

BOX TREE MOTH – *CYDALIMA PERSPECTALIS* (WALKER, 1859) (LEPIDOPTERA: CRAMBIDAE), A NEW INVASIVE PEST FOR THE BULGARIAN FAUNA*Veselin Arnaudov*¹, *Svilen Raikov*²

Abstract. Box tree moth *Cydalima perspectalis* (Walker, 1859) (Lepidoptera: Crambidae) is an invasive alien species of East Asia origin. In Europe, it was first reported in 2006 in Germany, rapidly becoming widespread in almost all European countries. *Cydalima perspectalis* was recorded for the first time as species for Bulgaria from three remote localities in disjunct parts of the country, in 2014. The danger they present is that larvae develop on commonly planted ornamental bushes *Buxus sempervirens* L. In 2016 caterpillars of the moth were found in many parks and gardens in different localities of Northeast and Central South Bulgaria for the first time. Available reports of the moth are presented and its potential effect on ornamental and native *Buxus* plants discussed.

Key words: *Buxus sempervirens*, *Cydalima perspectalis*, distribution, damage level, Bulgaria

Introduction

The box tree moth, *Cydalima perspectalis* (Walker, 1859) is naturally distributed in the subtropical regions of East Asia (India, China, Japan, Korea and the Russian Far East) (Walker, 1859; Hampson, 1896; Inoue, 1982; Kirpichnikova, 2005; Park, 2008; Leraut, 2012). This insect lives and feeds on the leaves of different species of *Buxus* genera, causing a severe defoliation in ornamental and wild plants. In recent years, *C. perspectalis* has become invasive specie in Europe. It was registered as new for Europe by Billen (2007) in the state of Baden-Wuttemberg (Germany), where the species was probably introduced in 2005. *C. perspectalis* was most probably introduced to Europe with containered *Buxus* seedlings (Mally & Nuss, 2010). After that it spread rapidly across Europe and it is now present in the Netherlands (Muus *et al.*, 2009), Switzerland (Kappeli, 2008; Sigg, 2009), France (Feldtrauer *et al.*, 2009), Austria (Rodeland, 2009), Liechtenstein (Slamka, 2010), United Kingdom (Mitchell, 2009), Belgium (Casteels *et al.*, 2011), Hungary (Sáfián and Horváth, 2011), Czech Republic (Šumpich, 2011), Romania (Szekely *et al.*, 2011), Italy (Griffo *et al.*, 2012; Tantardini *et al.*, 2012), Slovenia (Seljak, 2012), Turkey (Hizal *et al.*, 2012), Croatia (Koren and Črne, 2012), Slovakia (Pastoralis *et al.*, 2013), Denmark (Hobern, 2013), Chechen Republic (Russia) (Proklov and Karayeva, 2013), Spain (Perez-Otero *et al.*, 2014; Pino Perez and Pino Perez, 2014), and Montenegro (Hrnčić, S., Radonjić, S., 2014), Basnia and Herzegovina (Ostojić *et al.*, 2014), Greece (Strachinis *et al.*, 2015) and Serbia (Konjević *et al.*, 2015; Stojanović *et al.*, 2015).

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In European countries and Turkey, the species damages only box tree (*Buxus sempervirens*, *Buxus balearica*, *Buxus microphylla*, *Buxus sinica*, and *Buxus colchica*), causing significant harm to both park and natural lands, as well as complete defoliation and desiccation of plants. However, at home - in East Asia - the box tree moth is also found on euonymus (*Euonymus japonicus* and *Euonomus alatus*) and *Ilex pupurea* (Korycinska and Eyre, 2011; Hizal, 2012). This species has up to three generations per year in Asia, as well as in Europe (Korycinska and Eyre, 2009), and overwinters in the caterpillar stage (Zhou *et al.*, 2005).

In Bulgaria, *C. perspectalis* has been found for the first time in 2014, from three remote localities in disjunct parts of the country: Black Sea coast: Balchik, The Botanical Garden, 43°24'17.90"N, 28°08'49.40"E; South-west Bulgaria: Usoyka Village - 42°11'32.92"N, 23°03'36.71"E and South-east Bulgaria: Strandzha Mts, Gramatikovo Village – 42°03'43.84"N, 27°39'17.24"E (Beshkov *et al.*, 2015). They note that only one of the localities the new species has become a pest, reproducing and causing serious damage to *Buxus* spp.

From first report until now, the species is distributed continuously and covers more and more new areas of the country, which suggests that it is very flexible and quickly adapt to new conditions.

