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A contribution to the biology of the lime seed bug *Oxycarenus lavaterae* (Fabricius, 1787) (Heteroptera: Oxycarenidae) – a new overwintering strategy?

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Abstract. This paper presents the first observation of the mass wintering of the lime seed bug *Oxycarenus lavaterae* (Fabricius, 1787) on the thuja shrub (*Thuja occidentalis* Linnaeus, 1753) in Poland. Additional information about the biology of this species is also provided.

Key words: true bugs, invasive species, overwintering, *Thuja occidentalis*, Poland.

Introduction

The lime seed bug *Oxycarenus lavaterae* (Fabricius, 1787) is a species whose original range included the western Mediterranean basin. In the 1980s, the species expanded eastwards and northeastwards (Rabitsch 2008), and in 1985, the lime seed bug was recorded in Montenegro (Velimirović et al. 1992). Within the next 20 years, it was recorded in Hungary (1994), Slovakia (1995), Serbia (1996), Bulgaria (1998), Austria (2001), Finland (2003), Czech Republic and Germany (2004) (Rabitsch 2008).

The lime seed bug was first recorded in Poland in 2014 in Rzeszów (Hebda & Olbrycht 2016), and since then has been reported in over 300 localities in our country (Gierlasiński & Taszakowski 2024).

This species is very easy to observe because of the characteristic clusters it forms on the trunks of lime trees (*Tilia* sp.) and other tree species. The clusters are formed in autumn, which is how the lime seed bug hibernates (Marczak 2024).

In October 2023, it was noticed that individuals began to move in groups from the trunk of a lime tree (*Tilia cordata* Miller, 1768) to a nearby thuja shrub (*Thuja occidentalis* Linnaeus, 1753). Detailed observations of this *O. lavaterae* colony were carried out in the following months. The results of these observations are presented in this paper.

Material and methods

Observations of *O. lavaterae colonies* were made on the lime tree (*T. cordata*) and the thuja shrub (*T. occidentalis*) growing nearby in Kochanowice (Upper Silesia, Poland) [UTM CB41]. The colonies were monitored cyclically from 1 November 2023 to 1 July 2024. In the period from 1 December 2023 to 31 January 2024, the temperature was recorded inside the arborvitae bush (Fig. 1A) as well as directly on the bark of the lime tree at a height of about 2.5 m, where the largest aggregation of heteropterans was located (Fig. 1B). The temperature was recorded hourly using an Elitech RC-5 automatic data logger.

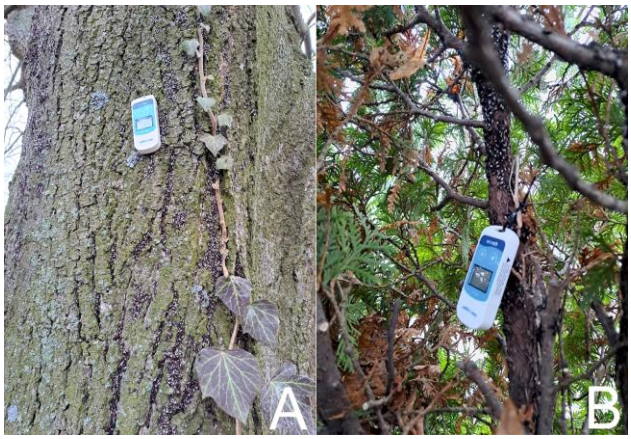

Fig. 1. The temperature automatic data logger: A - inside the thuja shrubs (*T. occidentalis*); B – on the bark of the lime tree at a height of about 2.5 m.

Results and discussion

The colony of *O. lavaterae* on the studied lime tree appeared for the first time in 2020 (Domagała 2022). Since then, these bugs have been constantly observed on the bark of this tree, and single individuals are seen in the summer. From the beginning of September, the number of individuals increases, and characteristic aggregations form, most often at 2 to 4 m above ground level. In the close vicinity of the tree, there are several different shrubs, i.e., thuja and common yew (*Taxus baccata* Linnaeus, 1753).

