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Original paper

An overview of invasive insect species in the city of Prešov

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Abstract
The topic of invasion is a constantly relevant and popular issue these days. This work therefore provides an overview of the invasive insect species that occur in the city of Prešov, Slovakia. We summarize the literature data, with six invasive species already known from Prešov, and we also bring seven newly recorded invasive insects. We recorded the invasive pests of woody plants (*Cameraria ohridella* (Deschka & Dimic, 1986), *Corythucha ciliata* (Say, 1832), *Parectopa robiniella* (Clemens, 1863)), of fruit pests (*Drosophila suzukii* (Matsumura, 1931), *Harmonia axyridis* (Pallas, 1773)), as well as epidemiologically significant invasive species (*Aedes japonicus japonicus* (Theobald, 1901), *Clogmia albipunctata* (Williston, 1893), *Lipoptena fortisetosa* (Maa, 1965)). This number of species is certainly not complete, and even more attention needs to be paid to this topic in the future.

Key words: invasions, invasive insects, non-native insects, urban ecosystem, Slovakia

Introduction

From the viewpoint of biodiversity, insects represent one of the most diverse groups of organisms (Kim 1993), and in terms of biomass, approximately 1,500 kilograms of insects are estimated to exist per person (Dicke 2018). This dominant form of animal biomass represents various trophic groups and fulfils a wide range of ecological functions (Gullan & Cranston 2010).

Many non-native insect species are often referred to as pioneers or colonists due to their ability to quickly adapt to new ecosystem conditions (Pearce 2016). However, the introduction of new insect species into ecosystems may not always have a positive impact, as many insect species are capable of becoming invasive and can reduce and otherwise suppress populations of many native species (Mascaro 2013) and also cause economic and ecological damage (Nevřelová & Becková 2015).

The issue of invasive insects has become increasingly topical in recent years, as evidenced by the growing number of publications dealing with this subject. Venette & Hutchison (2021) address the global challenges, strategies and opportunities that invasions bring. Fortuna et al. (2022) examine the impact of invasive insects on native insect communities and, for example, Skendžić et al. (2021) look at the impact of climate change on the spread of agricultural invasive insect pests in Europe.

In Slovakia, a relatively large number of introduced insect species of an invasive or expansive nature have already been recorded and registered. A detailed list is presented in Kohútová & Oboňa (2016). According to the available information, there are 386 non-native insect species in Slovakia, 89 of which are considered invasive (Insecta: Coleoptera: 21, Diptera: 6, Heteroptera: 7, Hemiptera: 29, Hymenoptera: 12, Lepidoptera: 14). This list already needs to be supplemented with information from Janský & Strmisková (2017), Oboňa et al. (2017), Borbély et al. (2020), Čabanová et al. (2021), Dvořák & Fryč (2023), etc.

In this work, we will therefore focus on invasive insects that occur in the city of Prešov, Slovakia.

Material and methods

Field research was conducted during the 2023 growing season in selected parts of the city of Prešov (especially parts of the old town – Staré mesto, housing estate 2 and housing estate 3 (Sídlisko 2 and 3); see Figure 1).

Figure 1. Map of the city of Prešov with marked areas where field research was conducted (https://www.google.com/maps; created by S. K Tkáčová).

It consisted of extensive walks, during which optical methods were used to (visually) record possible invasive taxa of insects or their residence signs (leaf eaters, galls,

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etc.). In addition to the field research, literature research was also conducted in parallel, where we searched for key words, "invasive", "insect", "Prešov", or their language variations from freely available sources in the database https://scholar.google.sk/.

Invasive species recorded in the city of Prešov are arranged alphabetically according to their Latin names. For each species a published record from Prešov (if it exists), knowledge from the field and basic information about invasive insects are given.

Results and Discussion

A total of 13 invasive insect species were recorded in the territory of the town of Prešov (field research and literature review; see species list below).

***Aedes japonicus japonicus* (Theobald, 1901)**
Ordo: Diptera
Published records: Oboňa et al. (2020, 2021), Čabanová et al. (2021).
Material examined: Kolmanka (48°59'29.4"N 21°13'35.3"E), 30.5.2023, sweep netting of vegetation (Figure 2).
Comments: This invasive mosquito spreads very quickly throughout the world and has a significant impact on the biodiversity of the invaded areas. In addition, we consider it a carrier of diseases, pathogens or viruses. It is often found in city parks, forests or rock lakes. In Europe, it was first recorded in 2000 in France and has gradually spread throughout the continent (Becker et al. 2010; Čabanová et al. 2021).

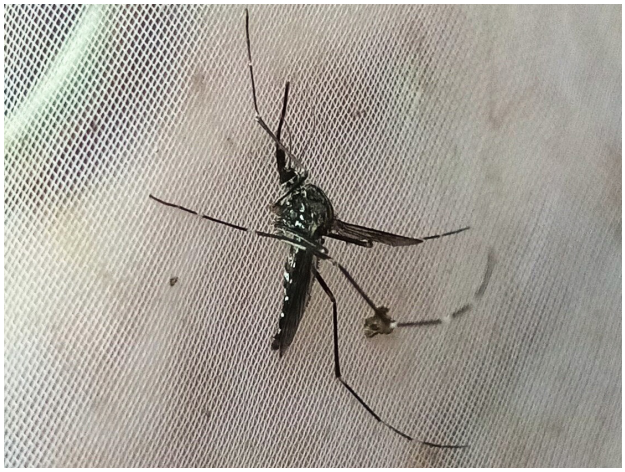

Figure 2. *Aedes japonicus japonicus* (Theobald, 1901) from Kolmanka. Photo by J. Oboňa.

