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Rapid Communication

Eastward range expansion of the ragweed leaf beetle (*Ophraella communa* LeSage, 1986) (Coleoptera, Chrysomelidae) in Slovenia

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Abstract

Ambrosia artemiisifolia is North American plant species established and invasive in Europe. In 2013 its natural enemy, chrysomelid beetle *Ophraella communa* was first recorded in Italy and Switzerland. Since then, it has been spreading spontaneously and unintentionally with transport across Europe. Until now, it has been recorded only in the southwestern part of Slovenia in 2017 and around Ljubljana in 2019. Here we report the first records of *O. communa* in the north–eastern part of Slovenia. Thirty-four sites with *A. artemisiifolia* stands were inspected for the presence of any developmental stage of *O. communa*. Adult beetles and all other developmental stages were registered at two distinct locations near the cities of Celje and Maribor in 2022. One case of predation of *Zicrona caerulea* on *O. communa* larva was also observed.

Key words: invasive species, Europe, biocontrol, *Ambrosia artemisiifolia*, herbivory, predation, *Zicrona caerulea*

Introduction

When species find suitable niches in new environments, they can establish stable populations and start expanding their area of distribution (Facon et al. 2006). Species monitoring is crucial to track, analyze, explain, and predict species' range expansions (Barbet-Massin et al. 2018). This is especially important for invasive species that often affect the functioning of the existing ecosystems in the areas they invade (Lodge 1993). One such species of interest is the ragweed leaf beetle (*Ophraella communa* LeSage, 1986) originating from North America.

First recorded in Italy and Switzerland in 2013 (Müller-Schärer et al. 2014), this chrysomelid beetle followed its native host the common ragweed (*Ambrosia artemisiifolia* L.) which has been present in Europe since the 19th century (Chauvel et al. 2006). Since then, *O. communa* has been recorded in Slovenia (Devetak et al. 2019), Croatia (Zadravec et al. 2019), Hungary (Horváth and Lukátsi 2020), Serbia (Petrović-Obradović et al. 2020), Romania (Leonardo et al. 2021) and Bosnia and Herzegovina (Vidović et al. 2022). A most recent meta-analysis shows a strong connection between stable *O. communa* populations and the presence of *A. artemisiifolia* (Keszthelyi

Table 1. Climatic data from April to August of the visited locations. The data refer to the period from 2013 to 2022. An asterisk indicates the data refer to the period from 2016 to 2022.

Weather station name	Locations visited	Average air temperature (°C)	Average relative humidity at 14:00 (%)	Average precipitation (mm)
Podgorje	1–4			433
Murska Sobota	5–9	18.1	50.7	429
Ptuj	10–16			451
Maribor	17–19	18.0	50.6	463
Šentilj v Slovenskih Goricah	20–22			515
Lendava	23–28	18.4	49.6	388
Dravograd	29			544
Gomilsko	30			577*
Celje	31–34	17.4	50.4	539

et al. 2022). The spreading of *O. communa* in the Palearctic seems continuous and is due to wind direction and topography features (Keszthelyi et al. 2022).

In Slovenia, *O. communa* was first recorded in 2017 in the western part named Primorska – Slovene Littoral with sub-Mediterranean climate (Devetak et al. 2019). Next year in 2018 it was present further eastward throughout the Vipava valley and in one location on the Karst Plateau (Devetak et al. 2019). By 2019 several more populations were discovered, and the easternmost record was registered 35 km east of Ljubljana (Karrer et al. 2020). The last public record from Slovenia is from 2022 when the beetle was found in Zaboršt, approximately 10 km northeast of Ljubljana (Mihoric 2022).

Here we report two new locations of *O. communa* from north-eastern Slovenia recorded in 2022. We complement visited locations with climatic parameters relevant for *O. communa* (Table 1).