At the beginning of October 2023, it was noticed that the aggregations of lime seed bugs on the bark of the linden tree began to decrease. The observations carried out showed that, at the same time, a vast number of heteropterans appeared on a nearby thuja shrub. Initially, the insects gathered mainly on the external and sunny parts of the plant, as well as on the cones (Fig. 2). Interestingly, a large number of larval forms were noticeable. During the cold, rainy weather, the individuals hid inside the shrub, most often between dry needles (Fig. 3). After the first frosts, the individuals stopped appearing on the external parts of the shrub. They remained on the shrub trunk until the linden tree bloomed in early June.

Fig. 2. The aggregations of lime seed bugs on the external and sunny parts of the thuja shrub (*T. occidentalis*) – picture taken on 7th November 2023.

Fig. 3. The aggregations of lime seed bugs between dry needles inside the internal parts of the thuja shrub (*T. occidentalis*) – picture taken on 14th November 2023.

It should be noted that not all *O. lavaterae* individuals migrated to the thuja shrub. Some individuals remained on the lime tree throughout the observation period, although it was noticed that the colony changed in location and size. During the winter and cold periods, it chose sunny places, and in late spring, it chose more shady places that were not exposed to direct sunlight. The aggregation was observed on the bark of the lime tree until the tree began to flower and finally disappeared at the time of full flowering, confirming previous observations of this species (Simov et al. 2012, Nevěd et al. 2023).

Sampling by the entomological net of the lower parts of the tree during peak flowering revealed the presence of *O. lavaterae* individuals. However, it was still impossible to determine whether they were aggregating on the flowers or other parts of the plant. Further observations showed that the individuals began copulating immediately after the lime trees had flowered and at the time of fruit set. It was observed that the individuals were feeding on freshly set lime seeds during copulation (Fig. 4).

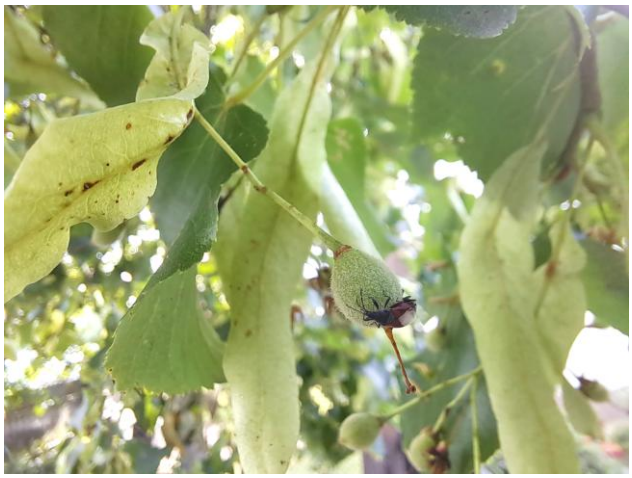

Fig. 4. The individuals of *Oxycarenus lavaterae* feeding on lime seed during copulation – picture taken on 28th June 2024.

The lime seed bugs tend to accumulate on various objects, including walls of buildings and fences (Kuźminski & Mazur 2019; Lis et al. 2019). Adults were observed on over 60 plant species; however, winter aggregations are reported on several plant species only, including the thuja (*T. occidentalis*) (Kment et al. 2006).

The wintering clusters of *O. lavaterae* on the thuja shrub were reported for the first time by Perini and Tamanini (1961). In this case, the shrub probably contained random individuals blown from the lime tree by the wind, and the colony itself survived until February. In the case of this observation, the colony survived the entire winter and ceased to exist when the lime tree bloomed (Fig. 5).

