance trucks, trains, ferries, etc) can serve as significant means for *C. ohridella* expansion. Adult moths and *C. ohridella* pupae sheltered in fallen leaves may "travel" long distances. The highest number of this pest was observed in greeneries of larger cities and on roadsides of the main highways (Kiss et al., 2004; Labanovski, Soika, 1998). Spreading speed of 50 km per generation was recorded for *C. ohridella* near the main roads planted with *A. hippocastanum* in Ukraine (Akimov et al., 2003).

Spread of *C. ohridella* was observed in 55 cities, towns and settlements of Lithuania (Fig. 2). The pest spread unevenly over all territory of Lithuania; some regions can be marked as being less influenced by the pest. The healthiest *A. hippocastanum* trees grow in western and north-eastern Lithuania (mean damage is 1–2 points), and the most injured trees grow in the middle and south-western Lithuania (mean damage is 4–5 points) (Fig. 1). *C. ohridella* has spread over all country within 7–8 years. Countries situated close to Lithuania were colonized faster (e. g.: Poland was colonized within 5 years with speed of expansion – 100 km per year) (Buszko, 2006).

It is common that tree damage grade differs in the same city or town. This depends on growing conditions. The heaviest damage of *A. hippocastanum* was noticed in parks and

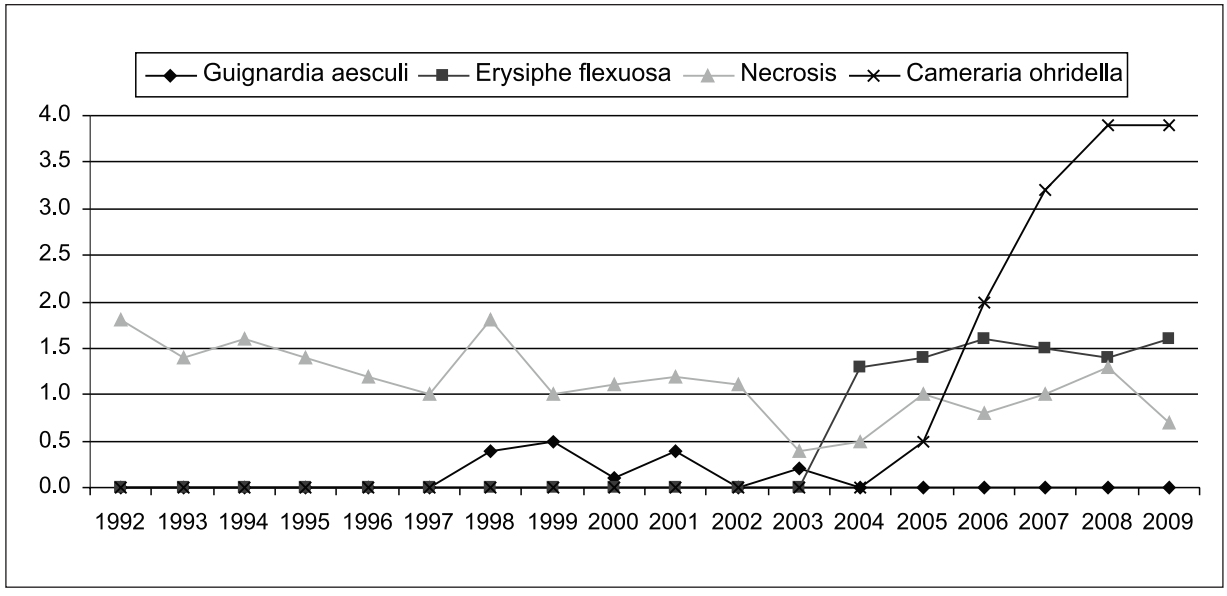

Fig. 4. Dynamics of horse-chestnut pests, disease agents and necrosis damage during 1992–2009 in Lithuania

streets where fallen leaves used to be left on the ground (near parks, squares, hedgerows or similar places). Nonetheless, trees growing on roadsides under the worst edaphic conditions (covered under-tree) where fallen leaves were removed regularly contained the least number of mines on their leaves.

Trunks of *A. hippocastanum* trees planted in the open areas (parking places near shopping malls, streets) often fissured at the end of winter and the beginning of spring, and wounds were colonized by saprotrophic fungus *Schizophyllum commune* Fr. The fungus causes white surface rot (Rypacek, 1957). The dead bark areas enlarge and form necrosis on the stem; bark detaches leaving bare areas on the stem. Trees of *A. hippocastanum* cultivar 'Baumannii' originating from Poland contained the same damages. Nonetheless, this type of injuries was not detected on pruned *A. hippocastanum*. Pruned *A. hippocastanum* trees are more resistant to *S. commune* than other tree species growing nearby (Snieškienė, Juronis, 1999). The fruit-bodies of *S. commune* were found on *A. hippocastanum* grown together with trees of other species (those from genera *Tilia*, *Acer*) only. If streets were planted only with *A. hippocastanum*, *S. commune* was detected neither on mechanically damaged nor on pruned trees (Snieškienė, Juronis, 2007).

In Lithuania, intensive pruning of trees growing at the roadsides has been exercised since 1995. Large wounds left after cutting branches of *A. hippocastanum* heal up poorly, especially those larger than 15–20 cm in diameter, moreover, about 80% of them become affected by wood and pith rot in 2 to 4 years.

Up to 30% of *A. hippocastanum* trees (especially those planted on the sidewalks of narrow streets of old towns and city centres) particularly suffered from leaf necrosis. This was recorded in Kaunas, Panevėžys and Šiauliai.

