

**All-Russian Research Institute of Silviculture and Mechanization of Forestry
East Palearctic Regional Section
International Organization for the Biological Control of Pests and Animals**



**INVASIVE DENDROPHILOUS
ORGANISMS:
CHALLENGES AND PROTECTION
OPERATIONS**



**Puskin
2019**

All-Russian Research Institute of Silviculture and Mechanization of Forestry
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CHALLENGES AND PROTECTION OPERATIONS**

Pushkino 2019

Всероссийский научно-исследовательский институт лесоводства
и механизации лесного хозяйства
Восточнопалеарктическая региональная секция Международной
организации биологической защиты растений от вредных животных и растений

**ИНВАЗИВНЫЕ ДЕНДРОФИЛЬНЫЕ ОРГАНИЗМЫ:
ПРОБЛЕМЫ И МЕРЫ ЗАЩИТЫ**

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Инвазивные дендрофильные организмы: проблемы и меры защиты : коллективная монография. – под общей редакцией Ю.И. Гниненко. – Пушкино : ВНИИЛМ, 2019. – 120 с.

Коллективная монография посвящена вопросам, связанным с проникновением в леса и озеленительные посадки древесно-кустарниковых растений новых инвазивных организмов, которые нередко наносят большой вред. Рассмотрены вопросы проникновения таких вредителей как самшитовая огневка, дубовый клоп-кружевница, уссурийский полиграф и др. на территорию России и стран Восточной Европы.

Предназначена для работников лесного хозяйства в области защиты растений и озеленения, а также для студентов высших учебных заведений.

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Invasive dendrophilous organisms: challenges and protection operations. Collective monograph. Under the general edition of Gninenko Yu.I. Pushkino: VNIILM, 2019. 120 pages.

The collective monograph is devoted to issues related to the penetration into forests and green planting of wood-shrub plants of new invasive pests, which often cause great harm. The issues of penetration of pests such as box tree moth, oak lace bug, Four-Eyed Fir Bark Beetle and others into the territory of Russia and Eastern Europe are considered.

It is intended for plant protection workers in forestry and greening, as well as students of higher education institutions.

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Content

Editor foreword	5
Chapter 1. Box tree moth: the conquest of Europe and not only	6
1.1 Box tree moth in the Russian Federation: disaster development and interim results.....	6
1.2 Invasion by the box tree moth, <i>Cydalima perspectalis</i> (Lepidoptera: Crambidae), in southeastern Europe	17
1.3 <i>Neoglyphodes perspectalis</i> (Walker, 1859) (Lepidoptera, Crambidae) – first record in Uzbekistan.....	29
Chapter 2. Dangerous invaders in forests and greenery plantations.....	32
2.1 Challenges of forest ecosystem biodiversity conservation in specially protected nature territories (SPNT) as foreign organisms invade	32
2.2 Heavy losses of thuja (<i>Thuja</i> , Cupressaceae) in the Sochi “Arboretum Park”	37
2.3 Horse chestnut condition in Moscow territory	46
2.4 Some biological features of the oak lace bug in the oak forests in the Caucasus region.....	53
2.5 <i>Polygraphus proximus</i> in European Russia	65
2.6 <i>Phylonorycter issikii</i> (Lepidoptera, Gracillidae) in Moscow	75
Chapter 3. Dendrophilous invaders in Siberia and Russian Far East.....	83
3.1 Robinia leaf gall midge <i>Obolodiplosis robinia</i> in the island of Sakhalin	83
3.2 <i>Polygraphus proximus</i>	87
3.2.1 Four-Eyed Fir Bark Beetle <i>Polygraphus proximus</i> Blandford, 1894 (Coleoptera, Curculionidae: Scolytinae) in Western Siberia: review of ten- year invasion studies.....	87
3.2.2 <i>Polygraphus proximus</i> in the Krasnoyarsk territory.....	104
3.3 <i>Ips amitinus</i> (Eichhoff, 1872) (Coleoptera, Curculionidae: Scolytinae) – a new pest of <i>Pinus sibirica</i> in Western Siberia.....	110
Editor's opinion	118

Editor foreword

Occurrence of new dendrophilous invaders in forests and greenery plantations of Europe and Asia is a great risk and creates new challenges for forest protection practitioners. Each new invader is not just a surprise but a protection crudity as well. People are always late as new invaders appear. It is difficult to develop protection operations against a hazardous insect or a disease agent when they are not available in the territory.