Temperature monitoring showed no significant differences between the inside of the thuja shrub and the bark of the lime tree. During the period of no sunshine, the average temperature inside the bush was only 0.5°C higher than on the tree trunk. Relatively significant temperature differences occurred on sunny days when the sun warmed the bark, reaching as much as 9°C. Literature data suggest that this species is not resistant to low temperatures. While the bugs in the observed clusters can withstand temperatures down to –10°C (Wermelinger et al. 2005), the mortality of insects can reach as high as 99% if the temperature falls below –15°C for several days (Nedvěd et al. 2014).

During the research, high mortality of individuals was observed after several days of frost when the minimum recorded temperature was –15.9°C (10.01.2024). After the frost period, numerous specimens of *O. lavaterae* were observed lying directly on the snow (Fig. 6), and their transfer to room temperature did not cause them to wake up.

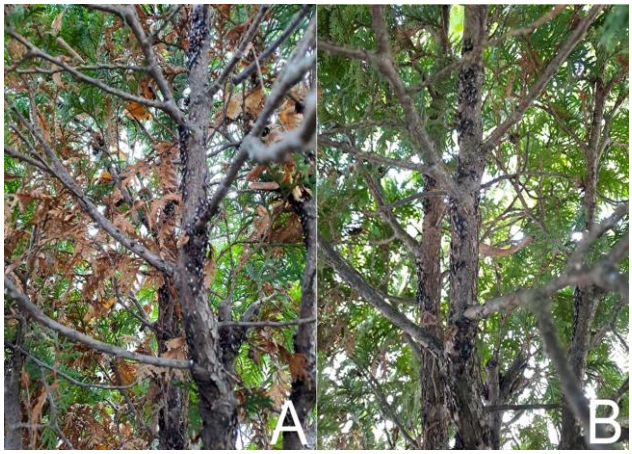

Fig. 5. The aggregations of *Oxycarenus lavaterae* inside the thuja shrub (*T. occidentalis*). The pictures were taken on 14th November 2023 (A) and 14th May 2024 (B).

Temperature is a significant factor influencing overwintering; however, other important factors, such as wind, rain and snow, must also be considered. Undoubtedly, individuals forming aggregations inside the thuja bush are less exposed to these factors than those overwintering directly on the tree bark. Additionally, the bush interior provides more excellent protection against accidental mechanical knocking down than the tree trunk.

O. lavaterae is polyphagous and can feed on over 20 plant species (Arslangündoğdu et al. 2018). The *T. occidentalis* is not included among the food plants of this species, and studies have shown that thuja seeds are not a preferred food source for this species (Kalushkov and Nedvěd 2010). However, it cannot be ruled out that evergreen needles, rather than seeds, are an alternative food source, especially in late autumn when the availability of other sources may be limited.

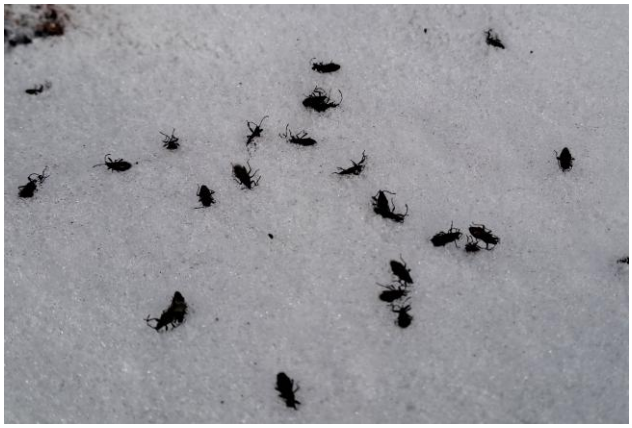

Fig. 6. Dead individuals of *Oxycarenus lavaterae* lying in the snow after a period of frost. Picture taken on 20th January 2024.

Summary

The study showed that *O. lavaterae* can form aggregations and overwinter on the bark of lime trees and inside thuja shrubs. Observations confirmed that individuals leave the overwintering aggregations when the lime trees begin to flower, which also induces mating.

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