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NEW DATA ON ALIEN INSECT PESTS OF ORNAMENTAL PLANTS IN BULGARIA

Aneliya Pencheva[1*] and Mariya Yovkova[2]

[1]Department of Plant Pathology and Chemistry, Faculty of Ecology and Landscape Architecture. University of Forestry. 10 St. Kliment Ohridski Blvd., 1756 Sofia, Bulgaria.
[*]E-mail: ajp84@abv.bg
[2]Institute of Ornamental Plants – 1222 Sofia, Negovan, Bulgaria.
E-mail: mariya_yovkova@abv.bg

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Abstract

In this study, the results of recent surveys (during the period between 2012 and 2015) on alien insects infesting ornamental plants in Bulgaria are reported. Fourteen species, associated with urban landscape areas and indoor plants, are discussed. Two of them, *Ceroplastes sinensis* Del Guercio and *Lepidosaphes flava* (Signoret), are reported for the first time in Bulgaria. Furthermore, *Acizzia jamatonica* (Kuwayama), *Ceroplastes ceriferus* (Fabricius), *Pseudaulacaspis pentagona* (Targioni Tozzetti) and *Cydalima perspectalis* (Walker) have been found in new localities. *Metcalfa pruinosa* Say has widened its host range in Bulgaria. Additional distribution data are also provided about *Aulacaspis yasumatsui* Takagi and *Cacoecimorpha pronubana* (Hübner). Details on current status, host plants, zoogeographical origin and probable pathways of introduction into Bulgaria are reported for each species. Morphological and biological remarks are given for *C. perspectalis* and *C. sinensis*.

Key words: box tree moth, Chinese wax scale, De Stefan scale, new pests, scale insects.

Introduction

In recent years, due to the active marketing of ornamental plants and plant material, a large number of non-native insects have penetrated in different continents and countries. After introduction into a new area, they may become acclimatized, surviving outdoors. In some cases these are very harmful species. They not only cause significant damage to ornamental plants, reduce their aesthetic and market values but also may threaten the native flora. Thus, their invasion becomes a global environmental problem regarded as one of the main factors that lead to a decline in regional biodiversity (FAO 2003, Chornesky et al. 2005).

As far as phytophagous insects are concerned, more than 25 alien species have been recorded as new pests in the last decade in Bulgaria (Beshkov et al. 2015, Doychev 2015, Pencheva et al. 2014, Tomov and Trencheva 2013, Yovkova et al. 2013, Yovkova et al. 2015). About two thirds of them are ornamental plant pests and may cause significant damage to cultivated plants both in Bulgaria and across Europe. Their unexpected massive appearance in urban habitats is attributed

mainly to the introduction and distribution of infested plant materials.

The aim of the present study was to investigate the current status and distribution of alien insect recently reported as pests on ornamentals in Bulgaria, as well as old invaders whose populations are increased in the last years. The survey results will contribute to get acquainted with alien insect's distribution and have a practical application, benefiting producers of ornamental plants.

Materials and Methods

The survey was conducted over a period of four years, between 2012 and 2015. Several localities with ornamental plants (city/urban parks, private gardens, ornamental nurseries, greenhouses, garden centres and collection in botanical gardens) were surveyed. They were located in various regions of Bulgaria (Fig. 1). Part of the biological materials was provided by different specialists working in urban parks or in nurseries.

During the visual inspection of ornamental plants, infested plant parts (twigs or leaves) and insects on them were collected and placed separately into plastic bags or in 70 % alcohol for further examination in the laboratory. For each insect's sample, origin of infested host plants or pathways of their introduction were checked. The surveys were carried out during the active phase of the insects' life, namely from May to October. Caterpillars of the lepidopteran pest species were reared to adults under laboratory conditions. Scale insect specimens were mounted for light microscopy according to the procedure detailed by Kosztarab and Kozár (1988). The species found in Bulgaria for the first time were identified using the keys of Danzig (1993), Gimpel et al. (1974) and Fetyko and Kozár (2012). The

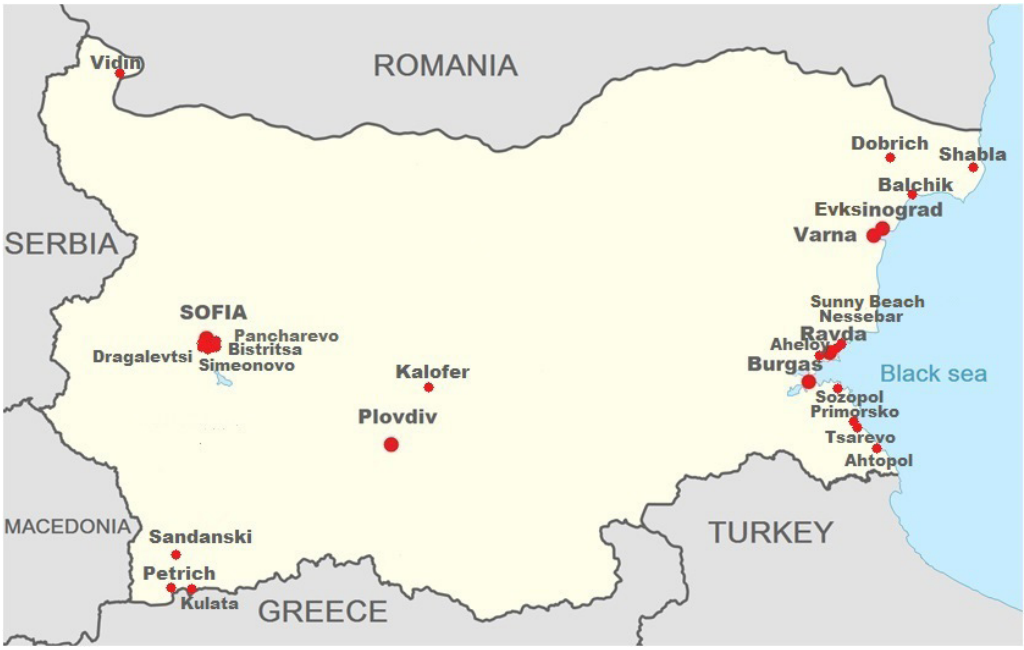

Fig. 1. Regions and locations in Bulgaria where alien insect pests included in this study were established.

identification of *Ceroplastes ceriferus* was confirmed by J. F. Germain, Plant Health Laboratory, Montpellier, France. The collected specimens are preserved in the department of Plant Pathology and Chemistry at the University of Forestry, Sofia.