However, after invader occurrence its damage is evident but protection operations have not been developed yet and pesticide testing and registration for protection against the invader take several years.

Very often government and community do not take new invader occurrence seriously as needed. It is a clear response since people including main experts do not have comprehensive knowledge about a new invader.

The actions to eliminate the infected boxwood in the Krasnodar Territory on the Black Sea coast were carried out incorrectly. Great risk evidence for forest protection experts was not adequately assessed by society and authorities. Just after loss of natural forests with Colchis boxwood which happened 2-3 years after the pest 1st identification urgency of protection operations was clear for everybody but in fact there was nothing to protect.

Thus, each new invader occurrence should be regarded seriously and an information sharing network should be a key element of tree shrub vegetation protection package against foreign invaders. Nature conservation legislation should be adjusted so that an invader infestation of nature reserves, national parks and specially protected territories would not prevent protection operations.

The idea to prepare a joint publication to sum up tree protection experience available in Russia and neighbor states was discussed in Budapest in 2018, The idea was realized in this monograph. We believe that the presented protection experience against specific pests and diseases is valuable for specialists.

Yu.I. Gninenko

1.2. Invasion by the box tree moth, *Cydalima perspectalis* (Lepidoptera: Crambidae), in southeastern Europe

Gábor Véték^{1*}, Peter Zach², Dinka Matošević³, Katalin Tuba⁴, Ferenc Lakatos⁴, Jan Kulfan², György Csóka⁵, Stanislav Gomboc⁶, Sándor Nagy⁷, Milka Glavendekić⁸, Dimitrios N. Avtzis⁹, Maarten de Groot¹⁰, Levente Szócs⁵, Irena Papazova-Anakieva¹¹, Sterja Nacheski¹¹, Snježana Hrnčić¹², Sanja Radonjić¹², Veronika Fekete¹

¹Department of Entomology, Faculty of Horticultural Science, Szent István University, Villányi út 29-43, H-1118 Budapest, Hungary

²Institute of Forest Ecology, Slovak Academy of Sciences, Zvolen, Slovak Republic

³Department for Forest Protection, Croatian Forest Research Institute, Jastrebarsko, Croatia

⁴Institute of Silviculture and Forest Protection, Faculty of Forestry, University of West Hungary, Sopron, Hungary

⁵Department of Forest Protection, Forest Research Institute, National Agricultural Research and Innovation Centre, Mátrafüred, Hungary

⁶Kranj, Slovenia

⁷Institute of Chemistry, Eötvös Loránd University, Budapest, Hungary

⁸Department of Landscape Architecture and Horticulture, Faculty of Forestry, University of Belgrade, Belgrade, Serbia

⁹Forest Research Institute, Hellenic Agricultural Organization, Demeter, Thessaloniki, Greece

¹⁰Department of Forest Protection, Slovenian Forestry Institute, Ljubljana, Slovenia

¹¹Faculty of Forestry, Ss. Cyril and Methodius University in Skopje, Skopje, North Macedonia

¹²Biotechnical Faculty, University of Montenegro, Podgorica, Montenegro

*Corresponding author: Vetek.Gabor@kertk.szie.hu

Вторжение самшитовой огнёвки *Cydalima perspectalis* (Lepidoptera: Crambidae) в юго-восточную Европу

