Cydalima Perspectalis Walker (Lepidoptera, Crambidae) a New Dangerous Pest Report on *Buxus Sempervirens* in Cluj Area

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ABSTRACT

In landscaping, one of the frequently used plants is *Buxus sempervirens* L. The aesthetic value of these plants are often affected by the pests species that attack the leaves. The main species that attacks the *Buxus* spp. plants are: *Monarthropalus buxi* Geoff., *Psylla buxi* L. and *Cydalima perspectalis* Walker. The attack of these species cause the drying of the plants. The Box Tree Moth, *Cydalima perspectalis* Walker, is a new species, on the European continent, being first recorded in 2006. In Romania, this species was reported in 2010, near Bucharest, from where it has been spread throughout the country. In Cluj has been reported in 2015. For establishing some control strategies, for this, it is necessary to know the bioecology of this species, depending on the specific environmental conditions of each area where the attack is present. In 2016 we have started the investigations to study the biological cycle, in Cluj area. The investigations were conducted in the laboratory and on the campus of UASVM Cluj-Napoca. In the investigated area, the species develops two full generations, and the third generation is partial. The adults of hibernating generation fly in the first decade of June until the first decade of July. Summer generation adults fly from the first decade of August, creating the second generation and the adults who establish the third generation (partial generation) fly in the second half of September. The incubation is between 5-6 days. Larval stage is between 29-38 days, pupal stage last from 10 to 14 days.

Keywords: *Cydalima perspectalis*, damage level, *Buxus sempervirens* L. life cycle

INTRODUCTION

In Cluj area, until recent years *Buxus sempervirens* (European box, or boxwood) plants were frequently attacked by *Monarthropalus buxi* Geoff., and also by *Psylla buxi* L., species that strongly affected the aesthetic value of the plants (Soporan et al., 2012). Since 2015 in this area was reported, another species, The Box Tree Moth, *Cydalima perspectalis* Walker. This is a extremely dangerous pest, due to the rapid spread and aggressiveness with which attack the plants.

This species belongs to the Lepidoptera order, family *Crambidae* and it originated in the East Asia (India, China, Korea, Taiwan, Japan and the Russian Far East) (Krüger, 2008; Leraut, 2012). In the scientific literature and on websources, this species is found in various synonymies, these being: *Cydalima perspectalis* Walker, 1859; *Diaphania perspectalis* Walker, 1859; *Glyphodes albifuscalis* Hampson, 1899; *Glyphodes perspectalis* Walker, 1859; *Neoglyphodes perspectalis* Walker, 1859; *Palpita perspectalis* Walker, 1859; *Phacellura*

advenalis Lederer, 1863; Phakellura perspectalis Walker, 1859 (Maruyama, 1993; Maruyama and Shinkaji, 1987, 1991, 1993; Kawazu et al., 2007; Zhou et al., 2005; Krüger, 2008; Park, 2008; Feldtrauer et al., 2009; Mitchell, 2009; Marja et al., 2010; MALLY and NUSS, 2010; Kim and Park, 2013).

In Europe it was for the first time reported in 2006, in southwestern Germany, being introduced with infested buxus cuttings (Krüger, 2008). Then this species has spreaded rapidly in the other European countries. In 2007 it was reported in Switzerland (Billen, 2007; Käppeli, 2008), in Netherlands (Muus et al., 2009; Van Der Straten and Muus 2010); in 2008 it has entered in Austria (Rodeland, 2009; Perny, 2010), France (Feldtrauer et al., 2009; Marja et al., 2010; Brua, 2013), Slovenia (Seljak, 2012; Raspudić et al., 2014), United Kingdom, Ireland (Mitchell, 2009; Salisbury et al., 2012); 2010 in Liechtenstein (Slamka, 2010), Belgium (Casteels et al., 2011), Italy (Tantardini et al., 2012; Bella, 2013; Governatori, 2013); Hungary in 2011 (Sáfián and Horváth, 2011; Szabolcs and Bálint, 2011; Szabóky, 2012), Czech Republic (Šumpich, 2011), Turkey (Hizal, 2012; Hizal et al., 2012); in 2012. it was reported in Croatia (Koren and Črne 2012; Matošević, 2013); in the year 2013 in Slovakia (Pastorális et al., 2013), Czech Republic (Proklov and Karayeva, 2013); Southern Russia (Karpun, 2013) and Denmark (Hobern, 2013), and starting with 2014 is present in Spain (Pérez-Otero et al., 2014; Pino Pérez and Pino Pérez, 2014), Bulgaria (Beshkov et al., 2015), Montenegro (Ostojić et al., 2015), Bosnia and Herzegovina (Ostojić et al., 2015), Serbia (Stojanović et al., 2015) and Greece (Strachinis et al., 2015).