***Aphrastasia pectinatae* (Cholodkovsky, 1888)**
Ordo: Hemiptera
Material examined: Československej armády street (48°59'53.3"N 21°13'37.1"E), 30.5.2023, on *Larix decidua* Mill.
Comments: This is a small and inconspicuous pest that forms cotton-wax tufts on conifers. It is often found in parks. It is originally a Nearctic species that was imported to Europe together with the tree *Pseudotsuga menziesii* (Mirb. (Franco)). When overly abundant, it can cause economic damage (Albrecht 2017).

***Cameraria ohridella* (Deschka & Dimic, 1986)**
Ordo: Lepidoptera
Material examined: Levočská ulica street (49°00'03.8"N 21°13'20.9"E), Obrancov mieru street (48°59'50.5"N 21°13'41.2"E), 16.9.2023.
Comments: A tiny butterfly whose larvae mine leaves of *Aesculus hippocastanum* L. It was first recorded in North Macedonia in 1986 (Deschka & Dimic 1986); later, it spread to Austria (Pschorn-Walcher 1994) Germany, Hungary and the Czech Republic. It was first recorded in Slovakia in 1994, in the vicinity of Bratislava (Reiprich 1994; Hrubík & Kollár 2007). This species causes significant damage, especially late-summer leaf browning on buckeye. Despite the bad appearance of these infested trees, there is no evidence that this damage leads to the death of the tree. Most damage appears to occur too late in the growing season to significantly affect tree vigour (Šefrová & Laštůvka 2001).

***Clogmia albipunctata* (Williston, 1893)**
Ordo: Diptera
Published records: Oboňa et al. (2016).
Material examined: On the walls of buildings; abundantly in/on most buildings (e.g. 48°59'45.0"N 21°13'55.2"E; 48°59'28.8"N 21°14'06.2"E; 48°59'47.7"N 21°14'14.4"E; 48°59'51.2"N 21°13'20.5"E; etc…), especially in late summer and autumn, frequent in public toilets.
Comments: This is an expansive species, found mainly in urban habitats due to favourable conditions for wintering. This species is less conspicuous but is assumed to occur throughout almost all of Europe (Oboňa et al. 2016, 2023; Baranová & Oboňa 2024; Kvifte 2023).

***Corythucha ciliata* (Say, 1832)**
Ordo: Hemiptera
Material examined: Námestie mládeže street (48°59'44.2"N 21°13'47.4"E), 6.9.2023, on *Platanus* × *hispanica* Münchh.
Comments: This is a significant pest of plane trees. It represents a threat, especially to trees of the genus *Platanus* (*P. occidentalis* L., *P. orientalis* L., *P.* × hispanica) (Malumphy et al. 2007; Mutun 2009). This species comes from North America. From there, it was accidentally introduced to Italy in the 1960s and later spread to other countries (Paulin et al. 2020). It first appeared in Slovakia in the 1990s in Bratislava and Rusovce (Tomiczek et al. 2005).

***Cydalima perspectalis* (Walker, 1859)**
Ordo: Lepidoptera
Material examined: Levočská street 63 (48°59'55.7"N 21°13'28.0"E), 24.9.2023, on *Buxus*.

Comments: This moth is found from the end of May to the end of October. It mainly attacks *Buxus*, while the female lays her eggs on their leaves. The damaged leaves then dry up and fall off (Rell et al. 2017). This butterfly was first recorded in Slovakia in Bratislava in 2012 (Pastorális et al. 2013). Currently, it occurs in a large part of Slovakia, while greater damage was reported mainly in the southern parts of western, central and eastern Slovakia (Rell et al. 2017).

***Drosophila suzukii* (Matsumura, 1931)**
Ordo: Diptera
Published records: Oboňa et al. (2017, 2021).
Comments: This fly is originally from Southeast Asia. This invasive insect appeared at the end of the 20th century in America and Europe as one of the most common pests of small and stone fruits. In 2012, its occurrence was recorded in Hungary (Kiss et al. 2013), in 2014 in the Czech Republic (Březíková et al. 2014), in 2015 in Slovakia (NPPO Slovenska 2014; Asplen et al. 2015; Oboňa et al. 2017) and in the same year also in Poland (Łabanowska & Piotrowski 2015; Asplen et al. 2015).