Materials and methods

The study was conducted in the north–eastern part of Slovenia. Thirty-four randomly selected sites with *A. artemisiifolia* were inspected in August and September 2022 (Supplementary material Table S1). Habitats, where *A. artemisiifolia* stands were established, comprised edge habitats surrounding arable fields, forests, rivers, canals, roads, and ruderal or abandoned areas. To cover a wide area in the north-eastern part of the country, we selected sites in the proximity of larger cities Celje, Maribor, and Murska Sobota along the west–east axis. Additionally, two sites were located at the national borders with Austria and Hungary. *Ambrosia artemisiifolia* plants were thoroughly inspected and any signs of herbivory and the presence of *O. communa* adult beetles, pupae, larvae, and eggs were recorded. We were also attentive to potential predators of *O. communa* and recorded such interactions. At each location where beetles were found, voucher specimens were collected by hand and transported to the ecology laboratory where they were identified under a stereomicroscope. The elytral stripe pattern which is unique among chrysomelid species was used for species identification (LeSage 1986) (Figure 1). Specimens are deposited in the dry collection of

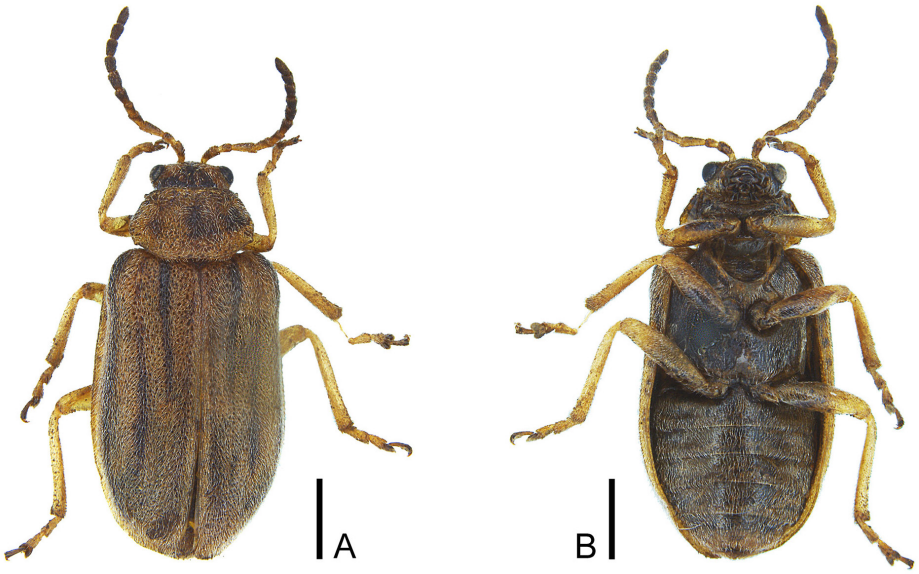

Figure 1. Adult *Ophraella communa* beetle dorsal (A) and ventral (B) view. Photographs by M. Šipek and E. Horvat.

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We also provide climatic data for some of the visited locations, namely average air temperature and average relative humidity at 14:00 which are most important for the development of *O. communa* (Augustinus et al. 2020a). For locations where these data are not available, we provide the average amount of precipitation for reference. Climatic data refer to the period from April to August which is the egg-laying period of *O. communa* (Augustinus et al. 2020a) and are available for the past ten years (2013–2022). Climatic parameters were obtained from Slovenian Environment Agency (ARSO 2023).

Results

Adult *O. communa* beetles and several larvae, pupae, and eggs were found simultaneously in two locations (Figures 2, 3A, B). In the first new location, two adult beetles were found in an abandoned orchard in Hoče (Hoče II, Botanical garden) (46.505671; 15.624175) of which one beetle was found on *A. artemisiifolia*, and the other was found on a grass spike adjacent to *A. artemisiifolia*. One specimen was collected. In the second new location, more beetles were present, at least 20 specimens. This location was represented by a forest edge near the ruderal site in Medlog (Celje II) (46.233966; 15.225533). Four beetles were collected of which three were found on a single *A. artemisiifolia* plant, and one was found on *Helianthus tuberosus* L. adjacent to *A. artemisiifolia* stand (Figure 3C). In both locations, *A. artemisiifolia* plants were visibly damaged by herbivory but no feeding was observed on *H. tuberosus*. Signs of herbivory on *A. artemisiifolia* were present in two additional locations in town Apače (46.698601; 15.897574) and Hoče (Hoče III, Botanical garden) (46.506204; 15.626937), however, adult

