SHORT COMMUNICATION

First record of *Cydalima perspectalis* (Walker, 1859) (Lepidoptera: Crambidae) in Greece

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Summary The study concerns the first records for the presence of the box tree moth *Cydalima perspectalis* in Greece and subsequent infestations on ornamental box trees in urban environment. Adults of the pest were first spotted in six locations around the country from October 2013 until April 2015, when infestation was also detected (mid April). The pest was found infesting plants of *Buxus sempervirens* in several private and public gardens and parks in the urban environment of Kifissia, Attica. Possible introduction scenarios, as well as preventive and control measures are discussed.

Additional keywords: alien species, box tree moth, Buxus, invasive

The box tree moth Cydalima perspectalis (Walker, 1859) (Lepidoptera: Crambidae) (synonyms: Diaphania perspectalis, Glyphodes perspectalis) is an invasive species on box tree Buxus spp., in Europe, which has been spreading and establishing across the continent during the last decade. The pest was included in the alert list of the European Plant Protection Organisation (EPPO) in 2007 but was removed in 2011 because no particular action was requested by the EPPO member countries (EPPO, 2011). However, the box tree moth could be a serious threat for natural habitats of wild Buxus in Europe (Bella, 2013) and a major pest of ornamental Buxus in urban landscape, at historical and decorative gardens and parks where they are highly used as design plants (EPPO, 2012; Seljak, 2012) as well as in nursery production (Leuthardt and Baur, 2013).

Herein we provide the first records of *C. perspectalis* in Greece. The presence of

the box tree moth was recorded for the first time in Thermi, Thessaloniki, northern Greece, in October 2013 (Theodosis Mamais, personal communication). On 18 May 2014, two adults C. perspectalis were found and collected by the first author (IS) in the city of Thessaloniki (40.608°, 22.971°) [vouchnumbers: NHMC.85.01.16129.01 NHMC.85.01.16129.02, Natural History Museum of Crete] and a photograph of a specimen from Thessaloniki taken on May 20, 2014 was published http://www.lepidoptera.eu/ContributorPics.php?ID=1688 (photograph by Theodosis Mamais). On 17 July 2014, the second author (CK) found another specimen at Ano Lechonia village, Pelion mountain (Figure 1) (39.328°, 23.058°). Four more observations made by different citizens followed: on 22 July 2014 an adult specimen was photographed by Dimitris T. Kaloutsikos in Drama city (41.153°, 24.117°); on 22 August 2014 Savvas Vassiliadis photographed another specimen in Katerini city (40.303°, 22.501°); on 27 August 2014 Ersi Augustidou observed and photographed the species in Kalamaria, Thessaloniki (40.586°, 22.941°); in September 2014 Lia Naki photographed an adult specimen in Kifissia, Attica (38.066°, 23.818°). Locations of the first records of *C. perspectalis* are indicated in the

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map of Figure 2. All specimens recorded had the white colour form. The aforementioned citizens contacted the first two authors requesting species identification and provided us their data, thus we include their observations in this short communication, having their written permission.

Heavy infestation by larvae of C. perspectalis was observed on plants of Buxus sempervirens grown as a tree and in border shrubs at Benaki Phytopathological Institute and several private and public gardens and parks in Kifissia, Athens, in mid April 2015 (Figures 3, 4). The plants had a dry appearance and were covered by dense webs (Figure 3). This is the first report of C. perspectalis as a pest in Greece with evidence of its consequent infestation. Samples of infested shoots were transferred to Benaki Phytopathological Institute and kept in cages (30 x 30 cm) at 25 °C, 16:8 L:D h until pupation of the larvae. Pupae were collected and placed in plastic containers until adult emergence (Figure 5). Forty one adults emerged; thirty five presented the white colour form and six of them the brown colour form (Figures 1, 6).

The box tree moth is native to subtropical regions of eastern Asia (India, China, Korea, Japan and the Russian Far East) (Walker, 1859; Hampson, 1896; Inoue, 1982; Kirpichnikova, 2005; Park, 2008; Leraut, 2012). It was introduced in Europe and was recorded for the first time in south-western Germany in 2006 (Krüger, 2008). It spread rapidly across Europe and it is now present in the Nether-



Figure 1. Specimen of *Cydalima perspectalis* from Ano Lechonia, Pelion mountain: adult of white colour form (Photograph by C. Kazilas).

lands (Muus et al., 2009), Switzerland (Käppeli, 2008; Sigg, 2009), France (Feldtrauer et al., 2009), Austria and Liechtenstein (Rodeland, 2009), United Kingdom (Mitchell, 2009), Belgium (Casteels et al., 2011), Hungary (Sáfián and Horváth, 2011), Czech Republic (umpich, 2011), Romania (Székely 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 (Pastorális et al., 2013), Denmark (Hobern, 2013), Chechen Republic (Russia) (Proklov and Karayeva, 2013), Spain (Pérez-Otero et al., 2014; Pino Perez and Pino Perez, 2014) and Bulgaria (Beshkov et al., 2015). This is the first record of the pest in Greece.