Самшитовая огнёвка *Cydalima perspectalis* (Lepidoptera: Crambidae), родиной которой является Восточная Азия, была завезена в Европу более 10 лет назад. Это привело к значительным повреждениям самшита (*Buxus* spp.) как в городских озеленительных посадках, так и в естественных лесах. Появление этого инвазивного вредителя в юго-восточной Европе еще не было достаточно подробно задокументировано. Основная цель этого исследования состояла в том, чтобы показать подробную картину распространения *C. perspectalis* в 11 европейских странах путем обобщения имеющихся данных о развитии инвазии за период с 2010 по конец 2016 года. Сбор данных в основном основывался на отчетах, полученных от граждан. Полученные результаты ясно показывают, что вредный организм был гораздо более широко распространен в этой части Европы уже в 2016 году, об этом можно судить по ранее опубликованным работам. Также были получены доказательства того, что *C. perspectalis* присутствовал в Албании, Венгрии и Косово, по крайней мере, за год до своего первого официального отчета в этих странах. Это исследование подчеркивает необходимость

использования всех сведений в мониторинге инвазивных чужеродных видов.

Ключевые слова: чужеродные виды, *Cydalima perspectalis*, самшит, распространение, юго-восточная Европа, наблюдения граждан.

Abstract

The box tree moth, *Cydalima perspectalis* (Lepidoptera: Crambidae), is native to East Asia and was introduced in Europe more than a decade ago. It causes severe damage to box trees (*Buxus* spp.) in both urban and natural habitats. The occurrence of this invasive pest in southeastern Europe has not been documented in a comprehensive way yet. The main objective of this study was to obtain a detailed picture of the spread and distribution of *C. perspectalis* in 11 countries by summarising the records of the species from 2010 to the end of 2016. Data collection was primarily based on reports received from citizens. The results, due to the involvement of citizen science, clearly indicate that the pest was much more widely distributed in this part of Europe as early as 2016 than judged from previously published works. Evidence has been obtained that *C. perspectalis* was present in Albania, Hungary, and Kosovo, at least one year before its first official record in these countries. This study highlights the utilisation of citizen science in the monitoring of invasive alien species.

Key words: alien species, *Cydalima perspectalis*, *Buxus*, distribution, southeastern Europe, citizen science.

Introduction

The current distribution of species has been shaped mostly by their natural dispersal ability, which has been ruled by several biogeographical barriers for a long time. However, these boundaries have easily been overcome by anthropogenic activities, including the intentional and unintentional transfer of living organisms. Therefore, more and more species, no longer restricted within their native range, become aliens in different biogeographical regions, where they may have a severe impact on the invaded ecosystem (Nentwig et Josefsson, 2009). The main pathway of introduction of alien pests of plants in Europe is the live plants trade (Kenis *et al.*, 2013).

The box tree moth, *Cydalima perspectalis* (Walker, 1859) (Lepidoptera: Crambidae: Spilomelinae), is native to East Asia (Mally et Nuss, 2010; Nacambo *et al.*, 2014; Bras *et al.*, 2019) and was introduced in Europe (Billen, 2007; Krüger, 2008), where it has been spreading since at least 2007 (Billen, 2007; Leuthardt *et al.*, 2010; Nacambo *et al.*, 2014). It causes severe damage to box trees (*Buxus* spp.) in both urban areas and natural *Buxus* stands. Larvae feed on leaves and can completely defoliate box trees, and they can also damage the bark. Severely affected plants may die (Kenis *et al.*, 2013; Leuthardt et Baur, 2013; Gutue *et al.*, 2014; Nacambo *et al.*, 2014; Matsiakh, 2016; Véték, personal observation). As indicated by the studies of Kenis *et al.* (2013), Matsiakh

(2016), Raineri *et al.* (2017), Matsiakh *et al.* (2018), and Mitchell *et al.* (2018), the most harmful consequences of the rapid dispersal of this invasive species within Europe may be expected in the forest ecosystems where natural populations of the box tree occur.