Results and Discussion

Fourteen alien insects associated with urban green areas were identified in different regions of Bulgaria during the present study (Table 1). They belong to two

Table 1. List of surveyed alien pests.

No	Alien insect pest	First record in Bulgaria	Established localities	Type of localities	Origin
1	*Metcalfa pruinosa* Say	2007– Plovdiv	Petrich, Balchik, Shabla – 2014; Nessebar, Balchik and Varna – 2015	Outdoors (private gardens and city parks)	North America
2	*Acizzia jamatonica* (Kuwayama)	2009 – Nessebar	Sofia – 2014; Nessebar – 2015	Outdoors (private gardens)	East Asia
3	*Trioza alacris* Flor.	2009 – Ahtopol	Aheloy – 2012–2015	Outdoors (private gardens)	Mediterranean origin
4	*Elatobium abietinum* (Walker)	2014 – nearby Sofia	Not found in its previous localities	Outdoors in private gardens	Central and Northern Europe
5	*Icerya purchasi* Maskell	1968 – Sofia	Ravda – 2012–2015	Indoors in garden centres	Australia
6	*Phenacoccus peruvianus* Granara De Willink	2010 –Ravda	Ravda – 2013–2014	Indoors in garden centres and greenhouses	South America (Argentina, Peru)
7	*Ceroplastes ceriferus* (Fabricius)	2011 – Vidin	Nessebar – 2012 and 2013; Sozopol – 2015	Outdoors (private gardens)	Neotropical
8	*Ceroplastes japonicus* Green	2007 – Sofia	Ravda – 2014	Outdoors (private gardens and garden centres)	Eastern Asia
9	*Ceroplastes sinensis* Del Guercio	**New record**	Nessebar – 2013	Indoors (garden centres)	Central or South America
10	*Aulacaspis yasumatsui* Takagi	2009 – Tsarevo	Sofia and Sunny Beach – 2013; Ravda – 2014	Indoors (greenhouses and garden centres)	Southeast Asia
11	*Lepidosaphes flava* (Signoret)	**New record**	Sofia, 2012 Burgas, 2013	Indoors and garden centres	Near East and Mediterranean Palaearctic
12	*Pseudaulacaspis pentagona* (Targioni Tozzetti)	1968 – Petrich, Sandanski, Kulata	Plovdiv, 2013; Sofia, 2012–2015; Balchik – 2014; Sunny Beach – 2013	Outdoors (private gardens, city parks and botanical gardens)	Eastern Asia
13	*Cacoecimorpha pronubana* (Hübner)	2009 – Aheloy	Ravda, Burgas, Aheloy – 2012–2015	Outdoors and indoor (garden centres)	Mediterranean region
14	*Cydalima perspectalis* Walker	2014 – Balchik	Dragalevtsi, Dobrich – 2014; Burgas, Plovdiv, Primorsko, Sofia, Kalofer – 2015	Outdoors (private gardens and city parks)	Asia

orders (Hemiptera and Lepidoptera) and 8 families. Half of them are scale insects (Coccoidea), which are able to spread easily with infested plant materials, because of their small size and cryptic behaviour. Details on detected species are given further down.

Metcalfa pruinosa (Say, 1830) [Hemiptera, Flatidae] – citrus flatid planthopper.

Collected material: 2014: 20 July – Petrich; 26 August – Balchik and Shabla; 2015: 15 July – Ravda and Nessebar; 20 August – Balchik and Varna.

In August 2014, in Balchik Botanical garden *M. pruinosa* had infested more than 45 herbaceous, ornamental and fruit plant species (Fig. 2). The most infested trees and shrubs were: *Acer platanoides* L.*, A. campestre* L.*, Broussonetia papyrifera* (L.) Vent.*, Catalpa bignonioides* Prints, *C. speciosa* Prints*, Cornus mas* L.*, Diospyros kaki* Thunb.*, Fraxinus excelsior* L.*, Ficus carica* L.*, Hibiscus syriacus* L.*, Parthenocissus tricuspidata* (Siebold & Zucc.) Planch., *Philadelphus coronarius* L. and *Vitis vinifera* L. The population density of citrus flatid planthopper was considerably lower in 2015, but number of infested host plants increased. At other sites *M. pruinosa* mainly infested weeds, including *Marsdenia erecta* (L.) R. Br. and *Clematis vitalba* L. (around Nessebar), and only in Petrich the insect was found on a single *Catalpa bignonioides* tree.

The North-American planthopper *M. pruinosa* was accidentally introduced into Europe (first in Italy), and subsequently caused economic damage to orchards and vineyards in some South-European countries (Strauss 2010). In Bulgaria it was first detected in 2004 on *Thuja occidentalis* L. at a locality near Plovdiv (Trenchev et al. 2007). The planthopper is gregarious and extremely polyphagous species. According to some authors it may feed on 200 to 300 plant species (Souliotis et al. 2008, Grozea et al. 2011). Three of infested plants species determined in Balchik – *Lonicera maacki* (Rupr.) Herder, *Securinega suffruticosa* J. F. Gmel. and *Cephalotaxus harringtonia* (Knight ex J. Forbes) K. Koch – have probably not been recorded earlier as hosts of *M. pruinosa*.

This species overwinters as eggs inserted in woody tissue or under tree bark. The first nymphs were found on the leaves and stems in the beginning of May. The total development period of the larval stages takes an average of 42 days (Lucchi and

a b

Fig. 2. *Metcalfa pruinosa*: adults (a) and signs of pest infestation to *Cornus mas* (b).

a b

Fig. 3. Psyllids: a – white wax on a leaf of *Albizia julibrissin* excreted by nymphs of *Acizzia jamatonica*; b – nymphs and gall of *Trioza alacris* on a leaf of *Laurus nobilis*.

Santini 1993). Nymphs surround themselves with long, waxy filaments, which protect them from their copious honeydew (Fig. 2b). In 2015 adults were present in all localities from the beginning of July to the end of September. Besides infested plants, *M. pruinosa* could be transported over long distances on vehicles, which often park along the roadsides near food plants of the pest. Local invasion of the surrounding area follows and is facilitated by the presence of uninterrupted belts of host trees and shrubs (Pantaleoni 1989). The protected waxy cover of the citrus flatid planthopper, the way it spreads and its adaptability, are factors that lead to the development of the species in large population density during the last 4 years in Bulgaria.

Acizzia jamatonica (Kuwayama, 1908) [Hemiptera, Psyllidae] – albizia psyllid.