The main host plants of C. perspectalis are Buxus species (common names box tree, box, boxwood), including B. sempervirens L., B. microphylla Siebold & Zucc., B. sinica (Rehder and Wils.) M. Cheng and B. colchica Pojark (Buxaceae). In its origin countries, the pest has also been reported on Euonymus japonicus Thunb., E. alatus (Thunb.) Siebold (Celastraceae), Ilex purpurea Hassk. (Aquifoliaceae), Pachysandra terminalis Siebold & Zucc. and Murraya paniculata (L.) Jack (Rutaceae), but there are no reports of these plant species being attacked in Europe (Wang, 2008; Hizal et al., 2012; Bella, 2013; Plantwise Knowledge Bank, 2015). Box trees are evergreen shrubs and small trees. Buxus sempervirens lives in



Figure 2. Locations of the first records of *Cydalima perspectalis* in Greece: A) Drama, B) Katerini, C) Kalamaria, Thessaloniki, D) Kifissia, Attica, IS) Thessaloniki and CK) Ano Lechonia, Pelion mountain.



Figure 3. Infestation of *Buxus sempervirens* by *Cydalima perspectalis* in Kifissia, Attica, Greece.



the wild in different habitats, in open phrygana and forest areas in a large part of Europe (Di Domenico *et al.*, 2011) whereas boxes are also economically important ornamental



Figure 4. Mature larvae of *Cydalima perspectalis* on infestated twigs of *Buxus sempervirens*.

species grown in nurseries, parks and public and private gardens. The ornamental *Buxus* species and varieties met in Greece are *B. sempervirens*, *B. sempervirens* 'Rotundifolia', *B. microphylla* and *B. microphylla* 'Faulkner'.

The adult of *C. perspectalis* has a wingspan of 3.5-4 cm, which makes it a large spe-

cies among European Crambidae (Székely et al., 2011). Two colour forms of adults have been described, the white one, which is the most common, and the melanic one, being less common. In the white form, adults have white, slightly iridescent wings with a large dark brown band at the margin and a characteristic white spot in the discoidal cell only in the forewings (Mally and Nuss, 2010). In the melanic form, the wings are completely brown with the exception of a white discoidal spot on the forewings (Figure 6). Eggs are laid in clusters of 5-20 on the underside of the leaves (Leuthardt and Baur, 2013); they are pale yellow when laid and black heads of the larvae are visible before hatching. The late instar larvae have a shiny black head and they are light green with two longitudinal black thick stripes and white dots in between at the lateral part of the body; they also have black dots outlined in white on the dorsal side of the body; in the last larval stage they can reach a length of up to 4 cm (Székely et al., 2011; Bella, 2013). The pupae are 1.5-2.0 cm long and they are concealed in a cocoon of white silk spun among the leaves and twigs. They are initially green with dark stripes on the dorsal surface and towards the end of pupation they turn brown with a dark pattern corresponding to the brown wing borders of the adult (Korycinska and Eyre, 2009).

The pest is reported to have 2-3 generations in Central Europe (Korycinska and Eyre, 2009; Leuthardt *et al.*, 2010; Sage and Karl, 2010) and is capable of hibernating and spreading naturally across the continent (Krüger, 2008; Feldtrauer *et al.*, 2009; Muus *et al.*, 2009; Sigg, 2009).



Figure 5. Pupae of Cydalima perspectalis.

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. Larvae can also attack the bark (Leuthardt and Baur, 2013). Other associated symptoms are webbing of the branches, frass and residues of moulting 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. However, severely damaged boxes in an area where *C. perspectalis* has established are less likely to survive. This also applies to naturally occurring boxes in the understories of forests in the invaded range of C. perspectalis (Plantwise Knowledge Bank, 2015).