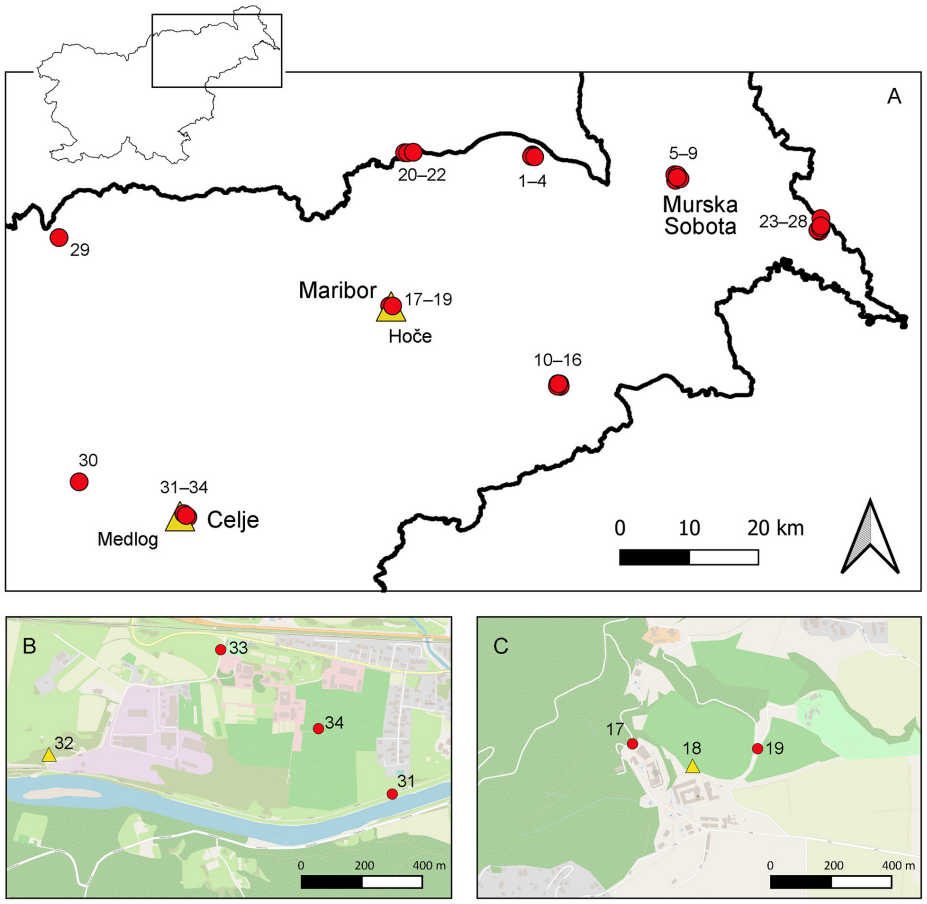

Figure 2. Distribution map of 34 locations with *Ambrosia artemisiifolia* (A) and two locations with *Ophraella communa* confirmed – Medlog (Celje II) (B) and Hoče (Hoče II, Botanical garden) (C). Red circle: no *O. communa* recorded, yellow tringle: *O. communa* confirmed.