Collected material: Simeonovo (nearby Sofia) – 25 September 2014; Nessebar – 16 July 2015.

In September 2014, psyllid nymphs and adults were collected on a young (about 6–7-year-old) solitary silk tree (*Albizia julibrissin* Durazz.) located on a private property nearby Sofia. Psyllid nymphs had excreted honeydew and spirals of white wax on the leaves (Fig. 3a). The damage caused by *A. jamatonica* was substantial and associated with leaf discoloration and premature leaf drop. The following year (2015) the infested tree died, probably due to bark necrosis. In the middle of July 2015, psyllid nymphs were also found around Nessebar.

A. jamatonica is native to East Asia, but has rapidly increased its geographical distribution during the last decade, becoming established in Europe and North America (Mifsud et al. 2010). It develops on *Albizia* spp. and is most commonly recorded on *A. julibrissin*. The first occurrence of *A. jamatonica* in Bulgaria was in July 2009 in Nessebar (Vétek and Rédei 2009). Since then, the insect has rapidly spread in South-eastern Bulgaria and particularly in the coastal areas (Harizanova et al. 2012).

Trioza alacris Flor, 1861 [Hemiptera, Triozidae] – laurel psyllid.

Collected material: Aheloy, during May – August in 2012 – 2015.

The abundant leaf galls on *Laurus nobilis* L. (used as a hedge), laurel psyllid adults and nymphs have been detected from April to October since its first appearance in 2009 (Pencheva et al. 2009). At present *T. alacris* is limited to a locality sit-

uated at a private property in Aheloy and since 2009 it has hibernated successfully for about 6 years. It is suspected that the laurel psyllid has been introduced in Bulgaria on imported plants originating from the Netherlands.

The species is most likely of Mediterranean origin but was introduced to Central and Northern Europe on cultivated bay laurel (Mifsud et al. 2010). Generally it develops on *L. nobilis*, but is also reported on *L. azoricus* (Seub.), producing characteristic large leaf galls by rolling down leaf margins (Fig. 3b). *T. alacris* has two to five broods in the year according to the weather (Ossiannilsson 1996), the last one maturing in the end of October. Its chemical control is difficult because of the lavishly waxy secretion covering the nymphs.

Elatobium abietinum (Walker, 1849) [Hemiptera, Aphididae] – green spruce aphid.

Collected material: 20 April 2014 – nearby Sofia.

The green spruce aphid was detected for the first time in April 2014 on three private properties nearby Sofia – Bistritsa, Pancharevo and Dragalevtsi. Dense colonies of larvae and apterae females have been registered on the branches of *Picea abies* (L.) Karst. and *P. pungens* Engelm. The damage to infested plants was significant and has led to needle necrosis and premature needle drop (Yovkova et al. 2015). Further observations conducted during growing season in 2015, the aphid was not found in either the previous or in any of the other aforementioned detected locations.

According to Carter and Halldórsson (1998) and CABI (2015a), *E. abietinum* originates from Central and Northern Europe. It is distributed throughout Europe (Blackman and Eastop 2015, CABI 2015a). The question why this species still has not been found in Bulgaria and why it disappeared so quickly remains open, especially taking into account that the *Picea* species are often used in landscaping and in forest wood production and are periodically investigated. Due to the lack of data on the presence of *Elatobium abietinum* in neighbouring countries (Turkey, Greece, FYR of Macedonia and Serbia) where, like in Bulgaria, the aphid's fauna is comparatively well investigated, and due to its very local appearance only near Sofia, it can be concluded that the green spruce aphid was probably introduced into Bulgaria via imported infested Picea plants.

Icerya purchasi Maskell, 1878 [Hemiptera, Monophlebidae] – cottony cushion scale.

Collected material: Ravda: 20 July 2011 and 25 October 2015; Burgas – 20 May 2015.

During the present study, dense colonies of cottony cushion scale nymphs and adult females have been registered on *Pittosporum tobira* (Thunb.) W. T. Aiton, *Citrus lemon* (L.) Burm, *Laurus nobilis, Parrotia persica* (DC.) C. A. Mey and *Liquidambar styraciflua* L. (Fig. 4a) in two garden centres in Ravda and in greenhouses in Burgas. In both locations the host plants were just imported from Italy.

I. purchasi was found for the first time in Bulgaria in 1968, when it was recorded as an important pest in the Botanical garden in Sofia, affecting *Acacia* spp., *Magnolia* sp. and other 4 ornamentals (Tsalev 1968). Although this species was not detected in the following investigations (carried out from 1990 to 1995 in ornamental greenhouses) (Pencheva 1995), it has appeared periodically in garden centres in the last 10 years because of the intensive trade of ornamental plants (Pencheva 2007).

The cottony cushion scale is an Australian species but now is widespread

a b

Fig. 4. Scale insects: Adult females of *Icerya purchasi* on *Parrotia persica* (a) and *Phenacoccus peruvianus* (b).

throughout the world. It has a wide climatic tolerance and has become established in Southern Europe and in greenhouses of temperate regions. *I. purchasi* is extremely polyphagous pest and infested more than 180 plants belonging to 66 families (García et al. 2015). Once introduced into glasshouses, it may become a significant risk for production of ornamentals in Bulgaria, because of its ability to rapid distribution. The cottony cushion scale spreads by crawling from plant to plant, via wind, on machinery, and with labour crews. Accidental introduction to new territories is possible through infested live plants, particularly in shipments of whole ornamentals and fruit trees (CABI 2015b).

Phenacoccus peruvianus Granara de Willink, 2007 [Hemiptera, Pseudococcidae] **–** Bougainvillea mealybug.

Collected material: Ravda – May 2012 and July 2014; Burgas – May 2012.

Specimens of Bougainvillea mealybug were detected two times in garden centre in Ravda and in greenhouses in Burgas on several *Bougainvillea glabra* Choisy plants (Fig. 4b), imported from Italy. Although *P. peruvianus* has been recorded in Bulgaria in 2014 (Pencheva et al. 2014), this species was first detected in May 2010 on the same hosts.

The mealybug is of Neotropical origin (Argentina, Peru) and was recorded to Europe (Spain) in 1999, prior being described by Granara de Willink. Since then *P. peruvianus* has been found in different European countries (Sicily, Italy, Corsica, Croatia, Portugal, Monaco, France and Greece) (Beltrà et al. 2010, Gkounti and Milonas 2013, Masten et al. 2015).

