

Rapid Communication**Invasion of the box tree moth *Cydalima perspectalis* (Walker, 1859) in the Balearic Islands (Western Mediterranean, Spain): a matter of islands**

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OPEN ACCESS**Abstract**

The introduction of alien species in insular ecosystems is one of the main causes of population decrease and extinction of native biodiversity. This is the first time that the arrival of *Cydalima perspectalis* in the Balearic Islands has been reported, which makes it possible to complete the distribution of this Asian moth in Europe. The box tree moth was reported on three out of the four islands that compose the archipelago. However, it seems to be only established in Mallorca because of the wider distribution of *Buxus balearica* and *B. sempervirens* as the host plants.

Key words: invasive species, Mediterranean islands, Crambidae, Mediterranean endemic plant

Introduction

The box tree moth *Cydalima perspectalis* (Walker, 1859) is a Crambidae moth species from subtropical regions of Asia, including China, Japan and Korea (Inoue et al. 1982), as well as part of Eastern Russia (Kirpichnikova 2005). Since its first report in Europe in 2007 (Germany) (Krüger 2008), it has expanded rapidly throughout the continent occupying most of the European countries (EPPO 2018). Concerning to Iberian Peninsula of Spain, the first occurrence was in 2014 in Galicia province, particularly in the southern area of Pontevedra, although its occurrence had already been detected before in Cantabria province (Pérez-Otero 2014). Nowadays, it is distributed in the northwest, the center and the west of the Iberian Peninsula, including the provinces of Asturias, Barcelona, Cantabria, Gerona, Guipúzcoa, Madrid, Navarra, Pontevedra and Vizcaya (Gómez-Undiano et al. 2018).

It has been assumed that the main route of arrival and dispersion of *C. perspectalis* within the European continent is due to the commercial trade of ornamental plants and bushes such as *Buxus sempervirens* L. (Matošević, 2013). Furthermore, this moth species is considered a pest for plants of the genus *Buxus* L. since it has been documented as its main host plant (Nacambo 2014), especially *B. sempervirens*, *Buxus microphylla* Siebold & Zucc., and

Buxus sinica (Rehder & E.H. Wilson) M. Cheng). Other species from different families have also been reported as hostplants, including *Euonymus alatus* (Thunb.) Siebold., *Euonymus japonicus* Thunb., *Ilex purpurea* Hassk. (syn. *Ilex chinensis* Sims) and *Murraya paniculata* (L.) (Maruyama 1993; Brua 2013; Wang 2008). In addition, it should be noticed that some native European plants, such as *Ilex aquifolium* L. or *Euonymus europaeus* L. could potentially be affected by the box tree moth (Vieira 2020). This affection could be because of the activity of the larval stage that can induce severe defoliation and consumption of the bark, which in turn affects the plant's health, even causing death in some cases (Bella 2013).

Up to date, there are no published records of the occurrence of *C. perspectalis* in the Balearic Islands archipelago (Western Mediterranean, Spain), where the native species *Buxus balearica* Lam. inhabits in Mallorca and Cabrera archipelago. The present work provides updated information about the records of *C. perspectalis* in three out of the four largest islands of the archipelago during its first years of the colonization and the subsequent years, suggesting differences in the establishment success among islands.

Methods

A compilation of information about confirmed records of *C. perspectalis* was done to detect its first date of arrival and the trend in the colonization process. For each record, information about the date, the number of specimens if available and the source of observations was detailed (Supplementary material Table S1). The information obtained from the Bioatles database did not provide information about the number of observed specimens.

All records were plotted on a map to obtain the minimum convex polygon in each studied island (Mallorca, Menorca and Formentera) and the occupancy area calculated in km².