Corroborating the growing trend of global temperatures and ecological plasticity of this species and the fact that it is a polivoltin species, we can expect an expansion of the spreading area to the northern limit of Europe (IPPC, 2014; Leuthardt and Ramin, 2011; Nacambo, 2012; Nacambo et al., 2014).

In Romania the species was reported in 2010 in Bucharest area (Iamandei, 2010), and then the area was continuously expanded (Székely et al., 2011; Gutuie et al., 2014; Skolka and Zaharia, 2014; Fora and Poșta, 2015; Bunescu and Florian, 2016).

The larvae of this species feed on leaves of different Buxus varieties: *Buxus microphylla*,

B. microphylla var. *insularis*, *B. sempervirens*, *B. colchica*, *B. sinica*, *B. balearica* (Korycinska and Eyre, 2009; Leuthardt et al., 2010; Marja et al., 2010; Mally and Nuss, 2010; Székely et al., 2011; Hizal, 2012; Todeschini, 2014). Studies in Europe have shown that the strongest attack occurs on *Buxus sempervirens* var. *Rotundifolia*, variety preferred by the females for oviposition (Leuthardt and Baur, 2013; Santi et al., 2013).

In the area of origin this species also attacks the *Euonymus japonicus* Thunb., *E. alata* (Thunb) Siebold, *Ilex purpurea* Hassk., *Pachysandra terminalis* Siebold & Zucc. and *Murraya paniculata* L. (Wang, 2008; Marja et al., 2010; Mally and Nuss, 2010; Bella, 2013).

The adult has a white body, except the head and the terminal part of the abdomen, which are brown. The wings are white with bright shades of purple (especially the fresh specimens). The forewings shows on the costal and posterior margin a wide brownish band. The costal band it shows a white central macula. The hindwings it has also a wide brownish band at the level of posterior margin (Mally and Nuss, 2010; Brua, 2013). Within the population are found also melanic specimens, on which both pairs of wings are brown with a white macula towards costal margin. (Korycinska and Eyre, 2011; Sáfián 2011; Szabóky, 2012).

The eggs are round, with a diameter of approx 0.8-1 mm. At first are pale yellow and around hatching they present a black dot corresponding to the cephalic capsule formation of the larva.

The neonatal larvae, has a length of 1-2 mm, and the final instar larvae reach 35-44 mm. The head is black, shiny, and the body is green. On the dorsal-lateral parts presents two wider strips of black bands bounded by a white thin band. On the back it shows black warts, each of them whit a white basal macula. It shows hairs all over the body.

Pupa has a length between 1.5-2 cm. In the beginning it is green with dark stripes on the dorsal surface, and the late development pupa is brown, with darker areas corresponding to the future adult brown bands wing. Pupa is protected by a silk white cocoon, hidden among the infested leaves and branches.

This is a polivoltin species, the number of generations is in line with the thermal particularities of the area where it is found. In the area of origin it develops 4-5 generations per