Bougainvillea mealybug feeds mainly on Bougainvillea plants, which are widely cultivated in gardens of the Mediterranean region and frequently traded as a potted plant (Mazzeo et al. 2014). It is also recorded on *Alternanthera* spp., *Araujia sericifera* Brot., *Aucuba japonica* Thunb, *Buddleja* spp., *Solanum vespertilio* Ait., *Plectranthus scutellarioides* (L.) R. Br., chilly peppers and others (Beltra et al. 2010). Among its hosts *P. peruvianus* shows a preference for members of Solanaceae and can successfully complete its life cycle on *Solanum lycopersicum* L. and *Nicotiana tabacum* L. (Beltrà et al. 2013). Large mealybug populations cause necrosis of the foliage, leaf loss, dieback and sooty mould development on the excreted

a b

Fig. 5. Adult females of *Ceroplastes* spp.: *C. ceriferus* (a) and *C. japonicus* (b).

honeydew (Malumphy and Eyre 2011).

Ceroplastes ceriferus (Fabricius, 1798) [Hemiptera, Coccidae] – Indian wax scale.

Collected material: 2013: 3 June and 25 July – Nessebar; 2015: 30 October – Sozopol.

A few *C. ceriferus* females (Fig. 5a) were detected in two private properties nearby Nessebar in 2013, on single *Pyracantha* sp. and *Ilex aquifolium* shrubs. This scale was found again in October 2015 on twigs of *Euonymus alatus* (Thunb.) Siebold in a private garden in Sozopol. In both localities *C. ceriferus* had been distributed along with plant material imported from Italy two years ago.

Indian wax scale was detected for the first time in Bulgaria in June 2009 on a private property in Vidin on a solitary *Acer palmatum* 'Atropurpureum' tree (Pencheva and Yovkova 2011).

C. ceriferus is most likely to be native to Asia, but it has already been widely distributed all over the world (García et al. 2015). In Europe, it has been intercepted several times at the imports of ornamental plants (Pellizzari et al. 2004). *C. ceriferus* has been found also in Netherlands, UK and Slovenia (Fetyko and Kozár 2012, Seljak 2012).

The Indian wax scale may use a wide variety of hosts comprising more than 120 plant species belonging to 51 families and 71 genera (García et al. 2015). Besides fruit crops, it attacks also lots of ornamentals (*Acer, Berberis, Buxus, Cornus, Deutzia, Euonymus, Ficus, Ilex, Lagerstroemia, Laurus, Magnolia, Platanus, Pyracantha, Rhododendron, Salix* and *Viburnum*) (EPPO 2015). Like all the others, wax scales *C. ceriferus* secretes large amount of honeydew which provides a medium for sooty mould. The sooty mould may become so dense that it interferes with photosynthesis (Hamon and Williams 1984, Seljak 2012).

The observations over the last three years indicated that *C. ceriferus* can successfully overwinter in locations around the Black Sea coast.

Ceroplastes japonicus Green, 1921 [Hemiptera, Coccidae] – Japanese wax scale.

Collected material: 2013: 25 July – Ravda and Aheloy; 2015: 20 July – Aheloy.

Adult females, first and second instar nymphs of *C. japonicus* were detected on leaves and twigs of *Ilex aqufolium*, *Citrus* sp., *Laurus nobilis, Viburnum thinus* L. and *Pyracantha coccinea* M. Roem (Fig. 5b) in garden centre in Ravda and in private property in Aheloy. The country origin of infested ornamentals was Italy. Japanese wax scale was found for the first time in Bulgaria in 2006 on plant material collected in greenhouses (Pencheva 2007).

C. japonicus is native to Eastern Asia and is currently a pest of significant economic impact for citrus and other fruit crops in Asia. In Europe it represents a serious phytosanitary threat mainly to laurel, holly and ivy (Mazzeo et al. 2014). *C. japonicus* is widespread on ornamentals in several European countries, both outdoors (i.e. Armenia, Croatia, Georgia, Italy, France, Netherlands, Russia and Slovenia) and indoors (i.e. Hungary, Unitved Kingdom) (Fetykò and Kozár 2012). The present investigation confirms that the species is established in the southern Black Sea coast where it overwinters outdoors (Pencheva 2009).

Ceroplastes sinensis Del Guercio, 1900 [Hemiptera, Coccidae] – Chinese wax scale.

Collected material: 2013: 25 July – Ravda.

Specimens of *C. sinensis* were identified on *Ilex aquifolium* imported from Italy to a garden centre in Ravda (Fig. 6). This is the first record of this scale species in Bulgaria. The adult females are convex, reach up to 3–7 mm in length and 2.0–6.0 mm in width. The dorsal wax cover is formed by 7 not very distinctly divided plates – 1 dorsal and 6 lateral. The wax cover is white in young females and reddish brown in old specimens (Gimpel et al. 1974).

Based on cladistics analysis of wax scale insects, Qin et al. (1994) predicted that *C. sinensis* originates from Central or South America. This supposition was supported later by the discovery of heavily parasitized individuals of Chinese wax scale in Argentina (Hodgson and Peronti 2012). It is a highly polyphagous pest and can damage more than 130 plant species belonging to 54 families (García et al. 2015). Currently *C. sinensisis* is distributed in several European countries (Croatia, France, Greece, Italy, Portugal, Spain, Turkey and subtropics of the former USSR) (Fetyko and Kozár 2012).

Chinese wax scale completed a single annual generation. The optimal conditions for its development are: temperature 22,4–26,0 ºC and air humidity 70–80 %. The pest is not as cold resistant as *C. japonicus*. The mean fecundity of adult females was 3260 ± 770 eggs per female (García et al. 2015). The heavy infestation leads to the death of branches and, some-

a b

Fig. 6. *Ceroplastes sinensis*: a – adult females; b – the antenna of Chinese wax scale is 7-segmented.

times, plants. Its introduction in Bulgaria may become a problem in ornamental plant production.

Aulacaspis yasumatsui Takagi 1977 [Hemiptera, Diaspididae] – Cycads aulacaspis scale.

Collected material: 2013: 3 April – Ravda and 28 July – Sofia.

A. yasumatsui was detected on a few imported plants of sago cycas **(***Cycas revoluta* Thunb.) in a garden centre in Ravda in April 2013. Although the infestation had not been detected prior to carrying the plants to the greenhouse, within two months all leaves were covered with a white crust, comprising scales of live and dead insects. Damage initially appears as chlorotic spots, but most of the fronds eventually become brown and withered. Later *A. yasumatsui* was collected in a greenhouse in Sofia, also on imported sago cycas plants. Although this infestation was not so drastic, in both cases the plants died. Cycads aulacaspis scale was first detected in Bulgaria by Trencheva et al. (2010a) in 2009 in a garden centre in Tsarevo, at the southern Black Sea coast.