The species either has actively dispersed in Greece from neighbour countries (e.g. Turkey), where its presence is already confirmed, or it has been passively introduced *via* one or more relatively recent commercial importations of plants of Buxus sp. infested with the moth's eggs or larvae. It has been assumed that the species is capable of spreading across Europe in both ways (Käppeli, 2008; Krüger, 2008; Feldtrauer et al., 2009; Muus et al. 2009; Sigg, 2009). Introduction seems more likely to have taken place via plant importations. However, one cannot yet exclude an active dispersal or a combination of both ways mentioned. Further investigation is needed to determine the origin of each different Greek population.



Figure 6. Adult of *Cydalima perspectalis*: melanic (brown) colour form.

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A climate model applied by Nacambo *et al.* (2014) suggests that *C. perspectalis* is likely to continue its spread across Europe, except for Northern Fenno-Scandinavia, Northern Scotland and high mountain regions and become a pest more likely in Southern and Central Europe where the moth is able to complete at least two generations per year; restriction of distribution of the species in the northern range is expected due to the limitation in degree-days above the temperature threshold to complete a generation whereas in the southern zone due to the absence of a cold period necessary to resume diapause.

Investigation of effective preventive and management methods is necessary. *Buxus* plants importation in European countries, such as the Netherlands, Germany and Italy, has largely increased in the recent years, mainly from China (EPPO, 2012). The trade of infested box trees may still be the most important dissemination pathway as detection of early larval stages or eggs is difficult (Leuthardt *et al.*, 2010). Campaigns to communicate the risk of displacing eggs, larvae and pupae when moving infested box trees will contribute in public awareness and slow down the dispersal of *C. perspectalis*.

Control of the pest in East Asia, where it was primarily studied until its invasion in Europe, embraces mainly biological control by nematodes (Choo et al., 1991; Lee et al., 1996), mating disruption (Kawazu et al., 2007) and chemical control (Zhou et al., 2005). Natural enemies of the pest include polyphagous parasitoids (Nacambo et al., 2014) and birds exhibiting low predation, probably due to the high levels of toxic alkaloids sequestered by its larvae (Leuthardt and Baur, 2013). Investigation on specific parasitoids of the moth in the places of its origin in Asia should be envisaged in the perspective of their use in a classical biological control programme which would offer a long-term control option in natural habitats of boxes.

Use of pheromones for monitoring did not give satisfactory results in field trials in Europe (Van den Straten and Muus, 2010; pers. comm. F. Griepink). Chemical control with contact insecticides has been proved very effective but may harm beneficial arthropods using the box trees for shelters, such as arachnids. Insecticides working by ingestions are also very effective, although the lag until death of all larvae is usually longer. Biopesticides based on Bacillus thuringiensis are usually the preferred option on ornamental box trees because of their limited impact on the environment (Plantwise Knowledge Bank, 2015). Recent research indicated the susceptibility of C. perspectalis larvae to baculovirus Anagrapha falcifera nucleopolyhedrovirus (AnfaNPV) as a potential control agent for the pest (Rose et al., 2013). Physical control by cutting the infested material, if applicable, may also be effective (Korycinska and Eyre, 2011). Nevertheless, since introduction of alien arthropods in Europe mainly occurs via ornamental plant trade (Rabitsch, 2010), a more efficient inspection of the condition of traded goods is necessary in order to prevent the pest's further spreading (Bella, 2013).

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ΣΥΝΤΟΜΗ ΑΝΑΚΟΙΝΩΣΗ

Πρώτη καταγραφή του *Cydalima perspectalis* (Walker, 1859) (Lepidoptera: Crambidae) στην Ελλάδα

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Περίληψη Η μελέτη αφορά στις πρώτες καταγραφές της παρουσίας του νυκτόβιου λεπιδόπτερου Cydalima perspectalis στην Ελλάδα και των επακόλουθων προσβολών από το έντομο σε πυξάρι στο αστικό πράσινο. Ενήλικα άτομα του εντόμου παρατηρήθηκαν αρχικά σε έξι περιοχές της χώρας από τον Οκτώβριο του 2013 έως τον Απρίλιο του 2015, οπότε εντοπίστηκε και η πρώτη προσβολή (μέσα Απριλίου). Η προσβολή αφορούσε φυτά του Buxus sempervirens σε πολλούς ιδιωτικούς και δημόσιους κήπους και πάρκα στο αστικό πράσινο της Κηφισιάς. Συζητάμε τους πιθανούς τρόπους εισαγωγής του εντόμου και μέτρα πρόληψης της εξάπλωσης και αντιμετώπισής του.

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