Results and discussion

During the first three years of the presence of *C. perspectalis* in the Balearic Islands (2018–2020), up to 31 records were reported in three out of the four islands of the archipelago: Mallorca, Menorca, and Formentera (Figure 1; Table S1). The species was determined according to the morphological and coloration traits described by Inoue (1982). The most common phenotype found was the one that presented hyaline white wings with a brown margin and white spot at the discoidal cell of the hindwings. The dark phenotype was also recorded, but with less frequency. There is only one species in the Balearic Islands that could be misidentified with *C. perspectalis*, i.e. the Crambidae species *Palpita vitrealis* (Rossi, 1894), but this species does not present the brown margin; instead it has a thin brown line in the front side of the hindwings.

In Mallorca, the occurrence area of the box tree moth was about 2978,85 km², larger when compared with Menorca (706,45 km²) and Formentera with

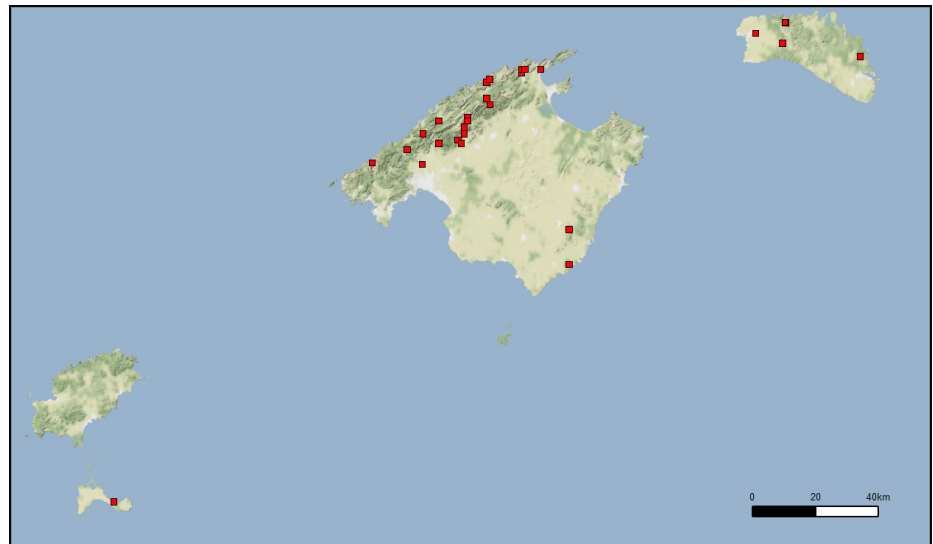


Figure 1. Distribution map of *Cydalima perspectalis* during 2018–2021 at the Balearic Islands. For details see Supplementary material Table S1.



Figure 2. Adult specimens of *Cydalima perspectalis* from Menorca (Balearic Islands). Photograph by Samuel Pinya.

a single record in 2018 (Figure 2). Regarding the occupancy area in km², Mallorca, Menorca and Formentera islands were occupied by 17 km², 4 km² and 1 km², respectively.

Most of the places where records were reported in Mallorca (21 out of 22) are included in Natura 2000 sites and natural protection areas such as the natural area of Serra de Tramuntana, the natural park of Dragonera and the national park of Cabrera archipelago, where natural communities of *B. balearica* are established. These natural areas match biodiversity hotspots in the Balearic Islands. The deleterious effects on the natural plant communities formed by sclerophyllous scrubs on calcareous rock slopes (*Berberion p.*) are crucial



Figure 3. Box tree community at the Tramuntana Mountain range (Mallorca, Balearic Islands) affected by defoliation due to high density of *Cydalima perspectalis*. Photograph by Samuel Pinya.

since these habitats are listed in Annex I of the Habitats Directive and must be protected all over Europe (Council Directive 92/43/EEC; habitat code 5110). Nowadays, the observations of *C. perspectalis* continue, detecting signs of impact in the landscape, such as most of the bushes being defoliated (Figure 3). These effects in Mallorca are becoming a worrying situation and even worse when synergistic effects, such as herbivory by feral goats, act on the bushes of *B. balearica*, an endemic species from the Mediterranean basin.