The importance of this study arises from the considerable size of the areas covered by this pest, the size of the damage they can cause, its ability to cause complete defoliation of the attacked plants, the fact that in Europe it causing damage mainly on *Buxus sempervirens* and the lack of natural enemies, given its recent introduction in our country.

The aim of this study was to determine the spread of this pest in Bulgaria at present, and to assess the level of damage caused *Cydalima perspectalis* on Boxwood plants in different regions of the country.

Material and methods

The spread study of the box tree moth, *Cydalima perspectalis* Walker, on individuals of *B. sempervirens* was conducted in the summer of 2016, in parks and gardens of different locations in the country. In every location are made visual assessments at least 50 individuals of *B. sempervirens*, including box trees and hedges. Then, evaluated plants are distributed in 5 different levels of damage, basing on assess for the degree of defoliation of box trees by pest caterpillars, using its own 5 point scale (Table 1).

Table 1. Injury scale of defoliation of box trees by *Cydalima perspectalis* Walker in percent

№	Defoliation (%)	Damage level	Damage significance
1.	0	0	undamaged
2.	1-25	1	weak
3.	26-50	2	middle
4.	51-75	3	strong
5.	> 75	4	very strong

The scale is designed taking into account the damage that *C. perspectalis* caterpillars can cause the host plants and the effects of defoliation which may occur on a plant host, taking into account the fact that the *Buxus* species are characterized by very slow growth, the recovery of foliage is especially difficult and can cause, in some cases, drying of defoliated trees. The levels of damage by *C. perspectalis* were evaluated and compared in different locations, on the basis of the defoliation index, calculated by the formula of McKinney (1923).

Results and discussion

The box tree moth, *Cydalima perspectalis* Walker was detected for the first time in Bulgaria in Black Sea coast: Balchik, The Botanical Garden; South-west Bulgaria: Usoyka Village and South-east Bulgaria: Strandzha Mountains, Gramatikovo Village in 2014 (Beshkov *et al.*, 2015). Our studies have shown that in a very short time *C. perspectalis* invaded the other northern and southern regions and was found in Black Sea coast: Balchik, Varna and Burgas (2015) and some areas of North-east Bulgaria, Shumen, Targovishte and Ruse (2016) and Central-south Bulgaria: Plovdiv (2015), Pazardjik and Karlovo (2016). The larvae feed on leaves and shoots of the box trees and the infestations lead to defoliation of the plants.

Study to establish the degree of damages caused from *C. perspectalis* on individuals of *B. sempervirens* was conducted in locations with confirmed presence of this pest in 2016. The results of the research are presented in Figure 1.

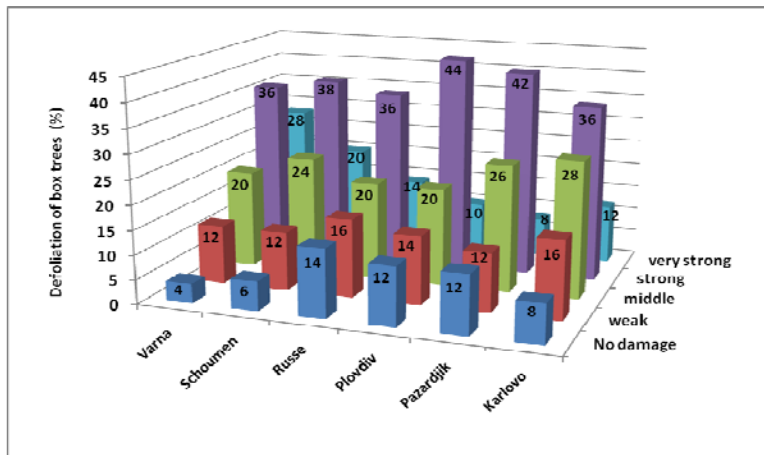


Fig.1. *C. perspectalis* damage level in different locations of Bulgaria (2016)

The results show that *C. perspectalis* is a serious pest on the box trees in the majority of studied localities. The percentages of defoliation ranged from 0 to 100%, more than 90% from analyzed individuals of *B. sempervirens* presenting different percentages of defoliation. Thus, it was determined that 9.33% from analyzed box tree individuals were not damaged, 13.67% from individuals had a weak damage level, 23.0

% had middle damage level, 38.67 % had strong damage level and 15.33 % very strong damage level. In general has been observed that the damage level of box tree individuals was weak to middle.

Index of defoliation in locations surveyed ranged from 44.0 to 53.2% and it is 47.5% average for the country. The highest index of defoliation was registered in Varna and Shumen – 53.2 and 50.8%, and lowest in Ruse and Pazardzhik, 44.0 and 44.4%, respectively. In other locations Karlovo and Plovdiv, it was 46.4 and 45.2 %, respectively. In generally it can be concluded that the level of damage in almost all analyzed areas and for the country were middle to strong.