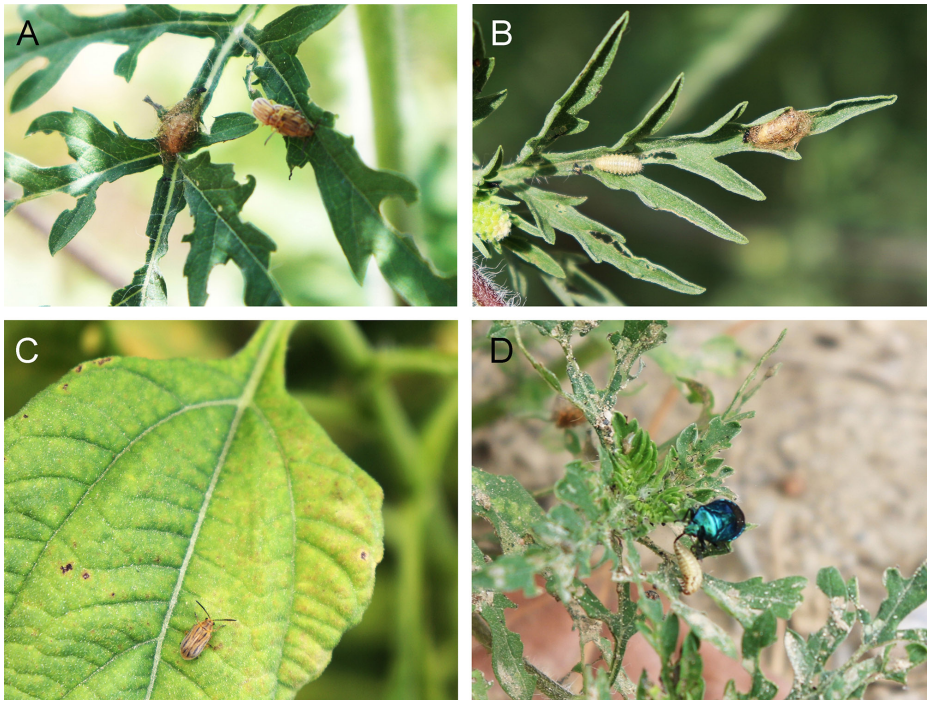

Figure 3. *Ophraella communa* in the natural environment – cocoon with pupa and adult beetles mating on visibly eaten *A. artemisiifolia* leaf (A), cocoon with pupa and larva (B), adult beetle on *Helianthus tuberosus* (C), and adult *Zicrona caerulea* eating *O. communa* larva (D). Photographs by N. Sajna.

beetles or other developmental stages of *O. communa* were not found. In Medlog (Celje II) location we also recorded *Zicrona caerulea* (Linnaeus, 1758) feeding on *O. communa* larva (Figure 3D).

Values of average air temperature and average relative humidity are slightly lower in reported new locations (Table 1) compared to the optimum values which are 23–25 °C and 53%–65% at 15:00 (Augustinus et al. 2020a). All visited locations on average received a similar amount of precipitation between April and August in the past ten years (Table 1).

Discussion

Our results confirm two new locations of *O. communa* developing on *A. artemisiifolia* in north-eastern Slovenia. All developmental stages of *O. communa* were found to co-exist. Our records suggest *O. communa* is dispersing in the north eastern direction in Slovenia by natural means. Adult beetles are most likely dispersing actively through the air. A similar trend was previously shown by Karrer et al. (2020). Our records also suggest an additional route of dispersal to the East and are thus complementing the results of a recent study by Keszthelyi et al. (2022). Dispersal of *O. communa* along highways is very feasible because its food plant *A. artemisifolia* is one of the successful plants rapidly spreading along roadsides (Follak et al. 2018) and is already widely occurring along high-speed motorways (Glasnović and Pečnikar 2010). What is more, turbulences of passing vehicles could help the flying beetles conquer larger distances in a shorter time.

We suggest *A. artemisiifolia* locations recorded in this study are re-visited in the following years and the presence of *O. communa* is reassessed. Moreover, as the species has a distinct elytral stripe pattern it could be monitored with the help of citizen science projects. In fact, first Hungarian record of the beetle was motivated by citizen science (Horváth and Lukátsi 2020). Afterwards a public call was made which resulted in six new locations (Kontschán et al. 2021).

Both studied species are native to North America (Bassett and Terasmae 1962; Futuyma 1990), however, *A. artemisiifolia* is distributed over a larger area than *O. communa* (Litto et al. 2021). This indicates that species have different environmental requirements as has been shown in Europe (Iannella et al. 2019; Augustinus et al. 2020a). Currently, low temperatures and low relative humidity are unsuitable for *O. communa* to establish high-density populations (Augustinus et al. 2020a). Following the prediction by Augustinus et al. (2020a), climatic conditions in Hungary are not suitable for *O. communa*, however, several occurrences were recorded in Budapest (Horváth and Lukátsi 2020; Kontschán et al. 2021). Authors suggest the introduction was accidental by transport and it is not due to natural spreading (Kontschán et al. 2021). Urban areas are generally warmer than the surrounding territory which could be suitable for *O. communa* in areas that would otherwise be considered too cold. The beetle could therefore establish in

other cities because it could be introduced unintentionally by transport (Zadravec et al. 2019; Kontschán et al. 2021). Moreover, *O. communa* is rapidly adapting to cold temperatures in high latitudes which has been detected at physiological and molecular levels (Tian et al. 2022). The species, therefore, has increased chances of spreading northward. On the contrary, results from a recent experimental evolution study by Sun et al. (2022) suggest *A. artemisiifolia* could become more resistant to herbivory by *O. communa* under climate warming.