The native populations of *Buxus sempervirens* L. and *B. balearica* Lam. in southern Europe underwent severe reduction in the last millennia and are undergoing a process of fragmentation and isolation (Di Domenico *et al.*, 2012; Kenis *et al.*, 2013). In southeastern Europe, *B. sempervirens* occurs naturally in Albania, Greece, Kosovo, Montenegro, and North Macedonia, whereas in Croatia, Hungary, the Slovak Republic, and Slovenia only its fossil sites are documented. In Bosnia and Herzegovina, and Serbia, the historical occurrence of box trees is not verified (Di Domenico *et al.*, 2012). However, in each country, the box tree is planted frequently in historical, formal and private gardens and cemeteries as an ornamental plant or for hedging.

The spatial distribution of *C. perspectalis* in Europe by the end of 2012 was shown by Kenis *et al.* (2013). Since then, a number of further reports have confirmed the widespread occurrence of the pest in Europe (for a recent summary see CABI, 2019; but see also Hellers et Christian, 2016; Kudła and Dawidowicz, 2016; Bengtsson, 2017; Bury *et al.*, 2017; Agius, 2018; Corley *et al.*, 2018; Perez et Guillem, 2019). Although some data about the occurrence of the pest in southeastern Europe up to the end of this current research in December 2016 have already been known from the region (e.g., Jež, 2012; Koren et Črne, 2012; Matošević, 2013; Glavendekić, 2014; Kulfan *et al.*, 2014; Véték *et al.*, 2014, and references therein; Marković *et al.*, 2015; Ostojić *et al.*, 2015; Pantić *et al.*, 2015; Stojanović *et al.*, 2015; Strachinis *et al.*, 2015; Nacheski *et al.*, 2016; Szanyi *et al.*, 2016; Tüske et Marczali, 2016; Hrnčić et Radonjić, 2014, 2017; Hrnčić *et al.*, 2017; Nacheski *et al.*, 2017), a comprehensive study providing an overview of the occurrence and distribution of *C. perspectalis* from this particular region was missing. This work aims to complete information on the presence of *C. perspectalis* in this large area representing a region in some parts of which vulnerable native (natural) populations of the box tree exist and are threatened by this pest.

Materials and methods

Data about the occurrence of *C. perspectalis* were collected from 11 countries until 11 December 2016: (in alphabetical order) Albania (AL), Bosnia and Herzegovina (BA), Croatia (HR), Greece (GR), Hungary (HU), Kosovo (under the terms of UNSCR 1244) (XK), Montenegro (ME), North Macedonia (MK), Serbia (RS), the Slovak Republic (SK), and Slovenia (SI). The countries joined the study in different years in the following chronological order: 2012: HU; 2013: HR, SI, SK; 2015: AL, BA, ME, RS, XK; 2016: GR, MK. As we could not find any contact persons to participate in this study in AL, BA and XK, the

data from these countries are limited and do not represent the actual distribution of the species in these regions.

The data about the occurrence of *C. perspectalis* were collected by active search for the pest by the authors of this study (in each country except for AL and XK) at locations with expected presence of *Buxus* spp. (e.g., cemeteries, public parks, castle gardens). This was primarily based on observations of individuals (larvae, pupae and adults) and damage symptoms of the pest, but catches of the moth in light traps were also considered (in HR, HU and SI). In addition, citizen science was also involved to gather data in some of the participating countries. In this case, citizens (partly including the members of professional organisations) were requested (e.g., through specific calls uploaded to professional websites and via e-mails) to provide relevant observational data. For each observation, the following basic information was recorded: location (name and geographic coordinates); date (at least the year) of the record; and name of the recorder. If available, the data such as an elevation and a brief description of the site and environment were also recorded. Sites with different geographical coordinates but within the same settlement (location) were considered as a single record. Due to the conspicuous appearance of the larva and adult of *C. perspectalis*, and the characteristic symptoms of damage to *Buxus* plants, identification by non-professionals was considered as reliable. Besides the data received and collected actively by the authors, the presence records in the studied region known from any types of publications (see Introduction; note: not all the sources are indicated there) were also used to complete the picture of the spread and distribution of the pest in southeastern Europe by the end of 2016.