A. yasumatsui is native to Southeast Asia. Its host plants are from the gymnosperm order Cycadales, which consists of three families – Cycadaceae, Stangeriaceae and Zamiaceae (CABI 2015c). It is highly damaging to cycads, which include horticulturally important and endangered plant species. It is difficult to control, as it forms dense populations and spreads quickly to new areas via infested plant trade (Howard et al. 1999).

Lepidosaphes flava (Signoret, 1870) [Hemiptera, Diaspididae] – De Stefan scale.

Collected material: 2012: 13 April – Sofia and 2013: 26 April – Burgas.

Only sporadically infestations of *L. flava* were detected on olive trees (*Olea europaea* L.) grown indoors in two garden centres. This is the first record of the De Stefan scale in Bulgaria. Apparently, all infested plants had been imported from Greece and Italy.

De Stefan scale is native to Near East and Mediterranean Palaearctic. In Europe it is distributed in Cyprus, Greece, Italy, Montenegro, France, Spain, Turkey, Ukraine and Russia (Central and Southern) (García et al. 2015). Their females are brown, elongated and 2.4–3.0 mm long. The male puparium is clear brown, 1.8 mm long (Danzig 1993). In Italy *L. flava* has one generation per year and it overwinters as a mature fertilized female. Each female produces 25–30 eggs (García et al. 2015). This pest prefers *Olea europaea* (Pellizzari.et al. 2011) and *Ligustrum* spp. (Gill 1997) as hosts, and should not be a major risk for Bulgaria since olive trees are grown predominantly in greenhouses and interior.

Pseudaulacaspis pentagona (Targioni Tozzetti, 1886) [Hemiptera, Diaspididae] – white peach scale.

Collected material: Balchik (13 May 2014), Sofia (from May to October in the period 2012–2015) and Plovdiv (6 June 2013).

P. pentagona was detected in Balchik (on *Broussonetia papyrifera*), Plovdiv (*Platanus* × *acerifolia* (Aiton) Willd.) and in different private properties on Sofia (on *Cornus alba* L. 'Elegantissima', *Syringa* x *persica* L. 'Alba', *Rosa hybrida* L. and 12 other arboreal hosts) mainly on *Catalpa bignonioides* and *Morus alba* f. *pendula* (Fig. 7). The last two hosts were imported from Italy and had been planted in private gardens approximately in 2007 or 2008. Heavily infested trees exhibited dieback and died after a few years.

The white peach scale is native to Eastern Asia, where it is a pest of *Prunus*

and *Morus.* It was accidentally introduced to Italy in the nineteenth century, and has nowadays spread to all major continents (CABI 2015d). The scale was first recorded in Bulgaria in 1968 (Tsalev 1968), but its distribution was limited predominantly in southwestern regions (Trencheva et al. 2010b) as an important economic pest of peach trees.

A batch of infested ornamental shrubs from a single nursery can easily spread the pest widely. In temperate regions, dense populations can form thick crusts of scales on tree trunks and older branches. In Central Europe it has colonized both cultivated and natural habitats. Heavy outbreaks of the scale insect have occurred on ornamental plants in Hungary (Kosztarab and Kozár 1988). *P. pentagona* can be mentioned as a significant invasive scale present in the highway margin zone (Bayoumy et al. 2011).

Fig. 7. Dense colonies of *Pseudaulacaspis pentagona* on branches of *Morus alba*.

Cacoecimorpha pronubana (Hübner, 1799) [Lepidoptera, Tortricidae] – carnation tortrix moth.

Collected material: Burgas – 26 May 2012; Aheloy – from May to September in the period during 2012–2015; Ravda – 2013: May and July.

Last four years *C. pronubana* was detected in Aheloy (in its previous locality) (Pencheva et al. 2009), with a low population density, because of continuous control, including pruning the branches with hibernating caterpillars and pheromone traps. In Burgas and Ravda the species was found in garden centres on *Viburnum tinus* L. and *Aucuba japonica* Thunb. (Fig. 8), imported from the Netherlands and Italy.

This Mediterranean species is widespread in Europe and North Africa. At present its range is expanding across Europe, having been able to invade even northern countries such as Lithuania, which is a confirmation of the great adaptability of this insect (Signorile 2012). Over 100 plant species have been noted as hosts, however, *Dianthus* is the most seriously affected, although other species have suffered infestations regarded as serious. In international trade, *C. pronubana* may be carried on plants for planting or cut flowers of carnations, chrysanthemums, pelargoniums, roses and other host plants (CABI 2015e).

Fig. 8. Adult of *Cacoecimorpha pronubana.*

Cydalima perspectalis (Walker, 1859) [Lepidoptera, Crambidae] – box tree moth.

Collected material: 2014: 25 August – Balchik, Dragalevtsi (near Sofia); 28 August – Dobrich; 2015: 20 May – Balchik and Evksinograd (near Varna); from 15 July to 15 October – Balchik, Burgas, Kalofer, Primorsko, Sozopol, Plovdiv and Sofia.

During the present observations in the end of August 2014, damage to *Buxus sempervirens*, as well as larvae, pupae and moths (Fig. 9a) were found in new locations: private gardens in Dobrich and Sofia. In summer 2015 the pest was detected both in private gardens and in city parks located in Burgas, Primorsko, Sozopol, Sofia, Plovdiv and Kalofer. Plants of different ages – from 5 to 80 and more years old (in Euxinograd) – were attacked in both old plantings and newly created sites. The infested box trees were defoliated, particularly in lower parts of the crowns. This damage reduced completely the aesthetic value of plants. Odher's were webbing of the branches with frass and residues of moulting. Heavy damage or repeated attacks lead to total defoliation and may cause the death of the shrubs. The young larvae of the box tree moth feed on the lower surfaces of the leaves, leaving the upper epidermis intact (Fig. 9b). Older caterpillars gnaw roughly on leaves, leaving thick veins only. They can also eat the green bark of the young twigs.