DISCUSSION

State-wide assessment of *A. hippocastanum* trees growing in Lithuanian urban areas lasted for 17 years (Snieškienė et al., 1999; Budriūnas et al., 2002; Žeimavičius et al., 2004; Zeimavicius, 2005). It was affirmed that the state of horse-chestnut trees got worse during 2004–2009 (Figs. 2 and 4). During 1992–1997 the state of *A. hippocastanum* was rather good and stable (mean damage was approximately 1 point), whereas the state used to become worse during the drier summers as trees growing near streets contained more necrosis damages on their leaves. In Lithuania *G. aesculi* was recorded and started to spread in 1998. The state of *A. hippocastanum* got worse irrespective of locality. Around 2002–2003 the intensiveness of *G. aesculi* spread decreased. However, due to the spread of insect pest *C. ohridella* tree state has been worsening since 2005 (Fig. 4). In Lithuania leaves damaged by *C. ohridella* become brown and fall down in July–August. Some trees tend to grow new leaves in August–September, therefore trees cannot prepare themselves for winter in time and can be injured by frost (Kosibowicz, Pawlowski, 2008). *A. hippocastanum* is grown in Lithuania as a decorative plant but due to *C. ohridella* activity it loses decorativeness and hence its suitability for planting becomes questionable.

Because of double flower and decorativeness *A. hippocastanum* cultivar 'Baumannii' could be more suitable for cities and roadside greeneries. However, non-resistance to wide temperature fluctuations in winter and spring and infection by *S. commune* were noticed. Raising trees of this variety from locally originating seedlings could possibly make them more resistant compared with presently used (imported) young trees.

The means for improvement of state of A. hippocastanum

The mechanical means related to pathogen development. The

pathogen fruit-bodies as well as C. ohridella larvae and pupae overwinter in fallen leaves and infect young leaves in spring. Hence, it is essential to eliminate fallen leaves during the whole period of vegetation and especially till the beginning of April when moths emerge from pupae. Leaves must be burned or put in compost heap covered with sheet or ground layer for a longer time: moths are killed when the temperature in a heap reaches at least 40 °C (Kehrli, Bacher, 2003). Death-rate of pupae during winter period kept under –39 °C temperature conditions and 30% relative humidity reached 100% whereas the death rate of pupae kept under –21 °C and 30% relative humidity, was merely 33% (Kosibowicz, Pawlowski, 2008). Moth elimination by pheromone traps did not decrease population of *C. ohridella* (Baranowski et al., 2008; Pudlis, 2008).

A. hippocastanum trees badly tolerate heavy pruning. In order to maintain vitality and not to decrease their lifespan, only small branches can be pruned, and the most preferable tree planting localities are those where pruning is completely unnecessary.

The activity of helpful organisms. Their effect in reducing the number of pests was not significant. In Switzerland and Germany there were recorded 28 species of natural predators and parasites of *C. ohridella*. Lacewings (*Chrysopidae*) and spiders were the most efficient among them (Grabenweger, 2001). Under natural conditions parasite insects infected not more than 3% of *C. ohridella* caterpillars (Kehrli, Bacher, 2003). The highest parasitism was recorded in localities where the pest has been present for 10-year and a longer period, consequently, the possibility of some sort of balance between the pest and its parasitoids can be expected (Kosibowicz, Pawlowski, 2008). Tits destroyed *C. ohridella* larvae and adults. However, birds were able to kill not more than 3% of the pest population (Kehrli, Bacher, 2003).

Insecticide application. This method is rarely used taking into consideration hygiene and ecology aspects. The method of insecticide application by microinjection into trunk was developed and tested (Labanowski, Soika, 2003; Labanowski, Soika, 2004). Initially considered to be effective this method later appeared noxious for tree (Pudlis, 2008).

CONCLUSIONS

During 1999–2004 new invader pest species (insect *Cameraria ohridella* and fungus *Erysiphe flexuosa*) were intensively spreading and damaging *Aesculus hippocastanum* in Lithuania. Since 2005–2006 *C. ohridella* (leafmining pest) has been the main factor reducing the decorativeness and resistance to diseases of *A. hippocastanum* in Lithuania. Powdery mildew has been a most common fungi disease caused by *E. flexuosa*. Moreover, the most negative influence for introduced *A. hippocastanum* cultivars is being done by surface wood corroder *Schizophyllum commune*. Removal of fallen leaves is the most effective means restraining the abundance of *C. ohridella, G. aesculi* and *E. flexuosa* due to elimination of significant number of ready to hibernate pupae and fungal fruit-bodies.

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Vilija Snieškienė, Ligita Baležentienė, Antanina Stankevičienė

PAPRASTOJO KAŠTONO, *AESCULUS HIPPOCASTANUM* L., BŪKLĖ LIETUVOJE: LIGOS IR KENKĖJŲ PAŽEIDIMAI

S a n t r a u k a

Paprastasis kaštonas (*Aesculus hippocastanum* L.) ilgą laiką Lietuvoje buvo sėkmingai naudotas apželdinimui. 1992–2006 m. įvertinta kaštonų būklė 55 Lietuvos miestuose bei vietovėse. Ilgą laiką medžių būklė buvo pakankamai gera, tačiau 1995–1997 m. pablogėjo plintant grybinėms ligoms, kurias sukėlė *Guignardia aesculi, Erysiphe flexuosa* ir *Schizophyllum commune*. Nuo 2005–2007 m. didžiausią žalą paprastojo kaštono medžiams visoje Lietuvos teritorijoje daro drugiai *Cameraria ohridella*. Straipsnyje aptartas įvairių priemonių taikymas siekiant reguliuoti *C. ohridella* gausumą ir užkirsti grybinių ligų plitimą.

Raktažodžiai: aplinka, *Aesculus hippocastanum*, kenkėjai, ligos