The records of the presence of *C. perspectalis* from the 11 countries were finally shown on a distribution map, where the data are displayed by the year of the earliest record for each location, to visualise the spread of the pest (ESRI ArcGIS Pro software, version 2.4.0, Coordinate system: GCS_WGS_1984, Map projection: WGS 1984 Web Mercator Auxiliary Sphere).

Results and discussion

By the end of 2016, we had collected data about the occurrence of *C. perspectalis* from a total of 685 locations in southeastern Europe. In this region, *C. perspectalis* was first recorded at Zalaegerszeg [46.8360°N, 16.8456°E], HU, in 2010 (Fig. 1). The total number of records and the year of the first record of the species in each country are shown in Table 1.

The distribution pattern of *C. perspectalis* in the studied area supports the CLIMEX map of predicted distribution and relative abundance of the species in Europe (Nacambo *et al.*, 2014). The species was recorded in the altitudes ranging from 0 m at Strunjan [45.5262°N, 13.6051°E] (adults) to 1031 m at Poljubinj [46.1905°N, 13.7822°E] (adult), both locations in SI.

Table 1. Total number of records and the year of the first record of *Cydalima perspectalis* in the 11 countries of southeastern Europe

Country	Total number of records	Year of the first record	Source of data of the year of the first record
Albania	1	2016	present study
Bosnia and Herzegovina	15	2014	Ostojić <i>et al.</i> (2015), present study
Croatia	72	2012	Koren and Črne (2012)
Greece	12	2013	Strachinis <i>et al.</i> (2015)
Hungary	404	2010	present study
Kosovo	1	2016	present study
Montenegro	21	2014	Hrnčić et Radonjić (2014), present study
North Macedonia	6	2014	Nacheski <i>et al.</i> (2016, 2017)
Serbia	53	2014	Glavendekić (2014), HabiProt (2019)
Slovak Republic	37	2012	Pastorális <i>et al.</i> (2013), present study
Slovenia	63	2011	Jež (2012), present study

Several locations in western SK, specifically Bratislava and nearby places, and the southwest of this country, a large part of western HU, mainly the northwestern region, and the area west of lake Balaton (including Zalaegerszeg, see above), northeastern SI and northwestern HR were invaded by the end of 2013. If we compare these findings with the information about heavily infested area shown in figure 3 in Kenis *et al.* (2013), it seems that *C. perspectalis* had reached the western part of the studied region (also) by active dispersal.

Considering the first published report (location and date) of the particular country combined with the data from Germany which indicate the rate of the spread of *C. perspectalis* to be approximately 5-10 km/year (Van der Straten and Muus, 2010), there were locations (with the damage by the moth) outlying from heavily invaded areas. These were, for example, the following ones: Dobrá Niva, Prešov, and Turňa nad Bodvou (SK); Budapest and Miskolc (HU); Osijek (HR); and Kifissia (GR). At least in these cases the occurrence of the species is not likely to be directly related to its first official reports from the countries concerned. Also, it may not be expected that the pest reached these sites by active spread from the known invaded areas but its arrival in outlying areas with infested planting material seems to be the most probable pathway of introduction. Human-assisted introduction, when *C. perspectalis* was introduced with plants for planting as a contaminant, following the terminology given by Rabitsch (2010), seems to be confirmed by the observations of damaged plants found in nurseries or garden centres at Dobrá Niva (*Buxus* trees introduced from Italy) and Budapest (*Buxus* plants introduced from Zala county, western HU), both as early as 2013. Moreover, damage to *Buxus* in nurseries or garden centres