The box tree moth was first detected in Bulgaria in July 2014 in Balchik Botanical garden and in Varna by Beshkov et al. (2015). It is a very destructive insect, injurious to *Buxus* spp. (*B. sempervirens* L., *B. microphylla* Siebold & Zucc. and *B. colchica* Pojark.). In its native range (China and Japan) it feeds on *B. sinica* (Leuthardt 2013). In Southern Russia *C. perspectalis* also attacks *Ruscus aculeatus* L. and *Prunus laurocerasus* L. (Skvortsov 2013).

The species is a well-known pest within its original range in Asia. It has spread widely throughout Europe in recent years, probably introduced with box tree seedlings. Due to a lack of natural enemies

a b

Fig. 9. *Cydalima perspectalis*: a – adults; b – damage by a young larva.

in its invaded range, *C. perspectalis* can reach large population sizes and densities (Leuthardt 2013, Hizal et al. 2012, Ramel and Ross 2013*).* Observation of the dispersal of European populations of *C. perspectalis* in northwest Switzerland allowed an estimate of the natural dispersal velocity of adults to be made at 7–10 km per year (Leuthardt et al. 2010).

The box tree moth has two to three generations per year in Europe, while in the native range up to 5 generations per year are possible (Perny 2010). It overwinters as a larva, spinning a cocoon between box leaves in autumn and completes its development the following spring. In Balchik, after overwintering, the larvae continued feeding until the middle of May 2015 and pupated in the crown of plants. The first generation moths appeared at the beginning of June**.** A new flight of moths was also detected in the middle of August. In Sofia defoliation of box trees was detected in the middle of July and flight of moths – in the end of August. The new generation larvae were in diapause in the middle of October. The results from the observations carried out in 2015 demonstrate that the box tree moth is spreading quickly throughout the country. Its introduction could represent a threat to nurseries, historical parks and gardens, as well as to plant hosts growing in the wild.

The above presented alien insects are mainly polyphagous except for five monophagous ones – *A. jamatonica, T. alacris,* the coccids *A. yasumatsui* and *L. flava*, and the moth *C. perspectalis.* Polyphagous insects are more likely to become major pests when introduced to new areas because the existing plant hosts may allow them to successful development and reproduction.

Five of the discussed insects are restricted to greenhouses or are merely interceptions, with the slight possibility of outdoors surviving. The species, which are able to adapt to outdoor conditions, are mostly detected as a small sample or in limited localities (with exception of *Metcalfa pruinosa* and *Pseudaulacaspis pentagona*). Probably within quite a short period of time they may release their potential to be more widely spread and established on the territory of Bulgaria, especially in its south-western part. Global warming and mild winters also indirectly affect acclimatization frequencies by increasing the abundance of suitable host plants for alien insect species (Mazzeo et al. 2014). Within Europe, the Mediterranean basin is especially susceptible to insect invasions, due to its climatic conditions being favourable for the establishment of tropical and subtropical non-native species (Roques et al. 2009). Currently the greatest part of ornamental plants in Bulgaria is produced in Italy, the Netherlands and Hungary. The surveying insects in these countries are common pests and their accidental introduction in Bulgaria is possible via imported plants because of reduced border control between EU-countries.

Conclusion

Fourteen insect species associated with urban landscape areas have been surveyed. Two of them have been reported for the first time in Bulgaria – *Ceroplastes sinensis* and *Lepidosaphes flava*. Three species (*Cacoecimorpha pronubana*, *Ceroplastes ceriferus* and *Metcalfa pruinosa*) have widened their host range in Bulgaria. *Aulacaspis yasumatsui, Acizzia jamatonica*, *Pseudaulacaspis pentagona* and *Cydalima perspectalis* have been found in new locations. The quick spread of the box tree moth indicates that the pest

will be a serious risk for *B. sempervirens* throughout the country.

The results of investigation indicate that exotic pests and especially scale insects use mainly ornamental plants as a pathway of introduction in new areas, so that urban landscapes and nurseries are the first habitats in which they become established.

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References

Bayoumy M.H., Fetyko K., Tobias I., Konczne Benedicty Z., Szita É., Kozar F. 2011. A geographical study on *Pseudaulacaspis pentagona* and its parasitoids in Hungarian highway margins using pheromone traps and molecular markers. Entomologia Hellenica 20: 17–30.

Beltrà A., Soto A., Germain J.F., Matile-Ferrero D., Mazzeo G., Pellizzari G., Russo A., Franco J.C., Williams D.J. 2010. The Bougainvillea mealybug *Phenacoccus peruvianus*, a rapid invader from South America to Europe. Entomologia Hellenica 19: 137–143.

Beltrà A., Tena A., Soto A. 2013. Fortuitous biological control of the invasive mealybug *Phenacoccus peruvianus* in Southern Europe. BioControl 58(3): 309–317 doi: 10.1007/s10526-012-9488-5.

Beshkov S., Abadjiev S., Dimitrov D. 2015. *Cydalima perspectalis* (Walker, 1859) (Lepidoptera: Pyraloidea: Crambidae: Spilomelinae) – new invasive pest moth in Bulgaria. The entomologist's record and journal of variation 127: 18–22.

Blackman R.L., Eastop V.F. 2015. Aphids on the world's plants. Verson 2015. Available: http://www.aphidsonworldsplants.info/ (Accessed on 23 November 2015).

CABI 2015a. *Elatobium abietinum* (green spruce aphid). Available: http://www.cabi.org/isc/datasheet/30897 (Accessed on 24 November 2015).

CABI 2015b. *Icerya purchasi* (cottony cushion scale). Available: www.cabi.org/isc/datasheet/28432 (Accessed on 23 November 2015).

CABI 2015c. *Aulacaspis yasumatsui* (cycad aulacaspis scale) Available: www.cabi.org/isc/datasheet/18756 (Accessed on 24 November 2015).

CABI 2015d. *Pseudaulacaspis pentagona* (mulberry scale). Available: www.cabi.org/isc/datasheet/45077 (Accessed on 25 November 2015).

CABI 2015e. *Cacoecimorpha pronubana* (carnation tortrix). Available: www.cabi.org/isc/datasheet/54205 (Accessed on 23 November 2015).

Carter C.I., Halldórsson G. 1998. Origin and background to the green spruce aphid in Europe. In: Day K.R., Halldorsson G., Harding S., Straw N. A (Eds.). The Green Spruce Aphid in Western Europe: Ecology, Status, Impacts and Prospects for Management. Edinburgh, Forestry Commission, Technical Paper 24: 1–14.