On the other hand, it is important to highlight that in Menorca Island, *C. perspectalis* was first detected in 2020 (Table S1). The detection of specimens of this species was done under a moth monitoring scheme. Up to three out of four moth monitoring stations showed evidence of the presence of *C. perspectalis*, recording a maximum of 47 specimens in a single night at one of the stations (Figure 2). In the following years (2021–2022), the moth monitoring continued at the same stations on this island, but no evidence of this species was recorded. Only an isolated record of larvae on *B. sempervirens* on April 3rd, 2021, by one of the authors (MM) was reported despite the Citizen Science Campaign carried out by the Ministry of Environment and the University of the Balearic Islands to compile information about *C. perspectalis* distribution at the Balearic Islands. Finally, since 2018 only a single record of *C. perspectalis* has been reported in Formentera on *B. sempervirens*.

These differences between Mallorca and Menorca islands could be explained by the presence of the food plants for *C. perspectalis*. First, in Mallorca and the islet of Dragonera as well as the Cabrera archipelago, there is a large population of *B. balearica*. In addition, many ornamental specimens of *B. sempervirens* can be found around the island of Mallorca,

specifically in public and private gardens and in public cemeteries. Finally, other host plants have been described as food plants for *C. perspectalis* including Aquifoliaceae and Celastraceae (Wan et al. 2014). Of them, only *I. aquifolium* occurs in Mallorca (Llorens et al. 2021), which would reinforce the stabilization of *C. perspectalis* at the island since it provides more host plants. On the contrary, there are no natural populations of *B. balearica* in Menorca or Formentera, although some specimens of *B. sempervirens* can be found in public and private gardens.

The pathway of arrival to the Balearic Islands has not been confirmed yet, but several possible hypotheses have arisen. Firstly, the natural arrival from mainland Spain, demonstrated in other further distance archipelagos from the continent, such as the Azores (Vieira 2020 and references therein); secondly, the arrival through nursery trade from the continent through cargo ships, or thirdly the passive transport on cruise ships. The potential areas of origin are still unknown. They could be eastern mainland Spain if the first introduction pathway hypothesis is confirmed or any European or Asian country of origin of the plant's trade under the second introduction pathway hypothesis.

Because of the occurrence of the native box tree species *B. balearica* at the Balearic Islands, the establishment of *C. perspectalis*, and its expansion in new territories around Europe, it is imperative to promote control actions against this invasive species, not only in the Balearic Islands but also in the European countries. These actions should be supported and coordinated with a precise record of observations so as to assess the colonization process. Also, these control actions must consider the possible impact on native invertebrates. In the case of trap-based control actions, traps must work specifically on the target species. There are specific pheromone commercial traps that have very low capture rates of non-target species. Finally, administrative actions such as the inclusion within the National and/or Regional Catalogue of Alien Invasive Species, as well as its declaration as a pest, would help to act against it and, consequently, to protect natural and native habitats.

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Author contribution

MM investigaton and data collection, data analysis and interpretation, writing original draft. SG data analysis and interpretation, writing original draft . MB data analysis and interpretation, writing original draft. NL data analysis and interpretation. LG research conceptualization, data analysis and interpretation, writing original draft. SP research conceptualization, sample design and methodology, funding provision, review and editing.