year (Maruyama and Shinkaji, 1987, 1991; Tang et al., 1990; Zhou et al., 2005; Matošević, 2013; Perny, 2010), and on the European continent it develops 2-3 generations, with the possibility that in the warmer areas to develop even the fourth generation (Korycinska and Eyre, 2009; Marja et al., 2010; Leuthardt et al. 2010; Sage and Karl, 2010; Santi et al., 2013; Brua, 2013, 2014). The larvae is the hibernating stage, Often in second or third instar stage, located between two leaves, protected by silky threads (Maruyama and Shinkaji, 1991; Nacambo et al., 2013). The attack continues in the spring and pupation occurs between the attacked leaves and branches. The flight of adults generally occurs at the end of May or beginning of June. Adults have a lively zigzag flight (Brua, 2014). They are able to travel long distances between 5-10 km (Van Der Straten and Muus, 2009; Marja et al., 2010; John and Schumacher, 2013; Brua, 2013). The flight takes place at night and adults show positive phototropism, being attracted by the light sources (Feldtrauer et al., 2009; Schmitt and Demergès, 2012; Delmas, 2013; Göttig and Herz, 2014). Females lay their eggs on the back of the leaves in the groups of 10-30 eggs stuck with a mucilaginous substance (Marja et al., 2010; Leuthardt and Baur, 2013; Brua, 2013).

Larval development is phased over an interval between 17-87 days, depending on the temperature (Maruyama and Shinkaji, 1991), 24 days (Park, 2008). The larvae prefer for feeding the older leaves (Leuthardt et al., 2013; Brua, 2013; Santi et al., 2013). Below the attacked plants it can be observed large quantities of droppings (Brua, 2013). Sometimes the population density is very high, causing total defoliation of the attacked plants (Leuthardt and Baur, 2013; John and Schumacher, 2013; Kenis et al., 2013; Brua, 2014; Wan et al., 2014). The larvae of this species are not consumed by the birds due to their content in alkaloids (Leuthardt et al., 2013; Brua, 2013). Pupal stage lasts about 10-14 days (Park, 2008), and the new adults fly from late July to early August (Brua, 2014). During the warmest years, when the species develops three generations, the last adults can be observed even until the beginning of October (Brua, 2014).

Sexual attractant pheromone of the species *Cydalima perspectalis* Walker, it was identified in 2007, (Z)-11-hexadecenal (Z11-16:Ald), (E)-11-hexadecenal (E11-16:Ald), e (Z)-11-hexadecenol

(Z11-16:OH), in a ratio of roughly 5:1.25:1 (Kawazu et al., 2007). Results of the studies concerning the synthesis and use of the sexual pheromones have been communicated by: Kim and Park, 2013; Göttig and Herz, 2014; YueQiu et al., 2015; Martin et al., 2015; Santi et al., 2015).

Regarding this insect pest dynamics, the useful entomofauna has a special and important role, (predators and parasites). There has been performed a series of researches concerning, the identification of useful entomofauna, which can grow on and during different development stages of the species *Cydalima perspectalis* Walker. Some entomopathogenic nematodes were reported: *Steinernema carpocapsae* and *Heterorhabditis bacteriophora* (Choo et al., 1991; Göttig and Herz, 2012; Zhou et al., 2005). Also hymenopteran parasitoids were identified, especially in the area of origin of the box tree moth, some of them are present on the European continent. The most important are: *Apanteles glomeratus* L. *Bracon brevicornis* Wesm., *Chelonus tabonus* Sonan, *Dolichogenidea stantoni* Ashmead, Braconidae family (She and Feng, 2006; Zimmermann and Wührer, 2010; Göttig and Herz, 2012, 2014; Brua, 2013; Wan et al., 2014); *Apechthis compunctor* L., *Casinarina* sp., Ichneumonidae family (Nacambo, 2012; Wan et al., 2014); *Trichogramma brassicae* Bezdenko and *Trichogramma dendrolimi* Matsumura, Trichogrammatidae family (Göttig and Herz, 2012; Herz, 2013; Wan et al., 2014); *Brachymeria lasus* Walker, family Chalcididae (Wan et al., 2014; Brua, 2013); *Tyndarichus* species, family Encyrtidae (Wan et al., 2014; Brua, 2013). From Diptera order, family Tachinidae, they were reported *Exorista* sp., *Pseudoperichaeta nigrolineata* Walker and *Compsilura concinnata* Meigen (Shi and Hu 2007; Nacambo, 2012; Wan et al., 2014).

From the predators, the most important species is *Vespa velutina* Lepeletier (Order: Hymenoptera; Family: Vespidae), also present in Europe (Leuthardt and Baur, 2013; Brua, 2013; Wan et al., 2014).