were noticed at locations in other countries as well, for example at Dajç (AL), Filiria (GR), Jastrebarsko (HR), Đenovići (ME), Marena (MK) and Liplje (RS). This indicates the potential contribution of these facilities to the unintentional dispersal of the pest highlighted by Gninenko *et al.* (2014) and Plant *et al.* (2019). Passive dispersal via plant trade may largely facilitate and speed up the spread of *C. perspectalis* in those regions or countries where *Buxus* spp. are not native to and in which box trees are used only for ornamental purposes in parks and private gardens. In these cases, the transportation, even for long distances, and planting of infested plants may make formerly uninvaded locations act as stepping-stones for further invasion of the surrounding areas. The potential steppingstone role of cemeteries may also be highlighted, because *Buxus* has been a quite popular plant here even at small settlements as we found in our survey. For example, in HU, the damage by the pest was recorded in more than 40 graveyards, also on relatively old bushes. It thus seems possible that if these sites contain the appropriate host (Matošević *et al.*, 2017), they provide the moth with suitable places for oviposition, supporting the consequent development of their offspring and their further ('unaided') spread (i.e. secondary spread from the point of entry) towards native environments (Rabitsch, 2010).

Damage to *Buxus* in countries where there are no natural stands of this taxon remains only of aesthetic concern, though potentially paired with severe economic effects especially in historical and formal gardens and parks. However, the loss of native *Buxus* populations may have huge ecological impacts (Mitchell *et al.*, 2018). As indicated by Raineri *et al.* (2017) and Načeski *et al.* (2018), the pest has already reached the natural *Buxus* stands in AL and MK. Therefore, heavy damage to *Buxus*, similar to that already observed, for example, in native populations of southwestern Germany and northern Switzerland (Kenis *et al.* 2013; Véték, personal observation, 2013), northern Italy (Raineri *et al.*, 2017), and the western part of the Republic of Georgia (Matsiakh *et al.*, 2018), may also be expected in the Balkans.

This study also indicates how citizen science can contribute to the better understanding of the history of invasion of an alien insect. As both the insect and the type of damage are easy to identify by non-professionals, *C. perspectalis* is an 'ideal' target organism for further monitoring by the involvement of the public. Nevertheless, the irregular pattern of distribution across the studied region as well as the great differences in the number of presence records by country should be interpreted very carefully regarding the real occurrence of the pest, because a wide range of factors might have influenced our results. For instance, the starting date of monitoring, efforts made and area investigated, and the enthusiasm and motivation of citizens to gather and provide the data should be considered. Our study comprehensively reveals the history of the spread of *C. perspectalis* in southeastern Europe by the end of 2016. It also shows that the pest had already been present in AL (at Dajç in 2016), HU (at Zalaegerszeg in 2010) and XK (at Kosovska Kamenica in 2016) at least one year earlier than the

first known ‘official’ record from these countries (cf. Raineri *et al.*, 2017; Sáfián et Horváth, 2011; Geci et Ibrahim, 2018).