Chornesky E.A., Bartuska A.M., Aplet G.H., Britton K.O., Cummings-Carlson J., Davis F.W., Eskow J., Gordon D.R., Gottschalk K.W., Haack R.A., Hansen A.J., Mack R.N., Rahel F.J., Shannon M.A., Wainger L.A., Wigley T.B. 2005. Science priorities for reducing the threat of invasive species to sustainable forestry. BioScience 55(4): 335–349.

Danzig E.M. 1993. Fauna of Russia and neighboring countries. Rhynchota. Vol. X. suborder scale insects (Coccinea): families Phoenicococcidae and Diaspididae. Nauka

Publishing House, St. Petersburg, Russia. 452 p. (in Russian).

Doychev D. 2015. First record of the invasive Elm sawfly *Aproceros leucopoda* Takeuchi (Hymenoptera: Argidae) in Bulgaria. Silva Balcanica 16(1): 108–112.

EPPO 2015. Global Database, *Ceroplastes ceriferus* (CERPCE), Host plants. Available: https://gd.eppo.int/taxon/CERPCE/hosts (Acccesed on 26 November 2015).

FAO 2003. Biological risk management in food and agriculture: scope and relevance. Document to the Technical consultation on biological risk management in food and agriculture, Bangkok, Thailand, 13–17.I.2003, Rome, 2003. Available: ftp://ftp.fao.org/es/esn/food/tc_bangkok/tc_brm_03_2en.doc

Fetyko K., Kozar F. 2012. Records of *Ceroplastes* Gray 1828 in Europe, with identification key to species in the Palearctic Region. Bulletin of Insectology 65(2): 291–295.

García M., Denno B., Miller D.R., Miller G.L., Ben-Dov Y, Hardy N.B. 2015. ScaleNet: A Literature-based model of scale insect biology and systematics. http://scalenet.info (Accessed on 26 November 2015).

Gill R.J. 1997. The Scale Insects of California: Part 3. The Armored Scales (Homoptera:Diaspididae).California. Department of Food & Agriculture, Sacramento, CA. 307 p.

Gimpel W.F., Miller D.R., Davidson J.A. 1974. A Systematic Revision of the Wax Scales, Genus *Ceroplastes*, in the United States (Homoptera; Coccoidea; Coccidea). Maryland Agricultural Experiment Station. Miscellaneous publication: 841–885.

Gkounti V., Milonas P. 2013. First record of the bougainvillea mealybug *Phenacoccus peruvianus* in Greece. Entomologia Hellenica 22: 16–18.

Grozea J., Gogan A., Virteiu A.M., Grozea A., Stef R., Molnar L., Carabet A., Dinnesen S. 2011. *Metcalfa pruinosa* Say (insecta: homoptera: flatidae): A new pest in Romania. African Journal of Agricultural Research 6(27): 5870–5877.

Hamon A.B., Williams M.L. 1984. The soft scale insects of Florida (Homoptera: Coccoidea: Coccidae). Arthropods of Florida and Neighboring Land Areas. Gainesville, Florida Department of Agriculture & Consumer Services, Division of Plant Industry. 194 p. Available: http://ufdc.ufl.edu/UF00000091/00001/1j

Harizanova V., Stoeva A., Mohamedova M. 2012. Preliminary study on the invasive *Acizzia jamatonica* (Hemiptera: Psyllidae) and its predators in Bulgaria. Agricultural science and technology 4(1): 56–61.

Hizal E., Kose M., Yesil C., Kaynar D. 2012. The new pest *Cydalima perspectalis* (Walker, 1859) (Lepidoptera: Crambidae) in Turkey. Journal of Animal and Veterinary Advances 11(3): 400–403. doi: http://dx.doi.org/10.3923/javaa.2012.400.403

Hodgson C.J., Peronti A.L.B.G. 2012 A revision of the wax scale insects (Hemiptera: Sternorrhyncha: Coccoidea: Ceroplastinae) of the Afrotropical Region Zootaxa 3372: 1–265.

Howard F.W., Hamon A., McLaughlin M., Weissling T., Yang S. 1999. *Aulacaspis yasumatsui* (Hemiptera: Sternorrhyncha: Diaspididae), a scale insect pest of cycads recently introduced into Florida. Florida Entomologist 82(1): 14–27.

Kosztarab M., Kozár F. 1988. Scale Insects of Central Europe. Akademiai Kiado, Budapest. 456 p.

Leuthardt F.L.G. 2013. *Cydalima perspectalis* (box tree moth). Invasive Species Compendium. Available: www.cabi.org/isc/datasheet/118433. (Accessed on 23 November 2015).

Leuthardt F.L.G., Billen W., Baur B. 2010. Ausbreitung des Buchsbaumzünsler *Diaphania perspectalis* (Lepidoptera: Pyralidae) in der Region Basel – eine fur die Schweiz neue Schadlingsart. Entomo Helvetica 3: 51–57.

Lucchi A., Santini L. 1993. Note morfo-biologiche sugli stadi preimmaginali di *Metcalfa pruinosa* (Say) (Hemiptera, Flatidae). Frustula Entomologica (N.S.) 16(29): 175–185.

Malumphy C., Eyre D. 2011. Bougainvillea Mealybug *Phenacoccus peruvianus*. The Food and Environment Research Agency (Fera). Available: http://fera.co.uk/plantClinic/documents/factsheets/bougainvillea.pdf (Accessed on 03 December 2015).

Mazzeo G, Longo S., Pellizzari G., Porcelli F., Suma P. Russo A. 2014. Exotic Scale Insects (Coccoidea) on Ornamental Plants in Italy: a Never-Ending Story. Acta Zoologica Bulgarica, Suppl. 6: 55–61.

Masten M. T., Šimala M., Markotić V. 2015. First records of bougainvillea mealybug *Phenacoccus peruvianus* Granara de Willink, 2007 and madeira mealybug *Phenacoccus madeirensis* Green, 1923 (Hemiptera: Pseudococcidae) in Croatia. In Trdan S. (edit.): Lectures and papers presented at 12th Slovenian conference on plant protection. Ptuj, March 3–4: 318–322.

Mifsud D., Cocquempot C., Mühlethaler R., Wilson M., Streito J.C. 2010. Other Hemiptera Sternorrhyncha (Aleyrodidae, Phylloxeroidea, and Psylloidea) and Hemiptera Auchenorrhyncha. Chapter 9.4. In: Roques A. et al. (Eds.). Alien terrestrial arthropods of Europe. BioRisk 4(1): 511–552. doi: 10.3897/biorisk.4.63.