There is an ongoing debate about whether *O. communa* can be used as a biological control for *A. artemisiifolia* which produces highly allergenic pollen threatening human health. The presence of high-density populations of *O. communa* in Milan, Italy has been linked to reduced pollen production of *A. artemisiiflia* (Bonini et al. 2015). There is a reasonable concern about *O. communa* feeding and developing on other economically important or endangered native species because in a no-choice environment it can complete the development on sunflower *Helianthus annuus* L., closely related to *A. artemisiifolia* (Lommen et al. 2017) and *Dittrichia graveolens* (L.) Greuter (Augustinus et al. 2020b). Whereby, *D. graveolens*, is also a rapidly spreading roadside plant in Slovenia (Frajman and Kaligarič 2009), increasing its Mediterranean distribution by moving inland (Šajna et al. 2017). Although, results so far suggest *O. communa* is unlikely to negatively impact other plants under field conditions where it prefers to feed on *A. artemisiifolia* (Cardarelli et al. 2018; Augustinus et al. 2020b), continuous monitoring of *O. communa* hosts should be encouraged.

Recently, a seed beetle *Megabruchidius dorsalis* (Fåhraeus, 1839), previously known to develop only inside the seeds of *Gleditsia triacanthos* L., has also spread to another host, *Gymnocladus dioicus* (L.) K. Koch (Callot et al. 2016; Temreshev and Valiyeva 2016; György and Tuda 2019). In addition, enemies of *O. communa* may also play a role in biocontrol efficiency. So far, two predators originating from North America have been recorded in Romania to feed on *O. communa* (Leonardo et al. 2021). One such Nearctic predatory stink bug is *Perillus bioculatus* (Fabricius, 1775) (Hemiptera: Pentatomidae), which is known for feeding on eggs and early instars of chrysomelid beetle *Leptinotarsa decemlineata* (Say, 1824) in its native range (Hough-Goldstein and McPherson 1996). In the introduced range, *P. bioculatus* nymphs and adults were observed to feed on *O. communa* larvae, pupae, and adults (Leonardo et al. 2021). Another adult pentatomid predatory stink bug feeding on *O. communa* larvae is cosmopolitan *Zicrona caerulea* (Leonardo et al. 2021; this study). This species preys preferably upon 3rd instar of chrysomelid beetles of the genus *Altica* Geoffroy, 1762 (Phillips 1977). The impact of predation on *O. communa* populations is yet to be investigated.

Most activities of *O. communa* and its interactions with predators in Romania (84%) and our study were observed on *A. artemisiifolia* but some were

recorded on *Xanthium strumarium* L. (Leonardo et al. 2021). *Ophraella communa* is established in Europe and in areas with high population densities it can negatively impact *A. artemisiifolia* populations (Zhou et al. 2014). There are however several other factors playing an important role in this relationship such as climate change (Augustinus et al. 2020a), the rapid evolution of cold tolerance of *O. communa* (Tian et al. 2022), and predators of *O. communa* (Leonardo et al. 2021) that need to be investigated simultaneously.

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Authors' contribution

NS and MŠ performed material collection, all authors contributed to species identification, and prepared figures. EH wrote the original draft and all authors reviewed and edited the final version of the manuscript.

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Supplementary material

The following supplementary material is available for this article:

Table S1. Locations with *Ambrosia artemisiifolia* (and *Ophraella communa*) in NE Slovenia.

This material is available as part of online article from:
http://www.reabic.net/journals/bir/2023/Supplements/BIR_2023_Sipek_etal_SupplementaryMaterial.xlsx