Because of its rapid expansion in Central Europe, *C. perspectalis* has been subject to an increasing number of studies during the last 2-3 years. Although its biology in Europe is not fully known yet, data from certain regions are already available in literature (e.g. Leuthardt *et al.* 2010, Sage & Karl 2010, van der Straten & Muus 2010, Korycinska & Eyre 2011, Hizal *et al.* 2012).

Adults of *C. perspectalis* have a wingspan of around 4 cm (Leuthardt and Baur, 2013), white color slightly iridescent wings with a large dark brown band at the outer margin and a characteristic white spot on the forewing, in the discoidal cell (Figure 2). Hind wings are white with the same band at the outer margin as in the forewings (Mally and Nuss, 2010). In a less common color variant, the adults are completely brown, but still show a white forewing spot. The moths are good flyers and can reach a lifespan of up to two weeks. After mating the females laid eggs on the leaves of the host plant in groups of 5-20, coated with a translucent jelly (Leuthardt and Baur, 2013). At beginning the eggs are pale yellow, but close to hatching, the black heads of the larvae are visible. The light green larvae are characterized by black stripes with white dots and hairs and a shiny black head and in the last larval stage they can reach a length of up to 4 cm. The pupae are between 1.5 and 2.0 cm long, initially are green with dark stripes on the dorsal surface, towards the end of pupation they turn brown with a dark pattern corresponding to the brown wing borders of the adult. They are concealed in a cocoon of white silk spun among the leaves and twigs (Korycinska and Eyre, 2009).

The caterpillars of *C. perspectalis* feed on leaves of *Buxus* spp. (*B. sempervirens*, *B. microphylla*, *B. sinica* and *B. colchica*), *Ilex purpurea*, *Euonymus alata* and *Euonymus japonicus* and are considered to be serious defoliators (Korycinska and Eyre, 2009). Larvae feed mainly on leaves but may also attack the bark. Young larvae prefer leaves containing a high concentration of alkaloids (older leaves). Indeed, under natural conditions, young larvae tend to feed on old leaves at the bottom of box tree plants (Leuthardt and Baur, 2013). This behavior permits a fast uptake of large amounts of alkaloids within a short time to increase protection against predators, before maximizing the larval growth rate. Young larvae feed at beginning with superior part of leaves and after that with entire leaf. Total defoliation is common and usually results in the death of the trees.

In infested areas, it has become impossible to maintain healthy box trees without chemical treatment or laborious mechanical removal of larvae (Kenis *et al.*, 2013). Infestation symptoms include feeding damage on the leaves of the shoot edges by the larvae, which can leave only leaf skeletons and the epidermis behind them (Leuthardt and Baur, 2013).

Other associated symptoms are webbing of the branches, frass and residues of molting such as black capsules of different sizes. Heavy infestation leads to dry plants and their defoliation, which combined with the subsequent attack of the bark results in the death of the plant. Box trees with a low level of damage are often able to recover if they do not suffer from renewed attacks (Strachinis *et al.*, 2015). If heavy defoliation overlaps on dry condition with lack of precipitation in summertime increase the risk that individuals of box tree to die.

This species has up to three generations per year in Asia, as well as in Europe (Korycinska and Eyre, 2009), and overwinters in the caterpillar stage (Zhou *et al.*, 2005). The first flight occurred from late May to mid June; the second one from mid July to mid August and the third from early September to early October. Males may be attracted by long distance (Santi *et al.*, 2015).

Young larvae overwinter in diapause in a cocoon built between leaves. Diapause is induced by day length and temperature experienced by young larvae (Maruyama and Shinkaji 1993). Larval feeding continues in spring and pupation also occurs in the foliage (Kenis *et al.*, 2013).

Conclusions

Analyzing the results of studies focused mainly on the distribution of the species *C. perspectalis* and assessment of the level of damage to the plant host *B. sempervirens* in different areas of the country can draw the following conclusions:

- The invasion of the species *C. perspectalis* after its registration in Bulgaria in 2013 continues.
- *C. perspectalis* established in six new regions of the country, three in Central South Bulgaria (Plovdiv, Pazardzhik and Karlovo) and three in northeastern Bulgaria (Shumen, Targovishte and Ruse).
- The level of damage in almost all analyzed areas and for the country were middle to strong.
- High level of damage to the box trees established in the regions of Varna and Shumen and average Ruse and Pazardzhik.
- It is necessary to continue research on the biology, bionomy and measures for prevention and control of *C. perspectalis* populations.

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