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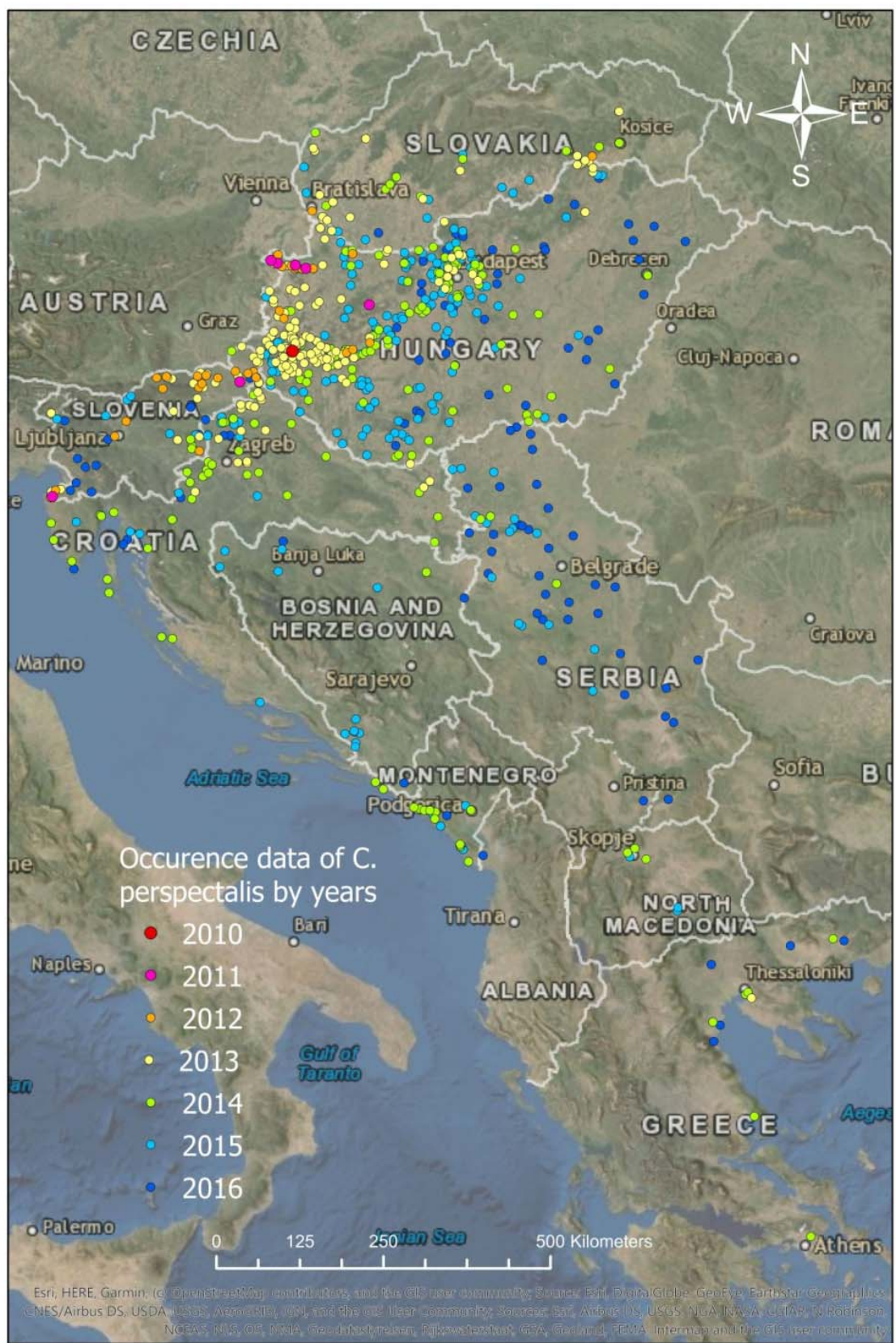


Figure 1. Distribution of *Cydalima perspectalis* in southeastern Europe (2010-2016)

Editor's opinion

The All-Russian Scientific Research Institute for Forestry and Mechanization of Forestry, together with the East Palaearctic Section of the International Organization for Biological Control of Pests and Animals, prepared this collective monograph to show the scale of penetration of new invaders into the forests of Eurasia and the problems that arise when each new invader appears. For quite a long time, new invaders appeared only in the forests of European countries, while the vast forests of Siberia were, as it were, outside their influence. However, the 21st century brought not only an increase in the flow of invasive deendrophilic insects into the forests of Europe, but also the spread of this process into Siberian forests. It is now becoming clear that the process of the emergence of new invaders in the forests of Europe and Siberia will not only slow down, but most likely, it may intensify. In order to effectively confront these new "invaders", the combined efforts of scientists and practitioners from all concerned countries are needed.

This collective monografia is an attempt to summarize some intermediate results of the study of forest invaders in the space from Western Europe to Siberia and Central Asia. It does not pretend to provide an exhaustive coverage of the issue: as the process of penetration of new invaders continues, so does the process of studying and developing measures to protect against them.

Yu.I. Gninenko

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