References

- Bella S (2013) The box tree moth *Cydalima perspectalis* (Walker, 1859) continues to spread in southern Europe: new records for Italy (Lepidoptera Pyraloidea Crambidae). *Redia* 96: 51–55
- Brua C (2013) La pyrale du buis, *Cydalima perspectalis* (Walker, 1859), espèce exotique envahissante, caractéristiques de sa dynamique d'expansion en France et en Europe, des dégâts occasionnés sur les buis (*Buxus* spp.) et des stratégies de lutte. – AFPP – 3^{ème} Conférence sur l'entretien des espaces verts, jardins, gazons, forêts, zones aquatiques et autres zones non agricoles. Toulouse, pp 365–377
- Gómez-Undiano I, Martínez-Ovejero P, Villegas S, Prieto N, Herrero A, Vives-Moreno A (2018) Primera cita de *Cydalima perspectalis* (Walker, 1859) para Madrid, España (Lepidoptera: Crambidae, Spilomelinae). *SHILAP* 46: 585–591
- Inoue H (1982) Pyralidae. In: Inoue H, Sugi S, Kuroko H, Moriuti S, Kawabe A (eds), *Moths of Japan*. Kodansha, Tokyo 1, pp 307–404
- Kirpichnikova VA (2005) Pyralidae. In: Ler PA (ed) *Key to the Insects of Russian Far East* 5(2). Dal'Nauka, Vladivostok, pp 526–539 [in Russian]
- Krüger EO (2008) *Glyphodes perspectalis* (Walker, 1859) – new for the European fauna (Lepidoptera: Crambidae). *Entomologische Zeitschrift mit Insekten-Börse* 118(2): 81–83
- Llorens Ll, Gil Ll, Tébar FJ, Cardona C, Capote MF (2021) La vegetació de Mallorca i Cabrera. Bases per a la Interpretació i Gestió dels Hàbitats i Paisatge Vegetal. Ed. Govern de les Illes Balears. Palma, Spain, 273 pp
- Matošević D (2013) Box tree moth (*Cydalima perspectalis*, Lepidoptera; Crambidae), new invasive insect pest in Croatia. *South-East European Forestry* 4: 89–94, <https://doi.org/10.15177/seeefor.13-09>
- Maruyama T (1993) Life cycle of the box-tree pyralid, *Glyphodes perspectalis* (Walker) (Lepidoptera: Pyralidae) IV. Effect of various host plants on larval growth and food utilization. *Japanese Journal of Applied Entomology and Zoology* 37: 117–122, <https://doi.org/10.1303/jjaez.37.117>
- Nacambo S, Leuthardt FL, Wan H, Li H, Haye T, Baur B, Weiss RM, Kenis M (2014) Development characteristics of the box tree moth *Cydalima perspectalis* and its potential distribution in Europe. *Journal of Applied Entomology* 138: 14–26, <https://doi.org/10.1111/jen.12078>
- Pérez-Otero RP, Vázquez JPM, Vidal M (2014) *Cydalima perspectalis* Walker, 1859 (Lepidoptera, Crambidae): una nueva amenaza para *Buxus* spp. en la Península Ibérica. *Archivos entomológicos* 10: 225–228
- Vieira V (2020) Primeira citação de *Cydalima perspectalis* (Walker, 1859) para a ilha de São Miguel, Açores (Portugal) (Lepidoptera: Crambidae). *SHILAP Revista de Lepidopterologia* 48(189): 141–146
- Wan H, Haye T, Kenis M, Nacambo S, Xu H, Zhang F, Li H (2014) Biology and natural enemies of *Cydalima perspectalis* in Asia: Is there biological control potential in Europe? *Journal of Applied Entomology* 138: 715–722, <https://doi.org/10.1111/jen.12132>
- Wang YM (2008) The biological character and control of a new pest (*Diaphania perspectalis*) on *Murraya paniculata*. *Journal of Fujian Forestry Science and Technology* 4: 161–164

Web sites and online databases

- Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. <http://data.europa.eu/eli/dir/1992/43/oj>
- EPPO (2011) European and Mediterranean Plant Protection Organization. *Cydalima* (= *Diaphania*) *perspectalis*. EPPO Deletions. http://www.eppo.fr/QUARANTINE/Alert_List/deletions.htm (accessed 12 December 2022)
- EPPO (2018) European and Mediterranean Plant Protection Organization. <https://gd.eppo.int/taxon/DPHNPE/distribution> (accessed 12 December 2022)

Supplementary material

The following supplementary material is available for this article:

Table S1. Records of *Cydalima perspectalis* at the Balearics Islands.

This material is available as part of online article from:

http://www.reabic.net/journals/bir/2023/Supplements/BIR_2023_Mascaro_et_al_SupplementaryMaterial.xlsx