Among the entomopathogenic agents, it is mentioned: baculovirus isolated from *Anagrapha falcifera*, nucleopolyhedrovirus (AnfaNPV), *Bacillus thuringiensis* var. *kurstaki*, *Beauveria bassiana*, (Rose et al., 2013; Brua, 2013).

Fig. 1. *Cydalima perspectalis* Walker in glass breeding cages (foto. Teodora Florian)

MATERIAL AND METHOD

In 2016 we performed some investigation regarding the life cycle of *Cydalima perspectalis* Walker, in Cluj area. The impact of this pest species, on *Buxus* plants has been also evaluated.

The investigations were carried out both in the laboratory and in the field. Regarding the experience conducted in the laboratory, the biological material was collected from the field before the beginning of the pest activity, placed in insect glass breeding cages, from where, then it was determined the time succession of all development stages (Fig. 1.). For settling the generation's succession, the adults of each generation were transferred to other breeding cages.

Field observations were performed in the area of UASVM Cluj-Napoca Campus Park. The occurrence moment of each development stage was recorded. Simultaneously, the larval attack mode was studied.

RESULTS AND DISCUSSION

The life cycle of *Cydalima perspectalis* Walker in 2016 is presented in Table 1.

The hibernating larvae generation have taken their activity in the last days of April. At this time the biological material was layout in the breeding cages from the laboratory. Since the species hibernate in different larval instars, in the laboratory the last active generation of hibernating larvae were reported in 1 June and in the field in June 16.

During the feeding time the larvae give large amounts of excrements, often this element being an indication of the presence of the species, which

are easy to observe under the *Buxus* sp. plants (Fig. 2). Also the signalling of the species can be done when observing the silky threads that the larvae bind the infested leaves (Fig. 3).

In the laboratory the minimum feeding time of the hibernating larvae was 17 days and in the field 29 days. In the laboratory the first pupae were reported in 16 May and in the field in 27 May. The pupae stage occurs between the infested leaves, the pupae being found inside a cocoon (Fig. 4).

In laboratory the pupae were reported between May 16 - June 5 and in the field between May 27 to June 20. The minimum duration of pupal stage was 11 days in the laboratory and 14 days in the field, so the flight of hibernating adults generation was launched on 27 May in the laboratory conditions and on June 10 in the field. The flight of the adults was spread over a period of 20 days in the laboratory conditions (the period 27 May to 15 June) and 30 days in the field (during June 10-July 9).

In the case of the adults obtained in the laboratory conditions they were separated taking under consideration the color of the wings. From the total number of the specimens analyzed 68% had were from the typical form and 32% of melanic form (Fig. 5).

Oviposition on the underside of leaves was observed at 2-3 days after the beginning of the flight. Given the gradual emergence of the adults the eggs were reported on a period of approximately three weeks in the laboratory conditions and about four weeks in the field. The incubation period was 6-7 days. In the laboratory conditions the first generation larvae were reported on 6

Tab. 1. The biological cycle of the species *Cydalima perspectalis* (Walker, 1859), Cluj-Napoca, 2016

STAGES	Laboratory		Field (campus USAMV)	
Winter generation				
Larva: ranged from	28.04	1.06	28.04	16.06
the minimum length of the stage	17 days		29 days	
Pupa: ranged from	16.05	5.06	27.05	20.06
the minimum length of the stage	11 days		14 days	
Adult: ranged from	27.05	15.06	10.06	9.07
The first generation				
Egg: ranged from	30.05	18.06	12.06	14.07
incubating	6 days		7 days	
Larva: ranged from	6.06	27.07	19.06	29.08
the minimum length of the stage	31 days		38 days	
Pupa: ranged from	7.07	31.07	27.07	12.09
the minimum length of the stage	10 days		11 days	
Adult: ranged from	17.07	5.08	7.08	20.09
The second generation				
Egg: ranged from	19.07	8.08	9.08	23.09
incubating	5 days		6 days	
Larva: ranged from	24.07	10.09	15.08	wintering
the minimum length of the stage	29 days		32 days	
Pupa: ranged from	22.08	18.09	16.09	***
the minimum length of the stage	10 days		12 days	
Adult: ranged from	1.09	23.09	28.09	
The third generation				
Egg: ranged from	3.09	25.09	30.09	17.10
incubating	6 days		7 days	
Larva	9.09	wintering	7.10	wintering