***Harmonia axyridis* (Pallas, 1773)**
Ordo: Coleoptera
Material examined: Levočská ulica street (48°59'55.7"N 21°13'28.0"E), Námestie mládeže (48°59'44.2"N 21°13'47.4"E), 17. Novembra street (48°59'31.9"N 21°13'58.8"E) (Figure 3), 6.9.2023. Walls of buildings in different parts of the city, especially in autumn 2023.
Comments: This is one of the most invasive species in the ladybug family (Coccinellidae). It has a negative impact on the environment and native communities, causing great damage to vineyards (Katsanis et al. 2013, 2017). This predator is originally from central and eastern Asia and Eurasia, including China, Taiwan, Japan, Mongolia and northern central and eastern China (Roy & Brown 2015). In Slovakia, it appeared for the first time in 2008 in the Tatras, specifically in the Tichá dolina valley and in the settlement of Podbanské (Panigaj et al. 2014).

Figure 3. *Harmonia axyridis* (Pallas, 1773) from 17. Novembra street. Interesting colour aberration. Photo by S. K Tkáčová.

***Leptoglossus occidentalis* (Heidemann, 1910)**
Ordo: Hemiptera
Material examined: Autumn 2023. Walls of apartment buildings in several places in the Prešov city streets: Československej armády (48°59'51.6"N 21°13'29.8"E), Marka Čulena (48°59'52.3"N 21°13'20.0"E), 17. Novembra (48°59'32.3"N 21°14'01.6"E), etc.
Comments: This is one of the largest terrestrial stink bugs in Central Europe. This pest attacks conifers, especially pines, firs and spruces. It was recorded for the first time in Slovakia in 2007 (Barta 2009).

***Lipoptena fortisetosa* (Maa, 1965)**
Ordo: Diptera
Published records: Oboňa et al. (2019).
Material examined: September 2023. The tree line between the streets Československej armády 34 – 40 and Marka Čulena 1 – 16 (48°59'50.8"N 21°13'21.6"E). Inner part of the city of Prešov (49°00'04.8"N 21°13'04.6"E).
Comments: This is a small and annoying blood-sucking dipteran, originally from East Asia, which has spread to Western Europe. It was recorded in Slovakia around 2007 (Oboňa et al. 2019). It also often sits on people, especially mushroom pickers, in the autumn (Oboňa et al. 2019), but so far no human bites have been recorded in Slovakia. The bite is known only from the native species *L. cervi* (Linnaeus, 1758) (Oboňa et al. 2024).

***Nezara viridula* (Linnaeus, 1758)**
Ordo: Hemiptera
Material examined: Požiarnícka ulica street (48°59'42.5"N 21°13'58.0"E), 17.9.2023, on *Vitis vinifera* L.
Comments: This is probably a species of Mediterranean or East African geographical origin (Horváth 1897). In Slovakia, this pest was first recorded in 2014 in Štúrovo (Vétek et al. 2014; Hemala & Kment 2017). Adults develop on more than 150 plant species (Smaniotto & Panizzi 2015; Panizzi & Lucini 2017; Hemala & Harman 2022).

***Oxycarenus lavaterae* (Fabricius, 1787)**
Ordo: Hemiptera
Material examined: Streets: Požiarnícka ulica (48°59'41.6"N 21°13'54.8"E), Fučíkova ulica (48°59'43.9"N 21°13'35.0"E) (Figure 4), 30.5.2023, on *Tilia platyphyllos* Scop.
Comments: Historically, this species was found mainly in the Mediterranean region, including North Africa, but from the 1970s it began to spread further north (Nedvěd et al. 2014). These stick bugs form large groups (aggregates) on the trunks and branches of trees to hibernate (Kalushkov 2000).

Figure 4. *Oxycarenus lavaterae* (Fabricius, 1787) from Fučíková street. Photo by S. K Tkáčová.

***Parectopa robiniella* (Clemens, 1863)**
Ordo: Lepidoptera
Material examined: 16.9.2023, near the Torysa River (48°59'13.7"N 21°14'11.9"E) on (Figure 5) *Robinia pseudoacacia* L.
Comments: This tiny butterfly comes from North America. It was first recorded in Europe in Switzerland in 1983 (Vakula et al. 2011). In Slovakia, this species was observed for the first time in 1987 (Turčáni et al. 2001; Rell et al. 2017). Caterpillars mine *Robinia* leaves, and in cases of overpopulation, this can cause the premature falling of the leaves at the end of summer (Kalivoda 2014).

Figure 5. *Parectopa robiniella* (Clemens, 1863) near the Torysa River. Photo by S. K Tkáčová.

Until recently, only 6 invasive species were known from the city of Prešov (Rell et al. 2017; Oboňa et al. 2016, 2017, 2019; Baranová et al. 2018; Čabanová et al. 2021). Thanks to the results presented here, this number has increased from the original 6 to 13 species.
This list of species is probably not complete because many insect species are constantly spreading and reaching non-native territories due to human influence. These species can quickly adapt to new conditions and cause serious damage (impact on native species, transmission of diseases, pathogens and pests) (Nevřelová & Becková 2015). Therefore, it is only a matter of time before other invasive animals are added to this list. It is also important to emphasize that we examined only a certain part of the Prešov city and not the whole city. Regular monitoring of invasive species is also important. There may still be several other species in the territory of Prešov, tied to, for example, nutritious plants that were found on inaccessible land or species that could simply have been overlooked.

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