Ossiannilsson F. 1996. The Psylloidea (Homoptera) of Fennoscandia and Denmark, Leiden, New York Koln. 350 p.

Pantaleoni R.A. 1989. Ways of invasion of a new area by *Metcalfa pruinosa* (Say, 1830) (Auchenorrhyncha, Flatidae). Bollettino dell'Istituto di Entomologia dell'Universita degli Studi di Bologna 43: 1–8.

Pellizzari G., Camporese P. 1994. The Ceroplastes species (Homoptera, Coccoidea) of the Mediterranean Basin with emphasis on *C. japonicus* Green. Annales de la Société Entomologique de France 30(2): 175–192.

Pellizzari G., Galbero G., Mori N., Antonucci C. 2004. Biologia di *Ceroplastes ceriferus* (Fabricius) (Hemiptera, Coccoidea) e possibilità di lotta. Informatore fitopatologico 54(9): 39–46.

Pellizzari G.P., Seljak F. G., Kozar F. 2011 Some additions to the Scale insect fauna (Hemiptera: Coccoidea) of Crete with a check list of the species known from the island None. Journal 292 of Entomological and Acarological Research Ser. II 43(3): 291–300.

PenchevaA. 1995. The species structure and significance on the scale insects (Homoptera, Coccinea) in the greenhouses in Bulgaria. Forestry Ideas 1(3–4): 141–151 (in Bulgarian).

Pencheva A. 2007. New and little known pests in greenhouses for ornamental plants in Bulgaria. Acta Entomologica Bulgarica 13(3–4): 35–43 (in Bulgarian).

Pencheva A. 2009. *Ceroplastes japonicus* (Green) (Hemiptera: Coccoidea: Coccidae) – a new pest on *Ilex* in Bulgaria. Forestry Ideas 15(1): 226–232 (in Bulgarian).

Pencheva A., Velcheva N., Yovkova M. 2009. New species on Bay laurel (*Laurus nobilis* L.) in Bulgaria. Proceedings of International scientific conference "Good practices in sustainable agriculture", 12–13 November, 2009, Sofia, Bulgaria: 312–320 (in Bulgarian).

Pencheva A., Yovkova M. 2011. Review of alien insect pests on ornamental plants in Bulgaria. Proceedings of Anniversary International conference: 60 years specialty "Landscape architecture", Sofia: Sezhani: 112–117 (in Bulgarian).

Pencheva A., Yovkova M., Kozarov D. 2014. Insect Pests on *Bougainvillea glabra* with Description of *Phenacoccus peruvianus* Granara De Willink – A New Species in Bulgarian Greenhouses. Plant sciences LI(6): 90–93.

Perny B. 2010. Mass outbreak of box tree pyralid *Diaphania perspectabitis* in the East of Austria. Forstschutz aktuell 50: 17–19.

Qin T.K., Gullan P.J., Beattie G.A.C., Trueman J.W.H., Cranston P.S., Fletcher M.J., Sands D.P.A. 1994. The current distribution and geographical origin of the scale insect pest *Ceroplastes sinensis* (Hemiptera: Coccidae). Bulletin of Entomological Research 84: 541–549.

Ramel J.M., Ross J.P. 2013. Geographical range of *Cydalima perspectalis* (Walker, 1859) [Lepidoptera: Pyraloidea: Crambidae: Spilomelinae] and its recent expansion in France. XVIII European Congress of Lepidopterology, July 29 – August 04, 2013. Blagoevgrad, Bulgaria. Available: http://www.ecl18.eu.

Seljak G. 2012 Six new alien phytophagous insect species recorded in Slovenia in 2011. Acta Entomologica Slovenica 20(1): 31–44.

Signorile L. 2012. An unusual, new larval host-plant for *Cacoecimorpha pronubana* (Hübner, 1799) (Lepidoptera: Tortricidae). Entomologist's Gazette 63: 49–51.

Skvortsov M.M. 2013. The Box Tree Moth in the Krasnodar region of Russia – three years after invasion. Federal Forestry Agency, Center of Forest Health of Krasnodar Region. Available: http://czl23.ru/news.php?extend.102 (Accessed on 26 November 2015).

Souliotis C., Papanikolaou N.E., Papachristos D., Fatouros N. 2008. Host plants of the planthopper *Metcalfa pruinosa* (Say) (Hemiptera: Flatidae) and observations on its phenology in Greece. Hellenic Plant Protection Journal 1: 39–41.

Strauss G. 2010 Pest risk analysis of *Metcalfa pruinosa* in Austria. Journal of Pest Science 83(4): 381–390.

Tomov R., Trencheva K. 2013. A review of pest status of recently recorded alien insects in Bulgaria. Proceeding of IV ESENIAS Workshop: International Workshop on IAS in Agricultural and Non-Agricultural Areas in ESENIAS Region, 16–17 December 2013, Çanakkale, Turkey: 108–114.

Trenchev G., Ivanova I., Nikolov P., Trencheva K. 2007. *Metcalfa pruinosa* (Say, 1830), new species in Bulgaria. Plant Science 34(3): 195–198.

Trencheva K., Trenchev G., Tomov R., Wu S.-A. 2010a. First report of *Aulacaspis yasumatsui* Takagi, 1977 (Hemiptera: Diaspididae) in Bulgaria. Rastenievadni Nauki 47(3): 206–209.

Trencheva K., Trenchev G., Tomov R., Wu S.-A. 2010b. Non-indigenous scale insects on ornamental plants in Bulgaria and China: A survey. Entomologia Hellenica 19: 114–123.

Tsalev M. 1968. Contribution to the study of scale insects (Homoptera, Coccidea) in the urban parks and ornamental plants in Bulgaria. Izvestia na zoologicheskia institut s muzei 28: 205–218 (in Bulgarian).

Vétek G., Rédei D. 2009. First record *of Acizzia jamatonica* (Kuwayama) (Hemiptera: Psyllidae) in Bulgaria. Acta Zoologica Bulgarica 61(3): 323–325.

Yovkova M., Pencheva A., Petrović-Obradović O. 2016. First Report of *Elatobium abietinum* (Walker, 1849) (Hemiptera, Sternorrhyncha, Aphididae) on Picea spp. in Bulgaria. Acta zoologica Bulgarica 68(1): 135–138.

Yovkova M., Petrović-Obradović O., Tasheva-Terzieva E., Pencheva A. 2013. Aphids (Aphididae, Hemiptera) on ornamental plants in greenhouses in Bulgaria. ZooKeys 319, special issue: 347–365.