Fig. 2. Excrements of *Cydalima perspectalis* Walker (foto I. Huluijan)

Fig. 3. Silky threads secreted by the larvae of *Cydalima perspectalis* (foto. Teodora Florian)

Fig. 4. Pupae of *Cydalima perspectalis* Walker (foto I. Hulanjan)

Fig. 5. Adults of *Cydalima perspectalis* Walker (foto I. Hulanjan)

June and in June 19 in the field. The larvae of the first generation have been reported up to 27 July (laboratory) and until the end of August (field).

The young larvae consume the inferior epidermis and the mesophyll of the leaf, but some specimens can be observed on the upper side of

Fig. 6. Attack of *Cydalima perspectalis* Walker on leaves (foto. Teodora Florian)

Fig. 7. Attack of *Cydalima perspectalis* Walker on bark (foto I. Hulujan)

the leaves (Fig. 6). The intense feeding the larvae occurs inside the attacked plant bushes and thus the attack signs are sometimes observed to late and the control is sometimes delayed. Often, the mature larvae attacks the bark on the branches, in which case the drying of these branches occurs faster (Fig. 7). In case of powerful attacks, besides damaging the aesthetic value of plants the plants can be partially or totally destroyed (Fig. 8 and Fig. 9).

The minimum duration of first instar larvae development was 31 days in the laboratory, respectively 38 days in the field, so the pupation period began on July 7 in laboratory conditions and July 27 laboratory field. In laboratory conditions the pupae were present until 31 of July, but the field this stage of development was reported on an extremely large period of time

because in the natural environment was observed an overlapping of the developmental generations and the demarcation of the generations was very difficult to perform. For this reason the pupae were reported by the end of September (we reported live pupae even on 19 of November, but subsequent studies are needed in order to see if these pupae will survive the winter conditions).

The minimum duration of the first generation pupal stage was 10 days in the laboratory and 11 days in the field, so the adults of this generation appeared on 17 of July in laboratory experiments and in 7 of August in the field. Their flight is largely nocturnal, showing a strong positive phototropism. In the case of the biological material grown in laboratory, the adults of this generation, they flew within a 20 days period and in the field the adults were reported until 20 September (certainly here

Fig. 8. Attack of *Cydalima perspectalis* Walker foto I. Hulanjan)

Fig. 9. Attack of *Cydalima perspectalis* Walker (foto M. Varga)

the flying adult generation partially overlapped with the following generation).

These adults represented the foundation of the second generation. The first egg masses were reported two days after the start of the flight. At this generation the incubation period was between 5-6 days, the larvae of the second generation appeared in 24 of July laboratory and August 15 in the field. In the laboratory the minimum period of development for this stage was 29 days. The adults of the first generation appeared in the laboratory early in August and the period during which the seconds generation larvae were signaled was the first decade of September (thus, a part of the

population grown in the laboratory resented only two generations).

In the laboratory, on 22 of August the pupation started for this generation. In the field most of the larvae especially those who hatched in September entered in a hiemal diapause. However, the larvae that hatched in the first half of August continued their development and after almost 32 days they pupated, in 16 of September fresh pupae were signaled.

The adults of the second generation grown in the laboratory began their flight on first of September, they being observed in the breeding cases until September 23, creating this way, the third generation. The larvae of this generation

hatched starting from 9th of September, so this stage represented the hibernating instar of the species. Also in the field a small part of the population laid the foundations of the third generation, the new egg masses being observed in the last decade of September and the neonate larvae in the first decade of October; larvae that went into hiemal diapause.

CONCLUSIONS

In Cluj area, *Cydalima perspectalis* (Walker, 1859) develops two full generations, the third generation is partial.

In field the flight of the hibernating adults generation, occurs between 10.06-9.07.

Depending on the generation the incubation takes place in 5-7 days.

Development of the larvae is between 29 to 38 days.

Pupae stage lasts from 10 to 14 days.

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